THE WILSON BULLETIN

A Quarterly Magazine
of
Ornithology

Volume 68
1956

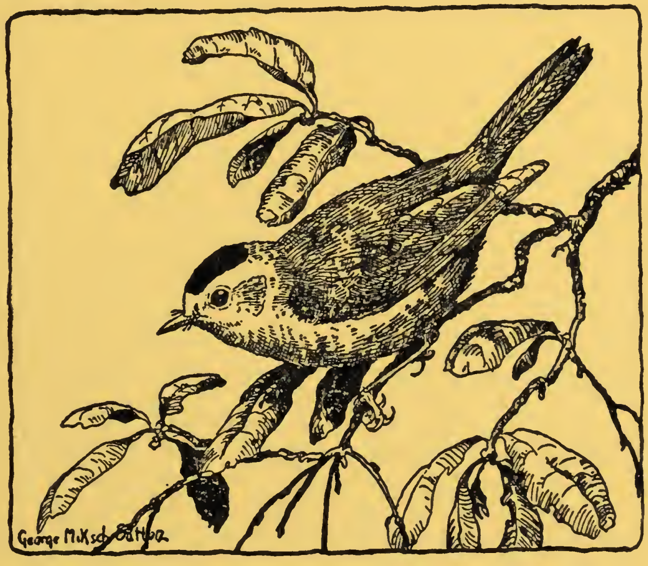
Published
by
THE WILSON ORNITHOLOGICAL SOCIETY

Aj-W

March 1956

VOL. 68, No. 1 PAGES 1–88

The Wilson Bulletin



Published by

The Wilson Ornithological Society

at

Lawrence, Kansas

THE WILSON ORNITHOLOGICAL SOCIETY

Founded December 3, 1888

Named after ALEXANDER WILSON, the first American ornithologist.

President—Burt L. Monroe, Ridge Road, Anchorage, Kentucky.

First Vice-President—John T. Emlen, Jr., Dept. of Zoology, University of Wisconsin, Madison 6, Wisconsin.

Second Vice-President—Lawrence H. Walkinshaw, 1703 Central Tower, Battle Creek, Michigan.

Treasurer—Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia.

Secretary—Phillips B. Street, Route 1, Chester Springs, Pennsylvania.

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. In the United States the subscription price is $3.00 a year, effective in 1951. Single copies, 75 cents. Outside of the United States the rate is $3.25. Single copies, 85 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,

Entered as second class matter at Lawrence, Kansas. Additional entry at Ann Arbor, Mich.

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by The Wilson Ornithological Society

Vol. 68, No. 1 | March 1956 | Pages 1–88

CONTENTS

Male Red-winged Blackbird (*Agelaius phoeniceus*) engaged in "song-spread" display. Photographed by Robert W. Nero, near Madison, Wisconsin, on May 15, 1955.

A BEHAVIOR STUDY OF THE RED-WINGED BLACKBIRD[1]

I. Mating and Nesting Activities

BY ROBERT W. NERO

This study is concerned with the behavior of the Red-winged Blackbird or "Redwing" (*Agelaius phoeniceus*) on a breeding ground near Madison, Wisconsin, during the years 1948 through 1953. Part I describes the behavior related to pair formation, courtship and mating activities. The formation, maintenance, size, and structure of the male territory, female territorial behavior, and behavior of first-year (immature) males will be described in a subsequent issue of this journal. The study is a continuation and expansion of a more general study of this species initiated in the same area by James R. Beer in 1945 (Beer and Tibbitts, 1950) and is part of a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Zoology at the University of Wisconsin (one aspect published previously: Nero and Emlen, 1951).

Grateful acknowledgment is tendered Professor John T. Emlen, Jr., who offered advice and guidance throughout the study. Thanks are due the following persons for aid in various ways: Professors Robert A. McCabe and Joseph J. Hickey; Drs. James R. Beer, Ernst Mayr, Nicholas E. Collias, Ruth L. Hine, Howard Young, Arnold Bakken, Arnold Petersen, Robert L. Strecker, Fred A. Ryser, Frederick Greeley; Mr. Jack Kaspar, Mrs. L. S. Miller, and Miss Margaret Grismer. I wish to give special thanks to my wife, Ruth F. Nero, for her constant support during the years of graduate study. This study was aided by a Louis Agassiz Fuertes Research Grant awarded by the Wilson Ornithological Club in 1952.

Methods

The main study area was a 2.4-acre cattail (*Typha*) marsh on the east shore of Lake Wingra in the University of Wisconsin Arboretum at Madison. This marsh is bordered by red osier dogwood and willow, and is surrounded on three sides by a fairly dense stand of mixed hardwoods. Observations were also made at a feeding and flocking area in Vilas Park Zoo, about one-half mile north of the marsh. Additional records were obtained wherever Redwings were encountered.

Field notes were recorded on 358 days during six breeding seasons, from 1948 through 1953. (Supplementary notes were made in 1954 and 1955.) Observations began each year with the arrival of the first resident males in March and continued until August or September when resident birds (marked) left the area. Most of the photographs were taken by the author

---

[1]Journal Paper No. 32, University of Wisconsin Arboretum.

in April and May, 1955, on several marshes within eight miles of Madison. The photos in Figure 3, however, were taken in July, 1955, in Saskatchewan, Canada, with the aid of Mr. Fred W. Lahrman.

Trapping of adults and immatures was accomplished by means of wire-mesh, treadle-sprung traps baited with white bread. These traps were placed on top of muskrat houses and floating boards, and on top of wire screens which were pressed onto old, standing cattails. Several females were captured by placing a screen-bottomed trap directly on top of the nest when the female had a full set of eggs or young. Individual identification was obtained by the use of combinations of colored plastic "leg" bands. A drop of Duco cement applied within the plastic coil secured the band. From 1948 through 1952, 282 birds were so marked, 175 of these being juveniles. Observations were made with the aid of binoculars from several vantage points within the area as well as along the edge. In 1949 observations were greatly aided by watching from a board fastened between two trees on the edge of the marsh, about 12 feet above the water. This worked so well that in 1950 two towers 12 feet high were erected in the marsh. These elevated platforms permitted close observation of behavior ordinarily concealed by the vegetation.

The Birds

Size of population.—The number of adult males holding territories on the study area during the height of the season (middle of April to middle of June) ranged from about 17 to 25 during the years 1948 through 1953. The number of females with nests during the same period ran from 27 to 50.

Dates of arrival and last appearance.—From 1949 to 1953 previously-resident males (8 to 13 marked males each year) first appeared between March 6 (1950) and March 17 (1952) (average, March 10–11). The last ones to arrive appeared between March 22 (1953) and April 21 (1949). The minimum period for arrival of all the marked residents was 9 days (1953, 9 birds); the maximum, 43 days (1950, 13 birds). The average arrival period was 29.2 days. Certain males were consistently early arrivals, others consistently late. First arrival dates for individuals varied in consecutive years over a period of up to 20 days (average, 13.6 days). Previously-resident females arrived first on April 8 (1952), April 16 (1951), and April 17 (1950). Information on dates of last arrivals of females is available only for 1951, in which year the last marked bird appeared May 7. This gives a period for arrival of females that year of 21 days.

Very few marked birds were seen on the marsh in August, but some were seen on the feeding grounds at Vilas Park during this month. In 1948 a resident female and her young were still on the marsh on August 4;

they appeared to be the last birds present. On August 15 of the same year a marked adult male was seen at the park. A banded young was seen on the marsh on August 6, 1949. Evidence that at least some of the local residents do not migrate until later was obtained in 1951 when two marked adult males were seen on October 22 and 23, respectively, three miles from the breeding marsh. Each male was with a flock of about 50 males.

Annual returns.—Fifty-six per cent of 50 marked adult resident males returned at least once during the period from 1947 to 1953. Each season, from 10 to 22 adult males were present (see Table 1). Marked resident females showed a similar rate of return. Of 48 birds, 56.2 per cent returned at least once during the seasons 1949 to 1953. Table 1 shows the survival of each year's marked population. Of 16 different males, 10 survived five years, three survived six years, and three survived seven years. (Note: two 8 year olds returned in 1954 and a 9 year old bird returned in 1955.) Two females survived at least six years. Some of these birds were banded as adults and may have been older. Davis (1953) reports a life span of 15 years in captivity for the Cuban Redwing, *A. p. assimilis.*

Polygyny.—Polygyny in the Redwing has been recorded by several authors (Allen, 1914:92; Roberts, 1932:306; Linsdale, 1938:140–141; Mayr, 1941:83), although a few observers have reported this species to be

TABLE 1

YEARLY RETURN OF MARKED RESIDENT REDWINGS

The top number in each vertical column is the number of new residents marked that year. Reading down each column one sees the subsequent return of each year's population.

Males

Year	1947	1948	1949	1950	1951	1952	1953	Total Population
1947	11							11
1948	7	10						17
1949	5	5	12					22
1950	2	3	8	7				20
1951	2	2	5	5	7			21
1952	1	1	1	2	3	4		12
1953	0	0	1	2	3	4	0	10

Females

Year	1949	1950	1951	1952	1953	Total Population
1949	15					15
1950	12	32				44
1951	5	14	2			21
1952	2	9	0	0		11
1953	0	9	0	0	0	9

monogamous (Williams, 1940:268; McIlhenny, 1940:85). Redwing matings in this study were occasionally monogamous but were mainly polygynous. Of 25 males for which accurate records were kept, five had one mate each, 16 had two mates each, and four had three mates each. I have no record of a male breeding successfully with more than three females. However, in at least one case where a male had three mates, one female returned for a second nesting, so that four broods were brought off in this territory. Linsdale (*loc. cit.*) working with unmarked birds in Nevada, reported that one male ". . . would have as many as 6 females all actively nesting."

According to Linsdale (*loc. cit.*), "The success of a male in obtaining females in its territory seemed to depend almost entirely upon the suitability of the habitat for nest locations." My females showed a preference for nesting on the edges of the openings within the dense cattail stands. Since not all territories had an equal amount of edge, some might have been more suitable for nesting than others. Linford (1935:37) found that the territories of polygynous Redwing males were twice the size of those of monogamous males, but I found no relationship between territory size and the number of nesting females. In Linford's study, however, the birds obtained the bulk of their food within their territories, whereas my birds obtained most of their food outside their territories.

Allen (1934:136) considered that the male Redwing was not "agreeable" to polygamy because of the great difficulty of running two or three double families each season. He suggested that a male was "satisfied" with one female. However, the males in my study played little part in feeding the young and only a very few birds (three) had more than one brood. Female intolerance of other females may play a large part in limiting the number of females breeding in one territory; a male is rarely able to successfully "court" two females at exactly the same time. Nesting data tend to support this — in most, but not all, cases females within a single male's territory are "out of phase" with each other (see Table 2).

Second nesting.—As Beer and Tibbitts suggested (1950:73) double broods are uncommon in the Redwing in this area. Only three cases of double broods were recorded in this study (in 1949, all successful). In 1950, the year for which the most data are available, 20 marked females had successful first nests, but none of these females returned to the marsh for a second brood. In each case in which females had second broods, they bred with their original mates. A female which arrived on April 17 had fledged young on June 8, and nine days later she had her first egg in her second nest. Another female which left with her young on June 15, returned on June 28 and had her first egg on July 4, seven days later. A third female was feeding her fledged young until June 27 and on June 28 had her first

TABLE 2

NESTING STAGES OF FEMALE HAREM MATES IN SEVEN MALE TERRITORIES ON JUNE 7, 1950

Territory	Female 1	Female 2	Days apart
A	young at 2 days	young at 3 days	1
B	3 eggs	young at 6 days	6
C	3 eggs	young at 5 days	25
D	2 eggs, young at 1 day	young at 4 days	3
E	4 eggs	young at 3 days	12
F	3 eggs	young at 7 days	7
G	4 eggs	2 eggs, young at 2 days	2

egg in her second nest. In two of the above cases the pairs were never separated, the females remaining on or near the territory while feeding the young.

PROMINENT DISPLAYS AND POSTURES

The behavioral characteristics described below include sexual, aggressive, and social posturings. Other sequential displays which are neither as well-defined nor elaborate are discussed under various sections (see Courtship and Copulation). Vocalizations are not completely covered in this study.

Exposed epaulets.—Exposure of the patch of red feathers on the male's wing is a generalized display seen on many occasions, usually in conjunction with other postures or movements. At higher levels of intensity the red coverts may be erected and even vibrated, thus greatly increasing their area and color effect. When a hawk is overhead, when a male trespasses on another territory or is being dominated, or when a male is feeding together with other males on the ground, the red coverts are kept concealed.

Male song-spread.—"Song-spread" designates the behavior of the Redwing during the delivery of the well-known "oak-a-lee" song. Variations of the male display may be seen in Figure 1 (*a*, *b*, *c*, *g*, *h*, *i*). Usually the head is lifted or thrust forward, the tail is spread and lowered, the wings are spread, and the epaulets are raised (see Figure 1*g*, *h*). The head is thrust out with the first note of the song; at the climax, the drawn-out "lee," the tail and wing feathers are carried to the extreme position. The closure of song usually marks the return to normal position, but often the spread display is held for some time afterwards. The extent of song-spread, and other displays, varies with the level of motivation. In extreme or "complete" displays the wing-tips touch the outer tips of the tail, the bird sometimes assuming an almost disk-like form (Fig. 1*h*, *i*). The last phrase of the song is similarly given with varying emphasis. According to Allen (1914: 89) the song ". . . is always accompanied by spreading of the wings and tail feathers and by erection of practically all the body feathers, especially those of the shoulder patches." However, this song is sometimes given with little plumage display (Fig. 1*a*).

Song-spread is given commonly on the territory but it is also frequently given off the territory and before and after the breeding season, though generally without the postural components. Migrating Redwings are in constant song, especially on the roosting grounds. Although song is often given by solitary males, it is given with a greater frequency and extent in the presence of other males. It appears most extensive when directed toward a particular individual. Song is most frequently given while the male is perched but it is also given while in flight. It may at all times, however, be readily distinguished from the "flight-song" described below. Song-spread is given on the territory long before the females arrive, and although it may be given more frequently and extensively in the presence of a female, it appears to be directed mainly toward other males. The presence of a female seems simply to elicit a greater amount of "warning" song.

Female song-spread.—A song-spread display resembling that of the male is commonly given by females (note comparable postures in Figure 1). As in the male, the degree of posturing changes with the intensity of the display. In the "complete" display the bird stands upright, with head raised, tail spread and lowered, with the red-tinged epaulets sometimes erected. The female song, although given with considerable variation, is generally a series of high, shrill and rapid notes, slowing and descending at the end, the last phrase often very sibilant and slurred. It may be rendered "spit-a-chew-chew-chew . . ." or "check-check-a-skew-skew-skew. . ." A more halting and labored call "pee-chee-ta-chee-ta-chee-chee-chee . . ." often leads into the former call and seems to be a more general excitement or alarm call. Song-spread of the female usually is given to other females from prominent positions within her area. Often most of the females present on the marsh may be shrilling or screeching in song-spread to a single female circling overhead. In early May these calls sometimes seem to be the main sound on the marsh, almost eclipsing the songs of the males. Female song-spread has been heard on the study area as early as April 8 (1952), one day after the first females had made their appearance.

Male flight-song.—"Flight-song" is a display given by males which often serves to distinguish territorial birds, although it is given less frequently than song-spread. The full call, always given in flight, is a long, rapid series of notes something like: "tseeee . . . tch-tch-tch-tch . . . chee-chee-chee-chee . . .", (the middle phrase often very nasal in tone, sometimes

---

FIG. 1 (opposite page) Song-spread display, male and female. All photos taken at height of display, and the figures are arranged to show increasing intensity of display. Note comparable postures of the two sexes.


A
B
C
D
E
F
G
H
I
J
K
L

"tank"). Sometimes only a portion of the call is given, and often the number of notes in each phrase varies, but the call is very distinctive.

What is apparently the same display is mentioned by Allen (1914:90): ". . . a sort of scolding song, which is given in the air, with quivering wings, can easily be resolved into: *check, check, check, t'tsheah.*" The "flight song" described by Beer and Tibbitts (1950:67) may be the same thing: "The victory display or flight song . . . is normally given after successfully chasing a trespassing male from the territory. After the chase has been completed the male slows his wingbeat, spreads his tail and 'parachutes' back to his singing perch. During this display he is in continuous song." I have only occasionally observed this display as an aftermath of an aggressive chase. It is regularly given when leaving or returning to the territory, the return flight often being a long, slow glide.

A rapid call which resembles the middle phrase of the flight-song ("tch-tch-tch . . .") is frequently given during sexual chasing, where it appears to be a scolding or vocal threatening. A similar call was heard on other occasions also suggesting an aggressive motivation. For example, on May 21, 1950, a male gave it repeatedly while chasing a Kingbird (*Tyrannus tyrannus*).

Bill-tilting.—Beer and Tibbitts (1950:67) described a posture assumed by males in mutual threat on their territory boundaries which they called the "bluff" or "stretch display." A closely similar display has been observed in several other icterids. For example, Williams (1952:8) called a probably-related display in the Brewer's Blackbird (*Euphagus cyanocephalus*) the "head-up display." Since the most constant characteristic of this display in the Redwing appears to be the raised beak, I have called it "bill-tilting." Prominent aspects of this pose are the stretched neck with raised beak and compressed body plumage (see Figure 2*a*, *b*). Although the epaulets are exposed in this display, they are never erected. Bill-tilting is most commonly given by adult males on their territory boundaries, each moving up, when suitable perches are being used, as if one bird were attempting to avoid the other without giving ground. On one occasion when two males were tilting to each other in a tree, the uppermost bird moved *down* and even hung down to display to the lower bird as the latter moved up. It is also given by females (Fig. 2*c*), immatures and young. It is mainly an intraspecific display, but both males and females have been observed to give it when confronting other species of birds. Females commonly used it in threat to other females (Fig. 2*d*), occasionally to first-year males, and rarely to adult males. Juveniles used it mainly against first-year males. On several occasions aggressive action was observed immediately following bill-tilting.

Male crouch.—The "crouch" is a tense crouching posture assumed by the

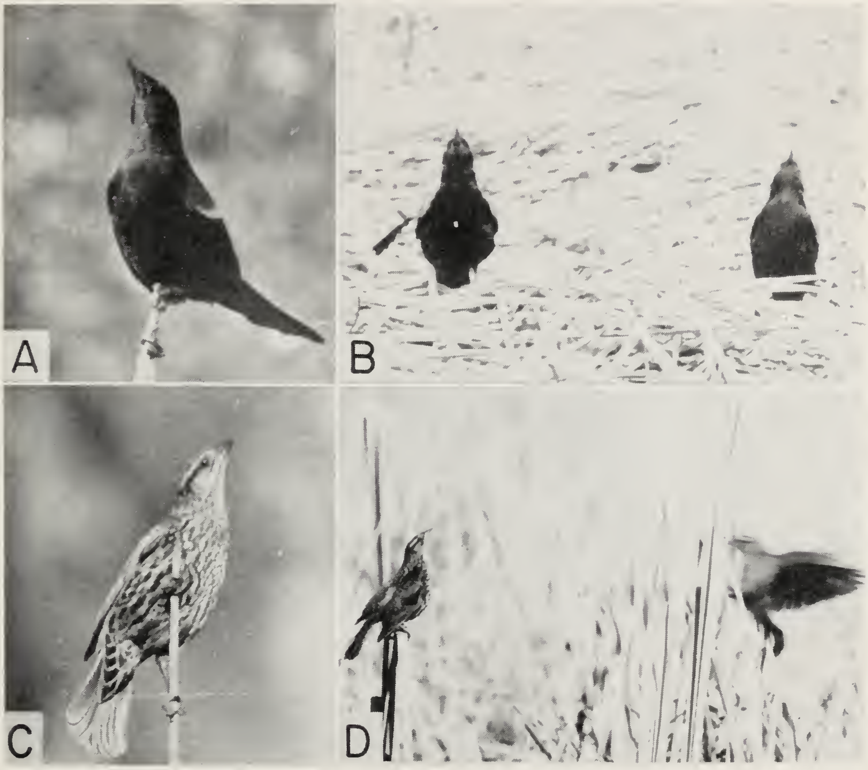


Fig. 2. Bill-tilting display, male and female.

male while perched (see Figure 4*a*). The body is depressed, the head is hunched and held low, the tail is spread and brought downward, and the "shoulders" are held out from the body with the epaulets erected. The wing tips may be crossed over the back or dropped close to the sides. Rarely, the spread tail is momentarily raised. (Males also occasionally held their tails nearly straight up in evident alarm, but nothing comparable to the "elevated tail display" described by Williams (1952:7–8) in the Brewer's Blackbird was seen in the Redwing. Flocks of Redwing males feeding on the ground often keep their tails lifted, a gesture not at all understood.) The crouch posture often is assumed by the male when near one of his mates, usually while facing her, and often preceding further sexual activity. It is also given before new females and before dummy females, but it has not been seen otherwise. Apparently it is an indication of sexual interest.

Female wing-flipping.—During the period of "feeding-the-young" the female frequently raises and flips one or both wings when her mate is

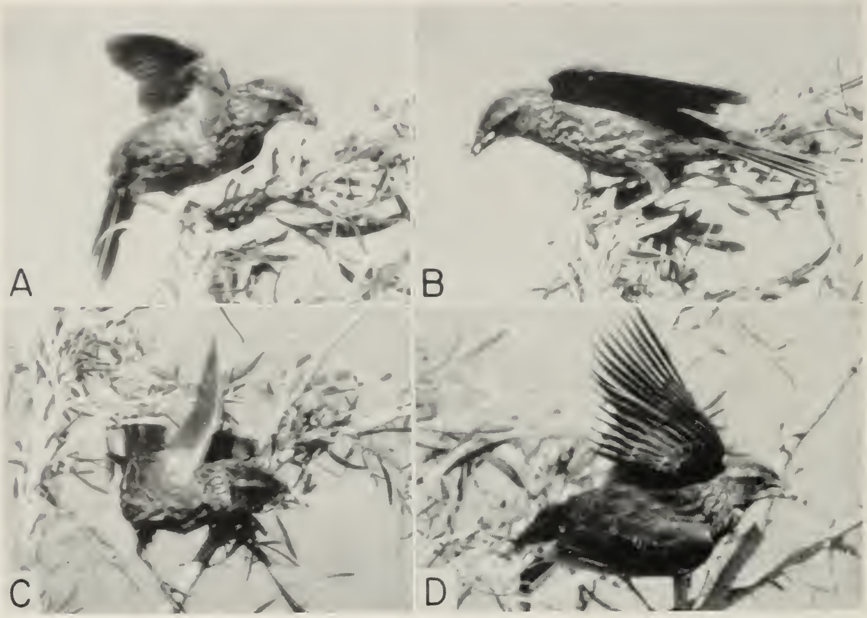


Fig. 3. Female wing-flipping display.

nearby. Such "wing-flipping" involves movement of the whole wing at body level, and, at high intensity, nearly vertically (see Figure 3). In some cases the wing on the side toward the male was held highest. This behavior is apparently not accompanied by any vocalization, but in two cases females held their beaks open. In one instance a female repeatedly bowed "as if to touch her beak to water to drink" and increased her wing-flipping (higher and faster) as her mate approached. Finally the male dived at her aggressively.

Wing-flipping was observed to be given as much as 10 feet from the nest, although it was usually seen at a lesser distance. It was given especially just after a return to the territory with food for the young, and shortly before departure for more food. In one case a female flipped her wings before feeding her young and then kept them raised while actually feeding them. In all of 20 detailed observations of wing-flipping recorded between June 7 and July 16 (1950) the females had young in their nests ranging from one to eleven days old. The mate was always nearby when the female wing-flipped. On a few occasions both male and female have been observed to give a kind of wing-flipping when leading young off the marsh.

One female, whose nest had been transported experimentally into a strange territory, upon being attacked at her nest site by the resident male, raised a wing on the side away from the male as if in defense. At this time she had eggs in her nest. This is the only instance in which a female with eggs raised a wing to a male. Two days later when the eggs had hatched she raised and flipped both wings to the same male. At the Vilas Park feeding grounds several observations were recorded of females lowering a wing to the ground when being approached aggressively by adult males. The latter usually appear antagonistic to strange females on the feeding grounds. In one case when a female was threatened by an adult male she raised and fluttered her wings at her sides in the manner of a young bird begging for food. The above actions by females appeared to be defensive reactions. According to Nice (1937:57), male Song Sparrows (*Melospiza melodia*) attempting to invade a territory often held one wing straight up in the air and fluttered it as they faced the defending resident male. In one unusual case when a female (which sometimes drive off trespassing males) faced a trespassing male she was ". . . all puffed out and *flipping a wing* . . ." at the male (Nice, 1943:187).

A unique observation was made on an unmarked pair of birds on June 22, 1950, at a lake 30 miles from the study area. A male was seen approaching a female which was perched near a nest. The female began slowly flipping both wings quite high and then, apparently coincident with signs of sexual excitement in the male, she lowered her wings, fluttered them more rapidly and went directly into precopulation display (see Figure 4*h*), quivering her wings and raising her tail slightly. The male soon dropped his excitement postures, but the female maintained hers for a few seconds later.

These observations under normal conditions were supplemented by observations in Saskatchewan in 1955 during an experimental attempt to elicit wing-flipping behavior for photographic coverage (see Figure 3). On July 16 five newly-fledged young were placed in a small cage which was set about 12 feet from the camera. For 1½ hours the female attempted unsuccessfully to feed her young, meanwhile giving extensive wing-flipping before the thoroughly-alarmed male. The female frequently raised both wings, often holding the one of the side toward the male higher, and rapidly reversing wings when she changed position. Much of this sequence was suggestive of the behavior of fledglings begging for food (see Nice, 1950:89). The female continued to show wing-flipping as she searched for food as much as 50 feet from the young and the male, but her wings were held highest when the male was near. Sometimes one wing would be raised over her back and tilted over the opposite side (see Figure 3*c*, *d*). When her wings were held up and shaking, her posture resembled the "elevated wings" of the courting male (Figure 4*c*). In extreme display her wings were raised over her back until they touched and were then directed toward the male, sometimes by tilting or bowing. The male seemed to show some aggression to the female at this point and once raised his wings while pecking toward his displaying mate.

Wing-flipping by the female seems to be an indication of her concern with "feeding-the-young." Just as the male simulates female nest-building behavior during courtship (see Symbolic Nesting) and in moments of anxiety during that stage of their cycle, so the female simulates the behavior of hungry young.

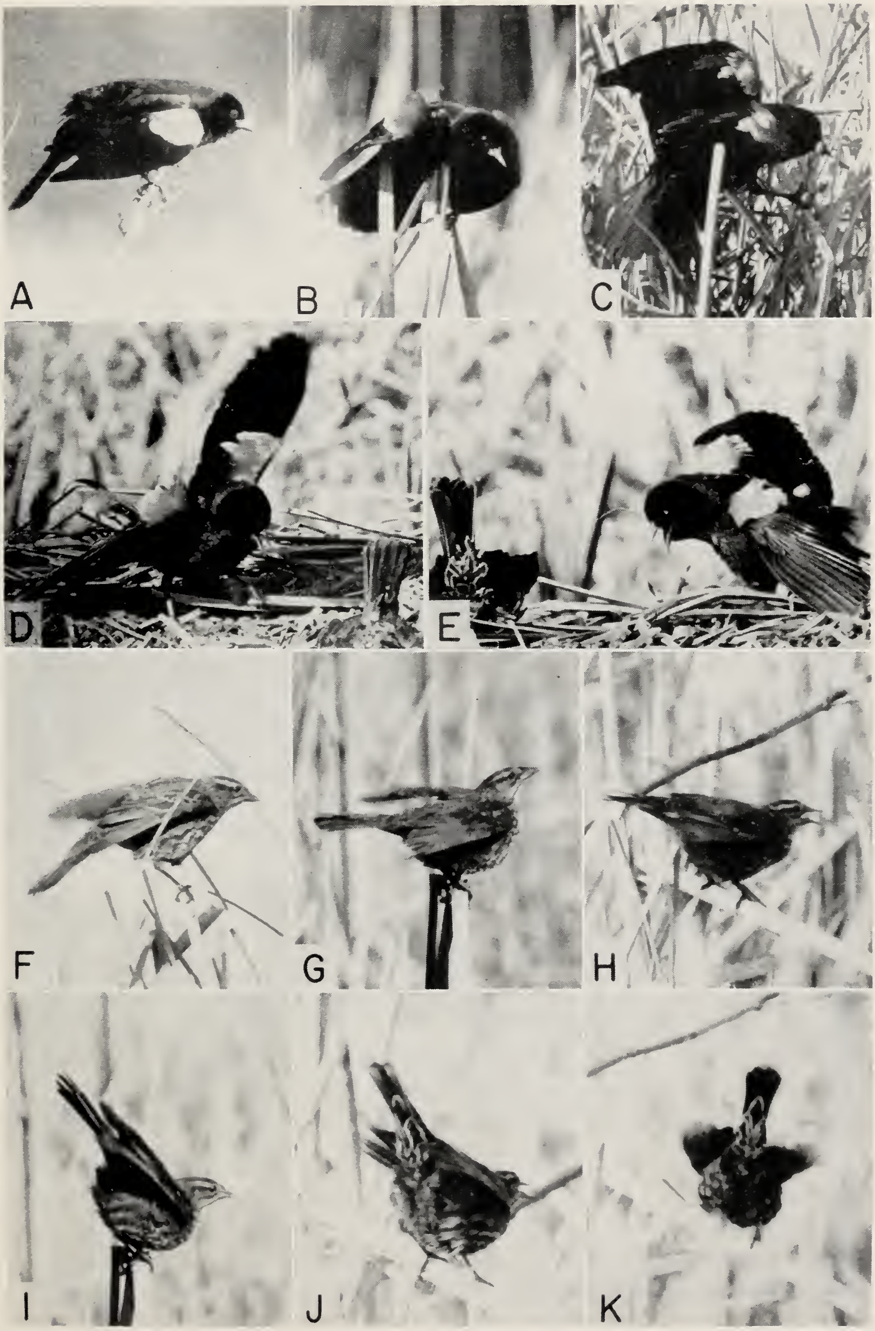
The Pairing Bond

In the Redwing, as in the majority of passerines, the sexes form a bond for the breeding period only. In many species the members of the pair remain together until the young are self-sufficient, but Redwings appear to separate as soon as the female leaves the territory with the young. This must be the case when the male remains on his territory with his other females, but even monogamous pairs apparently separate. Individuals of either sex have been observed caring for young off the territorial grounds, but I have never observed a marked pair together caring for their young off of the male's territory, or at least very far from it. The pairing bond evidently lasts only while the pair is attached to the territory. I made many unsuccessful attempts to observe breeding pairs feeding together outside their territory. Mated pairs only infrequently left the marsh together to feed (the male usually returning first), although males often left in small groups and these birds sometimes fed close together.

In the Redwing the pairing bond does not appear to carry over from season to season as it does in the Brewer's Blackbird (Williams, 1952:9–11). Several of my returning females remated with their former mates but others mated with other males even though their previous mates were present. Nevertheless, females which reassociated with former mates seemed to establish themselves with less effort than did those which acquired new mates.

In Redwings it is well-known that the sexes tend to remain separate throughout the non-breeding season. Males revert to flocking behavior as soon as they quit their territories. My marked males were often seen associating together with other adult males on the Vilas Park feeding grounds in late July and August. In one unusual case a male cared for two of his young until they were 36 days old; during the last nine days of this period he was observed on the feeding grounds in loose association with a flock of males. Females also flock together at this time and move to the uplands with the majority of the young.

Fig. 4. (opposite page) Sexual displays, male and female. Figs. *a-c*: male "courtship"; *d-e*: male precopulation; *f-k*: female precopulation, showing increasing intensity.


A
B
C
D
E
F
G
H
I
J
K

Arrival and Establishment of Females

Arriving females are generally fairly quiet and may only give soft "check" or "prit" calls. Single birds or small groups circle in the air over the marsh, or perch nearby and sit quietly or give frequent tail flips until approached by males. Usually the appearance of a new female alerts the males within several hundred feet and various short calls, such as a "check" or soft "ticka-ticka" or shrill "tseee" are given. Some males may sing and fly down to their respective territories; some may stay up on their perches; others may fly up and perch near a female. If a female remains up in a tree, then the males, perhaps several of them, fly up and perch near her, slowly hop along the branches toward her (usually with erect epaulets), and then fly down with song-spread to their territories. Often the females flee at the approach of the males; the latter sometimes fly after them for several hundred feet before returning to their territories. Sometimes these females circle the marsh before flying away and occasionally they suddenly dive into the cattails.

When a female lands in the cattails all the males nearby usually move up to their borders nearest the female and perform a song-spread broadly (Fig. 1*g, h, i*). The holder of the territory on which the female lands often approaches to within a few feet of her to do this and then displays for several seconds after the cessation of song (Fig. 4*b*). This "after-song" pose is sometimes accompanied by a soft-whimpering "ti-ti-ti-ti-. . ." On some occasions males held their wings spread before they sang. At this time there may be comparatively little song from the holder of the territory. If the female approaches the male he sometimes drops down to the base of the cattails, often down onto the early spring ice, and struts around with wings extended laterally, sometimes rapidly vibrating them, while giving the call mentioned above. Sometimes the extended wings may be partly raised. This display was also given immediately after song-spread with the male perched on the cattails. A similar posturing was observed when males approached a female dummy. In repeated observations of this display before a dummy, the males walked rather stiffly with raised rump feathers and lowered head, occasionally pausing to rest or to give song-spread. This display is similar to part of the male precopulatory display (Fig. 4*d, e*). It may be considered an indication of a high level of sexual excitement.

Similar displays were also given on several occasions to other males early in the season before any females had arrived On March 6, 1951, an adult male at least three years old repeatedly held his wings outspread and quivering while giving the "ti-ti- . . ." call. This display was given alternately with full song-spread and erect epaulets to approaching flocks of male Redwings, as well as to approaching individuals, including one first-year male. From March 12 to 27, 1952, several different males were observed giving this display to other males. It seemed especially to be directed by residents toward new males, which often came in without song and with epaulets more or less concealed. These observations suggest that responses in the male which are normally geared to the female may be set off momentarily by movements or postures in other males which in part resemble or are suggestive of female characteristics. However, this does not imply an outright failure of sex-recognition.

Females sometimes flew in quietly and remained perched near males without making any apparent sound or motion, appearing quite relaxed. Although these females might evoke a display in the male they sometimes flew away quietly afterwards without being chased. Established females occasionally flew into the marsh without arousing any special interest from the males which were apparently able to recognize them as one of their own or a neighbor's mate. In many cases formerly-resident females appeared to arrive at the marsh late in the evening after most activities had ceased. A few which were actually observed dropped right down into the cattails with little hesitation. These females were often found within an hour after sunrise the next morning sitting quietly on a male's territory, behaving like established females, i.e., they stayed on the territory and sang to passing females. Some females showed much "tail flashing," that is, rapid spreading and closing of the rectrices, sometimes accompanied by slight movement of the primaries. (This occurs in both sexes, but is especially prominent in females). Rarely, females visited several territories before finally settling in one, even though they sometimes had remained for several days in one territory. This was regarded as very unusual behavior since ordinarily if a female remained for one day in a male's territory she kept that position. Females which were probably transients (or young?), however, often visited several territories in rapid succession.

Once a female has settled on a male's territory and has become paired she may receive little attention from him, particularly if she remains low in the cattails and quiet. However, her quarrels with other females settling within the territory nearly always bring forth aggressive interference by the male. At times the female follows the male around as he shifts about in territorial defense. She may alight a few feet from him and slowly move toward him, upon which the male usually retreats. The newly-established female may also move toward an adjacent male in the same way for a few days, but in this case she is apt to draw an aggressive response from which she retreats. At other times the male shows an interest in his mate by diving at her, by giving various displays near her, and by sometimes following her off the marsh. Occasionally males followed their females as they circled high over the territory or marsh. These flights were usually silent and were seldom accompanied by other birds. Generally the male keeps himself between his mate and the neighboring males, meanwhile giving song-spread, especially when they approach his borders. He is always active in driving intruders from her vicinity. Such behavior may be seen throughout the season.

Pair Formation

Pair formation apparently begins (or actually occurs) when a female enters a male's territory. The male appears to assume a proprietary interest in a female which stops in his territory and suitably stimulates him. In several cases when a newly-arriving female which had briefly visited one territory entered another, the owner of the first territory dashed into the next territory to bite or to strike her. These reactions were repeated several times under experimental conditions in which a female dummy was placed in one territory and then moved to another. The first male persistently trespassed in order to strike the dummy in spite of vigorous attacks by the second male. The male thus appears to "claim" the female from the first moment, but the latter's interest appears to be mainly in potential nest-sites. Newly-arrived females sometimes fought hard and long to keep other females from encroaching on their territories.

Williams (1952:9–11) believes that pair formation in the Brewer's Blackbird occurs gradually over a long period right up to nesting. Males and females remain in mixed flocks throughout the non-breeding season, and as the breeding season approaches they begin to show signs of pairing, i.e., they walk about together and the males guard certain females. In Redwings, pairing behavior is *inconstant* at first, gradually becoming more constant as "true" pairs form. Former pairs often reassociate and these show less *inconstancy* than do new pairs. Inconstancy in the Redwing during the period preceding nesting is probably held to a minimum by the territory system. Females attached to one male usually are driven out of adjacent territories by the occupants; moreover, once a female has chosen an area for nesting she shows little inclination to search elsewhere. There is thus little wandering except on first arrival. The concept of gradual pair formation therefore cannot be applied to Redwings. However, some strengthening of the bond undoubtedly occurs through association during the ensuing days of breeding, although it probably never reaches the level of that shown by the Brewer's Blackbird. The stronger pairing bond indicated in the latter species probably results from the longer association of the pair.

Courtship

Symbolic Nesting

"Symbolic nesting" or "symbolic building" are terms used by Nice (1943:

178–179) to describe the manipulation of nesting material by the member of a pair which does not ordinarily help construct the nest, or "unnecessary" handling by the other member (or both, if both build) prior to actual building. Such behavior is characteristic of courtship in many species, from grebes and cormorants to songbirds. According to Nice (*loc. cit.*), although the female Song Sparrow alone builds the actual nest, young males (2 to 3 months old) show nest-*molding* behavior, and adult males sometimes carry nesting material, particularly during the preliminary stage prior to nesting. Both sexes in this species indulge in symbolic nesting, but the male does so more frequently than the female.

Symbolic nesting occurs in both sexes in the Redwing, but it is more pronounced in the male. Since it is also somewhat difficult to differentiate between symbolic nesting and the onset of "real" nesting behavior in the female, I shall refer mainly to the male's activities. His sequence of behavior has been grouped under the terms *symbolic nest-site selection* and *symbolic nest-building* (the former leading right into the latter). This behavior was observed mainly from the arrival of the female on the male's territory until coition and subsequent egg-laying.

Symbolic nest-site selection.—In general, the male "crouches" near the female (see Figure 4*a*), gives song-spread, then flies to a clump of cattails to which he clings, while holding his wings up over his back ("elevated wings," Figure 4*c*). Sometimes he holds this posture for several seconds and may glance back over his shoulder toward the female which often flies down near him. If the female comes, he may leave her to fly back to his perch; but more often he slowly works through the cattails, or *crawls*, still holding his wings partly upright (Fig. 4*c*). Then he stops, *bows* with beak between his feet and bites at the nearby cattail blades or breaks off bits which he manipulates in the manner of a female building a nest. Often the female quietly follows him through the same tortuous path and watches him. This entire sequence, or portions of it, may be repeated many times. Usually this behavior is given to the mate, but on two occasions males gave fragments of it before strange females which flew low across their territories.

The male's flight to the clump is slow and usually appears awkward, the wing-beat being below body level. Sometimes a male will fly from clump to clump continuing this strained flight. A few observations of Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*) made by me in 1955 convinced me that a pattern of behavior similar to symbolic nest-site selection in the Redwing occurs in that species. Wetmore (1920:403) stated that as the male Yellow-headed Blackbird started toward the female the ". . . wings were brought down with a slow swinging motion and were not closed at all . . ." Ammann (1938) also noticed this kind of flight in this species and pointed out how noticeable the white wing-patches were at this time. This is apparently the kind of flight described by Howard (1929:9) as expressing sexual excitement. He states: "Two forms of sexual flight are common in bird life: one like the flight of a butterfly, the other like that of a moth. In the former the wings are fully expanded and slowly flapped; in the latter, partially expanded and rapidly vibrated. In both forms the bird travels slowly."

As the Redwing male hits the clump he commonly utters a low, harsh, buzzing "hahh . . ." or "shhh," the "growl." a call often given in threat when harassing other species, immature males, occasionally his mates. and other females (?), but apparently not other adult males. (Females sometimes emit a similar call when driving off other species.) This call is sometimes quite long and is given with open beak, the beak sometimes being held open for a short time afterward. Although generally a low sound, it is quite audible and may be heard from at least 100 feet. Although it may be given at any time during the sequence outlined above, the growl is usually given as the male peers into the cattails, either from the outside of the clump or as he crawls and bows within. On one occasion a male came up out of a clump and faced his mate while giving this call.

While the male clings to the clump his wings may be held completely erect, sometimes even touching over his back; but at other times they may be only slightly elevated and slowly flapped, or held out with only the tips shaking. In one case a male raised and flapped his wings successively higher and faster as his mate approached him in flight. This observation and others suggest that the higher position indicates a greater intensity. In one unique case a male which appeared to be unusually excited during an intense elevated-wing display, uttered a series of short, high-pitched notes which increased in tempo and pitch to the end.

The male's use of the threat call or growl during symbolic nesting recalls the use of similar calls in other species. A "harsh rasping note" was given by a male Mockingbird (*Mimus polyglottos*) when it went into a potential nest-site during symbolic nest-building (Laskey, 1933:31). Tinbergen (1939: 25) stated that during the pre-oestrus period of the female Snow Bunting (*Plectrophenax nivalis*) the male and female frequently go about together inspecting little rocky crevices of the sort in which the female eventually builds her nest. "When entering a hole the male often uttered a sound that to us was indistinguishable from the sound that was heard from a threatening bird. We did our best to detect a possible difference, because we did not expect to hear the same call in such widely different situations, but we must confess we did not succeed."

Occasionally song-spread was given during the sequence. When this occurred, the sequence appeared to be momentarily interrupted. In several instances males came up out of the cattails to sing and then crawled back and resumed their displays. In one instance a male continued to display when an immature male dived at his female which was watching nearby.

Lack and Emlen (1939:226) state that the male Tricolored Redwing (*Agelaius tricolor*) would often ". . . flutter slowly down into the cattails until out of sight. . . The female sometimes followed, and his behavior presumably influenced her selection of a nest-site and mate." Although male Redwings often went repeatedly to a particular clump to display, I did not observe any case in which a female built her nest in the "selected" clump. In several cases, however, the nest was built within a few yards thereof.

Symbolic nest-building.—Ordinarily symbolic nest-site selection ends with the bowing movement in which occasionally the male bites at the nearby cattail leaves or breaks off bits with which he "plays." However, more elaborate sequences of nest-building have been observed. Two such cases were recorded in May, 1950. In one case a male was courting a female which had been present on the marsh for several days, but which had just come to his territory. This male displayed at the nearly-completed nest of another of his females which was absent at the time. While the new female watched, he went inside the nest and then went through the motions of building, forming it with his chest, lowering his head into it, and picking here and there, meanwhile holding his wings erect. After two minutes the female moved away from him. He went near her and then she followed him back near the nest and again he went through the nest-building behavior, although this time not in the nest. The female moved away from him again and then he once more led her back. Finally he went up to the nest and, while the female watched, he lowered his head into it and then reached outside and appeared to pull in material. This observation is of special interest since in many hours of watching I have never seen the male take part in actual nest-building. A report by Hackett (1913) stating that the male helps construct the nest may possibly have been inspired by an observation of a male engaged in symbolic nest-building.

In a second case a different male, after leading a new female into a clump of cattails, broke off some dead leaves and pulled at a piece of string that had been left there in trapping operations. When the female moved away from him, he went to her, bowed with raised wings and erect epaulets, and then climbed up to an unfinished nest nearby, where he gave the growl call. Then he reached into the nest and picked at the nest material. Later he went through the same behavior with this female in a cattail clump at a different place in his territory.

Such behavior by the male in a species where only the female builds the nest seems remarkable. However, a few cases have been reported in which males of such species apparently constructed complete nests. Dawson (1921: 92) reported that a male Hooded Oriole (*Icterus cucullatus*) ". . . was observed day after day as he constructed a nest on the underside of a palm leaf." And Nuttall (1832:157) tells about a male Baltimore Oriole (*Icterus galbula*) building a nest. Schantz (1937) watched a male Song Sparrow construct a complete nest in which a female later nested. In referring to the latter case, Nice (1943:211) said that the latent nest-building ability, appearing in most male Song Sparrows in the symbolic manipulation of material, developed through practice when this male was mateless for two years.

Symbolic nesting by the male apparently occurs in several other icterids besides the Redwing and the orioles mentioned above, in which the female alone builds the nest. Petersen and Young (1950:467) reported that a courting male Bronzed Grackle (*Quiscalus quiscula*) ". . . repeatedly picked up and moved a bit of paper with his bill, replacing it in a crude nest consisting of a few twigs in a crotch about 25 feet above the ground. He frequently lifted his wings, spread his tail, and '*skreeked*'. The female, perched about a yard away, also held a scrap of paper in her bill, but she remained more quiet than the male." Williams (1952:12) states that in the Brewer's Blackbird "The male of the pair is sometimes the first to hold nesting material in the bill, but he rarely places it at a site." Although symbolic nest-building has not been observed in either of the meadowlarks, a hand-raised male Eastern Meadowlark (*Sturnella magna*) showed nest-molding behavior (Nice, MS, 1950). Mrs. Nice also observed nest-molding behavior in a hand-raised male Redwing at 39 days of age (1950:88). Ammann (1938:116) quoted Wheelock as stating that "she has known the male Yellow-headed Blackbird to make a pretense at nest-building a few feet away from the real cradle . . ." And Ammann (*loc. cit.*) observed males of this species ". . . casually pecking at a few strands of nesting material attached loosely to the reeds near finished nests." Although the parasitic Brown-headed Cowbird (*Molothrus ater*) does not build a nest, Laskey (1950:160) twice saw a courting male Cowbird ". . . toying with a dead leaf or a piece of debris while bowing to a female."

Symbolic nesting in male Redwings as well as in these other species may represent vestiges of functional behavior in a time when the male played an active part in the actual activities of selecting a site and building a nest. Although in nearly all of the Icteridae the nest is built solely by the female, in cowbirds we find at least one exception (Friedmann, 1929). The most primitive species, the Bay-winged Cowbird (*Molothrus badius*), is nonparasitic but mated pairs locate and fight for the possession of nests of other species of birds which they then occupy. Usually some alterations of the nest are made, and when no nest is readily available they build their own, the *male* generally building more than the female. And in the Shiny Cowbird (*Molothrus bonariensis*), which is parasitic and which normally does no nest building, both male and female have been seen attempting to build. According to Beecher (1950:52) the cowbirds are very close to the original primitive form, the buntings or Emberizinae, from which he believes the blackbird sub-family (Icterinae) has arisen.

Possible functional significance of "symbolic nesting" behavior.—In 1953 I observed that when an incubating female was frightened from her nest by my jerking of the nearby cattails by means of a piece of string, her mate would often come in response to her alarm cries and fly down near her nest. When he withdrew the female would return to her nest. This happened repeatedly. Sometimes when the male was absent or otherwise occupied and did not come to her calls the female would fly about, scolding for several minutes, and would fail to return to the nest until the male arrived. The male's visit nearly always sufficed to quiet the female. Once when a female which was building the basal portion of a nest became greatly alarmed by the click of a concealed camera, her mate flew down near the nest and finally hopped right into it and peered about. These actions of the male somewhat resemble his behavior in symbolic nesting and suggest that the latter may have a "reassuring" effect upon the female.

This interpretation is substantiated by observations of symbolic nesting in "non-courtship" situations. During the egg-laying period the female is irregular in incubation and the male, which sometimes appears restless or agitated when the female is not on the nest, may give symbolic nest-site selection near the nest in what suggests an apparent attempt to induce her to return. On May 28, 1950, in the morning of which a female laid her first egg, her mate was watched from 5:15 to 6:30 p.m., while she was absent. Toward the end of this period the male flew back and forth in his territory and finally flew to the nest and "craned his neck to peer in . . ." From 8:00 to 9:00 a.m., and from 6:00 to 7:00 p.m. the following day, the male went through complete sequences of symbolic nesting (even to the breaking of cattail leaves) near her, but especially near her nest (containing two eggs). He visited the nest in conspicuous display attitude as if in an attempt to lead her into it. On the next day she laid her third and last egg, and again, from 5:00 to 7:25 p.m., her mate repeatedly went through "nest-site selection" behavior. When she finally settled on her nest he flew to the other end of the territory, where he remained perched and quiet. On succeeding days she kept on her nest in more or less constant incubation and the male no longer showed the "courtship" behavior. In another case (May 22, 1950) a female was kept off her nest by a trap which had been placed directly over it. The male went down near her, suddenly bowed, elevated his wings, and entered a dense clump of cattails where he bowed and manipulated cattail blades while the female watched from nearby.

In many species during the egg-laying period or incubation period the male performs nidocentric displays directed toward its mate. Nice (1943:224–225) offers this explanation: "A bird instinctively responds to certain situations; the situation eggs-in-nest implies mate-on-nest-much-of-the-time; if the second element in the situation is not functioning he is disturbed; if his mate has disappeared he starts to sing (for her or another); if she is around, he tries to get her into the appropriate situation."

Sexual Chasing

Sexual chasing or pursuit of the female by the male during the courtship period has been described for many song-birds (Howard, 1920, 1929; Tinbergen, 1939) and for several non-songbirds (Hochbaum, 1944; Sowls, 1951). It has been noted in the Redwing by Nuttall (1832:171); Audubon (1834:349); Allen (1914:91); Linsdale (1938:141-142); Mayr (1941:53); Smith (1943:190); Mehner (1950); and Beer and Tibbitts (1950:68). Sexual chasing has also been observed in the following icterids: Bobolink, *Dolichonyx oryzivorous*, (Nuttall, 1832:187); Brewer's Blackbird (Williams, 1952:10–11); Brown-headed Cowbird (Friedmann, 1929:158); Yellow-headed Blackbird (Ammann, 1938:102–103); and Wagler's Oropendola, *Zarhynchus wagleri*, (Chapman, 1928:136); but apparently it does not occur in the highly-colonial Tricolored Redwing (Lack and Emlen, 1939:227).

More than 100 sexual chases were recorded in detail in this study. In nearly every case these chases involved birds which had already paired. Howard (1929:70), in discussing sexual chasing (his "sexual flight") stated: "Sexual flight is a certain indication of pairing; I have never known a female desert a male once it had occurred." Sexual chases between pairs of Snow Buntings usually indicated that the birds ". . . had mated and that the female would stay with the male she had chosen." (Tinbergen, 1939:21). Sexual chases in the Brewer's Blackbird are believed to be part of the mechanics of pair formation ". . . since they occur more frequently in pairs forming for the first time and apparently cease when the pair is formed." (Williams, 1952:10–11). Pair formation in this species, however, is considered to be an extended process occurring over a considerable period prior to nesting (see Pair formation).

Sexual chases in the Redwing are usually marked by aggressive pursuit by the male and rapid elusive flight by the female. Females occasionally flew into obstructions and even into the water. Sometimes the female stays within the male's territory, but often she flies out over neighboring territories. Occasionally these flights take her far from the male's territory, but she usually returns at the close of the chase. Sex chases are often preceded by signs of sexual excitement in the male, and in most cases it is the male who first springs into action, suddenly diving at the quietly-perching female. In some cases, however, it seems to be precipitated by special situations which bring the female into sight of the male. For example, the male seems to be stimulated by the appearance of the female carrying nest material, particularly when she carries it for a greater distance and more openly than is ordinary or necessary. Females in conflict call forth aggression by the male, and this may lead to sexual chasing. Various calls of the female, or simply her arrival on the territory after an absence, may evoke a sudden chase.

The ending of a chase is sometimes as sudden as its beginning, the participants often stopping shortly after they have begun. Usually the male is the first to stop and, as soon as he quits, the female stops fleeing, often landing in sight of the male and usually on his territory. The extreme development of a chase occurs when the male overtakes and hits or catches the female. This may occur in the air or on the ground, either on or off the territory. In seven observed cases the male hit the female or seized her by the rump feathers. In one case a male caught the female in the air and held onto her while both birds fell together some 40 or 50 feet down into the marsh. Hochbaum (1944:42) saw this occur once in Mallards (*Anas platyrhynchos*) and once in Pintails (*Anas acuta*). A male Redwing sometimes held a female by the rump feathers for several seconds while she struggled to escape. On one occasion a male was seen holding a female in this manner for over 30 seconds while she struggled to free herself. In another unusual case a strange male which intruded on a territory to chase another's female, caught her by the rump feathers and then momentarily stood on top of her (female response not apparent). Seizure of the upper tail coverts or the rectrices of the female during sexual chasing has been described for the Reed Bunting, *Emberiza schoeniclus*, (Howard, 1929:7), the Snow Bunting (Tinbergen, 1939:21), and the Canvasback (*Aythya valisineria*) (Hochbaum, *op. cit.*:29).

Biting or seizing of the rump feathers was also seen under experimental conditions. Males which had courted a mounted female in their territories repeatedly flew after it and bit or seized it by the rump feathers when it was placed in a neighboring territory. Noble and Vogt (1935:280) placed a female dummy before a Redwing male on his territory and noted that ". . . he flew back to the female mount and attempted copulation. He then pecked this mount at the base of the tail, both above and below, before again attempting copulation. . . When the male did not evoke a response on the part of the female mount, he again resumed the cloacal pecking until he knocked the mount to the ground." Only female mounts were so pecked and the authors interpreted such pecking as ". . . apparently a sign of annoyance on the part of the male." (In a similar experiment of my own in June, 1955, a male approached a female dummy which was set up in precopulation attitude in his territory, displayed to it, mounted, showed annoyance and pecked vigorously at the rump and cloaca. "Annoyance" behavior was accompanied by a low "tch-tch-tch . . ." call similar to the call given at the onset of many sex-chases [see below]. In another instance in which a freshly-shot female was propped up with the aid of wires so that the cloaca was clearly visible, the male approached and pecked earnestly at the exposed cloaca. Such behavior may be substitute or outlet behavior for sexual excitement, and there may possibly be some stimulation to the female in these attacks on her cloacal region.

There is some suggestion that female Redwings may threaten strange males which attack them, and in two unusual cases, females apparently momentarily fought with their own mates (May 29, 1950; May 12, 1951). Ammann (1938:102–103), states that when occasionally a male Yellow-headed Blackbird caught a female after a sexual chase the female vigorously resisted the male's attempts to copulate. Tinbergen (1939:21), in describing sexual chasing in Snow Buntings, says that the ". . . female tried to escape and fought with great perseverance" with her mate. And Howard (1929:22) notes that Yellow Buntings (*Emberiza citrinella*), at the conclusion of a sexual chase, may face each other in the air, apparently fighting. Whatever the outcome of a Redwing chase, both members of a pair might be sitting quietly side by side seconds after its end. Similar behavior was observed in Wagler's Oropendola by Chapman (1928:136).

Copulation was never observed as the immediate end of a sex chase in the Redwing. However, on May 25, 1950, a male engaged his female in a sex chase and then, two minutes later, flew up to her again and mounted in apparent copulation, although she showed no signs of sexual readiness beyond sitting still. Eight minutes later, however, she showed extreme sexual readiness (complete precopulatory behavior) and copulation then clearly took place. In his final approach to the female the male's posturing was more extreme than that of his two earlier approaches. Sex chasing may probably be considered an indication of the female's unreadiness. Eventually, however, the female comes into readiness and on such an occasion one might observe copulation closely following a sex chase, as described above.

Song-spread often accompanies chasing, occurring both before and, in part, even during the rapid flight. A call which resembles the middle phrase of the "flight song" and which has been heard in other situations suggesting a threat function is often given by the male during the chase This call is a high, loud, and nasal "tch-tch-tch . . ." often repeated several times. It may be given before as well as during the chase.

Group sexual chasing.—Often other males from neighboring territories join a chase of the type described above. It then becomes a group chase. Although the basis for a group chase is usually a pair, occasionally a female may become the center of a group chase in the absence of her mate. Even in the confusion of a group chase, it is usually her mate who catches and seizes her. In one case a male returned to strike his female a second time after a neighbor male had intervened to hit her.

Group chases are typically noisy affairs, all males involved tending to give rapid and repeated song and even some spread-display, while on the wing. At this time the typical "oak-a-lee" song is given quite hastily, so that the first part is slurred and the last emphasized. Friedmann (1929:161) describes a similar sexual flight in the Brown-headed Cowbird in which two males were ". . . singing and attempting to display in mid-air . . ." while following a female. It is not clear just what causes other males to join a chase. They always appear interested in each other's chases but do not always join them. The movement of others to join is usually general — when one flies toward a chasing pair, others follow. Group chases in the Reed Bunting appear to be very similar to those described above (Howard, 1929:7). "Owing to some seasonal organic change she is in a condition to stimulate and so to attract. . . as yet she has acquired no experience of boundaries, and straying, passes outside the dominion of her mate . . . she evokes in turn the sexual nature of each neighboring male; and they, on their part, become excited, and their excitement may terminate in the sexual flight." I think that in the Redwing, at least, the group response may often be of a more general nature, perhaps akin to group flocking about a predator. In the course of one group chase, several immature males and females gathered in the vicinity. In some instances groups formed so rapidly that it appeared the males were responding to the chasing pair rather than directly to the female. The "tch-tch-tch" call mentioned above seems to arouse other males. Very often just after a chasing male gives that call, his neighbors fly to join the chase, meanwhile giving the same call. On at least one occasion I have seen males fly to join a chase when the pair was out of their sight behind shrubbery. These birds seemed to respond to the vocalization of the male. In a few cases males evidently were aroused by the calls of others' females. The extended chase, low and over several territories, usually, but not always, brings about group behavior. Sometimes neighboring males fly into a territory to join a chase which is limited to that territory. The stimulus to chase a female or to join a chase, seems to vary depending on the particular circumstances. It should be noted that the males which join chases are usually themselves in the midst of courtship with their own females, and hence leave their mates to jointly chase another's mate. The behavior of a strange male which catches a female is apparently the same as that of her mate.

Nuttall's statement (1832:171) that during group chase the several males do not show any "jealous feud" with each other seems not entirely true. I think that the great amount of song which occurs during the group chase is an indication of the mutual aggression of the males rather than a direct response to the female. Almost always, at the close of a chase, and often before, the male mate, or owner of the territory on which the group gathers, turns to evict his neighbors. Sometimes the pursuing male even turns away from his female to do this. However, this may not always be the case, especially when the chase ends, as often happens, on a foreign territory or even on a neutral area. What seems more remarkable is that other males which are approaching a chasing pair often turn back in flight when the chase ends.

Group chasing is evidently the kind of chasing that Nuttall (1832), and Audubon (1834) referred to. Audubon's idea that the female Redwing receives the attention of a number of males in group sexual chase and then chooses one of them as her mate (*op. cit.*:349), does not seem in agreement with present observations. Beer and Tibbitts (1950:68) also apparently had such chases in mind when they described a "teasing" flight, involving one female and several males, which purportedly ended in promiscuous copulation. They implied that this was a general occurrence. I have no observation of promiscuity in Redwings, but at the close of one group chase four males in courting postures briefly surrounded a female on the ground and then dispersed.

Stolen matings.—Sometimes in non-promiscuous species, stolen matings occur. Howard (1929:42) says this of the Yellow Bunting: ". . . stolen matings . . . are by no means uncommon where territories adjoin and different females are in different stages of development; and despite the efforts of the owner to prevent it, a male will sometimes succeed — as far as one can tell — in reaching a sexual union." Nice (1943:184–185) says that in the Song Sparrow stolen matings do not occur.

I have no record of a stolen mating in the Redwing, and consider it unlikely, at least on the territorial grounds. Males do cross boundaries to harass another's female, and in one case a strange male even stood on top of the female. However, no copulation was ever observed under such circumstances. Even at a later time, when the members of the pair are about to copulate, although neighboring males may move up to their near-borders, molestation of the pair is rare or absent. Females generally are recalcitrant to strangers, and their mates are completely so. This is well illustrated by the following observation made off the study area at a place where plowed fields adjoined a small marsh. A resident female flew into the field to feed several hundred feet from the territory, where she was soon joined by a strange adult male. Seconds later she came flying back, giving alarm calls, with the male in close pursuit. When they reached the territory she flung herself into the cattails, and her mate, along with several neighboring males, drove the intruder away.

Period of sexual chasing.—Sexual chasing occurred between members of pairs in varying degree with no particular order of frequency or severity from the first few days of meeting for at least as long as 11 days. In some instances females were with males on their territories for several days before chasing was observed. Sex chases occurred throughout the breeding period, however, owing to late arrivals, remating, and renesting. The period of chasing is possibly correlated with physiological and psychological changes in the female, for once copulation occurred sexual chases were noticeably fewer or absent. Tinbergen (1939:21) stated that in the Snow Bunting ". . . weeks may pass, after the female has taken a mate, before she is willing to copulate . . ." and sex chasing occurred throughout this period. In a few cases a recurrence of chasing was observed in Redwings just prior to second nesting. In one case a violent chase occurred 22 days after a pair had fledged their first young.

The meaning of sexual chasing.—Tinbergen believed that sexual chasing in the Snow Bunting originated from attempts of the male to copulate (1939:30). "When the female did not take notice of the male, that is, when she did not adopt the attitude of readiness, she fled, and a sexual flight originated." The fact that the female flees before the postures or advances of the male is taken as an indication of her sexual unreadiness, since later, upon similar advances, she assumes proper copulatory postures and receives her mate. Howard (1929:11, 40) states that ". . . the behavior of the male is a genuine attempt to complete the sexual act . . . eventually when he flies excitedly towards her and settles beside her, she stays, postures, etc., and copulation results." Nice (1943:174–175) considered "pouncing" in the Song Sparrow analogous to sexual chasing in the above species. (An actual chase does not occur in the Song Sparrow; when the male pounces on the female, the latter usually stands still and at times even fights back.) Nice stated (*loc. cit.*) that ". . . pouncing has no immediate connection with copulation. . . pouncing on the mate may be a technique of the male for impressing himself upon his mate . . . of making his presence keenly felt!" Although sexual chasing in the Redwing is not connected directly with copulation, it is part of a pattern of actions and reactions which leads to copulation.

Precopulation and Copulation

During precopulatory behavior the female gives a long, rapid series of soft, high notes ("whimpering"). In low intensity the call is slow and these notes seem composed of two sounds: "tse-sit" or "seek-seek," but later the speed of delivery increases and these become: "tsee-tsee-tsee. . . " The rapid series may also gradually become slower and end with double notes. This call may be given alone but ordinarily it is accompanied by rapid spreading and closing of the primaries and, to a lesser extent, the rectrices, while the wings are held close to the body (Fig. 4*f*, *g*, *h*). The whimpering call and wing flutter are usually given while the Redwing is perched, sometimes quite high in a tree but usually on or near the ground. Occasionally the female displays in flight. This display is similar to the female "generalized display" of the Brewer's Blackbird (Williams, 1952:5–7), and, as in that species, is used long before copulation actually begins. It also precedes the high-intensity display (described below). As the intensity of the display increases the female leans forward and lifts her tail and wings, exposing the cloacal region (Fig. 4*i*, *j*, *k*). At high degrees of intensity the female sometimes raises her head slightly while whimpering and fluttering her wings (Fig. 4*g*). Complete readiness for copulation is indicated by both the tail and head being tilted upward sharply with the beak sometimes held open. At this time the body is depressed, sometimes with the breast resting upon the ground or perch. During copulation the female usually rests upon her tarsi with bill and tail still raised. In one observation the female swung her tail to one side and clearly extruded her cloaca just before the male mounted.

The male reacts to the female's precopulatory display by first perching close to her in the "crouch" position (Figure 4*a*). If her display is limited to the whimper and wing flutter he may do nothing more and may pay little attention to her, but on one occasion a male approached while displaying and mounted a female which had been sitting quietly on the ground. When the female goes into full display the male typically drops down to the floor of the marsh, flutters his wingtips while holding them out, either raised or lowered, and gives a soft whimpering cry somewhat similar to the female's, but not as loud and usually not as long. Then, with erected and sometimes violently-shaking epaulets, puffed-out feathers, lowered and spread tail, and lowered head, the male slowly, and often silently, walks stiffly toward the displaying female (see Figure 4 *d*, *e*).

If the birds are in a tree the male sidles along on the branch until he reaches the female. When approaching on the floor of the marsh he sometimes walks for several feet, awkwardly climbing over obstructions. On one occasion a male walked about five feet along the ground toward a displaying female and then, still fluttering his wings, flew up over an intervening cattail clump and landed directly on top of the female which had been out of his sight. Wetmore (1920:403), reported a very similar behavior for the Yellow-headed Blackbird — when approaching their mates, the males ". . . clambered stiffly along, hobbling over masses of bent-over rushes, with heads bent down, tails drooping and back humped. . . "

As the male nears the female he may begin to quiver his wings more and then raise them higher, especially as he mounts. Then he may flap his wings rapidly and sometimes may even hold them almost vertically while on top of the female. He may also do this before mounting her. In a few cases males approached with wings lowered to the ground and mounted the female without raising their wings. The male mounts the female from the rear, slowly moving around her to do this when he approaches from any other direction, since the female usually remains in a fixed position. He remains on top of her for a very short time, perhaps two or three seconds, and then steps off. Usually the male mounts only once but occasionally a male may mount more than once. However, I have never seen a male mount more than three times in quick succession. After dismounting the male usually moves off without any conspicuous display, but occasionally he may continue to move his wings, even though walking away from the female.

During copulation the female is apparently silent and motionless, but afterward she may both call and flutter and sometimes preen. On one occasion the male left the territory shortly after copulation occurred and the female then promptly went into precopulation display again, giving an even louder and more rapid whimpering call than she had previously given.

Wetmore (1920:404), apparently observed precopulatory behavior of the male Redwing when he wrote: "one male . . . often slowly ran along the ground with wings partly spread and half-raised and epaulets showing to their fullest extent, a very pretty display." Tyler (1923:697) wrote: ". . . he faced her with his wings partly spread and, although I was immediately in front of him, I could see practically the whole of his shoulder-patches. . . an actual courting maneuver . . . proved by the immediately subsequent action of the pair."

The precopulatory behavior of both the male and the female Brewer's Blackbird (Williams, 1952:5–6) closely resembles that of the Redwing. Similar behavior has also been noted in the Tricolored Redwing (Lack and

Emlen, 1939:226); the Yellow-headed Blackbird (Ammann, 1938:104); the Snow Bunting (Tinbergen, 1939:29); and many other species.

Length of the "Courtship" Period

The length of the period between pair formation and the laying of the of the first egg averaged 20.7 days for four pairs for which complete data are available. In two pairs which were closely watched, copulation was observed for the first time four days and three days, respectively, before their first eggs were laid. I have no record of copulation after egg-laying commenced, but I have observed females which had eggs in their nests engaged in precopulatory behavior. The earliest record of copulation was April 30 (1949).

Courtship Feeding

In many species of birds the male feeds the female during courtship or during incubation. Usually the male brings food to the female, which begs like a young bird (Lack, 1940). I observed no signs of courtship feeding in the Redwing although it has been reported for the following icterids: Baltimore Oriole (Brackbill, 1941), Yellow-headed Blackbird (Roberts, 1909:374), Rusty Blackbird, *Euphagus carolinus*, (Kennard, 1920: 420), Melodious Blackbird, *Dives dives*, (Kendeigh, 1952:271), and the Brewer's Blackbird (Williams, 1952:13–14).

Distraction Display

I have never observed distraction display (injury feigning) in the Redwing. However, F. V. Hebard states (pers. commun.) that he once saw a male engaged in this behavior. It has been reported in two other icterids, the Eastern Meadowlark (Hebard, MS) and Bobolink (Hebard, MS; Nero, 1955).

Summary

From 1948 through 1953 observations were made of a breeding colony of Red-winged Blackbirds, most of the members of which were individually marked with color-bands, at Madison, Wisconsin.

Adult males arrived between March 6 and April 21. Females arrived between April 8 and May 7. Most of the birds left the breeding marsh by August, but two males were seen within three miles as late as October 23. More than half of all the marked birds returned at least once; a few returned for several successive seasons.

Displays consisted of various movements or positions of the wings, and usually involved exposure and erection of the red wing-coverts. "Song-spread" was the most common of these and was prominent because of the loud vocal accompaniment. Although this is mainly a male display, an

analogous display with a different song was given by females. Males also had a "flight-song" involving a different vocalization. Both sexes indulged in "bill-tilting," a threat display in which the beak is pointed upward to members of the same sex. This was most commonly seen between adjacent males meeting on the borders of their territories. Females often raised and flapped one or both wings when approached by their mates during the period when they were feeding young. The significance of this display was not clear. A tense crouching posture of the male seemed an indication of sexual interest since it appeared to be directed only toward the mate.

Pair-formation began, or actually occurred, when the female entered the male's territory. The pairing bond existed only during the breeding period. The length of the period between pair-formation and the laying of the first egg averaged 20.7 days for four birds for which complete data were available. Single broods were usual, but three cases of double broods (all successful) were recorded. Polygyny was common, but no more than three females ever were observed with one male; two was average.

Male "courtship" behavior consisted mainly in slowly flying away from the female down into the cattails. The male then displayed with wings elevated over his back, crawled through the cattails, bowed, and picked at nesting material. This sequence was termed "symbolic nest-site selection." A related, less common display was called "symbolic nest-building." Sexual chasing, or pursuit of the female by the male, was a common occurrence. Chasing occurred normally between members of a pair during the period between pair-formation and egg-laying. Copulation was never observed at the immediate end of a chase, but chases were seldom observed between members of a pair once copulation had occurred. Neighboring males sometimes joined a chasing pair, forming group chases.

Sexual excitement in females was indicated by a quivering motion of the flight feathers accompanied by a soft whimpering cry. At a higher intensity the tail and bill were raised, the latter sometimes being open. In response to this "precopulation-display" of the female, males assumed a position in which the wings and tail were spread and lowered and then slowly approached the female. Copulation was always of short duration, and usually one mounting seemed to suffice.

Literature Cited

Allen, A. A.

1914 The red-winged blackbird: a study in the ecology of a cat-tail marsh. *Proc. Linnaean Soc. New York*, 24–25:43–128.

1934 The red-wing. *Bird Lore*, 36:128–138.

Ammann, G. A.

1938 The life history and distribution of the yellow-headed blackbird. (Ph.D. thesis, Univ. Michigan Library).

Audubon, J. J.
1832 Ornithological biography. Vol. 1 (Philadelphia; Carey and Hart).
Beecher, W. J.
1950 Convergent evolution in the American orioles. *Wilson Bull.*, 62:51–86.
Beer, J. R., and D. Tibbitts
1950 Nesting behavior of the red-winged blackbird. *Flicker*, 22:61–77.
Brackbill, H.
1941 Additional cases of 'courtship feeding.' *Auk*, 58:57.
Chapman, F. M.
1928 The nesting habits of Wagler's oropendola (*Zarhynchus wagleri*) on Barro Colorado Island. *Bull. Amer. Mus. Nat. Hist.*, 58:123–166.
Davis, M.
1953 Longevity of Cuban red-wing (*Agelaius assimilis*) in captivity. *Auk*, 70:92.
Dawson, W. L.
1923 The birds of California. (San Francisco; South Moulton Co.).
Friedmann, H.
1929 The Cowbirds. (Baltimore, Md.; C. C. Thomas).
Hackett, N. L.
1913 Notes on breeding habits of Agelaius phoeniceus. *Wilson Bull.*, 25:36–37.
Hochbaum, H. A.
1944 The canvasback on a prairie marsh. (Washington, D.C.; Amer. Wildlife Inst.).
Howard, H. E.
1920 Territory in bird life. (London; Murray).
1929 An introduction to the study of bird behaviour. (Cambridge Univ. Press; New York).
Kendeigh, S. C.
1952 Parental care and its evolution in birds. *Illinois Biol. Monogr.*, 22:1–356.
Kennard, F. H.
1920 Notes on the breeding habits of the rusty blackbird in northern New England. *Auk*, 37:412–422.
Lack, D., and J. T. Emlen, Jr.
1939 Observations on breeding behavior in tricolored red-wings. *Condor*, 41:225–230.
Lack, D.
1940 Courtship feeding in birds. *Auk*, 57:169–178.
Laskey, A. R.
1933 A territory and mating study of mockingbirds. *Migrant*, 4:29–35.
1950 Cowbird behavior. *Wilson Bull.*, 62:157–174.
Linford, J. H.
1935 The life history of the thick-billed red-winged blackbird, *Agelaius phoeniceus fortis* Ridgway, in Utah. (M.S. thesis, Univ. Utah Library).
Linsdale, J. M.
1938 Environmental responses of vertebrates in the Great Basin. *Amer. Midland Nat.*, 19:1–206.
McIlhenny, E. A.
1937 Life history of the boat-tailed grackle in Louisiana. *Auk*, 54:274–295.
Mayr, E.
1941 Red-wing observations of 1940. *Proc. Linnaean Soc. New York*, 52–53:75–83.

p. 50

Mehner, J. F.
1950 An ecological study of the eastern red-winged blackbird (*Agelaius phoeniceus phoeniceus*) at Pymatuning. (M.S. thesis, Univ. Pittsburgh Library).
Nero, R. W.
1955 Distraction display in the bobolink. *Passenger Pigeon*, 17:34.
Nero, R. W., and John T. Emlen, Jr.
1951 An experimental study of territorial behavior in breeding red-winged blackbirds. *Condor*, 53:105–116.
Nice, M. M.
1937 Studies in the life history of the song sparrow. I. A population study of the song sparrow. *Trans. Linnaean Soc. New York*, 4:1–248.
1943 Studies in the life history of the song sparrow. II. The behavior of the song sparrow and other passerines. *Trans. Linnaean Soc. New York*, 6:1–328.
1950 Development of a redwing (*Agelaius phoeniceus*). *Wilson Bull.*, 62:87–93.
Noble, G. K., and W. Vogt
1935 An experimental study of sex recognition in birds. *Auk*, 52:278–286.
Nuttall, T.
1832 A manual of the ornithology of the United States and of Canada. Vol. I. (Cambridge, Massachusetts).
Petersen, A., and H. Young
1950 A nesting study of the bronzed grackle. *Auk*, 67:466–476.
Roberts, T. S.
1909 A study of a breeding colony of yellow-headed blackbirds; including an account of the destruction of the entire progeny of the colony by some unknown natural agency. *Auk*, 26:371–389.
Schantz, W. E.
1937 A nest-building male song-sparrow. *Auk*, 54:189–191.
Smith, H. M.
1943 Size of breeding populations in relation to egglaying and reproductive success in the eastern red-wing (*Agelaius p. phoeniceus*). *Ecology*, 24:183–207.
Sowls, L. K.
1951 A study of the ecology and behavior of some surface-feeding ducks. (Ph.D. thesis, Univ. Wisconsin Library.)
Tinbergen, N.
1939 The behavior of the snow bunting in spring. *Trans. Linnaean Soc. New York*, 5:1–94.
Tyler, W. M.
1923 Courting orioles and blackbirds from the female bird's eyeview. *Auk*, 40: 696–697.
Wetmore, A.
1920 Observations on the habits of birds at Lake Burford, New Mexico. *Auk*, 37:393–412.
Williams, J. F.
1940 The sex ratio in nestling eastern red-wings. *Wilson Bull.*, 52:267–277.
Williams, L.
1952 Breeding behavior of the Brewer's blackbird. *Condor*, 54:3–47.

Saskatchewan Natural History Museum, Regina, Saskatchewan, October 15, 1955

FOSSIL BIRDS OF THE LATE PLIOCENE OF CITA CANYON, TEXAS

BY ALDEN H. MILLER AND ROBERT I. BOWMAN

Among the extensive collections of vertebrate fossils assembled by the late C. Stuart Johnston from the panhandle of Texas was a small number of bird remains. These, which total 9, are from the locality known as Cita Canyon. This material is now deposited partly in the Museum of Paleontology of the University of California and partly in the collection of the Panhandle Plains Historical Museum at Canyon, Texas. Dr. Donald E. Savage has kindly made it available for study.

The Cita Canyon locality, no. V-3721 Univ. Calif. Mus. Paleo., is 3½ miles south and 13 miles east of Canyon, Randall County, Texas. It is situated on the Newton Harrell-Edd Ranch. The sediments are sandstones of lacustrine or playa origin. The deposits and mammalian assemblage of this locality (Johnston and Savage, 1955) are of Blancan age which is classed by Wood *et al.* (1941) as late Pliocene.

Description of Material

Family Threskiornithidae

Plegadis gracilis, new species

Type.—Left tarsometatarsus, including proximal end and shaft, 44 mm. in length, and lacking medial calcanial ridge of hypotarsus; well preserved; no. 45088 Univ. Calif. Mus. Paleo.; fig. 1 *d, e.*

Referred material.—Right carpometacarpus, lacking most of central segment of metacarpal III; well preserved, the appearance of the fossilization being identical with that of the type; no. 3170 Panhandle Plains Hist. Mus. Left ulna, including distal end and shaft, 43 mm. in length; well preserved; no. 3171 Panhandle Plains Hist. Mus.

Diagnosis.—Similar in configuration to both *Eudocimus albus* and *Plegadis mexicana* but tarsometatarsus smaller (Table 1), at least 12 per cent less in width across cotylae.

The tarsometatarsus is referred to the family Threskiornithidae on the basis of general agreement in configuration of the hypotarsus, which in all three genera studied *(Eudocimus, Plegadis,* and *Theristicus)* shows a consolidated basal stalk, not perforated by tendinal canals but supporting an open tendinal groove. In the one specimen of *Theristicus* with which comparison was made, there is a very thin bony bridge over the single canal. In all genera of the Ardeidae and Cochlearidae examined, the basal hypotarsal stalk is perforated or deeply cut with two tendinal canals. The non-perforate hypotarsus is also found in the families Phoenicopteridae and Ciconiidae, but the fossil is markedly smaller and shows differences in details of configuration from them.

The carpometacarpus is assigned to the family Threskiornithidae on the basis of general agreement in configuration to the genera *Eudocimus* and *Plegadis* and particularly the presence of a short "tendinal ridge" located in the middle of the anconal groove of the distal metacarpal symphysis, in line with the process for digit III. There is close familial accord in proportion, especially in the ratio of the length of the distal carpometacarpal symphysis to the total length of the carpometacarpus (Table 2), which is generally of a higher value in the family Threskiornithidae than in the families Ardeidae, Cochlearidae, and Ciconiidae. Comparative osteological material was not available for the families Scopidae and Balaenicipitidae. Recent New World genera of Phoenicopteridae show a value for the "symphysis ratio" slightly greater than that of *Eudocimus* and *Plegadis,* and also the carpometacarpus of the phoenicopterids is of much larger size.

The distal end of the fossil ulna shows no diagnostic features but is of the same general size as the two other fossil elements; therefore it is referred to the same species.

Table 1

Measurements in Millimeters of the Tarsometatarsus and Carpometacarpus of Four Species of the Threskiornithidae

Species	Tarsometatarsus				Carpometacarpus		
	Total length	Narrowest medio-lateral width of shaft	Cotylar width	Antero-posterior width of proximal end[1]	Total length	Width of proximal head	Width of distal head
Theristicus caudatus	92.3	5.9	15.2	11.7	73.4	18.0	10.8
	79.2	5.5	14.3	11.0	68.4	16.8	10.4
Plegadis mexicana	113.1	4.3	11.1	11.3	58.0	11.6	7.3
	87.6	3.7	9.1	9.4	50.7	10.0	6.5
	87.5	3.7	9.2	9.3	50.6	10.2	6.8
Eudocimus albus	83.6	4.3	10.2	10.3	57.2	12.5	7.5
	77.7	4.3	10.4	9.1	51.4	11.6	7.2
Plegadis gracilis	–	3.4	8.0	7.9	45.3	9.5	5.7

[1] Measurement taken from anterior surface of lateral cotyla to posterior edge of lateral hypotarsal ridge.

Because skeletal material was available for only three of the 17 genera of the Threskiornithidae listed by Peters (1931), namely *Guara (Eudocimus)*, *Plegadis*, and *Theristicus*, it was necessary to utilize the measurements of wing and tarsus obtained from study skins to eliminate certain genera from consideration on the basis of size alone. Table 3 lists the species which approach the small size of modern *Plegadis* and *Eudocimus* most closely in length of wing or length of tarsus or both. Whereas *Lampribis*, *Harpiprion*, and *Mesembrinus* possess a short tarsus, possibly as short as the fossil, the

Table 2
Ratio of Length of Distal Metacarpal Symphysis to Total Length of Carpometacarpus in 19 Genera of the Ciconiiformes

Family	Genus	Ratio
Phoenicopteridae	*Phoenicopterus*	.156
	Phoenicoparrus	.173
Threskiornithidae	*Eudocimus*	.141
	Plegadis	.146
	Theristicus	.117
	Plegadis gracilis	.161
Ardeidae	*Ardea*	.104
	Casmerodius	.117
	Heterocnus	.101
	Botaurus	.119
	Nyctanassa	.106
	Egretta	.114
	Nycticorax	.102
	Hydranassa	.104
	Florida	.103
	Butorides	.106
	Leucophoyx	.111
	Ixobrychus	.124
Cochleariidae	*Cochlearius*	.112
Ciconiidae	*Mycteria*	.083

wing measurements of these three genera and also *Phimosus* suggest a relatively longer carpometacarpus than in the fossil. If *Lampribis*, *Harpiprion*, and *Mesembrinus* are of general build and wing length similar to *Eudocimus* and *Plegadis*, even though short-legged, we may presume that the tarsus would be short but broad and thus not slender as in the fossil.

With respect to the two genera *Eudocimus* and *Plegadis*, the fossil is similar to both of these in the relative slimness of the hypotarsal stalk but it appears to be more closely related to *Plegadis* in size (Table 1). *Theristicus* not only differs significantly in general size from *Plegadis* and *Eudocimus*, but it also lacks the medial "tendinal ridge," possesses a broader hypotarsal stalk, and shows a much larger value for the "symphysis ratio."

Wetmore in 1940 listed no fossil records of *Plegadis*, *Guara* (*Eudocimus*), or *Ajaia* prior to the Pleistocene of North America. The same author later (1944:92) called attention to a fragment of a coracoid from the Upper Pliocene of Kansas which he tentatively relates to *Plegadis* but which was "from one-fourth to one-eighth smaller than the modern white and scarlet ibises and the glossy ibises." It may well be that the coracoidal element from Kansas represents the same small extinct species of *Plegadis* here

Table 3
Measurements of Wing and Tarsus of Seven Species of the Threskiornithidae[1]

Species	Wing range in mm.	Tarsus range in mm.
Eudocimus albus	263–298	78–101
Plegadis falcinellus	225–295	85–110
Plegadis ridgwayi	256–304	68– 97
Lampribis rara	270–290	56– 65
Harpiprion caerulescens	279	58
Mesembrinus cayennensis	290–340	60– 65
Phimosus infuscatus	292	–

[1]Data from various sources in literature.

described from fossil beds of similar though slightly later age in Texas, less than 200 miles to the southwest.

Indeterminate ciconiiform

A left phalanx 1, digit II, no. 3172 Panhandle Plains Hist. Mus., in a good state of preservation and measuring 32.7 mm. in length, appears to belong to the Ciconiiformes on the basis of general configuration and particularly the outline of the metacarpal facet. Although the fossil is almost complete, this element shows insufficient character to permit more than ordinal assignment. On the basis of length and width of the phalanx, the bird presumably was about the size of *Theristicus caudatus* and thus much larger than *Plegadis gracilis*.

Family Anatidae
Anas sp.

The distal end and shaft of a left humerus (no. 3173 Panhandle Plains Hist. Mus.) of a teal is well preserved distally and matches closely in configuration and size the distal end of the humerus of *Anas cyanoptera*. The bone is too broad and stout to be confused with *A. carolinensis*, 9 specimens of which have been available for comparison. The fossil in similar fashion differs from two examples of *A. discors*, but *discors* and *cyanoptera* are such closely similar species that we distrust this difference and think that larger samples of *discors* would show overlap in dimensions with the fossil. Since *discors* cannot surely be excluded and since there is a number of small teals in other parts of the world which have not been examined, the fossil should not be designated as to species; nonetheless it probably represents the modern *A. cyanoptera* of the New World. "*Querquedula floridana*" of the Pleistocene has recently been shown (Wetmore, 1955) to belong to the genus *Lophodytes* rather than to *Anas*.

Family Meleagridae

Meleagris leopoldi,* new species

Type.—Right tarsometatarsus, lacking proximal end, tip of spur core, and entire internal trochlea and lateral half of external trochlea; well preserved; no. 45086 Univ. Calif. Mus. Paleo.; fig. 1*c*.

Paratypes.—Right tarsometatarsus, complete except for spur core and small part of hypotarsus; well preserved throughout; no. 3169 Panhandle Plains Hist. Mus.; fig. 1*a*, 1*b*. Short section of shaft of right tarsometatarsus including spur core, the tip of core lacking; no. 45087 Univ. Calif. Mus. Paleo.

Diagnosis.—Similar in general shape to the turkeys *Meleagris gallopavo* and *Parapavo californicus* but spur core more distally situated, less than 40 per cent of length of tarsometatarsus from distal end rather than 41 per cent or greater as in *Meleagris* and *Parapavo*; spur core more medially directed, the angle with anterior surface of shaft less than 59 degrees rather than 62 degrees or greater as in *Meleagris gallopavo* and *Parapavo*. Size similar to *Parapavo californicus*.

Measurements.—Paratypes: total length from intercotylar tubercle through middle trochlea, 138.8 mm.; width across trochleae, 20.9 mm.; width across cotylae, 21.3 mm.; minimum mediolateral transverse diameter of shaft, 8.6 and 8.6 mm. Minimum mediolateral diameter of shaft of type, 8.6 mm.

Referred material.—Distal one-fourth of left tibiotarsus, no. 3174 Panhandle Plains Hist. Mus. This fragment represents a turkey of the same general size as that represented by the tarsometatarsi of *M. leopoldi*. No diagnostic features of specific or generic type are discernible in this part of this element. Because of size and presence in the same formation, no. 3174 is referred to *M. leopoldi*.

Comparative material.—*Parapavo*, 8 tarsometatarsi with complete spur cores from Pleistocene of Rancho la Brea (Univ. Calif. Mus. Paleo.). *Meleagris gallopavo*, 3 male tarsometatarsi with complete spur cores (Mus. Vert. Zool. no. 119,318; Loye Miller coll. nos. 921 and 2295). *Agriocharis ocellata*, 1 male without spur core (Mus. Vert. Zool. no. 129,318) and 1 male with complete spur core (Loye Miller coll. no. 1743).

The Cita Canyon turkey material was originally assigned to *Parapavo californicus* by Loye Miller (1937) on the basis of correspondence in "size, proportions, elevation of spur core, relative positions of the trochleae, the small intertrochlear foramen on the inner side, the shape of the proximal cotylae and hypotarsus, the incipient hypotarsal third ridge." Of these characters we now find that the elevation of the spur core is different and forms part of the basis for recognizing the Cita Canyon bird as a distinct species. The remaining characters do not now appear to be of service in separating the genera *Parapavo* and *Meleagris*. Size of the order here involved can not serve in generic distinctions as there are many size types among races and species in *Meleagris*. The proportions of length to width of the tarsometatarsus appear similar in the two genera (see Howard, 1927). In the relative position of the trochleae there is considerable overlap with *Meleagris*. The inconstant development of the intertrochlear foramen and

*Named in recognition of the contribution of A. Starker Leopold to the knowledge of the biology of modern turkeys.

the incipient hypotarsal third ridge in *Parapavo* and *M. gallopavo* has already been reported by Howard (*loc. cit.*) and is confirmed by us. We have found no character in the shape of the proximal cotylae which warrants

FIG. 1. Fossil birds from Cita Canyon, Texas; drawings by Owen Poe.

a, **b**, paratype of *Meleagris leopoldi*, anterior aspect and proximal articular surface, no. 3169, Panhandle Plains Hist. Mus.; **c**, type of *Meleagris leopoldi*, no. 45086, Univ. Calif. Mus. Paleo.; all $\times \frac{3}{4}$.

d, **e**, type of *Plegadis gracilis*, medial aspect and proximal articular surface, no. 45088, Univ. Calif. Mus. Paleo.; both $\times 2$.

confidence. Thus in none of these particulars nor in any other features of the tarsometatarsus do we find grounds for generic separation of *Parapavo* and *Meleagris*, although there appears to be justification for separation of these genera on the basis of differences in other skeletal elements, particularly the skull (Howard, *op. cit.*), and *Agriocharis* may similarly be separated.

TABLE 4
HEIGHT AND ANGLE OF SPUR CORE IN TURKEYS

Species	Height of spur core as per cent of total length of tarsometatarsus[1]				Angle of spur core[2]			
	No.	Range	Mean	SD	No.	Range	Mean	SD
M. leopoldi	1	–	39.8[3]		2	53.0–58.5		
Parapavo californicus	6	11.7–16.0	12.7	2.04	8	62.0–78.0	68.3	5.13
M. gallopavo	3	11.2–13.4	12.1	1.00	3	63.5–71.5	67.1	4.18
M. crassipes[4]	1	–	15	–	–	–	39	–
Agriocharis ocellata	1	–	36.0	–	–	–	–	–

[1]Height of spur core was measured from the mid-point of the base of spur core to the end of the middle trochlea.

[2]Angle of spur core was determined by preparing plaster casts of tarsometatarsi from moulds composed of gelatin-agar agar mixture. The cast was sectioned transversely through the main axis of the spur core. From a tracing of the outline of the section, the angle of the spur core was measured in the same manner as illustrated by L. Miller (1940).

[3]To obtain this figure, total length of tarsometatarsus was measured on the paratype, whereas height of spur core was measured on the type.

[4]*Fide* L. Miller (*loc. cit.*).

This situation means that there is no basis for the assignment of tarsi such as those from Cita Canyon to *Parapavo* in contradistinction to *Meleagris*. They could relate to either. In the absence of associated diagnostic skeletal elements, such as the skull, it would seem best to carry a species like *leopoldi* in the more inclusive genus *Meleagris* and thereby avoid any implication of special affinity with *Parapavo*. The tarsus of *Agriocharis* seems separable from both *Parapavo* and *Meleagris* on the basis of its slenderness, particularly across the trochleae.

Several fossil species of turkeys previously assigned to *Meleagris* seem to bear no close similarity to *leopoldi*. *M. crassipes* (L. Miller, 1940) from the Pleistocene of San Josecito Cave, Nuevo León, was a small, short-legged species with the spur core situated high, near the middle of the shaft and directed more medially even than in *leopoldi* (see Table 4). *Meleagris superba* from the Pleistocene of New Jersey and Pennsylvania was much longer legged than modern *M. gallopavo* and therefore not like the much smaller *leopoldi*, whereas *Meleagris richmondi* of the Pleistocene of California, based on a sternum, was only about half the size of *M. gallopavo* and thus too small to be identical with *M. leopoldi. Meleagris tridens* of the Pleistocene of Florida had a very distinctive triple spur development. *Meleagris celer* from New Jersey, likewise of the Pleistocene, although much smaller than *superba,* with which Marsh compared it, falls in the general size range of *gallopavo.* On the basis of the tibiotarsus it was claimed (Marsh, 1872) to be slender legged but whether in fact it was so in relation to *gallopavo* and *M. leopoldi* is uncertain as Marsh's measurements of the shaft fall in the range of *gallopavo* as given by Howard (*loc. cit.*: 23). The critical parts of the tarsometatarsus on which *M. leopoldi* is based cannot be compared in *celer.* The latter may indeed prove to be identical with *gallopavo.* The much older *Meleagris antiqua* of the Oligocene of Colorado, although the size of a female *M. gallopavo,* is based on the distal end of the humerus and cannot be compared with *M. leopoldi.* It is not likely to be specifically identical with the late Pliocene and Pleistocene forms.

The particular interest in *Meleagris leopoldi* lies in the further representation through it of turkeys in the Pliocene. Wetmore (1944:98) reported *Meleagris gallopavo* from the Rexroad fauna of the Upper Pliocene of Kansas on the basis of a tibiotarsus; probably on the basis of this element alone *leopoldi* and *gallopavo* could not be differentiated. The meleagrid line had presumably appeared in the Oligocene and diverged by the Pleistocene to form at least two generic types *Meleagris* and *Parapavo,* and probably also *Agriocharis,* known only from the Recent. At least several species of turkeys, of whatever genus, existed in the late Pliocene and the Pleistocene, with a very considerable size range. *M. leopoldi* has no certain phyletic relation to any one of these, although it is close to several of them. Its distinctive location and angulation of the spur core alone set it off from previously known species.

Ecologic and Zoogeographic Considerations

The bird remains from Cita Canyon are of two ecologic types, a water bird assemblage and a terrestrial representative. The ibis (*Plegadis gracilis*), the teal (*Anas*), and the unidentified ciconiiform could have become entombed in any lacustrine situation or river channel pond even if of very limited extent. The turkey (*Meleagris leopoldi*) would have demanded an open woods or scrub cover if not a denser type of vegetation. The avifauna suggests, then, a mixture of woodland and open bordering terrain, with ponds and marshes present.

The very small ibis herein described suggests a fragment of an ibis of similar size previously mentioned as occurring in the Upper Pliocene of Kansas. The ibises as a group are of world-wide occurrence in equatorial and temperate latitudes and the teals are cosmopolitan.

The turkey, herein described as a new species, is now assigned to *Meleagris* rather than to *Parapavo* as formerly. The doubting of its generic affinity with the Pleistocene *Parapavo* leaves the latter restricted in known distribution to the coastal districts of California.

Literature Cited

Howard, H.

1927 A review of the fossil bird, *Parapavo californicus* (Miller), from the Pleistocene asphalt beds of Rancho La Brea. *Univ. Calif. Publ. Bull. Dept. Geol. Sci.*, 17:24–26.

Johnston, C. S., and D. E. Savage

1955 A survey of various late Cenozoic vertebrate faunas of the panhandle of Texas. Part 1. Introduction, description of localities, preliminary faunal lists. *Univ. Calif. Publ. Bull. Dept. Geol. Sci.*, 31:27–50.

Marsh, O. C.

1872 Notice of some new Tertiary and post-Tertiary birds. *Amer. Jour. Sci. and Arts, third ser.*, 104:261.

Miller, L.

1937 A Pliocene record of *Parapavo* from Texas. *Condor*, 39:229.

1940 A new Pleistocene turkey from Mexico. *Condor*, 42:154–156.

Peters, J. L.

1931 Check-list of birds of the world. Vol. 1. Cambridge; Harvard Univ. Press.

Wetmore, A.

1940 A check-list of the fossil birds of North America. *Smithsonian Misc. Coll.*, 99:1–81.

1944 Remains of birds from the Rexroad fauna of the Upper Pliocene of Kansas. *Univ. Kans. Sci. Bull.*, 30:92.

1955 The genus *Lophodytes* in the Pleistocene of Florida. *Condor*, 57:189.

Wood, H. E., R. W. Chaney, J. Clark, E. H. Colbert, G. L. Jepsen, J. B. Reeside, Jr., and C. Stock.

1941 Nomenclature and correlation of the North American continental Tertiary. *Bull. Geol. Soc. Amer.*, 52:1–48.

Museum of Vertebrate Zoology, Berkeley, California, June 1, 1955

MEASUREMENTS OF THE HABITAT NICHE OF THE LEAST FLYCATCHER

BY W. J. BRECKENRIDGE

Exact measurements of habitat niches occupied by higher animals, particularly birds, have been difficult to make and few have been reported. During a recent six-year study of the breeding birds of an upland oak habitat, opportunity arose to measure certain elements influencing the distribution of Least Flycatchers (*Empidonax minimus*). A 20-acre study plot had been chosen for the study since it appeared to be homogeneous habitat. A population of about 60 pairs of Least Flycatchers per 100 acres nested in the area. Year after year these birds were recorded as occupying one particular half of this tract almost exclusively. Obviously some rather subtle environmental differences were influencing the birds' choices of nesting sites. For this reason, an analysis of the habitat was undertaken.

The study-tract lies about 35 miles north of Minneapolis, Minnesota, and within the limits of the University of Minnesota-owned Cedar Creek Research Forest. The dominant tree of the plot was the northern pin oak (*Quercus ellipsoidalis*). A few bur oaks (*Q. macrocarpa*) and some jack pines (*Pinus banksiana*) were scattered throughout the area. A few large white pines (*Pinus strobus*) and a small number of white birch (*Betula papyrifera*) and red maple (*Acer rubrum*) trees occurred. The height of the overstory was mostly 40 to 50 feet with an occasional northern pin oak and some of the white and jack pines rising to 70 feet. Here and there one or a few of the scattered dead trees had blown down causing small openings in the forest crown. The shrub story was made up largely of young oaks, Juneberries (*Amelanchier* sp.), wild cherries (*Prunus serotina* and *P. virginiana*), red maple (*Acer rubrum*) and hazel (*Corylus americana*). This layer varied in abundance, being denser under the openings in the forest crown. The ground cover varied from sparse to moderate with two species of blueberries (*Vaccinium angustifolia* and *V. canadense*), bracken (*Pteridium aquilinum*), Solomon's seal (*Polygonatum canaliculatum*) and wild sarsaparilla (*Aralia nudicaulis*) being common along with a sparse growth of grasses and sedges.

In this study area the Least Flycatcher nested almost invariably from 10 to 30 feet above the ground in vertical forks of small trees. Its territories were small, usually less than one acre in extent, and were of the type wherein courtship, nesting, and the feeding of the nestlings all took place within these narrow limits. The feeding birds darted out from convenient lookout perches to capture prey, then alighted on another perch, and another and another in succession as they circulated throughout their territories. Singing continued throughout their feeding periods. The estimated heights in feet of

29 successive perches used by an individual flycatcher were recorded on July 9, 1954. The extremes in this particular series, 8 and 35 feet, are representative of what had been observed for other individuals over the years. This stratum used by the Least Flycatchers extended vertically from the top of the shrub stratum up to the leafy canopy of the forest overstory.

Figure 1 is a copy of the map of the area used in recording field observations. The numbers appearing in the half-acre plots represent the total recorded observations of the Least Flycatcher for each plot as recorded in the regular breeding-bird censuses of 1948 through 1954 (1953 excepted). Since these are based on over 108 hours of observation extending over six years, during which time all species were being recorded and all parts of the tract receiving similar attention, it is assumed that these figures represent an unbiased, numerical evaluation of the amount of use made by the birds

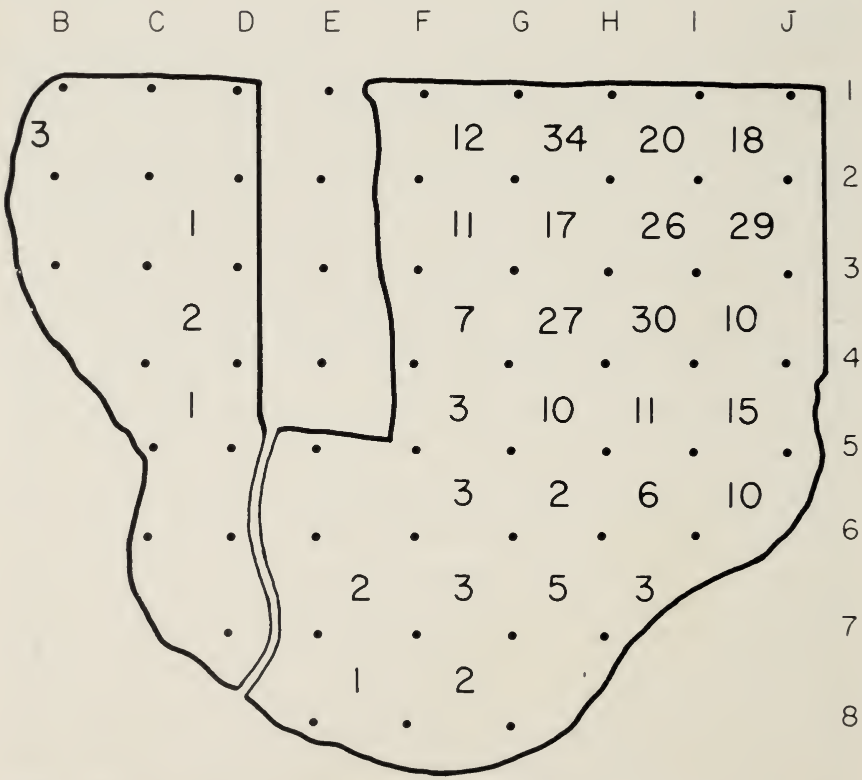


FIG. 1. Map of the Least Flycatcher census area. Numbers on the half-acre plots record the numbers of observations as indicating use of that portion of the habitat by flycatchers during six years of censusing on this 20-acre area.

TABLE 1
NUMBERS OF TREES AND HAZEL SHRUBS ON STUDY PLOTS

	Heavy Use		Moderate Use		Little or No Use	
Plot Number	G34 H34	H23 I23	F23 G23	G45 H45	C34 D34	E56 F56
Use by Birds[1]	27	26	11	10	2	0
N. Pin Oak	129	115	109	168	230	272
Bur Oak	32	19	34	18	6	3
Jack Pine	15	44	66	2	0	18
White Pine	1	1	1	0	3	2
White Birch	2	7	0	0	12	0
Total Trees	179	186	210	188	251	295
	356		398		546	
Hazel 3 ft. 6 in. or larger	477	1982	858	198	45	31

[1]Values refer to numbers of observations plotted in Figure 1.

of the various half-acre plots. This pattern of use was essentially the same during each of the six seasons of the study.

Several possible elements of the environment were studied in sample plots to ascertain which might be correlated with flycatcher use. First, it seemed reasonable to suspect that the abundance of certain species of trees (1-inch DBH and larger) or shrubs was influencing the birds. Accordingly, a census was made of the trees and shrubs in six half-acre plots, two each in the little-used, moderately-used, and heavily-used areas (Table 1). Of the forest tree species present, only the northern pin oak, bur oak, and jack pine were sufficiently abundant to influence habitat selection. The least-used plots definitely had the least number of bur oaks but no difference existed between the numbers of these oaks in the moderately- and heavily-used areas. Variation existed in the numbers of jack pines present but in no way were these correlated with flycatcher use. The numbers of the dominant northern pin oaks varied inversely with the use by the flycatchers when total numbers for each pair of the three areas classified according to use were considered: 244 in the two heavy-use plots, 277 in the two moderate-use plots, and 502 in the two little-use plots. However, marked discrepancies in this relationship between individual plots indicated that this probably was not the critical element influencing flycatcher behavior.

A census of trees in different size classes was then undertaken (Table 2). The numbers in the two larger size classes showed no variation which correlated with flycatcher use. In the two smaller classes, the plots with the most trees had the least use by the birds, but these figures do not differentiate between moderate- and heavy-use areas.

It was noticed that the growth of hazel varied between different plots. William Hsuing's ecological study of an allied species, the beaked hazel, *Corylus cornuta*, (1951. Unpubl. thesis, Univ. Minnesota Library) showed

TABLE 2
NUMBERS OF TREES ON STUDY PLOTS
ENUMERATED BY SIZE GROUPS (DIAMETER BREAST HIGH)

Plot	Trees 1 to 2⅞ in.		Trees 3 to 6⅞ in.		Trees 7 to 9⅞ in.		Trees Over 10 in.		Totals	
G3/4 H3/4	44		81		40		14		179	
Heavy Use		86		152		97		30		378
H2/3 I2/3	42		71		57		16		186	
F2/3 G2/3	48		80		66		16		210	
Mod. Use		102		148		107		41		407
G4/5 H4/5	54		68		41		25		188	
E5/6 F5/6	130		106		44		15		295	
Little Use		204		226		91		25		548
C3/4 D3/4	74		120		47		10		251	

that the growth usually increases with the increased light resulting from openings in the forest crown. Accordingly, counts were made of the hazel stalks 3½ feet high or higher in six representative half-acre plots (Table 1). The total numbers of hazel plants in the three use classes varied directly with flycatcher use.

However, one plot used moderately had nearly twice as much hazel (858) as did one of the plots having heavy use (477). This result suggested that the degree of closure of the forest crown was related to flycatcher use but again this measurement did not differentiate between medium- and heavy-use areas.

Examination of the varying conditions in this habitat finally suggested that the real limiting factor was the degree of openness just beneath the forest crown; in other words, the abundance and distribution of limbs intersecting the zone of use of the flycatchers (8 to 30 feet in height) beneath the leafy forest canopy. The technique devised to measure this condition was to elevate to various heights a closed umbrella frame which was then opened to 42 inches in diameter and a record made of whether it did (+) or did not (—) touch a branch in opening. This was accomplished with the use of a sectional bamboo pole with control strings for opening the umbrella frame. Readings were made at four different levels (8, 15, 20, and 25 feet) and these measurements were repeated at five-step intervals along six or seven string-marked lines intersecting each half-acre plot, making 264 or 308 readings on each plot. Six plots were so measured (Table 3), two plots each representing the little-used, moderately-used and heavily-used areas. In this table the percentage of openings of the testing frame in which no obstructions were encountered is designated as the percentage of openness.

In this series the percentage of openness is correlated directly with flycatcher use to a surprising degree.

TABLE 3

MEASUREMENTS OF THE FREQUENCY OF OPEN SPACES IN THE BRANCHES BENEATH THE FOREST CANOPY

Plot Number	Little used E56 F56	Little used C34 D34	Moderately used G45 H45	Moderately used F23 G23	Heavily used G34 H34	Heavily used G12 H12
No. Flycatcher Observations	0	2	10	11	27	34
No. Readings	264	308	264	308	308	308
Percent of Openness	26.5	23.4	36.4	37.0	45.1	48.7

It thus appears that limb density in a forest habitat is a critical factor in limiting its use by Least Flycatchers and that the density threshold beyond which the habitat became unsuited to their use was reached within the narrow limits existing in this study tract.

Pertinent to this study of the nesting territory of the Least Flycatcher is the observation that far higher populations of 200 and 271 pairs per 100 acres were recorded by MacQueen (1950. *Wilson Bull.*, 62:194–205) in two seasons' study at the Michigan Biological Station at Douglas Lake, Michigan. Her description of the environment is similar to that of this study but involved different species of trees, and included more small openings. This Douglas Lake habitat probably represents more nearly the optimum for this flycatcher, since no denser populations have been reported. Habitats more open than that at Douglas Lake would doubtless support smaller populations and would represent the approach toward the opposite (more open) limb density threshold from the one dealt with in the present study. MacQueen states that in a more closed type of forest near the station 60 pairs per 100 acres were found. This latter habitat (presumably with denser branching beneath the canopy) probably more nearly resembled the habitat in this study and correspondingly it had a comparable Least Flycatcher population.

Furthermore, it is probable that the territories of birds such as these can be measured better in three dimensions rather than in two. In this connection, the observation of Saunders (1936. *New York State Mus. Handb.* No. 16) that orchards commonly attracted small populations of these flycatchers (12 pairs per 100 acres) appears to bear out this suggestion. The low growth form of orchard trees reduces the vertical dimension of the canopied habitat, forcing the birds to extend their territories horizontally to secure the same cubic content of favorable habitat.

UNIVERSITY OF MINNESOTA MUSEUM OF NATURAL HISTORY, MINNEAPOLIS, MINNESOTA, JULY 18, 1955

THE ROCK PTARMIGAN IN SOUTHERN BAFFIN ISLAND

BY GEORGE M. SUTTON AND DAVID F. PARMELEE

In his discussion of the local distribution of land birds along the south coast of Baffin Island, Soper (1940:15) names the Rock Ptarmigan (*Lagopus mutus*) among the "common residents" of grass-tundra districts "interspersed with rocky ridges." He includes the Snow Bunting (*Plectrophenax nivalis*), Water-Pipit (*Anthus spinoletta*) and Horned Lark (*Eremophila alpestris*) in the same category, and says of the four species: "They are invariably associated with granitic areas and are therefore absent in the wide, swampy tundras, except for sporadic companies during migration. Where isolated granite ridges protrude from these plains . . . a few pairs will be found nesting." In a more recent paper (1946:225), this author calls *Lagopus mutus* "one of the most characteristic land birds of southern Baffin Island."

In the summer of 1953 we found the Rock Ptarmigan decidedly rare about the head of Frobisher Bay, Baffin Island. Our headquarters were at Lat. 63° 45′ N., Long. 68° 33′ W., at a Royal Canadian Air Force Base. We covered an area of 18 square miles near the Base by foot fairly regularly. Much of this area was "desert tundra," and birdlife was scarce. A very few pairs of Rock Ptarmigan nested there. At the mouth of the Jordan River, 16 miles west of the Base, we failed to see a Rock Ptarmigan on either of our two visits (July 13; July 17–20). Most of our time there we spent in meadow tundra near the river, not in the rough country farther west. We did not see the bird on Hill Island, Bishop Island, or any of several other islands at the head of the Bay. At Lat. 68° 31′ N., Long. 71° 22′ W., near a large lake about 50 miles east-northeast of Wordie Bay, we did not see the species on August 8. At Lat. 65° 20′ N., Long. 77° 10′ W., near Cape Dorchester, we saw both adults and young on August 11 and collected two adult males that day. At Lat. 63° 38′ N., 70° 28′ W., along the southeast shore of Lake Amadjuak, we saw no Rock Ptarmigan on August 8 but saw literally hundreds of them on August 15. Some sort of migration must have been taking place, although we witnessed no such migration anywhere about the head of Frobisher Bay.

From June 15 to 22 we looked in vain for a ptarmigan in the vicinity of the Base. Daily we came upon evidence that the birds had inhabited the region — recently molted white body feathers; parts of carcasses, principally wings, with white primaries still attached; and droppings. A wing found June 15 looked as if the flesh had been picked from the bones only a week or so before.

On June 21, civilian workmen told us that for some time they had been seeing a pair of "partridges" in high, rough country near a construction road a mile or so north of the Base. Describing the cock as white, the hen as grey, they said that "just recently" they had not been seeing the hen, so had assumed that she was on her nest. The cock they had been seeing daily.

Early the following morning we found a white male ptarmigan, almost certainly this very bird. He was standing motionless on a huge rock. He gave a low cackle, otherwise we might never have seen him. Despite his being in almost complete winter plumage he was anything but conspicuous, for his white feathers were badly soiled, probably by dust from the much-used road. The red combs above his eyes were scarcely visible, but dark summer feathers spotted his head and upper neck. This was the latest date on which we saw a male ptarmigan largely in winter feather. Soper (1928: 105) informs us that in the Nettilling Lake area in 1925 "male birds remained white until well into July." At the head of Clyde Inlet in 1950, Wynne-Edwards (1952:366) saw a male with "dark feathers only on the crown and nape, and a spot on the breast" as late as June 23. In the Kotzebue Sound area of Alaska, on May 28, 1899, Grinnell (1900:36) collected males "in entire winter plumage" except for a few new dark feathers hidden among the old white crown feathers. Along the base of Wales Mountain, in northwestern Alaska, on June 5, 1921, Bailey (1926:123) took a courting male which was "entirely white except for the black loral patch." Delay of the male bird's molt into summer feather is described in detail by Salomonsen (1939).

We never saw this male ptarmigan again. We later found a female and her brood in this same area, but no male was with them. Salomonsen (1939: 417–418) says that in "the latter part of the brooding-time the male will retire to the higher parts of the mountain, where it lives alone the entire summer. The female . . . takes care of the newly hatched young, but when the juveniles are medium-sized it will fly with them higher up the slopes, joining the male, and from now on the . . . family will stick together." Jourdain (in Witherby, *et al.*, 1948:230) says that where ptarmigan are "plentiful, males generally desert broods and join in packs."

On July 6, in high country six or seven miles northeast of the Base, we happened upon a mother ptarmigan and her recently hatched brood. Having found the nest of a Snowy Owl (*Nyctea scandiaca*) along a little stream, we were crossing a rocky ridge. The day had lost its sun and hard snow was falling. The owls had been hooting and diving at us so fiercely that we had been forced to pay attention to them. Now that we were no longer being attacked, we were experiencing the rare sensation of being in owl habitat without either seeing or hearing owls. Suddenly, as we stepped down out of the wind into a sort of gully, we heard a rattling *grrr* or *krrr* and there, about 15 feet away, was a female ptarmigan running rapidly off with head held low. Standing still while the ptarmigan scurried about, we heard cheeping and saw several chicks scrambling clumsily through the tough strands of heather (*Cassiope tetragona*). We counted nine chicks and set about catching them. Soon we had five, one of which we lifted from water; then a sixth, which had dropped into a foot-deep crevice; finally a seventh, which had crouched among coarse lichens on a rock. The chicks we failed to find must have cheeped from somewhere behind us, for the mother bird ran a few steps in that direction, flew swiftly upslope, alighted, then fluttered back in response to the outcry of the chicks we had captured. Salomonsen (1950:174) discusses at some length "injury feigning" of the mother ptarmigan while the chicks are small, and "distraction by running" after the chicks have begun to fly. What we have just reported clearly shows that running may at times be the "diversionary display" of a hen with very small chicks, and we regard as somewhat finespun and over-complex Salomonsen's statement that the "change . . . from injury-feigning to distraction by running is correlated with physiological alterations, viz. an activation of the feather-growth, the achievement of the autumn-plumage now starting, *i.e.*, a fortnight later than in the male."

The chicks were in the creel we used for carrying specimens. We put them on the ground and covered them with our hands, thus quieting them. The agitated mother came closer. Her crest was lifted, but her body plumage was pressed down tightly so she had a slender, long-necked appearance. She gave two callnotes — the throaty *krrr* just referred to, and a clucking *kit* or *krit*, which made the chicks restless. Wanting to take photographs, we decided on a procedure. One of us was to cover the chicks with his hands until the camera was ready; then, when the female came close and called *krit*, the chicks were to be freed. We did not let all the chicks go at once. When two of them ran to their mother she stood perfectly still, lifted her plumage, and became broody. One by one the rest of the chicks pushed their way under her, and we took photographs at a distance of two or three feet (Fig. 1).

The mother ptarmigan was in virtually complete summer feather. Her wings were largely white, of course, and there were many pure white feathers on her belly and lower breast. Whether these white belly feathers were of the outgoing winter plumage or part of the summer plumage we could not be sure. From the appearance of midsummer adult Rock Ptarmigan specimens we have handled, and from certain illustrations in Salomonsen (1939), we are led to suspect that some white belly feathers are replaced, season after season, in both males and females, with *white* feathers — in other words that the lower belly stays white the year round, just as the remiges do.

We looked in vain for the male bird. Wondering why this particular spot had attracted the ptarmigan, we noticed that no owls were in sight and wondered if we were in an area removed from, or between, the nest-territories and hunting-grounds of the owls. Many owls lived in the vicinity. That these birds were subsisting chiefly on lemmings was becoming more evident to us with every visit we made to their nests. Was this "ptarmigan area" uninhabited by lemmings and therefore unattractive to the owls?

FIG. 1. Female Rock Ptarmigan brooding chicks. Photographed near head of Frobisher Bay, Baffin Island, July 6, 1953.

We did not kill that mother bird, but we collected the largest and smallest of the chicks (GMS 11741–42). These proved to be, respectively, a male and a female. Their crops and gizzards were well filled with tiny green leaves of crowberry (*Empetrum*) and bits of sand.

The brood could not have been more than a few hours old. So little developed were the incoming primaries that we had to part the natal down of the manus to find them at all. Jourdain (in Witherby, *et al.*, 1948:230) states that in the Scottish Rock Ptarmigan (*Lagopus mutus millaisi*) the eggs are laid "at intervals of 24 to 28 hours," and the incubation period is 24–26 days; so egg-laying in this case probably started not later than June 3 or 4. On that date there must have been much snow in the high country. Soper (1946:225) found fresh eggs as late as June 28 in the Bowman Bay area in 1929.

On July 8 men at the Base told us of having seen that day a mother ptarmigan and several small young not far from the spot at which we had seen the solitary male July 6. On July 11 we learned that this (or another) hen and her chicks had just been seen in the same place, but we failed to find them. These chicks and the July 6 brood must all have hatched at about the same time. The two areas were about four miles apart.

On July 21, Derry V. Ellis reported that he had just seen a male, female, and at least four young ptarmigan in rough country about two miles east of the Base — between the Hudson's Bay Company post and Tarr Inlet, and not far from the sea. The chicks, about one-third grown, could fly well. Salomonsen (1950:174), discussing the "return of the male" to the female and brood in Greenland, reports "both parents in the covey as early as 28 July . . ." and "hens and chickens without the male" as late as August 25. We have no way of knowing, of course, whether the male seen by Ellis had left the female and brood at all.

On July 22, guided by Ellis, we found this family group about a quarter of a mile from the spot at which Ellis had last seen them. There were five young. The male flew upslope rapidly, alighting a few rods from us. The female beat her ragged wings briefly and noisily, as if trying to fly, but after rising a short distance dropped back to the ground. The young birds all flew well. We collected the adult male and female (GMS 11782–83) and three of the young, one male and two females (GMS 11784, –85, –86). The parent birds were largely white on the belly and lower breast. The male weighed 1 lb., 1 oz., the female, 14 oz. The testes of the male each measured about 3×5 mm. The female had a large, but ill-defined, brood-patch. The crop and gizzard of each of the five specimens was crammed with leaves, stems, buds, green berries, and gravel.

The young birds were still partly in natal down. The white of their incoming remiges was not yet noticeable. From Bent's statement (1932:207) one might expect to find two white outer primaries in chicks at this stage. Actually, as Salomonsen (1939:50) carefully explains, the two white outermost primaries "commence to grow much later than" the other juvenal remiges; they do not reach full length until most or all of the brown juvenal primaries have dropped out; and they may not be part of the juvenal plumage at all. In the three young birds collected by us July 4, the *functional* outermost primaries were dark and brown, but the actual outermost two, mere tips and utterly non-functional, were barely visible. These incoming feathers were white, but there was dusky mottling along the midrib. In each chick one or more proximal primaries, or distal secondaries, or both, were pure white. These were, though very short, visible when the wing was fully spread.

We had no way of knowing, of course, where these ptarmigan had nested, but the area in which we found them was far removed from our other two "ptarmigan areas"; it was, furthermore, the only area in which we found the Short-tailed Weasel (*Mustela erminea*), the only area in which we actually saw the Arctic Hare (*Lepus arcticus*), and one of the very few areas visited by us in which we never saw a Snowy Owl.

On July 22, Derry Ellis saw another "dark" adult ptarmigan, probably a male, on a bluff headland just west of Tarr Inlet. This bird we looked for but did not find.

On July 26 we found a female ptarmigan and six half-grown chicks in high country north of the Base. These birds were feeding contentedly on the lee side of a rocky hill not far above a big lake. The mother bird stood on a rock not far away — motionless until we drew close, whereupon she walked a few steps, flicking her tail excitedly. The brood kept together, moving slowly in the same general direction and pulling the greenery off with rapid jerks of their heads. They were somewhat older than the chicks we had seen on July 22, a fact apparent from their size as well as from the noticeable amount of white showing in their wings as they took flight. Every chick had this white wing-spot. The functional outer primaries were dark, the wing-spot being composed of inner primaries (and outer secondaries?). The mother bird, though in full summer feather, was white-bellied. Her rump was not, so far as we could tell, a mixture of coarsely- and finely-marked feathers, so she probably had not yet started to don "fall" plumage. Her wings were ragged with molt, but she flew fairly well.

On July 28, on a talus slope just above the raised beach paralleling the shore of Tarr Inlet, Parmelee flushed a pair of ptarmigan at about 20 feet. He followed and collected the male (GMS 11793), a handsome gray individual, white on the belly, throughout most of the wings, and in the middle of the throat. The combs above the eyes, though not large, were bright red. The testes each measured about 3.5×5 mm. The crop and gizzard were packed with broken-up leaves, twigs, and buds of willow (*Salix* sp.) and birch (*Betula* sp.).

On August 3, while climbing a steep, boulder-strewn slope just east of Tarr Inlet, we noticed among the unusually luxuriant birch and willow a great deal of ptarmigan sign — fresh droppings, scattered white feathers, nipped-off twigs, and, finally, a few buff-and-black summer feathers. We looked hard for the birds but failed to find them. That afternoon Sutton returned, investigated the windless places, and found a group of four birds, an adult female and three young, all very tame. Motionless for a time, they came suddenly to life, lifted their heads, pressed their body plumage close, and flicked their tails, as if about to fly, but presently they returned to "normal" and walked slowly to one side. The chicks were almost as large as the adult.

Sutton collected the adult female (GMS 11802) and the largest chick (GMS 11803), a male. Both were molting, the chick extensively. The chick's combs were a brighter shade of red than the adult's, and its two outermost primaries, white except for dusky mottling along the rachis near the tip, were still sheathed at the base. The primary next to these two was brown, and this was the only dark primary left (see Figure 2). The incoming plumage on the sides was pure white; but the body plumage is general was much mottled and barred. The testes measured about 2 $\times$ 3 mm. The crop and gizzard in both specimens were packed with willow leaves and other vegetation.

Fig. 2. Young male Rock Ptarmigan collected near head of Frobisher Bay, Baffin Island, August 3, 1953 (GMS 11803). Note the one unmolted brown juvenal primary among the white first-winter primaries.

On August 10 workmen saw a female ptarmigan and nine large young in high country about a mile north of the Base. This could hardly have been the brood seen by us on July 26. We tried to find the birds, but failed. We did not see a ptarmigan anywhere about the head of Frobisher Bay after August 3.

On August 11 we saw several Rock Ptarmigan in the vicinity of Cape Dorchester, near the northwest tip of Foxe Peninsula, an area in which we had fully expected to find the Willow Ptarmigan (*Lagopus lagopus*) if we found any ptarmigan at all. The country there was much flatter than that about the Base; but just east of the lake-dotted meadow tundra rose several parallel rocky ridges, all low, all extending from the coast to as far southward and inland as the eye could see. Near them, but definitely away from them, out in the grassland, we found several Rock Ptarmigan — first a female and five quarter-grown young; then two adult males feeding together fully three hundred yards from the nearest rocks; then two more adult males. We collected an adult male (GMS 11828) among the rocks and another adult male (GMS 11829) on the tundra. The former we almost certainly would never have seen had it not given a dry, rattling, belch-like cry. The two specimens were very gray, but in both of them the white feathers of the belly, tibiae, tarsi and toes were largely of the *incoming* winter plumage, so the darkest stage of the fall or late summer plumage must surely have passed. The undertail coverts were very dark. These birds were not very fat. Their testes each measured about 3 × 5 mm.

Along the southeast shore of Lake Amadjuak, on August 15, again in country throughout which we expected to find Willow Ptarmigan, we came upon great flocks of Rock Ptarmigan — most of the birds undersized and young, all in mixed, piebald plumage. They were feeding on the rough, rocky slopes rather than in the grasslands. Not a bird did we see along the lakeshore proper or in a marshy place near a tundra pond. In one flock were several one-third grown young with their solicitous mother, whose cries were unlike those of the other adult birds. In one area fairly swarming with ptarmigan the rattling or cackling was an almost continuous sound. The wind was high and the birds were restless. More than once, in the lee of a hill, we flushed a hundred or so birds at a time and the air was filled with the flashing of white wings. In this country there were many Barren Ground Caribou (*Rangifer arcticus*). We were amused when several of these fine animals, having put the ptarmigan to flight by suddenly breaking into a run, themselves were startled by the whirring and flashing of wings beneath their feet.

We collected an adult male ptarmigan (GMS 11839) which seemed to keep separate from the flocks. This bird was gray, but throughout its body plumage were scattered new white feathers. The testes each measured about 3 × 5 mm.

Nesting Success

We saw, or heard of, the following broods: 9 small chicks (July 6), "several" small chicks (July 8), 5 third-grown chicks (July 22), 6 half-grown chicks (July 26), 3 almost full-grown chicks (August 3), 9 "large" chicks (August 10), 5 quarter-grown chicks (August 11), and "several" third-grown chicks (August 15). The last two broods must have been unusually late in hatching. One pair of adults, seen July 28, were without chicks. The big flocks seen by us August 15 were composed largely of well-developed young birds which seemed to be free of "family ties."

We found no evidence that Snowy Owls nesting near the Base were feeding on ptarmigan. We visited several owl nests quite regularly, carefully examining them and their surroundings at each visit.

Factors favoring the ptarmigan in the vicinity of the Base were (1) absence of the Arctic Fox (*Alopex lagopus*); (2) great rarity of weasels; (3) abundance of lemmings (*Dicrostonyx groenlandicus* and *Lemmus trimucronatus*), the sole prey of the Snowy Owl and Rough-legged Hawk (*Buteo lagopus*), so far as we could ascertain, and an important food-item of the Peregrine (*Falco peregrinus*); (4) absence of jaegers (*Stercorarius* spp.); (5) rarity of the Glaucous Gull (*Larus hyperboreus*) and Herring Gull (*L. argentatus*); (6) an artificial food supply for the Raven (*Corvus corax*) at the Base's dump.

The personnel at the Base did little, if any, gunning. The Eskimos occasionally shot a ptarmigan, we were told, but they did not shoot any during our stay.

Discussion of Specimens

Our five adult male specimens do not, when lined up in order of capture, show gradual change from "early summer" to "late summer" plumage (Fig. 3). The earliest (July 22) is certainly the most coarsely marked above, especially on the crown, neck, rump and upper tail coverts, but the general appearance of the back is not dissimilar to that of the latest (August 15). The under parts of these two specimens are similar, too, though the white of the July specimen seems to be composed wholly of outgoing feathers, while in the August specimen all these white feathers are new. In only one specimen of the five (July 28) is the middle of the throat noticeably white. In no specimen is the lower belly anything but white. The under tail coverts, throughout the series, are very dark.

Of the two adult females, the earlier (July 22) is decidedly the more boldly marked above, and the under parts of this bird have a blotchy appearance resulting from the presence of numerous unmolted winter feathers. In the August specimen many of the back and rump feathers, scapulars, and upper tail coverts are of the finely vermiculated "late summer" plumage, and the under parts, save for the white of the very middle of the lower belly, are boldly maculate.

The almost full-grown male (August 3) is decidedly like the adult female taken the same day in some respects, an interesting point of similarity being the dusky mottling along the midrib near the tip of the longest primary

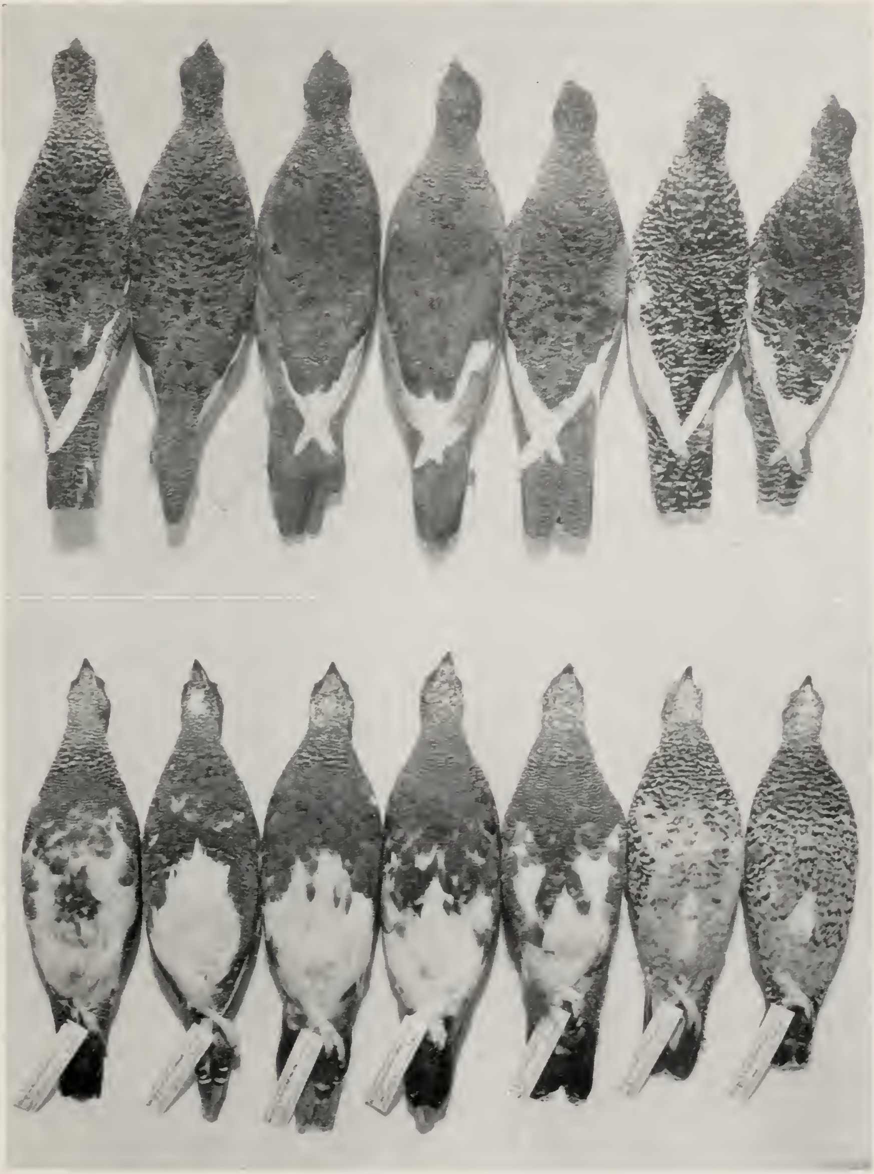


FIG. 3. Dorsal (above) and ventral views of five adult male (left) and two adult female Rock Ptarmigan specimens from southern Baffin Island, arranged in order of capture. Males, left to right: GMS Nos. 11782 (July 22), 11793 (July 28), 11828 (Aug. 11), 11829 (Aug. 11), 11839 (Aug. 15). Females, left to right: GMS Nos. 11783 (July 22), 11802 (Aug. 3).

(see Figure 2). Worth mentioning is the possibility that these primaries are equal or correspondent — that in the female having been held over from the preceding fall. and showing her to be a one-year-old bird, that in the young male being one of its two very first outermost primaries. The outermost primaries of adults more than a year old probably are without this dusky mottling.

Acknowledgments

These studies were aided by a contract between the Office of Naval Research, Department of the Navy and the Arctic Institute of North America N7onr–367–01. We wish to thank especially Mr. Derry V. Ellis, a student at McGill University, for his field assistance; Messrs. Ross Peyton and Brandon Halloran of the Hudson's Bay Company, for helping us to reach certain islands in Frobisher Bay; Constables Robert Van Norman and Robert Pilot, of the Royal Canadian Mounted Police, for taking us by boat to the mouth of the Jordan River; and personnel of the Royal Canadian Air Force for permitting us to accompany them on flights to remote parts of southern Baffin Island.

Literature Cited

Bailey, A. M.
1926 A report on the birds of northwestern Alaska and regions adjacent to Bering Strait. Part 9. *Condor*, 28:121–126.

Bent, A. C.
1932 Life histories of North American gallinaceous birds. *U. S. Nat. Mus. Bull.* 162:1–490.

Grinnell, J.
1900 Birds of the Kotzebue Sound region, Alaska. *Pac. Coast Avif.* no. 1:1–80.

Salomonsen, F.
1939 Moults and sequence of plumages in the rock ptarmigan (*Lagopus mutus* [Montin]). *Vidensk. Medd. Dansk Naturhist. Foren.*, 103:1–491.
1950–51 The birds of Greenland. (Copenhagen.) Pt. 1: 5–158 (1950); pt. 2: 159–348 (1951); pt. 3: 349-608 (1951).

Soper, J. D.
1928 A faunal investigation of southern Baffin Island. *Bull. Nat. Mus. Canada*, 53:76–116 (Birds).
1940 Local distribution of eastern Canadian arctic birds. *Auk*, 57:13–21.
1946 Ornithological results of the Baffin Island expeditions of 1928–1929 and 1930–1931, together with more recent records. *Auk*, 63:1–24, 223–239, 418–427.

Witherby, H. F., F. C. R. Jourdain, N. F. Ticehurst and B. W. Tucker
1948 The handbook of British birds. Fifth impression. Vol. 5:1–381.

Wynne-Edwards, V. C.
1952 Zoology of the Baird expedition. (1950). I. The birds observed in central and south-east Baffin Island. *Auk*, 69:353–391.

Department of Zoology, University of Oklahoma, Norman, Oklahoma, March 4, 1955

WHAT CONSTITUTE SCIENTIFIC DATA FOR THE STUDY OF BIRD DISTRIBUTION?[1]

BY JOSSELYN VAN TYNE

THE student of bird distribution is now having placed before him not only far greater amounts, but also wholly new types, of data. Hence he will do well to occasionally stop and re-examine the materials with which he is constructing his account of bird distribution. If he were to fall into conversation with some of those zoologists who deal with mammals, reptiles, or amphibians, he would find that when they work out and map the distribution of a species they use only *specimen* records. If he were then to try to tell the mammalogist, for example, how much better we ornithologists do things, the mammalogist, if he knew his literature well, would surely read to him the following passage published in 1928 by Joseph Grinnell, probably the most distinguished student of bird distribution America has produced:

"With the great majority of the species of birds and mammals, of reptiles and amphibians, there is only one acceptable basis for determining presence and that is the taking of actual specimens and the preservation of these permanently, with attached, signed statements of locality and other circumstances of capture. So-called 'sight records,' even of the commonest birds, have proved over and over again to be wrong. Many, many species and subspecies are difficult enough of systematic determination with actual specimens in hand; especially is this true as regards the ultimate taxonomic unit, . . . the subspecies. The results of distributional study to be valid must be made on the basis of accurate identifications of materials; and these materials must be preserved so as to permit of repeated verification as refinements in systematic analysis accompany increased experience. Hence the research museum, functioning as the repository for this accumulating evidence. Popular testimony, impression, the sight record, have, perhaps, their place in the 'romance' of natural history; but this province belongs to literature and not to science." ("Presence and Absence of Animals," *University of California Chronicle*, 30, 1928:429–450. Reprinted in "Joseph Grinnell's Philosophy of Nature," 1943.)

Certainly these are sound principles to follow in dealing with most land vertebrates. For example, most mammals, reptiles, and amphibians are not meant (so to speak) to be identified at a distance, nor primarily by vision. They identify each other only at rather close range, and then mainly by scent or sound, neither of which can be received really well by man. Indeed

[1]Presented October 21, 1952, at the meeting of the American Ornithologists' Union at Baton Rouge, Louisiana. Those interested in this topic should not fail to read also Ludlow Griscom's excellent discussion in the *Proceedings of the Linnaean Society of New York*, Nos. 63–65, 1954:16–20.

some mammals cannot be positively identified even by the expert mammalogist until he examines the teeth with a dissecting microscope.

But we may be justified in treating birds somewhat differently from the way we treat other vertebrate groups. Birds, by and large, readily recognize each other at a distance, and primarily by vision. Man (if we include field glasses as "factory equipment") has finer vision than any other mammal and is therefore especially equipped to act as a bird among birds and to distinguish the various species at a distance. Further, the ornithologist has the advantage of what may be called the "Roger Peterson effect," for, thanks to Peterson, identification of birds in the field has become a science in itself.

Early in the century, before the era of scientific field-guides and good binoculars, the careful ornithologist was almost wholly restricted to the use of specimen records, but there has been a great change. The shift came slowly at first. Single notes by ornithologists of repute began to appear in the *Auk* and other major journals, reporting a sight record of some strikingly plumaged bird in a region where it had not previously been recorded. These notes were distinguished by their wealth of supporting detail. The author recorded how near the bird was and how long he watched it, adding that he had become familiar with the species elsewhere and that he was aware at the time of observation of the rarity of the occurrence. The permanent scientific value of the note was also safeguarded at every step in its preparation for publication. The note was sent to the editor, who probably returned it to the author at least once, calling his attention to ambiguities in expression and to certain details that it would be desirable o add. Then the note was returned to the editor, set in type, and the proof sent to the author for checking. When it finally appeared in print it was almost equal in value to a specimen record.

A major influence in the changing situation in American ornithology was the development of the "Season Report." Frank Chapman, who originated so many things in ornithology, introduced the "Season Report" in his popular journal, *Bird-Lore* (1917) in order, he stated, "to give a general idea of the more unusual features of each season in different parts of the country" and "to accumulate a valuable fund of data on the fluctuation in the abundance of species."

The contributors of the early reports were:

Boston region—Dr. Winsor Tyler
New York City region—Charles H. Rogers
Philadelphia region—Julian K. Potter
Washington, D.C., region—H. C. Oberholser
Oberlin region—Lynds Jones

Soon he added:

Denver region—Dr. W. H. Bergtold
Minnesota region—Dr. T. S. Roberts

The reports were brief (usually but half a page) and were based on the direct observations of these recognized ornithologists and the field workers they personally knew. (Potter, for example, would quote Witmer Stone, or Oberholser would quote a young man named Alexander Wetmore.)

The "Season Report" section of *Bird-Lore* was immediately popular. More regions were added, and regional editor followed regional editor. Much information valuable to ornithology was printed. Indeed, T. S. Roberts published his collected reports of 20 years in book form ("Logbook of Minnesota Bird Life," 1938).

The section grew so large that it had to be published separately as a supplement; and soon it became a separate journal, *Audubon Field Notes*, under the joint auspices of the National Audubon Society and the U.S. Fish and Wildlife Service. It is now a journal of over 300 pages to a volume and treats 19 different regions. Furthermore, the idea has so spread that we have "Season Reports" (under one name or another) in many State and other local bird journals.

These regional reports have—almost necessarily—come to be handled by an ever larger and ever shifting group of regional editors, who are not always the most critically minded scholars in the field. Further ,the editors (and, in turn, their contributors) are increasingly under pressure to work fast and get their records and summaries in before a prescribed deadline. (It approaches the pressure under which newspaper men work!) Records are rushed in, combined and summarized as quickly as possible, and hurried on to the central editor. There can be no submitting of printer's proof to contributors; nor, as a rule, any correspondence about even questionable records. The tendency is to go ahead and publish a given record "for what it is worth" (a defense I have actually heard many times!). Under such circumstances the record may be worth exactly zero; or, indeed, it may have a negative value, for it may seriously mislead the student of bird distribution. Worst of all, there is no way of distinguishing good records from bad, nor of correcting the mistaken records afterward. (Though a specimen record may involve an error in identification, the specimen remains as a basis for correction.)

Thus as the acceptance of the sight record became more general, safeguard after safeguard was dropped and the use of these sight records became less and less defensible from the point of view of scientific method.

Noting the number of patent errors appearing in print which related to my own immediate geographical area, and noting that other writers were beginning to use these "records" in their serious publications, I began to wonder how the "Season Reports" should be treated—and indeed how the editors *intended* that they should be treated. Therefore I wrote some of the editors and asked in what light they themselves viewed these publications. I was dismayed to find that some editors had not even thought about the matter! Others cheerfully replied that these records they were putting in print were "scientific data" to be treated at their face value. However, I am glad to say that Mr. Chandler Robbins, the editor of the leading journal in this field, *Audubon Field Notes*, sent me a thoughtful, critical statement:

> "Regarding the scientific value of observations reported in *Audubon Field Notes*, I consider that they may safely be used collectively, but that individually each must be judged separately on the reputation of the observer. In many areas the compilers know most of their regular correspondents personally, and so they screen out dubious material before writing their reports. A few deletions on grounds of questionable validity are made in editing the reports in this office; and we make a practice of publishing all corrections that are brought to our attention (except for misspellings or typographical errors which do not alter the details of observations).
>
> "Obviously, when we publish thousands of observations each year without providing details of each, this material cannot be considered of equal scientific value with detailed records published in the *Auk*, *Condor* or *Wilson Bulletin*. However, since the observer's name is given with almost every occurrence, contemporary ornithologists interested in confirming any given record can get further details by corresponding with the regional editor, a local compiler, or the observer himself.
>
> "In summary, I would say that: (1) in mass, *Audubon Field Notes* records may be taken at face value; (2) individually, sight records should be evaluated either by the reputation of the observer, or through further inquiry; (3) I consider a report of a specimen record in *Audubon Field Notes* as on a par with a specimen record in the *Auk* as far as validity is concerned; (4) rarities on Christmas Bird Counts are open to more question than are unusual reports in the other issues" (quoted with Mr. Robbins' kind permission).

We then come to the question of what can be done to improve the general situation.

It is clear that we need a widespread revision of editorial criteria. And here I am referring not only to the "Season Report" category but to our general scientific literature on birds which appears in serial publications. Let me illustrate by mentioning a recent issue of a very excellent British bird journal. There we find under the heading, "American Pectoral Sandpipers in England in 1951," a half-page note with no author's name attached, giving the dates and places of five new "records" of the Pectoral Sandpiper (an extralimital species there) with no details whatever, nor even a statement whether the birds were collected or merely seen. In short, we have gone so far that we now even forget to state whether we are talking about sight records!

While we all recognize the great value of the "Season Report" as an irreplaceable record of the mass movements of birds and the fluctuations in their numbers, the scholarly investigator of bird distribution dares not rely on any individual record that appears there without checking it by correspondence and by using every other safeguard he can devise. In the meantime, editors can help ornithologists greatly by raising standards in every possible way and by so editing that the "Season Report" will deal more exclusively with the general population changes and movements, which it alone can trace and put on permanent record, and less with the individual sight record.

Museum of Zoology, University of Michigan, Ann Arbor, Michigan, September 1, 1955

GENERAL NOTES

Incubating American Robin repels female Brown-headed Cowbird.—At my home in New Castle, Lawrence County, Pennsylvania, the House Sparrows (*Passer domesticus*) have half a dozen nests every year and Brown-headed Cowbirds (*Molothrus ater*) parasitize several of these nests regularly. There is also a Robin (*Turdus migratorius*) which regularly places her nests in the "S"-shaped offset of the conductor pipe draining the metal gutter at the front of the house. Thus, the nest is sheltered by the roof. By early July of 1954 she had raised one brood, made some repairs to the nest, completed her second clutch of three eggs, and begun to incubate them. The time of day had arrived one morning when she would normally leave her nest briefly for food, drink, and perhaps even a bath. I noticed she was turning her head in a peculiar way, and looking intently for a moment at something at a distance; then she would utter a barely audible "churrup."

Following the line of her gaze, I noticed a female cowbird stalking in the grass at the edge of the street about 30 yards away. I thought the latter was trying to stay out of sight behind a maple tree, but it was plain that it was watching the robin by slight turns of the head every few seconds. This continued for perhaps five minutes and may have been going on for some time before I noticed it.

Suddenly the robin took off across the street toward a small swamp. No sooner was she out of sight than the cowbird flew directly to the robin's nest, perched on the rim for an instant, and then settled down on the nest. At almost the same instant, I saw the robin returning at full speed, with beak outstretched and, when within ten feet or so, scolding vociferously. The cowbird started awkwardly from the nest and had barely taken to flight when the robin hit her with feet, breast, and beak. The cowbird lost altitude rapidly. The robin made a circle and attacked with such force that both birds fell to the ground. Then the robin with wing and beak beat the interloper ferociously while the cowbird seemed to have no notion of defense except for flight. Every time the cowbird tried to rise, the robin pummelled her back to earth. The scuffle continued as they moved further up the street until, after much running and jumping, the cowbird made her escape. The robin did not follow further, but continued to scream and scold before returning to her nest.

I traced the route of the battle and noticed numerous specks of blood on the green grass, and, to my surprise, a cowbird egg. This was warm when I touched it. I left it until the next day to see if the robin would break it, but nothing happened. I then carried it ostentatiously to a point under the nest. The robin watched the performance but did not disturb it and the egg remained there for three days and then disappeared from causes unknown.—Carl L. Leathers, *1004 North Jefferson Street, New Castle, Pennsylvania, May 3, 1955.*

Goose-behavior by a White Leghorn chick.—Six hours after leaving the shell, an African gosling (a domestic breed of the Swan Goose, *Anser cygnoides*) was placed in a brooder with half a dozen White Leghorn (*Gallus gallus*) chicks, all of which were between the ages of 18 and 24 hours. One week later, the gosling, together with one of the chicks, was removed from the group and the two were placed in a separate room where a large pen had been prepared for them. Originally, the chick had been kept with the gosling only to provide company, for this gosling gave vent to loud distress cries whenever left alone. The animals were visited by the observer several times each day.

Within one week after hatching, the gosling proved itself imprinted onto humans, the following-reaction being readily elicited. It did not appear to discriminate between different individuals, however, this ability not appearing until it was more than four weeks of age. The chick, in the meantime, had become imprinted upon the gosling, following it, "cheeping" loudly when prevented from following, and fluttering excitedly towards the gosling upon the latter's return after an absence. Initially, the goose showed no overt response to this behavior of the chick, but by the middle of the second week it was apparent that the goose was reluctant to leave its pen to follow its human *Kumpan* unless the chick was permitted to accompany it. The gosling clearly showed ambivalence, following, stopping when the chick's "peeps" reached a crescendo, ofttimes returning to the chick, then following again. By starting the gosling off at a run or very rapid walk, this ambivalence could be overcome. Apparently, the inertia of a more rapid movement overcame the attraction of the chick's distress calls.

At this time, it was noted that the chick was adopting many of the behavioral traits of the goose. When the goose was treated to a handful of freshly cut grass, the chick would join it in pulling the grass from the observer's hands, eating it as eagerly as its Anserine partner. At first, the chick's efforts to manipulate large blades of grass were rather ridiculous, but it soon achieved considerable skill. In addition, the vocalizations of the chick began differing radically from what they had been earlier and from those of normally-reared chicks. Ordinarily, even when reared in isolation, the conversational sounds of chicks when feeding consist of a series of rather short, discrete "pips." In contrast, young goslings emit much softer notes which are run together to a much greater degree. The tone-quality of the chick's voice was not greatly altered, but the phraseology and modulation were clearly that of the gosling. (A tape recording has been made.)

This chick has not, it may be noted, progressed to the stage where it voluntarily will join the gosling in the latter's swim-tub. Regularly, however, it would perch on the rim of the tub while the gosling took its daily ablutions. Dr. Dillon Ripley has observed a hen-mother in the water with her foster brood of goslings.

Such a modification of normal patterns as that shown by the chick underscores the importance of social interaction as a determinant of behavior.—PETER H. KLOPFER, *Osborn Zoological Laboratory, Yale University, New Haven, Connecticut, July 8, 1955.*

Changes in English Sparrow population densities.—The English (or House) Sparrow (*Passer domesticus*) in general is associated with man and his works. When the English Sparrow was introduced and established in North America, the densest populations developed in the cities where human populations were densest. There, horses used for transportation supplied an abundance of waste grain for the sparrows to eat. With the replacement of horse-drawn transport by motor-transportation there was a decrease in the density of sparrow populations in the cities. (See especially Chapman, 1936. "Handbook of Birds of Eastern North America," p. 480, and Taverner, 1939. *Can. Field-Nat.*, 53:99.) Such a decrease is even now taking place in London (Fisher, 1954. "A History of Birds," p. 165).

A similar decrease in sparrow population has presumably taken place in Chicago. The magnitude of the decrease in the horse population is indicated by data from T. Carulin, writing in the Chicago Daily Tribune of May 26, 1955: In 1890 there were 101,566 horses brought into the city for sale; in 1931 there were 4,009 licensed horse-drawn vehicles; in 1955 it is estimated that there are 500 horses, including riding horses, in the stock yards and various stables, and only 52 licensed horse-drawn vehicles.

In the Chicago area there are now no English Sparrows in the heart of the city, where I have crossed part of the "Loop" twice a day for much of the past seven years, on my way to and from the Museum. There are sparrows on adjacent Michigan Avenue with its park, and there are sparrows on the city's south side, where the buildings are spaced out and there are trees and bits of gardens. But I've seen none in the downtown business section. Presumably they used to be there in abundance, feeding on the refuse from the horses that moved so much of the city's traffic at an earlier period.

It is not that there is no food available in the "Loop," for Domestic Pigeons (*Columba livia*) thrive there. About the La Salle Station there is often a flock of more than 100 pigeons, and probably several hundred of them live within two or three blocks of the station. These get their food in part from grain put out for them by bird-lovers; in part from cadging peanuts from passengers on the elevated train stations, and in part from foraging for scraps along the streets and amongst the garbage in the alleys. But evidently what is satisfactory for the pigeons is not for the sparrows.

In the Chicago area I know the sparrow populations are denser in the suburbs and outlying towns, but densest about the stock farms where hogs are being fed on special, ground-grain food. In the summer the sparrows spread out, some even visit the picnic areas on the Lake Michigan shores; in late summer the grain fields attract them in numbers. But in winter they withdraw to the human communities, to farm buildings, and most of all to farms where hogs are fed. At such hog-feeding places I've seen flocks of hundreds on a winter afternoon.

Some ecology textbooks correlated densities of House Sparrow populations at an earlier period directly with the density of human population, though they might have more pertinently correlated it with the density of the populations of the domestic horse. Fisher has already pointed out that the House Sparrow is not so much a parasite of man as an associate of domestic beasts, especially of horses, and Hausman (1946. "Field Book of Eastern Birds," p. 544) gives its habitat as the edge of cities, etc., especially where chaff, chicken feed, and similar foods are available.

The correlation of population densities is probably best put somewhat as follows: English Sparrow densities correlate directly with the densities of certain domestic animals, the species varying from time to time and from place to place. Earlier the densest sparrow populations were correlated with the densest populations of horses; presently they are correlated in the Chicago area with the densest hog populations, while in New Jersey they seem to be coincident with the densest domestic fowl populations. Perhaps in other areas, other correlations will emerge.—A. L. Rand, *Chicago Natural History Museum, Chicago 5, Illinois, May 5, 1955.*

Behavior of a Ring-necked Pheasant on a Prairie Chicken booming ground.—A thorough review of galliform hybrids was compiled by Peterle (1951. *Wilson Bull.*, 63:219), who pointed out the importance of similar habitat and behavior in hybridization. Lincoln (1950. *Wilson Bull.*, 62:210) reported a hybrid between the Ring-necked Pheasant (*Phasianus colchicus*) and Prairie Chicken (*Tympanuchus cupido*), but he offered no theories as to how it might have occurred. In May, 1954, I had occasion to observe how hybridization between these species might possibly occur in the field. The opportunity was afforded while I was in a blind, observing Prairie Chickens on a booming ground in Section 20, T23N, R5W, Missaukee County, Michigan. The surrounding area either is under cultivation or is grazed by sheep or cattle. There is a fairly dense pheasant population in the area.

I was in the blind on May 12 at 4:30 a.m. The weather was cloudy and foggy, the temperature about 37°F. The Prairie Chickens began flying in at approximately 5:00 a.m., and immediately started booming and displaying. There were eight males and one female on the ground.

At 6:00 a.m. I heard a pheasant crow about one-quarter mile south of the blind. At 6:25 a.m. the pheasant was crowing 75 yards south of the blind. During the next five minutes, the pheasant walked into the midst of the displaying Prairie Chickens. Suddenly, it ran toward one of the males, which flew off about 50 yards. The pheasant flew after it immediately. The Prairie Chicken again took flight, with the pheasant still in pursuit. The pheasant alighted about one-quarter mile away, but the Prairie Chicken flew a few hundred yards farther. For a few minutes, the pheasant crowed in this area; then started slowly walking back toward the booming ground. At 6:45 a.m., the Prairie Chicken returned to the booming ground; a few minutes later the pheasant was back among the Prairie Chickens. The pheasant then ran after another male Prairie Chicken, which ran a short distance and then flew off. The pheasant flew after him for about 25 yards, alighted, and again returned to the booming ground.

Finally, a third Prairie Chicken was singled out, and the performance was repeated, after which the pheasant walked off about 30 yards, and at 7:00 a.m., flew toward the point from which it was originally heard.

One might theorize that the cock pheasant was merely intent on driving away possible rivals for his harem. On the other hand, he might have mistaken these relatively drab birds for female pheasants, after being attracted to the area by the dancing activity. In either case, if a receptive female had been "selected," the hen might possibly have submitted to copulation and *Phasianus-Tympanuchus* hybrids could have resulted.—Elsworth M. Harger, *Michigan Department of Conservation, The Heights, Michigan, June 3, 1955.*

Altitudinal records for Chimney Swifts.—Mr. Paul Farren, a former student of mine who pilots airplanes in attending to his work as a geophysicist, has given me records of Chimney Swifts (*Chaetura pelagica*) seen at high altitudes. The records are especially interesting because they are accompanied by precise meteorological data. The first of these records was so unusual in Mr. Farren's experience that he called to tell me about it. I asked him to keep me informed of other such observations; but it was more than three years before he reported to me again. At this time he wrote: "I average 3,500 miles per month air travel and frequently fly in the vicinity of 7.000 feet; so you can readily estimate how many miles I have traveled between sightings of these birds." Data on the three observations follow:

1. April 30, 1951, at 2:30 p.m., over Lufkin, Texas; altitude 7,300 feet; ground 325 feet above sea level. Two Chimney Swifts seen together, and then one about 10 miles farther on. A south to southeast wind blowing 25 to 30 m.p.h. at the ground and at the altitude of the plane; ground temperature 75°F.; a strong cold front about 150 to 200 miles to the west; light scattered clouds with bases at 4,000 feet and tops at 6,000 feet. The birds were flying above the clouds. Mr. Farren said: "I had never before seen birds at such a height."

2. May 18, 1954, at 4:30 p.m., over Refugio, Texas; altitude 7,000 feet; ground 80 feet above sea level. A single Chimney Swift "which struggled with considerable alarm and finally avoided my plane." Southeast wind 15 to 20 m.p.h. at the surface; variable winds 7 to 10 m.p.h. at the altitude of the plane; ground temperature 83°F.; squall line from the northwest about 50 miles distant, and a cold front coming in from the north, with rainy weather; an overcast of stratus clouds at 8,000 to 12,000 feet.

3. August 30, 1954, at 3:35 p.m., over Ames, Liberty County, Texas; altitude 6,500 feet; ground about 50 feet above sea level. One Chimney Swift "flying south in a frantic hurry." Temperature at the surface 102°F.; a cold front, preceded by a squall line, about 50 miles to the north. "Smooth, warm air, 25 miles south of a squall line of considerable turbulence."

All the circumstances of these three unusual observations suggest that, in each case, a cold front was beginning to drive a wedge of cold air under the warm air mass of southern Texas; that the warm air, in typical fashion, was riding high up the slope of the cold front; and that the Chimney Swifts were riding with the warm air. A little earlier, the warm air and the birds would have been at a lower altitude; a little later, the warm air would have cooled off, and the birds would have descended to more normal levels. Mr. Farren happened to see them at just the right moment.—George G. Williams, *The Rice Institute, Houston, Texas, June 20, 1955.*

Nesting of the Mountain Bluebird in Cleveland County, Oklahoma.—During the fall and winter of 1950 and the spring of 1951, large numbers of Mountain Bluebirds, *Sialia currucoides*, were seen in many counties of western, central, and east-central Oklahoma. They were first seen in early November and were seen continually until June. (November 3, 1950, is the earliest recorded date of which I am aware, and June 4, 1951, is the latest.) The species was regularly reported by both amateur and professional ornithologists, including M. Dale Arvey of the University of Oklahoma and Fred M. Baumgartner of Oklahoma A. and M. College. According to my observations they were generally more abundant than the Eastern Bluebird as late as early May, and in some areas occurred in flocks of several hundred birds.

Nice (1931. *Publ. Univ. Okla. Biol. Surv.*, 3[1]:145) declared the Mountain Bluebird to be a "common fall and winter visitant" in the "northeastern corner of Cimarron County" and a summer resident in that area. This is apparently a misstatement, since her earlier report (Nice and Nice, 1924. *Univ. Okla. Stud.*, no. 286:101) mentioned nesting in *northwestern* Cimarron County, and her source of information for the nesting record (Tate, 1925. *Proc. Okla. Acad. Sci.*, 4:32) stated that for two summers (1922, 1923) several Mountain Bluebirds nested in *northwestern* Cimarron County.

On April 21, 1951, Mr. and Mrs. Harold Cooksey located what they believed to be the nest of the Mountain Bluebird on the University of Oklahoma's South Campus (now a U. S. Navy Base) at Norman, Cleveland County, Oklahoma. They reported their discovery to me. They had seen a pair of birds going in and out of a hole in a small frame building, the *male* carrying nesting material. The building was unused at this time. The hole, about nine feet above the ground, was above the ceiling, so the nest could not be observed from the inside; however, it could be seen from the outside with the aid of a mirror and flashlight, and it could be touched by poking a finger through the hole in the building.

During almost daily observations throughout the next month, the pair was seen regularly in the immediately vicinity of the nest. They exhibited the typical nervous behavior of nesting birds, and were seen to copulate. On May 27, both birds were observed carrying food (insects) into the nest, and the female removed fecal sacs.

Two well-feathered young were visible in the nest on June 2. On June 4 at least one young was still in the nest. I did not visit the nest after this date.

To my knowledge, the species was not recorded east of the panhandle from June, 1951 to March, 1953, when it was seen in considerable numbers in Comanche County.

It was recorded by George M. Sutton and graduate students from the University of Oklahoma in Ellis, Harmon, Comanche, Caddo, and Canadian counties in 1954, and in Harper and Dewey counties in 1955. Certainly a large eastward emigration similar to that of 1950–51 has not recurred.

I am indebted to Mrs. John R. Whitaker, of Norman, for several of the observations at the nest site, and to George M. Sutton for the use of his field notes.— Carl D. Riggs, *University of Oklahoma, Norman, Oklahoma, July 15, 1955.*

The Prothonotary and Kentucky warblers on Cozumel Island, Quintana Roo, Mexico.—Our observations of individuals of *Protonotaria citrea* on August 4, 5 and 9, and of one *Oporornis formosus* on August 5, 1954, on Cozumel Island, seem to constitute the earliest fall records of these species south of the United States.

Two immature males of the former species, taken on August 9, had a small amount of fat along the feather tracts, and the breast muscles appeared emaciated. The stomach of each contained only a small quantity of fruit pulp. An immature Kentucky Warbler had a stomach full of insects, but its breast muscles were extremely emaciated, suggesting a long flight on the previous night.

The fact that both of these species have also been taken in western Cuba seems to give further support to the hypothesis of a route through Florida and Cuba to Quintana Roo.

The foregoing observations and collections were made on the western coast of the island, and the specimens are in the collection of Dr. George M. Sutton at the University of Oklahoma.—Ernest P. Edwards, *Box 611, Amherst, Virginia, and* Richard E. Tashian, *Department of Tropical Research, New York Zoological Society, New York 60, New York, July 27, 1955.*

An old nesting record for the Whooping Crane in North Dakota.—Because of the scarcity of nesting records of the Whooping Crane (*Grus americana*) it seems desirable to report an old North Dakota record for the species. This is a nest found by Mr. Frank Vejtasa in May, 1909, in Walsh County, North Dakota. I have found only two other recorded nestings for the state. One is given by Allen (1952. "The Whooping Crane," *Nat. Audubon Soc. Res. Rept.* no. 3) for Ina, Rollette County, June 3, 1871, one egg collected by Delos Hatch. Another is a rather indefinite record for Lakota, Nelson County, reported by Wood (1932. *Misc. Publ. Mus. Zool. Univ. Mich.* no. 10) who quotes Alfred Eastgate as saying they nested there "until 1908."

Mr. Vejtasa, who is a practising taxidermist and excellent nature-observer from Fairdale, North Dakota, gives me the following information about this record: On May 18, 1909, when he was 18 years of age, he flushed a pair of these cranes from a slough approximately nine miles south of Adams, Walsh County, North Dakota. This was a slough of about 30 acres containing cattails (*Typha latifolia*) and bullrush (*Scirpus* sp.). Waiting about two hours for the birds' return, he followed their movements and discovered a nest containing one egg. The nest was on a heap of rushes and cattails over about 10 inches of water. Returning to the nest 10 days later, on May 28, he found the egg still unhatched with the old birds very vehement about the intrusion. On June 15 the egg had hatched and the young bird was observed through field glasses with its parents. Returning about September 9, Mr. Vejtasa states that "I found the birds in the same slough. The young bird seemed as big as its parents, only it was tan in color and had no bare skin on its face." He again studied the birds with field glasses as they waded about in the open part of the slough.

No birds returned to this area the following year or thereafter. Mr. Vejtasa reports that the last whoopers he saw were three birds seen in company with a flock of several hundred Sandhill Cranes (*Grus canadensis*) on May 2, 1912, about eight miles east of Edmore, Ramsey County. The birds were feeding in a stubble field and in a nearby slough.— Edmund A. Hibbard, *Windsor, North Dakota, July 18, 1955.*

Behavior of Purple Martins with displaced nests.—Purple Martins (*Progne subis*) have nested in community bird houses maintained on the campus of Kent State University for many years. In June of 1955, while nesting was in progress, a violent type of behavior was observed as the result of one of the martin houses being shifted in position. This one, having 16 compartments, is located on a pole set between two college buildings. On June 4 Mr. William Kline, one of the maintenance men on the campus, observed that the martin house had been turned during the previous night through an angle of 180°. The pole on which the house rests is a hollow pipe which can be revolved on its standard. That morning two male Purple Martins which had been pecked to death were found lying on the ground along with five or six smashed eggs. The birds, bleeding from being pecked in the head, and the eggs were still warm when found. The house was then returned to its original position. On June 15 it was discovered that the house had been turned again during the previous night, this time through an angle of about 90°. Two newly-hatched nestlings, blind and naked, and six smashed eggs were found on the ground. The person or persons responsible for turning the house and the reasons for doing so were not known, but probably it was done as a campus prank. Apparently the Purple Martins became confused when the nests were displaced so that they entered the wrong compartments which led to the killing of two adult males on one occasion, the destruction of two nestlings in the other, and the destruction of half a dozen eggs each time.— Ralph W. Dexter, *Department of Biology, Kent State University, Kent, Ohio, July 29, 1955.*

American Egret feeding with cattle.—Rice (1954. *Auk*, 71:472–3) discussed the phenomenon of symbiotic feeding of Snowy Egrets (*Leucophoyx thula*) with cattle and mentioned that he had no knowledge of a similar association by American Egrets (*Casmerodius albus*).

On May 22, 1955, Thomas R. Hellier, Jr., and I were observing a flock of at least 100 Snowy Egrets feeding with cattle in a pasture 12½ miles west of Vero Beach, Indian River Co., Florida. No Cattle Egrets (*Bubulcus ibis*) were observed, although the locality is only about 35 miles from Okeechobee, where they are numerous. I identified (verified by Hellier) a single American Egret standing in front of, and facing, the head of a cow. No other egrets were associated with this cow. The bird appeared more skittish than the Snowy Egrets, and, unlike them, seemed quite wary of the cow. However, I definitely observed it to capture at least one insect which had been flushed by the cow. Shortly afterward the bird flew to another cow (also unaccompanied by other egrets) where it again assumed a similar waiting stance at the animal's head, although it was not seen to feed again. It is likely that the American Egret had been attracted to the pasture by the large numbers of Snowy Egrets, and that it would not have directly associated with the cattle in the absence of the other birds.— David K. Caldwell, *Department of Biology, University of Florida, Gainesville, Florida, September 5, 1955.*

Breeding of Cassin's Sparrow in central Oklahoma.—The Cassin's Sparrow (*Aimophila cassinii*) is considered a rare bird in most of Oklahoma. Nice (1931. *Publ. Univ. Okla. Biol. Survey*, 3 [1]:185) reported its breeding in Cimarron County at the western end of the panhandle and in Jackson and Harmon counties in the southwestern corner of the state. She mentions that McCarthy and Clark, in 1860, collected eggs at Adalene Creek, Corral Creek, and Rabbit Ear Creek, but states that "most of these creeks unfortunately have changed names, making the location of the collections rather indefinite;" however, she believes that probably these sites were in what is now the westernmost column of counties in the state. Howell (*Proc. Okla. Acad. Sci.*, 29, 1948:36–37) reported a small colony of breeding Cassin's Sparrows in Woods County, just east of the panhandle.

This sparrow has been recorded only once from central Oklahoma. On November 21, 1952, Jean W. Graber (1953. *Wilson Bull.*, 65:208) collected an immature female in postjuvenal molt near Noble, Cleveland County. The occurrence of such a bird in that locality seemed puzzling at the time.

On May 5, 1955, in the moderately overgrazed, open prairie two miles north of Norman, Cleveland County, I encountered three singing males along a fence row and among abandoned oil well equipment in an area of approximately two acres. They sang either from perches or, more often, during short display flights. I collected one in full adult plumage (U. O. M. Z. no. 2068); its testes were much enlarged. These Cassin's Sparrows probably had arrived at the locality some time after April 28, on which day I had spent at least an hour at this spot without detecting a bird of this species. On May 6, Margaret M. Nice, Donald H. Baepler and I observed one individual there and heard two others along fence rows, about one-eighth and one-fourth miles distant. On May 12, I recorded four singing birds, even more widely distributed over the prairie, always along fences. A male which George M. Sutton and I watched for at least 30 minutes on May 13 sang repeatedly during display flights and remained within a maximum of 100 yards of a silent Cassin's Sparrow, most probably a female, the first we had encountered.

Thus it appeared that a breeding population of this bird was indeed present here, at least 100 miles east of its previously-known breeding range. However, no proof of nesting was to be obtained until after several weeks had passed. From May 9 until about May 25, 1955, Oklahoma experienced unusual amounts of rainfall; in the central part of the state up to four inches fell each day on May 16, 18, and 19. Perhaps coincidentally, May 17 was the last day of the month on which I heard the song of this sparrow; still, while it may have entered into a period of little or no song at about this time, it seems likely to me that the abundance of rainfall retarded the nesting cycle of this species whose breeding center in the state is in the markedly drier western portions.

My visits to the area became less frequent during June, and not until June 23 did I detect the bird again. On June 30 I observed a solitary pair within 200 yards of the original location. For an hour I watched them from a minimum distance of about 50 yards; both remained most of the time along an approximately 100-yard stretch of fence. The male sang from posts and wire, never during flight, with silent periods of up to 20 minutes; its mate spent much of her time on the ground near the fence, occasionally flying for brief visits to a growth of small wild plums about 75 yards to the south. No young birds were in evidence, nor did either adult appear to be visiting a nest. Within half an hour after moving into my car, using it as a "blind," I twice saw the male, with food in its beak, fly directly from one fence post to a particular small area of ground nearby; during the next half hour the female also visited this spot twice with food, though she arrived by a much more devious route. The nest held five nearly-fledged young; it was on the ground, well concealed among weed one to two feet high, primarily ragweed (*Ambrosia psilostachya*), about 20 feet north of the fence, and in the firelane 35 feet in width paralleling the fence. The young showed clearly the distinct dark striping on the breast; one was collected (U. O. M. Z. no. 2161).

The presence in the fall of 1952 of an immature Cassin's Sparrow (mentioned above) provides evidence that this bird probably has nested in central Oklahoma for a minimum of four years. Considering the facts that in the three intervening years a considerable amount of time has been spent in the field in the vicinity of Norman by ornithologists from the University of Oklahoma and by local enthusiasts, and that prior to this year no Cassin's Sparrows have been encountered during the breeding season, it seems certain that this bird breeds here only in widely-scattered, small populations.— JOHN C. JOHNSON, JR., *Department of Zoology, University of Oklahoma, Norman, Oklahoma, July 29, 1955.*

Wilson's Petrel in southern Ontario.—Hurricane "Connie" passed south of Buffalo, New York, at approximately 6:00 p.m. on August 13, 1955, bringing gale-force winds and torrential rains to the eastern end of Lake Erie. The following morning Eric W. Bastin, George Meyers and Glenn Meyers, all of Hamilton, Ontario, searched the north shore of Lake Erie at likely points in the affected area, hoping to see unusual pelagic birds.

At Grabell Point, near Long Beach, Ontario, the body of a Wilson's Petrel (*Oceanites oceanicus oceanicus*) was picked up by Glenn Meyers. Lying just above high-water mark, it was water-soaked but otherwise in good condition, no decomposition being apparent. Identification was confirmed shortly afterwards by Dr. Harold Axtell of The Buffalo Museum of Science, who joined the party later. The petrel was given to The Royal Ontario Museum of Zoology, Toronto, Ontario. The only previous record for the species in Ontario occurred in the year 1897, at Gull Lake in the Muskoka District.— ERIC W. BASTIN, *43 Inglewood Drive, Hamilton, Ontario, Canada, September 2, 1955.*

Prairie Warbler breeding in Texas.—Breeding of the Prairie Warbler (*Dendroica discolor*) in east Texas has been suspected for some time, for some of these birds remain here several weeks after the main migration has ended. Bent (1953. *U. S. Nat. Mus. Bull.* 203:436) does not list this warbler as breeding in Texas. I saw and heard singing males of this species in the late spring and early summer in 1952, 1953 and 1954 in three localities in Smith County, Texas, but found only two abandoned nests and three immature birds during that time. These observations were witnessed by my wife and some of the members of the Tyler Audubon Society.

In 1955 my observations were begun 12 miles south of Tyler in an abandoned field of about 15 acres which contained second-growth sweet gum (*Liquidamber*), hickories (*Carya* sp.) and oaks (*Quercus* sp.). Nearby were shortleaf pines (*Pinus* sp.), various shrubs and a stand of grass 15 inches tall. On visiting this area on April 17, I discovered that some of the Prairie Warblers had already arrived, and during the following weeks I observed from four to six singing males in the vicinity of the old field at all times. On May 30, I observed a female gathering nesting material and flying into a 25-foot sweetgum, but I did not locate the almost-completed nest until

June 5. The nest was situated about 15 feet above the ground and was well hidden in the dense foliage close to the trunk of the tree. Both male and female were seen in the nesting tree on the latter date and other males were heard singing nearby. My observations were discontinued until June 22, at which time I carefully observed the nest but found no nesting or feeding activities being carried on. Both birds were seen near the nest and the male sang only occasionally. On June 26, there was no activity around the nest but adult Prairie Warblers were seen gathering insects in a field of partridge peas (*Cassia*) and flying into a large oak on the edge of the old field. This feeding was repeated several times, but a high wind and the thick foliage in the tree prevented my locating the young.

On July 4, I abandoned my watch at the nest and moved some 200 yards away. After hiding about 30 minutes, I saw a pair of Prairie Warblers gathering insects from the partridge peas and flying in different directions. Following the female to a small sweetgum, I saw her feed a fledgling in juvenile plumage, its tail about one-half inch long. I observed this pair, mostly the female, feed the young bird 12 times in about 35 minutes. In the meantime, the fledgling changed locations three times. Although active for a young bird, it could barely fly and ran on the ground part of the distance between bushes.

On July 10, I observed a pair of adults feeding two young within 50 feet of where I had seen them on July 4. This was probably the same family for the young were more mature, but were being fed by the adults most of the time. Also seen in the area at this time was a juvenile which was feeding itself and which showed some pale yellow on its underparts. The adults were now beginning to show signs of molting and only three songs were heard in a three-hour period, these being rather weak as compared to the songs heard earlier in the spring.

I wish to thank Mr. Horace H. Jeter for suggestions and encouragement which enabled me to locate the nest and young of the Prairie Warbler.— O. C. SHEFFIELD, *817 West Houston, Tyler, Texas, September 7, 1955.*

Rose-throated Becard nesting in the Chiricahua Mountains, Arizona.—On July 7, 1954, the writers, during a hurried excursion in the Chiricahua National Monument, Arizona, were fortunate in discovering a female Rose-throated Becard (*Platypsaris aglaiae*). The bird was first seen in a tall pine beside the road, about halfway between Monument headquarters and Massai Point, where it was following and scolding a female Cooper's Hawk (*Accipiter cooperii*), which we had frightened off a nearby nest. At first the becard was carrying food, but either ate or dropped it after a time. After watching the bird for more than half an hour, we went back to headquarters and immediately returned to the area with Mr. Robert Barrel, the park naturalist. Although the Cooper's Hawk was again flushed from its nest, the female becard was not found. Shortly after our return, however, we discovered two becard fledglings which had extremely short tails but otherwise were quite recognizable.

No attempt was made to find the nest, but the area appeared favorable. A creek bed runs beside the road on the opposite side from that on which the becards were observed; hence sycamores and other stream-bank trees are present. This habitat is reminiscent of that in which the nests described by Phillips (1949. *Condor*, 51:137-139) were located. Even though the nest was not found, the presence of the very young birds definitely establishes this breeding record, which is apparently the third reported nesting of this species in the United States.

The Rose-throated Becard has been considered rare in the United States, but recently it has been observed several times. Until 1945, the only authentic record of this species for the United States was that of an adult male taken by Price (1888. *Auk*, 5: 425) in the Huachuca Mountains of Arizona. In 1945, Davis (*Auk*, 62:316-317) reported the presence of summer-resident becards in Cameron and Hidalgo counties, Texas, and in 1949, Phillips (*loc. cit.*) described six active nests, which he located during the summers of 1947 and 1948 in the Santa Cruz River drainage of central southern Arizona. The Arizona birds were identified by Phillips as *Platypsaris aglaiae richmondi*. The Texas birds, however, were assigned to *P. a. gravis* by Sutton (1949. *Auk*, 66:365-366), who collected three specimens in Hidalgo County. Those observed in the Chiricahuas may be presumed to be *richmondi*.—Robert H. Gibbs, Jr., *Department of Conservation, and* Sarah Preble Gibbs, *Department of Zoology, Cornell University, Ithaca, New York, July 17, 1955.*

Goshawk captures American Crow.—On July 23, 1955, the writer observed what appears to be an unusual instance of predation by an adult Goshawk (*Accipiter gentilis*) on an American Crow (*Corvus brachyrhynchos*). At their call of alarm, my attention was focused on a flock of approximately 10 crows roosting in the tops of some large hemlocks in a heavily-wooded area in the Upper Peninsula of Michigan, near Shingleton. In a moment a Goshawk was noted swiftly diving upon the crows from a southwesterly azimuth, which, in midafternoon, was directly in line with the sun. Although the flock quickly dispersed, the goshawk singled out one bird and gave pursuit. For a few short moments this crow desperately attempted maximum evasive action; however, despite its valiant flight the hawk easily matched each maneuver and the crow was quickly driven to ground. At this point both victim and raptor were lost from view due to the presence of low but dense vegetation. The remaining flock meanwhile circled overhead, frenziedly cawing and repeatedly diving to within a few feet of the hawk, which was settled on the ground. However, after several minutes of such action the crows departed silently.

During the short period of time which elapsed before it reappeared to view, the Goshawk presumably was consuming a portion of the kill. When next seen it was laboring in flight with the crow clutched tightly to its body. An eight-foot woven wire fence with a two-foot overhang obstructed its path at the end of about 200 feet of flight; however, this was cleared easily at the last moment and the hawk continued into the heavy timber beyond. Careful search did not again reveal its presence in the immediate area.

Although Goshawks are not commonly abundant in the Upper Peninsula of Michigan during summer, Wood (1951. *Misc. Publ. Mus. Zool. Univ. Mich.*, no. 75:103–105) has recorded several recent instances of Goshawks nesting in this locality. Due to its large size, agility, and speed of flight, Goshawk predation on game animals, particularly the Ruffed Grouse (*Bonasa umbellus*), has been commonly noted. There is evidence suggesting that the Ruffed Grouse may serve as a staple food item wherever these species coexist. This instance of predation on crows may be related to the relative scarcity of both the Ruffed Grouse and Sharp-tailed Grouse (*Pedioecetes phasianellus*) at the present time due to their cyclic low populations. Perhaps when natural prey species are reduced in abundance Goshawks resort to feeding on normally less preferred prey which are commonly available in large numbers.— Louis J. Verme, *Michigan Department of Conservation, Shingleton, Michigan, September 9, 1955.*

ORNITHOLOGICAL NEWS

We are pleased to announce that Drs. George A. Bartholomew, William A. Lunk, Kenneth C. Parkes, and Raymond A. Paynter, Jr., have indicated their willingness to serve on the newly-constituted Editorial Advisory Board for *The Wilson Bulletin.* Dr. Lunk has served the Society as Illustrations Editor for the past three years.

Excellent opportunity, including financial aid, for field studies in ornithology during the summer of 1956 is provided at the University of Michigan Biological Station located at Cheboygan, Michigan. An introductory course, an advanced course and graduate student research, under the direction of Dr. Olin Sewall Pettingill, Jr., and facilities for independent research by mature ornithologists, will be offered.

Courses and similar research opportunities in various other aspects of field biology also will be offered under the leadership of distinguished faculty members in each of these fields.

Through the generosity of the National Science Foundation, financial aid will be available to about 20 applicants, irrespective of field of interest.

For further information, address Biological Station, Unversity of Michigan, Ann Arbor, Michigan.

The American Museum of Natural History announces that annual awards will be made from the Frank M. Chapman Memorial Fund during the month of April. This fund was established to provide financial aid to individuals conducting research in any branch of ornithology. The awards usually are made to younger scientists, in particular graduate students, but there are no hard and fast restrictions.

Applications should be received before March 31 of the year in question. Each applicant should state clearly the nature of the proposed research and give a careful estimate of the financial requirements of the project. Letters of recommendation should, wherever possible, be included. All correspondence should be directed to the Chairman, Chapman Memorial Fund Committee, Department of Birds, American Museum of Natural History, New York 24, New York.

SOME THOUGHTS CONCERNING THE INTRODUCTION OF EXOTIC GAME BIRDS

(A Contribution from the Wilson Ornithological Society Conservation Committee)

Intentionally or unintentionally, man has been transporting plants and animals hither and yon about the world for centuries. Many of these transplants have failed; a few have succeeded, some with disastrous results. Of the many introductions of exotic game birds which have been made in the United States since the first planting of Hungarian partridges in New Jersey about 1790, three, the Ring-necked Pheasant (*Phasianus colchicus*), Hungarian Partridge (*Perdix perdix*), and the Chukar (*Alectoris graeca*), have been successful.

Interest in the introduction of exotic game birds—and mammals—has increased greatly during the past decade. A part of this has been due to the interest sportsmen acquired in the new species which they had seen during overseas duty with the armed forces. Possibly of equal importance has been the year by year increase in the number of hunters without a corresponding increase in the amount of game or in areas open to hunting. Also, many areas have been so altered by man that the native species no longer exist in sufficient numbers to provide hunting. The forces generated by the disgruntled hunter and the game administrator seeking to satisfy the demand for more game have resulted, among other things, in the recent reopening or enlarging of game farms and in an increased interest in new game species.

In 1949 the International Association of Game, Fish and Conservation Commissioners appointed a committee to study the problem of game introductions. This committee found that the U.S. Fish and Wildlife Service had already begun work in this field, having employed Dr. Gardner Bump to investigate the desirability and adaptability of certain exotic game birds, particularly species which would be successful in the arid and semi-arid southwest. Although the costs of this activity were being paid out of Pittman-Robertson administrative funds, apparently some state administrators were not aware of the program.

With the federal program already in operation, it is not at all surprising that the committee concluded in March, 1950: "1. That investigations and restrictions on the introduction of exotic animals into the United States and Canada should extend to all species of wild birds, mammals and fish, including non-game species. 2. That some central agency should undertake the task of determining, insofar as possible, the desirability or undesirability of exotic animals proposed for introduction, and of effecting the introduction of those game species which investigations indicate to be desirable and which will fill an existing need. 3. That the United States Fish and Wildlife Service is the most logical agency to act in this capacity, and that the eight per cent administrative funds available to that agency out of federal aid in wildlife restoration appropriations is the most logical and equitable source for financing the project. 4. That the project should involve not less than two full-time qualified technicians, nor more than $50,000. annual expenditures. 5. That the legal restrictions upon the importation and/or introduction of species known or believed to be undesirable should be strengthened in every way possible, particularly within the state and provincial codes." (The fortieth conv. of the Intern. Assoc. of Game, Fish and Conserv. Comm., Sept., 1950. pp. 23-24). The committee also concluded that the existing program of the Fish and Wildlife Service should be expanded and that the introduction of mammals and fish should be investigated.

The following year the committee observed that four species of birds held promise of "filling voids in extensive ranges in our Southwest". These were the Chukar, the Seesee, (*Ammoperdix griseogularis*), the Black Partridge (*Francolinus francolinus*) and the Oriental Sand Grouse (*Pterocles*). The Black Grouse (*Lyrurus tetrix*) and Capercaillie (*Tetrao urogallus*) were already being tested in Wisconsin. The committee observed that the Fish and Wildlife Service was financing the program from their regular appropriations and that interested states should see that these appropriations were not killed by "people who misunderstand the intent and purpose of this activity." (The forty-first Conv. of the Intern. Assoc. of Game Fish and Conserv. Comm., Sept., 1951, p. 25).

In addition to the federal program referred to above, several states have embarked upon their own programs. These activities are founded upon the thesis that many habitats have been so changed by man that the native species can no longer maintain themselves in sufficient numbers to provide hunting. "Competing interests and the cost of reversing this trend are such that only a fraction of these lands can be restored to reasonable productivity in the foreseeable future. There are other coverts which never were fully occupied by native game birds or mammals possessing the characteristics requisite to survival in the face of today's intensive hunting pressure. For these, new, adaptable species possessing a high hunting resistance must be found or such areas will continue to provide hunting opportunities far below their productive potential." (Bump, G. 1951. *Trans. No. Amer. Wildl. Conf.*, 16: 317–18). These states are experimenting with various species of pheasants and exotic quail or attempting to create new forms through breeding.

A tremendous number and variety of exotic birds and mammals have been, and are still being, liberated by individuals and clubs. Some idea of the extent of this activity is obtained when we read that by 1940 at least 18 species of game mammals and 21 game birds had been imported into New York State alone, nearly all of them entirely or in part by individuals or clubs (Bump, G. 1941. *Trans. No. Amer. Wildl. Conf.*, 5: 409-420). The writer's experience has been that the tempo of this type of activity by individuals and clubs has been steadily increasing during the past 10 years.

There are a number of dangers inherent in the introduction of exotics. According to H. W. Levi (1952. *Sci. Monthly*, 74 [6]:315) these are: ". . . those of bringing in diseases, of hybridization with animals already present, and of ecological maladaption, including the crowding out of native species." The writer is doubtful that adequate study can be made in the federal program to properly guard against these dangers; he is certain that these dangers receive little if any attention from most states, clubs or individuals.

The successful introduction of an exotic will produce changes in the ecology of the region in which the transplanted species thrives. In spite of apparent belief to the contrary by many administrators and some biologists, the idea that all of these changes can be predicted at present is ridiculous. Man has, however, made tremendous changes in the ecology of nearly every part of the world. He has the desire and the capability to continue making these changes at an ever increasing rate. It may not be presumptuous to point out, however, that although the position taken by the "ecological purist" may be indefensible, the fauna and flora of America is the heritage of us all not just the hunter. It is barely possible that something may be gained and little will be lost by informing, or even consulting, other segments of the population concerning the direction and goals of the coming planned ecology.

In the writer's opinion, the state is the key to the control of the introduction of exotics. Exotics are unlikely to be introduced into a region by federal agencies unless the states involved express a desire for them. Some states lack adequate legislation to control the introduction of exotics by clubs and individuals. Even with authority though, it is often difficult for a state administrator to prohibit an importation and some state administrators apparently feel that it is expedient, at times, to encourage the importation of exotics. Decisions in matters of this kind are usually made at the administrative level; biologists often become informed of the situation when they are ordered to make the importation. A few states appear to have abandoned hope of being able to manage their native game birds and are searching for an exotic that can satisfy the demands of the hunter without management. In this respect, it appears possible that it is one thing to introduce Chukars into the southwest but quite another to introduce an Eurasian quail into the southeast where, presumably, it is supposed to multiply in those ". . . areas (which) have been so altered by man that the native species no longer exist in sufficient numbers to provide hunting" but avoid those areas still occupied by the native bobwhite.

The importation of exotic game birds—and mammals—will continue. The successful introduction of these exotics will alter the ecology of the regions involved, whether for better or for worse will depend upon one's point of view. The writer suggests, however, that adequate study and control of these importations is woefully lacking at state and local levels. Expediency does not appear to be an adequate substitute for study in guarding against the importation of diseases and the possible deleterious effects of hybridization (particularly when subspecies of indigenous forms are imported from other states) or the possibilities of ecological maladaption. It is furthermore respectfully suggested that, when importations of exotics are being contemplated, the desires and advice of biologists and conservation organizations other than those directly concerned with hunting might well be given consideration by both federal and state agencies.—Robert A. Pierce.

THE WILSON ORNITHOLOGICAL SOCIETY LIBRARY

The following gifts have been recently received. From:

Aaron M. Bagg—3 reprints
Andrew J. Berger—3 reprints
William H. Burt—8 reprints
Stephen W. Eaton—8 reprints
Karl W. Haller—10 books
Stuart Houston—3 reprints
T. H. Hubbell—1 pamphlet
David W. Johnston—4 reprints
Alden H. Miller—28 magazines
Margaret M. Nice—7 reprints
Frank A. Pitelka—2 books
Eustace H. Poor—3 reprints, 29 magazines
L. L. Snyder—16 bulletins
Wendell Taber—8 bound volumes of magazines
Josselyn Van Tyne—12 reprints
Dale A. Zimmerman—1 reprint

ORNITHOLOGICAL LITERATURE

North American Birds of Prey. By Alexander Sprunt, Jr. Based upon and supplementary to "The Hawks of North America," by John Bichard May. Published under the sponsorship of the National Audubon Society by Harper & Brothers. New York, 1955: $6\frac{1}{2} \times 9\frac{1}{2}$ in., 227 pp., 47 plates (43 in color) by Allan Brooks and others. $5.00.

Serious ornithologists should be grateful that popular interest in birds has increased to the point that American publishers now feel that it is worth their while to publish an average of one new bird book a week. Many fine ornithological works have been produced in recent years, and some of these have been outstanding financial successes. An unfortunate corollary to this spate of bird books lies in the temptation, to which publishers submit all too often, to jump on the band wagon with an ill-conceived, hastily produced volume, on the assumption that *anything* about birds will sell these days.

Neither the publisher nor the National Audubon Society has gained stature by the publication of the latest of Alexander Sprunt's scissors-and-paste jobs (see J. C. Dickinson's review of "Florida Bird Life," *Wilson Bull.*, 67, 1955:146–147). Once more a work widely regarded as a classic of its kind, in this case May's "Hawks of North America," published in 1935, has been replaced by a patchwork volume which is an insult to the original book.

To take up the illustrations first: all but one (European Merlin and Kestrel) of the original Brooks color plates have been reprinted, but the reproduction is mediocre, about one-third of the plates in my copy being badly out of register. Since the present volume, unlike the 1935 edition, includes the owls, colored illustrations of owls have been rounded up from a variety of sources to be reused. Four artists (Brooks, Fuertes, Horsfall and Weber) are represented among the owl plates. Although all but two species of the diurnal birds of prey are figured in color, only 10 of the 18 included species of owls are so favored.

The text, following a foreword by Roger Tory Peterson and a general introduction by the author, is organized into 10 chapters; one for the owls and one each for nine more-or-less natural subdivisions of the Falconiformes, as originally used by May. Each chapter is introduced by a short general discussion, largely paraphrased from May. The individual species and subspecies accounts begin with the English and scientific names, with a translation of the latter. Then comes a list of "local names," usually an abridgment of May's similar list. A paragraph entitled "Recognition" follows: this is again usually a paraphrased and abridged version of May's "Description" (a more accurate term, since field marks are seldom pointed out as such). No particular purpose seems to have been achieved by thus changing the original wording, and the abridgment has sometimes been detrimental; thus, nowhere in Sprunt's text is the dusky head-color of immature Turkey Vultures mentioned.

Next comes a paragraph entitled "Nesting." This is an addition to the original May material. The descriptions of nests and eggs appear to be adapted from those of Bent (1937–38. *U.S. Nat. Mus. Bull.* 167, 170), although no source is specified except for occasional direct quotations. A summary of the range follows; the useful little maps which appeared in May's book are not reprinted.

After these introductory paragraphs, the general discussion of the species (entitled "History") is presented. It is the avowed intention of the author to shift May's strong emphasis on food habits toward a more general description of the ecology of each hawk or owl. The very detailed food analyses of the 1935 book are thus either briefly summarized or largely omitted. Much of the remainder of the text is a rehash of Bent and other standard authorities; little or no attempt seems to have been made to utilize the abundant recent literature on the birds of prey. Other than the author's own publications, only two works subsequent to Bent (1937-1938) are listed in the bibliography: Arnold on the Golden Eagle (*U.S. Fish and Wildlife Serv. Circ. no. 27, 1954*) and Koford on the California Condor (*Nat. Audubon Soc. Research Rept. no. 4, 1953*). There is a strong subjective vein running through the book, the author's own field experiences receiving a rather disproportionate amount of space considering the small number of pages available for each species. This is carried to an extreme in the case of the Rough-legged Hawk, a species for which much authentic life history material is available. One of the three pages allotted to the "history" of this species is devoted to a fantastic hearsay story of a supposed nesting of the Rough-legged Hawk at Lake Okeechobee, Florida, a story which Sprunt admits he has already told in print on two previous occasions!

The most inexcusable aspect of this book is the obvious haste and carelessness with which it was thrown together. The classification and nomenclature are roughly those of the A.O.U. Check-list as amended through 1954, but with dozens of errors. One species and eight subspecies accepted by the A.O.U. prior to 1954 are omitted, while five subspecies no longer admitted to the Check-list are included by Sprunt. A half-hearted attempt was apparently made to conform to purely nomenclatorial changes instituted since the 1931 Check-list, but the amount of care given to this task may be judged by the fact that the two subspecies of Elf Owl are assigned to separate generic names. The paragraphs on *Otus trichopsis* and *Otus flammeolus* appear in the middle of the list of subspecies of *Otus asio*. Typographical errors abound, especially in scientific names: *cathartes* for *Cathartes*, *fuertsi* for *fuertesi* (twice), *Haliaetos* (twice) and *Haliaetus* for *Haliaeetus*, *Asiootus* for *Asio otus*, etc. Baja California is variously rendered as Lower California, lower California, and Baja, California (the latter twice on one page). Two subspecies of *Strix occidentalis* are transferred to *S. varia*. Little attention is paid to gender within scientific names; thus, we have *Aegolius acadicus acadicus* but *Aegolius acadica brooksi* and *Aegolius funerea magnus*. The statement is made that "the Dwarf Horned Owl is not included here since it inhabits the southern part of Lower California and is not to be seen in this country." yet full treatment is allotted to one full species and three additional subspecies whose ranges are also confined to Baja California. The paragraph from which the above statement is quoted also contains a misspelled subspecific name and a verbless sentence. The list is interminable.

The book closes with a convenient summary, by Kenneth D. Morrison, of state and provincial laws relating to bird protection. There is no index.

Most book reviews end with some such sentence as "The minor errors cited above in no way detract from the general high quality of the work." Such a statement cannot be made about "North American Birds of Prey," especially when we have May's classic "Hawks of North America" as a standard of comparison. Fortunate, indeed, are those of us who bought the 1935 edition at the fantastically low original price of $1.25. Today's buyer of bird books would be well advised to ignore the Sprunt book completely, and apply the $5.00 price toward the eventual purchase of a set of Bent's "Life Histories."—KENNETH C. PARKES.

The Birds of Massachusetts. An Annotated and Revised Check List. By Ludlow Griscom and Dorothy E. Snyder. Peabody Museum of Salem, Inc., 1955: $5\frac{1}{2} \times 8$ in., xiii + 295 pp., 3 maps. $3.75.

A full quarter-century has elapsed since the publication (1925–1929) of Forbush's three-volume classic, "Birds of Massachusetts and Other New England States." This period coincides with that during which "the virtuoso of field identification," Ludlow Griscom, has been associated with the Museum of Comparative Zoology at Harvard, first as Research Curator and subsequently as Research Ornithologist. As a consequence of Mr. Griscom's residence in Massachusetts since 1927, the science and the sport of recording birds in that State have achieved peaks of popularity and brilliant technique equaled in few similar areas. This has produced a great increase, quantitative and qualitative, in information about Massachusetts birds.

In the volume under review, Mr. Griscom and his eminently capable collaborator, Miss Snyder, have given us "an annotated and revised check list" which is abundantly justified by the timeliness of its appearance, the soundness of its approach, and the importance of the new material it contains (including not only the post-Forbush data, but also the hitherto-unpublished resources of various manuscripts, journals, and collections).

The student of avian faunistics who is concerned with the problem of what constitutes a valid record will find the case for the "severe school" presented ably (and at emphatic length) in this book. The long and active history of field ornithology in Massachusetts has provided the authors with an extraordinary abundance of material, ranging from data of the early 19th century to the latest spate of sight-reports. The sheer wealth of this material has permitted the authors the luxury of using the most severely strict criteria in assembling a state list based upon absolutely valid data. Just as this book is timely in meeting a need, so also does it fulfill the authors' avowed intent: ". . . to record adequately, and prove by documentation wherever possible, the true status of the forms found in Massachusetts."

This check list, then, has been compiled according to the following rules: "For every bird officially on the state list we require a specimen, a banding record by a reputable ornithologist, or a recognizable photograph on file and readily available for examination. All other forms have been placed in the Hypothetical List, without regard to the observer."

Griscom and Snyder give the number of authentic Massachusetts birds as 430 (384 species, 46 additional subspecies). The Hypothetical List numbers 51 forms; of these, there are 21 birds of which it is indicated that their identification is considered to have been correct. This latter device seems a realistic method of treating those birds which have been accurately "sight-recorded" beyond reasonable doubt, but for which no specimens, photographs, or banding records exist.

The long and active history of Massachusetts ornithology gives this book a further advantage: dimension and perspective in the changing status of various species. Thus, we are shown not only the major swings in avian populations, but also the short-term fluctuations over chronological periods which, in some cases, involve more than a century.

It is difficult to fault this book in any serious respect. There are the inevitable trivial errata. There will be raised eyebrows (particularly among Wilson Society members) over this isolated clause: ". . . since the technique of nest finding is a lost art,"— a significant statement, indicating the fact that the emphasis in Massachusetts is upon listing and recording, rather than on observing and studying. The emphasis upon such abundantly-worked areas of Massachusetts as Essex County, the Boston region, the

Cape Cod area, and the Connecticut and Housatonic valleys will serve to point the fact that, even in the 1950's and in the limited extent of the Bay State, there are considerable areas which are, ornithologically, virtual *terrae incognitae.*

Great potentialities for ornithological research, in all the various aspects of that broad science, are available in Massachusetts. (For example, recent banding studies of fall migrants, conducted by John V. Dennis on Nantucket Island, are most promising). Whatever the coming years may produce of ornithological significance in Massachusetts, future historians of the birds of that State can build with confidence on the solid facts which this book provides.— Aaron M. Bagg.

Prairie Ducks. A Study of Behavior, Ecology and Management. By Lyle K. Sowls. The Stackpole Company, Harrisburg, Pennsylvania, and The Wildlife Management Institute, Washington, D.C., 1955:193 pp. $4.75.

Frequently we are brought to the feeling that wildlife management is based more on the managerial practices of laymen than on science. It is such splendid works as "Prairie Ducks" that help immeasurably to make wildlife research a science of maturity and dignity. This book is a must for any serious student of waterfowl management or research, and it is equally indispensable to the layman who wishes to understand something of the problems and programs of state and federal waterfowl management.

This treatise is based on an immense amount of field observation, experimentation and study by the author, supplemented by the work of a number of able colleagues, mostly at the Delta Wildlife Research Station, Delta, Manitoba. Most of the data were obtained at the Delta marshes between the years 1946 and 1950; but much stimulation, help, and constructive criticism came from outstanding authorities in the field of waterfowl research and management.

This book gives evidence of having been developed in a scholarly and scientific atmosphere. It sets a high standard hitherto unattained in waterfowl research, and adds much to both information and techniques. The approach was an intensive study of individual birds, with particular reference to behavior, habits and ecology at different periods, and in different areas, on the summer range. Also considered are such problems as homing instincts, nesting and renesting, hen and brood behavior, molt, territoriality, mortality, and problems associated with fall migration.

In the main the book is well written, although some chapters seem to represent better writing than others. On a few minor points one might wish for a little additional treatment, or regret an omission of what appears to be an important point. For example, one of the greatest mortality factors is drought in the prairies. However, a discussion of this seems to have been largely omitted in this book. I believe the brief summary dealing with the food habits of predators would have been even clearer and more convincing had the standard volumetric percentages been given to supplement the information included. The brief treatment of crippling loss in the last chapter is likely to leave the inexperienced worker or sportsman with the feeling that this waste will be eliminated if only a retriever is added. While this recommendation is very worthwhile it will by no means answer the problem. A campaign to get shooters to desist from shooting so much out of range and to refrain from flock shooting would probably do much more good. These are indeed minor points as compared to the outstanding treatment of the subject as a whole.

While it is strictly scientific, the book is written in a popular style for public consumption; and all scientific names, and nearly all technical jargon, are omitted from the body of the text and are reserved for a short appendix in the back. A particularly helpful feature that makes the book stand out is the succinct summary of salient points recorded following each of the 11 chapters.

The most attractive features of the book, which give understanding, feeling and atmosphere of prairie waterfowl habitat, are the numerous and excellent line or black and white drawings by Albert Hochbaum and the beautiful colored frontispiece which is one of Peter Scott's best waterfowl paintings. The numerous photographs, figures, charts, and tables are well done, and add much to the finished product. The book is outstanding in its attractiveness, design, readability and accuracy of subject matter treated. Certainly the author, the artists, the publisher and the sponsor are all to be congratulated for a superior job which adds an effective milepost to the uncertain road of waterfowl conservation in America. This book sets a high standard for future workers to follow.— Clarence Cottam.

The Ornithogeography of the Yucatán Peninsula. By Raymond A. Paynter, Jr. Peabody Museum of Natural History, Yale University, Bulletin 9, 1955: 10¼ × 7¼ in., 1–347 pp., 2 maps, 4 pl. $9.50.

With the growth of interest in the avifauna of México and in the migration routes of North American birds, an authoritative work on the bird life of the Yucatán Peninsula is a welcome addition to the literature.

An introductory chapter of Dr. Paynter's book considers the methods used and the physical and biotic setting of the area under discussion. There follow 283 pages devoted to an annotated list of the 429 species (487 forms) reported from Campeche, Yucatán, Quintana Roo, and their offshore islands. In each account one is oriented as to the general range of the species; this is followed by a list of specimens recorded, data on habitat distribution, and remarks. When available, weights and data on breeding condition are included. Of greatest theoretical interest is the 21-page discussion of composition, distribution and origin of the avifauna. A bibliography and an index complete the book.

Of the 429 species recorded, 285 (330 forms) breed in the area or are presumed to do so, 115 winter, 26 are transient, and three are considered accidental. Excluding marine birds and vultures, the breeding avifauna of the peninsula proper consists of 262 species, while 90 species breed on the islands; eight of the latter are not found on the peninsula.

Since the Yucatán Peninsula is somewhat isolated from the rest of México and lacks topographic diversity, the problems of speciation are different from those of the remainder of the country. For example, among the land birds one group reflects the effects of decreasing humidity which are indicated by the increasingly xeric appearance of the vegetation found in proceeding from south to north on the peninsula. This rain forest element is represented by 105 species on the mainland, but by only five on the islands, whereas corresponding totals for the other major group, species characteristic of drier habitats, are 112 and 55. Seventeen species of the rain forest have developed subspecies on the peninsula, and these differentiates are paler and, as a rule, smaller than their representatives in the more luxuriant forests to the south. No such trend is found in the peninsular subspecies of the birds of drier habitats, which are restricted principally to the northern part of the peninsula. The importance of the role of population structure is indicated by the observation that the species which form races on the peninsula are those which exhibit similar variability elsewhere in their ranges.

From the standpoint of its origin, the breeding avifauna is broken down into three categories, a widely-ranging element, a group of six species which probably arrived from the West Indies directly, and eight endemic species. Since the major portion of the peninsula is young geologically and physiographic barriers are absent, differentiation above the level of subspecies probably has occurred there only a very few times. Hence most of the endemics must have originated elsewhere.

The faunistic analyses are handled in a thorough and convincing manner, and the taxonomy used is progressive. For example, all the wood thrushes are united in *Catharus*, the genus *Chamaethlypis* (Gray-crowned Yellowthroat) is merged with *Geothlypis*, and a monotypic genus (*Agriocharis*) is no longer retained for the Ocellated Turkey. Further study of the latter case may prove desirable.

Production of the book is generally excellent, although a few misprints appear among the generic names in the faunal analysis section. Even though the price seems excessively high, students of zoogeography in general and Mexican birds in particular will find this work an invaluable addition to their working libraries.—Keith L. Dixon.

This issue of *The Wilson Bulletin* was published on March 5, 1956.

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.

PLAN NOW TO ATTEND THE

THIRTY-SEVENTH ANNUAL MEETING

OF THE

WILSON ORNITHOLOGICAL SOCIETY

AT

BUFFALO, NEW YORK

THURSDAY, APRIL 26 to SUNDAY, APRIL 29, 1956

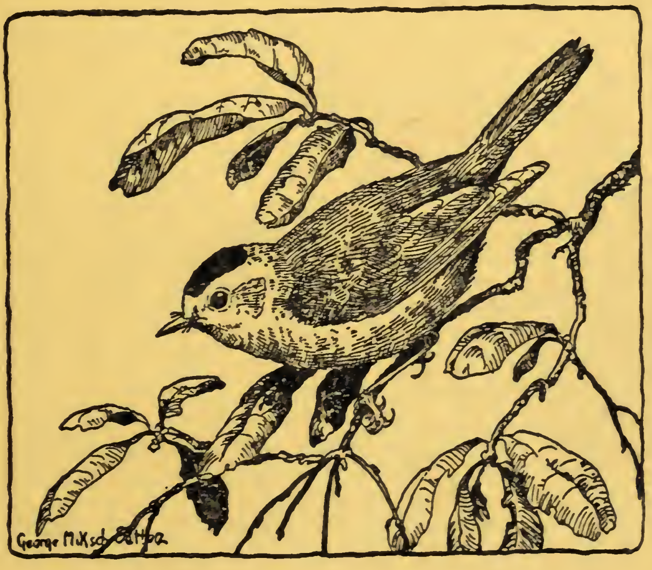
HOST SOCIETIES

Buffalo Society of Natural Sciences
Buffalo Audubon Society
Buffalo Ornithological Society

June 1956

VOL. 68, No. 2 PAGES 89–168

The Wilson Bulletin



Published by

The Wilson Ornithological Society

at

Lawrence, Kansas

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 Central Tower, Battle Creek, Michigan.

Second Vice-President—Phillips B. Street, Route 1, Chester Springs, Pennsylvania.

Treasurer—Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia.

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 Comittee, 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. In the United States the subscription price is $3.00 a year, effective in 1951. Single copies, 75 cents. Outside of the United States the rate is $3.25. Single copies, 85 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.

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.

Entered as second class matter at Lawrence, Kansas. Additional entry at Ann Arbor, Mich.

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY
Published by The Wilson Ornithological Society

Vol. 68, No. 2 | June 1956 | Pages 89–168

CONTENTS

PREDATION BY SHORT-EARED OWLS ON A SALICORNIA SALT MARSH

BY RICHARD F. JOHNSTON

THE Short-eared Owl (*Asio flammeus*) is a regular and common winter visitant to the San Francisco Bay region of California. It lives there in suitable habitat from August and September until about the first week in May. The winter populations of this owl leave in late April for northern or interior breeding grounds. Short-eared Owls may breed in the marshes around San Francisco Bay and elsewhere in the region (Grinnell and Wythe, 1927:85); however, none has been recorded doing so in recent years. All owls dealt with in this paper have been migrants or winter residents.

The study area was a part of San Pablo salt marsh, one mile north-northwest of Richmond, Contra Costa County, California. This marsh is a good example of a San Francisco Bay salt marsh (see Hinde, 1954); it is characterized by two plant associations. There is on low ground, subject to daily tidal coverage, the *Spartina* zone, characterized by extensive pure stands of *Spartina foliosa*. Short-eared Owls are uncommon in the *Spartina*. Higher ground is covered by the *Salicornia* association (Fig. 1). The dominant plants of this zone are *Salicornia ambigua*, *Grindelia cuneifolia*, and *Distichlis spicata*. *Grindelia* is a woody perennial growing along the tidal creeks, or sloughs, on the more elevated parts of the marsh. All the dominants of this zone may be found in the lower zone wherever the elevated slough banks produce higher marsh conditions. Other important plants of this association are *Frankenia grandifolia*, *Jaumea carnosa*, *Limonium commune*, *Triglochin maritima*, *Cuscuta salina*, and *Achillea millefolium*. It is in this area of the marsh that Short-eared Owls find conditions most suitable for foraging and concealment.

On the upper portion of the marsh where the tidal sloughs branch in intricate patterns the densest and tallest vegetation on San Pablo marsh is found. This is composed mainly of leafed-out *Grindelia*, but there is a varying admixture of *Distichlis* and *Salicornia*; the height reached is two to four feet. Short-eared Owls find roosting cover in daylight hours in these tangles, especially when there is stranded driftwood amongst the plants. Less frequently the owls are found in small, irregularly-shaped openings in the *Salicornia* mat or within clumps of arrowgrass (*Triglochin maritima*). Individuals of this plant commonly grow grouped in a ring shape and the owls easily find concealment within these clumps, in spite of the fact that the clumps are surrounded for tens of feet by pure *Salicornia* that is usually only about six inches high.

FIG. 1. A tidal slough on San Pablo salt marsh. The slough is about 25 feet wide. In the center foreground *Spartina* is evident; along the slough banks grows *Grindelia*; the remainder of the vegetation is almost wholly *Salicornia*.

Numbers of the owls.—A trustworthy method of counting these birds was not developed. The behavior of the owls in the presence of an observer was highly unpredictable. They would not necessarily flush when an observer was as close as 20 yards from them. Those that did flew variously 50 to 500 yards. It was not always possible to determine the exact spot on the marsh where the birds alighted because the marsh is flat and diagnostic landmarks uncommon. Thus, when an owl was flushed, frequently it was difficult to know whether or not it had already been counted.

The best count of owls was made on December 26, 1951. when an extremely high tide covered everything on the marsh except the topmost six to ten inches of *Grindelia* branches and pieces of wood and other flotsam. The fauna of the marsh was pushed up to these dry posts and consequently was generally ill-concealed. Under these conditions the owls foraged conspicuously up and down the *Grindelia* rows. Normally the owls are night-time feeders in this area, but during the high tides they spent a large amount of time in the air in daylight foraging. When they alighted, they were still exposed to view on emergent posts and floating timbers. Four, and possibly five, owls were visible simultaneously at 11:30 a.m. on the day mentioned. Sibley (1955) recorded ten Short-eared Owls during a two-mile walk along a levee in salt marshes near Alviso, at the southern end of San Francisco Bay, under similar tidal conditions. Thus, since I had about 150 acres under observation, I saw possibly only half of the owls that were present on that day. The number of owls on San Pablo salt marsh in the winter may be taken at no less than four or five and probably no higher than eight or ten.

This broad estimate may well apply to all years of the study, since there is no evidence that 1951 was any different from the subsequent years with regard to the number of Short-eared Owls on the marsh. At the beginning and end of the winter period the density of owls is definitely less than that reached in midwinter.

Feeding Relationships

Foraging behavior.—My best observations on foraging behavior were made in daylight hours during high tides, as has been indicated. Yet the owls here are nocturnal foragers in the main, and my observations may not be wholly representative. The most common foraging method used is harrying flight. Harrying flight is effected by flying slowly along the course of a tidal slough and is punctuated by sudden drops to the level of the vegetation or ground surface after prey or to alight. Also, the owls occasionally sally forth after prey from their roosting places, or, more usually, from higher prominences.

The owls become active foragers about a half-hour before sunset, or somewhat earlier on overcast days. I do not know how much of the night is spent foraging, but it is unlikely that these birds differ much from other nocturnally-foraging Short-eared Owls in this respect. Normally they cease feeding by one hour after sunrise at most. Twice I have disturbed owls in the act of eating Dowitchers (*Limnodromus griseus*) in the middle of the afternoon, two and three hours before sunset.

A possible explanation for the almost complete absence of daytime feeding in this species that is known to hunt in the daytime as a rule on its breeding grounds and in certain parts of its winter range (Errington, 1932:178) is that gulls flock around the owls and mob them in flight. Species known to fly at the owls are the Glaucous-winged Gull (*Larus glaucescens*) and Ring-billed Gull (*L. delawarensis*); other gulls also participate. When attacked by the gulls, the owls invariably increase their flying altitude. The reasons for this seem obscure, for the extra altitude is not used by the owls for aerial maneuvers. I never saw a gull actually strike an owl; either the gulls were content merely to come close, or the erratic, bouncy flight of the owls served to throw the gulls off course. But, there is no question that the owls were disturbed by the gulls.

Pitelka, Tomich, and Treichel (1955:112) reported that territorial Pomarine Jaegers (*Stercorarius pomarinus*) harried Short-eared Owls on the breeding grounds near Barrow, Alaska. The chasing was so severe that these observers were not certain just when the owls found time to forage unmolested, but they thought it was probably in the twilight hours when the jaegers possibly were not as alert as in the full light of day. Certainly the situation on San Pablo marsh is not as critical to the owls, and there is no territoriality involved, but it is worthy of note that daytime foraging of owls is absent and harrying by gulls occurs.

Prey items.—Although there is a good-sized literature on the food of Short-eared Owls in the breeding season (for example, Pitelka, Tomich, and Treichel, 1955; Errington, 1937) little information is available on their food in the winter in North America. Fisher (1893), Cahn and Kemp (1930), Errington (1932), and Tomkins (1936) report the largest winter samples of food items; Huey's (1926) report is the only one listed in Bent (1938) for western North America. It is, coincidentally, for a salt marsh locality but involves only two pellets.

On San Pablo salt marsh I picked up pellets of Short-eared Owls at irregular times and stations within an area of about 200 acres. No definite pattern was followed in picking up the pellets because the owls had no preferred casting spots and dropped pellets at random stations throughout the marsh. This made it difficult to get dates for most of the pellets. In the one instance of finding a true casting station only 32 pellets were found and these spanned a period in time of about three months.

A mammal was counted as occurring only on the basis of a skull; this avoided the possibility of duplication of individuals. Therefore, this count presents a minimum occurrence for the mammalian remains. In the case of birds, and especially small birds, occurrence of many bones and feathers in a pellet was taken to represent at least one bird, whether or not the skull was present. In point of fact, but one bird skull was found; the Short-eared Owl chops and mangles all of a bird's head except the bill, which it does not necessarily ingest. If an isolated long bone or a few feathers occurred in a pellet, the dominant remains in which were mammalian, no count was made of them. Any occurrence of insect hard parts was taken to represent one, or more, insect(s). From this it will be seen that a maximum occurrence of birds and insects is indicated in the tabulation, contrary to the situation in the mammals.

TABLE 1

FOOD ITEMS FOUND IN PELLETS OF THE SHORT-EARED OWL ON SAN PABLO SALT MARSH

	Absolute Occurrence	Frequency in per cent				
		1952	1953	1954	1955	Total
Microtus californicus	272	56.1	44.8	37.0	33.6	42.9
Rattus norvegicus	116	7.2	16.7	20.5	27.3	18.0
Reithrodontomys raviventris	56	8.4	7.0	11.5	6.9	8.6
Mus musculus	40	8.4	3.5	6.5	5.7	6.1
Sorex vagrans	17	6.1	2.6	1.0	1.3	2.6
Thomomys bottae	6	4.0	—	—	—	0.9
Scapanus latimanus	1	0.7	—	—	—	0.2
Mammals: total	508	90.9	74.6	76.5	74.9	79.8
Erolia-Ereunetes	21	1.0	6.2	4.5	3.8	3.2
Unidentified birds	17	—	3.5	4.5	1.3	2.6
Sturnella neglecta	15	1.0	0.9	3.0	3.8	2.2
Erolia minutilla	12	3.0	—	1.5	1.9	1.8
Passerculus sandwichensis	9	—	2.5	1.0	1.9	1.4
Ereunetes mauri	6	0.7	—	1.0	1.9	0.9
Erolia alpina	6	—	—	0.5	3.2	0.9
Limnodromus griseus	5	—	1.7	—	1.3	0.8
Melospiza melodia	4	—	0.9	1.5	—	0.6
Rallus longirostris	3	—	—	0.5	1.3	0.5
Anthus spinoletta	1	—	—	0.5	—	0.2
Pooecetes gramineus	1	0.7	—	—	—	0.2
Passerella iliaca	1	—	—	0.5	—	0.2
Birds: total	101	6.4	15.7	19.0	20.6	15.5
Stenopelmatus (sand-cricket)	28	2.0	8.8	4.5	3.8	4.7
Unidentified insects	3	0.7	0.9	—	0.7	0.5
Total	638	100.0	100.0	100.0	100.0	100.0

Table 1 presents the list of the occurrence of all the species and groups identified from the pellets. The gross breakdown shows about 75 per cent of the items to be mammals, 20 per cent birds, and 5 per cent insects. This is only a crude indication of the various groups as to their importance to owls as food, for the relative masses involved place the mammals as responsible for about 85 to 90 per cent of the food of the owls. Most of the mammals, and presumably also the birds, in the pellets were subadults, but this is true of most free-living populations of vertebrate animals in the period September to April.

In the discussion of the prey species, which follows immediately, I have attempted to indicate something of the relative numbers of the wild populations that are involved. I have relied on the number of occupied nests as the major indication of mammal numbers; this type of information was gathered primarily in the spring, not in the early winter. With this as an index, none of the mammals on which I could gather data appeared to fluctuate in numbers. Probably it would be more realistic to say that the fluctuations that did occur were not large enough to be detected by my relatively crude techniques. As Table 1 shows, there were some important shifts in the occurrence of the mammals as prey items in the pellets from year to year. I would say that these shifts in occurrence reflect changes in population density possibly of similar direction and size.

As for the birds, they can be counted directly, especially in the breeding season, or otherwise simply dealt with. It has been possible to list their occurrence on the marsh as populations with some accuracy. This good fortune actually means little; in the first place, the incidence in the pellets of any one bird or group of birds is so slight that their fluctuations have little importance to the diet of the owls (see Table 1). In the second place, the density of the resident birds (mainly Song Sparrows) varies little (Johnston, MS), so that the owls have about the same number to choose from always. I cannot speak with the same assurance about the migrants.

The California vole (*Microtus californicus*) is the most numerous prey species found in the pellets. In 1952 it was also the most important animal to the owls in point of food mass furnished. In 1953, 1954, and 1955 the Norway rat (*Rattus norvegicus*) furnished the greatest bulk. The reduction of *Microtus* in the pellet samples after 1952 seems a significant trend in spite of the fact that the number of nests and fresh cuttings of the vole indicated a steady level of population density; probably there was a real drop in density. It should be noted that there may be some as yet undemonstrated relationship between the drop in *Microtus* and the rise in *Rattus* in the pellets.

Further, the incidence of *Microtus* in the pellets does not indicate this population to follow the regular and periodic fluctuations in density that have been described for microtines elsewhere. It is probable that *M. californicus* only three to four miles distant in the headwaters of Wildcat Creek shows the classic four year cycle (Robert Hoffmann, MS), yet the present data show a "high" in 1952 and a decrease every year since that time. 1955 should have been "high" again if this population were to parallel the classic cycle.

The Norway rat showed a steady rise in incidence of occurrence in the pellets. It remained, at its highest, second to *Microtus* in numbers, but was responsible for most of the food eaten by the owls. Since the rat lives successfully in the wild state on the marsh, and its numbers are constantly augmented by ingress of individuals from the nearby Richmond city dump, it would be thought that its numbers would remain relatively constant. This is not true: at least, a four-fold increase in occurrence in the pellets seems to indicate a related increase in population density.

The occurrence of the other mammals in the pellets does not indicate annual variation in numbers. Possibly the numbers of shrews (*Sorex vagrans*) fluctuate, but the sample sizes are basically too small to make certain. However, there is little doubt that the salt marsh harvest mouse (*Reithrodontomys raviventris*) and the house mouse (*Mus musculus*) were taken by the owls at a steady rate.

The pocket gopher (*Thomomys bottae*) and the western mole (*Scapanus latimanus*) are not residents of San Pablo salt marsh but they occur nearby in cultivated fields and along San Pablo and Wildcat creeks, which flow through the marsh. The low incidence and sporadic occurrence of these mammals show that they are not important to the Short-eared Owls of San Pablo salt marsh.

About seven and one-half per cent of the items taken were migrant, charadriiform birds, and some four and one-half per cent were resident birds, mainly passerines. Within the limits of a small sample I consider these frequencies to be practically equivalent with one another. If it is borne in mind that, although the shorebirds at their peak density outnumber passerines by at times over 10 to 1, the shorebirds are transient and are never for long at a maximum density, then the practical equivalence of occurrence between them and the passerines seems reasonable. Table 2

TABLE 2

ESTIMATED NUMBERS OF RESIDENT AND MIGRANT BIRDS ON SAN PABLO SALT MARSH IN MIDWINTER[1]

RESIDENT BIRDS	
Clapper Rail, *Rallus longirostris*	about 30
Marsh Wren, *Telmatodytes palustris*	about 30
Western Meadowlark, *Sturnella neglecta*	possibly 50
Savannah Sparrow, *Passerculus sandwichensis*	about 150
Song Sparrow, *Melospiza melodia*	very near 450
Total	710
MIGRANT BIRDS	
Short-billed Dowitcher, *Limnodromus griseus*	up to 1000
Western Sandpiper, *Ereunetes mauri*	up to 1000
Red-backed Sandpiper, *Erolia alpina*	up to 1500
Least Sandpiper, *Erolia minutilla*	up to 5000
Total	8500

[1]The resident birds occupy about 200 acres; the migrants use this and in addition 500 to 1000 acres of intertidal mudflat.

presents a rough estimate of the density of these two groups of birds on 200 acres of salt marsh.

For the resident birds I arrived at the figures in the following manner: I know there are about 150 pairs of Song Sparrows in the breeding season and that these will produce about four fledglings per pair to make a total of about 900 birds at the late spring maximum. Of these, about 450 ought to be available to the owls in mid-December. Winter estimates (Table 2) based on 50 breeding pairs of Savannah Sparrows, 10 pairs of Clapper Rails, and 10 pairs of Marsh Wrens are 150, 30, and 30 individuals, respectively. About 50 Western Meadowlarks should be added to make a total of 710 birds. Earlier in the season there would be more, later in the season fewer, birds.

The migrant shorebirds occur sometimes in numbers as large as I have indicated, but I think usually the occurrence would be somewhat less. Certainly one-quarter to one-half of my estimate of 8500 would be a conservative indication of mean occurrence. These relatively vast numbers probably adequately account for the number of individuals taken by the owls. But, it must be remembered that on San Pablo marsh the Short-eared Owl is a nocturnal feeder; accordingly, it would be the roosting shorebirds on the high marsh that would be prey for the owls, and presumably these birds would be easy to catch. Therefore, it seems a little unusual that more were not taken. Perhaps this is further evidence of the already known preference of the Short-eared Owl for small mammals as food.

It should be mentioned that the Western Meadowlark does not live on the marsh but large numbers of them every day venture far out on the marsh in foraging. The Fox Sparrow (*Passerella iliaca*) probably was taken along the nearby Wildcat Creek. All other birds found in the pellets occur normally on the marsh, either as residents or migrants.

Relationships of Short-eared Owls to the Community

An accurate perspective on the impress made by the predation of an owl population can be gotten only through placing this predation properly in the setting of the community. The Short-eared Owl is influenced by the population dynamics, movements, and indeed the mere presence of virtually every animal species on the marsh. Many of the animal interrelationships are subtle, and some are doubtless yet unsuspected. My information on community interaction is almost wholly restricted to that relating to the food situation. The food relationships outlined in Figure 2 are those that I have become aware of in the course of studies on the population ecology of the Song Sparrow. Thus, except for the owl pellet samples and counts of resident birds, the details of the pyramidal structure of the community are purely qualitative. Fortunately, this community is a simple one and

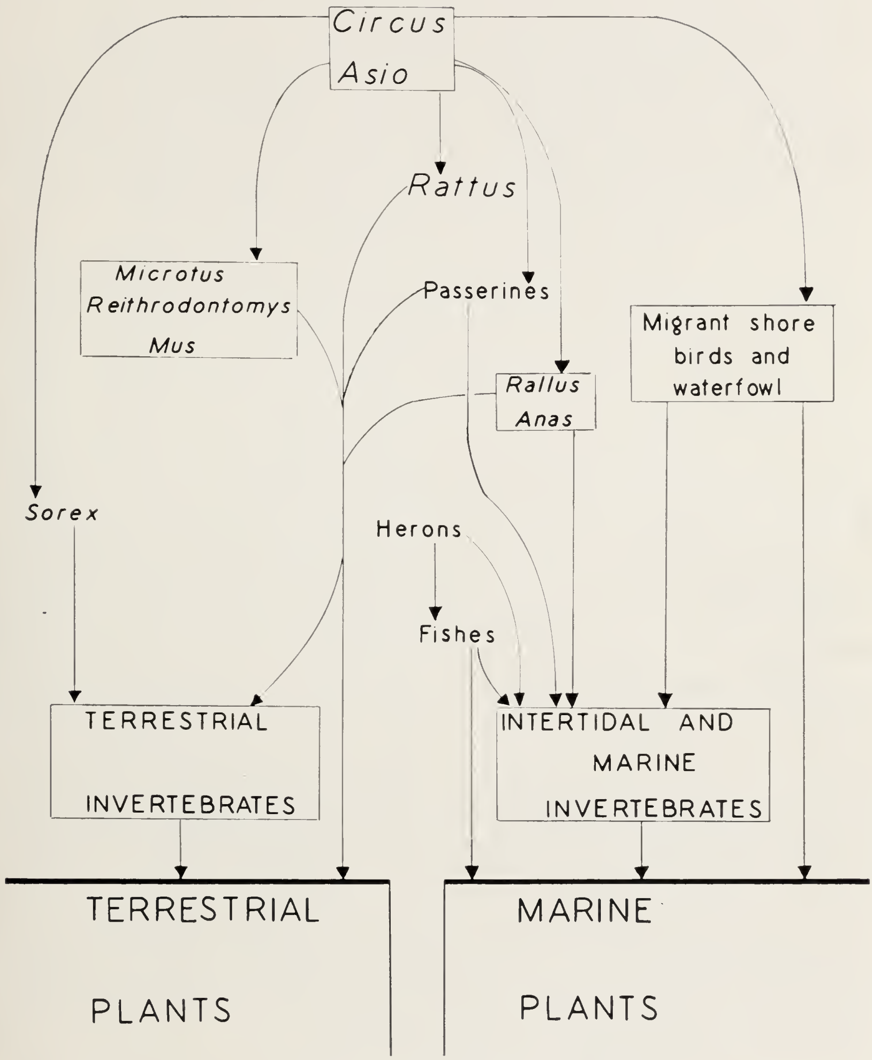


Fig. 2. The food web in winter on a *Salicornia* salt marsh.

the available information indicates the generalization represented by Figure 2 to be valid in all respects.

Several of the groups deserve comment and listing of the animals included. The groups are considered in order as they increase in total number of individuals.

Predators.—The Short-eared Owl has been discussed. Of the hawks only the Marsh Hawk (*Circus cyaneus*) was resident and of major importance.

One pair nested in a nearby *Spartina* area, producing two to four young each year. The winter population numbered four to six individuals.

Other hawks that hunted on the marsh were the Peregrine Falcon (*Falco peregrinus*) and the Merlin (*F. columbarius*). These two were seen but rarely. More commonly seen were the Sparrow Hawk (*F. sparverius*), Red-tailed Hawk (*Buteo jamaicensis*), and Sharp-shinned Hawk (*Accipiter striatus*): but these three were never seen to hunt on the marsh.

Four herons hunted on the marsh. The Common Egret (*Casmerodius albus*) and the Great Blue Heron (*Ardea herodias*) were the most important; the Black-crowned Night Heron (*Nycticorax nycticorax*) and the Snowy Egret (*Leucophoyx thula*) were less abundant and were present only in the late winter and spring. Probably some rodents were taken by these herons.

The Norway rat is the only mammalian predator of any importance on the marsh. It is known that the rat takes eggs and young of the Mallard (*Anas platyrhynchos*), Clapper Rail, Savannah Sparrow, and Song Sparrow. Probably it preys also on the young of the other, smaller mammals.

Secondary consumers.—This group includes those animals that stand in an intermediate position in the predator-food resource sequence. The box labeled, "Rallus/Anas" refers to the Clapper Rail and the Mallard; there are two pairs of nesting Mallards on the marsh.

Passerine birds may be broken down into two groups, as per the following lists:

Resident	Winter visitant
Telmatodytes palustris	*Anthus spinoletta*
Sturnella neglecta	*Pooecetes gramineus*
Passerculus sandwichensis	*Passerella iliaca*
Melospiza melodia	*Dendroica auduboni*
	Geothlypis trichas

Migrant shorebirds and waterfowl make up the bulk of the marsh avifauna during the winter period. In the following lists those species of most importance on the marsh are marked with an asterisk. All records are based on sight identification made in the field.

Waterfowl

Branta canadensis	*Aythya americana*
Branta bernicla	*Aythya marila*
Chen hyperborea	**Aythya affinis*
Anas platyrhynchos	*Bucephala clangula*
Anas carolinensis	*Oxyura jamaicensis*
**Anas acuta*	*Mergus serrator*
Mareca americana	**Fulica americana*
Aythya valisineria	

Shorebirds

**Squatarola squatarola*	*Capella gallinago*
Charadrius vociferus	*Crocethia alba*
Numenius phaeopus	**Ereunetes mauri*
Numenius americanus	**Erolia minutilla*
Limosa fedoa	**Erolia alpina*
Totanus flavipes	*Recurvirostra americana*
**Catoptrophorus semipalmatus*	*Lobipes lobatus*
**Limnodromus griseus*	

Of the fishes only the three-spined stickleback (*Gasterosteus aculeatus*) was found to be a permanent inhabitant of the creeks and ponds of the marsh. Utilizing the tidal creeks as foraging grounds during periods of high water, and occasionally becoming stranded when the water level dropped were the following species: northern anchovy (*Engraulis mordax*), jack smelt (*Atherinopsis californiensis*), top smelt (*Atherinops affinis*), and staghorn sculpin (*Leptocottus armatus*). The striped bass (*Roccus saxatilis*) probably also should be included in this list, but I did not find it; it would prey on shrimps and smaller fishes.

Terrestrial invertebrates.—This list is far from complete; many additions could be made, most probably among the insects.

	Insecta
Amphipoda	Coleoptera
Isopoda	Lepidoptera
Arachnida	Diptera

Intertidal and marine invertebrates.—Insects are here included by virtue of those species that live part of their lives in the quiet waters of ponds and occluded oxbows; the water in these sometimes is highly saline, due to evaporation.

Nemertea	Insecta
Polychaeta: Nereidae	Dysticidae
Ostracoda	Notonectidae
Copepoda	Diptera
Isopoda	Aspidobranchia
Amphipoda	Pectinibranchia
Decapoda	Filibranchia

The relationships diagrammed in Figure 2 hold only for the fall and spring months, when all the animals indicated would be present on the marsh. Especially in the summer the relationships would be markedly different. As an example, the insects are extremely abundant and the water-fowl and shorebirds are practically absent in summer. Actually, almost all the larger and conspicuous birds use other areas for breeding; the Short-eared Owl and the herons are included here. Thus, the fullest expression of the relationships subsumed by the intertidal and salt marsh food web and pyramid of numbers is reached in the fall-to-spring period, for which Figure 2 is valid.

Summary

The Short-eared Owl is a common winter visitant to the salt marshes around San Francisco Bay. Between four and ten owls live in the winter on the study plot of some 200 acres on San Pablo salt marsh. The owls forage mainly at night there. Of 638 items found in pellets, 75 per cent were mammals, 20 per cent birds, and 5 per cent insects. Mammals were responsible for about 90 per cent of the mass consumed, *Microtus* and *Rattus* being the most important kinds. The relationship of Short-eared Owl predation to the community food web is indicated by means of a diagram.

Literature Cited

Bent, A. C.
1938 Life histories of North American birds of prey. Pt. 2. *U. S. Nat. Mus. Bull.* 170.

Cahn, A. R., and J. T. Kemp
1930 On the food of certain owls in east-central Illinois. *Auk*, 47:241–270.

Errington, P. L.
1932 Food habits of southern Wisconsin raptors. I. Owls. *Condor*, 34:176–186.
1937 Summer food habits of the short-eared owl in northwestern Iowa. *Wilson Bull.*, 49:121.

Fisher, A. K.
1893 The hawks and owls of the United States and their relation to agriculture. *U. S. Dept. Agric., Div. Ornith. and Mamm., Bull.* 3.

Grinnell, J., and M. W. Wythe
1927 Directory to the bird-life of the San Francisco Bay region. *Pac. Coast Avif.* No. 18:1–160.

Hinde, H. P.
1954 Vertical distribution of salt marsh phanerogams in relation to tide levels. *Ecol. Monogr.*, 24:209–225.

Huey, L. M.
1926 Bats eaten by short-eared owl. *Auk*, 43:96–97.

Pitelka, F. A., P. Q. Tomich, and G. W. Treichel
1955 Ecological relations of jaegers and owls as lemming predators near Barrow, Alaska. *Ecol. Monogr.*, 25:85–117.

Sibley, C. G.
1955 The responses of salt-marsh birds to extremely high tides. *Condor*, 57:241–242.

Tomkins, I. R.
1936 Notes on the winter food of the short-eared owl. *Wilson Bull.*, 48:77–79.

Museum of Vertebrate Zoology, Berkeley, California, July 13, 1955

BIRDS OF THE SWAN ISLANDS

BY RAYMOND A. PAYNTER, JR.

The Swan Islands lie in the Caribbean Sea (Lat. 17°25′ N., Long. 83°56′ W.) about one hundred miles north of Punta Patuca, in eastern Honduras, the nearest point on the mainland, and nearly two hundred miles southwest of the Cayman Islands, the next nearest land. Swan Island, the larger of these low, coral islets, is slightly more than two miles long and about three-quarters of a mile wide; it is nearly rectangular. To the east, separated by less than a quarter of a mile of shallow water, is Little Swan Island, which is also roughly rectangular, but only a little more than a mile in length and about one third as wide.

According to Lowe (1909; 1911), both islands are covered by low forest, with the exception of parts of Swan Island which have been cleared for dwellings and extensive groves of coconuts. The number of species of trees enumerated by Lowe (1911) is notable, considering the isolation and small size of the islands. There is a small grassy area on Swan Island which was probably once a lagoon, although only a shallow area of fresh water remains in the center; this may disappear when rain is infrequent. From a description given by Delacour (1938), the vegetation seems not to have been further disturbed since Lowe's visit.

The first collection of birds from the islands was made by C. H. Townsend between February and March, 1887. The collection was studied by Ridgway (1888), who lists 30 species.

The next naturalist on the islands was Lowe, who remained there from mid-January to mid-February, 1908. He collected 18 species, saw an additional seven species, and from descriptions provided by the islanders tentatively records the following: *Anas discors*, *Anas crecca*, *Anas americana*, *Aythya valisineria*, *Gallinula chloropus*, *Columba squamosa*, *Tyrannus dominicensis*, and *Passerculus sandwichensis* (Lowe, 1909). In a later account (Lowe, 1911) he includes on the tentative list *Anas acuta* and *Anas clypeata*, two species not listed earlier, but omits *Anas discors* and *Anas crecca*. If it were not for the fact that *Anas discors* and *Tyrannus dominicensis* have since been reported from the islands, one might have disregarded the second-hand observations. All of these birds would not be unexpected on the islands; the failure of recent collectors to find more of the water birds may indicate that the pond has disappeared, or is rarely full enough to attract those species.

In 1912, George Nelson, of the Museum of Comparative Zoology, began a series of trips to the Swan Islands. Between February 25 and March 22, 1912, he collected 57 specimens, representing 19 species. From July 10 to 14, 1912, he took 13 specimens of two species. Finally, from April 8 to 19, 1913, five specimens of four species were secured. These collections contain much of importance, but no report was prepared. Bond's (1950*a*) record of *Limnothlypis swainsonii* from Swan Island is based on the specimen obtained by Nelson (Peters, 1913); none of the other records has been published.

In 1926 and 1927 the Museum of Comparative Zoology received single specimens of 18 species which were secured by Neal Wilson on the Swan Islands between September 25, 1926, and April 10, 1927. These birds are also of considerable interest but never were studied.

A. K. Fisher stopped at the islands from April 19 to 20, 1929, recording 21 species (Fisher and Wetmore, 1931). The last ornithologist to visit there appears to have been Delacour, who, on October 20, 1937, noted about a dozen forms, including several new to the islands (Delacour, 1938).

Annotated List

The following list contains all of the species known, with certainty, to have occurred on the islands. Those birds which have not been noted previously in publications are indicated by an asterisk (*). The collectors, or observers, of each species are listed and full data are presented for specimens in the collections of Nelson and of Wilson.

Sula leucogaster leucogaster (Boddaert). Brown Booby. Townsend; Lowe; Fisher; Delacour. Breeds on Little Swan Island.

Sula sula sula (Linnaeus). Red-footed Booby. Townsend; Lowe; Fisher; Delacour. Breeds on Little Swan Island.

Fregata magnificens rothschildi Mathews. Man-o'-War Bird. Townsend; Lowe; Fisher; Delacour. Breeds on Little Swan Island.

Ardea herodias subsp. Great Blue Heron. Fisher; Delacour. Sight records.

Florida caerula (Linnaeus). Little Blue Heron. Lowe. Sight record.

Butorides virescens virescens (Linnaeus). Green Heron. Townsend; Fisher; Delacour; Nelson (1 female, Apr. 8, 1 female, Apr. 18, 1913); Wilson (1 unsexed specimen, Sept. 25, 1926). Townsend collected specimens on March 6 and 26, 1887, and Fisher one on April 19, 1929. The fact that Lowe did not find the species in mid-winter probably indicates that it is a transient. Fisher and Wetmore (1931) reached the same conclusion when discrediting *B. v. saturatus*, which Ridgway (1887) described from Swan Island.

**Nyctanassa violacea violacea* (Linnaeus). Yellow-crowned Night Heron. Nelson (1 male, Apr. 14, 1913).

Botaurus lentiginosus (Rackett). American Bittern. Lowe. Sight record.

Anas discors Linnaeus. Blue-winged Teal. Delacour. Sight record.

Pandion haliaetus subsp. Osprey. Lowe. Sight record.

Falco peregrinus anatum Bonaparte. Peregrine Falcon. Townsend; Lowe.

Falco columbarius columbarius Linnaeus. Pigeon Hawk. Townsend; Lowe; Fisher.

Falco sparverius subsp. Sparrow Hawk. Delacour. Sight record.

Porzana carolina (Linnaeus). Sora. Townsend.

**Fulica americana americana* Gmelin. American Coot. Wilson (1 male, Dec. 25, 1926).

**Charadrius hiaticula semipalmatus* Bonaparte. Ringed Plover. Wilson (1 male, Oct. 11, 1926).

Charadrius wilsonia subsp. Thick-billed Plover. Lowe. Sight record.

Arenaria interpres morinella (Linnaeus). Ruddy Turnstone. Lowe; Nelson (1 female, Mar. 2, 1912); Wilson (1 unsexed specimen, Oct. 9, 1926).

Tringa flavipes (Gmelin). Lesser Yellow-legs. Townsend; Nelson (1 female, Mar. 13, 1912); Wilson (1 female, Feb. 19, 1927).

Actitis macularia (Linnaeus). Spotted Sandpiper. Delacour. Sight record.

Calidris pusilla (Linnaeus). Semipalmated Sandpiper. Townsend.

Calidris melanotos (Vieillot). Pectoral Sandpiper. Townsend.

**Sterna fuscata fuscata* Linnaeus. Sooty Tern. Wilson (1 male, Oct. 4, 1926). The failure of earlier collectors to record this species, and the apparent lack of suitable nesting localities on the islands, suggest that Sooty Terns are visitants only.

Columba leucocephala Linnaeus. White-crowned Pigeon. Townsend; Lowe; Fisher; Delacour; Nelson (3 males, 3 females, Feb. 28 to Mar. 22, 1912). White-crowned Pigeons breed on both islands. The species is migratory in the northern section of its range and possibly part of the winter population on the Swan Islands is composed of visitants. There is no evidence of this, but the lack of evidence is of little significance since the data are scant; even the date of the nesting season is unrecorded.

Coccyzus minor nesiotes Cabanis and Heine. Mangrove Cuckoo. Townsend; Nelson (1 male, Mar. 1, 1912); Wilson (1 female, Oct. 11, 1926; 1 female, Apr. 10, 1927). The Mangrove Cuckoo is presumed to breed, but it should be noted that Lowe (1909) failed to record the bird in mid-winter, which implies that it may be only a transient. The recent discovery (Voous, 1955) that *C. m. maynardi*, a contiguous race to the north of *C. m. nesiotes*, is a visitor on Curaçao and Bonaire makes this seem more probable.

Coccyzus americanus americanus (Linnaeus). Yellow-billed Cuckoo. Townsend.

Crotophaga ani Linnaeus. Smooth-billed Ani. Lowe; Delacour; Nelson (2 females, Mar. 1, 1912). Lowe (1911) has made the plausible suggestion that since Townsend failed to take any specimens of the ani, the species probably became establishd on the islands sometime after 1887. Although Townsend may have neglected to collect anis, this seems improbable in view of the fact that he even collected series of boobys and frigate birds, species which are often purposely slighted by selective collectors. In further support of his idea, Lowe (1909; 1911) points out that the islands were heavily wooded until the mid-1800's when the first settlers arrived, and that it is unlikely that anis would have found an adequate habitat prior to the creation of clearings. Similar situations are known, with fair certainty, to have occurred on Tobago Island, where *Crotophaga ani* arrived in 1822 or 1823 (Kirk, *in* Jardine, 1840), and on the islands of San Andrés and Providencia, where the species became established within recent years (Bond, 1950*b*).

Chordeiles minor gundlachii Lawrence. Common Nighthawk. Fisher. A migrant.

Ceryle alcyon subsp. Belted Kingfisher. Lowe; Fisher. Sight records.

**Sphyrapicus varius varius* (Linnaeus). Yellow-bellied Sapsucker. Nelson (1 female, Mar. 7, 1912).

Tyrannus tyrannus (Linnaeus). Eastern Kingbird. Townsend.

**Tyrannus dominicensis dominicensis* (Gmelin). Gray Kingbird. Wilson (1 male, Mar. 30, 1927). This flycatcher is probably a transient since no other collector has found it.

Contopus virens virens (Linnaeus). Eastern Wood Pewee. Townsend; Fisher.

Iridoprocne bicolor (Vieillot). Tree Swallow. Delacour. Sight record.

**Riparia riparia riparia* (Linnaeus). Bank Swallow. Wilson (1 female, Mar. 26, 1927).

Hirundo rustica erythrogaster Boddaert. Barn Swallow. Townsend; Fisher; Wilson (1 male, Mar. 19, 1927).

**Petrochelidon pyrrhonota pyrrhonota* (Vieillot). Cliff Swallow. Wilson (1 male, Mar. 21, 1927).

Dumetella carolinensis (Linnaeus). Catbird. Townsend; Lowe; Fisher; Nelson (3 males, 2 females, Mar. 15 to 22, 1912).

Mimocichla plumbea rubripes (Temminck). Western Red-legged Thrush. Townsend collected ten specimens, but the bird has not been observed since. It is presumed to have been extirpated, possibly owing to the disturbance of the forest.

Catharus ustulatus swainsoni (Tschudi). Olive-backed Thrush. Fisher; Wilson (1 male, Oct. 22, 1926).

**Catharus minimus minimus* (Lafresnaye). Gray-cheeked Thrush. Nelson (1 female, Apr. 19, 1913).

Vireo griseus noveboracensis (Gmelin). White-eyed Vireo. Lowe.

**Vireo flavifrons* Vieillot. Yellow-throated Vireo. Nelson (1 female, Mar. 14, 1912).

Mniotilta varia (Linnaeus). Black-and-white Warbler. Townsend; Lowe; Fisher.

Limnothlypis swainsonii (Audubon). Swainson's Warbler. Nelson (1 female, Mar. 1, 1912). This specimen appears to have been the one cited by Bond (1950*a*).

Helmitheros vermivorus (Gmelin). Worm-eating Warbler. Lowe; Nelson (1 male, Mar. 1, 1912).

Parula americana pusilla (Wilson). Parula Warbler. Townsend; Nelson (1 female, Feb. 28, 1912).

**Dendroica tigrina* (Gmelin). Cape May Warbler. Nelson (1 male, Mar. 22, 1912).

Dendroica caerulescens caerulescens (Gmelin). Black-throated Blue Warbler. Townsend; Fisher; Nelson (1 female, Feb. 29, 1912).

Dendroica coronata coronata (Linnaeus). Myrtle Warbler. Townsend; Lowe; Nelson (3 females, Mar. 14 to 22, 1912).

Dendroica fusca (Müller). Blackburnian Warbler. Fisher. Sight record.

Dendroica dominica dominica (Linnaeus). Yellow-throated Warbler. Nelson (1 female, Feb. 29, 1912).

Dendroica discolor discolor (Vieillot). Prairie Warbler. Townsend.

Dendroica vitellina nelsoni Bangs. Vitelline Warbler. Townsend; Lowe; Fisher; Delacour; Nelson (11 males, 12 females, 1 unsexed specimen, Feb. 25 to Mar. 12; 6 males, 5 females, 1 unsexed specimen, July 10 to 12, 1912). This is the only breeding passerine on the islands and also the only endemic form.

Dendroica palmarum palmarum (Gmelin). Palm Warbler. Townsend; Lowe; Nelson (1 female, Feb. 28, 1 male, Mar. 2, 1912).

Seiurus aurocapillus aurocapillus (Linnaeus). Ovenbird. Townsend; Nelson (1 unsexed specimen, Feb. 28, 1 male, Mar. 22, 1912); Wilson (1 unsexed specimen, Mar. 15, 1927).

**Seiurus motacilla* (Vieillot). Louisiana Waterthrush. Nelson (1 female, July 14, 1912). This is an unusually early date for the species to be so far south.

Seiurus noveboracensis notabilis Ridgway. Northern Waterthrush. Townsend; Wilson (1 unsexed specimen, Sept. 28, 1926).

Geothlypis trichas brachidactyla (Swainson). Common Yellowthroat. Townsend.

**Wilsonia citrina* (Boddaert). Hooded Warbler. Wilson (1 male, Mar. 25, 1927).

Setophaga ruticilla (Linnaeus). American Redstart. Townsend; Lowe; Fisher; Nelson (1 female, Feb. 29, 1912); Wilson (1 female, Oct. 9, 1926).

**Icterus spurius spurius* (Linnaeus). Orchard Oriole. Nelson (1 male, Apr. 17, 1913).
**Dolichonyx oryzivorus* (Linnaeus). Bobolink. Wilson (1 male, Oct. 2, 1926).
Piranga rubra rubra (Linnaeus). Summer Tanager. Fisher.
Spiza americana (Gmelin). Dickcissel. Townsend; Fisher.

Discussion

There is little doubt that wanderers or hurricane-wafted strays reach the Swan Islands with some regularity. However, owing to deficient numbers, because of an incompatible habitat, or for a number of other reasons, most species are unable to become established. Indeed, even on larger and ecologically more diverse oceanic islands, successful colonization is not common, as indicated by their depauperate avifaunas. The fortuitous manner by which the Swan Islands were populated is vividly evident. Of the 65 species recorded from there, only seven or eight are resident. Three of these (*Sula leucogaster*, *Sula sula* and *Fregata magnificens*) are marine and five (*Columba leucocephala*, *Coccyzus minor* [resident ?], *Crotophaga ani*, *Mimocichla plumbea*, and *Dendroica vitellina*) are land forms. It is interesting to speculate on the origin of the latter group.

Columba leucocephala disperses widely after the breeding season, which undoubtedly has led to its colonizing even the remote islands of the western Caribbean region. Its presence on the Swan Islands is in no way unusual.

Coccyzus minor nesiotes is a race found also on Jamaica, the Cayman Islands, Hispaniola, and other islands in the vicinity. If it is resident on the Swan Islands, it could most easily have arrived from Jamaica or the Cayman Islands, possibly through the agency of hurricanes. Its failure to differentiate in the manner of other isolated populations of the species, as, for example, those on San Andrés and Providencia islands, may be attributed to its recent arrival or, possibly, to genetic swamping by frequent immigrants. An alternate and more simple explanation may be that the bird is merely a transient on the islands.

Crotophaga ani, which apparently arrived between 1887 and 1908, seems to have been quick to exploit a newly created habitat, considering that the nearest source of immigrants is 200 miles across the Caribbean. If the lack of open fields had prevented Smooth-billed Anis from inhabiting the Swan Islands, and if clearings were first made about 1850, then colonization must have occurred within a maximum of fifty years after the habitat was altered; it could have occurred within half that time. This suggests that these isolated islands receive stray anis frequently, or that it was merely a matter of chance that the species should arrive so promptly. No matter which proposal is correct, the ani undoubtedly colonizes with more ease than many species, since it is highly social and several birds may wander, or be blown, to an island at one time, thereby facilitating the establishment of a breeding population.

The former presence of *Mimocichla plumbea rubripes*, a race found on the Isle of Pines and in central and western Cuba, is unexpected. Assuming that the source of Townsend's specimens is correctly indicated, which is reasonably certain, one must accept the Cuban or Isle of Pines origin of the Swan Islands population. The birds may have been carried there by the northeastern trade winds, or they may have been swept to sea by hurricanes and later wandered to the Swan Islands. Thrushes are secretive and seem among the species most unlikely to colonize an isolated island. Nevertheless, they are distributed widely and have reached even as remote a place as Gough Island, in the South Atlantic. In this light, the presence of a thrush on the Swan Islands is not extraordinary.

Dendroica vitellina is restricted to the Cayman and Swan Islands. The Swan Islands endemic, *D. v. nelsoni*, was certainly derived from Cayman Islands stock. Hurricanes often sweep across the Caribbean in a path ideally suited to dispersal in this pattern.

The fact that 57 species have been recorded as migrants or visitants on the islands, in spite of scattered and infrequent observations, makes it obvious that migration across the Caribbean in the vicinity of the Swan Islands is of considerable magnitude. The presence of so many migrants cannot be accidental and suggests that the islands are on a migration route.

The available data are not sufficient to be confident of differentiating all of the visitants from all of the migrants. Therefore, if the discussion is confined to species which are not known to winter in the West Indies, we are left with the following 12 birds, which are certainly transients on the islands: *Chordeiles minor gundlachii*, *Tyrannus tyrannus*, *Contopus virens*, *Riparia r. riparia*, *Petrochelidon p. pyrrhonota*, *Catharus ustulatus swainsoni*, *Catharus m. minimus*, *Dendroica fusca*, *Wilsonia citrina*, *Icterus spurius*, *Dolichonyx oryzivorus*, and *Spiza americana*. Only *Riparia r. riparia* and *Dolichonyx oryzivorus* are found regularly east or south of the northern West Indies, indicating that most of the species on the list reach the mainland by some route other than through the chain of Greater and Lesser Antilles.

Tyrannus tyrannus, *Petrochelidon p. pyrrhonota*, *Catharus ustulatus swainsoni*, *Catharus m. minimus*, and *Dendroica fusca* winter exclusively in South America but do not occur on migration in the Lesser Antilles. In order to reach their winter quarters from the northern West Indies they must cross the open Caribbean. Since the Swan Islands are well to the west of a direct route from the Greater Antilles to South America, yet they receive migrants destined for South America as well as other migrants, it is logical to conclude that they lie on a migration path extending from the northern Antilles to northern Central America. The five species under consideration occur in Central America but, unfortunately, all are known to migrate through Middle America, as well as via the West Indies. This has obscured the northern trans-Caribbean migration route and led to the generalized assumption (*e.g.*, Lincoln, 1950) that south-bound (or north-bound) birds migrate through Middle America or through the West Indies, but seldom utilize sections of both routes.

From the list of migrants found on the Swan Islands, it can be seen that not only do birds which winter in South America use this path, but also species which winter in Central America. When longer and more detailed studies have been made in the Caribbean, it may be found that the Greater Antilles–Central America route is fully as important as that between the Greater Antilles and South America.

Summary

Sixty-five species of birds have been recorded from the Swan Islands. Seven or eight are resident; three are marine (*Sula l. leucogaster*, *Sula s. sula*, and *Fregata magnificens rothschildi*) and five are land forms (*Columba leucocephala*, *Coccyzus minor nesiotes* [resident ?], *Crotophaga ani*, *Mimocichla plumbea rubripes*, and *Dendroica vitellina nelsoni*.

The thrush, whose origin was in Cuba or the Isle of Pines, was extirpated between 1887 and 1908; the ani arrived within the same period. Deforestation may have been responsible for both events.

The only endemic is *Dendroica v. nelsoni*, which was derived from Cayman Islands stock.

The presence of many migrants suggests the occurrence of large-scale migration between the northern Antilles and Central America.

Acknowledgments

James Bond and James C. Greenway, Jr., critically read the manuscript. Their suggestions and assistance are gratefully acknowledged.

Literature Cited

Bond, J.

1950*a* Check-list of birds of the West Indies. Philadelphia; Acad. Nat. Sci. Phila., 200 pp.

1950*b* Results of the Catherwood-Chaplin West Indies Expedition, 1948. Part II. Birds of Cayo Largo (Cuba), San Andrés and Providencia. *Proc. Acad. Nat. Sci. Phila.*, 102:43–68.

Delacour, J.

1938 Journal de Croisiere. (Yacht *Rosaura*, octobre 1937–janvier 1938). *L'Oiseau*, 8:541–557.

Fisher, A. K. and A. Wetmore
1931 Report on birds recorded by the Pinchot Expedition of 1929 to the Caribbean and Pacific. *Proc. U. S. Nat. Mus.*, 79(10):1–66.

Jardine, W.
1840 On the history and habits of Crotophaga. *Ann. Nat. Hist.*, 4:160–171.

Lincoln, F. C.
1950 Migration of birds. *U. S. Fish and Wildlife Serv., Circ.* 16. 102 pp.

Lowe, P. R.
1909 Notes on some birds collected during a cruise in the Caribbean Sea. *Ibis*, 1909:304–347.
1911 A naturalist on desert islands. New York; Charles Scribner's Sons, 230 pp.

Peters, J. L.
1913 List of birds collected in the territory of Quintana Roo, Mexico, in the winter and spring of 1912. *Auk*, 30:367–380.

Ridgway, R.
1888 Catalogue of a collection of birds made by Mr. Chas. H. Townsend, on islands in the Caribbean Sea and in Honduras. *Proc. U. S. Nat. Mus.*, 10:572–597.

Voous, K. H.
1955 De Vogels van de Nederlandse Antillen. The Hague; Martinus Nijhoff, viii + 205 pp.

Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, August 1, 1955

DISTRIBUTION OF THE CARDINAL IN SOUTH DAKOTA

BY HERBERT KRAUSE AND SVEN G. FROILAND

THE extension of the range of the Cardinal (*Richmondena cardinalis*) and its seasonal status in the upper Midwest apparently have received little attention in ornithological literature. This seems particularly true of the area bordering the upper Mississippi River in Minnesota and the Missouri River in South Dakota. Roberts (1936:335) states that by 1936 this species was established in Minnesota but was "confined as a resident breeding bird to the southeastern portion of the state." However, he found that it was "extending its range northward and westward."

In South Dakota, Visher (1915:332) reported the Cardinal as "a tolerably common resident in the Missouri Valley near Vermillion" (Clay County) by 1913. Five years later, according to Stephens (1918:101) it had "become very well established as a permanent resident" in Union County. Both Clay and Union counties are located in the extreme southeastern part of the state. Few reports of the Cardinal in South Dakota appeared subsequently, and, as late as 1930, Stephens observed (pp. 365–366): "It would be very interesting to know how far up the Missouri River these birds have extended their range at the present time; and also how far up the tributaries in this region they have penetrated." This study has been undertaken in an effort to throw light on some of these queries.

In order to obtain as broad a presentation of data as possible, the historical background was searched and the items in Stephens' (1945) bibliography and in the available literature checked. In addition to notes and observations of some seven years of personal field work, the writers interviewed and corresponded with competent observers located in strategic positions in the state. These persons' generous reports and comments are gratefully acknowledged. Those of Art Lundquist, Alfred Peterson, Ruth Habeger and V. H. Culp have been especially helpful.

The literature on the Cardinal in South Dakota is admittedly scanty. The scarcity of observers and collectors may be held responsible for many of the gaps in the information on this species. It was not listed in the journal of Audubon (1900), who was on the Missouri in 1843, nor was it included in Baird's (1858) list of the railroad survey made during the period 1853–56. The first record seems to have been that of McChesney (1879:78), who observed a pair at Fort Sisseton in the extreme northeastern part of the state in the spring of 1877. During that summer he saw a male several times. Neither collection nor nesting data was reported, however.

McChesney (*op.cit.*) remarked that the Cardinal was "only of casual occurrence in this region." However, it is possible that these individuals were accidental rather than casual. It is not unusual for a Cardinal to appear far from its accustomed range. Roberts (1936:335) speaks of a male Cardinal reported in Minnesota in 1930 some 300 miles north of any previous record.

It may be significant that in the 75 years following McChesney's report of them, no further mention seems to be made of appearances of Cardinals in the vicinity of Fort Sisseton or in the northeast generally. Agersborg, whose list (1885) is the first important published record for the state by a resident, does not include it either for the state as a whole or for the southeastern part of the state. Larson (1925) did not list the Cardinal in his 10-year study (1906–1916) of the east-central area centering about Minnehaha County. Alfred Peterson, whose field work and publications began in the early 1920's, writes (letter, October 15, 1954) that he has never seen the Cardinal in the central northeastern region. Art Lundquist (letter, October 12, 1954), a veteran field man in the northeast area adjacent to the Fort Sisseton country, does not include occurrences until 1950 and does not report nesting data at this writing.

Though the Cardinal was noticed first in the 1870's, what seems to have been the first report of a Cardinal nest in South Dakota and perhaps the first indication of permanent residence in the state did not appear until after the turn of the century. In 1902 D. H. Talbot published a note regarding the breeding of this species in Union County, not far from Sioux City, Iowa (Fig. 1). Ten years later Visher (1915) noted it as "tolerably common in the Missouri Valley near Vermillion." This represents an advance upstream of some 40 miles. By the second decade, its nesting range seems to have included only the two counties in the extreme southeastern part of the state.

At the same time, as a winter bird, the Cardinal was appearing farther and farther up the Missouri. In the early 1920's it was found at Yankton, 50 miles upstream from Sioux City. In the 1930's it continued its march. In fact, during the period from 1930 to 1946, it apparently extended considerably its winter range in all the eastern part of the state. This species was making headway not only on the Missouri, but also on the James and the Big Sioux rivers, tributaries which drain a major share of the eastern half of the state. Reports of its appearances were noted from the Missouri on the south to the North Dakota border on the north. As early as the winter of 1929 Larrabee mentioned it as a December visitant in Minnehaha County, which is traversed by the Big Sioux. In the spring of 1937 Dr. J. F. Brenckle banded an individual in Spink County, 260 miles up the James River. In the years 1940–42 it appeared as a winter bird in those northeastern counties bordering on North Dakota. This brought it again into the Fort Sisseton area where McChesney had seen it some 75 years before. In some forty-odd years then, it had traversed the eastern portion of the state from south to north. What is more, apparently this area became familiar ground. In the years following the middle 1940's the Cardinal has been reported fairly regularly in the northeastern portion of South Dakota. In 1954 wintering individuals were reported at Mobridge in the Missouri bottoms, which brings this species to within 30 miles of the North Dakota border in the north-central portion of the state also.

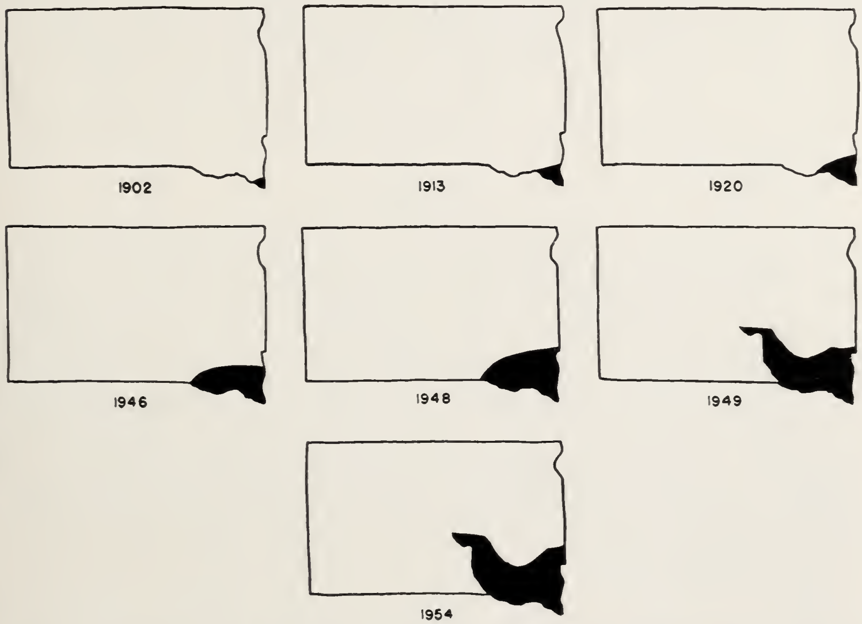


Fig. 1. Extension of the breeding range of the Cardinal in South Dakota based on available nesting records.

However, all these northern occurrences were recorded in fall, winter and early spring, and most involved male birds only. No summer records are available in spite of search by field men such as Lundquist and Peterson.

Meanwhile the breeding range of the Cardinal was advancing northward also. Randall (1953) found nests and young in the Fort Randall (Pickstown) locality in 1946, a 72-mile advance up the Missouri and some 125 miles from Sioux City. In 1950 a nest was reported at Fort Thompson, 100 miles north of Fort Randall. At present (1954) the Cardinal is reported nesting in the river bottoms at Farm Island and at Pierre, some 260 miles upstream from the place in Union County where the first nest was found. This, according to present evidence, is its farthest penetration up the Missouri as a breeding bird.

In the eastern part of the state, Krause in 1948 found two nests and eggs at Sioux Falls, Minnehaha County, an advance of about 80 miles up the Big Sioux River. Since 1948 there have been many reports of nests, eggs, young and juveniles in this area (Froiland, Krause and others). The Cardinal is common the year around in Minnehaha County, and it is continuing to spread northward. According to Ruth Habeger (letter, October 29, 1954) it nests regularly in Lake and Moody counties just north of Minnehaha County, an advance in six years of some 40 miles northward along the Big Sioux River. On the basis of available data, this represents its farthest penetration northward as a breeding bird and perhaps as a permanent resident. Thus in half a century, the breeding range of the Cardinal has advanced some 100 miles northward in the eastern part of South Dakota.

Habitat Distribution

A study of the distribution map (Fig. 2) suggests that the main streams and their tributaries played a part in the widening range of the Cardinal in South Dakota. In almost every instance the reports come from localities on fairly large streams or their tributaries. There are no reports of Cardinals from areas of high land between watersheds. Neither is there information on appearances or nesting on the wide prairies or the hill counties or along the small prairie tributaries of larger streams with their somewhat less abundant vegetation. Few records come from counties which have intermittent streams and which therefore seem to offer less cover and fewer nesting possibilities.

It is perhaps significant that McChesney's sight record of the Cardinal occurs at Fort Sisseton, for this military post was in the lake country in that portion of the northeastern part of the state which is drained by the tributaries of the Big Sioux River and which lies some 200 miles north—almost straight north—of the point where the Big Sioux empties into the Missouri.

Evidently the vegetation bordering these waterways offers the type of habitat suitable for nesting and cover. Generally, in the adjacent areas appear shrubby willow (*Salix* sp.), plum-choke cherry (*Prunus* sp.) and dogwood (*Cornus* sp.) over which in many places tower cottonwood (*Populus deltoides*) and American elm (*Ulmus americana*), hackberry (*Celtis occidentalis*) and boxelder (*Acer negundo*), basswood (*Tilia americana*) and ash (*Fraxinus lanceolata*) trees. Vines, such as wild grape (*Vitis vulpina*) and Virginia creeper (*Parthenocissus quinquefolia*), occur in some localities. This kind of habitat provides not only shelter for the Cardinal but food as well.

Extension of the Cardinal's Range Westward

It is curious that appearances of the Cardinal have been singularly lacking in the area west of the Missouri River. At least available records fail to report them. Visher (1909) does not include this species in his comprehensive "List of the Birds of Western South Dakota" which takes into account the observations of Hayden on the Warren Expeditions in 1857 and 1869, and the Grinnell report on the Custer Expedition of 1874, as well as the reports of such competent observers and collectors as Lee, Sweet, and Behrens, whose collections are still available. The region covered by Visher's "List" includes the Bad Lands and the Black Hills with the adjacent areas. The

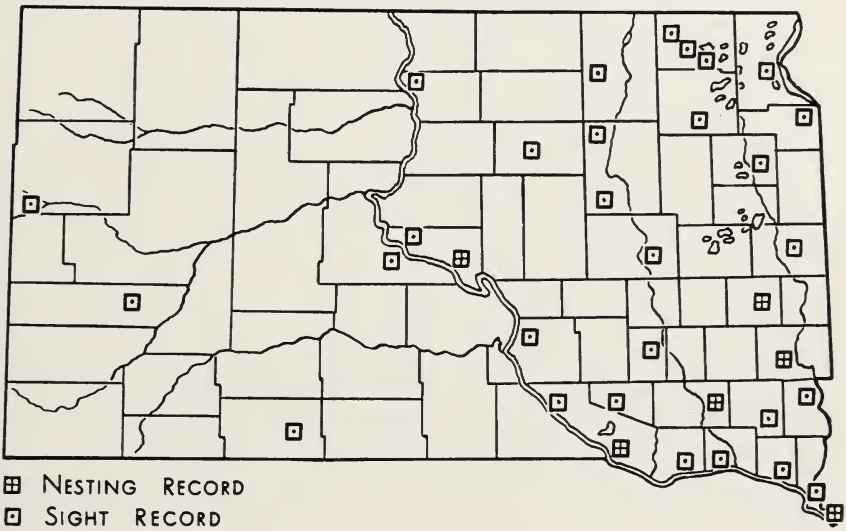


Fig. 2. Distribution of the Cardinal in South Dakota based on available records, 1875–1955.

Cardinal was not found on the Pine Ridge Reservation during Tullsen's (1911) stay there (1901–1908) nor was it seen by Visher (1912) during his survey (in 1908) of the area which also included a good portion of the White River drainage system.

Much of this region is semi-arid in character. The streams for the most part are intermittent and even those which persist during the greater part of the year are generally saline. While streams in the Black Hills are freshwater, they too are frequently intermittent. Plants which produce bushy thickets or viny tangles are not as abundant as in the east nor do they appear as regularly. It may be that the area, including as it does both the Black Hills and the Bad Lands, offers a complex of factors which might be operative here—factors which involve unusual and often puzzling floral and faunal distribution patterns.

The first mention of the Cardinal in western South Dakota appeared in the literature in 1951, when Haight reported two Cardinals seen near Belle Fourche on the Cheyenne River in the northwestern part of the state. In the early spring of 1955 two occurrences were observed, one by Hyde (1955) in Rapid Canyon near Rapid City in the Black Hills and one by Krumm (1955) at La Creek Wildlife Refuge on the Nebraska border in the southwest. All three appearances were in winter and early spring and involved males. Considering the non-migratory behavior of this species and its sporadic appearances, one wonders whether these individuals came from the Missouri, following its tributaries, the Cheyenne in the north, the White in the south. There is also the possibility that the southern birds came from another tributary of the Missouri, the Niobrara River in Nebraska. At any rate, according to the data, the Cardinal has appeared west of the Missouri three times, all within the last five years. It will be interesting to see whether in the next 20 or 30 years it will increase in numbers as it did east of the Missouri with the possibility of finally establishing itself as a permanent resident in this western region.

Summary

1. During the past 52 years the Cardinal has extended its range as a breeding bird into eastern South Dakota. The initial entry was made in the southeastern portion and to the present time it is distributed approximately over the eastern one-fourth of the state.

2. During this time it has appeared as a wintering bird in appreciable numbers in various places outside the breeding range in the eastern part of the state.

3. The extension of range of the Cardinal closely parallels major rivers and their tributaries. It would appear that these streams play an important role in the immigration of this species by contributing suitable habitat.

4. The Cardinal has not been reported in the area west of the Missouri until very recently. This peculiarity in distribution may be the result of lack of suitable habitat on the frequently-intermittent streams and their tributaries in the Bad Lands–Black Hills region and in the adjacent areas.

Literature Cited

Agersborg, G. S.
1885 The birds of southeastern Dakota. *Auk*, 2:276–289.

Audubon, Maria R.
1900 Audubon and his journals. Vols. I and II. New York; Charles Scribner's Sons.

BAIRD, S. F.
1858 Birds. *In*: Explorations and surveys to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean. Vol 9. *Senate Ex. Doc.* no. 78, Washington, D.C.

HAIGHT, C.
1951 Birds of the hills. *South Dakota Bird Notes*, 3:52–54.

HYDE, MRS. A. R.
1955 Cardinal at Rapid City. *South Dakota Bird Notes*, 7:29.

KRUMM, K.
1955 Cardinal at LaCreek Federal Wildlife Refuge. *South Dakota Bird Notes*, 7:29–30.

LARRABEE, A. P. AND P. J.
1929 Christmas bird census. Yankton. S. Dak. *Bird-Lore*, 31:58.

LARSON, A.
1925 The birds of Sioux Falls, South Dakota, and vicinity. *Wilson Bull.*, 37:18–38, 72–76.

MCCHESNEY, C. E.
1879 Notes on the birds of Fort Sisseton, Dakota Territory. *Bull., U. S. Geol. and Geogr. Surv. Terr.*, 5:71–103.

RANDALL, R.
1953 Birds of the Fort Randall reservoir area. *South Dakota Bird Notes*, 5:68.

ROBERTS, T. S.
1936 The birds of Minnesota. Vol. 2. Minneapolis; Univ. Minnesota Press.

STEPHENS, T. C.
1918 Notes on the birds of South Dakota, with a preliminary list for Union County. *Proc. Iowa Acad. Sci.*, 25:85–104.
1930 Bird records of two winters, 1920–1922, in the upper Missouri Valley. *Proc. Iowa Acad. Sci.*, 37:357–366.
1945 An annotated bibliography of South Dakota ornithology. Privately printed, Sioux City, Iowa.

TALBOT, D. H.
1902 The Cardinal breeding at Sioux City, Iowa. *Auk*, 19:86–87.

TULLSEN, H.
1911 My avian visitors: notes from South Dakota. *Condor*, 13:89–104.

VISHER, S. S.
1909 A list of the birds of western South Dakota. *Auk*, 26:144–153.
1912 The biology of south-central South Dakota. In *South Dakota State Geol. and Biol. Surv. Bull.*, 5:61–130.
1915 A list of the birds of Clay County, south-eastern South Dakota. *Wilson Bull.*, 27:321–335.

DEPARTMENT OF ENGLISH AND DEPARTMENT OF BIOLOGY, AUGUSTANA COLLEGE, SIOUX FALLS, SOUTH DAKOTA, MAY 16, 1955

ROOSTING AND NESTING OF THE GOLDEN-OLIVE WOODPECKER

BY ALEXANDER F. SKUTCH

THE Golden-olive Woodpecker (*Piculus rubiginosus*) is to my eye one of the most beautiful members of its family. Its back and wings are a most attractive shade of olive-green with a golden cast. The under parts are yellowish-olive with transverse yellowish bars; and the tail is brownish-olive, its central feathers becoming black at the tip. As with most woodpeckers, male and female are alike in appearance except for the markings of their heads. The male wears a large, bright crimson patch on his nape. This color extends forward along the sides of the crown to the base of the bill and encloses the slate gray of the forehead and center of the crown. His grayish cheeks are bordered below by broad, crimson malar stripes. The female has a large patch of crimson on her nape but lacks the conspicuous malar stripes of the male. About eight inches in length, these are woodpeckers of medium size.

The species has a vast range from México to northern Argentina and is highly variable, with many named races. I found the race *differens* fairly abundant in the coffee plantations on the Pacific slope of Guatemala, where the trees of the original forest had been left to shade the coffee which was set out after the undergrowth was cleared away and the canopy thinned. In October these woodpeckers were usually in pairs and rather difficult to approach. The Costa Rican form (*uropygialis*) is most abundant in the highlands. Carriker (1910. *Ann. Carnegie Mus.*, 6:584) found it ranging from 1500 to 6000 feet above sea level, but in greatest numbers between 2000 and 4000 feet, in the Reventazón Valley on the Caribbean side of the country. But in the region of El General on the Pacific slope I have never met it as low as 3500 feet. In the vicinity of Vara Blanca on the northern or Caribbean side of the Central Cordillera, the Golden-olive Woodpecker was rather rare at 5500 feet. Here I met it in the heavy, epiphyte-laden forest and in adjacent clearings with scattered trees.

Sleeping Habits

The first Golden-olive Woodpecker that I found at Vara Blanca was discovered one evening in August, as I made the rounds of the dead trunks standing in a pasture amid the forest, trying to learn what birds slept in the numerous cavities they contained. When I tapped on a low trunk with a woodpecker's hole in its side, a female of this species stuck her head through the doorway to see what was causing the disturbance. I attempted to make her come into the open; for I wished to see enough of her plumage to identify her with certainty, and also to learn whether perchance a mate was in the hole with her. But although her chamber was only 20 feet high, she was not easily frightened into leaving it. Neither by hammering and tapping on the trunk—all that the tottering stub seemed capable of withstanding—clapping my hands, nor throwing up my cap, could I persuade her to quit her snug retreat.

But the following evening, August 20, 1937, I watched for her to enter her dormitory. The mountain was shrouded in clouds and a fine drizzle fell. At 5:10 p.m., she flew up to the trunk and entered without hesitation, although I stood fairly near and unconcealed. She slept alone in her trunk in the pasture, only a few paces from the forest's edge. This was her nightly lodging for the next two months.

I was absent from Vara Blanca during much of November and December. After my return in January, 1938, I found that the upper half of the low stub in which the woodpecker slept had fallen, and with it her bedroom. She now slept in a hole only head-high above the ground, in a low, slender stub in the midst of the pasture, up the slope from her former dormitory. This cavity had been the lodging of a female Hairy Woodpecker (*Dendrocopos villosus*), which had abandoned it before the Golden-olive Woodpecker's first hole fell (see Skutch, 1955. *Wilson Bull.*, 67:25–32). Early in March, I discovered that a male Hairy Woodpecker slept in a freshly carved hole in the top of the same low stub, about six feet above the old cavity in which the Golden-olive Woodpecker still roosted, and on the same side of the trunk. But before the end of the month, the female Golden-olive Woodpecker was lodging in the newer and higher hole, the Hairy Woodpecker having gone elsewhere. I do not know whether his desertion was voluntary, or whether his bigger neighbor had somehow evicted him, possibly merely by ensconcing herself within before his arrival in the evening. The lower hole in this trunk was now without a tenant.

Voice

About the middle of February, I began to hear, especially in the early morning, the far-carrying challenge of the male Golden-olive Woodpecker. This was a high-pitched, clear, powerful note, repeated very rapidly to form a long-continued roll or trill, all in approximately the same key. It was quite distinct from the shorter, weaker, slower roll of the Hairy Woodpecker, and from the queer, little, wooden rattle of the Smoky-brown Woodpecker (*Veniliornis fumigatus*), which were the chief picarian neighbors of our species at Vara Blanca. Clinging in some high tree-top, the Golden-olive Woodpecker repeated his loud trill over and over.

The call-note of both sexes is a high, loud, sharp *beee*; and they utter also a dry *churr*.

INCUBATION

On April 5, 1938, I learned that the Golden-olive Woodpeckers were incubating in the hole where the female had of late been sleeping, and where the male Hairy Woodpecker had formerly passed his nights. Since this cavity was 13 feet above the ground in a slender and exceedingly rotten stub standing amid tall, rank grasses in a steep hillside pasture, I could not reach it to look in without assistants to hold a ladder; and two days passed before these could be enlisted. When the interior had been illuminated by introducing a small bulb attached to an electric torch by means of a flexible cord, the mirror stuck through the doorway revealed four beautiful, glossy, pure white eggs, resting upon clean chips on the bottom of the cavity. I did not jeopardize the nest by attempting to remove them for closer examination.

Now that the female woodpecker's former dormitory had been converted into a nest, the male occupied it by night and kept the eggs warm, as is the custom of all the woodpeckers which sleep singly, so far as I know. The female returned to sleep in her earlier lodging six feet lower in the same stub, but only for a few nights, after which she moved to a more distant abode which I failed to find. In using the female's rather than the male's dormitory as a nest, the Golden-olive Woodpeckers did just the reverse of a pair of Red-crowned Woodpeckers (*Centurus rubricapillus*) whose habits I studied during two years in southern Costa Rica. With this pair, the male was the more industrious hole-carver and usually provided himself with a lodging far more substantial than that of his mate, who was often content to sleep in cavities which he had deserted as no longer fit to occupy. Hence it was natural that at the outset of the breeding season the male Red-crowned Woodpecker's dormitory should be chosen to hold the eggs and young; and of course he continued to sleep in it, incubating or brooding through the night. I was not certain which bird made the hole in which the Golden-olive Woodpeckers nested. Did they themselves carve it out and the Hairy Woodpecker take possession of it for a while, to be evicted later by the rightful owners? The size of the doorway suggested that it was the work of the bigger Golden-olive Woodpeckers.

By day, male and female Golden-olive Woodpeckers sat alternately upon the eggs. Despite the lowness of the nest-cavity, both were extremely confiding, and did not fly out when I stood directly below their doorway, even after I had made a noise which caused them to look forth. When I came with a man and a boy to hold the ladder while I climbed up to look in, we found the male woodpecker in charge of the nest. After I drew his attention by tapping on the trunk, he gazed calmly down upon the three of us. It was necessary to clear a space at the foot of the stub in order to set up the ladder, and for a while the bird watched me chop down the grass and weeds so close below him. But before I had finished the work of clearing, he lost courage and flew away.

The female, after she had retired at nightfall to rest in her still lower hole, was also reluctant to quit it. If I stood in front and made a noise, she would look out; but when I approached closer she shrank back into the interior. While in charge of the eggs, her conduct was most variable. Sometimes she watched me set up the ladder beneath the nest and climb up to the first step before she winged away. At other times, a slight tap on the trunk would cause her to forsake the nest. Her steadfastness seemed to depend upon how she felt at the moment. In these sparsely-peopled mountain forests, most of the birds were more confiding in my presence than I have ever found them elsewhere; and I rarely had to conceal myself in a blind while studying a nest.

After incubation had been in progress about ten days, I devoted a day to learning how the woodpecker pair divided the duty of keeping the eggs warm. Seated on a distant stump on the hillside without concealment, I began my vigil as it grew light at 5:30 on April 15. There was no sign of activity about the nest until 7:15, when the female woodpecker suddenly flew up to the top of the stub, uttering a single, low, wiry note. The male, who had not previously showed himself in the doorway, now looked forth for the first time, then silently flew off. The female at once entered the nest. Four hours slipped slowly by without my having a glimpse of the female in the nest or of her mate on the outside. Beginning at last to suspect that the male might have replaced her on the eggs, during a moment when my attention wandered, I clapped my hands and called to bring to the doorway whichever woodpecker was in the nest. When these sounds failed to obtain a response, I advanced and tapped lightly on the trunk. Instead of merely looking out, as she usually did in similar circumstances, the female came forth and flew away. But after only six minutes she returned to the nest, and sat for another hour. Through much of her long morning session of nearly five hours' duration, she amused herself by hammering lightly on the inner wall of the chamber.

At 12:12 p.m. the male returned and clung beside the doorway. The female flew out and he entered at once. At 1:34 she returned, alighting beside the entrance with the low, wiry note I had heard early in the morning. The male silently departed and she entered. I was now obliged to be absent for a little over an hour while I visited some other nests. The female was still within when I returned at 2:42 and she sat until her mate replaced her at 3:05. I believe that she had been in charge of the nest continuously since 1:34: for had the male taken a turn on the eggs in the interval, the period between 1:34 and 3:05 must have been occupied by three shifts—two by the female and one by the male—which would make these sessions far shorter than any taken while I was present. At 4:50 the female again returned to the stub and voiced the same low, wiry notes as before. She waited two or three minutes before the doorway for her mate to come out, but he did not even show his head. Then she went in, but emerged again at once and flew away. After her departure the male looked out, then promptly settled back upon the eggs. At 5:03 the female returned, sounded the wiry note, then entered while her mate was still inside. He at once made his exit and flew off. At 5:54 he returned, clung beside the doorway and uttered a low note; whereupon the female came forth and departed. Then he entered to pass the night on the eggs.

The female woodpecker's long morning session of nearly five hours surprised me greatly. Her two afternoon sessions lasted 91 and 51 minutes, respectively; while the two afternoon sessions of the male were 82 and 118 minutes, respectively. Considering the woodpeckers' day to extend from 5:45 in the morning to 6:15 in the evening, a period of 12.5 hours, the female occupied the nest for a total of 439 minutes, the male for 311 minutes of the day. Had her mate yielded up the nest to her when she arrived at 4:50 p.m. to relieve him, she might have had a still larger share of the day to her credit. At no other woodpeckers' nest which I have watched continuously has the female been in charge for such a large part of the day.

When one of the pair of woodpeckers came to relieve the mate in the nest, it usually waited beside the entrance for the other to leave, before it went in. This appears to be the rule with woodpeckers that sleep singly. Only at the end of the day, when the male was slow in leaving, did the female, on two occasions, enter the nest while he was still within. The first time, she came out again immediately; the second time, her mate left as soon as she went in. They did not linger together in the nest when one relieved the other, as woodpeckers which sleep together often do.

The Nestlings

Three of the eggs hatched on April 16, the fourth on the following day. The newly-hatched nestlings were pink-skinned, completely glabrous—as the botanists would say—and blind, as is usual with woodpecker nestlings. Their parents were negligent about removing the empty shells, allowing parts of them to remain in the nest for at least five days after the nestlings had emerged. Two of the young woodpeckers vanished a few days after hatching, evidently having lost out in the competition with their nest-mates for food. This is a common occurrence among woodpeckers, and appears to result from the parents' inability to see their little ones well at the bottom of the deep cavity and to distribute the food equably among them. Eight days after they hatched, the two survivors, which had grown with wonderful rapidity, were sprouting their pin-feathers.

After the nestlings hatched, the parent woodpeckers became more wary than they had been during the course of incubation, and they would fly from the hole with far slighter provocation. I tried to watch the nest from a blind set close in front of the doorway; but the female delayed so long in approaching that I finally decided that it would be better to remove the offending brown tent and look on without concealment from a more distant point, as I had done while studying the mode of incubation. On April 27, after the cessation of the rain which at dawn a cold wind was driving over the mountain, I took my station on the hillside and watched the parent woodpeckers attend their two eleven-day-old nestlings. In the four hours and 40 minutes from 6:50 to 11:30 a.m. the male visited the nest only thrice, the female twice. Presumably they fed the nestlings on each visit, which would make the rate of feeding little better than once per hour for the two of them combined. Once I could discern a small particle of food projecting from one side of the female's bill as she entered the nest, but otherwise the parents came with no visible food. The feeding of the nestlings was evidently by regurgitation; but since this was done within the cavity, I could not watch the process. The female still made her first morning appearance at the nest at about a quarter past seven, as she had done during the course of incubation; and the nestlings received their breakfast late. They were now brooded very little during the day; for their mother remained in the nest for periods of 10 and 9 minutes only, while the father stayed for 7, 7 and then 8 minutes. And the parents did not warm the nestlings even for the whole of these brief periods in the cavity, but spent part of the time looking through the doorway. They attended to the sanitation of the nest, from time to time carrying away droppings.

Another nestling died after its feathers had begun to sprout, leaving only one alive out of the four that had hatched. At the age of 21 days the lone survivor began to appear in the doorway to receive food. She was well feathered, quite resembled her mother, and was without much doubt a young female, since juvenile woodpeckers, if they do not bear the markings of the parent of the same sex, are more likely to wear the colors of the adult male than of the adult female. On May 10, when the young woodpecker was 24 days of age, I devoted five hours of the morning to watching the parents attend her. I began my vigil at dawn, and as the light increased I could distinguish the father's head in the top of the cavity. He still passed the night with the nestling, but perhaps clinging to the side of the chamber above her rather than actually brooding. At 5:58, immediately after he flew out, the nestling's head appeared in the doorway. She continued to watch and wait for her breakfast for nearly two hours more, for it was 7:45 before the male returned with her first meal of the day. He brought nothing that I could see in his bill; but upon arriving he clung to the outside of the trunk beside the doorway, placed his bill in his daughter's mouth, and proceeded to regurgitate food to her. The feeding was completed in two installments, each lasting a few seconds; then he flew away. Three-quarters of an hour later he came again with a second and apparently more copious meal. The youngster, still looking through the doorway, leaned far out to receive it. Clinging to the trunk beside the entrance, the father placed his bill in her mouth, but only momentarily, and apparently passed no food. Then, after a pause of a few seconds, he again inserted his bill into her mouth, and this time seemed to give her nourishment. He removed his bill, but after a pause inserted it again and delivered more food. Then twice he placed his bill momentarily into the nestling's mouth, but apparently without giving her anything. Next followed two more-liberal feedings, after which he flew away. As he went off, the youngster looked through the doorway and uttered a low trill.

The female first appeared that morning at 8:55. Clinging in a neighboring tree, she uttered the sharp, staccato *beee*, then the rapid trilled call. Thence she proceeded to the entrance, with nothing visible in her bill, and fed the nestling by regurgitation in a number of brief installments. After this she flew off and did not return during the next hour and a half. At 9:05 the male appeared for the third time. From a neighboring tree he called and trilled, and was answered by the nestling with a much weaker trill. She stuck out her long, slender, white tongue, as though in anticipation of the good things she was about to receive. But this time the feeding was short. After her father had gone, the young bird amused herself by scratching and pecking the inner wall of the nest-cavity. Through the doorway, I could see that she hung backward in the top of the nest to preen her breast feathers. In 20 minutes the male was back again and fed her more liberally, in four courses.

Thus during the first four and a half hours of the woodpeckers' active day the single nestling was fed only five times, four times by the male and once by the female. When woodpeckers nourish their nestlings by regurgitation, they bring food at a very slow rate. Two feathered nestlings of the Lineated Woodpecker (*Dryocopos lineatus*) were fed upon regurgitated food only nine times in as many hours. The rate of food-bringing for the brood as a whole was about the same as at the nest of the Golden-olive Woodpecker on the morning I watched; but since the Lineated Woodpeckers had two young instead of one, the rate per nestling was only half as great. or 0.5 times per hour. On the other hand, woodpeckers which bring particles held visibly in their bills make far more frequent visits to the nest. The Golden-naped Woodpecker (*Tripsurus chrysauchen*) and the Red-crowned Woodpecker feed their young without regurgitation; and I have known the former to bring food at the rate of 6.7 times per nestling per hour, the latter at the rate of 9 times per nestling per hour, over brief periods. But these woodpeckers seem to give their brood much less at each meal than those that feed by regurgitation. And since they take a morsel to the nest as soon as they find it, without waiting to fill their crops, they do not make their family wait so long for breakfast as was the custom of the Golden-olive Woodpeckers.

Now that they could feed their nestling through the doorway, the parent Golden-olive Woodpeckers no longer took the trouble to go inside and remove the droppings. As a result of this neglect, the bottom of the chamber was soon covered with an accumulation of filth. This was probably no serious inconvenience to the young woodpecker, which now no doubt passed day and night clinging to the inner wall of the deep cavity, rather than resting on the bottom, as when she was younger. Other hole-nesting birds which are careful of the sanitation of the nest while the nestlings are callow and helpless cease to remove the droppings after they are no longer obliged to enter in order to deliver food; this is true, for example, of woodpeckers of the genera *Centurus* and *Dendrocopos*, of Allied Woodhewers (*Lepidocolaptes affinis*), and of the Quetzal (*Pharomachrus mocino*). None of these birds leads the young back to sleep in the nest after they have taken wing. But the Golden-naped Woodpecker and the Olivaceous Piculet (*Picumnus olivaceus*), which use the nest-cavity as a family dormitory long after the fledglings have begun to fly about, never relax their attention to its cleanliness.

In the afternoon of May 10, I looked into the nest to check upon the number of young it now contained. As we set up the ladder below her, the young woodpecker looked down at us through the doorway, then watched me climb up to her, and even permitted me to touch her bill, before she retreated into the bottom of the cavity. I had thoughtlessly placed the mirror for looking into the hole in one of the pockets of my shirt, instead of in a trousers pocket, where it should have been. As I was ascending to the topmost step of the ladder, balancing myself in a difficult position, this mirror rubbed against the stub and produced a grating noise, which frightened the woodpecker more than my approach. Suddenly darting from the nest, she turned down the slope toward the woods in the ravine. Her flight was slow and labored; but without a rest she covered about 25 yards, in a course which at first was inclined downward, but toward the end veered slightly upward; and she came to rest in a tangle of vines that covered over a small tree within the edge of the woodland. Since other woodpeckers of about the same size (such as Golden-naped Woodpeckers and species of *Centurus*) linger in the nest a full month, I was surprised that this young Golden-olive Woodpecker could fly so well when frightened from the nest at the age of only 24 days. I had felt sure that when I looked in she would crouch in the bottom of the cavity and not attempt to fly out, and doubtless she would have done so but for the unfortunate scratching of my mirror against the trunk.

The young woodpecker was completely feathered and very pretty in her fresh, new plumage, colored like that of her mother. Soon after her premature departure from the nest, I began to keep watch to learn whether her parents would try to bring her back to its shelter; for the sun was already sinking low. The mother did not again appear in the vicinity, but at about 6:30 the father returned to the nest. Clinging before the doorway, he peered inside and all around him, as was his custom before entering, but he showed little concern over the absence of the nestling. He uttered not a syllable to call her back, as Golden-naped Woodpecker parents would have done, but silently retired into the shelter of the nest, while his daughter of tender age remained in the open, exposed to the rain.

Four days later, I found a young female Golden-olive Woodpecker, attended by her parents, high up in a moss-burdened tree at the forest's edge. Although she was about 1000 feet from the nest that I had watched, I believe that she was the fledgling who had been raised in it; for Golden-olive Woodpeckers were not abundant in the region, and each pair wandered over a wide area. I was happy to see that she was alive and well, and had suffered no ill consequences from her premature departure from the nest in the rainy weather then prevailing. Probably the great amount of rain and mist during the nesting season at Vara Blanca in 1938 contributed to the deaths of the other three nestlings from inadequate nourishment; and, since on these storm-swept mountain slopes such weather was not unusual, this might explain why the Golden-olive Woodpecker was not more abundant in the region.

For a number of nights after the departure of the nestling, her father continued to use the nest-cavity as a dormitory; but I never again saw the young woodpecker in its vicinity. In the use of the old nest for sleeping by the male parent, while the young remain in the open, the Golden-olive Woodpecker agrees with the Red-crowned Woodpecker, the Lineated Woodpecker, and the Hairy Woodpecker (see Skutch, 1955. *Wilson Bull.* 67:30).

Doubtless, as with these other species of which adults always sleep singly, the young Golden-olive Woodpecker roosted clinging to a trunk in the open, until she succeeded by her own unaided efforts in finding an unoccupied cavity suitable for a lodging.

An Ecuadorian Nest

The only other nest of the Golden-olive Woodpecker which I have seen was situated in a dead, branchless trunk, standing in the midst of a swampy area covered with bushes and low trees, in the well-wooded valley of the Río Pastaza below Baños, Ecuador, at an altitude of 4200 feet above sea level. On October 18, 1939, this inaccessible hole contained, as far as I could discover, a single well-feathered male nestling, which spent most of the time looking through his doorway. During an hour and a half each of the parents fed him twice, by regurgitation; and it is perhaps significant that the male returned in slightly less time than the female. Although they delivered food while clinging below the doorway, at the conclusion of a feeding they pushed past the nestling to enter the cavity and clean it. The fact that the head markings of this nestling resembled those of the adult male, while those of my Costa Rican nestling were like those of the adult female, shows that in this species young in their first plumage wear the colors of adults of the same sex.

Summary

In Guatemala, Golden-olive Woodpeckers were found in pairs in October, among the shade trees of the coffee plantations.

At an altitude of 5500 feet in the Costa Rican highlands, the roosting and breeding behavior of one pair were followed through most of a year. From August until the following April, a female lodged alone in various low cavities in stubs in a pasture surrounded by heavy forest. She occupied one dormitory for at least two months. After sleeping for some weeks in an old hole in a stub, she moved to a freshly carved hole higher in the same trunk, which had been used as a lodging by a Hairy Woodpecker.

The high-pitched, clear, powerful, long-continued roll or trill of the male was heard from mid-February onward.

At the beginning of April, four eggs were found in the cavity where the Hairy Woodpecker and then the female Golden-olive Woodpecker had slept. Now the male Golden-olive Woodpecker occupied this hole by night, while by day he took turns with his mate in warming the eggs. In the course of a day, the female incubated for three sessions lasting 297, 91, and 51 minutes, the male for two exclusively diurnal sessions of 82 and 118 minutes. Allowing 12.5 hours for the woodpeckers' active day, the female was in

charge of the nest a total of 439 minutes, the male for 311 minutes (which includes extensions within the active period of his long nocturnal sessions).

Although four nestlings hatched, only one was raised, the others apparently succumbing from malnutrition in inclement weather. Both parents fed by regurgitation at a very slow rate. With two 11-day-old nestlings, they brought food only 5 times in 4 hours 40 minutes. With a single 24-day-old nestling, they brought food 5 times in 4.5 hours. The male was the more active provider.

The parents at first kept the nest clean, but neglected sanitation after the young took food through the doorway and they were no longer obliged to enter for feeding.

The young woodpecker, completely naked at hatching, was well feathered at the age of 21 days and resembled her mother. Frightened from the nest when 24 days old, she flew with slow but sustained flight.

After her departure, the fledgling did not return to sleep in the nest, which the male parent continued to use as a lodging.

An Ecuadorian nest contained, in October, a feathered nestling which resembled the adult male, showing that in this species young in their first plumage resemble adults of the same sex.

El Quizarrá, San Isidro del General, Costa Rica, August 7, 1955

A BEHAVIOR STUDY OF THE RED-WINGED BLACKBIRD[1]

II. Territoriality

BY ROBERT W. NERO

The first portion of this study (Nero, 1956) dealt with the behavior of the "Redwing" (*Agelaius phoeniceus*), particularly as related to mating and nesting activities. The present paper describes the formation, maintenance, size and structure of the male territory; female territorial behavior; and behavior of first-year (one-year-old) males, as observed in the vicinity of Madison, Wisconsin.

Territorial Behavior of Adult Males

Male intolerance.—The territory of the male Redwing is a clearly circumscribed portion of the breeding grounds from which he repels Redwing males, females other than his mates and, at times, even fledgling Redwings. Territorial boundaries are well-defined and fixed throughout a season, the boundaries often being maintained within a few feet or less (Nero and Emlen, 1951). Resident males responded to strange males by first giving song-spread, then bill-tilting, and then flying to attack (but usually displacing the intruder without actual contact). (For description of bill-tilting and song-spread see Nero, 1956:9–12.) These three responses probably represent increasingly greater threat displays. The direct, fast flight toward an opponent also seemed to have an intimidatory effect. Further aggression was shown by a sudden "crash-landing" with which males often displaced intruders. This was often accompanied by the threatening "growl-call" (Nero, 1956:22) and an antagonistic open-beak display.

A resident male's aggressive intolerance extends to a wide variety of birds on or near his territory. Between 1948 and 1951 I recorded incidents wherein 20 species (of 13 families) were threatened or attacked; often the individuals were merely chased. Redwing males were persistently aggressive toward Bronzed Grackles (*Quiscalus quiscula*) and Long-billed Marsh Wrens (*Telmatodytes palustris*), which were nesting on the marsh, but they seemed only temporarily interested in evicting other species. In spite of the impressive array of evicted species, three male Cardinals (*Richmondena cardinalis*) were once observed singing on the marsh unmolested. The nesting male's aggression toward the human species is well known, but deliberate encounters with Sparrow Hawks (*Falco sparverius*) are probably rare. On two occasions I watched Redwing males triumph in fights in mid-air (beak to beak) with this species. Hawks of other species elicited a different reaction. Redwing

[1]Journal Paper No. 32, University of Wisconsin Arboretum.

alarm whistles (high and shrill) passed from marsh to marsh when hawks were first sighted. Nearly all Redwings on the marsh sat quietly on their perches with concealed epaulets when hawks were soaring overhead or when they were perched nearby. It seemed that different species drew different responses, but this was not clearly documented. Redwings responded to accipitrine hawks, which were actually hunting on or near the marsh, by suddenly diving down into the cattails to hide or by flying in a group high above them. The admirable boldness of the male was sometimes exhibited by his mate, particularly in conflicts with the Marsh Wrens and Bronzed Grackles. On one occasion when a sheep approached an upland Redwing nest the female owner attacked first, landing on the sheep's forehead; she was later joined by the male which landed on the rather unperturbed sheep's nose. Under this onslaught the mammal withdrew. The largest and heaviest "opponent" which I ever saw evicted from a territory was a large plow-horse which had come to the edge of a lake to drink. A male Redwing clung to the horse's rump and pecked determinedly as he plunged toward higher ground. Neverthless, the tiny Warbling Vireo (*Vireo gilvus*) has often driven my Redwing males from the vicinity of its nest in the trees bordering the marsh. Determination and "moral right" often decide the "victor," but so does opportunity: Redwings frequently chased other species after the latter had taken flight!

Size and Shape of the Male Territory.—Individual territories were roughly square, rectangular, circular, or highly irregular. Some variability was presumably due to response to the pattern of the marsh vegetation. It seems probable that the presence of a high song-perch also had some influence on territory shape. Nearly every territory included a tree and in several instances birds which were located centrally on the marsh had territories with long extensions out to the trees along the edge. Mayr (1941:78) found a similar situation in New Jersey. I found that whenever a tree branch was artificially set up in the cattails in a territory it was quickly utilized as a perch by the resident male. Territory size appeared to be strongly affected by the pressure of other males. New residents, especially those which moved into a well-populated area, often had very small territories. These might be suddenly increased through disappearance of an adjacent male, or gradually, as a result of persistent aggression.

The average size of 17 territories of well-established males during incubation and fledgling stages of breeding was 3,550 square feet (roughly corresponding to a 60-foot square or approximately one-twelfth of an acre). The minimum size was 1,330 square feet (about 1/32 acre), the maximum size, 6,280 square feet (about 1/7 acre). Linford (1935) found much larger territories in Utah: average, 31,603 sq. ft.; minimum, 17,292 sq. ft.;

maximum, 45,903 sq. ft. Twelve territories of the Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*) measured by Fautin (1940:78) averaged 1,294 sq. ft. (range, 760 to 2,275).

Territory size generally varied inversely with population density. In 1947, 14 males shared the eastern one-third of the marsh (Beer and Tibbitts, 1950: 75); in 1953 the same area was divided among only seven males, nearly all parts being completely utilized and defended. The territory of one persistently-returning male showed a constant increase in size from 1949 to 1953 (1,326 sq. ft., 3,125, 4,400, 4,450, 5,350). Similar data for other individuals were not obtained. Although territory size increased, the number of females per male remained about the same, the female population having decreased during this period. In 1947 Beer and Tibbitts (*loc. cit.*) found 91 nests with eggs in the marsh. From 1950 to 1952 I found, respectively, 50, 38, and 35 nests with eggs. In 1953 two cooperating students, Messrs. Roy Gromme and Norbert DeByle, found only 27 nests. These figures are probably complete in all cases, as the coverage was thorough.

Incipient Territorial Behavior in Transients.—From March 20 through 28, 1952, I observed many adult males (unmarked) apparently occupying definite areas in the tops of the high trees across the road on the south side of the marsh. These birds behaved in many respects like typical territorial birds, showing complete song-spread and fighting. This behavior was possibly associated with the heavy migration which occurred at this time (in 1952 the marked residents arrived between March 17 and March 30), and suggests the appearance of the territorial urge in migrants.

These "temporary residents" often flew considerable distances to drive off other males and then returned to their original positions. Often two or more of them perched close together without showing any intolerance, but they gave song-spread to newcomers and also drove the latter birds away. Some of the temporary residents flew away after a short time, but others remained for several hours. Some of them showed an interest in the marsh as well as the tree-top area, but the many new males which frequented the tree tops seemed to offer more attraction. The temporary residents gave some displays which are usually given to females and in some cases appeared to contest with their associates for the right to display or to chase newcomers. For example, on March 26, when a new male approached the tree-tops without song and with his epaulets covered, one of the temporary residents gave song and displayed to him, and at once another temporary resident flew to them and chased the displaying bird. The new arrival meanwhile flew after the chaser and seized his tail momentarily while in flight. Perhaps aggression was aroused by the sight of display, so that while associates at rest ignored each other the display by one to a new bird provoked an attack. Similar behavior was not observed on the marsh, owing perhaps to the stable conditions of the territorial system.

A few birds appeared to be more persistent and later showed an interest in the nearby marsh by at times swooping down over it with song, although returning to their tree positions. Some of these may have been true residents, but lack of marking made this impossible to ascertain. Some resident males on the marsh, particularly those with territories adjacent to the trees, also tended to utilize the tree-tops, apparently in response to the temporary residents and migrants.

Reestablishment of Territories by Returning Residents

Beer and Tibbitts (1950) have shown that there is a strong tendency for former residents to return each year to the same breeding grounds and also to hold the same general area as a territory. On the first day of their arrival former residents usually appear wary and are easily flushed, but in a short time, even by the second day, they become less wary. At this time it is sometimes possible to determine their territorial inclinations by simply forcing them to move several times, their movements often being within a limited area (often corresponding to their territory of the previous year). In the early spring they may be found on their territories in the early morning and late afternoon, giving song-spread, particularly from one or two special song-perches, within or on the edge of their territory, and constantly flying out onto the cattails to sing or to confront neighbors (Fig. 1).

Some early arrivals show a tendency to occupy a territory larger than that which they had held in the previous year, retracting as other birds move in and take up territories. Residents which had previously held small territories usually attempted to enlarge their holdings and often succeeded. Most birds, however, remain within the approximate boundaries of former territories. Former residents generally seem more casual about territory establishment than do new birds: that is, they appear to be more tolerant of trespassers.

Respect for boundaries is apparent even in the temporary absence of the owner, although trespass is then more frequent. Residents occasionally trespassed for short times on other territories in order to drive off strange adults or first-year males, to engage in sexual chases with females, and to harass predators. When a female which has been on a territory with a male flies to another territory, the first male may dash across the border to strike the female and then hastily return, sometimes even before the neighbor has a chance to drive him back. On at least one occasion when this happened, the female flew back to the original male's territory. These conditions provided one of the few occasions upon which males persistently crossed territory boundaries. Similar reactions were elicited when a female dummy was moved from one territory to another, the trespassing "husband" continually returning to the dummy even though severely attacked by the second male. A trespassing male usually shows signs of recognition of the territorial rights of neighbors. This was clearly seen in the above experiments. Each time the "claiming" male invaded a neighbor's territory to "visit" the dummy, his epaulets were concealed and he never gave song-spread, but each time he returned to his own territory he immediately gave song-spread with fully-exposed epaulets. Similar behavior was observed when a male trespassed in order to feed on a piece of bread placed a few feet beyond his boundary.

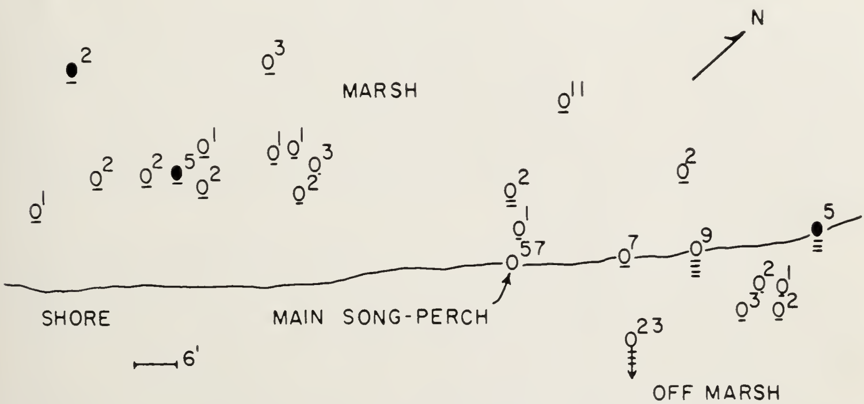


Fig. 1. Activities of one adult male, 7:00 a.m. to 9:30 a.m., March 30, 1948, showing time spent on the main song-perch and excursions into the territory. Circles indicate areas visited by the male; lines beneath the circles, number of visits; figures, total number of minutes at the site; dots, encounters with other males. Most, but not all, visits were made directly from the song-perch.

In cases where adjacent males returned a second year, territory lines often closely followed those of the previous year. Males whose territories do not adjoin may not have developed the tolerance or mutual respect, possibly developed in the previous year, which characterizes settled neighbors. For example, on April 5, 1953, it was first noticed that a resident male had disappeared and that his neighbor to the north had moved onto his territory and was being attacked furiously by the neighboring male to the south with which he had previously had no contact.

Nevertheless, well-established males continue to meet on their boundaries throughout the breeding season. There seemed to be a tendency for adjacent males to face each other at rather definite places along the border of their territories, especially where shrubs or trees provided higher perches. Ordinarily these contacts are confined to mutual bill-tilting, but occasionally quite severe fights occur. Meetings of this sort arise primarily from movements or behavior of the resident females which bring about sexual responses in neighboring males. A male seldom interferes when his wandering mate is aggressively repulsed by the neighboring male, but when the latter approaches the border with obvious sexual response he is immediately met by the "guarding" owner.

Establishment of Territories by New Birds

1. *Territorial establishment on unoccupied areas (early in season).*—In general, a male selects a location to which he constantly returns and in which he remains for long periods of time. Song-spread is given frequently from definite perches within or on the edge of the territory and also from other points within the area. Territory settlement in the very early part of the breeding season often occurs without any fighting or interactions simply because of the low number of competing males. However, as more males appear vigorous battles may ensue and complicated situations may develop. Some illustrative cases follow.

2. *Intrusion between and adjacent to occupied territories.*—Males may intrude or insert themselves on established territories through a gradual process of persistence often involving a sequence of behavior which I have called "challenging."

A new arrival persistently flies toward a male on territory as if inviting chase and when this occurs retreats or dodges ("testing the male"). He flies low over the territory with slowly-moving down-held wings, alternately gliding and flapping ("testing the territory"). Sometimes as he glides over the territory he suddenly looks back over his shoulder toward the resident ("head toss":=bill-tilting?). When the resident flies toward him the intruder retreats, or dodges and circles about the territory, now fast, now slow—sometimes gliding, as the resident moves. In this fashion the intruder leads the resident, which keeps above him, higher and higher, ever circling, sometimes until they are hundreds of feet in the air and sometimes far from the territory ("soaring flight"). Often during the flight the intruder swoops and pecks at the resident, and vice versa. The resident attempts to keep above the other, alternately gliding and flying "in step" with him, until one or the other breaks off. Then the intruder either flies elsewhere or back to the territory, and the flight begins again.

New males may challenge or make sorties at several males on the territorial grounds, as if attempting to find a suitable opponent. For example, on March 26, 1952, at 5:30 p.m., a new male was seen challenging several residents, one after the other, all surrounding a central area on which the new bird was focusing its attention. Soaring with the first male lasted well over four minutes and took the two up in the air about 200 feet. The newcomer persistently returned to the center of the marsh and glided over the cattails with head up, thus invoking immediate chase by the nearest male, which he would then lead up in soaring flight. He did not land on the cattails, but glided over them and then headed for an individual. Although as many as three birds chased him at one time, only one of the three followed him up into the air.

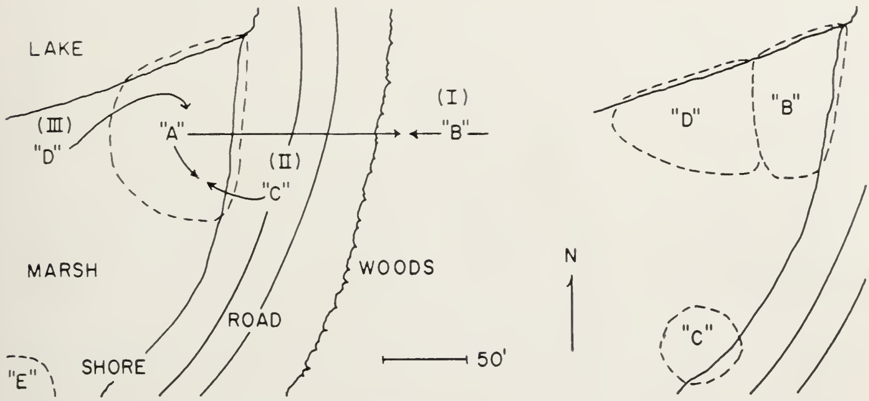


Fig. 2. Spatial relations of 5 males, March 20 to April 24, 1952. (Left map) (I). Male A held male B far back in woods from March 20 to April 21. (II). On March 30 male C arrived and challenged male A. (III). Male D quietly took over a portion of the territory during the period when male A was fighting male C. Male A was trapped on April 21 and disappeared following his release; D and B shared the area subsequently (right map). Male C, beaten by male A, finally established a territory farther south (April 24).

In other instances a new male "selected" a particular male to challenge. From March 20 to April 21, 1952, the owner of a territory, A, forced a challenging male, B, to remain at bay, some 400 to 500 feet back in the woods away from the territory (Fig. 2). Whenever male B made the least approach toward the marsh, the resident immediately flew toward him and repulsed him. The bird thus held back in the woods (male B), repulsed all other males from his vicinity just as if he were on territory, even though the area he occupied was unsuitable as a nesting area. When male A became concerned, eight days later, in chasing and fighting with a second, more aggressive rival, C, male B moved up to the edge of the territory. Each time when the owner returned, however, he quickly withdrew. The situation remained as above up to April 21, with male B pushed even farther back into the woods away from A's territory. On April 21, male A entered a trap, and male B moved in and occupied a portion of his territory opposite another rival, D. The latter male had easily intruded during the period that A was concerned with male C which was driven away. The trapped owner was released but disappeared (his remains were later found in the marsh, possibly killed by a mink) and B held his portion of the territory through the remainder of the breeding season.

Male C had performed beautifully as a challenging male, engaging in all the stages of the pattern, gliding over the territory, swooping at male A, tossing his head, and leading male A in soaring flight. Male A became so concerned with driving C from the area that he "permitted" male B to venture to the edge of his territory, and he seemed to overlook completely the presence of D, which very easily slipped in and gave extreme song-spread display right next to the panting owner (A). However, male D, in contrast to all the other males, had occupied this area in 1951.

Male C was badly beaten and did not return to this disputed territory. However, a few days later (April 3) he was found engaged in a contest with another resident male, E, three territories to the south. A summary of the field notes of this latter contest follows:

5:00 p.m. When first observed, male C was on "territory" far back in the woods (south of the territory held by male E) and was apparently held there by male E, which sang from the cattails to another resident at times but spent the majority of his time on the trees across the road, apparently watching male C.

5:10 After 10 minutes C began flying toward E, making short flights directly at him, but always swerving aside at the last moment. E usually at once darted at him and each time male C returned to his distant perch.

5:20 After 10 more minutes he began flying toward E and then swerving past him toward the territory; but he always retreated whenever E moved toward him. But C appeared to have gained some ground, he was closer to the edge of the woods, and he seemed more confident. A short while later C began striking at E, but always dodging and withdrawing before E's attacks, and then leading E up into the air in soaring flight. They circled higher and higher, making short darts at each other and then came down again, and C returned to his distant perch, probably to rest.

5:35 Fifteen minutes later E sailed down to his cattails and C at once flew straight in to join him, sailing over the cattails in a similar fashion. But at the first sign of attack by E, male C retreated. E then showed his ownership, almost seemed to flaunt it, by parachuting onto the territory with song-spread display, and as soon as he did this C flew right in to him and, as he passed by, E pecked at him and drove him back.

5:40 This again led to the soaring flight. No matter how high they flew E always kept above C and often tried to peck him. But C maneuvered from side to side and nicely eluded his attacks.

5:45 Male C sailed first over the territory and of course E at once drove him off. C constantly provoked a fight, but always retreated.

Finally C sailed into the territory, hovered over the cattails with raised head and then returned to the woods. Again and again he did this, never landing, while male E watched closely but did not chase. Then E soared down to his territory and landed while C cruised over him and then retreated to the woods.

5:55 E chased C numerous times as the latter flew past him. Male C kept coming closer, but he was always on the dodge. He "tested" the territory by hovering over it, but he did not land, nor did he stay to fight. He did this again and again, ever more frequently, and finally he *went down low* over the cattails when E chased him. He went through this behavior dozens of times more and, as he sailed and hovered over the territory with raised head, looking back over his shoulder, there was no mistaking his challenge.

6:30 At 6:30 male C succeeded in *landing* on the edge of the territory, if only for short moments, and then he finally *remained* there facing male E with song-spread.

The next day (April 4) at 8:30 a.m., C was still back in the woods, but he flew straight and low to his "beach-head" on the edge of the territory (on the border of E territory and another) where he sat low and under cover and singing. Male E, meanwhile, sat high above him, also singing.

Observations were discontinued until 5:45 p.m. At this time it was found that E had entered a trap and C was now uncontested owner of the territory —and he plainly showed it. The situation was left thus (April 4, 1952). (However, on April 23, 1952, male C was dominated by a new male and forced off his territory to an adjacent position—see 3b, below.)

(On April 22, 1955, I observed a challenging male flying over a territory and being driven alternately by three residents. The challenger never sang once during 1½ hours of observation although the three residents sang with extreme display. When I placed a mounted male in the "wanted" territory the resident bird paid no apparent attention, but the challenging male dived down at the dummy several times when crossing over the territory. It seemed as though the challenging male "resented" the dummy more than did the resident.)

3. *Displacement of established residents.*—Sometimes males intrude on established territories in the presence of the owners by simply appearing on the area and persisting in the face of attacks by the residents. Occasionally, however, they show immediate dominance over the resident. Three cases illustrating this phenomenon under various conditions are recounted below.

a. *An old resident is dominated.*—A remarkable case of an intrusion occurred in May, 1953, when a male which had been a resident since 1948 was completely dominated and forced off his territory by an unmarked adult male. This case was first noticed on the morning of May 5, when the resident male, which had arrived on March 21, was seen resting on the edge of his territory while the new male sang from the resident's favored perch. Throughout the period of observation the intruder drove the owner with fierce attack whenever the latter attempted to move into the territory. The resident was seen returning to the area in the late afternoon, but he was immediately driven across two territories by the new male. The resident was not in sight the morning of the next day, but at 5:30 p.m. he was found on his territory, giving extreme song-spread near a trap which held an unbanded male, presumably the intruder. The trapped male was removed from the marsh and the resident held the area for that season and the next as well.

b. *A new resident is dominated.*—In another case, shortly after the arrival of a female on a territory, and probably before the pairing bond was fixed between the male and the female, a second male appeared and rather quickly dominated the resident, forcing him off of his territory onto adjacent holdings. Neither bird had held the area in the previous year. This case is described in detail below:

Male C (second-year adult) held a new territory from April 4 to April 21, 1952. No observations were made on April 22. In the afternoon of the following day a marked female and an unbanded adult male (distinguished by a broken feather in one wing) were present on his territory. The resident bird was also present and was clearly being dominated by the new bird. The full story follows:

5:00 p.m. Male C is being threatened by an intruder which actually attacks him on his own territory! He follows the resident about, crouches above him, flies above him as he flies, drives him constantly—in short, completely dominates him, so that the resident is forced to sing while in flight over his own territory much like an intruder. The new male attacks him constantly, wherever he goes. There is a battle in the cattails, and then another; the resident always losing. The resident drives at the female, then flies at the new male which at once drives him lower down into the cattails.

5:15 p.m. The old resident makes another pass at the new bird which now seems more excited and gives an even fuller display. There is a great deal of bill-tilting between them, especially by the resident when the new bird approaches him. They both tilt and walk up on the song-perch. It is clear that the resident does not display as much as the new bird. The owner displays most when in flight gliding over his territory. The new male often gets above him and displays down to him.

5:30 p.m. The action continues as above with the new male constantly driving the old resident which has moved farther east onto the next territory (whose owner remains aloof) from which area he makes futile attempts to return to his territory. Finally they engage in a furious fight which takes them up into the air; again and again they engage in aerial combat.

April 24, 4:00 p.m. The old resident and the new bird are apparently still engaged in the duel, but to a lesser extent, for the resident seems to have moved to the east of his territory, the male in that area having withdrawn for him.

5:15 p.m. The old resident now sings from a new perch 70 feet to the east. He remains there for 20 minutes even though the new bird which now holds his territory is temporarily absent.

He subsequently held a territory in the new area and the male which evicted him held the original territory.

c. *A male loses a portion of his territory including a female and her nest.*—In this case a newly-arrived male seized a portion of a resident's territory in which a female had already built a nest. The female stayed with her nest and later mated with the new male for a second brood. Since this is a unique occurrence it is presented below in some detail.

Male F arrived on March 28, 1952, and quickly occupied essentially the same area he held as a territory in 1951. On April 16, female F appeared on his territory. She had been a resident in 1951 on an adjacent territory with another male. This female associated with male F for at least the next 18 days (until May 3). No observations were made on May 4 or 5, but on May 6 a newly-arrived male, G, in adult plumage for the first time (second-year male), was observed holding a portion of F's territory which included female F's completed nest. Male G was also courting a new female (G). On this day male F still showed an attachment to female F, but also a respect for the new male. On May 20 and 28 male F still showed an interest in and a tolerance of female F, but on June 3 when she was feeding fledged young he seemed antagonistic toward her.

Since it was not clear whether male and female F were entirely separated a simple experiment was performed on June 4 which showed this to be the case. Two caged young of female F's brood were placed in territory F and for half an hour male F kept female F from feeding her young. Female F later nested again but with male G. She was seen with him on the marsh on July 10.

* * *

Male Song Sparrows (*Melospiza melodia*) show a "challenging" behavior when attempting to intrude on established territories (Nice, 1937:57–58). The intruder puffs up like a ball, often holds one wing up and fluttering, and sings rather constantly and rapidly, if often incompletely. The defender sits silent and hunched in menacing attitude, following every move of the newcomer, which sings in flight from one bush he wants to claim to another. "Soon the owner begins to chase the intruder, but the latter, if determined, always returns to the spot he wants to claim." The two finally fight and either the intruder is routed or the resident retreats. In a later work Nice (1943:155) considers the "puff-sing-wave" behavior indicative of the ". . . threat of a bird at a temporary disadvantage." Even returning residents adopted a subservient attitude to new occupants of their old territories, but the old birds soon reversed their roles and regained their territories. An old Song Sparrow was never observed to be defeated. This was not, as noted, always true in the Redwing.

In the Robin Redbreast (*Erithacus rubecula*), Lack (1946:41–43) observed eight encounters in which a new male attempted to dispossess another of its territory. In six cases a kind of "challenging" behavior, a ". . . formal procedure, of alternate loud singing and chasing, was continued all over the territory." In two of these encounters ". . . the dispute ended with the newcomer leaving the territory." But in three the owner left, and the newcomer took possession. Fighting in these cases was minimal. The newcomer in one case ". . . did not attempt to strike the previous owner; it seemed just to wear it down by persistence."

The male Reed-Bunting (*Emberiza schoeniclus*), according to Howard (1929:5–6), sometimes invades established territories by persistently clinging and returning to a corner of one. He is ". . . so insistent in maintaining his position that he breaks down all opposition: and in the course of a few days his rival yields, retires to the opposite corner of his ground and there makes for himself a new headquarters."

Brown and Davies (1949:77) report the following for the Reed-Warbler (*Acrocephalus scirpaceus*): "Sometimes the encroaching male may take over the entire territory and perhaps the nest and hen of the original owner. Sometimes the encroaching male may be completely repulsed, in which case he will almost certainly try to elbow himself in on some other territory in which he may find weaker opposition. Between these two extremes there will be all gradations from the cock which manages to establish himself in a small territory, to a cock which almost but not quite swamps the territory of the bird into which he is encroaching." The same may be said for the Redwing.

Competition for Territory Sites

Response of extra males to a vacancy.—Territory-seeking males appear commonly on the breeding area throughout the season. The absence of a resident bird through death or even his enclosure in a trap immediately sets the stage for the appearance of new birds. The pressure of males and the complications which may develop under these circumstances may be shown by the following case.

On May 4, 1950, (at 1:45 p.m.) two resident males, H and I, were found in traps which had been set early in the morning in their respective territories. Two new males, H1 and I1, were in possession of their territories. Male I was held but male H was released. At once H returned to his territory and drove the new male, H1, away from his territory. Male H1 then moved over to I territory and quickly dominated the second new male, I1, forcing him to leave the marsh at 2:23 p.m. although the latter (a banded bird) continued to visit the territory.

At 2:35 the resident male I was released. He flew to his territory, bathed quietly and then left, with his territory in the possession of H1. The latter had flown down near him but had not attacked. At 4:40 a third new male, I2, appeared and quickly dominated H1. I1 then returned and remained. These three birds quarreled over the area until 6:15 p.m., when observations were discontinued. At 5:00 a.m. the following morning, male I was found in complete control of his territory and the three temporary occupants had disappeared. I arrived in time to see him drive an unmarked adult from his territory.

Responses of established males to new neighbors.—Established males usually contend more with new neighbors than they do with their old associates, but the amount of interaction varies with circumstances and individuals. Most new males are quickly integrated into the territorial system, especially if they observe the established boundaries. However, aggressive efforts to expand their holdings create active disputes. Contacts occur generally only when territories are contiguous, and former residents usually remain within their territories. Occasionally, however, former residents, subjected to persistent aggression, move beyond their boundaries to retaliate.

In one unusual case in 1950 a new male was persecuted by several residents at the same time. Although this male showed the typical behavior of a territorial male and used full displays and complete song at all times, he was driven by six different males until he eventually relinquished his claim. Although he backed off in the face of aggression he always responded with full displays. One wonders why this bird elicited constant and vigorous aggression from all the adjacent males (some even left their territories to attack him) when those birds which preceded and also followed him on the same area did not.

Behavior of First-year (one-year-old) Males

Territorial.—It is well known that male Redwings do not generally breed until their second year, by which time they have also attained the adult plumage. A few observers have noted occasional first-year males holding territories (Beer and Tibbitts, 1950:65) and even breeding (Wright and Wright, 1944:58), but there are no published observations on the behavior of first-year males on territory and their relationship with adults. Wright and Wright (*loc. cit.*), have shown that males come into active spermatogenesis in their first year, although their testes reach a maximum in May, three weeks later than those of the adults, and are not as large as in the adult. Beer and Tibbitts (*loc. cit.*) stated that first-year males ". . . do not usually have the drive to establish a territory for themselves." They observed first-year males establishing temporary territories three times. In each instance the territory was only maintained for two to three weeks, from about the middle of April until the first week in May.

There is no record of a first-year male breeding on the study area, but in 1950 I found one about 1/4 mile away in the company of a female near an empty nest. Both birds were evidently feeding fledged young, although these young were not found. The pair was seen in the same place from June 19 to June 24, (both having been trapped and color-banded). Neither bird was seen after the latter date. The neighboring, resident adult males had shown the usual recognition of male territory boundaries. On June 23 I observed several adult males driving other first-year males away from the territory of the absent, resident first-year male. An adult male circling above me in alarm quickly left when the resident first-year male appeared and took his place. In most cases the few first-year males I observed holding territory on the study area quickly retreated before adult threats, but they also appeared to be treated by the adults with a certain amount of deference (or indifference?) at times. In two cases first-year males behaved as active territorial birds for several days and then suddenly withdrew although apparently undefeated. The song-spread of these birds seemed as complete as that of the adults, although they lacked the brighter plumage. The urge to hold a territory simply seemed to wane after a few days.

The temerity of first-year males is also evident from the numerous occasions upon which they have been seen to pursue and hit adult males while in flight, even seizing them by the tail. On one occasion when this occurred the adult turned about and the two birds fought with beaks and toes while in mid-air. A moment later the chase was resumed with the first-year bird again driving or following the adult (April 30, 1950). Most encounters of this sort seemed to be with non-territorial adults. It is evident that first-year males sometimes may behave like adults and show bold and aggressive territorial inclinations. Under such conditions they appear to be treated in much the same manner as intruding adult males, except that the resident adults show a much greater tolerance toward them. First-year males only rarely succeed in breeding; ordinarily they seem to lack persistence in maintaining a territory.

Behavior of First-year Males Toward Females and Young

Throughout the breeding season first-year males often attempted to approach resident females on the breeding marsh. In nearly all instances the females gave a loud, rapid, and shrill "pee-see-hee-hee-hee . . ." sometimes accompanied by fluttering wing tips (that is, rapid opening and closing of the primaries). The resident adult males usually responded by flying up at once and driving off the first-year males. Females were never receptive to first-year males and often escaped their advances by diving into the cattails when the latter came close. The females showed a special reaction to first-year males, often bill-tilting and sometimes giving song-spread, responses which they have seldom, if ever, been seen to give to adult males. In one case a first-year male approached a female whose mate was momentarily involved with another male and thereby drew more responses than are ordinarily seen. Each time he flew toward her the female fluttered her wing tips and screeched; finally she bill-tilted and pecked at him as he sidled close to her along a branch. Her mate returned at this time and the first-year male flew away. In another instance on the Vilas Park feeding ground (July 29, 1948) an adult female repulsed and then drove off a first-year male as he attempted to approach her. When the same female was approached by adult males she dropped one wing to the ground and moved away.

The first-year males also attempted to approach young of the year in a manner suggesting a sexual motivation. On numerous occasions at Vilas Park in June and July, 1948, first-year males were seen attempting to approach juveniles (as well as females) from the rear. The males were possibly attracted to the young by the latter's begging posture which greatly resembles the pre-copulatory posture of the female. On nearly all attempts they were repulsed, even by the youngest birds which seemed to recognize the first-year males as readily as did the females. Several times juveniles were seen to beg food from adult males and immediately afterward repulse first-year males. Even the juveniles assumed the bill-tilting posture when repulsing first-year males. In some cases first-year birds succeeded in mounting young. On July 8, 1950, a young bird begged to a first-year male three times and each time the young male mounted the juvenile and fluttered his wings overhead as if in attempted copulation. The first-year male in this case had held a kernel of corn in his beak. Somewhat similar behavior was observed on other occasions and could presumably have induced begging.

The Female "Territory"

Female Territorial Behavior.—The activities of an established female on the marsh are largely within her mate's territory, owing mainly to the aggressive responses of neighboring males. (Alien mated or paired females usually draw only antagonistic responses from resident males; see Nero and Emlen, 1951). I have only one record of an adult male "courting" an alien, mated female and this occurred under experimental conditions. A female which had eggs was placed in a cage in a distant territory for 20 minutes and then given a slow release (June 1, 1950). Instead of immediately flying away as usual, she slowly walked out, drank and fed. The territory owner approached her at once, with fully extended wings, stopping only to drive off his chattering mate. The female paid little attention and soon left. One of the main activities of the female is the aggressive defense of an area (with song-spread, bill-tilting, and attack) against instrusion by other females. Female intolerance of other females, however, varies considerably. At first, females often attempt to defend a large portion of the male territory, but as breeding progresses their attention turns more to the nest and to a much smaller surrounding area. By the time females have eggs in the nest they usually have developed a mutual tolerance over most of the male's territory, although the nest-site is still vigorously defended. Linford (1935) seems to have been the only previous author to describe "territoriality" in the female Redwing. He noted that each female claimed an area around her nest which she defended from other females.

Usually newly-arriving females establish territories without too much opposition by resident females. In large male-territories, where there is more room for subdivision by females, quarreling may be slight; in smaller male-territories female quarreling may be more pronounced. This is presumably the situation that Linford (*op. cit.*) observed. He stated that in a large male-territory the outlines of the female ". . . sub-divisions will be rather vague; but if it was small, then they will be sharply defined." Sometimes in the early stages of female territory development, intolerance of females is so general that other females have difficulty entering a male's territory. New females occasionally forced their way into a territory by persistence, threat, and actual fighting. The male often interferes in such disputes, invariably attacking his original mate. In one case (June 12, 1950) interference by his mate, which was just beginning to build a second nest, caused a male to lose a new female which had just appeared on his territory. While he was engaged in driving his mate far from his territory, the newly-arrived female was attracted to an adjoining territory by the resident male which had courted her from along the territory boundaries. However, in another case (April 18, 1950) a female which had arrived only the previous day drove a new female off of the male's territory several times, while the male looked on without interfering. The new female persisted in returning to the territory, however, and finally located there.

Nest-moving experiments (Nero and Emlen, 1951) showed that even after a mutual tolerance was developed between intra-harem females, actual visits to the nest were repulsed. Females from neighboring male-territories were actively repulsed at first, but later a partial mutual tolerance developed.

Female Territoriality in Other Icterids

Similar territorial behavior in females has been noted in the highly-territorial Yellow-headed Blackbird (Fautin, 1940:81–82). "The females seemed to exercise dominion over a small area immediately surrounding their nests but did not recognize the boundaries of the male's territory in which they nested. . . several females nested in the same male's territory, and although the different females in a few cases constructed their nests less than a meter apart, yet they were generally intolerant of each other in the vicinity of their own nests and more frequently occupied opposite extremities of the same male's territory. . ."

In the Brewer's Blackbird (*Euphagus cyanocephalus*), in which the male territory is loose and mainly connected with individual nest site and adjacent perches, the females " 'lay claim' " to nest sites before actual construction begins (Williams, 1952:12). Aggressive activity for the possession of a nest-site ". . . is frequently prolonged and often acute and is largely carried on by females." According to Lack and Emlen (1939:226), in the highly-colonial Tricolored Redwing (*Agelaius tricolor*) ". . . the females usually ignored each other, but occasionally chased each other short distances." In Wagler's Oropendola (*Zarhynchus wagleri*) the males show no territoriality but accompany the females as the latter move about in small groups selecting their nest-sites. There is considerable quarreling among females over these sites (Chapman, 1928:138–140). Female Boat-tailed Grackles (*Cassidix mexicanus*) build in colonies apart from the males, which play no part in the nesting activities and remain in flocks (McIlhenny, 1937:278–282). No mention is made of inter-female tolerance at the nest-sites, but an island 34 feet by 32 feet was found to contain 34 nests.

Territorial Site Selection and Change of Mates

The nest-sites selected in successive years were recorded for 16 marked females. Nine of these returned for three seasons, four for four seasons, and one for five seasons. These records showed that females frequently nested in different places in successive seasons. The relocation distance of 30 nest-sites (Table 1) ranged from 4 feet to 240 feet (average, 65). These shifts caused some change of mates. On 10 occasions seven females mated with other males even though their former mates were present on the marsh. These females moved from 16 feet to 240 feet (average, 98; see Table 1). Nine females mated with the same male two years in succession, and two of these nine mated with the same male in three successive seasons. Change of mates was largely due to female movements since males returned to the same approximate area year after year. Of the six males whose females relocated and mated with other males, one made a territory shift of 80 feet (center to center); one remained in the same place but showed a slight decrease in territory size; one remained in position and showed an increase in territory size; and three held territories with approximately the same boundaries as in the previous year.

In one case a female which had already chosen a nesting area and which had been there for two weeks suddenly moved to another territory to nest, even though a male was available on the first territory. A male was removed from his territory on May 12. 1950; the next day a neighboring male moved into the vacant territory, thus expanding the latter's holdings. One of his females, which had not yet nested and which he was actively courting, came with him. At the same time he showed an active interest in the resident female which had been present for 12 days: he flew to her again and again, gave song-spread, and remained near her. She persistently kept low in the vegetation as if to avoid him; after two days on the territory with him and his mate, she gradually moved into a third adjoining territory against some opposition by its owner. She was finally accepted by the latter male and nested successfully in his territory.

Females sometimes built nests and even laid several times in different places before bringing off a brood. They sometimes kept within the territory boundaries of their mates, but often they moved beyond them. In 1949, a female twice nested unsuccessfully within one territory, and then moved to

Table I

Relocation Distance of 30 Nests.

Each figure shows the distance from the nest-site of the same female in a previous year, except for A and F, in which one year is skipped. Figures in heavy type indicate cases in which females mated with other males even though their former mates were present on the marsh.

Females	1949	1950	1951	1952	1953
A	?	80			
B	20	40			
C		100			
D		**66**			
E	30	**200**	**34**	6	
F	**100**	180	40	?	100
G	24	6			
H	14				
I		76	10		
J			76	4	46
K			**16**	30	**50**
L			**70**	50	
M			46		
N			**46**	**240**	
O			**160**		

another territory 225 feet away where she nested successfully, and to which she returned the next season. Generally when females move across territory boundaries to renest they necessarily mate with new males. In one case, however, a female remained with her mate even though she nested on an adjacent territory (Fig. 3). In May, 1950, female I1 deserted a completed nest for unknown reasons, and renested successfully in an adjacent territory (H), though retaining her original mate (I). Her encroachment was not observed by me but on at least one occasion I saw male H chase her. Occasionally female I1 was joined by her mate; apparently the tolerance

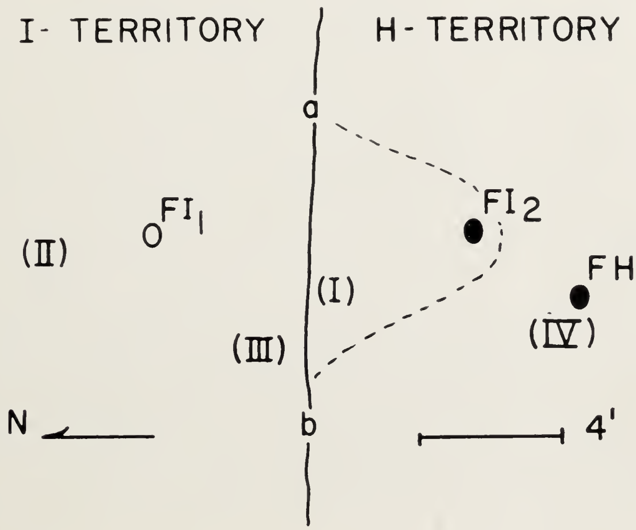


FIG. 3. Map illustrating boundary relationships after female renested in an adjacent territory. A female (FI) deserted her nest in I territory (FI_1) and renested in H territory (FI_2), placing a section of boundary *a–b* in questionable status. A caged young from the nest in H territory (FH), when placed at the positions indicated by Roman numerals in parentheses, drew the following reactions:

(I). Male I and female I remained on the area enclosed by the dashed line when female H first visited the area to feed her caged offspring, but only female I offered any resistance. One minute later male I withdrew before an attack by male H and both male H and female H occupied the area.

(II). Male H halted at line *a–b*; female H attempted to reach her young, but was routed each time by male I (and harassed by female I). Female H was unable to reach her offspring during 30 minutes.

(III). For 10 minutes female H was unable to reach her young. Male I remained perched between the young and its parents (MH, FH) facing them across the line *a–b*.

(IV). Male H and female H at once visited their young without any interference.

shown by the resident male to the intruding female was partly extended to the latter's mate. Results obtained from experimentally moving a fledgling showed, however, that the original territory boundary had not shifted and was recognized by both males. Hence the nest in question was actually located on a foreign territory.

This observation agrees with conclusions reached by experimental transportation of nests across territory boundaries. Under these conditions males accepted females which became familiar through repeated contact (Nero and Emlen, 1951:113). Somewhat similar observations have been reported in other species. Nice (1943:188), particularly, tells in detail how a female Song Sparrow, which built her fourth nest on a neighbor's territory, fought with the male owner and finally dominated him. Her mate later also fought the male and by that means procured the area of her nest as part of his territory. In the case I described above, although male I was occasionally tolerated within H's territory, male I did not claim any of the latter's territory. In the succeeding year female I1 left male I and bred on H territory with a new male which had succeeded in ousting male H.

Two females which had their nests with eggs or young experimentally transferred and left in foreign territories, nevertheless remained with their original mates (Nero and Emlen, *loc. cit*). One of these females led her young back to her own territory after they fledged, then led them off the marsh. She later returned to the original territory to nest for a second time with her mate. This is surprising, considering the amount of disturbance she was subjected to in her first nesting. In a similar case in the Snow Bunting (*Plectrophenax nivalis*) a female built a nest outside of her mate's territory. After a few days the male joined her, attacked the original owner, and after two days' fighting seized the area in the vicinity of the nest (Tinbergen, 1939:31). On the other hand, in one extraordinary case, a female Redwing, which had already built a nest, deserted her mate when a second male stole a portion of the territory which included the nest site. The female stayed with the second male, brought off her young, and later returned for a second brood with her new mate (see p. 139).

Howard (1952:54–55) tells how one pair of Great Tits (*Parus major*) nested in a nest-box which was in the territory of another pair. They flew straight from the nest-box to their own territory, never perching anywhere else within the strange territory. Nest material was gathered out of the territory and neither the male nor the female ever uttered a note or displayed when the resident male visited their nest. The latter made no objection to their presence. "There *were* no boundary lines, for the strangers made no claim to land . . . all they wanted was the nesting box, for they had no suitable hole in their territory."

Summary

Males established territories on the breeding marsh from which all Redwings except the mate, and sometimes other species of birds, were aggressively repelled. Returning males often held the same or nearly the same area year after year. The average size of the territories was about one-twelfth of an acre. Incomplete territorial behavior in migrants was shown by males settling for short periods in the tops of trees in non-nesting areas near the marsh.

When adjacent territories were held by former neighbors, aggression was minimal, but new males created considerable disturbance. Territory boundaries were well-defined and usually remained in approximately the same position throughout the breeding period. New males obtained territories by moving into vacant areas, by "challenging" and forcing withdrawal or eviction through persistent attack, and also through sheer dominance. In one case a male seized a portion of a territory including a female and nest. Throughout the breeding period new males appeared and contested for vacated areas.

First-year males do not generally breed, but occasionally they held territories for short periods, and to a large extent were treated as adults by the territorial adults.

Females met the males on their territories and formed "sub-territories" within the boundaries of their mate's territory. Females were restricted to the mate's territory by the aggressive reactions of adjacent males. Considerable quarreling occurred among females within a male's territory over female-territories and later over actual nest-sites. Females also showed some seasonal persistence in nesting-sites, but frequently changed sites, as well as mates.

Literature Cited

Beer, J. R., and D. Tibbitts
1950 Nesting behavior of the red-winged blackbird. *Flicker*, 22:61–77.

Brown, P. E., and M. G. Davies
1949 Reed-warblers. An introduction to their breeding-biology and behaviour. (Surrey, England; Fox Publ., Ltd.).

Chapman. F. M.
1928 The nesting habits of Wagler's oropendola (*Zarhynchus wagleri*) on Barro Colorado Island. *Bull. Amer. Mus. Nat. Hist.*, 58:123–166.

Fautin, R. W.
1940 The establishment and maintenance of territories by the yellow-headed blackbird in Utah. *Great Basin Nat.*, 1:75–91.

Howard, H. E.
1929 An introduction to the study of bird behaviour. (New York; Cambridge Univ. Press).

Howard, L.
1952 Birds as individuals. (London; Collins).

Lack, D.
1946 The life of the robin. (London; H. F. and G. Witherby, Ltd.).

Lack, D., and J. T. Emlen, Jr.
1939 Observations on breeding behavior in tricolored red-wings. *Condor*, 41:225–230.

Linford, J. H.
1935 The life history of the thick-billed red-winged blackbird, *Agelaius phoeniceus fortis* Ridgway in Utah. (M.S. thesis, Univ. Utah Library)

McIlhenny, E. A.
1937 Life history of the boat-tailed grackle in Louisiana. *Auk*, 54:274–295.

Mayr, E.
1941 Red-wing observations of 1940. *Proc. Linnaean Soc. New York*, 52–53:75–83.

Nero, R. W.
1956 A behavior study of the red-winged blackbird. I. Mating and nesting activities. *Wilson Bull.*, 68:5–37.

Nero, R. W., and J. T. Emlen, Jr.
1951 An experimental study of territorial behavior in breeding red-winged blackbirds. *Condor*, 53:105–116.

Nice, M. M.
1937 Studies in the life history of the song sparrow. I. A population study of the song sparrow. *Trans. Linnaean Soc. New York*, 4:1–248.
1943 Studies in the life history of the song sparrow. II. The behavior of the song sparrow and other passerines. *Trans. Linnaean Soc. New York*, 6:1–328.

Tinbergen, N.
1939 The behavior of the snow bunting in spring. *Trans. Linnaean Soc. New York*, 5:1–94.

Williams, L.
1952 Breeding behavior of the Brewer blackbird. *Condor*, 54:3–47.

Wright, P. L., and M. H. Wright
1944 The reproductive cycle of the male red-winged blackbird. *Condor*, 46:46–59.

Saskatchewan Museum of Natural History, Regina, Saskatchewan, December 10, 1955

GENERAL NOTES

A case of microphthalmia in the American Robin.—In the spring of 1953 a pair of American Robins (*Turdus migratorius*) at East Lansing, Michigan, raised a completely blind microphthalmic nestling to nest-leaving age. Though anophthalmia (eyelessness) and microphthalmia (small eyes) have been fairly widely reported in genetical literature dealing with laboratory and domestic animals, I have not been able to find any previous record of their occurrence in strictly wild birds.

The history of this unusual individual is as follows: On June 9, 1953, Dr. William M. Seaman, of the Department of Foreign Languages at Michigan State University, called me regarding a nest of robins which his family had watched with great interest in a conifer tree beside their house. At nest-leaving time it was noted that one of the four fledglings was apparently blind, for it blundered helplessly into obstacles in its path. Twice it was rescued from a pool in the yard. Examination of the captured bird disclosed that the orbital region was depressed and completely feathered over. Otherwise the bird appeared to be of normal size and development for a young robin of nest-leaving age. It was kept captive and hand-fed for nine days, but feeding posed a problem because it could not see to take food voluntarily and the constantly bobbing and weaving head was an exasperating and often-missed target.

Post-mortem examination disclosed that concealed eyes were present. The right eyelid appeared to be sealed with an underlying opaque tissue. The eyeball within was approximately 3 mm. in diameter (3.5×2.5), complete with lens, but about one-fourth normal size. (A full grown robin of unknown age but still in juvenal plumage, examined for comparison, had eyeballs that were 12–13 mm. in diameter.) The left eyelid could be pried open slightly. This eyeball was 6 mm. in diameter (one-half normal size), but was flattened and had no lens. Thus vision in the ordinary sense seemed out of the question, for the eyelid of the smaller eye appeared to be sealed shut, and the other eye, which possibly had openable lids, had no lens.

Various eye defects, including unilateral anophthalmia and microphthalmia, are of course frequent in animals, especially laboratory stock. These are usually non-genetic, and are due to various accidents in development. But bilateral microphthalmia is known from breeding experiments to be hereditary, resulting from homozygous recessive genes. This condition has been observed and studied in white rats and mice, guinea pigs, rabbits, and domestic pigs. A fairly complete bibliography of the mammalian literature on the subject is presented by Chase (1945. *Jour. Comp. Neurol.*, 83:121–139). Microphthalmia in birds was first studied by Jeffrey (1941. *Jour. Heredity*, 32:310–312), who reared microphthalmic Barred Plymouth Rock (*Gallus gallus*) chicks from parents of known heterozygous stock (carriers). The microphthalmic chicks, produced in an approximately 3:1 ratio, had eyes about one-half developed, but entirely concealed, at hatching time. About half the potential offspring died in the embryo; the others died soon after birth as they could not see to feed. None was reared by hand feeding.

Later, Hollander (1948. *Jour. Heredity*, 39:289–292) progeny-tested a pair of pigeons known to be carriers of microphthalmia and systematically studied the offspring, even succeeding in raising one fertile female (letter of August 7, 1954). Dr. Konrad Lorenz, who has carried out large-scale behavior studies on semi-wild ducks in Germany, tells me that microphthalmic individuals have appeared occasionally in his stock and that the young, in some cases at least, have been able to feed themselves. He suggests that ducks, probing about underwater for their food, may be less dependent on vision and employ a tactile sense in making contact with submerged foods.

In the case of the young robin here described several provocative thoughts arise. In the first place, *both* parents, though appearing normal, must have been carriers of the eye defect in order to produce an offspring with a homozygous recessive trait. The chances of two such adults meeting and mating in the wild are of course unknown. It seems remarkable also that the defective offspring lived as long as it did. It survived approximately 13 days of embryonic development (where it had only a 50 per cent chance of living), was successfully cared for during another 10 to 14 days of nest life, and left the nest with its three normal nest mates. How much longer, if at all, the parents would have cared for their blind offspring is conjecture, but it presumably would have soon fallen prey to some mishap.

Though I can find no other records of microphthalmia among wild birds, one wonders if carriers of the defective gene are not of common occurrence, but that two such adults seldom mate and produce young, or if they do the blind offspring (theoretically one-fourth of the brood) would not survive long enough to be detected. Possibly an examination of a large series of nestlings, or unhatched eggs which failed to hatch because of the semilethal gene, would disclose that the condition is more common than heretofore known.—George J. Wallace, *Department of Zoology, Michigan State University, East Lansing, Michigan, August 1, 1955.*

Bird Records for Utah.—The recent accumulation of some bird records for Utah that are not listed in the two check-lists for the state (Behle, 1944. *Condor*, 46:67–87, and Woodbury, Cottam and Sugden, 1949. *Bull. Univ. Utah*, 39:1–40) has prompted us to record them in the literature. All specimens, with the exception of one in the Weber College collection, which will be so designated (WC), are in the University of Utah Museum of Zoology. All specimens unless otherwise designated were collected by the authors. We are grateful to Herbert Friedmann and Gorman M. Bond of the United States National Museum and to Alden H. Miller of the Museum of Vertebrate Zoology, University of California, for the identification of some of these specimens. Our thanks also are extended to Howard Knight of Weber College and Robert J. Erwin of Ogden, Utah, for the use of the data from the specimen at Weber College.

Buteo jamaicensis kriderii.—Red-tailed Hawk. Parker and Johnson in their check-list of Utah bird eggs (published privately about 1899, *fide* Woodbury, *et al.*: 36) reported this subspecies as nesting in Utah. It is now known that the breeding range of this race does not extend into Utah (Friedmann, 1950. *U. S. Nat. Mus. Bull.*, 50:258). Two specimens of this subspecies recently collected in Utah indicate this race to be a fall migrant and possibly a winter resident within the state. One immature male hawk was found dead on October 15, 1951, (WC) by Robert J. Erwin at Willard Bay, 4200 feet, Box Elder County, while the other, also an immature, was collected on August 24, 1953, by Heber H. Hall at Kings Pasture, 9000 feet, Garfield County. The subspecific status of these two birds was verified by Herbert Friedmann.

Calypte costae.—Costa Hummingbird. Although this bird has been observed several times in the Virgin River Valley, only two specimens are known from the state (Behle, 1943. *Bull. Univ. Utah*, 34:41). The collection of a Costa Hummingbird by Heber H. Hall in Garfield County, during the spring of 1953, represents a 100-mile northward extension of range for this species in Utah.

Empidonax traillii traillii.—Traill Flycatcher. In Utah the Traill Flycatcher is represented by two resident subspecies, *E. t. brewsteri*, which is found throughout most of the state, and *E. t. extimus*, which is a breeding bird of the Virgin River valley (Woodbury, *et al.*, 1949:20). The collection of a northern migrant (*E. t. traillii*) on May 25, 1954, at Orr's Ranch, Tooele County, constitutes a first record of occurrence in Utah for the nominate race. The subspecific determination for this specimen was made by Gorman M. Bond.

Anthus spinoletta rubescens.—Water Pipit. Although Woodbury, *et al.* (1949:26) have reported this subspecies as being a sparse migrant and winter resident in Utah, very few specimens exist for the state. Gorman M. Bond identified two specimens recently collected in Utah as *A. s. rubescens.* One was collected at Orr's Ranch, Skull Valley, on May 1, 1954, and another secured on May 12, 1954, at Government Creek marsh, 4 miles north of Camel Back Mountain, both in Tooele County.

Vireo griseus noveboracensis.—White-eyed Vireo. A specimen which proved to be this species was secured by Heber H. Hall eight miles west of Boulder, Garfield County, on May 11, 1953. It was taken from a mixed-species flock of birds in a fruit orchard. This is apparently the first record of the White-eyed Vireo from Utah. Since this species normally ranges east of the Great Plains, the specimen reported here and the one collected August 24, 1933, at Cyanthanis, Cochise County, Arizona (Bent, 1950. *U. S. Nat. Mus. Bull.*, 197:237) constitute the only records to our knowledge of this species west of the Rocky Mountains. The Utah specimen was assigned to *V. g. noveboracensis* by Herbert Friedmann.

Oporornis agilis.—Connecticut Warbler. Not only does the occurrence of this warbler in Utah establish a new record for the state, but it also represents the only known occurrence west of the Rocky Mountains. A specimen collected from Lincoln County (Aiken, 1900. *Auk*, 17:298) in eastern Colorado on May 24, 1899, was formerly the western-most record in this country. The Utah specimen was obtained from the ground beneath dogwood (*Cornus stolonifera*) and willows (*Salix* sp.), of a lower streamside community at the mouth of South Willow Canyon, 5200 feet, 10 miles south of Grantsville in Tooele County, on September 22, 1954.

It is possible that individuals from the populations of this warbler in Alberta, Canada, (Bent, 1953. *U. S. Nat. Mus. Bull.*, 203:522) occasionally pass through Utah and other western states during migration, and due to the lack of collecting during periods of migration and also because of their similarity to the Tolmie Warbler (*Oporornis tolmiei*) they have been overlooked. Further collecting is needed to check this possibility. This specimen was determined by Gorman M. Bond.

Seiurus noveboracensis limnaeus.—Northern Water Thrush. A Water Thrush taken on May 16, 1954, from the edge of a pond at Orr's Ranch, Skull Valley, Tooele County, is the second record of *S. n. limnaeus* from Utah. Behle and Selander (1952. *Wilson Bull.*, 64:30) reported an atypical specimen of *S. n. limnaeus* taken on May 10, 1949, at Farmington Bay Waterfowl Refuge in Davis County. A specimen of *S. n. notabilis*, which was with the aforementioned Skull Valley bird, was also collected. The determinations for these two specimens were verified by Alden H. Miller and Gorman M. Bond.

Passerculus sandwichensis anthinus.—Savannah Sparrow. This northern race is known in Utah from only two records, one collected on October 2, 1888, by Bailey (Woodbury, *et al.*, 1949:33) and another taken on December 19, 1939, by Behle (1943. *Bull. Univ. Utah*, 34:74). The collection of three additional specimens at Orr's Ranch, Skull Valley, Tooele County, during spring migration (April 13, 14 and 21, 1954) would seem to indicate that this race is more common in Utah during migration than was formerly thought. Gorman M. Bond and Alden H. Miller identified these sparrows for us. —RICHARD D. PORTER AND JOHN B. BUSHMAN, *Department of Zoology, University of Utah, Salt Lake City, Utah, August 31, 1955.*

Sparrow Hawk preys upon American Robin.—On July 16, 1955, while driving north on Dale Drive near Silver Spring, Montgomery County, Maryland, I saw a male Sparrow Hawk (*Falco sparverius*) fly low across the road in front of me carrying in its talons, gripped by the anterior part of the breast, an adult American Robin (*Turdus migratorius*).

The screaming hawk was pursued closely by two adult robins which called excitedly and, at one time, pulled up parallel with it, without venturing to attack the small raptor. The hawk and its pursuers went out of sight behind an evergreen tree.

I had parked my car and was walking back to investigate when the hawk, which had doubled back on its path, crossed the road again still carrying its prey with the two protesting robins close behind. The hawk was not more than 10 feet above the ground, and its flight was labored from the weight of its prey. This group of three birds swerved behind another evergreen, and I could not locate them again.

The literature shows that robins are among the heaviest birds taken by Sparrow Hawks. John B. May (1935. "The Hawks of North America") recorded meadowlarks (*Sturnella neglecta*) and Brewer's Blackbirds (*Euphagus cyanocephalus*) as the largest birds taken by Sparrow Hawks in the western United States. A. K. Fisher (1893. *Bull. No. 3, U. S. Dept. Agric., Div. Ornith. and Mammal.*) listed the Bobwhite Quail (*Colinus virginianus*), Starling (*Sturnus vulgaris*), and Red-winged Blackbird (*Agelaius phoeniceus*) among the small birds identified in stomach content examinations of these hawks.

However, the identification of the prey is often based upon stomach content remains or else the observation does not indicate that the hawk was seen in flight carrying its prey. More rarely, records of the hawk apparently carrying its prey are published. May (*op. cit.*) stated that "John Steidl (1928) saw a Sparrow Hawk several times with two-weeks-old chickens in its talons."

Use of some of the data from the bird weight files of the U. S. Fish and Wildlife Service makes it possible to compare approximate weight relationships of the Sparrow Hawk and its avian prey: Sparrow Hawk, 83 to 140 grams; Bob-white, 195 to 198 grams; Eastern Meadowlark (*Sturnella magna*), 145 grams; Robin, 74 to 85 grams; Starling, 84 grams; and Red-winged Blackbird, 70 to 73 grams. I was informed at the Poultry Department of the University of Maryland that for rapidly-growing breeds of chickens, a two-weeks-old bird would probably weigh between 140 and 160 grams, as compared to 130 to 140 grams for a two-weeks-old bird of a breed that grows slowly. Sparrow Hawks have not been seen carrying prey species appreciably heavier than themselves, even though they are known to feed on larger birds.—DONALD LAMORE, *2C Garden Way, Greenbelt, Maryland, August 16, 1955.*

Preening and other behavior of a captive Horned Grebe.—On March 20, 1955, I captured a molting Horned Grebe (*Colymbus auritus cornutus*) at Island Beach State Park, Ocean County, New Jersey. The breast feathers were soaked with oil which I removed with a detergent and mineral oil. The bird lived for eight days; the following observations were made in this period.

Preening.—After the oil was removed, the grebe was placed on the floor where it immediately began to preen. The tameness of the bird allowed close observation. The grebe preened for 40 minutes without interruption, slept for 10 minutes, and then preened for 20 minutes more before it went to sleep for a more extended period. Preening began with the feathers of the back and wings. First the grebe removed the water from these feathers. This was done by manipulating the bill along small bunches of feathers, from base to tip. After the bird did this several times it shook its head vigorously, spraying water around the room. The bill made a snapping sound when this was done. After removing water for 20 minutes, the bird began to use the oil gland. The upper tail coverts were erected and the nipple of the gland seemed to be protruded several millimeters. The bird manipulated its bill over the nipple from the base to the tuft of feathers at the tip. I saw oil exude from the pore on to the tuft from which it was picked up on, and probably in, the bill. The oil was worked into the feathers with a method similar to that used in cleaning and drying. The primaries were preened only once.

The feathers of the flanks and neck were next to be preened. The procedure was the same: cleaning and drying first, and then oiling. Sheaths and bits of feathers accumulated at the corners of the bird's mouth, and sometimes entire feathers (mostly worn, gray winter feathers) were dislodged. These were quickly discarded. The head was often rubbed over the oil gland, but only following "milking" of the nipple by the bill. After doing this the bird usually rubbed its head over the scapular feathers. This may have been done to adjust the feathers of the head, many of which were disarranged. The bird did not preen its white breast and belly feathers until the following day, after bathing. The grebe pushed itself over on one side, grasped a transverse row of feathers in its bill, extracted the dirt and water as described above, and then applied oil. The entire breast was preened in this way.

Bathing.—On March 21, I placed the grebe in a bathtub. A platform was put in the tub and tap water was brought up to this level. When placed in the tub the bird first drank, then bathed. The scapular feathers were elevated, the head immersed and quickly brought over the back. Several applications of water were followed by vigorous shaking. Paddling strongly, but remaining in place, the bird rose high in the water and shook. The wings were often flapped when this was done. The bird soon became waterlogged and climbed on to the platform. The first few attempts at getting out of the water were difficult for the bird, but it soon became adept. It faced the platform, its chest a few inches from it, stroked the water with both feet and jumped to a standing position.

Sleeping.—The bird slept only on the platform. When sleeping the bill was tucked forward into the feathers at the base of the neck, and the feet were sometimes raised and placed on the flank feathers. In the water, this sleeping position would reduce heat loss from the poorly-insulated feet.

Molting.—The grebe was in prenuptial molt when captured. On March 20, the only evidence of breeding plumage was scattered rufous flank feathers and some golden feathers of the "horns." Eight days later, when the grebe died, more of these feathers had appeared and the white feathers of the throat and cheeks were almost entirely replaced by black ones. Rufous feathers had become numerous on the neck where none had been evident, and many new feathers had appeared on the crown. A few feathers of the scapular tract were also replaced. Other Horned Grebes in the area were in a similar stage of molt.

Walking.—On a sunny day I placed the grebe in the yard hoping to observe sun bathing, but this did not occur. Standing upright, the grebe wandered in different directions. It was able to go 15 to 20 feet before flopping down on its breast.

Voice.—The bird called often. The note was a short, one-, or two-syllabled, plaintive "aow." It was high pitched, matching B flat, above middle C on a piano.

Feeding.—The bird was fed strips of squid (*Loligo*) for four days. The first five pieces had to be pushed down the esophagus with forceps, but thereafter the grebe ate eagerly. It snatched food dangled or placed before it, but never went after food at the bottom of the tub. When I prepared to feed the grebe it became excited and frequently called. Strips of squid wider than 25 millimeters were swallowed only with considerable difficulty. On March 26, my supply of squid was gone so I bought some frozen sand launces (*Ammodytes americanus*), used locally for fishing bait. The first half dozen were taken by the grebe with the usual avidity, but it soon refused to eat them. No other food was obtainable and the bird was found dead on March 28. The stomach contained numerous feathers, none of which I had seen being swallowed.

When the bird defecated while on the platform it always backed up a few steps. The grebe was seen scratching its head twice. It did not place its foot over the wing to do this. The bird was a male (testes 6×3 mm.). It had little fat and weighed 387 grams when it died.

F. I. Dewald and John Verdier of the New Jersey parks commission kindly granted me access to Island Beach.—GLEN E. WOOLFENDEN, *Museum of Natural History, University of Kansas, Lawrence, Kansas, September 1, 1955.*

Connecticut Warbler in Kansas.—Among 230 birds killed by striking a television transmitting tower one mile west of Topeka, Shawnee County, Kansas, on the night of September 22–23, 1955, was an immature male Connecticut Warbler (*Oporornis agilis*). The birds were collected by members of the Topeka Audubon Society and given to the University of Kansas. The Connecticut Warbler (KU 32622) is the first record of the species in Kansas authenticated by a specimen. Wetmore reported this species from the state in 1909 (*Condor*, 11:162), but in 1920 (Condor, 22:158–159) stated that the specimen reported earlier was actually an immature Mourning Warbler (*Oporornis philadelphia*), a species of regular occurrence in Kansas. T. W. Nelson and L. B. Carson (*Topeka Audubon News*, 3(4), July, 1949) reported seeing a male Connecticut Warbler in Topeka on May 1, 1949. I know of no other records of the species in Kansas.

Occurrence of the Connecticut Warbler in Kansas in autumn is of special interest because the species normally migrates east of the Alleghany Mountains in fall, returning north in spring through the Mississippi Valley. The specimen from Kansas weighed 14.9 grams, was moderately fat, and had an incompletely ossified skull. Measurements were: wing (chord), 71 mm.; tail, 48 mm.—HARRISON B. TORDOFF, *Museum of Natural History, University of Kansas, Lawrence, Kansas, September 29, 1955.*

Tree Swallows playing with a feather.—On October 23, 1955, while watching ducks on the Boonton Reservoir, Boonton, New Jersey, I saw a white object drop from the sky and float on the surface of the water. Puzzled as to what it could be, I continued to watch it and then saw a Tree Swallow (*Iridoprocne bicolor*) scoop it up and fly off with it. This bird was pursued by four or five other Tree Swallows and, in his effort to evade them, he twisted and turned violently, finally dropping what I could see was a feather about four inches long.

Another Tree Swallow picked the feather up from the surface and the action was resumed. This same sequence of events occurred three or four times. Finally, one swallow dropped it but as the feather floated and twisted toward the water one and then another swallow tried unsuccessfully to pick it out of the air. Their failure was quite interesting to watch for they had always succeeded in taking it off the surface of the water. It occurred to me that pursuit of a slowly dropping object might have been more difficult and strange than catching insects.

After several birds had missed the feather, one caught it in mid-air and the chase continued. Apparently, picking it out of the air was more fun than taking it off the surface of the water. for thereafter the swallows generally tried to get it in mid-air. This observation lasted several minutes. At this time there were hundreds of Tree Swallows over the reservoir but only about a half-dozen were playing with the feather. —Charles W. Lincoln, *392 Highland Avenue, Upper Montclair, New Jersey, October 24, 1955.*

Nesting heights of some woodland warblers in Maine.—During 17 summers at the Audubon Camp on Hog Island (and adjacent mainland) in Lincoln County, Maine, we found a great many nests. I kept a record of the height from the ground of many of the nests of woodland warblers (Parulidae) and tabulate herewith the accumulated data. The heights reported for the lower nests represent actual measurements. The remainder, although estimates, were obtained mostly with the aid of a camera range finder and may be considered reasonably accurate.

Species	Total nests	Height of the nests from the ground (in feet) 0-5	5-10	10-15	15-20	20-30	30-40	40+	lowest	highest
Parula Warbler	71	0	7	16	22	9	11	6	5 7/12	54
Magnolia Warbler	33	18	13	2	0	0	0	0	1 1/12	14
Myrtle Warbler	44	0	4	12	17	6	2	3	6 2/12	43
Black-throated Green Warbler	58	1	5	15	19	10	6	2	3	51
Blackburnian Warbler	7	0	0	0	0	0	0	7	43	76
Bay-breasted Warbler	4	0	1	2	1	0	0	0	7 2/12	16
American Redstart	50	2	6	18	11	5	6	2	1 1/12	52

The study area is located in red spruce (*Picea rubens*) and white spruce (*P. glauca*) woodlands or in mixed spruce and hardwood forests. All the nests of the Parula Warbler (*Parula americana*) were located in *Usnea* lichen. All nests of the Magnolia (*Dendroica magnolia*), Myrtle (*D. coronata*), Blackburnian (*D. fusca*), and Bay-breasted (*D. castanea*) warblers were located in red or white spruce or in balsam-fir (*Abies balsamea*). Nearly all the Black-throated Green Warblers (*D. virens*) nested in conifers, whereas all but two of the American Redstarts' (*Setophaga ruticilla*) nests were found in deciduous growth.—Allan D. Cruickshank, *R.R. 1, Box 1590, Rockledge, Florida, October 18, 1955.*

Nest-building movements performed by a juvenile Olive-backed Thrush.—A captive juvenile Olive-backed Thrush (*Hylocichla ustulata*), when approximately 17 days old and while snuggling down into my wife's cupped hands, performed perfectly typical nest-shaping movements characteristic of adult females. The bird simultaneously kicked backward with both feet and forcibly thrust its breast against the side of the cup. The wings were held rather high on the back but not unfolded and the tail was rather depressed. The bird would perform a few rapid thrusts and kicks and then turn slightly in the cup and repeat these acts. It fell asleep after a few such attempts.

Several hours later I held this bird in my cupped hands in order to see if I could observe this behavior pattern again. The performance was repeated and by increasing a gentle pressure with the edge of my hand against the pushing breast I could provoke an increased effort at this particular spot. It would seem likely that the irregularities of a nest as it is being shaped provide a tactile-proprioceptive stimulus to the bird's breast which acts as a releaser for the thrusting response; the thrusting ceases when the nest fits as the thrusting ceased when I allowed the bird to "push" my hand into shape.

Other similar observations have been made; for example, D. Goodwin, (1954. *British Birds*, 47:81–83) describes nest-building movements performed by juvenile Mistle Thrushes (*Turdus viscivorus*). These observations indicate that the innate releasing mechanisms responsible for reacting to nest-building releasing stimuli must be present at an early age. These precocious behavior patterns are probably not observed more often because of lack of observers and because the stimuli releasing these acts seldom are available to juvenile birds, which, in any case, must have a low state of internal readiness to perform patterns of behavior associated with nest building and other reproductive activities.—WILLIAM C. DILGER, *St. Lawrence University, Canton, New York, October 22, 1955.*

Water moccasin as a predator on birds.—During field investigations of rails in the coastal marshes of Cameron Parish, Louisiana, a water moccasin, *Agkistrodon piscivorus*, with an engorged digestive tract was observed and collected on April 13, 1955. Upon dissection a male Sora Rail (*Porzana carolina*) was found in a fairly fresh condition with only the head and forequarters digested.

On October 13, 1955, in the same locality, a water moccasin was collected and found to contain the feathers, feet and bill of a Seaside Sparrow (*Ammospiza maritima*).—WILLIAM H. ADAMS, JR., *Department of Forestry and Game Management, Louisiana State University, Baton Rouge, Louisiana, October 25, 1955.*

Pleistocene Birds from Crystal Springs, Florida.—Among several lots of fossil birds submitted to me for identification by S. J. Olsen of the Museum of Comparative Zoology are three specimens from Crystal Springs run, in the southeastern corner of Pasco County, Florida. This material was collected on June 4, 1941, by Dr. L. J. Marchand of Gainesville. The bones are well mineralized and resemble Pleistocene material from other Florida spring deposits; all represent living species.

Anas carolinensis. Green-winged Teal. Left humerus. Recorded from the Pleistocene at Seminole Field, Florida (Wetmore, 1931. *Smithsonian Misc. Coll.*, 85(2):21), as well as from several localities in the western United States.

Aythya collaris. Ring-necked Duck. Left carpometacarpus. The previous fossil records of this species are somewhat unsatisfactory. Shufeldt (1913. *Bull. Amer. Mus. Nat. Hist.*, 32:156) recorded it with a query from Fossil Lake, Oregon, and Howard (1946. *Carnegie Inst. Wash. Publ.*, 551:174, 191) also queried the determination. Wetmore (1940. *Smithsonian Misc. Coll.*, 99(4):26) listed it from the Lower Pliocene of Nevada. This record is based on a report by Merriam (1916. *Univ. Calif. Publ. Dept. Geol. Sci.*, 9:173), whose specimens were so fragmentary that it would have been preferable to confirm the determination with better material before extending the record of living species of birds back to the Lower Pliocene.

Aramus guarauna. Limpkin. Right carpometacarpus. Previously recorded from two Pleistocene localities in Florida (Wetmore, 1931).—PIERCE BRODKORB, *Department of Biology, University of Florida, Gainesville, Florida, November 11, 1955.*

Singing and window-fighting by female Cardinals.—On three occasions in the last 25 years I have observed female Cardinals (*Richmondena cardinalis*) exhibiting behavior usually considered characteristic of the males. One of these females was singing only a part of the Cardinal song, the second engaged in window-fighting, and the third sang a large part of the Cardinal repertory. The first singing bird built a nest in a privet (*Ligustrum* sp.) in a small unpaved corner of a paved court at Vanderbilt University, Nashville, Tennessee, in early May, 1930. This court was enclosed by walls 35 feet high. The nest which was about seven feet above the floor of the court was built largely of small pieces of newspaper and twigs which this bird carried over the top of the building. As the nest location was only about five feet outside my dormitory window, I was able to watch from the semi-dark room as though from a blind. On several occasions during nest construction by the female the male Cardinal sang the "what cheer" beginning of the song (repeated two or three times) from his perch in the privet above the nest and the female immediately answered with, "cheaper," "cheaper," "cheaper," "cheaper," from the floor of the court where she was gleaning small privet twigs, plucked and dropped by the male.

For several days in mid-May, 1945, at the Cranbrook Institute of Science, Bloomfield Hills, Michigan, I watched a pair of Cardinals through the window of a darkened room. These birds were in the branches of a 12-foot hawthorn (*Crataegus* sp.) whose branch tips brushed against the window. From about 2:00 to 5:00 p.m. each day for about a week the female of this pair vigorously attacked with wings and beak her reflection in the lower part of the window while the male sat on a branch within a few feet uttering call notes. Neither bird sang during any of these performances and only the female was seen engaged in window-fighting. A photographic record in 16 mm. colored motion pictures was taken of this behavior. This female built a nest in the hawthorn, beginning about the time her window-fighting ended.

On July 17, 1955, I found another Cardinal's nest, also on the Cranbrook Estate. The female was sitting on two small young and one egg, and left the nest reluctantly. She flew immediately to another bush about 15 feet away and sang almost the full song of the species 11 times in about five minutes. Her state of excitement was evident in the greatly increased tempo of each song sequence. When I walked away from the nest to a distance of about 30 feet, her singing ceased and she began to utter the usual call notes. While the female sang the male sat a few feet away uttering the familiar "chip" notes but otherwise apparently little excited. It will be noted that both instances of the female's singing and one of window-fighting were related in order, to nest building, choice of nest site, and nest protection.—WALTER P. NICKELL, *Cranbrook Institute of Science, Bloomfield Hills, Michigan, October 13, 1955.*

Vertical nest placement in the Blue-gray Gnatcatcher.—The nest placement of the Blue-gray Gnatcatcher (*Polioptila caerulea*) is generally described in the literature as resting on, or saddled on horizontal branches either under or attached to another upright or diagonal branch. This, apparently, is the usual placement (Fig. 1). The horizontal branching habit found in most taller trees in wooded habitats furnishes a minimum number of suitable upright crotches for nest placement while open, low shrub growth furnishes an abundance of such sites. This is attested by use of the latter by such abundant nesting birds as the Yellow Warbler (*Dendroica petechia*), Alder Flycatcher (*Empidonax traillii*), Indigo Bunting (*Passerina cyanea*), Common Goldfinch (*Spinus tristis*), Field Sparrow (*Spizella pusilla*) and Catbird (*Dumetella carolinensis*). J. J. Murray at Lexington, Virginia, (1934. *Wilson Bull.*, 46:128) reported a nest of the Blue-gray Gnatcatcher which was "not saddled on a limb but set between three small forks of an upright crotch, in the manner of the nests of the Yellow Warbler and Redstart." R. A. Hallman of Panama City, Florida, (A. C. Bent, 1949. *U. S. Nat. Mus. Bull.*, 196:346) wrote of another nest of this species which was in the "upright fork of a small scrub oak bush, . . . by actual measurement 38 inches . . . from the ground to the top of the nest." These two references to nest placement in upright forks by the Blue-gray Gnatcatcher are the only ones I find in the literature.

FIG. 1. Horizontal (left) and vertical placement of Blue-gray Gnatcatcher nests. Photograph by Luella C. Shroeder.

Recently I found two vertically-placed nests of the Blue-gray Gnatcatcher. A nest placed in an upright crotch of an elm (*Ulmus* sp.) and enclosed by three branches was collected on December 15, 1954, 3 miles west of Aurora, Indiana. The second, found in Oakland County, Michigan, in January, 1955, was enclosed by four upright branches of wild crab (*Pyrus coronaria*). Heights of the rims of the two nests from the ground were 50 and 42 inches, respectively.—WALTER P. NICKELL, *Cranbrook Institute of Science, Bloomfield Hills, Michigan, September 14, 1955.*

WILSON SOCIETY ACTIVITIES

THIRTY-SEVENTH ANNUAL MEETING

The *Proceedings* of the Thirty-seventh Annual Meeting, held at Buffalo, New York, April 26–29, 1956, will be published in the September issue of *The Wilson Bulletin*. The names of the officers elected for the ensuing year appear on the inside front cover of this issue. Elective members of the Executive Council are Harvey I. Fisher, Leonard C. Brecher and Andrew J. Berger. The Council reelected Keith L. Dixon as Editor of *The Wilson Bulletin* and accepted an invitation from the Minnesota Ornithologists' Union, the Duluth Branch of the University of Minnesota and the Duluth Bird Club to hold a mid-June meeting at Duluth in 1957.

RESEARCH GRANTS

Kenneth C. Parkes, Chairman of the Research Grant Committee, reported that two applications for the Louis Agassiz Fuertes Research Grant were judged equally meritorious and deserving. The Council, therefore, made an exception to the general rule and awarded duplicate grants of $100 each to John Burton Millar, University of Wisconsin, whose study is "An investigation of possible factors involved in the initiation of migration" and Lester L. Short, Jr., Cornell University, whose project is "Hybridization and isolating mechanisms in North American Flickers (*Colaptes*)."

Donald R. Altemus, State College, Pennsylvania, was voted an award of $25 from the S. Morris Pell Fund for the encouragement of bird artists. The Chairman of the Research Grant Committee wishes to acknowledge the assistance of William C. Dilger, who is acting as art consultant to the committee.

THE WILSON ORNITHOLOGICAL SOCIETY LIBRARY

The following gifts have been recently received. From:

William H. Burt—6 reprints
Powell Cottrille—1 reprint
William R. Dawson—4 reprints
John T. Emlen—17 reprints
J. Harold Ennis—2 magazines
Harvey I. Fisher—3 reprints
Karl W. Haller—3 books
Frederick and Frances Hamerstrom—10 reprints
F. Haverschmidt—1 book
Daniel S. Lehrman—3 reprints
Russell E. Mumford—1 bulletin
William H. Phelps—2 reprints
Walter E. Scott—1 book, 7 pamphlets
Mrs. J. Murray Speirs—1 reprint
Alexander Sprunt, Jr.—1 reprint
Phillips B. Street—1 book
Josselyn Van Tyne—12 reprints
Lawrence H. Walkinshaw—1 reprint
University of Wisconsin Department of Zoology—3 reprints

ORNITHOLOGICAL LITERATURE

THE HONEY-GUIDES. By Herbert Friedmann. Bulletin 208 of the United States National Museum, Smithsonian Institution, Washington, D.C., 1955: 6×9 in., vii+292 pp., 6 text figures, 20 photographs, 5 color plates by Walter A. Weber.

Along with "The Cowbirds," this book is bound to become an ornithological classic, not only for the unusual interest attached to the subject matter, but for the excellence of the scholarship and detective work it displays. A first opinion might consider that 300 pages is a lot to devote to a preliminary report on an obscure family of birds containing only 11 species, some of them known from only a few specimens and a few casual field observations. A few minutes of perusal will dispel any such delusion, and a thorough study will convince the reader that in this volume Dr. Friedmann has made a highly significant contribution not only to ornithology, but to several facets of animal behavior and even to digestive physiology. In compiling this work Dr. Friedmann consulted or corresponded extensively with most of the active field ornithologists of Africa and Southern Asia. Cooperators and consultants on various aspects of the work included a large number of biologists, bacteriologists, chemists and anatomists. The list of references cited contains 285 titles.

In the first part of the book (83 pages) Dr. Friedmann discusses the basic biological problems raised by the peculiar behavioral characteristics of the honey-guides, particularly their interesting development of brood parasitism, the remarkable "guiding" habit, and wax eating or cerophagy. The second part (181 pages) contains descriptive materials and observations on each of the 11 species known to science. Twenty well-selected and instructive photographs and five beautiful color plates show the characteristics of each of the species and depict various significant aspects of their structure and behavior.

The honey-guides, a small and relatively obscure family of arboreal birds of tropical Africa and southern Asia, belong to the order Piciformes and show their closest affinities with the barbets. The eleven species, largely dull gray in coloration, range in size from two warbler- or tit-sized foliage gleaners (*Prodotiscus*) to the tanager- or waxwing-sized Greater Honey-guide (*Indicator indicator*) of open woodlands and "brushveldt." Although information is still incomplete on several species, the honey guides are apparently all parasitic in their nesting. In this respect they go farther than any of the other bird families which display this behavioral trait. Friedmann believes the habit probably antedates the evolution of the group into its present generic sections and is older and more advanced than in any other family of birds. A large variety of hosts or victims is selected, most of them, at least for the members of the genus *Indicator*, being hole-nesting species. This specialization on cavity nesters would seem largely to eliminate any elements of competition for hosts with the parasitic cuckoos and ploceids.

Associated with brood parasitism is a reduction in specialized territorial and courtship displays, although several species, notably the remarkable and little known Lyre-tailed Honey-guide (*Melichneutes robustus*), of the tropical forests have interesting flight displays in which rustling noises are produced by the tail feathers. Mating in the Greater and Lesser Honey-guides takes place at call sites or "stud posts" which are occupied by a single male and visited by a series of females apparently for mating purposes only. Several males may use a "stud post" successively or concurrently, singing their simple two-syllabled song, and waiting without evidence of competition. Stud posts are used continuously by singing males year after year, in one case for 20 years.

Unlike the parasitic cuckoos and cowbirds, the honey-guides, typical of their picarian relationships, have long fledging periods; competition with their nestling associates depends on direct action rather than speed of maturation. In two species, at least, nestling aggressiveness is aided by the possession of a pair of sharp-pointed mandibular hooks which may be used with great effectiveness in biting the delicate skins of nest-mates. Nestlings of the Greater Honey-guide have also been observed to evict their nest-mates directly. More than one honey-guide egg in a parasitized nest is rare, and only one fledgling is produced per nest.

The mandibular hooks, like the familiar egg tooth of other birds, are shed during the nestling stage. Special histological studies showed a basic similarity between "hook" and "tooth," and an examination of the bills of nestlings belonging to other picarian species reveals that this peculiar structure is not wholly without homologous counterparts in the barbets and woodpeckers.

Perhaps the main objective of the book, and its major contribution to science, is an examination and analysis of the guiding habit as observed in the Greater Honey-guide (*I. indicator*) and occasionally in the Scaly-throated Honey-guide (*I. variegatus*). After reviewing early accounts and interpretations of this remarkable behavior, Friedmann carefully describes all aspects of the performance based on his own experience (23 instances) and the observations of a large number of competent eye witnesses. Typical guiding behavior is summarized as follows: "When the bird is ready to begin guiding it either comes to a person and starts a repetitive series of churring notes, or it stays where it is and begins calling these notes and waits for the human to approach it more closely. These churring notes are very similar to the sound made by shaking a partly-full, small matchbox rapidly lengthwise. If the bird comes to the person to start leading him, it flies about within 15 to 50 feet from him, calling constantly, and fanning its tail, displaying the white outer rectrices. If it waits for the potential follower to approach it for the trip to begin, it usually perches on a fairly conspicuous branch, churring rapidly, fanning its tail, and slightly arching and ruffling its wings so that at times its yellow "shoulder" bands are visible. As the person comes to within 15 to 50 feet from it, the bird flies off with an initial conspicuous downward dip, with its lateral rectrices widely spread, and then goes off to another tree, not necessarily in sight of the follower, in fact more often out of sight than not. Then it waits there, churring loudly until the follower again nears it, when the action is repeated. This goes on until the vicinity of a bee's nest is reached. Here the bird often (usually in my experience) suddenly ceases calling and perches quietly in a tree nearby. Some observers record no such cessation of the churring notes when near the bee's nest, but all agree that the bird perches unobtrusively in a nearby tree or shrub and there waits for the follower to open the hive, and it usually remains there until the person has departed with his loot of honeycomb, when it comes down to the plundered bee's nest and begins to feed on the bits of comb left strewn about. The time during which the bird may wait quietly may vary from a few minutes to well over an hour and a half."

Man is not the only symbiont in these cooperative guiding performances. The Honey Badger or Ratel (*Mellivora capensis*) is known to play the role of follower and hive opener at times, and baboons may occasionally participte. Ratels apparently grunt noisily when following a Honey Guide, and natives often make a practice of grunting in a similar manner and beating trees with sticks, believing that in so doing they get better cooperation from the bird.

Of particular interest is the fact that the guiding habit is apparently unknown in certain sections of Africa and has been disappearing in others, particularly near cities where natives can buy their sweets in shops and no longer make a regular practice of following the birds. There is a danger, in fact, that this interesting behavior may disappear except in the remote hinterland where natives continue to contribute their part in the symbiotic relationship.

The peculiar habit of cerophagy or wax-eating is apparently important as a basic element in the evolution of guiding behavior. Formerly thought to be primarily insectivorous birds with special predilections for bees and bee larvae, honey-guides have now been shown to feed extensively and preferentially on beeswax and even to thrive for a month on an exclusive diet of wax. Because of the special problems involved in assimilating and utilizing wax as food, laboratory studies were initiated to determine the chemical changes induced in the digestive tracts of these birds. Preliminary results indicate that either the microflora of the alimentary canal or the endogenous avian enzymes are capable of splitting these waxes into fatty acids of considerably lower molecular weight, so that it becomes possible for the birds to extract nourishment from them.

An interesting discussion is devoted to the "behavioristic level" of the guiding habit and to its antiquity and evolution. "Guiding" is regarded as a dangerous term if it implies purposive or adaptive behavior at the individual level. Friedmann believes that guiding is basically instinctive and stereotyped, although the selection of the symbiont or "guiding kumpan" is probably the result of learning. A study of the routes followed by guiding birds suggests that in many cases, at least, the destination at the hive was not known to the bird at the start of the tour, but was discovered by random searching after the human participant had been enjoined. It is suggested that the sight of a human being or a honey badger may tend to excite a bird which has previously encountered one of these creatures at the site of a freshly opened bee nest. The excitement of the bird results in the approaching and calling behavior characteristic of the first stage of guiding. The human or badger symbiont responds to this calling, presumably through associative memory, and the guiding-following act ensues. The encountering of a swarm of buzzing bees is thought to suppress the bird's excitement and, in terminating the stimulus situation for the follower to lead to localized foraging near the site and the discovery of the hive.

Friedmann believes that the habit is quite old and probably antedates the advent of man. He suggests that the ancestral honey-guides may have been primarily followers rather than guides and have developed a simple functional relationship with other bee predators before any guiding behavior evolved.

In these days when scientific workers struggle and groan under an overwhelming avalanche of scientific publication, there will be some who decry the anecdotal presentation and frequent reiteration to be found in this work. One might wish to see some of the data tabulated and some of the sections summarized in precise phrases; but the subject in general does not lend itself to concise quantitative treatment. Here, in fact, is an admirable example of what the naturalist means when he tells his experimentalist colleagues that much in science can only be presented in narration and description. "The Honey-Guides" is an exhaustive compendium of information, objectively gathered, scientifically organized and ably presented as a record of several remarkable biological phenomena, and as a firm basis for launching further exploration and study.—John T. Emlen, Jr.

A DISTRIBUTIONAL CHECK LIST OF THE BIRDS OF ILLINOIS. By Harry R. Smith and Paul W. Parmalee. Springfield; Illinois State Museum. Popular Science Series IV. and Illinois Audubon Society, 1955:4⅜ × 7½ in., 62 pp. $ .25.

The last previous list of the birds of Illinois was Gault's "Check List of the Birds of Illinois" published by the Illinois Audubon Society in 1922. It was published to "render assistance to observers and students of bird life everywhere in Illinois" and was printed in handy pocket form for the benefit of the field student. The present volume brings Gault's list up to date with the inclusion of all new records of the past 30 years, and retains the useful shape and size of the original. All species recorded are included in a single list, with a short résumé of their abundance in northern, central, and southern Illinois, and, in the case of rarer species, brief notes on recent observations. Common names are those of the forthcoming American Ornithologists' Union Check-List, and when these differ from those of the 1947 edition of Peterson's "A Field Guide to the Birds," the latter are added in small type. Scientific names are to the species level only, as is proper in a work of this type.

Many of the new species added to the list, and indeed several of the old ones that are retained, are based upon sight records only. The authors recognize that they may be open to criticism on this score, and they are careful to point out that "before a new state record should be accepted as scientific data, this record should be based on and verified by a collected specimen. . ." Further, they place an asterisk before the name of a species included solely on the basis of a sight record. Despite these precautions on the part of the authors, there is an unevenness in the value of these records that makes the reviewer wish that at least some of the species had been removed to a hypothetical list. Although the check-list was prepared primarily for the field student, the fact that it is the only recent list of Illinois birds will make it an important source for museum workers, and a more critical evaluation would have been desirable. At least a fuller account of the circumstances surrounding the previously unpublished sight records would have made it possible for the reader to make his own evaluation.

Although it is not possible or proper to review all the doubtful forms, there are a few species to which attention should be drawn. The Mexican Cormorant is considered as being based upon a collected specimen, but the source of this specimen was doubtful, and the species should be considered hypothetical rather than accidental. The Royal Tern and the Gull-billed Tern are both based on unsupported observations of Nelson of 80 years ago, and both forms should go on a hypothetical list. The Brown-headed Nuthatch is based solely upon recollections 40 years old at the time of recording. The same is true of Ridgway's "recollection of what he believes to have been" an Ivory-billed Woodpecker. Certainly some comment is due on the quoted sight records of the Passenger Pigeon reported in 1923, since the last authenticated specimen of that extinct form was collected in 1900. The few recent observations listed under the Snowy Owl are incomplete and give a misleading idea of the relative abundance of that form in years when there is a major flight. The only omission that is apparent is the Long-billed Dowitcher, *Limnodromus scolopaceus*; Pitelka, in his recent monograph (1950. *Univ. Calif. Publ. Zool.*, 50:1–108.) lists specimens of both the Long-billed and Short-billed Dowitchers from Illinois.

The above comments are not meant as a major criticism of a work which is admirably suited for the use for which it was intended. Rather it is to be hoped that the future revisions which the authors promise will contain enough additional information to broaden its usefulness to students outside the state.—MELVIN A. TRAYLOR.

Manual de las Aves de El Salvador. By A. L. Rand and Melvin A. Traylor. San Salvador; Universidad de El Salvador. 1954: $7\frac{3}{8} \times 9\frac{5}{8}$ in., iv + 308 pp., 108 figs. in text. Paper bound; lithoprinted.

The only book on the birds of El Salvador prior to the appearance of this volume was Dickey and van Rossem's monumental "The Birds of El Salvador," published in 1938, a treatise of limited usefulness to Central American ornithologists since it is printed in English and includes no sections on field identification. The present volume, printed in Spanish and containing keys to species and detailed descriptions of each species, makes available a comprehensive volume which should be most useful to Central American ornithologists, whether amateur or professional.

Much of the material presented is taken from Dickey and van Rossem, supplemented by data from J. T. Marshall, Jr.'s paper (1943. *Condor*, 45:21–33) and by the observations and collections made by Rand, who spent six months in El Salvador. The introductory sections cover such topics as topography, climate, vegetation, composition of the avifauna, migration, and breeding. Much of this material has been condensed from Dickey and van Rossem.

Wetmore's classification of families is used. The classification of non-passerines follows Peters, and that of passerines, Hellmayr. Following each family is a brief characterization of the group. Then follows a key for the identification of those species which are found in El Salvador. Appearing under each species are sections on description of adults and young, diagnostic characters, range (both general and in El Salvador), biology (status, relative abundance, habitat, food habits, extreme dates for migrants, and nesting), and lastly a general section on behavior, voice, and related topics. Much of the material in the general sections has been taken from Dickey and van Rossem, and the source of such material is indicated throughout.

Both scientific and vernacular names are given for each species. Where the scientific name differs from that used by Dickey and van Rossem, the latter is given in a footnote, so that the two sets of names can be equated. In a few cases citations are given pertinent to the name changes, but most are unexplained. Many of the vernacular names are awkward translations of the English. How many ornithologists will commit to memory such names as "Colymbo sureño de pico moteado" (Southern Pied-billed Grebe) or "Ave tropical del norte de pico rojo" (Northern Red-billed Tropic-bird)? Such cumbersome vernaculars will undoubtedly force serious students to memorize the scientific names, which is all to the good. The authors should not be criticized adversely for these vernaculars, since translation into Spanish of an already confused set of English names poses almost insuperable problems.

The book contains many of the illustrations by Douglas E. Tibbitts which first appeared in E. R. Blake's "Birds of Mexico." These are fairly well reproduced, although most have been considerably darkened with consequent loss of fine detail.

The chief defect that appears is the treatment of each subspecies, where two or more races of a given species occur in El Salvador, as a separate entity, with its own account. Since most of the races concerned are indistinguishable in the field, it would have been less confusing to have had an over-all account for each species, with a listing of the various races and their distributions in the section on range. The treatment of races as separate entities does not seem compatible with the statement in the introduction that this volume is designed for the non-specialized reader.

It seems obvious that if interest in natural history is to be awakened in Central

America, competently written books, printed in Spanish, must be made available to students there. The Instituto Tropical de Investigaciones Científicas de la Universidad de El Salvador is to be congratulated for its projected series of scientific works in Spanish, of which this is the first, and the authors are to be commended for a job well done.—John Davis.

Aves, Zoological Record, 91 (for 1954), Sect. 17. By W. P. C. Tenison. Zoological Society of London. 101 pp. Paper. 7s 6d.

Lt. Col. W. P. C. Tenison has again performed an important service to ornithology by preparing the *Aves* section for the *Zoological Record.* The 1954 tabulation, received in the Wilson Ornithological Library in November, 1955, lists 1,972 titles of bird papers from all parts of the world. The usual cross-index provides an extensive key to the subject matter by "Subject" (67 headings), "Distribution—Geographical and Geological" (58 headings), and "Systematic" (110 family headings). Although by no means a complete tabulation of the ornithological output of 1954, this summary is easily our best single bibliographic source. Whether or not one has need to look up any reference whatever, a mere glancing through the Aves volume will give the reader such a cross-section of modern ornithology as can be secured in no other way.

Bird students may purchase copies of this valuable 101-page booklet from the Zoological Society of London, Regent's Park, London, N.W.1, England, for a dollar and ten cents, postpaid (7 shillings 6 pence, which may be conveniently paid by foreign money-order obtainable at U.S. Post Offices).—Josselyn Van Tyne.

NEW LIFE MEMBER

Lukas Hoffmann, a native of Switzerland, earned his doctorate at the University of Basle, Switzerland. He now lives in the Camargue in southern France and spends much of his time in studies of migration and ecology of birds. Dr. Hoffmann bands about 5,000 birds each year. This picture shows him on his way to band Flamingoes. He has banded about 2,000 downy young of that species and has received some 60 returns from southern Europe and Africa.

This issue of *The Wilson Bulletin* was published on June 15, 1956.

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.

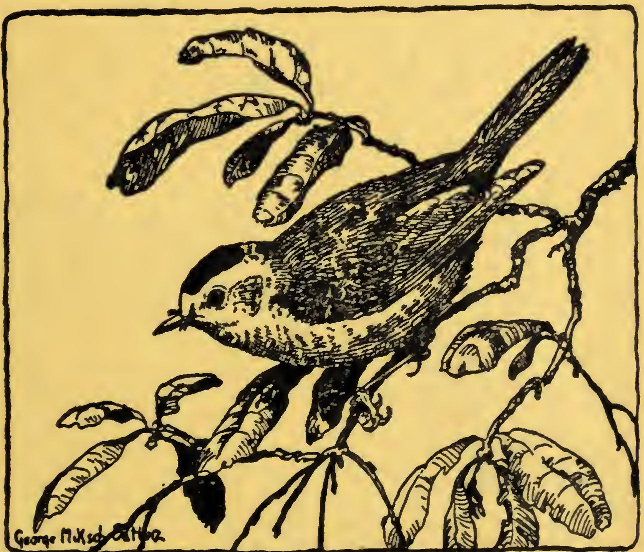
PAST PRESIDENTS
OF
THE WILSON ORNITHOLOGICAL SOCIETY

J. B. Richards, 1888–1889
Lynds Jones, 1890–1893
Willard N. Clute, 1894
R. M. Strong, 1894–1901
Lynds Jones, 1902–1908
F. L. Burns, 1909–1911
W. E. Saunders, 1912–1913
T. C. Stephens, 1914–1916
W. F. Henninger, 1917
Myron H. Swenk, 1918–1919
R. M. Strong, 1920–1921
Thos. L. Hankinson, 1922–1923
Albert F. Ganier, 1924–1926
Lynds Jones, 1927–1929
J. W. Stack, 1930–1931
J. M. Shaver, 1932–1934
Josselyn Van Tyne, 1935–1937
Mrs. Margaret Morse Nice, 1938–1939
Lawrence E. Hicks, 1940–1941
George Miksch Sutton, 1942–1943
S. Charles Kendeigh, 1943–1945
George Miksch Sutton, 1946–1947
Olin Sewall Pettingill, Jr., 1948–1950
Maurice Brooks, 1950–1952
W. J. Breckenridge, 1952–1954
Burt L. Monroe, 1954–1956

September 1956

VOL. 68, No. 3 PAGES 169–272

The Wilson Bulletin



Published by

The Wilson Ornithological Society

at

Lawrence, Kansas

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 Central Tower, Battle Creek, Michigan.

Second Vice-President—Phillips B. Street, Route 1, Chester Springs, Pennsylvania.

Treasurer—Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia.

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 Comittee, 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.

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.

Entered as second class matter at Lawrence, Kansas. Additional entry at Ann Arbor, Mich.

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by The Wilson Ornithological Society

Vol. 68, No. 3 | September 1956 | Pages 169–272

CONTENTS

BREEDING MALES OF FOREST THRUSHES, from top to bottom:
Gray-cheeked Thrush *(Catharus minimus bicknelli)* from Essex County, New York
Olive-backed Thrush *(Catharus ustulatus swainsoni)* from Ulster County, New York
Hermit Thrush *(Catharus guttatus faxoni)* from Cattaraugus County, New York
Veery *(Catharus f. fuscescens)* from Essex County, New York
Wood Thrush *(Hylocichla mustelina)* from Tomkins County, New York

ADAPTIVE MODIFICATIONS AND ECOLOGICAL ISOLATING MECHANISMS IN THE THRUSH GENERA *CATHARUS* AND *HYLOCICHLA*

BY WILLIAM C. DILGER

CLOSELY-RELATED sympatric species, if they are to retain their sympatry, must develop mechanisms which enable them to surmount the detrimental effects of ecological competition. Lack (1949) and Gause (1934), for example, have expressed the idea that two species with identical requirements for existence cannot exist together in the same ecological niche. Experimental studies such as those conducted by Park (1948) on two species of flour beetles (*Tribolium*) support this idea.

When a species becomes divided by geographical barriers a certain amount of genetic change takes place in the then-isolated populations. What happens upon the subsequent contact of these populations depends upon the kind and amount of differentiation that has occurred. The two populations can continue to live side by side in the same habitat if the differentiation that has taken place is in the nature of a certain amount of preadaptation for ecological and reproductive isolation. The initial preadaptations, if sufficient, become reinforced in both forms by the selective pressures applied to each by the other. Since these phenomena have been discussed at length by Mayr (1942:147) and Lack (1949), they will not be pursued further here.

The following discussion is an attempt to describe and evaluate the ecological isolating mechanisms operating in two genera of forest-inhabiting thrushes, *Catharus* and *Hylocichla*. The reproductive isolating mechanisms developed by these species have been described elsewhere (Dilger, 1956*a*).

The species dealt with here are the Wood Thrush (*Hylocichla mustelina*) and four other species of forest thrushes which formerly were placed in the same genus. The four now are considered congeneric with the nightingale-thrushes (*Catharus*) of Middle America (Dilger, 1956*b*). They are the Veery (*C. fuscescens*) and the Hermit (*C. guttatus*), Olive-backed (*C. ustulatus*) and Gray-cheeked (*C. minimus*) thrushes. The distributional ranges of these five species are roughly allopatric, extending across the forested portion of North America. There are extensive areas of sympatry, and as many as four species may occupy certain areas in the northeastern United States and southeastern Canada (Fig. 1).

ACKNOWLEDGMENTS

It is a pleasure to acknowledge the aid of a number of people who contributed their efforts and materials in my behalf during the course of this investigation. Drs. Arthur A. Allen and Charles G. Sibley offered advice freely and provided a constant source of encouragement and enthusiasm.

Drs. W. Robert Eadie and LaMont C. Cole were most helpful regarding certain ecological aspects of the study. The latter also was of great aid in helping me with the statistical analysis of the data. Dr. Edgar M. Reilly, Jr., supplied the data from which the range maps were drawn. The hospitality of Dr. and Mrs. Stephen W. Eaton allowed me to pursue my studies, particularly of *C. ustulatus*, with greater ease and comfort than otherwise would have been possible. My wife, Martha, was of great assistance in helping with the statistical computations.

I am indebted to the following persons and institutions who kindly loaned materials and/or compiled certain data for me: Dr. Herbert Friedmann (United States National Museum), W. Earl Godfrey (National Museum of Canada), James C. Greenway, Jr. (Museum of Comparative Zoology, Harvard University), Drs. Alden H. Miller and Frank A. Pitelka (Museum of Vertebrate Zoology at the University of California), Dr. Austin L. Rand (Chicago Museum of Natural History), L. L. Snyder (Royal Ontario Museum), Dr. Harrison B. Tordoff (Museum of Natural History at the University of Kansas), Dr. Josselyn Van Tyne (Museum of Zoology, University of Michigan) and Drs. John T. Zimmer and Dean Amadon (American Museum of Natural History).

Much needed financial aid was provided by a New York State Science Service Grant for 1953 and by a Louis Agassiz Fuertes Research Grant awarded by the Wilson Ornithological Club.

Methods

The breeding seasons of 1952, 1953 and 1954 were devoted to field observation and to the accumulation of specimens. The field work was conducted in New York State, where all five of the forms breed. Two hundred and six skeletons representing *Hylocichla mustelina*, the four North American species of *Catharus* and the American Robin (*Turdus migratorius*) were examined and measured. Nearly one hundred other skeletons representing other species of *Catharus* and various additional turdine as well as saxicoline genera also were examined and measured. The collection of study skins at Cornell University was continually available.

Measurements of bones.—These were made with a dial caliper graduated in tenths of millimeters. The following are the measurements taken and the methods followed: The femur, tibiotarsus, tarsometatarsus, humerus, ulna, and manus (the entire hand from the proximal articular surface to the tip of the third digit) were measured across their greatest possible dimensions. This was accomplished by holding the bone perpendicularly between the faces of the caliper and sliding the caliper until it could go no further without damaging the bone. All the measurements listed above are believed to be reliable and free from instrumental error.

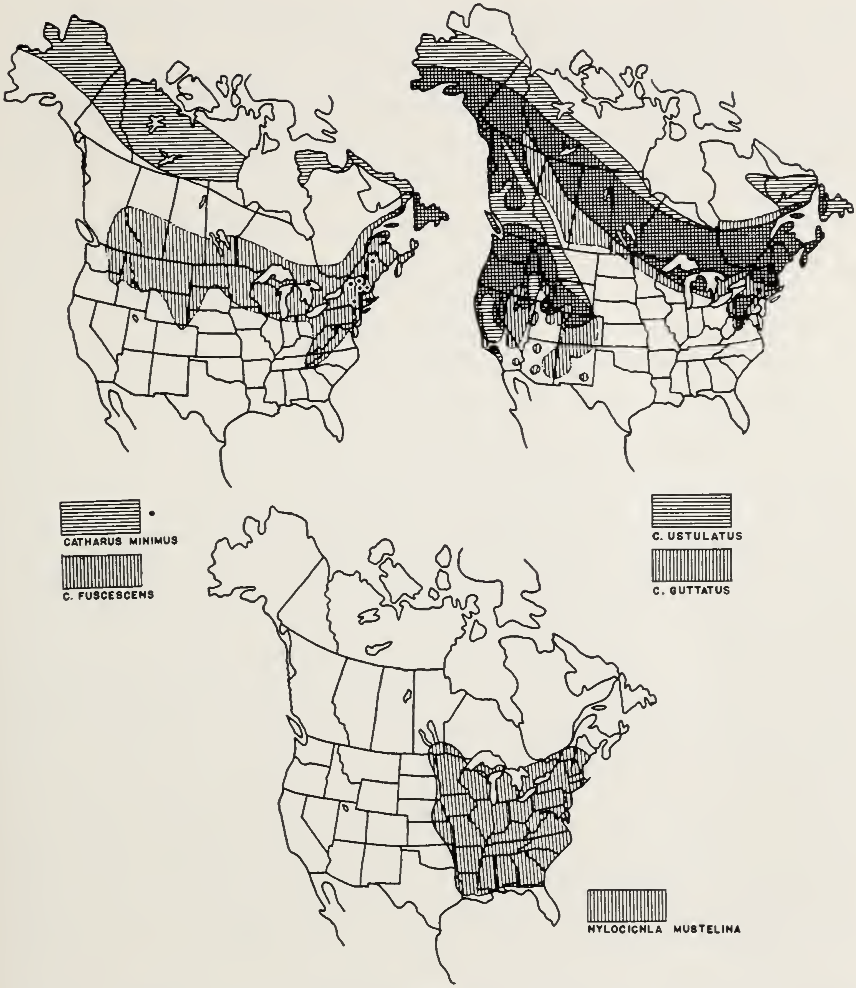


FIG. 1. Breeding ranges of *Catharus minimus, C. fuscescens, C. ustulatus, C. guttatus* and *Hylocichla mustelina.*

Several skull measurements were made as follows: the skull length was taken from the tip of the maxilla to the posteriormost portion of the cranium (just above the foramen magnum). The skull width was measured at the greatest width (between the auditory bullae). The skull width at lacrimals was taken as the greatest distance between the two lacrimals. The mandible was measured from its anterior tip to the posteriormost point of the condyle. The maxilla was measured from its anterior tip to the center of the crease of the naso-frontal hinge. The jaw width was measured between the posterior points of the quadratojugals. The statistical analyses of these measurements are presented in Tables 1 to 5.

Weights.—Weights were accumulated for all of the species and subspecies in question. In order to minimize the error from seasonal fluctuations of weights only those of breeding males were utilized. The weights used were recorded to the nearest tenth of a gram and these data are summarized in Fig. 5.

Since the species being examined differed in absolute size, sometimes markedly, it was necessary to equate these measurements so that they could be compared directly. Body weight was used as an index to size and was employed as a measurement with which to equate the various bone measurements. The method proposed by Amadon (1943) was utilized. Since weights and measurements from the same individuals were not always obtainable, only the arithmetic means were compared. The procedure was to compute the cube root of the mean weight for each species and this figure was then divided into the mean skeletal measurements for each species. The various measurements thus were expressed as a proportion of body size. For ease of comparison these figures were further adjusted as percentages of the largest for each measurement of the same structure in different forms, the largest being regarded as 100 per cent.

Measurements of study skins.—Lengths of the tail and tarsus, and of the bill from the nostril were taken in the manner specified by Baldwin, Oberholser and Worley (1931). Measurements of the wing were taken as the chord of the closed (flattened) wing.

General Biology

Breeding Cycle.—The males arrive on the breeding grounds prior to the females and establish and defend territories against members of their own species. The females, upon arrival, seek out males of their own species and pair formation takes place (Dilger, 1956*a*). Nest building and incubation are performed by the female, but both parents help feed the young. The nests are typically rather bulky but neatly-constructed of twigs, grasses, mosses, leaf mold and leaves. Considerable mud is utilized by *H. mustelina*, the nests of which are similar to those made by the American Robin. All lay from three to five blue eggs, which are spotted with brownish in *C. ustulatus* and *C. minimus*. The eggs of *C. fuscescens* and *C. guttatus* are rarely spotted and, as far as is known, the eggs of *H. mustelina* are never spotted. The nests may be placed on the ground, as is typical of *C. guttatus* and *C. fuscescens* in the eastern part of their ranges, or they may be placed in trees or shrubs. Incubation requires about two weeks and fledging another two weeks.

Molts and Plumages.—The spotted young attain their first winter plumage by a molt involving all but the flight feathers and a few pale-tipped scapulars or wing coverts. At this time the immature thrushes are indistinguishable from their parents except for the few remaining pale-tipped feathers. These are retained until the first post-nuptial molt. Once they are fully adult these birds are thought not to have any molt other than the annual post-nuptial, which is complete. There is a little evidence, however, that there may be at least a partial pre-nuptial molt. My captive thrushes had limited late-winter molts involving the crown, sides of the head and breast, back, rump and some of the wing coverts. This molt may have occurred because of the unnatural conditions imposed upon the birds by captivity. It is interesting to note, however, that these molts were symmetrical and always the same. It is also interesting that the breeding plumage in all these species is noticeably grayer than the warmer-toned winter plumage. The difference is thought to be due to feather wear. The new feathers acquired by these captives in the late winter or early spring were much grayer than the ones they had grown the previous autumn. Partial pre-nuptial molts have been described for several Old World species of thrushes (Witherby *et al.*, 1943). The question of whether or not *Hylocichla* and *Catharus* have at least a partial pre-nuptial molt is still unsolved. Dr. Kenneth C. Parkes kindly examined specimens in the Carnegie Museum taken on their wintering grounds and found no evidence of a pre-nuptial molt.

Feeding and Food.—All the thrushes considered are forest inhabitants, feeding largely on the forest floor. Food is obtained by flipping aside the débris of the forest floor with the bill, and progression on the ground is by means of long, springing hops. The feet are not used for scratching aside the débris as in some other birds utilizing similar environments. All these thrushes eat considerable amounts of vegetable matter, principally small fruits. The animal food consists mostly of small invertebrates, such as beetles, ants, and spiders. Small vertebrates, such as tiny frogs and salamanders, are sometimes utilized. Quite a bit of flycatching and foraging in foliage also are done, particularly by *C. fuscescens* and *C. ustulatus.*

More detailed information on the general biology of these forms is presented by Bent (1949).

Habitat Preferences

Dr. Herbert Caswell and I, using Cole's (1949) method for the analysis of interspecific association, have arrived at some figures indicating the degree of association of these thrushes with various habitats. The results for the species under consideration are summarized in Figure 2. The sources of data for these computations were habitat-specific breeding-bird censuses taken mainly from *Audubon Field Notes.* About 500 censuses were utilized in this investigation. A scale of from minus 1 to plus 1 was used to

	UC	DC	FA	DD	UD
H	-.50	-.69	-.48	+.16	+.41
CF	+.06	+.24	-.90	+.12	-.01
CG	+.29	+.28	-1.0	-.07	-.31
CU	+.47	+.12	-1.0	-.41	-.56
CM	? +.80	? +.50	-1.0	-1.0	-1.0

	CM	CU	CG	CF	H
CM	+1.0	? +.30	? -.70	-1.0	-1.0
CU		+1.0	+.75	+.23	-.35
CG			+1.0	+.56	-.41
CF				+1.0	-.08
H					+1.0

FIG. 2. (Left) Coefficients of association of *Hylocichla mustelina* and the North American species of *Catharus* with habitats in eastern North America. H = *Hylocichla mustelina*, CF = *Catharus f. fuscescens*, CG = *C. guttatus faxoni*, CU = *C. ustulatus swainsoni*, and CM = *C. minimus bicknelli*. UC = undisturbed coniferous, DC = disturbed coniferous, FA = farmland, DD = disturbed deciduous, and UD = undisturbed deciduous. Plus 1 = complete association, zero = association expected by chance alone, and minus 1, complete negative association. See text for further explanation.

FIG. 3. (Right) Coefficients of association among *Hylocichla mustelina* and the four North American species of *Catharus*. These figures are based on the total range of each species in eastern North America. Key to species and the scale of values used are the same as in Fig. 2. See text for further explanation.

express these various associations. Minus 1 indicates that the form and habitat under consideration are found together the minimum number of times possible for the data available. Zero indicates the amount of association one would expect by chance alone. Plus 1 indicates the highest association possible. A detailed report of this work on these forms and others of North America will be published separately by Caswell.

Hylocichla mustelina.—An abundance of sapling growth is apparently associated with optimum conditions for this species. Wood Thrushes tend to avoid the drier habitats and are most abundant in edge situations associated with hardwood forests. Weaver (*in* Bent, 1949) mentions that this species is showing a growing tendency to occupy suburban areas, a trend that had its beginnings about 1890. The suburban areas occupied are mostly edges of hardwood forests and it is not surprising that this species is taking advantage of this type of man-made habitat, much as the American Robin did earlier. In addition to its beginning to expand into suburban habitats, the Wood Thrush is steadily pushing its range northward, but it is still weakly associated with coniferous situations (—.50 for undisturbed coniferous forests and —.69 for disturbed coniferous habitats). The Wood Thrush is most strongly associated with undisturbed deciduous woodland

(+.41). It must be kept in mind that, for the most part, edge situations in these habitats are utilized.

Catharus f. fuscescens.—This subspecies of the Veery reaches its greatest concentrations in rather damp areas, either deciduous or coniferous. Moist bottomland woods with a lush understory of ferns and other plants seem to provide optimum conditions. The densest concentration of the Veery of which I am aware is one reported by Harding (1925). She found a three-acre area containing 12 pairs at Lake Asquam, New Hampshire. This area was a forested hillside fronting on the lake and covered with a dense understory of laurel (*Kalmia latifolia*). She does not mention the presence of any other thrushes. Our analysis showed that the greatest associations of the Veery were with disturbed deciduous (+.12) and disturbed coniferous (+.24) forests. The undisturbed habitats probably do not usually contain a dense enough understory for this species.

Catharus guttatus faxoni.—This subspecies of the Hermit Thrush is associated with edge type situations within forested areas. It is most often found along the margins of old burns, fire lanes, power line cuts, margins of lakes, and bogs, rather than the "exterior" edge situations inhabited by *H. mustelina*. The greatest concentrations of this species are associated with a rather dense, young, mixed coniferous-deciduous growth in the above areas. This thrush is much more tolerant of rather dry habitats than are its close relatives, although it is also frequently found in rather damp habitats. The Hermit Thrush is more closely associated with coniferous woodlands and mixed conifers and hardwoods than with pure deciduous woodland. It is most abundant in the proper habitats within coniferous woods, both disturbed (+.28) and undisturbed (+.29).

Catharus ustulatus swainsoni.—This form of the Olive-backed Thrush is most closely associated with undisturbed coniferous forests (+.47), although mixed forests appear acceptable, especially in the southern parts of its range. In mountainous areas in New York State it occurs from the mixed hardwoods (beech, maple, hemlock) upward into the mature forests of red spruce and balsam-fir. The presence of some conifers seems to be a necessity, for nest sites usually are located in them.

Catharus minimus bicknelli.—This is the most habitat-specific of the forms studied. In New York State it is confined, as a breeding bird, to the cloud-drenched, stunted fir and spruce tangles of mountain tops. It occurs at lower altitudes farther north but the habitat is similar. The substrate, where almost all of the foraging is done, is composed of a deep tangle of limbs and trunks in all stages of decomposition, and the whole is clothed with a sodden blanket of *Sphagnum*, other mosses and small herbaceous plants. The dense coniferous tangles provide deep shade on the ground even on the brightest days. Unfortunately the number of censuses containing the Gray-cheeked Thrush do not permit a reliable statistical analysis of its habitat associations. However, in view of the statements presented above, its association with coniferous forests of this particular type must be in the neighborhood of +1.

Ecological Isolating Mechanisms

It is apparent that the greatest competition should exist among individuals of the same species. This seems logical because members of the same species are most similar in their requirements. Various mechanisms that tend to reduce the adverse effects of intraspecific competition have evolved. Behavior patterns associated with territoriality (breeding territory, individual distance and other hostile behavioral patterns) have evolved which permit an equable intraspecific distribution throughout a favorable environment. Differential adaptations of body size and/or size of the bill between the sexes may evolve, and these differences may serve to reduce the amount of intraspecific competition (Rand, 1952). Such differences may also become secondarily involved in sexual recognition. All of these adaptations permit maximum use of the suitable environment by the species population and insure maximum abundance and reproduction of individuals.

There is an ever-present tendency for animals to occupy more of the immediately-available environment, and the range inhabited by a form at any given time is the resultant between the forces tending to permit the form to spread and the forces opposing its spread. The genetic variability of any species tends to permit preadaptations to occur in varying degrees and frequencies. These preadaptations may serve in multitudinous ways, such as permitting higher reproductive rate, the utilization of different foods, or greater tolerance for the various aspects of the physical environment. The primary opposing factor is low genetic variability.

Likewise, the genetic variability of a species at any given time is mostly the resultant between environmental selective forces making for more precise adaptiveness to a particular niche (consequently reducing the variability) and the selective forces permitting expansion into adjacent niches (which tend to favor variability). Consequently, some species have narrower variability ("adaptive peaks") than do others. Among the forms presently under discussion, the Gray-cheeked Thrush provides the best example of a narrow adaptive peak, which is a reflection of its highly specialized existence. The relatively small range of variability in the skull characters studied may be a manifestation of this (see Table 2). On the other hand, the Hermit Thrush is the best example, among those under discussion, showing a rather wide range of variability in the skull characters studied. This may be a reflection of its rather wide tolerances for habitats and food.

If the greatest competition is among individuals of the same species it follows that usually the next most serious competition would have come *originally* from individuals of a closely-related, sympatric form. These would have the next most similar genotypes and hence will have the next least differences in their requirements. Mechanisms must be evolved in these cases to minimize the effects of what must otherwise be rather severe competition, especially for food. The very existence of adaptive differences among closely-related, sympatric forms suggests that such forms usually do compete severely enough to initiate selective pressures bringing about adaptive differences. The selective pressures must be supplied by each of the different species to all of the others in competition with it. It would seem that these selective pressures must also be proportional to the amount of competition; the greater the competition, the greater the selective pressures. The selective pressures should gradually dwindle as the adaptive modifications become progressively more effective. Forms more distantly related may also tend to compete if a convergence in requirements is taking place. Here, again, isolating mechanisms must develop if the two forms are to continue to exist sympatrically.

Food is apparently one of the most important single factors involved in competitive situations. This has been borne out in ecological studies (such as that of Lack, 1949). Many of the adaptive differences arising between competing forms seem to have a direct bearing on allowing the differential taking of foods, either different kinds of foods in the same environment or similar foods in different environments. Many closely-related, sympatric forms have diverged markedly in size, enabling them to minimize the competition for food by permitting the taking of different foods because of this size difference. One of the most familiar examples of this phenomenon is provided by the relatively large Hairy Woodpecker (*Dendrocopos villosus*) and the smaller Downy Woodpecker (*D. pubescens*). These two species are very similar in appearance and habits but differ chiefly in body size and in the relative size of their bills. Another example is found in the hawks of the genus *Accipiter*, the larger Cooper Hawk (*A. cooperi*) and the smaller Sharp-shinned Hawk (*A. striatus*). These two species also differ mainly in size and, in addition, there is a strong sexual disparity in size which no doubt helps to reduce the intraspecific competition (Storer, 1952:284).

Another mechanism allowing the differential taking of foods is a divergence in the size and/or the proportions of the bill. A classic example of this may be seen in the Galapagos finches of the genus *Geospiza* (Lack, 1947). This mechanism, too, may work to reduce intraspecific competition. Many species of birds have a marked sexual difference in the size and/or proportions of the bill. Probably the most extreme case is that of the extinct Huia (*Heterolocha acutirostris*) of New Zealand, discussed by Lack (1947:155). The bill of the male was rather stout and short while that of the female was very long, slender and decurved. The males foraged by tearing open rotten logs for the invertebrate life within and the females followed them, able to utilize the food found in the deeper burrows and crevices by virtue of their remarkable bills. Of course, these are but a couple of the mechanisms utilized by birds to avoid ecological competition, but others exist and they undoubtedly exist in various combinations and degrees of divergence.

There is evidence to show that the divergence, presumably partly in response to competition, may be most marked in areas of sympatric occurrence and less evident in areas of solitary occurrence. Two species of rock nuthatches studied by Vaurie (1951) furnish an example. The two species, *Sitta neumayer* and *S. tephronota*, have rather wide distributions in western Asia and with a considerable area of sympatry. *Sitta tephronota* has a slightly larger bill than has *S. neumayer*, but in the area of sympatry this size difference is greatly enhanced. These two species appear to be very similar and this difference in bill size has been evolved, presumably resulting in minimizing the adverse effects of competition for food in the overlap area.

The forms considered in the present study, except for *H. mustelina*, are all closely related and demonstrate a high degree of sympatry. Since their sizes, foraging behavior and general biology are so similar it seems likely that there must have been a relatively great amount of interspecific competition for food during the period of initial contact of these forms. The ecological isolating mechanisms which must have developed in this situation are not immediately apparent.

It would seem likely that the amount of divergence that has taken place must be in proportion to the amount of competition among the various forms in the same environment. Dr. Herbert Caswell and I have measured the amounts of interspecific association in a number of North American bird species, including the present forms, by use of the method of measurement of interspecific association proposed by Cole (1949). The resulting coefficients of association are shown in Figure 3. The figures are based on the same scale as the species-habitat coefficients discussed earlier. These coefficients are based on the total breeding ranges of the species as they occur in eastern North America. If the coefficients were based on the overlap areas only, the figures would be much higher. About 500 censuses were utilized for this work. The above coefficients of association coincide very nicely with the amounts of divergence found to be associated with ecological isolating mechanisms.

An attempt was made to compute the coefficients of association for the overlap areas but this was not feasible because of a lack of sufficient data from many areas. Coefficients of association were computed, however, for broad, roughly latitudinal bands which somewhat approximate the distributions of these thrushes (Fig. 4). These values give some interesting results but break down, especially in the southern parts of their ranges, because of the irregular distributions effected by the eastern mountains and by the paucity of breeding bird censuses in some critical areas. With these limitations in mind it may be seen that these latitudinal coefficients of association are about what one would expect from an examination of the breeding ranges and the total range coefficients.

The initial attempts to gain some knowledge of the ecological isolating mechanisms that must be in operation consisted of watching foraging individuals of all five species on their breeding grounds. Aside from the quite evident propensity of some forms for feeding largely at or near the edge and of others for feeding largely in the interior of the woodland, different strata appeared to be used in foraging. All the species fed commonly on the forest floor but those that did so most frequently were the Wood, Hermit, and Grey-cheeked thrushes. The Veery and, especially, the Olive-backed Thrush fed more often in the foliage and engaged in frequent flycatching. It is interesting to note that the three predominant ground feeders alternate with the two arboreal foragers in a north-south sequence, and that the edge foragers alternate with the interior foragers, except for *C. minimus* which is an interior forager.

Others have noticed these apparent differences in foraging levels. Francis H. Allen (*in* Bent, 1949:223) watched a Wood Thrush and a Veery foraging in the same vicinity and noted that "while the wood thrush hopped along in the manner of a robin, more or less, the veery was continually flitting from a perch in a bush or tree (2 to 4 feet from the ground) down to the ground, where he picked up an insect or something of the kind, and then again to another perch." This seems to be very typical *fuscescens* behavior. In addition, they are more frequently seen "flycatching" while foraging in this manner than are the others with the exception of the Olive-backed Thrush, the most inveterate flycatcher of them all. Bent (1949:176) says of that species: "They come with the warblers and other late migrants, and, like the warblers, they are often seen in the tree tops, feeding on insects in the opening foliage." This tree-top foraging behavior, as mentioned above, is by no means confined to migration but is the usual feeding behavior on the breeding grounds as well. The colloquial names of "Flycatching Thrush" and "Mosquito Thrush" reflect a general observance of this frequently-used feeding method.

Summarizing these observations, it would seem that *H. mustelina* and *C.*

	CU	CG	CF	H
CU	+1.0	+.86	+.25	
CG		+1.0	+.20	
CF			+1.0	
H				

A

	CU	CG	CF	H
CU	+1.0	+.33	−.66	+.08
CG		+1.0	+.47	+.37
CF			+1.0	+.54
H				+1.0

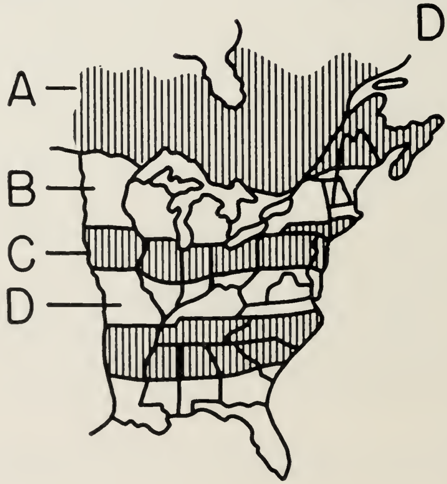
B

	CU	CG	CF	H
CU				
CG		+1.0	+.73	+.57
CF			+1.0	+.47
H				+1.0

C

	CU	CG	CF	H
CU	+1.0	+.89	+.88	−.08
CG		+1.0	+.67	−.30
CF			+1.0	+.05
H				+1.0

D



guttatus faxoni are mainly ground feeders at edge type situations, that *C. f. fuscescens* and *C. ustulatus swainsoni* are primarily arboreal foragers of interior situations and that *C. minimus bicknelli* is a ground forager in the interior of the forest.

Adaptations for Foraging

Some method of analysis was sought that would demonstrate any adaptive differences and supply a test for the validity of these subjective field observations. Two methods of approach were considered. It was reasoned that if this seeming difference between ground feeding and arboreal feeding were a real one, then there should be detectable adaptive differences in the bills and in the limbs consistent with the different habits. It was also reasoned that a detailed analysis of the contents of a number of stomachs of the various species should show something about the place of capture of the insects they contained.

Stomach Contents.—Hundreds of stomachs of these species have been investigated but, unfortunately, none ever was analysed carefully enough to gain much insight as to the ecology of the food organisms it contained. A notation of "beetles, 12 per cent" does not give one any idea whether the beetles in question were arboreal or terrestrial forms. Beal reported (Bent, 1949:152, 181) on the analysis of 551 stomachs of *C. guttatus faxoni* and 403 stomachs of *C. ustulatus swainsoni*; these represent birds taken in every month of the year. His data suggest that their foraging sites differ. Diptera, for example, were represented as 3.02 per cent of the diet of *C. guttatus faxoni* and 6.23 per cent of the diet of *C. ustulatus swainsoni*; Orthoptera comprised 6.32 per cent of the diet of *C. guttatus faxoni* but only 2.42 per cent of the diet of *C. ustulatus swainsoni*. Likewise, the percentage representation of spiders and millipedes for the Hermit Thrush was 7.47, while for the Olive-backed Thrush it was but 2.22. These figures are certainly suggestive of where the birds did much of their foraging but a careful detailed analysis of a large number of stomachs from all five species would still be desirable in order to gain a more accurate impression of their respective food habits.

Hind Limb Adaptations.—A number of skeletons of all five species concerned in this study were examined and measured along with those of the Russet Nightingale-thrush (*C. o. occidentalis*) and the American Robin. Special attention was paid to features that were likely to demonstrate adaptive

Fig. 4. (opposite) Coefficients of association among *Catharus ustulatus*, *C. guttatus*, *C. fuscescens*, and *Hylocichla mustelina* based on mutual occurrence within each of four latitudinal belts (A, B, C, and D). Open square in upper left of each box indicates that figure is not statistically significant, while solid square indicates significance. Key as in Figure 2. See text for further discussion.

modifications in respect to food getting, principally the bills and hind limbs. It was hoped that analysis might reveal some adaptive modifications consistent with what had been learned about the differential feeding habits of these forms. It is well known that limb lengths and the proportions of the component segments vary with the use to which they are adapted. Cursorial birds, for example have relatively longer legs than do arboreal ones. Not only do the relative lengths vary but cursorial forms tend to have relatively shorter femurs and relatively longer tarsometatarsi than do the arboreal forms. This is easy to demonstrate by the examination of two extreme forms: a ground-foraging thrush, such as *C. minimus*, and an aerial bird such as the Chimney Swift (*Chaetura pelagica*). Of course, extreme differences such as these were not expected upon examining the limb lengths and proportions of the forest thrushes but it was hoped that some detectable trend toward

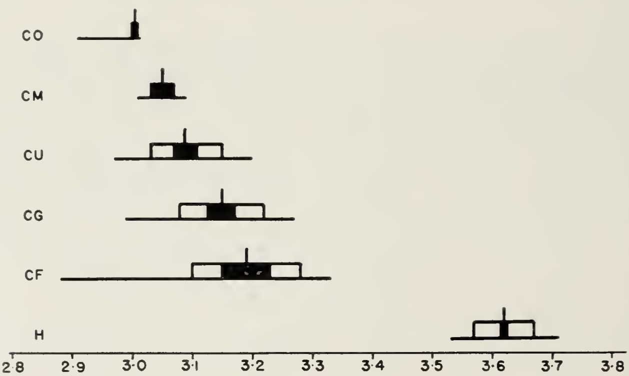


FIG. 5. Statistical analysis of the cube roots of weights in grams of breeding males of *Catharus* and *Hylocichla* species. CO = *Catharus o. occidentalis*; other symbols as in Figure 2. The horizontal line indicates the range, the vertical line, the mean, the black rectangle, two standard errors on either side of the mean, and the open rectangle, one standard deviation on either side of the mean.

arboreal proportions might be revealed in *C. fuscescens* and *C. ustulatus*. Indeed this is shown by the relatively-shorter tarsometatarsus in those two species (see Tables 1 and 2 and Figures 6 and 7).

The method used to equate the measurements of various appendages to body weight was discussed earlier. The weights of the several species of thrushes are compared graphically in Figure 5, and the various equated measurements appear in Tables 1 to 5.

In most cases the differences between the mean measurements of critical structures were readily evident without utilization of the equating procedure. However, it is felt that the equated measurements give a more

Table 1

Measurements of the Hind Limb Elements in Adult Male Thrushes of the Genera *Hylocichla*, *Catharus* and *Turdus*

	Size of sample	Observed range	Mean with standard error	Standard deviation	Coefficient of variation	Equated value[1]	Per cent of largest
			Femur				
H. mustelina	21	22.60–24.60	23.50±.11	.51	2.17	6.4913	94.53
C. fuscescens	20	19.90–22.10	21.27±.13	.59	2.77	6.6750	97.20
C. guttatus	14	19.00–21.80	20.36±.19	.74	3.14	6.4565	94.02
C. ustulatus	21	19.50–21.40	20.28±.11	.51	2.51	6.5550	95.45
C. minimus	4	20.50–21.00	20.65±.12	.24	1.16	6.7691	98.57
C. occidentalis	4	20.20–20.90	20.48±.15	.31	1.51	6.8676	100.00
T. migratorius	12	26.50–28.20	27.34±.17	.59	2.16	6.3927	93.09
			Tibiotarsus				
H. mustelina	20	40.00–44.20	42.10±.25	1.09	2.59	11.6291	86.31
C. fuscescens	20	37.80–40.50	39.39±.29	1.00	2.54	12.3615	91.75
C. guttatus	12	37.70–40.60	39.04±.27	.94	2.40	12.3802	91.88
C. ustulatus	11	36.00–38.40	36.97±.20	.66	1.79	11.9497	88.69
C. minimus	4	38.60–38.90	38.78±.06	.12	.31	12.7122	94.35
C. occidentalis	5	39.20–41.20	40.18±.40	.87	2.11	13.4737	100.00
T. migratorius	12	45.50–49.10	46.98±.28	.98	2.09	10.9848	81.53
			Tarsometatarsus				
H. mustelina	22	29.70–34.10	31.10±.23	1.00	3.21	8.5906	78.22
C. fuscescens	18	27.50–31.50	30.04±.21	.88	2.93	9.4273	85.84
C. guttatus	12	28.80–32.00	30.08±.21	.75	2.16	9.5389	86.85
C. ustulatus	13	26.00–29.60	27.58±.21	.76	2.76	8.9146	81.17
C. minimus	5	28.80–30.90	30.04±.37	.83	2.76	9.8472	89.66
C. occidentalis	6	30.70–34.80	32.75±.67	1.67	4.89	10.9821	100.00
T. migratorius	12	32.00–34.80	33.05±.30	1.03	3.12	7.7277	70.36

[1]Actual measurement divided by cube root of body weight (see text).

accurate picture of the adaptive differences than do the unadjusted data.

All of the forms considered here are primarily adapted for ground foraging and the proportions and lengths of their legs are consistent with this mode of feeding. An apparent discrepancy is found in *H. mustelina*, which is terrestrial in habit although it has a relatively short tarsometatarsus (Fig. 7). The American Robin and other species of *Turdus* are mainly cursorial and also have relatively short tarsometatarsi as compared to *Catharus*. The limb proportions of *Turdus* and *Hylocichla* are clearly of the cursorial type but appear as if they both had been adapted from a common ancestor with a shorter tarsometatarsus than had the form from which *Catharus* was derived. In other words, a bigger step was involved in the selection for a more arboreally-adapted limb in *Catharus* than it would have been in the equally ground-adapted *Turdus* and *Hylocichla*.

TABLE 2

MEASUREMENTS OF THE SKULLS OF ADULT MALE THRUSHES OF THE GENERA *Hylocichla, Catharus* AND *Turdus*

	Size of sample	Observed range	Mean with standard error	Standard deviation	Coefficient of variation	Equated value[1]	Per cent of largest
			SKULL LENGTH				
H. mustelina	23	40.70–44.20	42.30±.23	1.45	3.43	11.6844	93.62
C. fuscescens	15	35.60–38.60	37.21±.26	.99	2.66	11.6773	93.56
C. guttatus	13	35.30–40.30	38.04±.35	1.34	3.52	12.0631	96.65
C. ustulatus	14	35.00–37.70	36.66±.19	.70	1.91	11.8495	94.94
C. minimus	6	36.10–37.80	36.80±.25	.61	1.66	12.0632	96.65
C. occidentalis	5	36.60–38.70	37.22±.41	.91	2.44	12.4811	100.00
T. migratorius	12	45.00–49.10	46.93±.33	1.15	2.45	10.9731	87.92
			SKULL WIDTH AT LACRYMALS				
H. mustelina	23	10.50–11.60	10.90±.07	.35	3.21	3.0108	97.23
C. fuscescens	17	9.00–10.50	9.76±.12	.51	5.23	3.0629	98.91
C. guttatus	14	8.90–10.00	9.56±.07	.25	2.61	3.0316	97.90
C. ustulatus	13	9.00–10.10	9.58±.09	.35	3.65	3.0965	100.00
C. minimus	6	8.80– 9.30	9.05±.08	.21	2.32	2.9660	95.80
C. occidentalis	5	8.50– 9.50	9.02±.18	.40	4.43	3.0247	97.68
T. migratorius	11	11.60–13.20	12.44±.16	.54	4.34	2.9087	93.93
			JAW WIDTH				
H. mustelina	23	13.40–16.60	15.10±.13	.61	4.04	4.1711	93.67
C. fuscescens	17	13.60–14.80	14.19±.08	.35	2.47	4.4531	100.00
C. guttatus	13	12.60–14.10	13.40±.10	.39	2.91	4.2493	95.42
C. ustulatus	12	12.60–14.60	13.67±.15	.53	3.88	4.4185	99.22
C. minimus	6	12.50–13.80	13.00±.21	.52	4.00	4.2615	95.70
C. occidentalis	5	12.60–13.60	13.06±.19	.42	3.22	4.3794	98.34
T. migratorius	12	15.50–18.40	17.26±.21	.72	4.17	4.0357	90.63

[1]Actual measurement divided by cube root of body weight (see text).

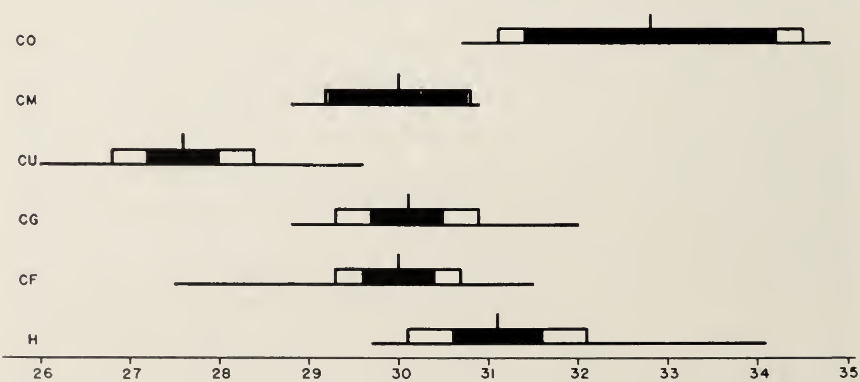


FIG. 6. Statistical analysis of the length (in millimeters) of the tarsometatarsus in adult male *Catharus* species and *Hylocichla mustelina*. Key as in Figure 5.

There are two other factors that have a bearing on length of limb in addition to the degree of ground- or arboreal-adaptiveness. Everything else being equal, a larger bird will tend to have a relatively shorter tarsometatarsus than will a smaller one. This is merely a reflection of the greater weight of the larger bird and the need for proportionately greater support. Gustav Kramer (pers. comm.) has found that condition among the corvids: the Raven (*Corvus corax*) has relatively shorter legs than has the smaller Fish Crow (*C. ossifragus*). The depth of the debris on the substrate upon which a bird forages also has a bearing on leg length. The greater the depth of the "clutter" in proportion to the size of the ground-foraging bird, the longer its legs must be if the bird is to move about efficiently. Whether or not the ground has a certain depth and density of debris also has a bearing upon whether a particular species walks or hops. Those species that forage on substrates that are deep and densely-tangled in proportion to their sizes must progress by hopping (*Catharus*, *Pipilo*, *Dumetella*, *Hylocichla*, *Melospiza*). Ground-foraging birds of relatively uncluttered substrates (for their sizes) walk (*Sturnus*, *Molothrus*, *Quiscalus*, *Anthus*, *Alauda*). The relatively-shorter tarsometatarsus of *Hylocichla mustelina* is probably due to the fact that it is larger than the *Catharus* species to which it is supposedly closely related and because it forages over substrates which are actually and relatively less-cluttered than those used by the *Catharus* species. Also, the Wood Thrush is probably most closely related to the genus *Turdus*, which is characterized by a short tarsometatarsus. The hopping motions of *Hylocichla* are much like those of *Turdus migratorius*, while those of the *Catharus* species are rather long and springing; this suggests that a relatively-longer tarsometatarsus may be associated with a greater mechanical advantage for long, high hops.

Among the forest thrushes considered, the non-migratory and ground-

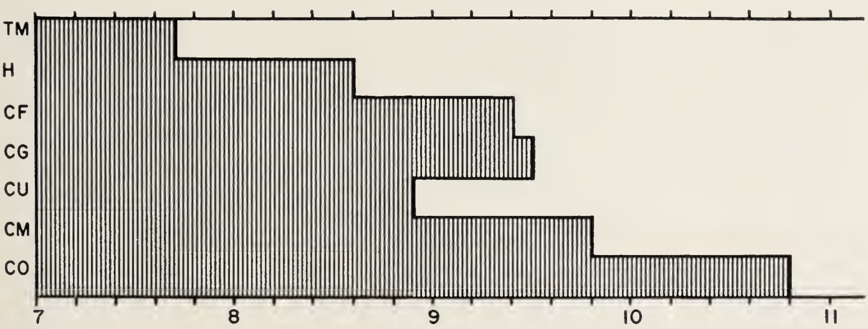


FIG. 7. Mean length of tarsometatarsus equated to mean cube root of the body weight in several species of thrushes. TM = *Turdus migratorius*; other symbols as in Figure 5.

dwelling Russet Nightingale-thrush (*C. occidentalis*) has the longest leg and also the longest segments of the leg. The next in order of modification for foraging on the ground is the Gray-cheeked Thrush, *C. minimus bicknelli*, and *C. guttatus faxoni* follows (see equated tarsometatarsus, Table 1). Observations in the field certainly bear this out. I have never seen *minimus* feeding anywhere but on the ground and it probably has to contend with a more-cluttered substrate, for its size, than does any of the others (see above under Habitat Preferences). The Hermit Thrush does some flycatching as well as foraging in trees and shrubs for small fruits, especially in the fall and winter. The remaining two species are the arboreal foragers and *fuscescens* is obviously not as highly adapted as *ustulatus* in this respect.

Apparently when a limb is becoming adapted for an arboreal mode of life the distal segment is the first to become shorter and the femur begins to adapt much later, or at least not as rapidly. The tarsometatarsus of the largely arboreal Olive-backed Thrush (*ustulatus*) has become more adapted for this mode of life than has the femur. The segment in most immediate contact with the environment is apparently the first one to experience modification due to selective pressures. It is apparent that the femur is becoming relatively longer both in *ustulatus* and *fuscescens*, but for some reason that of *fuscescens* is longer than that of *ustulatus*. I would have expected just the opposite condition. It may be that the limb proportions of *fuscescens* have had a different history than those of *ustulatus*. There is no reason to suppose that selection cannot proceed toward a more terrestrial-type limb, change to selection for an arboreal-type limb and reverse itself again, in various combinations of strengths and durations, depending on the vicissitudes of these selective pressures.

Perhaps the short tarsometatarsus of *H. mustelina* can be explained in a similar way, but it does not seem likely in view of the thoroughly-terrestrial habits of the Wood Thrush and the fact that *Turdus* and its close relatives are ground feeders for the most part and still have proportionately-shorter tarsometatarsi than do the species of *Catharus*. The femur is also relatively short in these latter forms. If there is a lag in femoral adaptation over tarsometatarsal adaptation, one would expect an arboreal form (with short tarsometatarsus and long femur), which is under selection favoring ground foraging, to develop a longer tarsometatarsus before the femur begins to shorten. This is not the case with the short-femured *mustelina*, which apparently was derived from terrestrial ancestors.

The long femur of *C. minimus bicknelli* can probably best be explained by taking into account the lengthening of the whole leg in response to the deeply cluttered substrate over which this small form feeds. The long femur of *C. occidentalis* can be explained in the same way.

TABLE 3

MEASUREMENTS OF MANDIBLE, MAXILLA AND BILL IN ADULT MALE THRUSHES OF THE GENERA *Hylocichla*, *Catharus* AND *Turdus*

	Size of sample	Observed range	Mean with standard error	Standard deviation	Coefficient of variation	Equated value[1]	Per cent of largest
			MANDIBLE				
H. mustelina	22	32.00–35.60	33.20±.30	1.41	4.25	9.1707	96.19
C. fuscescens	15	26.90–30.50	28.85±.25	.98	3.40	9.0538	94.97
C. guttatus	14	26.00–32.40	29.12±.43	1.66	5.70	9.2344	96.86
C. ustulatus	12	26.50–28.70	28.07±.17	.58	2.07	9.0729	95.17
C. minimus	6	27.70–29.60	28.65±.28	.69	2.41	9.3915	98.51
C. occidentalis	4	27.50–29.80	28.43±.50	1.00	3.52	9.5336	100.00
T. migratorius	12	35.20–39.50	36.84±.41	1.43	3.88	8.6139	90.35
			MAXILLA				
H. mustelina	23	16.70–20.00	18.40±.18	.88	4.78	5.0825	95.32
C. fuscescens	15	15.10–17.00	16.09±.14	.56	3.48	5.0494	94.70
C. guttatus	12	15.10–18.00	16.49±.28	1.00	6.13	5.2292	98.07
C. ustulatus	13	14.20–16.30	15.27±.15	.56	3.67	4.9356	92.57
C. minimus	6	15.50–16.50	15.83±.15	.38	2.40	5.1891	97.32
C. occidentalis	5	15.20–16.80	15.90±.29	.66	4.15	5.3318	100.00
T. migratorius	12	20.00–22.90	21.05±.29	1.00	4.75	4.9219	92.31
			BILL FROM NOSTRIL				
H. mustelina	16	10.50–11.70	11.23±.10	.41	3.65	3.1020	98.93
C. fuscescens	17	8.70–10.40	9.58±.13	.53	5.53	3.0064	95.88
C. guttatus	16	9.50–10.80	9.84±.09	.38	3.86	3.1204	99.52
C. ustulatus	19	8.00– 9.50	8.67±.09	.39	4.49	2.8024	89.38
C. minimus	9	8.60– 9.40	9.10±.10	.30	3.30	2.9830	95.14
C. occidentalis	4	9.10–10.00	9.35±.21	.44	4.70	3.1354	100.00
T. migratorius	11	11.20–14.40	13.00±.26	.86	6.62	3.0396	96.94

[1]Actual measurement divided by cube root of body weight (see text).

Jaw Adaptations.—The bill tends to be longer and more slender in ground-foraging forms and shorter and wider in forms that forage in trees. A long, slender bill is a much better tool for flipping aside the debris of the forest floor and for probing into the crevices and cracks of this feeding niche than a shorter, stouter bill would be. Conversely, a relatively shorter and, especially, a wider bill would be of greater use in flycatching and for foraging in the foliage. A cursory comparison of the bills of a number of species that forage in the foliage and also indulge in flycatching will demonstrate this very nicely. Compare, for instance, the bills of the ground-foraging *Catharus* species and of *Turdus migratorius* with the bills of such arboreal feeders or flycatchers as the Red-eyed Vireo (*Vireo olivaceus*), Scarlet Tanager (*Piranga olivacea*) or the Eastern Wood Pewee (*Contopus virens*).

Various skull measurements were made for the species of *Catharus* and for *Hylocichla mustelina* and *Turdus migratorius* in order to detect any

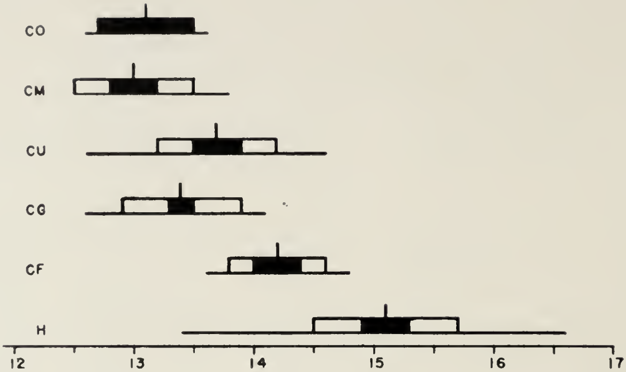


FIG. 8. Statistical analysis of the jaw width in adult males of *Catharus* species and *Hylocichla mustelina*. Symbols as in Figure 5.

drift toward shorter and wider bills in the more arboreal forms, *C. fuscescens* and *C. ustulatus*. The results of this investigation are summarized in Tables 1 through 5 and further in Figures 8 and 9. These measurements also were equated to the mean weights used as an index of body size. The necessity for equating the jaw measurements is not as clear as it was for the leg measurements. Bill proportions are not as intimately concerned with body size as are the proportions of the limbs. In any case, both the equated and unequated data (Table 2) show essentially the same pattern. The bills of *fuscescens* and *ustulatus* are both wider and shorter than are the bills of the more purely ground-foraging forms. Again, these differences in proportions are not extreme but they are significant statistically and they are consistent with what we know of the thrushes' feeding habits. The differences are demonstrated most clearly by comparisons of the maxilla length to the skull width at the lacrimals or the mandible length with the jaw width (Fig. 10).

It is of some interest that *C. ustulatus*, which is more arboreal than *fuscescens*, has a slightly narrower mouth than has *fuscescens*. Again, this is not what one would expect, but again we do not know the past history of adaptation in these forms. It may be that *fuscescens*, instead of progressing toward the arboreal feeding habit, is actually in the later stages of becoming secondarily adapted for ground feeding. The fact that it has a slightly longer femur, actually and relatively, than has *ustulatus* (see above) lends some credence to this idea.

Wing Adaptations.—The lengths and proportions of the segments of the wings follow the same pattern as was found in the hind limbs. Those forms utilizing their wings to the greatest extent have the longest distal segments (hands) and the shortest proximal segments (humeri). The converse is true

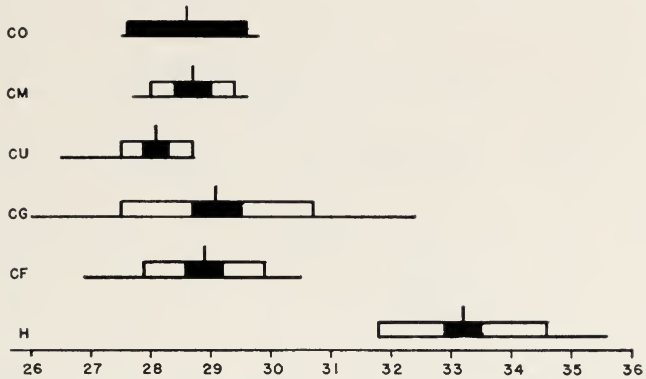


FIG. 9. Statistical analysis of mandible length in adult males of *Hylocichla mustelina* and *Catharus* species. Key as in Figure 5.

for the forms which use their wings the least. This is again easy to demonstrate by examining the wings of extreme examples, such as the wing of the Chimney Swift and the wing of a flightless bird such as the Kiwi (*Apteryx*). No such extreme differences as these are to be found among the thrushes studied, of course, but again there is modification in the direction consistent with their specific habits. It is not surprising that *Catharus occidentalis*, a non-migratory ground-forager, should have a wing least-adapted for sustained flight. The ground-dwelling, moderately-migratory Hermit Thrush also has a wing relatively poorly adapted for flying. The longest manus and the longest wing (measured from the wrist to the tip of longest primary) is found in *Catharus ustulatus*, a form which flies a great

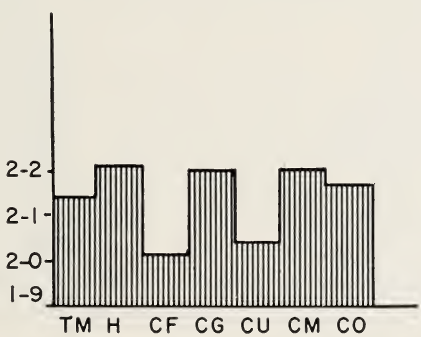


FIG. 10. Ratios of equated means of jaw width and mandible length (equated mandible length divided by equated jaw width) in several species of thrushes. The higher the ratio, the relatively longer and narrower the jaw. Key as in Figure 7. See text for further explanation.

TABLE 4

MEASUREMENTS OF THE WING ELEMENTS IN ADULT MALE THRUSHES OF THE GENERA *Hylocichla*, *Catharus* AND *Turdus*

	Size of sample	Observed range	Mean with standard error	Standard deviation	Coefficient of variation	Equated value[1]	Per cent of largest
			HUMERUS				
H. mustelina	23	22.50–26.60	24.07±.16	.78	3.24	6.6489	98.50
C. fuscescens	18	20.70–22.20	21.24±.11	.46	2.17	6.6656	98.74
C. guttatus	16	19.40–21.80	20.59±.17	.69	3.35	6.5295	96.73
C. ustulatus	15	19.80–21.10	20.43±.09	.38	1.86	6.6035	97.82
C. minimus	5	19.30–20.60	19.92±.25	.55	2.76	6.5298	96.73
C. occidentalis	6	19.50–20.10	19.87±.10	.24	1.21	6.6630	98.71
T. migratorius	12	28.00–29.80	28.87±.19	.65	2.25	6.7503	100.00
			ULNA				
H. mustelina	23	28.30–31.10	29.76±.15	.75	2.52	8.2205	96.98
C. fuscescens	17	25.90–28.70	27.01±.19	.77	2.85	8.4763	100.00
C. guttatus	13	25.10–28.90	26.64±.27	1.08	4.05	8.4481	99.66
C. ustulatus	12	25.30–26.60	26.08±.11	.38	1.46	8.4298	99.45
C. minimus	5	23.30–26.00	24.22±.51	1.14	4.71	7.9394	93.66
C. occidentalis	5	23.50–23.70	23.56±.05	.11	.47	7.9004	93.20
T. migratorius	12	34.70–37.20	35.88±.27	.91	2.59	8.3894	98.97
			MANUS				
H. mustelina	21	24.70–27.40	26.16±.17	.81	3.09	7.2261	93.53
H. fuscescens	16	23.50–25.70	24.40±.15	.62	2.54	7.6573	99.12
C. guttatus	10	22.50–24.20	22.95±.10	.53	2.31	7.2778	94.20
C. ustulatus	11	22.40–24.90	23.90±.27	.91	3.81	7.7251	100.00
C. minimus	5	21.10–24.10	22.14±.52	1.18	5.33	7.2575	93.94
C. occidentalis	6	19.20–20.50	19.80±.19	.47	2.37	6.6396	85.94
T. migratorius	12	31.70–34.30	32.69±.21	.71	2.17	7.6435	98.94

[1]Actual measurement divided by cube root of body weight (see text).

deal while foraging in the tree tops and which has a very long migration route (Fig. 13). The other species also show the correlation between wing length and proportions when their flying habits are taken into consideration. One thing to keep in mind is that the wing length and manus length are not always perfectly correlated. All else being equal, a larger bird will have a proportionately longer manus in relation to the wing length than will a smaller bird. Gulls of the genus *Larus* have been investigated in this respect (Gustav Kramer, pers. comm.) and it has been found, for instance, that the Great Black-backed Gull (*L. marinus*) has a relatively longer manus than has the Herring Gull (*L. argentatus*). Equated wing length, therefore, probably is a better index of the amount of flying a bird does than is the manus length. Values for the equated wing lengths of a number of thrushes are presented in Table 5 and in Figure 13, and those for equated manus lengths

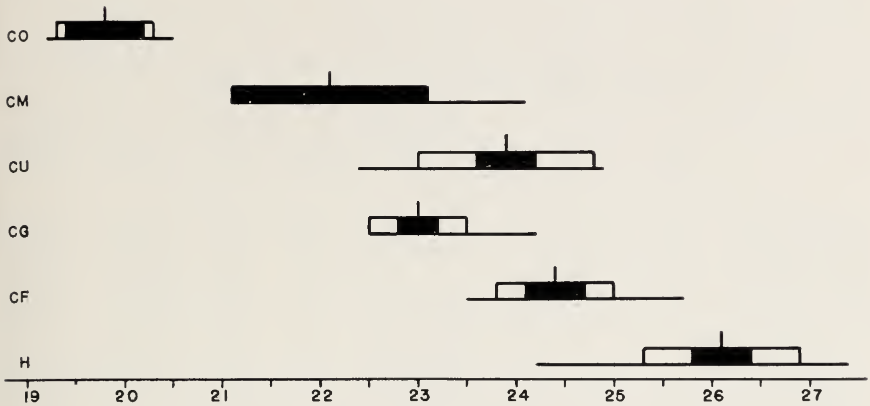
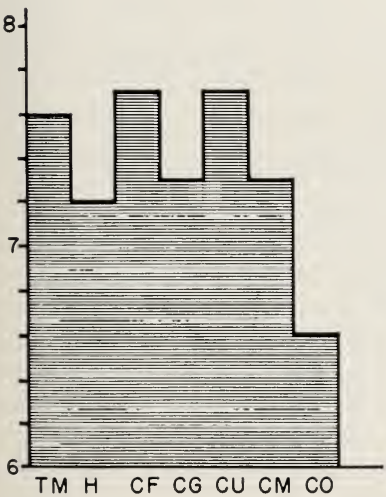


FIG. 11. Statistical analysis of the length of the manus in adult male *Catharus* species and *Hylocichla mustelina*. Key as in Figure 5.



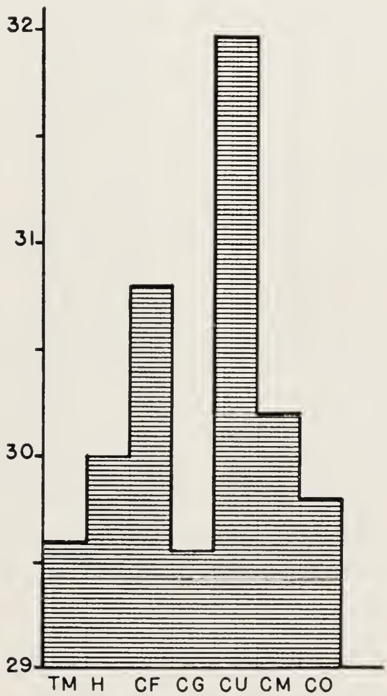


FIG. 12. (Left) Equated length of the manus in adult male *Turdus migratorius*, *Hylocichla mustelina* and *Catharus* species. Key as in Figure 7. Values were obtained by dividing the mean length by the mean cube root of the body weight.

FIG. 13. (Right) Equated wing length (wrist to tip of longest primary) in adult male thrushes. Key as in Figure 7.

TABLE 5
MEASUREMENTS OF THE WING, TAIL AND TARSUS IN ADULT MALE THRUSHES OF THE GENERA *Hylocichla*, *Catharus* AND *Turdus*

	Size of sample	Observed range	Mean with standard error	Standard deviation	Coefficient of variation	Equated value[1]	Per cent of largest
			WING				
H. mustelina	16	105–112	108.75± .53	2.12	1.95	30.0400	94.07
C. fuscescens	17	93–102	98.24± .60	2.51	2.55	30.8300	96.54
C. guttatus	16	88– 97	93.19± .88	2.79	2.99	29.5520	92.54
C. ustulatus	20	94–103	98.80± .51	2.28	2.31	31.9340	100.00
C. minimus	9	86– 97	92.20±1.23	3.70	4.01	30.0000	94.63
C. occidentalis	4	85– 91	88.80±1.32	2.60	2.93	29.7780	93.25
T. migratorius	11	123–132	126.64± .87	2.91	2.30	29.6110	92.72
			TAIL				
H. mustelina	16	64.30– 77.00	69.69± .78	3.13	4.49	19.2503	74.15
C. fuscescens	17	66.30– 73.50	70.13± .57	2.35	3.35	22.0084	84.78
C. guttatus	15	65.00– 71.50	68.23± .49	1.92	2.81	21.6369	83.35
C. ustulatus	20	62.10– 71.50	66.20± .57	2.55	3.85	21.3976	82.42
C. minimus	9	60.30– 69.30	64.88±1.08	3.24	4.99	21.2679	81.92
C. occidentalis	4	70.70– 81.50	77.40±2.34	4.68	2.93	25.9548	100.00
T. migratorius	11	92.50–101.90	96.81± .87	2.90	2.99	22.6361	87.19
			TARSUS				
H. mustelina	16	28.70–32.30	30.84±.25	1.00	3.24	8.5188	75.88
C. fuscescens	17	27.50–30.80	29.35±.32	1.32	4.50	9.2107	82.04
C. guttatus	16	28.40–30.80	29.78±.20	.82	2.75	9.4437	84.12
C. ustulatus	20	25.30–28.70	27.10±.16	.72	2.66	8.7594	78.02
C. minimus	9	27.00–30.70	28.90±.11	1.10	3.81	9.4735	84.38
C. occidentalis	4	32.60–34.60	33.48±.42	.84	2.51	11.2269	100.00
T. migratorius	11	31.50–33.60	32.57±.25	.82	2.52	7.6155	67.83

[1]Actual measurement divided by cube root of body weight (see text).

appear in Table 4 and Figure 12. Figure 11 contains a statistical comparison of the unequated manus measurements.

It is clear from this examination of characters of the wing that the proportions and lengths are as completely associated with the habits of the birds as are the lengths and proportions of the leg. Wing length, then, may be a poor index of general body size, even among closely-related forms. There also seems to be a tendency toward a more pointed wing in the better flyers and toward a more rounded one in birds whose flights are relatively infrequent and of short duration. The tenth primary in the *Catharus* species of South and Central America is much longer than that of the migratory forms breeding north of the Mexican border. Among the forms under consideration here, *C. guttatus* has the longest tenth primary and, as mentioned above, is the least migratory. Another genus of thrushes which has both northern, migratory forms and southern, sedentary forms is *Turdus*. Northern, migratory species, such as *Turdus migratorius* and *T. iliacus*, have short tenth primaries and the southern, sedentary *T. nudigenis* and *T. jamaicensis* have longer ones. It appears that a shortening of the tenth primary is associated with the amount of flying done.

Habitat Association and Ecological Isolation

The coefficient of breeding-habitat association of *ustulatus* with *guttatus* (Fig. 3) is plus 0.75. Its association with *minimus* must be high, but the number of habitat-specific breeding-bird censuses that included *minimus* was too small for analysis. My own field observations indicate a high association of *ustulatus* with *minimus*. In all of the areas occupied by *minimus* there was a broad overlap with *ustulatus*. The only other species which has a positive association with *ustulatus* is *fuscescens* but this is slight, being plus 0.23.

The coefficients of association of *guttatus* with its near competitors are *guttatus* to *ustulatus*, plus 0.75 and *guttatus* to *fuscescens*, plus 0.56. There is some association of *guttatus* with *mustelina* but it is low, minus 0.41. This is less than one would expect from chance alone.

As mentioned above, we have no significant data on the association of *minimus*, but *ustulatus* is the only related species with which it is in regular contact.

The coefficients of association of *fuscescens* with its near relatives are *fuscescens* to *guttatus*, plus 0.56; *fuscescens* to *ustulatus*, plus 0.23 and *fuscescens* to *mustelina*, minus 0.08.

H. mustelina, despite its recent range expansion into more northerly regions, has no positive associations with any of the four species of *Catharus*. As might be expected, it is most weakly negative with *fuscescens*. Study of Figure 3 will help to summarize the information on coefficients of association among these species.

An examination of the above data, augmented with what we know of the ranges and habitats of these species, indicates that the two species with the strongest positive associations with near competitors are *Catharus ustulatus* and *C. guttatus*. Each has strong association with another adjacent form, *guttatus* with *fuscescens*, and *ustulatus* with *minimus*. The selective pressures toward adaptive modifications to minimize ecological competition must be strongest in these two forms. The results of this adaptive divergence are well marked at this time and these two forms are the most widely separated, as to niche, of the competing forms; *guttatus* is a bird of interior edges and forages on the ground while *ustulatus* is a bird of the forest interior, feeding largely in the trees. All four of these species of *Catharus* have achieved a maximum amount of adaptive radiation with a minimum of biological "effort." All vary principally in whether they inhabit interior or edge situations, and whether they are arboreal or forage on the ground. By an alternate expression of these few variables, along with their intergrading habitat preferences, the four species have achieved a rather high degree of ecological isolation from one another (Table 6).

Apparently *ustulatus* has become adapted for a more arboreal foraging niche in response to selective pressures brought to bear upon it by *guttatus* and *minimus*. As has been pointed out, it now forages largely in the forest canopy where it seemingly is beginning to enter into some competition with the other arboreal foragers, such as the Scarlet Tanager (*Piranga olivacea*). The evidence for this is indirect. First, both of these species commonly feed in the canopy, are of about the same size, and take about the same types of food. Secondly, both species have a hostile call (Dilger, 1956*a*) which is very similar (the "chuck-burr" note). This would function as a "spacer" in this stratum much as do the intraspecific hostile displays characteristic of any species. These calls are very much alike in both species and it seems likely that innate releasing mechanisms have developed in both that permit response to either. Considering the great variety of vocalizations of which birds are capable it seems highly unlikely that two such similar calls would have developed in these partially-sympatric forms without some reciprocal selective pressures being responsible. When the degree of foliage-foraging in *ustulatus* is finally stabilized it seems likely that it will be the resultant between the pressures from above, from already long-established foliage foragers, and the pressure from below supplied by *guttatus* and *minimus*.

Since hostile movements and vocalizations that are mutually "understood" are of value in insuring an equable intraspecific distribution it would seem highly plausible that the degree of similarity and "understanding" of hostile displays in interspecific situations might provide clues as to the amounts of existing interspecific ecological competition. An investigation into this subject would be a worth-while contribution that a behaviorist might do well to conduct.

It would be of interest to make a quantitative study of the adaptive differences among these various species of *Catharus* both in areas of sympatry and in areas of lone occurrence. It would seem likely that these adaptive differences are enhanced in areas of contact and to a lesser extent in areas of lone occurrence, much after the fashion of the nuthatches studied by Vaurie (1951). Many more specimens than I had available would be required to demonstrate this. My material was collected from areas of sympatry and probably represents the extreme conditions of adaptive divergence in these forms. I would expect a clinal type of distribution in these

TABLE 6

SOME RELATIONSHIPS OF SPECIES ASSOCIATION, BILL STRUCTURE, FEEDING STATION AND HABITAT PREFERENCES IN THE THRUSH GENUS *Catharus*

Species	Coefficient of Species Association (see Fig. 3)	Difference Between Percentages of Equated: Maxillae	Jaw Widths	Feeding Station	Habitat
minimus				Ground (forest interior)	Undisturbed stunted coniferous (+.80?)
	+.30	4.75	3.52		
ustulatus				Largely arboreal (forest interior)	Undisturbed coniferous (+.47)
	+.75	5.50	3.80		
guttatus				Ground ("interior edges")	Undist. conif. (+.29) Undist. decid. (+.28)
	+.56	3.37	4.58		
fuscescens				Somewhat arboreal (forest interior)	Dist. conif. (+.24) Dist. decid. (+.12)

The species are arranged from top to bottom as they replace one another from north to south or from the top of a mountain to its base. The amount of actual association (overlap) is indicated by the association coefficient (see text). It is interesting to note that the two species with the highest association coefficient (*ustulatus* and *guttatus*) have the greatest differences in the percentages of equated maxilla length.

Species	Coefficient of Species Association (see Fig. 3)	Difference Between Percentages of Equated: Maxillae	Jaw Widths
minimus / guttatus	—.70	.75	.38
ustulatus / fuscescens	+.23	2.13	.78

The species have been arranged according to the least amounts of overlap and hence the low coefficient of association figures. Since these species do not overlap very much, their similarities are greater. Note the little difference between the percentages of equated maxillae and jaw widths. Even here, however, the species pair with the most overlap (*ustulatus* and *fuscescens*) have the greatest differences between the maxillae and jaw widths.

characters to occur, the regularity of which would depend on the quantitative abruptness of occurrence of competing forms.

This study was conducted in eastern United States where *Hylocichla mustelina* and all four North American species of *Catharus* occur. In the extreme western United States, only two species occur commonly, *ustulatus* and *guttatus*. Here they have apparently solved the problems of ecological competition in a somewhat different manner. I have insufficient data from these areas and was unable to borrow sufficient anatomical material for critical comparisons. A study of the interrelations of *Catharus* in these areas would be interesting in comparison to the work reported here.

Summary

The very similar, roughly-allopatric, forest-inhabiting species of the thrush genera *Catharus* and *Hylocichla* often are found living beside one another in the areas of geographic overlap. Although each species differs somewhat in habitat, these habitats are shared with adjacent species, and differences in feeding niches have developed in response to selective pressures presumably stemming from competition for feeding areas.

The typical order of overlapping replacement from south to north or from lower altitudes to higher ones is *Hylocichla mustelina*, *Catharus fuscescens*, *C. guttatus*, *C. ustulatus* and *C. minimus.* The differences in feeding niches involve both the height at which foraging takes place and the location with respect to forest-edge or forest-interior sites. By a simple alternation of these places of foraging a maximum amount of ecological diversification is accomplished with a minimum amount of biological "effort" (Table 6). Adaptive modifications of the bill, hind limbs, and wings enable each species to occupy its specific feeding niche. A broader, shorter bill is associated with arboreal foraging and shorter legs accompanied by longer femurs and shorter tarsometatarsi are associated with arboreal feeding. Conversely, a longer, narrower bill and longer legs with shorter femurs and longer tarsometatarsi are associated with ground foraging. Longer, more pointed wings are associated with a greater amount of flying than are wings that are relatively shorter and more rounded. The Olive-backed Thrush, the most arboreal of the forms considered, has the longest wing in apparent response to the long migration route and also to the fact that it spends much of its time foraging in the foliage and in flycatching. The amounts of adaptive difference, in these respects, between the various pairs of species tend to be in direct proportion to the amounts of association between them. Coefficients of association were computed for the species by using habitat-specific breeding-bird censuses with Cole's (1949) method for the computation of interspecific association.

It is presumed that these species have achieved their ecological isolation by coming "rough sorted" as to habitat by virtue of their largely allopatric distributions and by developing differences in their feeding niches which allow them to occur sympatrically in the broad overlap areas.

Literature Cited

Amadon, D.
1943 Bird weights as an aid in taxonomy. *Wilson Bull.*, 55:164–177.

Baldwin, S. P., H. C. Oberholser and L. G. Worley
1931 Measurements of birds. *Sci. Publ. Cleveland Mus. Nat. Hist.*, 2:x + 1–165 pp.

Bent, A. C.
1949 Life histories of North American thrushes, kinglets and their allies. *U.S. Nat. Mus. Bull.* 196:vii + 1–454 pp.
Cole, L. C.
1949 The measurement of interspecific association. *Ecology*, 30:411–424.
Dilger, W. C.
1956*a* The hostile behavior and reproductive isolating mechanisms in the avian genera *Catharus* and *Hylocichla. Auk*, 73:313–353.
1956*b* Relationships of the avian genera *Catharus* and *Hylocichla. Systematic Zool.*, (in press).
Gause, G. F.
1934 The struggle for existence. Baltimore; Williams and Wilkins.
Harding, K. C.
1925 Semi-colonization of veeries. *Bull. Northeastern Bird-Banding Assoc.*, 1:4–7.
Lack, D.
1947 Darwin's finches. Cambridge Univ. Press.
1949 The significance of ecological isolation. *In* Genetics, paleontology, and evolution. Princeton Univ. Press.
Mayr, E.
1942 Systematics and the origin of species. New York; Columbia Univ. Press.
Park, T.
1948 Experimental studies of interspecies competition. I. Competition between populations of the flour beetles, *Tribolium confusum* Duval and *Tribolium castaneum* Herbst. *Ecol. Monogr.*, 18:265–308.
Rand, A. L.
1952 Secondary sexual characters and ecological competition. *Fieldiana Zool.*, 34:65–70.
Storer, R. W.
1952 Variation in resident sharp-shinned hawks of Mexico. *Condor*, 54:283–289.
Vaurie, C.
1951 Adaptive differences between two sympatric species of nuthatches (*Sitta*). *Proc. Xth Internat. Ornith. Congr.*, 163–166.
Witherby, H. F., F. C. R. Jourdain, N. F. Ticehurst and B. W. Tucker
1943 The handbook of British birds. Vol. 2. London; H. F. and G. Witherby.

Laboratory of Ornithology, Cornell University, Ithaca, New York, January 15, 1956.

MINIMUM SPACE REQUIREMENTS OF SOME NESTING PASSERINE BIRDS

BY JAMES R. BEER, LOUIS D. FRENZEL AND NORMAN HANSEN

Many workers concerned with the problems involving home range and territorial behavior in vertebrates consider space to be one of the more important facets. It is believed that a minimum amount of space is required by an individual or pair before it will occupy an area even though the area may contain apparently adequate nesting cover, escape cover, food, song perches and other specific requirements for survival and perpetuation of the species.

The Quetico-Superior Wilderness Research Center provided facilities for us to conduct investigations on the ecology of the vertebrates found in the vicinity of Basswood Lake, Lake County, Minnesota. This is paper No. 3419 of the Scientific Journal Series from the Minnesota Agricultural Experiment Station, St. Paul 1, Minnesota. We here report on the data gathered on the space requirements, during the nesting season, of the Song Sparrow (*Melospiza melodia*), Yellow Warbler (*Dendroica petchia*) and the Red-eyed Vireo (*Vireo olivaceus*) during the six field seasons, 1950 to 1955, inclusive.

The Basswood Lake area, with its many islands (Fig. 1), is well suited to the study of the minimum area that birds require. Many of the islands are situated so that the birds resident thereon do not have ready access to the mainland or to other islands. On the islands where single pairs are found the physical and vegetational aspects are the factors determining minimum space needs, and social intolerance should be of little or no importance. There is no chance to expand the area defended or utilized at the expense of other pairs.

The original dominant vegetation was composed primarily of red, white and jack pines (*Pinus resinosa, P. strobus and P. banksiana*), white spruce (*Picea glauca*), balsam-fir (*Abies balsamea*), white birch (*Betula papyrifera*) in the uplands and black spruce (*Picea mariana*), tamarack (*Larix laricina*), white cedar (*Thuja occidentalis*) and black ash (*Fraxinus nigra*) in the swamps and wet areas (Rosendahl, 1955). The present vegetation on most of the islands shows the effects of logging and burning, with aspen (*Populus tremuloides*) and white birch now being the principal dominants, although some of the islands retain remnants of the original pine forest.

Methods

The islands used in this study vary from a small fraction of one acre to about 15 acres in extent. They were chosen on the basis of size, availability, and the ease with which reasonably accurate observations could be

FIG. 1. Map of the Basswood Lake area, Minnesota. The islands on which bird populations were observed are blocked in and numbered.

made. The method of study was to make direct observations using sight and song records to determine the presence or absence of birds and to establish the number of pairs present. These observations were normally made early in the morning. Each island was visited on at least four different days during the breeding season. The maximum number of males found showing signs of stability (observed on two or more days and with behavior suggesting that they were in residence) was taken to be the number of nesting areas occupied. Rarely, verification of the presence of breeding birds was based on active nests even though the adults were neither heard nor seen. "Area per pair" as used here is based on dividing the area of the island (in acres) by the number of pairs present rather than extensive observations of the areas actually utilized or defended.

The Song Sparrow, Yellow Warbler, and Red-eyed Vireo were chosen for study because of their abundance and the ease with which observations could be made. They also normally obtain all of their requirements in a single continuous area. Each species utilizes a different level in the habitat and represents a different family of the Passeriformes.

Findings

Song Sparrow. The Song Sparrow is a bird of the brushy edges which are found along the borders of forest openings and the lake shores. The preferred habitat here appears to be a grassy opening with a border of low brush and shrubs between it and the lake. Nesting, while normally on the ground, may take place in holes in trees or in small evergreens as much as seven feet off the ground where there are not suitable open areas.

It has been shown by Nice (1937) that during the breeding season this sparrow normally maintains and uses an area of between 0.7 and 1.5 acres. Nice (1943:152) stated that in central Ohio "the minimum size of a territory was some 2000 square meters (1/2 acre); an average size in a region well filled with Song Sparrows was some 2700 square meters (2/3 of an acre), while a few might include 6000 square meters (1 1/2 acres). During later years when the population was comparatively small, Song Sparrows might range over a larger region than when Interpont was filled to capacity." These figures represent very detailed observations of a mainland area.

The present study indicates that under the specialized conditions found on small islands the minimum territory size for Song Sparrows may be considerably less than that recorded for mainland areas. An examination of Table 1 shows that the minimum area may be as low as 0.04 acres, about one-tenth of the minimum size reported by Nice. This figure is for the small islands occupied by a single pair.

That the use of such a small area is of regular occurrence is borne out by the fact that island no. 8 had nesting birds for six consecutive years (see Table 1). In two of these years we observed second nests as well as fledglings. Island no. 33, which is also about 0.04 acres in size, had a nesting pair during one of the two years in which observations were made. The area may be nearly as small when two pairs are present, since the smallest average area per pair for two pairs was found to be 0.05 acres. However, this situation was unusual in that it involved a dominant and a definitely subordinate male. The dominant bird appeared at times to occupy all of the island while the subordinate bird was seen only on one half of the area except when being chased by the dominant male. Both males were observed to sing but the subordinate male's song was much weaker than that of his competitor and often was not carried to its normal completion. Repeated observations showed that both pairs were successfully

TABLE 1

NUMBERS OF BREEDING PAIRS OF SONG SPARROWS ON THE ISLANDS IN BASSWOOD LAKE, MINNESOTA

Island No.	Pairs Observed						Greatest No. of pairs	Island area (acres)	Acres per pair
	1950	1951	1952	1953	1954	1955			
1	1	2	2	2	1	1	2	.33	.16
2	1	2	2	3	2	2	3	.9	.45
3	3	1	4	4	3	3	4	2.4	.60
4	1	1	1	3	1	2	3	2.6	.87
5A	1	1	1	3	1	2	3	1.2	.40
5B	1	0	0	1	0	......	1	.1	.10
5C	1	0	0	......	1	0	1	.2	.10
5D	1	0	0	......	1	1	1	.2	.20
6	4	......	1	2	0	0	4	4.0	1.0
7	1	0	0	0	0	1	1	.06	.06
8	1	1	1	1	1	1	1	.04	.04
9	1	......	1	2	1	1	2	.1	.05
10	1	1	1	1	2	1	2	.2	.10
11	1	0	0	1	1	1	1	.1	.10
12	1	......	......	5	5	......	5	9.3	1.96
13	1	......	1	2	2	......	2	2.3	1.15
14	1	......	1	3	1	......	3	4.1	1.4
15	1	......	......	......	......	......	1	11.6	11.6
16	1	......	1	1	1	0	1	.08	.08
17	1	......	2	......	2	2	2	.35	.17
18	2	1	1	3	1	2	3	.9	.30
19	1	......	......	......	......	......	1	3.5	3.5
20	......	......	1	......	......	......	1	11.6	11.6
22	......	......	......	2	2	......	2	1.4	.70
23	......	......	1	2	2	......	2	3.1	1.55
24	......	......	......	......	1	......	1	5.9	5.9
25	......	......	......	......	5	4	5	6.1	1.2
26	......	1	......	......	5	......	5	1.6	.52
28	......	......	......	......	1	......	1	1.8	1.8
29	......	......	......	......	0	......	0	2.4	....
30	......	......	......	......	0	......	0	2.7	....
32	......	......	......	......	0	......	0	2.8	....
33	......	......	......	......	1	0	1	.04	.04
34	......	......	......	......	1	......	1	.05	.05
35	......	......	......	......	0	......	0	.06	....
36	......	......	......	......	1	......	1	.5	.5
37	......	......	......	......	1	......	1	1.7	1.7
38	......	......	......	......	0	......	0	1.0	....
39	......	......	......	......	0	......	0	18.6	....

raising young. The next smallest area observed to have two pairs was an island of 0.2 acres, about twice the size of that discussed above. This island was cigar shaped, which undoubtedly helped to maintain a state of stability. When three pairs of Song Sparrows were present the smallest average area occupied per pair was about 0.3 acres. Minimum areas per pair of 0.6 and 0.5 acres were observed when four and five pairs were present. These last figures are not appreciably different from the minimum-sized areas of one-half acre reported by Nice (1943:152).

TABLE 2

NUMBERS OF BREEDING PAIRS OF YELLOW WARBLERS ON THE ISLANDS IN BASSWOOD LAKE, MINNESOTA

Island No.	Pairs Observed						Greatest No. of pairs	Island area (acres)	Acres per pair
	1950	1951	1952	1953	1954	1955			
1	1	2	0	1	1	0	2	.33	.16
2	2	1	1	3	2	1	3	.9	.3
3	1	......	......	0	3	......	3	2.4	.8
4	1	......	......	1	0	......	1	2.6	2.6
5A	......	......	......	1	1	1	1	1.2	1.2
5B	......	......	......	0	0	......	0	.1	......
5C	......	......	......	0	0	0	0	.1	......
5D	......	......	......	0	0	0	0	.2	......
6	......	......	......	1	0	......	1	4.0	4.0
7	0	......	......	0	0	0	0	.06	......
8	0	0	0	0	0	0	0	.04	......
9	......	......	1	0	1	1	1	.1	.1
10	......	......	......	0	1	1	1	.2	.2
11	......	......	......	0	1	......	1	.1	.1
12	1	......	......	3	......	3	3	9.3	3.1
13	1	......	1	0	0	1	1	2.3	2.3
14	......	......	......	2	0	......	2	4.1	2.0
15	......	......	......	4	......	......	4	11.6	2.9
16	......	......	1	0	1	1	1	.08	.08
17	......	......	......	......	0	0	0	.35	......
18	......	......	1	1	2	2	2	.9	.5
22	......	......	......	1	1	......	1	1.4	1.4
23	......	......	......	0	0	......	0	3.1	......
24	......	......	1	......	5	......	5	5.9	1.2
25	......	......	......	......	4	......	4	6.1	1.5
26	......	......	......	......	5	......	5	1.6	.3
28	......	......	......	......	1	......	1	1.8	1.8
29	......	......	......	......	0	......	0	2.4	......
30	......	......	......	......	0	......	0	2.7	......
32	......	......	......	......	0	......	0	2.8	......
33	......	......	......	......	0	0	0	.04	......
34	......	......	......	......	0	......	0	.05	......
35	......	......	......	......	0	......	0	.06	......
36	......	......	......	......	1	......	1	.5	.5
37	......	......	......	......	2	......	2	1.7	.8
38	......	......	......	......	0	......	0	1.0	......
39	......	......	......	......	0	......	0	18.6	......

Yellow Warbler. The Yellow Warbler is a bird of the brushlands, preferring to nest and to do much of its feeding in underbrush and low trees, especially where an edge is present. Kendeigh (1941:171) has suggested that the average size of Yellow Warbler territories is about 0.4 acres. However, the area studied by him in Iowa apparently lacked adequate feeding grounds, since the birds regularly left their territories in thickets of *Cephalanthus* to feed in the forest nearby. Some flew as far as 1200 feet to feed. We have no observations of Yellow Warblers leaving one of the islands to feed, although the less common Myrtle Warbler (*Dendroica coronata*) was observed to do so frequently. The map drawn by Kendeigh (1941) shows that there is considerable variation in territory size but he did not give values for the maximum or minimum area. Differences in the two habitats make it difficult to compare the results of the two studies.

The smallest island observed to be occupied by a single pair of Yellow Warblers was about 0.08 acres in extent (see Table 2). Islands with two breeding pairs were not smaller than .33 acres, which allowed about 0.16 acres per pair. This is twice the minimum area per pair where only one pair was observed. For three or more pairs a minimum area of 0.3 acres each was observed. This figure agrees very well with the average figure given by Kendeigh (1941) but is three times as large as our minimum figure.

Red-Eyed Vireo. The habitat which the Red-eyed Vireo seems to favor is a broadleaved woodland with an undergrowth of brush and slender saplings. This situation gives the vireo a nesting site in the low undergrowth and a feeding area in the aspen and birch overstory. Lawrence (1953) and Kendeigh (1947:55–57) have shown that the space utilized by the Red-eyed Vireos on their study areas varied from 0.7 to 2.6 acres.

Singing males were observed on islands in Basswood Lake with areas as small as 0.08 acres. Although nests were not found, apparently-resident males were observed in two of the four years that we examined this island (island no. 16; see Table 3).

The smallest island upon which a Red-eyed Vireo's nest was found was island no. 1 which is 0.33 acres in extent. The smallest area per pair when two pairs were present was 0.4 acres. Nesting was not observed, although the singing males were observed consistently on the same song perches. When three pairs were present the smallest area per pair was 0.3 acres. An average area of 1.4 acres was available per pair when all three pairs were observed nesting. When four or five pairs were present the average available area was considerably larger—about 2.3 acres.

The smallest area observed when a single pair was present was about one-tenth the minimum observed on the mainland by Lawrence (1953) and Kendeigh (1947). When nesting was observed the smallest area was about 0.4 acres or about one-half the minimum observed by Kendeigh (1947) and Lawrence (1953). The average area available when four or five pairs were present approached the maximum figure of 2.6 acres determined by these workers. Of course some of the available area may not have been used, so that these figures may be larger than the areas actually utilized.

Discussion

The figures given on the space required, utilized, or available are averages of the number of pairs present divided into the area involved. Thus in some cases the actual minimum area may be considerably smaller than the one listed as used. Time limitations often made thorough search for nests

TABLE 3

NUMBERS OF BREEDING PAIRS OF RED-EYED VIREOS ON THE ISLANDS IN BASSWOOD LAKE, MINNESOTA

Island No.	Pairs Observed						Greatest No. of pairs	Island area (acres)	Acres per pair
	1950	1951	1952	1953	1954	1955			
1	1	0	1	1	0	0	1	.33	.33
2	1	1	1	3	1	2	3	.9	.3
3	1	1	1	1	0	1	1	2.4	2.4
4	1	1	......	1	1	......	1	2.6	2.6
5A	......	......	1	0	0	1	1	1.2	1.2
5B	......	......	......	1	0	0	1	.1	.1
5C	......	......	......	0	0	0	0	.1	....
5D	......	......	......	0	0	0	0	.2	....
6	1	......	......	1	1	......	1	4.0	4.0
7	0	0	0	0	0	0	0	.06	....
8	0	0	0	0	0	0	0	.04	....
9	......	......	......	0	0	......	0	.1	....
10	......	......	1	0	0	......	1	.2	.2
11	......	......	......	1	0	0	1	.1	.1
12	1	......	......	3	4	......	4	9.3	2.3
13	1	......	1	0	0	......	1	2.3	2.3
14	0	......	1	3	1	......	3	4.1	1.4
15	2	......	......	......	5	......	5	11.6	2.3
16	0	......	......	1	1	0	1	.08	.08
17	0	......	......	......	0	0	0	.35	....
18	......	......	1	2	1	......	2	.9	.4
19	1	......	......	......	......	......	1	3.5	3.5
20	1	......	......	......	......	......	1	11.6	11.6
22	......	......	......	0	0	......	0	1.4	....
23	......	......	......	0	0	......	0	3.1	....
24	......	......	......	......	3	......	3	5.9	2.0
25	......	......	......	......	1	2	2	6.1	3.0
26	......	......	......	......	0	......	0	1.6	....
28	......	......	......	......	0	......	0	1.8	....
29	......	......	......	......	0	......	0	2.4	....
30	......	......	......	......	0	......	0	2.7	....
32	......	......	......	......	0	......	0	2.8	....
33	......	......	......	......	0	0	0	.04	....
34	......	......	......	......	0	......	0	.05	....
35	......	......	......	......	0	......	0	.06	....
36	......	......	......	......	0	......	0	.5	....
37	......	......	......	......	0	......	0	1.7	....
38	......	......	......	......	0	......	0	1.0	....
39	......	......	......	......	4	......	4	18.6	4.6

impossible. No attempt was made to follow fledglings through to a stage of independence. Fledging is here considered to indicate that the area was adequate for the raising of young. However, some detailed data are available for some of the Song Sparrows found on the very small islands.

In the previous discussion it was shown that Song Sparrows which inhabit islands will utilize areas as small as one-tenth the minimum size defended by birds on the mainland and in contact with others of their own species. The Red-eyed Vireo was found on very small areas but the smallest island

TABLE 4

MINIMUM AREA IN ACRES PER PAIR AT DIFFERENT POPULATION LEVELS

No. of Pairs	Song Sparrow		Yellow Warbler		Red-eyed Vireo	
	All Observations	Nesting Observed	All Observations	Nesting Observed	All Observations	Nesting Observed
1	0.04	0.04	0.08	0.1	0.08	0.33
2	0.05	0.05	0.16	0.16	0.4	....
3	0.30	0.30	0.30	.30	0.3	1.4
4	0.60	0.60	1.5	....	2.3	2.3
5	0.52	1.20	0.3	.30	2.3	2.3

on which breeding was ascertained was about 0.33 acres. This is about one-half the minimum-sized area reported by Lawrence (1953) for mainland areas. On the other hand the smallest area utilized by the Yellow Warbler was 0.08 acres which is only about one-fifth the average of 0.4 acres given by Kendeigh (1941). However, this area is probably not much different than the minimum found by him.

In all three species the minimum area utilized increased with the number of pairs present until three to five pairs were present (Table 4). These values then were approximately the same as those reported from the mainland by other authors. We observed no cases of birds nesting on one island and feeding on (or including as part of their territories) parts of other islands or the mainland.

Many reasons for the spacing of pairs have been postulated. These include:

(1) it is necessary to have a certain amount of conflict in order to synchronize breeding;
(2) it ensures an adequate food supply for the young;
(3) it prevents the undue increase of the species;
(4) it offers protection from interference in the orderly sequence of the nesting cycle.

The first hypothesis, which suggests that it is necessary to have conflict in order to synchronize breeding within the population, appears to be quite workable with colonial sea birds but less so with non-colonial passerines. In the three species observed, the single pairs on small islands removed from direct contact with others of their own species appeared to be as successful as those nesting where there was considerable direct contact with their neighbors. There was of course a certain amount of indirect contact in that singing birds can be heard for considerable distances over the open water. This is especially true for the Red-eyed Vireo. However, it is difficult to see how this factor can be important with these species.

It has long been claimed that many birds limit their own breeding densities through territorial behavior, and thereby insure a food supply for themselves and their young. While the idea superficially is attractive, there is little positive evidence in its favor. The data presented earlier suggest that the size of the territory normally chosen by these three species on mainland areas is not determined by the food supply. In the case of Song Sparrows, island areas may be as little as one-tenth of the minimum area utilized on the mainland. These islands often appear to be quite sterile and it is difficult to visualize their approaching the production of food per unit area characteristic of the area studied by Nice (1937; 1943) in central Ohio. Observations of Song Sparrows on island no. 8 have shown that this area is large enough to serve this purpose. Although it is but 0.04 acres in extent, at least one brood has been fledged there in each of the six years in which observations were made. In one year two broods were known to have been raised. This island is so well isolated that feeding is definitely limited to its surface. The data for the Red-eyed Vireo and Yellow Warbler are similar but not so well defined.

If the food supplies were the all-important factor and the territories were defended on this basis, the minimum area occupied as demonstrated on the islands should be about the same as the minimum area defended and utilized on the larger islands and on the mainland.

The third theory suggesting "that it prevents undue increase of the species" does not seem tenable because most species tend to fill all the vacant areas available. Predation, accident and other extrinsic causes normally eliminate any surplus birds.

The last suggestion that a territory offers protection from interference in the orderly sequence of the nesting cycle seems to be the nearest the truth. This of course covers many factors and actually only suggests that a territory during the breeding season helps the species reproduce itself. Mayr (1935) considered that pairing and mating functions are at the root of territorial behavior. This allows for the best utilization of the area by reproducing birds with the possibility of many factors being involved.

Conclusions

The data gathered indicate that in some birds the minimum amount of space used by a pair to raise their young successfully may be much smaller when the boundaries are strictly physical barriers rather than invisible lines determined by intraspecific conflict. The three species observed reacted similarly to the situation of reduced space. The Song Sparrow on occasion successfully utilized islands less than one-tenth the size of the minimum area reportedly required on the mainland. The Red-eyed Vireo and the Yellow Warbler showed similar but less pronounced tendencies. The size of a territory is based upon a number of factors and not on single factors such as food.

Literature Cited

Kendeigh, S. C.

1941 Birds of a prairie community. *Condor*, 43:165–174.

1947 Bird population studies in the coniferous forest biome during a spruce budworm outbreak. *Biol. Bull. no. 1, Dept. of Lands and Forests, Ontario.*

Lawrence, L. de K.

1953 Nesting life and behavior of the red-eyed vireo. *Canadian Field-Nat.*, 67:47–77.

Mayr, E.

1935 Bernard Altum and the territory theory. *Proc. Linnaean Soc. New York*, 45–46:1–15.

Nice, M. M.

1937 Studies in the life history of the song sparrow. I. *Trans. Linnaean Soc. New York*, 4:1–247.

1941 The role of territory in bird life. *Amer. Midl. Nat.*, 26:441–487.

1943 Studies in the life history of the song sparrow. II. *Trans. Linnaean Soc. New York*, 6:1–328.

Rosendahl, C. O.

1955 Trees and shrubs of the upper midwest. Minneapolis; Univ. Minnesota Press. 1–411 pp.

Department of Entomology and Economic Zoology, University of Minnesota, St. Paul, Minnesota, September 28, 1955

ON CERTAIN CHARADRIIFORM BIRDS OF BAFFIN ISLAND

BY GEORGE M. SUTTON AND DAVID F. PARMELEE

The preference many arctic birds show for grass tundra as a nesting ground is noted by Soper (1940), but he does not explain the preference. Of the grass tundra he says (p. 13): "Where this is boggy and sprinkled with ponds and small lakes, the breeding population of birds reaches the peak of abundance.". Of the desert tundra he says (p. 19): "Practically, if not entirely absent over the greater part of these rocky sectors . . . will be . . . birds which are abundant as breeders on the grass tundra . . . especially . . . in close proximity to the sea."

Our observations in southern Baffin Island in the summer of 1953 support Soper's statements to a remarkable degree, especially with regard to charadriiform birds. Our headquarters were near the head of Frobisher Bay, at a Royal Canadian Air Force Base (Lat. 63°45′ N., Long. 68°33′ W.). An 18-square-mile area, most of it high desert tundra, but some of it marshy lowland near the sea, we covered thoroughly. In this study-area, which lay principally just to the north and northeast of the Base, we failed to record a jaeger (*Stercorarius*) of any species, we did not once see the Arctic Tern (*Sterna paradisaea*), and we found only one shorebird breeding at all commonly—the Semipalmated Plover (*Charadrius semipalmatus*). This species preferred well-drained gravelly places for its nesting. One other shorebird bred in the area or somewhere close by—the Red-necked (Northern) Phalarope (*Lobipes lobatus*). We did not find this species' nest, but we collected a male with well-defined brood-patches.

This failure to find jaegers, terns, and nesting shorebirds was not the result of inattention or inactivity. During the season of migration we recorded the White-rumped Sandpiper (*Erolia fuscicollis*), Semipalmated Sandpiper (*Ereunetes pusillus*), and Red Phalarope (*Phalaropus fulicarius*) repeatedly, and we fully expected to find these species breeding; but by the end of June they had left us. For a time we blamed the shorebird shortage on the comings and goings of aircraft, on mosquito-control and drainage measures, etc., but when we visited the undisturbed grassy flats near the mouth of the Jordan River, 16 miles west of the Base, and found very few shorebirds there, we concluded that the whole head of the bay was, for reasons beyond our understanding, unattractive to shorebirds. Near the mouth of the Jordan several Semipalmated Plovers and a few White-rumped Sandpipers and Semipalmated Sandpipers were nesting.

The absence of jaegers we attributed at first to the local abundance of Snowy Owls (*Nyctea scandiaca*). We reasoned that the owls had established themselves early, well before our arrival, and driven the jaegers out. But as our data accumulated, as it became increasingly apparent that lemmings (both *Dicrostonyx groenlandicus* and *Lemmus trimucronatus*) were common, while such lemming-eaters as foxes (*Alopex lagopus*) and weasels (*Mustela erminea*) were either very rare or missing altogether, we concluded that more than the single factor of lemming-availability was necessary to make the region attractive to jaegers. In this connection we point out that the Rough-legged Hawks (*Buteo lagopus*) of our study-area were living exclusively, and the Peregrines (*Falco peregrinus*) extensively, on lemmings.

What kept Frobisher Bay from being attractive to shorebirds, jaegers and terns became a sharply defined question with our first trip to the southeast shore of Lake Amadjuak (Lat. 64°38′ N., Long. 70°28′ W.) on August 8. Here, less than 100 miles northwest of the head of Frobisher Bay, we found the American Golden Plover (*Pluvialis dominica*), Purple Sandpiper (*Erolia maritima*), Pomarine Jaeger (*Stercorarius pomarinus*), Long-tailed Jaeger (*S. longicaudus*), and Arctic Tern breeding. Again, on August 11, in the vicinity of Cape Dorchester (Lat. 65°20′ N., Long. 77°10′ W.), we found the Parasitic Jaeger (*Stercorarius parasiticus*), Long-tailed Jaeger, Arctic Tern, American Golden Plover, and White-rumped Sandpiper breeding. On our second trip to Lake Amadjuak, August 15, we collected a Red Phalarope which almost certainly had bred there.

Some of the above-mentioned birds seem to require vast stretches of wet grassy tundra for their breeding. Here the comparatively lush vegetation furnishes some shelter when the weather turns rough. Here there is food. Here the great stretches of shallow water provide nest-sites inaccessible to certain predators—low islands of all shapes and sizes, some wet, some dry; long peninsulas; off-shore bars; marshes—areas in which it is possible during the brief but well-lighted period between arrival from the south and establishment of nest-territories to ascertain, through experience hour after hour, which spots are best—i.e., the closest to a good food supply, the most comfortable, and the least molested. Certain mammalian predators are a primary concern for all birds. Foxes prey on owls, jaegers and large gulls, as well as on plovers and "peeps." Factors which make an area attractive to shorebirds may not attract jaegers directly, but the shorebirds themselves do, for jaegers eat shorebirds. Islands are requisite to the successful breeding of some colonial species, such as the Arctic Tern, and in such species an abundance of individuals may be a factor attracting more individuals.

One has to cross this flat, monotonous grass tundra afoot, mile after mile of it, to appreciate its character. Off in every direction, as far as the eye can see, there are ponds. A distant lake, seen through the binocular, looks good for birds, for there is a scattering of little islands along the shore. Reaching this lake requires a circuitous route around and between a score of lesser ponds, for nowhere is the water shallow enough, or the bottom firm enough, for easy wading. By the time one has reached the lake, visited the nearest of the little islands, and followed a stretch of the shore-line, one realizes how birds nesting at the very tips of the long peninsulas, or off in the middle of the big marshes, escape predators by the sheer circumstance of being where they are.

We have reported on two of the following species, the Semipalmated Plover and Purple Sandpiper, in detail elsewhere, but we refer to them briefly for the sake of completeness.

Charadrius semipalmatus. Semipalmated Plover.—This, "the common plover of Baffin Island" (Soper, 1928:102), nested in the immediate vicinity of the Base, on Davidson Point, about Tarr Inlet, near the mouth of the Jordan River, and here and there in the interior, in gravelly places near rivers. We did not find it at Lat. 68°31′ N., Long. 71°22′ W., near a lake about 50 miles east-northeast of Wordie Bay, August 8; at Lake Amadjuak, August 8 and 15; or at Cape Dorchester, August 11 (see Sutton and Parmelee, 1955*b*:138). The Ringed Plover (*C. hiaticula*), a species reported from more northeasterly parts of Baffin Island (Kumlien, 1879:83; Soper, 1928:103; Shortt and Peters, 1942:343; Wynne-Edwards, 1952:367–369), we did not see.

Pluvialis dominica. American Golden Plover.—We recorded this species at the head of Frobisher Bay only once. On June 22, we collected a male (GMS 11718) in almost complete breeding plumage just north of the Base. The bird was blind in one eye, yet it was fairly fat and its stomach contained insect and spider remains, some tiny seeds, and the flesh of winter-refrigerated crowberries (*Empetrum nigrum*).

At Lake Amadjuak, on August 8, we saw two adults and heard others in the distance. The plateau-like breeding area was well back from the lake-shore. An adult male collected (GMS 11820) was in mixed plumage. It must have had young near by, for it flew toward us boldly then ran off with head low, tail spread, and wings drooping.

Near Cape Dorchester, on August 11, we heard the Golden Plover repeatedly; were followed about by a clamorous adult which must have had young near by; noted a flock of eight, high in air, and a single adult, not so high, flying swiftly southeastward; and observed two strong-flying young birds, siblings probably.

At Lake Amadjuak, August 15, we saw about 20 Golden Plovers, four of them sibling chicks barely able to fly. One of these (male, GMS 11840) we collected. It was downy on the forehead, supercilium, chin, throat, mid-chest, tibial region and under tail coverts. The incoming plumage of the fore-neck, chest, belly and sides was much spotted. The first-winter crown feathers, back feathers, scapulars, rump feathers, and upper tail coverts were spotted with rich yellow. Several parent birds followed us noisily in the high country back from the lake-shore. In one area the eight birds formed a sort of flock. They flew up together, circled us in a group, and alighted together. They were blotched or spotted rather than solid black on the under parts, and not one of them was boldly white on the sides of the neck. The alarm cry was not the familiar *too-lee-oo* or *too-di-lee*, but a more elaborate *kill-ee-oh kill-ee*, or *pull-ee-oo plee-ee*. This fact we had opportunity to check repeatedly. We collected one adult, a molting male (GMS 11848). Its under parts were lightly blotched with black.

Soper (1946:226) noted this species "frequently" at Cape Dorchester in late August, 1928. Neither Kumlien (1879) nor Wynne-Edwards (1952) listed it, and our Frobisher Bay record apparently is the first for that area. We did not see the species in the Wordie Bay district, August 8.

Fig. 1. Muddy tundra of the Purple Sandpiper breeding ground. Photographed August 15, 1953, near the southeast corner of Lake Amadjuak, Baffin Island.

Measurements, in millimeters, of our three adult males (GMS Nos. 11718, 11820, 11848) are: wing, 178, 173, 179; tail, 67, 65, 69; exposed culmen, 23.5, 23.5, 23.0; tarsus, 40.0, 42.0, 42.0. The specimens represent the nominate race.

Squatarola squatarola. Black-bellied Plover.—This species we recorded three times on the tidal flats near headquarters: on June 16, three seen in an area strewn with large boulders and seaweed; on June 19, one heard in the distance; and on June 20, one heard and another seen. Near Cape Dorchester, August 11, we heard the mellow *too-ree* in the distance several times but did not collect a specimen.

Soper (1946:227) found this species one of the "most characteristic birds" of the Bowman Bay area, June 6–18, 1929. After June 18 "the majority passed on to north, but fair numbers remained to breed on the lowlands . . ." Our Frobisher Bay records apparently are the first for that area.

Arenaria interpres. Ruddy Turnstone.—We saw two turnstones on the tidal flats near the Base, June 16. Though brightly colored, they were not in complete breeding feather. Taking alarm at our approach, they flew to some big rocks above high-tide mark where they were joined by three White-rumped Sandpipers. On June 27 we saw a single turnstone feeding in a sheltered cove along the shore of Davidson Point.

On August 11 we heard the rattling cry of a turnstone along the shore of the lake in which our amphibious aircraft alighted not far from Cape Dorchester.

Erolia maritima. Purple Sandpiper.—We collected several Purple Sandpipers on rocky islands near the head of Frobisher Bay July 29 to August 6, but the species did not breed near the Base or at the mouth of the Jordan River. Along the southeast shore of Lake Amadjuak (Fig. 1) we found a sparse breeding population, August 8 and 15. Here we took adult and young specimens, the latter barely able to fly (Sutton and Parmelee, 1955*a*:218). We did not record the species in the Wordie Bay district or at Cape Dorchester.

Erolia fuscicollis. White-rumped Sandpiper.—This species Soper (1946:229) found breeding about Nettilling Lake and Bowman Bay. Concerning its abundance at the latter locality in spring he says: "Like the Purple Sandpipers, they invaded the region in almost incredible numbers and swarmed over every available patch of tundra, only lately cleared of snow. This intense wave of migration persisted from June 8 to 14, after which their numbers gradually diminished, but a large . . . population remained to nest on the surrounding tundra."

We saw very little of the species anywhere about Frobisher Bay. In the vicinity of the Base we recorded it a few times June 15 to 21, but witnessed neither courtship nor flight-singing. On June 15 we saw five birds—two together by themselves and three with two Semipalmated Sandpipers. The White-rumps worked their way daintily through the grass, sometimes wading deep in water which spilled swiftly from a pond close by. June 16 we saw ten White-rumps, three "singles," two "pairs," and a group of three which joined two turnstones on a rock above high-tide mark. On June 18 we saw a few White-rumps on Davidson Point, one of them with some Red Phalaropes, and found White-rump remains below a Peregrine eyrie near the mouth of the Sylvia Grinnell. On June 21 we saw a single White-rump on the tidal flats not far from the Base.

On July 18, just west of the mouth of the Jordan River, we found a female White-rumped Sandpiper and her brood. The old bird's principal callnote was the well-known *chick* or *tsick*, which she uttered only in flight; but she also twittered or chattered as she circled us. Three of her brood, two males and a female, unable to fly and still quite downy, we caught one by one, with a series of prolonged waits and headlong dashes across the tundra. They ran with astonishing speed. One which disappeared while we were watching it through our glasses we found in a lemming burrow. Held in the hand, it struggled and cheeped. We heard no call from any of the chicks while they were running free. The adult's bill (GMS 11765) was rich orange-brown at the base, grayish black otherwise. The tarsi and toes were dark brownish-gray. In each of the young birds (GMS 11766,-7,-8) the bill was dark gray with olive base, the tarsi and toes gray with olive tinge. The area inhabited by these birds was decidedly wet—the marshy edges of a small, shallow pond. We failed to find the male parent.

On July 19 we found another adult White-rumped Sandpiper in about the same marshy area. It was not very demonstrative, but lingered in the vicinity. It proved to be a female (GMS 11772) with distinct brood-patches.

The grassy area in which we found these birds extended for two or three miles along the bay-shore and two miles or so up the Jordan. A few Semipalmated Sandpipers bred in slightly drier parts of the same area. The Semipalmated Plover was restricted to well-drained gravelly places not far from the river.

August 15 we saw a single White-rumped Sandpiper on the tundra well back from the shore at Lake Amadjuak. We did not record the species at the head of Frobisher Bay in August.

Measurements of our two adult females (GMS 11765, 11772) are: wing, 122, 120; tail, 53, 52.5; exposed culmen, 23.0, 22.0; tarsus, 24.5, 24.0.

Erolia bairdi. Baird's Sandpiper.—This species is said by Soper (1946:230) to be "much less common" than the White-rumped Sandpiper in southern Baffin Island. We noted it three times: June 15, in a grassy spot near the Base, three birds together not far from three White-rumped Sandpipers and two Semipalmated Sandpipers; June 16, three birds, together on the tidal flats near the Base; and June 18, three birds together along the sandy shore of a large shallow pond near the landing-strip. On each occasion the birds gave rolling cries on flying up. We did not observe courtship or flight-singing.

We looked in vain for the species in the Wordie Bay district, along the southeast shore of Lake Amadjuak, and at Cape Dorchester. Wynne-Edwards (1952:369) found the bird "common" at Clyde, on the coast and at the head of Clyde Inlet.

Ereunetes pusillus. Semipalmated Sandpiper.—This species we recorded several times in the vicinity of the Base: June 15, two feeding not far from three White-rumped Sandpipers and three Baird's Sandpipers; June 16, seven or eight birds in all, one of them trilling briefly from a standing position; June 17, two birds together in grassy tundra; June 18, three or four birds about pools on Davidson Point; June 20, one bird, feeding near the outlet of a tundra pond, another, trilling loudly both on the ground and in flight, on Davidson Point. This last bird we collected, finding it to be a male (GMS 11716). Each testis measured about 6×4 mm.

On grassy flats just west of the mouth of the Jordan River we found several Semipalmated Sandpipers on July 18. Well back from the high-tide mark we ran down a still partly downy chick (female, GMS 11768) and shot the parent, a male (GMS 11769), whose alarm cry was a musical *tsert* or *chert.* Much closer to the salt water, at the edge of the grassless flats, we caught a very small male chick (GMS 11770), probably only a day or so old. Here we saw several adults, probably both males and females. On July 19, in this same general area, we counted about 20 adults, all of which seemed to be agitated. Some distance inland we collected a single male (GMS 11773) not far from a little pond. It had well defined brood-patches but very small testes.

On August 15 we saw about twenty scattered Semipalmated Sandpipers in a flat stretch of tundra about 200 yards from the southeast shore of Lake Amadjuak. We collected one young bird, a partly downy male (GMS 11844). The adults had a way of standing quietly, then flying up suddenly in groups of three or four. One of them gave a bit of a trill.

We last saw the species on August 18—a single bird among several Semipalmated Plovers on the tidal flats not far from the Hudson's Bay Company Post.

Our three adult male specimens (GMS 11716, 11769, 11773) measure: wing, 90, 93, 94; tail, 42.5, 43.5, 42.5; exposed culmen, 20.0, 19.5, 20.0; tarsus, 20.5, 21.0, 21.0.

Phalaropus fulicarius. Red Phalarope.—We saw so much of this species near the Base June 15–20 that we thought surely it would remain to nest, but it did not. On June 15 we saw about 20 males and about 26 females in two and threes on little ponds just north of the Base. Several times we saw two males and a female together twirling about or dabbling for food. Callnotes were a reedy *pheep*, an incisive *fick* or *fitick*, and a *chu-eep.* June 16 we saw large flocks in salt water pools between the bay-ice and the shore, smaller flocks in tidal pools, and scattered groups on the tundra ponds. June 17 we saw good-sized flocks of both males and females in partly thawed lakes and the larger tidal pools and heard sounds of wing-fluttering from courting females. June 18 we saw a good-sized flock flying about the pools on the tidal flats, but on the tundra ponds the birds were in scattered twos and threes. On this date we found Red Phalarope remains below a Peregrine eyrie near the mouth of the Sylvia Grinnell and in the stomach of a male Peregrine collected.

By June 19 the height of the shorebird migration had passed. On that date we saw six Red Phalaropes, three of which (two males and a female) we collected. Each of the four testes measured about 10×6 mm. On June 20, the last date on which we recorded the species about Frobisher Bay, we saw three females and two males in a pond on Davidson Point.

In a marshy area between two ponds near Lake Amadjuak, August 15, we collected a molting male which fluttered about calling anxiously as if in concern over a brood. There was a large brood-patch at either side of the belly and feathers dropped out badly during skinning.

We did not see the species in the Wordie Bay district, August 8, or near Cape

Dorchester, August 11. Measurements of our three male specimens (GMS 11711, 11645, DFP 51) are: wing, 122, 126, 124; tail, 61, 61, 60; exposed culmen, 21.5, 23.0, 22; tarsus, 20.5, 21.0, 21.5; of the female (GMS 11712): wing, 126; tail, 62; exposed culmen, 21.5; tarsus, 21.0.

Lobipes lobatus. Red-necked Phalarope.—This species we found only on Davidson Point, just west of the Base; on July 1 we flushed a single individual from the grassy edge of a pond near the dump. It fluttered up, hesitated as if about to return to the water, then shot off erratically, calling *pit! pit!*

The following day we failed to find the bird at this pond, but took the general direction it had taken, and presently flushed a Red-necked Phalarope. We followed it, ascertaining that it was a male. While we were stalking it, a female appeared and the male fluttered its wings without leaving the water. The female flew off and we did not see her again. We collected the male, finding large brood-patches among the belly plumage. We searched a long time for a nest, but in vain.

These birds were in the marshiest, grassiest part of Davidson Point. In the middle of the pond from which we first flushed the male on July 2, the water was about a foot deep and the bottom muddy. There was no comparably marshy area anywhere just north of the Base or near the mouth of the Jordan River, but marshes near Cape Dorchester and at Lake Amadjuak were of similar character.

Wynne-Edwards (1952:370) reports "unidentified phalaropes" from several localities, including Frobisher Bay (September 13, 1950). Despite Kumlien's considerable discussion (1879:84) of the nesting of this species in Cumberland Sound, Taverner (1934: 526) says that it is known to breed "northward only to Southampton Island, northern Labrador, and the northwestern mainland." Soper (1946:232) mentions a male bird seen in the Bowman Bay area June 26–27, 1929. Bray and Manning (1943:526) collected a male and two females in the Taverner Bay area in 1939 and 1940. Shortt and Peters (1942:344) believed that six phalaropes which they saw at sea near Lake Harbour on August 14, 1939 were of this species.

Stercorarius pomarinus. Pomarine Jaeger.—We saw the Pomarine Jaeger only at Lake Amadjuak. At least two pairs bred near the southeast shore. Long-tailed Jaegers inhabited the same general area in August and we believe the two species had nested not far apart.

We first saw the Pomarine on August 8. That day a pair were flying about near our aircraft's anchorage. We soon discovered that the birds' activities centered about an arm of water in which a young bird, good-sized but apparently unable to fly, was swimming deep with head low. The old birds circled us, sometimes flying close, but they were not at all aggressive (see Pitelka, *et al.*, 1955:6). They tried no distraction behavior. Arctic Terns dived at them occasionally. The jaegers' callnote was a rough *heck* or *keck.* We collected them easily, finding the male (GMS 11821) to be immaculate on the chin, throat, breast and belly, except for a faint dusky band across the chest, while the female (GMS 11822) had a broad dark chest-band and much dusky flecking in the middle of the throat and throughout the whole belly. The female was the larger, but not conspicuously so. Her long middle rectrices, unlike those of the male, were almost perfectly flat. They protruded beyond the rest of the tail 71 mm., while those of the male protruded 75 mm. In both specimens the tarsi and toes (including the webs) were dull black, the bill brownish olive as far forward as the anterior edge of the nostrils, dusky on the tip. The testes measured about 6×4 mm. On the belly of the female, *but not of the male*, were two large brood-patches. Pitelka, *et al.* (1955:5) report brood-patches in specimens of both sexes.

The young bird (male, GMS 11823) was shaggy with brownish gray down, especially on the head and under parts. The tarsi and proximal parts of the toes (and their webs) were pale blue, with faint green tinge, the distal parts of the toes (and webs) dusky. The bill was dull bluish gray, the eyes dark brown.

On August 15, not far from the area in which we had collected the three above-discussed specimens, we saw at least three adult Pomarine Jaegers (one white below; one dark below; one white below except for a dark chest-band) and a young bird. We did not see two adults together, and when, apparently by sheer chance, we came upon the young bird, no parent bird attacked us. The chick was nowhere near a lake or marsh. It could fly a very little, but we had no trouble catching it. Though downy all over the head and under parts, it was perceptibly more mature than the chick collected August 8. Its tarsi were pale blue, fading gradually to pinkish flesh-color on the proximal third of the toes and their webs, then changing abruptly to dusky. It was very restless. We wanted to photograph it but it would not keep still. While we were handling it a parent bird called in the distance and it gave a weak-voiced reply.

The above-discussed breeding records may well be the first for Baffin Island. Kumlien (1879:94) reported the species' nesting along the west side of Davis Strait, but, as Salomonsen (1950:261) points out, the Pomarine Jaeger "certainly does not nest on high cliffs," and Kumlien's statements seem to us to describe jaegers at the nesting-cliffs of other seabirds upon which they possibly were preying. Soper, in his earlier report (1928:80), mentioned no breeding records aside from those of Kumlien; more recently (1946:232–3) he has called the Pomarine Jaeger "a comparatively rare bird" in the Bowman Bay area, and has stated that in southeastern Baffin Island its breeding is "uncertain."

We did not record the species anywhere about Frobisher Bay, in the Wordie Bay district, or in the vicinity of Cape Dorchester. Wynne-Edwards (1952:370) tells us that Anderson recorded it in Frobisher Bay September 15–16, 1950.

Stercorarius parasiticus. Parasitic Jaeger.—This species we saw only near Cape Dorchester, where we collected an adult male (GMS 11830) August 11. It was one of a pair to which we were attracted by hearing the loud *error, error* callnotes in the far distance. The specimen is creamy white on the chin, upper throat, breast and belly, but light brownish gray across the lower throat. The bill was black at the tip, olive throughout the dertrum, and purplish flesh-color on the basal half of the lower mandible. The tarsi and toes were blackish gray. In the stomach were Lapland Longspur feathers.

Stercorarius longicaudus. Long-tailed Jaeger.—This jaeger we did not record in the Wordie Bay district or in Frobisher Bay. We first saw it on August 8, at Lake Amadjuak, a single bird flying in the distance. On August 11 we found a family near Cape Dorchester. The two young, which were very dark and almost completely free of down, flew well. They amazed us by coming straight for us, diving at us in the manner of adults defending a nest. Their cry was a shrill *kree-a*, sometimes repeated rapidly. They were much bolder than their parents. They chased each other playfully, calling noisily, never getting very far apart, and alighting within a few inches of each other. We collected all four birds (GMS 11831, –2, –3, –4). One chick was a male, the other a female. The tarsi of the young were bluish gray, the toes (with webs) dusky. In the stomachs of the adults and of one of the chicks were lemming remains. In the stomach of the other chick was the humerus of a small passerine bird. Both chicks were very fat. The wing-spread of the young male was 31 inches.

At Lake Amadjuak, on August 15, we saw several Long-tailed Jaegers near marshy ponds about two miles from the comparatively dry upland in which we found the young

Pomarine Jaeger that same day. On a ridge between ponds we saw two parent Long-tailed Jaegers and their single progeny, a dark bird which flew well but giddily. The parent birds had a way of swinging upward into the wind and hanging in one spot with wings beating. The callnote of these three birds was a ringing *kree-kree* or *kree-pee.* The ridge was alive with Rock Ptarmigan (*Lagopus mutus*) to which the jaegers paid no attention so far as we could see.

Larus hyperboreus. Glaucous Gull.—This species we saw almost daily, usually near salt water, but occasionally well inland along a stream. We often saw it along the Sylvia Grinnell, invariably flying above water. Two birds which scolded us loudly three miles upriver from the mouth on Júne 19, probably had a nest on a low cliff there. On June 24, at a Snowy Owl nest near a small river east of the Base, a Glaucous Gull joined the owls in scolding and swooping at us. On this occasion the gull left the river entirely.

On rocky islands off the mouth of the Jordan River several pairs of Glaucous Gulls nested. We saw about 70 individuals (all adult) on our first visit to this area, July 13, but many apparently without nests or young. Above an island on which Common Eiders (*Somateria mollissima*) were nesting a pair of scolding gulls circled. We found a new-looking nest of this gull and part of a gull's egg, but no chicks. Near another island we collected an adult male Glaucous Gull (GMS 11755). It had three well-defined brood-patches into which new feathers were growing. The beak was yellow with a subterminal spot of orange on the mandible, the eyelids deep yellow, the irides light yellow, the tarsi and toes (including webs) pinkish flesh-color. In each wing five outer primaries were unmolted.

On July 17 we found three pairs of Glaucous Gulls nesting along the gorgelike channel between Hill and Bishop Islands. Their scolding note was a deep *ka, ka, ka.* Occasionally they squealed or yelped. They dived at us cautiously, never coming very close. That all were molting was evident from a notch in the following edge of each wing. Herring Gulls were nesting about lakes in the interior of Hill Island. Between the clifflike outer shore and these lakes we were scolded by both Glaucous Gulls and Herring Gulls and dived at fiercely by the latter. The same sort of overlap existed just west of the Jordan River mouth, July 18–19. In these zones of overlap a Herring Gull often gave chase to, or dived at, a Glaucous Gull, but not *vice versa.*

On July 27 we examined two well-grown young Glaucous Gulls which Eskimos had caught a week or so earlier. This taking of good-sized chicks, late in the season, may explain the non-breeding status of many of the adult gulls we saw near the mouth of the Jordan River.

On July 29, on a high rocky island across the bay from the Base, we found several Glaucous Gulls nesting. In an adult female specimen (GMS 11796) collected that day four outer primaries in each wing were unmolted.

We did not see the Glaucous Gull at Lat. 68°31′ N., Long. 71°22′ W., at a large lake 50 miles east-northeast of Wordie Bay, August 8, or along the southeast shore of Lake Amadjuak, August 8 and 15. We saw a single Glaucous Gull near Cape Dorchester, August 11.

The male and female specimens mentioned above (GMS 11755 and 11796) measure: wing, 465, 434; tail, 196, 186; exposed culmen, 61, 59; tarsus, 67, 68. The bill of the male, though only slightly longer than that of the female, is noticeably heavier.

Larus kumlieni. Kumlien's Gull.—This species we did not identify with certainty. A gull with pure white tail and with what appeared to be gray rather than black wingtips circled over us while we were on the tidal flats near the Base, June 16. A loose flock of 17 gulls, feeding on the Tarr Inlet tidal flats, June 25, seemed to be small for Glaucous Gulls, but no bird among them could we identify positively, so we could not be sure how large they were. Their wingtips were not conspicuously black. A compact flock of about 100 gulls at rest along the edge of Tarr Inlet at low tide on July 7 also appeared to be smaller than Glaucous Gulls. Many of these must have been subadult. Flying birds which appeared to have perfectly white tails did not have clearly black wingtips. Some of the youngest-looking birds were quite dark all over and cold gray, rather than brownish gray or buffy, in tone. None of these seemed to be conspicuously dark above and white below, like the young gulls seen by A. Anderson in Frobisher Bay, September 13 to 15, 1950 (Wynne-Edwards, 1952:371).

An immature gull with slight limp, feeding at low tide among seaweed near Davidson Point, June 30, had very dark remiges. The contrast between the "blackness" of these feathers and the lightness of the wing coverts was noticeable when the wings were spread. Note, in this connection, that Kumlien (1879:99) described the "primaries and tail" of full-grown young *Larus glaucescens* (=*Larus kumlieni*) taken in Cumberland Sound in early September as "*very nearly black.*"

Larus argentatus. Herring Gull.—This gull we saw repeatedly, usually inland rather than along the coast. It nested in scattered pairs or small groups on islands in large lakes.

The non-breeding gulls which we saw from time to time (July 7–22) in Tarr Inlet we have already discussed. Where these birds went at high tide we did not learn. We could not get near them, and we had difficulty seeing them clearly even with binoculars. They kept together, feeding near the tidal streams or resting in a compact group. On July 7, there was a marked difference between their wariness and the boldness of a single Herring Gull which circled us, scolding, and finally began diving at us. We collected this bird (GMS 11744), finding it to be a male with three well defined brood-patches, molting primaries, and small testes.

On July 17, near deep-looking lakes in the interior of Hill Island and about 300 feet above sea-level, we came upon three pairs of Herring Gulls, all of which dived at us. On scanning the largest lake with our binoculars, we descried five young gulls, two on an island and three in the water just beyond. These chicks, though good-sized, were still somewhat downy.

Between the mouth of the Jordan and the high country a mile or so to the west, were rough, lake-dotted hills. Here several Herring Gulls nested. So long as we stayed along the river the only gulls which scolded us were Glaucous Gulls; but if we moved westward into the tundra the Herring Gulls came to meet us. Dividing their attention between us and the Glaucous Gulls, they scolded loudly and dived with vigor.

On August 3, we saw four pairs of Herring Gulls flying about over lowland meadows just east of Tarr Inlet. In each of two lakes was an islet on which there was a gull nest. Not far from one of the nests was an apparently full-winged young bird, swimming high in the water. It was of a light buffy color, in this respect being quite different from "average" young *argentatus* Sutton had seen on the Labrador and on Southampton Island.

On August 11, we saw several adult Herring Gulls near Cape Dorchester. They dived at us repeatedly, so probably had young in the lakes. On August 15, we collected an adult female Herring Gull (GMS 11846) along the southeast shore of Lake Amadjuak. It was one of the four adult Herring Gulls we saw there that day.

Our male and female specimens (GMS 11744 and 11846) measure: wing, 420, 407;

FIG. 2. Wing-tips of breeding adult *Larus argentatus smithsonianus* from southern Baffin Island. *Left:* male, GMS 11754, Tarr Inlet, near head of Frobisher Bay, July 7, 1953. *Right:* female, GMS 11846, Lake Amadjuak, August 15, 1953.

tail, 178, 169; exposed culmen, 55, 51; tarsus, 60, 61. These represent the race *smithsonianus*, apparently. Whether *L. a. thayeri* is actually "a little smaller" than *smithsonianus* (see Dwight, 1917:414) or not, the wing-tip pattern of *thayeri* is distinctive. A comparison of Figure 2 with the wing-tip patterns of *smithsonianus* and *thayeri* as illustrated by Dwight (1917:413; 1925:353, Fig. 101, and 354, Fig. 103) reveals that, at least as regards this character, our birds are not even close to *thayeri*. Wynne-Edwards (1952:371) has reported *smithsonianus* from Frobisher Bay, but from the wording of his statement we are not sure that this subspecific determination was based on specimens collected or examined by him. Soper (1946:236) makes this statement: "All birds examined from southern Baffin Island are unmistakable *smithsonianus*."

Xema sabinei. Sabine's Gull.—Taverner (1934:125) calls "southwestern Baffin Island" the eastern limit of this species' breeding in the Arctic Archipelago. Soper (1946:237) says that the bird "breeds abundantly" about Bowman Bay, but that it is rare and irregular in eastern Baffin Island. Shortt and Peters (1942:345) report a September sight record for Clyde Inlet and a July specimen taken on Big Island (not far from Lake Harbour). We recorded it only once: seven adults in breeding feather on the tidal flats near the Base, June 16. After flying over the open water between the shore and the bay-ice and feeding about the numerous tidal pools, they settled on a mud bar. We collected three males and a female, all very fat, and all somewhat rosy on the breast and belly. They had dark brown eyes and vermilion eyelids and mouth-lining. The bill was black throughout the basal two-thirds, dull yellow at the tip. The legs and feet were grayish black except for the slightly paler distal third of the front of the tarsus. The gonads were considerably enlarged. The stomachs were well filled with small crustaceans, hundreds of which we had seen alive on the flats. These "shrimps" were somewhat curled up when dead; when straightened out and swimming they looked like tiny minnows.

Sterna paradisaea. Arctic Tern.—If this species breeds at all in southeastern Baffin Island it must do so irregularly. Taverner (1934:126) says that records "along the west shores of Davis Strait and Baffin Bay are few." Kumlien (1879:101) saw "thousands" on June 19 and 20 in Cumberland Sound, but this was his only record for that area. Dalgety (1936:587) found terns "fairly numerous on the rivers and lakes" about Eglinton Fjord August 14–29, 1934, but Wynne-Edwards (1952:372) did not even see the bird in that district August 20–27, 1950. Soper (1946:238) says that the Eskimos at Lake Harbour are familiar with the bird, that they observe it "sometimes commonly," especially in autumn, but that they "appear to know of no nesting places."

We did not see the species anywhere about Frobisher Bay in 1953. We did find it, however, at Lake Amadjuak and near Cape Dorchester. At Lake Amadjuak we saw at least seven adults on August 8. They flew up rapidly while we were trying to capture a young Pomarine Jaeger. They dived at us a few times but soon gave their undivided attention to the parent jaegers, which did not return the attack. On August 15 we saw five adult terns at Lake Amadjuak. One of these, a male (GMS 11847), we collected. It was not molting.

Near Cape Dorchester, on August 11, we saw several small parties of adult terns, but found no well-defined colony. As we were walking along the shore of a large lake, four scolding terns flew toward us, high in air. A Herring Gull also flew up, and the terns attacked it fiercely, pecking so hard that it made off squawking. Near a low island, well out from shore, we finally descried two tern chicks, fairly well grown but still downy. At lakes near by we collected two adult male terns (GMS 11835, –6). They were in full breeding plumage, i.e., not molting. The testes each measured about 7×5 mm. The stomach of one bird held a mass of partly digested small fish.

Uria lomvia. Brünnich's Murre.—Wynne-Edwards (1952:372) saw many Brünnich's Murres along the north side of Frobisher Bay, "especially . . . off the southeast coast of Lok's Land," on August 8, 1937. Soper (1946:238) mentions Eskimo reports of colonies "on the cliffs of Resolution Island and . . . the sheer rocky promontories of the opposite coast along Gabriel Strait." We recorded the species only once: a solitary adult male (GMS 11795) collected July 29 in the middle of the bay several miles south of the Base. It was in breeding plumage, not molting, and fat, but not excessively so. There was no brood-patch. The right testis measured about 4×25 mm., the left, 4×17. The mouth-lining was yellow. The feet were grayish black except for the dull brownish yellow of the front and sides of the tarsi and tops of the toes. The specimen represents the nominate race, the wing measuring 201 mm. (primaries pressed flat), the culmen, 33.

Cepphus grylle. Black Guillemot.—This species breeds in Frobisher Bay, but we found neither nests nor young. On June 24, an Eskimo reported seeing an adult at high tide between the bay-ice and the shore. On June 27, we saw about 20 near a mass of broken-up ice off the mouth of the Sylvia Grinnell River. On July 13, on our 35-mile boat trip to the Jordan River and back, we saw only two birds. They were flying along the edge of a mass of ice well out in the bay.

On July 17, we saw two guillemots along the outer shore of Hill Island and two more in the channel between Hill and Bishop Islands. The birds may well have been nesting in the rubble at the foot of the shoreline cliffs. On July 20, between the Base and the mouth of the Jordan, and late at night, two guillemots flew round our boat and alighted. We shot one (GMS 11776). An hour later, near Davidson Point, two more flew up, circled, and alighted, and again we shot one (GMS 11777). Both of these proved to be fat males with small testes. Neither had a brood-patch and neither had anything in its stomach.

On August 6 we saw several adults among islands about five miles southeast of Tarr Inlet. The only specimen collected, a male (GMS 11818), was not fat. A well-defined brood-patch, without any sign of median feather partition, extended across the belly. The stomach was empty.

Measurements of the three above-mentioned males (GMS nos. 11776, 11777, 11818) are as follows: wing (primaries pressed flat), 156, 155, 165; culmen, 31.5, 30, 31.

Whether these three birds were actually breeding is a question. The last was obviously the only full adult of the three. It was the only one having a brood-patch and the only one in which the flight feathers (both wings and tail) showed neither fading nor wear at the tips. Its black plumage throughout is exceedingly rich, glossy, and fresh looking. The white feathers of the wing-patch are without dark tipping of any sort, though the distal greater secondary coverts are dark basally along the shaft proper. The basal white area of the outer primary's inner web extends to within 49 mm. of the tip.

In no. 11776, virtually every feather of the white wing-patch is tipped with brown, most of the secondaries have a small white spot at the tip, and the basal white of the outer primary's inner web extends to within 35 mm. of the tip. In no. 11777, the secondaries and greater and middle primary coverts are boldly tipped with white, a very few feathers of the white wing-patch are tipped with brown, and the white of the outer primary's inner web extends to within 24 mm. of the tip. The wing is much like that of the "extreme" *mandti* figured by Wynne-Edwards (1952:373), though we find no statement as to the amount of white on the inner web of that bird's outer primary.

We wonder if birds in this plumage actually breed. We wonder, too, what advantage there is in recognizing this "hybrid swarm" (Wynne-Edwards, *loc. cit.*) or "heterozygotous assemblage" (Salomonsen, 1944:91) as a geographical race. Two of the specimens discussed above must be very close indeed to true *mandti*, for they have little or no black at the base of the greater secondary coverts, yet the three specimens vary greatly as regards the amount of white on the inner web of the outer primary. Gross (1937:37) reports both *mandti* and "*arcticus*" in certain Button Islands breeding populations.

Acknowledgments

These studies were aided by a contract between the Office of Naval Research, Department of the Navy and the Arctic Institute of North America N7onr–367–01. We are grateful to Corporal Robert Van Norman and Constable Robert Pilot of the Royal Canadian Mounted Police, Messrs. Ross Peyton and Brendan Halloran of the Hudson's Bay Company, and Dr. V. C. Wynne-Edwards, of Aberdeen University, for assistance in the field; and to Dr. Richard R. Graber for his photograph of the wingtips of our two Herring Gull specimens.

Literature Cited

Bray, R.

1943 Notes on the birds of Southampton Island, Baffin Island, and Melville Peninsula. (With comments by T. H. Manning). *Auk*, 60:504–536.

Dalgety, C. T.

1936 Notes on birds observed in Greenland and Baffin Land, June–September, 1934. *Ibis*, 1936:580–591.

Dwight, J.

1917 The status of "*Larus thayeri*, Thayer's Gull." *Auk*, 34:413–414 and plate 15.

1925 The gulls (Laridae) of the world; their plumages, moults, variations, relationships and distribution. *Bull. Amer. Mus. Nat. Hist.*, 52:63–408.

Gross, A. O.

1937 Birds of the Bowdoin-MacMillan arctic expedition 1934. *Auk*, 54:12–42.

Kumlien, L.

1879 Contributions to the natural history of Arctic America. *U. S. Nat. Mus. Bull.*, 15:69–105 (Birds). Reissued *in* Smithsonian Misc. Coll., 23 (1882).

Pitelka, F. A., P. Q. Tomich and G. W. Treichel

1955 Breeding behavior of jaegers and owls near Barrow, Alaska. *Condor*, 57:3–18.

Salomonsen, F.

1944 The Atlantic Alcidae. The seasonal and geographical variation of the auks inhabiting the Atlantic Ocean and adjacent waters. *Medd. Göteborgs Mus. Zool. Avd.* 108, Vol. 3:1–138.

1950–1 Grønlands Fugle. (Copenhagen.) Pt. 1:5–158 (1950); Pt. 2:159–348 (1951); Pt. 3:349–608 (1951).

Shortt, T. M., and H. S. Peters

1942 Some recent bird records from Canada's eastern arctic. *Can. Journ. Res.*, D 20:338–348.

Soper, J. D.

1928 A faunal investigation of southern Baffin Island. *Nat. Mus. Canada* (Ottawa) *Bull.* 53:76–116 (Birds)

1940 Local distribution of eastern Canadian arctic birds. *Auk*, 57:13–21.

1946 Ornithological results of the Baffin Island expeditions of 1928–1929 and 1930–1931, together with more recent records. *Auk*, 63:1–24, 223–239, 418–427.

Sutton, G. M., and D. F. Parmelee

1955*a* The Purple Sandpiper in southern Baffin Island. *Condor*, 57:216–220.

1955*b* Nesting of the Semipalmated Plover in Baffin Island. *Bird-Banding*, 26: 137–147.

Taverner, P. A.

1934 Birds of the Eastern Arctic. In 'Canada's Eastern Arctic': 113–128. (Department of the Interior, Ottawa.)

Witherby, H. F. (Editor)

1948 The handbook of British birds (Fifth Impression). (London; H. F. and G. Witherby). Vol. 5:1–381.

Wynne-Edwards, V. C.

1952 Zoology of the Baird expedition (1950). I. The birds observed in central and south-east Baffin Island. *Auk*, 69:353–391.

Department of Zoology, University of Oklahoma, Norman, Oklahoma, September 12, 1955

DESTRUCTION OF WARBLERS ON PADRE ISLAND, TEXAS, IN MAY, 1951

BY PAULINE JAMES

In May, 1951, I had an opportunity to investigate an incident of mass destruction of migrating warblers on Padre Island on the Gulf Coast of Texas.

Padre Island, extending from Corpus Christi on the north to Port Isabel, 125 miles to the south, is one of a series of sand bars that parallels the Gulf Coast of Texas. In June, 1950, a causeway connecting Padre Island with the mainland at a point about 15 miles south of Corpus Christi was opened. The Nueces County Park was established at the north end of the island on the Gulf side. It is located on the open beach with blowing sand dunes about 100 yards inland except for a level area at the entrance to the park from the causeway. Vegetation is very sparse in the park. About two miles to the north there is some scrubby underbrush, chiefly *Quercus*. In connection with recreation facilities, ten large floodlights on high poles are spaced through the park area for use in night fishing. It was in this recreation area in the immediate vicinity of the lights, which are controlled by photo-electric devices on the mainland at Corpus Christi, that thousands of song-birds were killed on May 7, 1951.

On May 6, 1951, South Texas in general experienced unusual weather conditions. Twelve inches of rain fell at Matagorda, and eight inches of rainfall in two hours was reported at Palacios. Widespread rains were reported and small craft warnings were displayed from Brownsville to Louisiana. The cold front that brought the rains moved out into the Gulf late that day (May 6) and was followed by unseasonably low temperatures and 25 m.p.h. winds. On May 7, 1951, local showers and cold northeasterly winds were reported, changing to southeasterly by May 8.

About 8:00 p.m. on May 7, large numbers of songbirds were reported flying into street lights and buildings in Rockport, on the coast about 30 miles northeast of Corpus Christi. At approximately the same time at the Padre Island causeway office, the manager noticed several small birds flying about and around the lights. In Corpus Christi thousands of birds filled the air around lights at a baseball park. At the Corpus Christi Naval Air Station, about five or six miles north of the Nueces County Park, so many birds were said to have flown against the buildings that they piled up to a depth of more than 12 inches. (Restrictions in effect there made it impossible to verify that report.)

About 10:00 p.m. one of the deputies on duty in the recreation area of the park on Padre Island noticed flocks of small birds flying in from over the Gulf. For the next three or four hours the park was the site of destruction for thousands of exhausted migrants as they flew into a northerly wind and cold drizzle toward the bright lights. Park officials were baffled as to what was happening, but they were concerned about the deaths of the many small birds which flew against the wires and lights. The men who were on duty gathered up as many of the live but exhausted birds as they could and put them into a building in the park to try to save them. However, thousands flew into obstructions and piled up around the light poles. Examination of the dead birds revealed that the necks of a large number of them were "burned" and broken and many showed broken beaks and crushed skulls as a result of their having flown into the wires around the lights.

On May 8, 1951, the early morning newscast carried a report of a "warbler invasion" on Padre Island and the Corpus Christi *Caller-Times* printed a note about the "wild canaries" that had invaded Padre Island during the night. As a result, a large number of Corpus Christi residents got out their bird cages and rushed over to get a free canary; others went out of interest and curiosity. The toll office of the causeway reported the largest number of week-day visitors since its opening.

On May 8, Dr. Ira N. Gabrielson, of the Wildlife Management Institute, and Mr. Luther Goldman, of the U.S. Fish and Wildlife Service, were in the coastal area of the Laguna Atascosa Refuge, approximately 125 miles to the south, and reported large numbers of warblers in the grass and shrubs, apparently resting. They did not see any dead birds there.

At Kingsville we heard the brief radio report and saw the note in the newspaper but could observe nothing unusual in the local bird life. That afternoon, two of my students and I drove the 60 miles to the Nueces County Park to check the reports and to see if we might find some specimens in suitable condition for making into study skins for class use.

Enroute we saw nothing unusual either as to species or as to abundance of birds. It was not until we crossed the causeway that we saw a few dead birds along the road under the light wires. When we entered the recreation area (about three miles beyond the causeway) about 4:00 p.m. we found dozens of birds scattered over the pavement and along the blowing sands. Literally hundreds of Magnolia Warblers in perfect plumage, brilliant Blackburnians, and Bay-breasted and Chestnut-sided and even Blue-winged and Cerulean warblers were scattered over the sands on every side of us. We stopped to examine a few of the specimens that seemed to be in fair condition and then moved on to try to determine the extent of the destruction. Although the dead birds, chiefly warblers, were scattered throughout the entire area, heaviest concentrations were in the immediate vicinity of the light poles. We counted the number of birds under one pole and found more than 900

TABLE 1

SPECIES REPRESENTATION AMONG BIRDS DESTROYED ON MAY 7, 1951, AT PADRE ISLAND, TEXAS

Species	Number of Individuals	Per cent of total
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	1	0.04
Nighthawk (*Chordeiles minor*)	1	0.04
Acadian Flycatcher (*Empidonax virescens*)	16	0.66
Traill's Flycatcher (*Empidonax traillii*)	9	0.37
Wood Pewees (*Contopus virens and C. richardsonii*)	23	0.95
Catbird (*Dumetella carolinensis*)	6	0.25
Olive-backed Thrush (*Hylocichla ustulata*)	1	0.04
Gray-cheeked Thrush (*Hylocichla minima*)	3	0.12
Veery (*Hylocichla fuscescens*)	1	0.04
Cedar Waxwing (*Bombycilla cedrorum*)	1	0.04
Red-eyed Vireo (*Vireo olivaceus*)	1	0.04
Philadelphia Vireo (*Vireo philadelphicus*)	15	0.62
Black-and-white Warbler (*Mnotilta varia*)	46	1.90
Golden-winged Warbler (*Vermivora chrysoptera*)	4	0.17
Blue-winged Warbler (*Vermivora pinus*)	1	0.04
Tennessee Warbler (*Vermivora peregrina*)	16	0.66
Parula Warbler (*Parula americana*)	1	0.04
Yellow Warbler (*Dendroica petechia*)	4	0.17
Magnolia Warbler (*Dendroica magnolia*)	1109	45.81
Black-throated Green Warbler (*Dendroica virens*)	42	1.74
Cerulean Warbler (*Dendroica cerulea*)	6	0.25
Blackburnian Warbler (*Dendroica fusca*)	64	2.64
Chestnut-sided Warbler (*Dendroica pensylvanica*)	165	6.82
Bay-breasted Warbler (*Dendroica castanea*)	221	9.13
Oven-bird (*Seiurus aurocapillus*)	84	3.47
Northern Water-thrush (*Seiurus noveboracensis*)	4	0.17
Kentucky Warbler (*Oporornis formosus*)	10	0.41
Mourning Warbler (*Oporornis philadelphia*)	1	0.04
Yellow-throat (*Geothlypis trichas*)	405	16.73
Hooded Warbler (*Wilsonia citrina*)	2	0.08
American Redstart (*Setophaga ruticilla*)	123	5.08
Orchard Oriole (*Icterus spurius*)	1	0.04
Baltimore Oriole (*Icterus galbula*)	1	0.04
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	3	0.12
Blue Grosbeak (*Guiraca caerulea*)	1	0.04
Indigo Bunting (*Passerina cyanea*)	24	0.99
Dickcissel (*Spiza americana*)	2	0.08
Lincoln's Sparrow (*Melospiza lincolnii*)	3	0.12
Total number of species—39	2421	99.99

by actual count plus an estimated 100 on the pavement side of the pole where the bodies were too crushed by traffic to get an exact count. Multiply this by the ten light poles in the area and you get a conservative figure of 10,000 dead birds. It is conservative because it does not take into account the many dead and injured birds already covered by the blowing sands, those eaten by the gulls and the crabs, or the hundreds that died after being rescued. In many instances we found only one or two bright feathers left uncovered by the wind and sand; large flocks of gulls fed in the area all day.

We wanted specimens for study skins, and others for closer examination so we worked until almost dark picking up specimens at random in addition to the ones we had collected and counted from the one light pole.

We found later that we had collected over 2,400 specimens which represented 39 species (Table 1). The majority was made up of warblers (95.35 per cent) but there were also 20 other species listed. There was obviously more than one race among the Yellow-throats, and, according to Dr. Gabrielson, possibly two races of the Oven-birds and the Redstarts. At present subspecific identification of the birds has not been completed.

Of the birds rescued by Mr. David Lebby at the Park, about 100 were given to the San Antonio Zoo and of the remainder, my students and I banded and released 180 warblers of 11 species. We were careful to band only birds that were apparently healthy and unharmed by their capture.

Acknowledgments

Mr. Ed Elmore, area representative of the U.S. Fish and Wildlife Service, and Mr. David Lebby, Manager of the Nueces County Park, cooperated in making it possible for us to collect data for this report. I would also like to acknowledge the assistance of Dr. Ira N. Gabrielson for verifying the identification of certain species; L. Irby Davis for the critical reading of the report; Arturo Garcia, Delia Gonzalez, Alonzo Lopez, and Barbara Everhart for assistance in collecting and banding of birds and Miss Everhart for further assistance in working with the specimens and preparing the data.

Science Division, Pan American College, Edinburg, Texas, September 21, 1955

RE-ESTABLISHMENT OF BREEDING POPULATIONS OF LONG-BILLED CURLEWS IN WASHINGTON

BY CHARLES F. YOCOM

Early travelers through the Columbia Plateau of eastern Washington mention seeing many curlews, and settlers knew them well by their calls which the birds made on their nesting grounds in the rolling grasslands, sagebrush plains, and channeled scáblands. The name Curlew Lake in Ferry County suggests that these birds frequented that area; they were known to occur in the Okanogan and Yakima Valleys also.

Apparently man was responsible for the decline in the populations of curlews that occurred with settlement. The birds were shot for food and their nesting areas were destroyed when much of the range land eventually was plowed under and planted to grain. Within recent years, the populations have increased in some of the grassland ranges. Figure 1 shows typical breeding habitat for Long-billed Curlews (*Numenius americanus*) in eastern Washington.

Changes in land use.—Settlements at the end of the last century were located along streams or near lakes, and often they were adjacent to yellow pine (*Pinus ponderosa*) timber. Human populations grew, and later more of the range lands formerly under the control of cattlemen were invaded by farmers. The better grasslands were continually being plowed, and homesteaders even invaded the scablands. So, for a time, rural populations grew, only to diminish as the more successful operators bought out those who were less successful or who desired to move elsewhere. Small holdings were not economically sound for the owners; thus large economic units developed.

Evidence of the reduced rural populations is obvious in the deserted country schools and old homestead sites. Data for Whitman County (Yocom, 1943), showing that private land holdings increased from 495.5 acres per unit in 1930 to 532.9 acres by 1940, also indicate that this trend started during the homestead era (Yocom, 1952). Buss and Dziedzic (1955) show how increase in cultivation of the rich Palouse country effected a decline in Sharp-tailed Grouse (*Pedioecetes phasianellus*).

After homesteaders moved out of the poorer soils, cattlemen again obtained control of most of the channeled scablands, thus placing the range lands under large operating units and permitting revegetation. This trend, in addition to better range management, may have affected the increase of curlews. These assumptions concerning factors that have affected populations of the Long-billed Curlew are subject to question, but whatever the cause, this species has increased in eastern Washington in recent years.

Fig. 1. Breeding habitat of the Long-billed Curlew in the channeled scablands of eastern Adams County, Washington. The loess hills in the background are cultivated for wheat production.

Records by Counties

Okanogan County.—Curlews nested in pasture land directly east of Lake Osoyoos on the Eder Ranch, spring of 1953.

Grant County.—There are no breeding records for this county. Sight records include two curlews seen on July 7, 1950, and two on May 6, 1951, in Potholes south of Moses Lake; one at Lake Lenore April 7, 1952 (Harris and Yocom, 1952); two, June 8; and one, August 4, 1954 (Johnsgard, 1954).

Lincoln County.—There are no published breeding records for this county. H. A. Hansen reported the following observations from the shallow, temporary marshland at the east end of Sprague Lake: one, March 22, 1949; two, March 25, 1949; three, March 30, 1949; two, July 19, 1949; five, May 5, 1950.

Spokane County.—H. A. Hansen found curlews breeding in the dry range lands directly east of Sprague Lake and west of Downs Lake, Spokane County, in 1950.

Adams County.—The eastern edge of Adams County, which lies in the Cheney-Palouse River Channel and is drained by Cow and Rock creeks (Yocom, 1951:53), supports many Long-billed Curlews. A sizable population nests at the west end of Sprague Lake in rolling range land. In 1947, John Harder stated that curlews were becoming more abundant on their 80,000-acre ranch along Cow Creek, which drains Sprague Lake. When he was a boy only scattered pairs were seen on the ranch; now they are common and breed at lower Sprague Lake and along Cow Creek east of Ritzville. LaFave (1954) found two young birds about three weeks old and saw eight pairs near Sprague Lake on May 29, 1954.

Another concentration center is near Twelve-mile Slough which is located northeast of Benge. East of this marsh on the Hodge's ranch, a pair was seen in 1947. By April 13, 1951, this population had increased to the point where the writer was able to count 18 adult birds in driving one mile through this rangeland. Elsewhere in Adams County this species has been reported during the breeding season by Hansen at Palm Lake, on rangeland north of Benge, at the Harry Harder Ranch near Lamont, and at Emden. Yocom noted a concentration of 150 at Twelve-mile Slough, July 13, 1949, and has seen curlews at Cow Lake, and at a small pond west of Macall.

Whitman County.—Whitman County encompasses the greater part of the land drained by the Palouse River (Yocom, 1943:169) and is actually the heart of the "Palouse Country" or the "Palouse Hills." Curlews nested in this county before the grasslands were converted to wheat fields, but it is not known how extensive the nesting populations were.

Evidence to support the above statement came from interviews with qualified observers. In 1949 Mr. William Hegler, former County Game Commissioner, stated that curlews were seen in the St. John area several years ago, but it was not known if they nested in this portion of the county.

Mr. Christenson, who lived near Cherry Lake south of Ewan for many years, related that there were many curlews which nested in this channeled area of western Whitman County in the early days. None is nesting in that area at the present time as far as the writer knows.

Other reports indicated that curlews nested along Alkali Creek west to the LaCrosse area at the time that the greatest extent of the range land was plowed under.

Recent information shows that curlews are again nesting in some areas of Whitman County where they formerly nested. Fay Lloyd was raised along the lower Palouse River and he observed these birds nesting in the range lands in the vicinity of Twin Buttes, which are about five miles south of Hooper, from 1909 to 1914. No curlews were seen again in this area by him until the spring of 1947 or 1948. Since then he has observed curlews every spring in this area. Three birds were seen at Twin Buttes on March 31, 1951, by the writer.

Suitable breeding areas still remain along the Palouse River from Winona to Hooper. The following recent records suggest that Long-billed Curlews breed in that area: one bird seen flying east over the Palouse River two miles south of the mouth of Union Flat Creek, April 2, 1948, (Hansen and Yocom); three curlews seen along the Palouse River northwest of Pampa, April 20, 1951.

Walla Walla County.—Records for this county are those of Carl V. Swanson, Game Biologist, State of Washington Department of Game: one near Burbank, April 1, 1947; two, two miles north of Touchet, April 25, 1947, and one seen in same locality on April 21, 1948; one adult and three young about the size of a Killdeer (*Charadrius vociferus*) between Burbank and Wallula, May 17, 1947. Swanson (personal communication, 1955) saw seven Long-billed Curlews in typical grassland habitat seven miles east of Burbank, June 6, 1955.

E. S. Booth (Hudson and Yocom, 1954) indicated that curlews were locally common near the Columbia River between Touchet, Wallula and Pasco.

Franklin County.—Mr. Oscar Rogers homesteaded the first wheat farm east of Pasco, Washington, in 1897 and at that time curlews were abundant. Farming practices and increased human populations reduced these populations (Swanson, 1955, personal communication).

The following records for this county are those furnished by Carl V. Swanson: Curlews seen approximately 15 miles northwest of Pasco near Byers Landing (now known as the Pasco Pumping Plant) in 1947; several birds seen east of Pasco along the Snake River in the 1930's during a Mormon cricket outbreak; four seen five miles east of Pasco about one-half mile from the Snake River, June 7, 1955; 30 or more curlews seen by Charles Swanson flying about near a grass fire east of Pasco on June 12, 1955. Possibly young birds that could not fly were in these grasslands.

Curlews arrive on the breeding grounds as early as March 22 (Hansen) and depart during the month of July. The latest date that this species has been seen in eastern Washington is July 21 (Hudson and Yocom, 1954). The writer hopes that interested people in Washington continue to follow population changes in Long-billed Curlews in the future.

Summary

Early records show that Long-billed Curlews were found at a number of localities in the Palouse prairie region of eastern Washington. These birds disappeared as the grasslands were plowed under, but they have reappeared with changes in land use. Distributional data tracing these population trends are listed by counties.

At the present time breeding populations are scattered over the lower portion of the Cheney-Palouse River Channel south of the yellow pine zone; this area includes parts of Whitman, Adams, Spokane and Lincoln counties (Yocom 1951:52–56). Other population centers are located along the lower Snake River and the Columbia River in Franklin and Walla Walla counties.

Literature Cited

Buss, I. O., and E. S. Dziedzic
1955 Relation of cultivation to the disappearance of the Columbian sharp-tailed grouse from southeastern Washington. *Condor*, 57:185–187.

Harris, S. W., and C. F. Yocom
1952 Birds of the lower Grand Coulee and Potholes area, Grant County, Washington. *Murrelet*, 33:18–28.

Hudson, G. E., and C. F. Yocom
1954 A distributional list of the birds of southeastern Washington. *Research Studies State Coll. Wash.*, 22(1):1–56.

Johnsgard, P. A.
1954 Birds observed in the Potholes region during 1953–1954. *Murrelet*, 35:25–31.

LaFave, L. D.
1954 Breeding of northern long-billed curlews at Sprague Lake. *Murrelet*, 35:48.

Yocom, C. F.
1943 The Hungarian partridge *Perdix perdix* Linn. in the Palouse region, Washington. *Ecol. Monogr.*, 13:167–202.
1951 Waterfowl and their food plants in Washington. Seattle; Univ. Washington Press. xvi+272 pp.
1952 Columbian sharp-tailed grouse (*Pedioecetes phasianellus columbianus*) in the state of Washington. *Amer. Mid. Nat.* 48(1):185–192.

Department of Game Management, Humboldt State College, Arcata, California, October 25, 1955

JUVENILE MORTALITY IN A RING-BILLED GULL COLONY

BY JOHN T. EMLEN, JR.

Colonial sea birds are characteristically long lived once they have fledged, but the period from hatching to fledging is a critical one in which heavy mortality may occur. The nature and circumstances of juvenile mortality was one of the objectives of a study of nesting Ring-billed Gulls (*Larus delawarensis*) made on Green Island in Mackinack Straits, Michigan, in July of 1952 by Mr. Carl Jacoby and the author. Supplementary observations were made by the author in June, 1953, and June, 1955.

I am much obliged to Dr. Joseph J. Hickey for a critical reading of the manuscript and for helpful suggestions on the handling of the statistics.

Green Island in 1952 was a narrow "J"-shaped sand and gravel bar about ½ mile in length, covered for the most part with a dense growth of grasses and shrubs. The main part of the island was inhabited by Herring Gulls (*Larus argentatus*) whose nests were scattered at intervals of two to ten meters among the grasses, weeds and driftwood behind the beaches. An oval-shaped area constituting the hook of the "J" was occupied by a nesting colony of about 850 pairs of Ring-billed Gulls crowded into a space of about 1200 square meters with nests often only about 0.45 meters apart (center to center). The central part of the Ring-bill colony was essentially without bushes, and by July the grass vegetation had been heavily trampled and puddled by the birds. A broad zone of low scrubby bushes of *Cornus stolonifera* with a moderate understory of grasses (*Elymus canadensis*) surrounded this central barren.

Casual observations made on walking through the colony on July 2 revealed many dead chicks of various sizes and in various stages of decay. In order to quantitate this mortality, four plots each three meters on a side were staked out at representative points in the colony. Blinds were set up at the edge of two of these plots for direct observation of the birds. A number of chicks resident in the plots were painted on the legs for individual identification, and adults were sprayed with colored India ink shot from a water pistol by the observer in the blind. Dead chicks were collected from the plots, counted, and measured for rough age determination.

Statistical Results

A total of 37 dead chicks was collected from the 36 square meters of the four plots. Since territory size on 20 square meters watched from blinds during the incubation stage (1953) averaged 1.2 square meters, the number of initial territories present on the four plots in 1952 was about 30, and the indicated juvenile mortality was approximately 1.25 birds per territory. A plotting of the size distribution of these dead birds as measured by tarsal

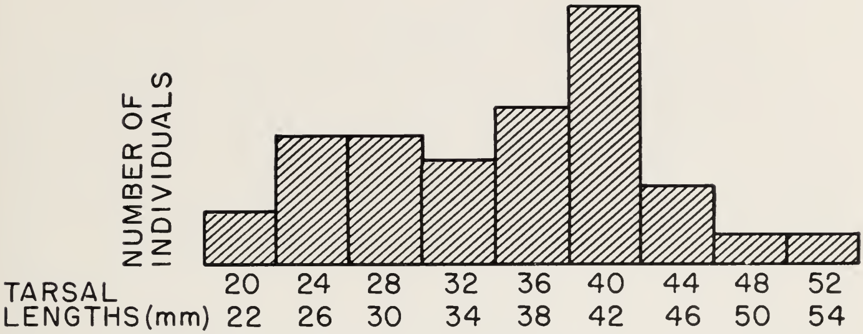


Fig. 1. Representation of age categories (by tarsal length) among Ring-billed Gull chicks picked up dead in the nesting colony.

length (Figure 1) indicates a distributed mortality with the greatest losses occurring in the middle size group, birds which were large enough to wander from the home territory but too small to protect themselves effectively. On the basis of this mortality curve it seems likely that deaths subsequent to our check (determined as at approximately the two-thirds point of the nesting stage) amounted to about five birds on the 36 square meters bringing the estimated total of deaths of juveniles on this area to 42, and the mortality per original territory to 1.40 for the season. This is actually a minimum figure since it excludes all deaths for which the carcasses were removed or obliterated by scavengers; Herring Gulls were observed to eat a number of Ring-bill chicks at the colony edge, and adult Ring-bills themselves were suspected of occasional cannibalism. Thus the actual figure probably approximates or exceeds 1.50.

Surviving chicks were estimated on July 5 and July 11, 1952, on the basis of observations made from blinds on 16 territories. The number of young birds on these 16 territories was 21, an average of 1.3 per territory. One of these had 3 young, three had 2 and twelve had 1. The absence from this tally of territories with no young is no indication that complete brood loss does not occur, since destitute parents apparently abandon their territories and do not return to build new nests as has been reported for the Herring Gull by Paludan (1951). The increase in average territory size in the colony center from 1.2 square meters during incubation (June, 1953) to 2.0 in the latter part of the nestling stage (July, 1952) is thought to reflect the occurrence of such nest failures. If we assume that complete losses of this order of magnitude did occur in 1952 before our counts were made, the 21 chicks recorded actually represent the survival of $\frac{2.0}{1.2} \times 16$, or 27 instead of 16 pairs. This survival should be further revised on the basis of mortality occurring in the last one-third of pre-fledging life, after our

TABLE 1

NESTING SUCCESS AT THE GREEN ISLAND RING-BILLED GULL COLONY IN 1952

	No. of pairs (out of 100)	Eggs Produced [a]	Eggs Hatched	Chicks Fledged	Eggs Lost	Chicks Lost
	A	B	C	D	E	F
Successful	60[b]	180[c]	?	67 (37%)	?	?
Unsuccessful	40[b]	120[c]	?	0	?	?
Total	100	300[c]	217[e]	67[d] (22%)	83[f]	150[d]

a—Refers to the final clutch when re-laying occurs.

b—Based on increase in territory size of persisting pairs from 1.2 square meters in egg stage to 2.0 square meters in nestling stage.

c—based on an assumed clutch size of 3.0.

d—Measurements made on sample plots.

e—Sum of totals of columns D and F.

f—Difference between columns B and C.

checks were made. According to our data in Figure 1, this would amount to about three birds. Actual survival to fledging in the colony in 1952 was thus apparently in the order of $^{18}/_{27}$, or 0.67 young birds per pair that started the nesting season.

No data are available on clutch size in the Green Island colony in 1952, but it was 2.9 in 1953 (20 nests, mostly in mid- or late-incubation). Full clutches are recorded in the literature as generally 3. The occasional clutches of 2 may often result from losses during incubation, and the rare reports of 4, 5 or 6 may well represent irregular deposition in nests by more than one female. Our findings of about 1.50 deaths and 0.67 survivals per pair seem to indicate a hatch of about 72 per cent of eggs laid (assuming a clutch of 3.0) and a survival to fledging of about 22 per cent of eggs laid and 31 per cent of eggs hatched. Within the group which was successful in raising at least one chick the survival to fledging was 37 per cent of eggs laid (Table 1). Repeat laying is known to occur in several species of gulls after loss of the first set, and our figures must be interpreted as representing survival from the eggs of the final clutch if and when more than one was produced.

OBSERVATIONS ON BEHAVIOR

A strong development of territorial defense in these birds seems to account for most of the mortality observed. A detailed mapping of territories on the plots watched from blinds indicated that, until their chicks were fledged, each pair of adult Ring-bills vigorously defended a territory around the nest site against all intruders, both young and old. Even small chicks trespassing within these bounds were vigorously attacked and in many instances killed directly. Older chicks took part in the territorial activity, attacking other young birds and even adults much larger than themselves. Trespassers were almost invariably subordinate in these encounters and retreated submissively.

Territorial boundaries remained definite and were well recognized by both owners and neighboring residents long after the young had hatched and scattered or trampled the crude nest into obliteration. Generally, at least one member of a pair was on hand, but there were many occasions when both birds were absent and the territory left undefended. At such times, neighboring adults characteristically extended their proprietary activity to include the temporarily deserted area, and in so doing frequently attacked the resident young birds. The first adult birds to return after a general exodus from the colony (as when flushed by the observer) freely occupied and defended an area encompassing as many as three or four adjacent territories until their neighbors had returned and claimed their own. Under such circumstances confusion reigned, and chicks were obliged to crouch or be severely buffeted until their parents returned.

The frequency of attacks increased as chicks became more independent and wandered beyond the boundaries of the parents' territories. Half-grown chicks often wandered off voluntarily, especially when their territories possessed no shade, to gather with others of similar age into groups of a dozen or more individuals under the bushes. However, feeding by the parents generally, if not invariably, took place on the home territory, and the chicks were often obliged to run a gauntlet of vicious attacks through three or four territories before reaching home. The greatest mortality occurred at this stage. Older chicks wandered much farther afield, even swam as much as 100 meters out into the lake for periods of four hours or more. Homing orientation developed concurrently and the return trip often involved the traversing of considerable stretches of occupied territory in which attacks were frequent and vicious. By this time, however, the birds were better able to care for themselves and fatal injury was apparently infrequent (Figure 1).

Aside from the infanticide described above, the only agent of mortality detected was the Herring Gull. The two gull species had divided the island between them, and segregation was complete except for a few Herring Gulls which periodically established beach-heads along the shore line bordering the Ring-bill colony. These birds wandered back and forth along the beach, occasionally penetrating a few feet inland and snatching any Ring-bill chicks which ventured within their reach. We watched about half-a-dozen chicks being killed in this way, but do not believe it was a major factor in the total mortality. In 1953 one pair of Herring Gulls actually established a territory at the edge of the Ring-bill colony and destroyed a considerable number of chicks. It is interesting and perhaps significant that Herring Gulls characteristically ate chicks which they killed or found dead, while Ring-bills were never observed to eat the chicks they killed.

The general picture of chick destruction here depicted is similar to the situation described by Kirkman (1937) in the Black-headed Gull (*Larus ridibundus*), which, like the Ring-bill, nests in crowded colonies. Similar, though perhaps less severe, persecution of young is apparently characteristic of various other species of gulls.

Discussion

The production of 0.67 fledged young per breeding pair in the Green Island Ring-bill colony would at first appear to be low and perhaps to suggest abnormal conditions for survival. Data on adult mortality rates could provide a basis for evaluating this production by indicating the recruitment rate necessary to maintain the population. Published analyses of banding data on this species (Ludwig, 1943) are, however, inadequate for these purposes.

Although we lack the necessary data for evaluating fledging rates in the Ring-bill, it is profitable to examine the available records for the closely-related Herring Gull. Studies of nesting success in Maine by Paynter (1949) revealed a fledging rate of slightly less than 1.0 birds per nesting pair. In Europe Paludan (1951) obtained figures of 0.5 or less in Denmark; Darling (1938) had 0.78 in his studies in 1936 and 0.96 in 1937 in Scotland; Lockley found a production of less than 0.33 fledgings per pair on Skokholm in Wales.

Marshall (1947), Paynter (1947, 1949), Paludan (1951) and Hickey (1952) have analysed banding returns on the Herring Gull for information on adult mortality and population turnover rates. Their results have been distressingly variable. In general the American studies have produced results which call for recruitment rates in the order of 1.0 to 1.5 per breeding pair per year, while Paludan's studies of birds banded in Denmark show lower adult mortality and hence imply lower recruitment rates. Paludan demonstrates that with the 15 per cent annual mortality of adult gulls from Denmark, each nesting pair would have to produce only 0.5 to 1.0 fledglings per year to maintain the population. Hickey (1952) in evaluating the discrepancies between results obtained by American and European workers proposes that the differences are at least in part attributable to the inferior wearing qualities of the American bands, and concludes that the Danish figures are more reliable. However, Paludan (1951) questions this interpretation because of the similarities of shape of the two mortality curves. In any event, our fledging rate of 0.67 per year for the Green Island Ring-bill gull chicks does not appear to be far out of line with the performance of at least some populations of Herring Gulls.

Even though the fledgling survival of the Green Island colony be essentially normal, it is profitable to speculate on factors affecting the chick mortality. Young Ring-bills seem to be able to absorb a great deal of physical punishment, but any extraneous factor which might serve to accentuate the aggressive attacks of territorial defenders or to lower the resistance of the chicks might have serious effects on survival of juveniles. Two such factors appear to contribute importantly to the infanticidal destruction of young birds in the Green Island colony. These were: 1) scarcity of shade in the central area, and 2) disturbance of territorial stability by nonavian intruders.

As already noted, nearly all of the grassy vegetation present in the central part of the colony at the beginning of nesting was obliterated by early July through puddling and trampling by the nesting birds. The flats exposed by this denudation were largely abandoned by chicks almost as soon as they could walk, and were quite uninhabited during the intense heat of mid-day. Recently-hatched chicks in one nest close to a blind succumbed after three hours of direct exposure to the noon-day sun and were subsequently pecked and tossed aside. Young birds only a few days out of the egg sought the shade of nearby bushes and the associated grass tufts when their parents were away; they commonly crowded into the shade of our blinds and even crawled into them under the sides. Aside from the occasional direct death, the effects of this exposure to intense solar heat would undoubtedly weaken the birds and reduce their resistance to the rough treatment they receive as they return home.

Also important were the effects of disturbances of territorial stability caused by human intruders. Young birds of all ages readily leave their territories on disturbance and may be driven from their homes for distances of many meters. The return of the adults may be inordinately prolonged by the continued presence of the intruder, but more important, the young are eventually obliged to return through a series of territories occupied by vicious defenders. Many of the young, indeed, may fail to find their way back at all. Of six medium-sized chicks painted for individual recognition and released on their home territories as I entered the colony on June 10, 1955, none returned the same day and four failed to return the second day. It is conceivable that these birds were fed by other adults elsewhere in the colony, but no evidence of such behavior was observed near the blinds. It is likely then that the disturbance created by our own intrusion into the colony significantly contributed to the mortality as here reported.

Summary

Juvenile mortality was measured, and mortality factors were studied, in an island colony of 850 pairs of Ring-billed Gulls in northern Michigan.

Thirty-seven carcasses of dead juvenile gulls were collected in plots cover-

ing 36 square meters of the colony area, indicating a total mortality, when corrected for subsequent deaths, of about 1.50 chicks per nesting territory. All size classes were represented among the carcasses collected, but the highest mortality apparently occurred in middle-sized birds, those large enough to move away from the nest but too small to defend themselves effectively against adult attack. Counts of chicks on two study plots revealed about 0.67 survivors per territory at fledging. Comparison with published data on the Herring Gull suggests that this low production rate may be adequate to maintain the population and hence normal for the species.

Vigorous defense of the small, tightly-massed territories against both young and old intruders was the direct cause of the great majority of juvenile deaths. Predation by Herring Gulls was a secondary factor.

Wandering of young from their territories during the absence of the parents indirectly contributed to juvenile mortality by necessitating returns for feeding through the defended territories of other birds. Destruction of shading vegetation and intrusion of the colony by human observers induced forced movements of chicks and thus aggravated the conditions producing mortality.

Literature Cited

Darling, F. F.
1938 Bird flocks and the breeding cycle. Cambridge Univ. Press.

Goethe, F.
1937 Beobachtungen und Untersuchungen zur Biologie der Silbermöwe auf der Vogelinsel Memmerstand. *Jour. f. Orn.* 85:1–119.

Hickey, J. J.
1952 Survival studies of banded birds. *U.S. Fish and Wildlife Serv., Spec. Sci. Rept.* no. 15, 177 pp.

Kirkman, F. B.
1937 Bird behaviour. London; P. Nelson and Sons, Ltd.

Lockley, R. M.
1947 Letters from Skokholm. London.

Ludwig, F. E.
1943 Ring-billed gulls of the Great Lakes. *Wilson Bull.*, 55:234–244.

Marshall, H.
1947 Longevity of the American herring gull. *Auk*, 64:188–198.

Paludan, K.
1951 Contributions to the breeding biology of *Larus argentatus* and *Larus fuscus*. *Vidensk. Medd. Dansk. Naturh. Foren.*, 114:1–128.

Paynter, R. A.
1947 The fate of banded Kent Island herring gulls. *Bird-Banding*, 18:156–170.
1949 Clutch size and the egg and chick mortality of Kent Island herring gulls. *Ecology*, 30:146–166.

Department of Zoology, University of Wisconsin, Madison, Wisconsin, January 10, 1956

OBSERVATIONS OF ELEGANT TERNS AT SAN DIEGO, CALIFORNIA

BY BURT L. MONROE, JR.

PRIOR to 1951 known occurrences of the Elegant Tern (*Thalasseus elegans*) in the United States were few, based on erratic wanderers from their nesting grounds along the Gulf of California in Mexico. Since 1951 records have shown that this tern has become regular and common on the southern California coast during the post-breeding season.

Occurrence of large numbers of this bird in southern California was first reported by Robert Pyle and Arnold Small (1951. *Audubon Field-Notes*, 5:308–309), who recorded 1100 individuals at Playa del Rey, Los Angeles County. There have been subsequent reports of Elegant Terns from this general area, but none exceeding 250 individuals.

The following article is based on observations of this tern on San Diego Bay, San Diego County, California, during the summer and fall seasons of 1953, 1954, and 1955.

Methods

Observations during 1953 and through mid-August in 1954 were periodic, averaging about one every two weeks. However, from August 15, 1954, through the remainder of 1954 and through the 1955 season until September 1, daily studies were conducted at the U.S. Naval Training Center, San Diego. The Training Center is located at the northern tip of San Diego Bay and is one of the several concentration points for terns on the bay. Studies conducted there averaged about 45 minutes daily, and were made with good back or side lighting at a maximum range of 250 feet, usually much less. The data obtained there were supplemented by weekly observations on terns at other points on the bay, especially at the other known concentration points.

Occurrence

I first encountered the Elegant Tern on September 21, 1953, among terns concentrated on the west side of San Diego Bay. This west border of the bay is a strip of land connecting Coronado, California, with the mainland to the south, and this particular tern concentration is situated on the south rim of the U.S. Naval Amphibious Base. More than 1000 terns were present on this date, and over one-half were Elegant Terns. The remainder were principally Forster's Terns (*Sterna forsteri*), with a small number of Common Terns (*Sterna hirundo*), Caspian Terns (*Hydroprogne caspia*), and Royal Terns (*Thalasseus maximus*).

After October 1, 1953, most of the Elegant Terns disappeared from this area, but scattered individuals were noted at many points along San Diego Bay until October 28.

In 1954 the Elegant Terns were first observed on July 18, when a group of 18 birds appeared on an exposed mud flat at the southern tip of the bay. Further observations during 1954 were impractical on my part until August 15, at which time I discovered the large concentration of terns on the U.S. Naval Training Center. On this date approximately 400 Elegant Terns were present, with a smaller number of the other four terns with this group. Virtually all detailed study of plumage, voice and behavior is based on observations of this concentration at the Training Center.

Continuing study of the group at the Training Center in 1954 showed an increase in number of individuals from 400 to a maximum of 600 on September 26. On this date I made another check of the group at the Amphibious Base and found well over 700 Elegant Terns there. The total number of Elegant Terns on the bay on this date was estimated at 1500 birds, and is a peak number for the entire three-year period of study. Numbers declined rapidly thereafter, leaving only 275 at the Training Center on October 2, 20 on October 31, four on November 22, and two on December 1, the latest recorded in 1954.

Prompted by the rather astounding numbers of these terns in 1954, I decided to make a very close study of the Training Center concentration in 1955, to determine fluctuations in the population and to study closely the behavior of these terns, very little having been done on this species in the past.

Two adult Elegant Terns in breeding plumage, a truly beautiful sight, appeared among the nesting Caspian Terns on the southern end of the bay on June 18, 1955. This marks the earliest occurrence in this country and indicates the possibility of nesting here in the future. However, as mentioned in Bent (1921. *U.S. Nat. Mus. Bull.*, 113:220), the known egg dates of this bird are for early April, so the probability at present is small.

Small numbers of Elegant Terns began to appear at various points on the bay after July 2, and the first individual appeared at the Training Center on July 16. A very gradual buildup of numbers took place at the Training Center, reaching 60 terns on August 18. A definite influx then began, reaching 149 by August 26 and a maximum of 294 on September 1, the final day of observation by the writer in 1955.

On September 1, a complete survey of the bay was made, and the estimated number of Elegant Terns was placed around 700 birds. This is slightly below the total for the same time in 1954.

C. H. Channing, of San Diego, informed me (*in litt.*) that three Elegant Terns remained at the Training Center until January 2, 1956. This is by far the latest occurrence ever recorded in this country.

Plumage

In breeding plumage there is probably no more spectacular a tern than the Elegant. The rosy underparts and orange-red bill set it apart from any other tern. The only birds observed in full breeding plumage were the ones seen on June 18 and on July 2, 1955.

All adults after July 2 appeared in various plumage stages from partial breeding to full winter. This transition is marked by the molt of the black forehead feathers and subsequent replacement with white, as in the Royal Tern and Cabot's or Sandwich Tern (*Thalasseus sandvicensis*), and the disappearance of the rosy bloom on the underparts. The former occurs first, with birds on July 18 with much white on the forehead. By August 5, at least 50 percent of the birds at the Training Center possessed completely-white foreheads (this white extending back on the top of the head just behind eye, as in the Cabot's Tern, but not as far back as in the Royal). By August 14, only 5 per cent of the adults were not in complete winter plumage, as far as the forehead goes. On the other hand, many individuals retained their rosy bloom into early September, the last bird on which it was discernible in the field being observed on September 7.

Once the rosy bloom has disappeared, the birds are not as easily distinguished in the field. If one consults present-day field guides, passages such as "similar to Royal Tern, but smaller," or "one should not attempt to distinguish this species until he knows the Caspian and Royal completely" are encountered. This is not of much help to the field observer and it is not a true picture of the situation, for the Elegant Tern is distinguished from the two larger terns much as the Cabot's Tern is along the Gulf of Mexico, with the exception of bill color.

In addition to smaller size, the Elegant is slimmer, more graceful in flight, and usually has a more rapid wing-beat. As in the Cabot's Tern the proportionately-slim bill is noticeable, although the color in the Elegant Tern parallels that of the Royal. The most distinctive field character is the crest, which is longer and more extensively black than that of the Royal. When the tern is at rest the crest feathers tend to lie down along the nape unless ruffled by the wind or erected by the birds. But the crest of the Royal Tern is shorter and tends to remain erect even when the bird is resting. Further, the black of the crest begins at a point just above the eye in the Elegant, and is not intermixed with white feathers, while in the Royal Tern the white feathers of the forehead extend much behind the eye and usually intermix with the black feathers of the crest, giving a grayish appearance to the crest. I use the term "usually" here because this crest character is not evident in Royal Terns of the coast of the Gulf of Mexico, but is evident in all the Royal Terns of the Pacific coast which I have observed or examined.

The primaries of the Elegant Tern normally show more black above than the Royal, but this is not a reliable character, especially in immature birds.

Color variation of the bill of Elegant Terns is much greater than in either the Royal or Caspian Tern. Adult Royal Terns have orange-red bills, adult Caspians have carmine-red bills, the variation in these colors among individuals being very slight. On the other hand, the Elegant Tern's bill varies from a light yellow-orange to a deep orange-red, the most frequent condition being orange-red as in the Royal. In immatures there is an even greater variation, as is discussed later.

The most remarkable feature of the coloration that I observed was the foot color. The normal foot color (in about 90 per cent of the adults) is black, as in all other terns. However, about 10 per cent possess *bright orange* feet and legs. I first noticed this odd foot color in late August, 1954, at the Training Center. A close check revealed at least fifteen individuals with completely orange feet and legs, and another ten with partially orange feet and legs. In no other way were these birds different from typical black-legged adults. To my knowledge, there is no mention in the literature of this color variation.

Orange-legged adult Elegant Terns again appeared at the Training Center in August, 1955. Since collecting is out of the question there, color photographs were secured of several of these orange-legged adults. Although somewhat unsatisfactory, due to the distance involved, these photographs are sufficient to show the foot color.

The immature plumage, with the exception of bill and foot color, is similar to that of the Royal Tern. It differs from the adult in the presence of dark coloring in the secondaries, upper wing coverts, and rectrices. However, this dark coloring is not as pronounced as in Royal Tern immatures, and in a few immature Elegants is barely discernible.

Foot and bill colors are quite variable in immatures, but generally run paler than in adults. Typical immature bill color is yellow (about 60 per cent of immatures observed), ranging from a pale straw color to light orange-red. Foot color is usually greenish or greenish-black (about half the birds observed), ranging from bright yellow-orange to black.

Very few immatures and none of the adults possessed dusky-tipped bills, in which cases the dusky was restricted to the very tip. All Elegant Terns observed, immature or adult, had bills appearing totally yellow or orange at a moderate distance.

The remainder of the immature plumage, including head feathers and crest, is similar to the adult winter plumage.

Voice

The voice of the Elegant Tern is distinctive, if one is familiar with that of the Royal Tern. It is higher pitched and less harsh, a rather clear *ke-e-e-r*, dropping very slightly in pitch toward the end. Of course, it is totally unlike the grating, low-pitched *kra-a-ak* of the Caspian, or the *kri-i-ick* of the Cabot's.

Both adults and immatures are also very noisy when sitting in flocks. The sound emitted from a flock of 100 birds sounds very much like a hatchery, with myriads of baby chicks constantly peeping. I have heard groups of Royal and Cabot's terns produce a similar sound on the coast of the Gulf of Mexico, but it is not quite so chick-like in these two terns. This sound is usually given incessantly by a group of Elegant Terns, and often an observer is unaware of the noise, for it is high-pitched and constant; this situation is much the same as arises with large flocks of Cedar Waxwings (*Bombycilla cedrorum*) producing high-pitched notes near the upper limit of human hearing range.

The peeping sound is given most notably by immatures begging for food, or by adults engaging in residual nesting activity, as discussed later.

In regards to voice, it might be well to mention here that I have noted Caspian Terns in flight emitting a high-pitched *pe-e-e-e*, drawn out and on the same pitch. I believe only immature Caspian Terns do this, but I am not positive of this. I am unaware of reports mentioning any high-pitched sounds of this nature by Caspian Terns.

Behavior

The Elegant Tern was observed feeding most commonly in quiet waters of lagoons or along the shores of the bay, rather than out in the rougher open water of San Diego Bay. Most observations of feeding at the Training Center indicated that the birds flew along at heights of from two to ten feet above the water, then plunged down after small fish. When feeding in this manner, Elegant Terns have a rapid wing-beat and hover often, much as the Forster's Terns do. In fact, if one is down-sun from the birds or directly behind them, it is easy to mistake the Elegant for a Forster's. However, when not engaged in feeding, the wing-beats are slower and the birds can be mistaken for Royal Terns if no size comparison is available and the head and bill cannot be seen in profile.

While at rest the Elegants normally concentrate in large groups, although scattered individuals among a mixed flock of terns may be the case. It is in these large groups that the residual nesting activity occurs. This phenomenon was also observed by Pyle and Small (*op. cit.*) and recorded as such, but not described.

Immatures continue begging for food, and have been noted doing so into late November. Begging is accomplished exactly as in the Royal Tern. The immature bird, upon arrival of an adult with food, lowers its head, thereby erecting the crest feathers, chases the adult with head low and slightly uptilted, and peeps continuously until fed.

Activity, which could only be residual courtship activity, was also observed among the adults as late as October 15, 1954. Usually three adults took part at once, but occasionally only two birds participated. These terns would run along side by side for a few feet, with their wings extended down and away from the body anteriorly, but with the tips still crossed over the back. The neck was stretched upward as far as possible during the performance and the bill alternately raised and lowered from the horizontal up to an angle of about 75° and back to the horizontal. Each time the bill was elevated to the high angle, the peeping sound was given. It should be pointed out that the two or three birds taking part in each activity normally raised and lowered their bills in unison, or very nearly so.

I noticed that the Elegant Terns would sleep, or at least close their eyes, while in a position of rest commonly observed in other terns. That is, they would rest on their bellies with their heads stretched forward and their bills lying flush with the ground.

Bathing by Elegant Terns in shallow water was also observed at the Training Center.

Acknowledgments

I wish to express my appreciation to Paul E. Popejoy, Harriet M. Popejoy, and William F. Reeves, for their help in securing photographs of the Elegant Terns at the Training Center, and to E. C. Trowbridge, C. H. Channing, and Mrs. T. H. Brown for their assistance with this study. All are members of the San Diego Audubon Society.

BTU-1-S, NAAS, Whiting Field, Milton, Florida, November 1, 1955

THE WILSON ORNITHOLOGICAL SOCIETY LIBRARY

The following gifts have been recently received. From:

Dean Amadon—20 reprints
Robert F. Belden—1 pamphlet
G. Reeves Butchart—2 books
Malcolm S. Gordon—1 reprint
Karl W. Haller—3 books
F. Haverschmidt—2 reprints
Joseph J. Hickey—3 reprints
Lyle Miller—5 pamphlets
M. Moynihan—2 reprints
Russell E. Mumford—1 reprint
Margaret M. Nice—11 reprints
Fred M. Packard—6 bulletins, 8 magazines
Charles G. Sibley—1 book; 11 reprints
Josselyn Van Tyne—6 reprints
J. M. Winterbottom—1 reprint
Wisconsin Conservation Department—2 pamphlets
Richard Zusi—8 reprints

GENERAL NOTES

Long-tailed Jaeger in Kansas.—On June 22, 1955, we saw a jaeger at Cheyenne Bottoms, a natural swamp converted into an artificial reservoir, 6 miles east and 3 miles south of Hoisington, Barton County, Kansas. Our efforts to collect the bird finally drove it from the area. We returned to the same place on June 23, found the bird again, and collected it.

The specimen (KU 32610) proved to be an adult female Long-tailed Jaeger (*Stercorarius longicaudus*). It was very fat, had light blue tarsi and black feet, and was in "normal" (that is, light) plumage phase. Measurements were: wing, 287 mm.; tail, 260 mm.; tarsus, 44 mm.; middle toe (without claw), 31 mm.; exposed culmen, 28.5 mm.; cere, 13.6 mm.; dertrum, 15.8 mm.; depth of bill at base, 10.3 mm.; width of bill at base, 9.1 mm., and middle rectrices projecting 124 mm. beyond adjacent pair.

The specimen represents the only record of the species in Kansas. There is, however, one record for the Pomarine Jaeger (*Stercorarius pomarinus*) from the state. This record of the Long-tailed Jaeger is of interest in relation to the overland, continental migration suggested for the species by some authors (Murphy, 1936. "Oceanic Birds of South America," vol. 2:1039). It should be noted, however, that inland records of the species in North America are too few to suggest any substantial inland migration. The late date of the record here reported suggests that the bird might not have been migrating northward to breed. Unfortunately, no record was kept of the condition of the ovary.—Larry D. Mosby and William M. Lynn, *State Biological Survey, University of Kansas, Lawrence, Kansas, November 3, 1955.*

Nocturnal predation on Song Sparrow eggs by milksnake.—On June 25, 1955, at Camp Arbutus, near Traverse City, Grand Traverse County, Michigan, a nest of a Song Sparrow (*Melospiza melodia*) was discovered. The nest was 15 inches above the ground in a low evergreen (*Juniperus* sp.). It was in such an open situation that I had been able to make hourly observations on it and was able to watch the entire construction and subsequent deposition of eggs.

On July 1 incubation of the three-egg clutch began. On the afternoon of July 3 an adult bird was still incubating the eggs. At 10:00 p.m. my wife and I visited the nest and found a 30-inch Milksnake (*Lampropeltis doliata*) coiled around the nest rim. Only one egg, still warm, remained in the nest. The adult sparrows were not seen nor heard. Our flashlight did not seem to disturb the snake, but it dropped to the ground when I reached out to capture it. We left the nest and returned five minutes later. The snake had returned and was in the process of grasping the egg with its mouth. After two attempts at engulfing the egg, the snake succeeded in getting it entirely in its mouth. The snake was then captured and the unbroken egg was removed and placed back in the nest. The adult sparrows never returned to the nest.

More nocturnal observations on the nest life of birds need to be made in order to determine the extent of predation on eggs, young, and even adult birds.—Harold D. Mahan, *421 W. Jefferson, Ann Arbor, Michigan, November 7, 1955.*

Cape May Warbler summering in lower Michigan.—The Cape May Warbler (*Dendroica tigrina*) passed through southern Michigan earlier than usual in the spring of 1955 (although no early records were broken). Males appeared in the Ann Arbor region on May 5, 6, and 7 (L. C. Binford, D. A. Zimmerman), and a female on May 12

(Zimmerman). Binford last saw the species at Point Pelee, Ontario, May 14. Numerous observers in the field during the last two weeks of the month did not report the species. Therefore, I was surprised to find four singing male Cape May Warblers in a spruce bog in Oscoda County, Michigan, on June 4. The exact location was T. 28 N., R. 1 E., Section 12, three miles northeast of Red Oak. The birds did not behave like migrants. Each acted as if on territory, singing persistently from one or a few perches for long periods of time. Later in the day Marian Zimmerman and I collected a singing male (UMMZ 136,505) with enlarged testes in another spruce bog near Luzerne, 12 miles farther south.

The following morning Mr. and Mrs. Richard Zusi returned with us to the Red Oak region where we located seven singing males. One bird, watched for 30 minutes, spent most of his time foraging among the spruces (*Picea mariana*). He sang frequently (the usual *seet seet seet seet*, and a shorter, softer song: *sa-wit sa-wit sa-wit sa-wit*), but less often than the other males. We saw this individual carry food into a spruce top on one occasion. Another time it vigorously chased a second Cape May Warbler from a nearby tree and pursued it for an unknown distance into the swamp. Upon returning from the chase the bird sang once, then resumed feeding.

In a stand of spruce partially isolated from the rest of the bog we studied another male for nearly two hours. He was not very active, and sang or preened for many minutes at a time from one of three or four spruce-top perches within 150 feet of each other. We saw no female and searched unsuccessfully for nests in and near what we believed to be his territory. At least one other male sang frequently from not far away.

The songs of these birds seemed louder than those I have heard from migrating Cape May Warblers. They were the dominant sounds in this swamp, together with the songs of Golden-crowned Kinglets. They had surprisingly great carrying power.

One week later (June 12), Andrew J. Berger, Dr. and Mrs. Powell Cottrille, J. Van Tyne, and L. H. Walkinshaw watched these birds, but again no breeding evidence was obtained. However, Berger saw a female Cape May Warbler in the area on June 16.

N. A. Wood (1951. "The Birds of Michigan," p. 385) listed one summer record of this species from the Upper Peninsula (Luce County, 1941), and none at that season for Lower Michigan. According to O. E. Devitt (1950. *Canadian Field-Nat.*, 64:147), Dr. J. Murray Speirs observed a male Cape May Warbler on Beckwith Island, Simcoe County, Ontario, in July, 1948, marking "the most southerly summer occurrence for Ontario." Simcoe County is in approximately the same latitude as Oscoda County, Michigan.—Dale A. Zimmerman, *University of Michigan Museum of Zoology, Ann Arbor, Michigan, December 10, 1955.*

The northernmost nesting of the Rough-legged Hawk in North America.— Among the ornithological surprises of my 1949 visit to Prince Patrick Island in Canada's Arctic Archipelago was the discovery of a pair of Rough-legged Hawks (*Buteo lagopus*) and their nest, hundreds of miles north of previously known nesting localities of the species. The northernmost summer specimens examined by Cade (1955. *Condor*, 57:316) in his review of the species came from Point Barrow, Alaska; Herschel Island, Yukon Territory; and Franklin Bay, southeastern Victoria Island, and southeastern Somerset Island, Northwest Territories, Canada.

The hawks were first noted on Prince Patrick on June 22 when I tramped inland to study nesting brant. The tundra was more than 80 per cent snow-covered, and snowshoes were still necessary for travel. Because valleys and ravines were flooded with meltwater, I was forced to go out of my way some distance up a stream to find a crossing, and thus came into an area that I had not previously examined (Fig. 1).

I was astounded when a large bird being harassed by a pair of Long-tailed Jaegers (*Stercorarius longicaudus*) proved to be a Rough-legged Hawk. Soon another appeared, and as I approached to within a quarter of a mile of an isolated, perpendicular-sided rock in a small canyon at the base of the mountain, the hawks began to attack me. This rock was about 1.6 miles inland from the frozen Mould Bay at approximately 76°21′20″ N. latitude and 119°28′50″ W. longitude.

Fig. 1. Nest site of a Rough-legged Hawk on Prince Patrick Island, Canada, viewed from a distance of about one mile. July 17, 1949.

Both hawks uttered repeated screams, somewhat like one of the screams of the jaeger, and one of the birds dived at me again and again as long as I remained in the vicinity. The other soared, hovered, and screamed, but never came very close to me. The plumage of both individuals was typical of the light extreme of *Buteo lagopus*. I had been previously acquainted with this species on its nesting grounds along the coast of Labrador and in southern Michigan where it is a common winter visitor.

I returned to the area on July 9 and found the suspected nest, about 30 feet from the ground, near the top of the perpendicular-sided rock (Fig. 2). Observed with binoculars from a distance of 10 or 15 yards, the nest appeared to be constructed of sticks and twigs, probably those of the prostrate willow (*Salix anglorum*), the only woody plant known to occur on Prince Patrick Island. Inasmuch as I found no trace of bones or animal remains beneath the nest, it is possible that it had been recently constructed.

On this occasion the brooding hawk left the nest when I was 300 or 400 yards from it and immediately launched an attack against me. It alternately hovered overhead, screaming, and swooped down-wind to within 30 or 40 yards of me. Its mate was content to hover screaming high in the air. It had only to flap its wings slightly to remain more or less stationary in the strong wind. The white bases of its primaries flashed brightly in the sunlight. The hawks possibly were molting on this date, for several flight feathers were missing from the wings of both individuals.

When I visited the place on July 17, the non-brooding hawk came screaming toward me while I was yet a mile from the nest. It dived at me half-heartedly a few times.

The other individual remained on the nest until I had been standing directly beneath it for several minutes. After it flushed, it soared screaming but did not dive. It showed more evidence of molt than the other bird. From a vantage point on the mountain slopes above the nest, I could see that it contained two eggs. In the nest rim was a fresh willow sprig with green leaves.

On this date I located a nest of the Long-tailed Jaeger about half a mile from the hawk nest (see figure in *Wilson Bull.*, 62:130, 1950). Both jaegers furiously attacked

Fig. 2. View of the rock column upon which the nest of a Rough-legged Hawk was located. July 17, 1949, Prince Patrick Island, Canada.

me when I was near their nest, but would leave me, even with my hand on the egg, to attack the Rough-legged Hawk whenever it came near. A resounding scraping of feathers several times indicated that they actually struck the hawk. In defense, the hawk hesitated in flight and turned open beak toward the jaegers when they came very close to it. The harassing tactics of the jaegers reminded me of those of the Eastern Kingbird (*Tyrannus tyrannus*).

When I visited the hawk nest again on August 16 I found it deserted and partially destroyed. The hawks were not to be found. Only birds or human-beings could have reached the nest. Ravens (*Corvus corax*), Glaucous Gulls (*Larus hyperboreus*), and jaegers had been seen in the neighborhood from time to time, and there were unaccountable tracks of human-beings in the vicinity.

Where the hawks hunted was an unsolved mystery. Although the nest was only about 3.5 miles from the Mould Bay Weather Station, the hawks were never seen there, nor for that matter, at any other point away from the immediate vicinity of the nest. No remains of prey were found. Varying lemmings (*Dicrostonyx groenlandicus*) were present in the area but were not abundant. Hares (*Lepus arcticus*) were seen within 200 yards of the nest and seemed not to be disturbed by the screams of the hawks.

I wish to acknowledge the assistance of the Arctic Section of the U.S. Weather Bureau, whose cooperation made possible the studies here reported.—Charles O. Handley, Jr., *U.S. National Museum, Washington 25, D.C., December 15, 1955.*

Purple Finch nesting at Toledo, Ohio.—On June 19, 1955, Mayfield watched a female Purple Finch (*Carpodacus purpureus*) carrying nesting material into a cluster of twigs near the top of a blue spruce in Ottawa Park, Toledo, Ohio. On July 7, McCormick erected an extension ladder with guy wires at this point, and at about 7:00 a.m. found a nest containing two eggs and three young that appeared to have been hatched the same morning.

The nest was supported in a horizontal fork 31 feet from the ground, 8 feet south of the center of the tree, and 1½ feet from the tip of the bough. A third branch from the same fork lay closely over the nest, concealing it except for a small opening directed almost horizontally outward. The nest was built of small twigs and lined with grasses. A rosy-plumaged male sang frequently from the nest tree during the building activities and on several occasions chased a brown-plumaged male that sang nearby. At least two males had been singing in this area when they were noticed by Mayfield several days earlier.

There are several interesting circumstances about this nest: (1) We believe it to be the first nesting of the Purple Finch in northwestern Ohio, the few other nesting records for the state coming from the northeastern portion, where there are remnants of original pine and hemlock. (2) The birds nested among planted spruce in an area where there are no original conifers. The only nesting locations reported for Michigan south of the conifer belt have also been among planted evergreens at Ann Arbor and Bloomfield Hills. (3) The nest was completely invisible from below and was not discovered until McCormick parted the branches above it. (4) The birds seemed little disturbed by human activity nearby. The nest tree was located in one of the busiest portions of the Park, at the edge of a baseball diamond used every day and less than 50 feet from a main road through the Park. The female dodged between passing cars as she carried nesting material.—HAROLD F. MAYFIELD, *2557 Portsmouth Ave., and* JOHN M. MCCORMICK, *1827 Richards Road, Toledo, Ohio, December 28, 1955.*

Winter foods of Evening and Pine Grosbeaks in West Virginia.—During the past few winters Evening and Pine Grosbeaks have been recorded in unprecedented numbers in West Virginia. Evening Grosbeaks (*Hesperiphona vespertina*) were abundant and wide-spread during the winters of 1952–53, 1954–55, and 1955–56. Pine Grosbeaks (*Pinicola enucleator*), rarely recorded in any previous years, were common in mountainous sections during 1954–55, and have returned in some numbers in 1955–56. These visitations have afforded many opportunities for observing food habits of the two species in a region which has been thought of as south of their customary winter ranges.

During all their visits Evening Grosbeaks have, in snowy times in particular, habitually fed on cinders and other gritty material scattered on public highways to prevent car-skidding. They have shown special preference for cinders which have been treated with some salt. On December 22, 1954, five flocks numbering over 200 birds were seen in a ten-mile stretch of state route 32, in Tucker County, West Virginia. Since the birds were slow in flying from approaching cars, many of them were killed, and Wayne Bailey, C. O. Handley and others had the chance to examine numbers of specimens.

From the specimens whose digestive tracts were examined, and through field observations, it became evident that Evening Grosbeaks were eating a much wider variety of foods than might have been expected from their recorded feeding habits northward. The year 1954 saw a remarkably heavy crop of beechnuts (*Fagus grandifolia*) in this region, and birds examined by Bailey and Handley had their crops stuffed with these nuts. Near Morgantown, the home of Richard F. Sowers has a large beech tree on the lawn. Evening Grosbeaks in flocks up to 50 birds searched the grass for these nuts, remaining until May 12, 1955.

On a number of occasions in 1952, Marion L. Hundley and the writer watched Evening Grosbeaks cutting through the hulls of and feeding on the nuts of scarlet oak (*Quercus coccinea*). The birds used their bills to slice open acorns which had fallen to the ground. We examined a number of the partially-eaten nuts.

Another much-eaten food was the winged seeds of tulip poplar (*Liriodendron tulipifera*). Since this tree does not grow very far northward, the birds are obviously adapting their eating habits to new foodstuffs when they move south. Other winged seeds, particularly those of box elder (*Acer negundo*) and white ash (*Fraxinus americana*) were, as might be expected, commonly eaten. Buds of trees, especially of large-toothed aspen (*Populus grandidentata*), birches (*Betula* sp.), and maples (*Acer* sp.) were frequently fed upon.

Not until the winter of 1954-55 did observers in West Virginia have many opportunities to observe food habits of Pine Grosbeaks. In November of that year, however, the birds were widely distributed and locally common in mountainous areas. They remained until February, affording bird students many chances to make field observations.

The birds fed on frozen fruits (particularly apples), seeds of maple and white ash, and on some portion of the twigs of conifers, especially pitch pine (*Pinus rigida*). In addition they made extensive use of other plant foods, some of which would not be available northward. These included seeds of tulip poplar, wild grapes (*Vitis* sp.), black haw and wild raisin (*Viburnum prunifolium* and *V. cassinoides*), flowering dogwood (*Cornus florida*), and greenbrier (*Smilax* sp.). Bailey, James Beach, and others found the birds feeding on fruits of staghorn sumach (*Rhus hirta*).

Local observers are hoping that the wider range of acceptable foodstuffs southward may influence future winter movements of these two bird species.—MAURICE BROOKS, *Division of Forestry, West Virginia University, Morgantown, West Virginia, January 10, 1956.*

A Lincoln Sparrow on the east coast of Florida.—In the course of trapping small mammals at Ormond Beach, Volusia County, Florida, December 26–28, 1954, I caught by fortunate accident a specimen of the Lincoln Sparrow (*Melospiza lincolnii*). The bird, a male, was dead but in good condition when found about 8:00 a.m. on the 27th; it was made into a study skin (R.A.N. 1501) and has been deposited in the collection of the Biology Department at the University of Georgia. The vegetation of the trapping site, which was in a residential area, included grasses, sere composites, a clump of yellow jessamine, camphor trees, and a patch of scrub palmetto. There was no water or marshy vegetation close by; the nearest salt marsh was a quarter mile away, the ocean a half mile away.

As compiled by Sprunt (1954. "Florida Bird Life," pp. 491, 492), previous records of the Lincoln Sparrow in Florida are as follows: Orlando, January 23, 1911, one seen (H. W. Ballantine); Lake Iamonia, March 26, 1919, one seen (L. Griscom); Whitney Plantation, Leon County, March 13, 1925, one collected (H. L. Stoddard); and near Pensacola, December 28, 1952 (and again some days later), one seen (F. M. Weston). As reported by Stevenson (1955. *Audubon Field Notes*, 9(1):22), one of these sparrows was collected by H. L. Stoddard on Alligator Point, Franklin County, October 15, 1954, the first autumnal record for the state. Still more recently, Mr. Stoddard (written communication) established another fall record when he picked up a bird, too much damaged for preparation as a skin, under the television tower on Tall Timber Plantation, northern Leon County, on October 9, 1955.

Although my December bird is by no means a "first" for Florida, it seems nonetheless the first Lincoln Sparrow to be recorded for the Atlantic coastal strip of the southeastern United States.—ROBERT A. NORRIS *(University of Georgia Ecological Studies, AEC Savannah River Plant area), 535 Powderhouse Road, Aiken, South Carolina, January 31, 1956.*

Breeding record of Brewer Sparrow in northwestern Montana.—The Brewer Sparrow (*Spizella breweri breweri*) breeds in Montana east of the continental divide (Saunders, 1921. *Pacific Coast Avif.*, No. 14) and in eastern Washington (Wing, 1950. *Auk*, 66:41). This sparrow, however, has not been recorded from the northwestern mountainous region of Montana.

In the summer of 1955, in the course of work carried on at the Flathead Lake Biological Station of the Montana State University, a small breeding population of the Brewer Sparrow was found in sagebrush habitat at 3,000 feet elevation in the valley of the Little Bitterroot River in Sanders County, Montana. This is about midway between the populations of Washington and eastern Montana. Six specimens were collected 5 miles south of Niarada, July 16 to 22. Two of the birds were adult males with testes in breeding condition (7 and 8 mm.). Two were adult females (ova 1.5 and 1.0 mm.), each with a naked brood patch. The other two were juveniles, one still in postnatal molt with rectrices unsheathing (July 16), the other with postnatal molt completed (July 17). It is likely that these juveniles were recently out of the nest and were produced near the locality where they were collected.

The Brewer Sparrows were found mainly on low hillocks and in swales supporting a sagebrush vegetation in which two types of wormwood, *Artemisia ludovicianus* and *A. dracunculus*, occurred and also two species of rabbit brush, *Chrysothamnus viscidiflorus* and *C. nauseosus*. The shrubs were typically one to three feet high. Also snowberry (*Symphoricarpos* sp.) and hawthorn (*Crataegus* sp.) were scattered about, and in a few moister places service-berry (*Amelanchier* sp.), rose (*Rosa* sp.), and willow (*Salix* sp.) occurred. The life zone is Upper Sonoran. Sagebrush habitat is quite limited in northwestern Montana, and this may be why the Brewer Sparrow has been overlooked here.

Associated with the Brewer Sparrow in the dry sagebrush habitat were Vesper Sparrows (*Pooecetes gramineus*), Horned Larks (*Eremophila alpestris*), and Sharp-tailed Grouse (*Pedioecetes phasianellus*), while a greater variety of species was present at interspersed moist or marshy spots, including the Song Sparrow (*Melospiza melodia*), Traill Flycatcher (*Empidonax traillii*), and the Eastern Kingbird (*Tyrannus tyrannus*). —PAUL H. BALDWIN, *Department of Zoology, Colorado A. and M. College, Fort Collins, Colorado, and Montana State University Biological Station, Bigfork, Montana, February 17, 1956.*

Unusual eggs of the Boat-billed Heron.—The eggs of the Boat-billed Heron (*Cochlearius cochlearius*) have seldom been described, although the species occupies much of the Neotropical lowlands and is fairly common locally. Belcher and Smooker (1934. *Ibis*, p. 583), apparently the first to publish detailed information, described the eggs as "pale bluish-white, the larger pole being usually faintly spotted or splashed with red. Four average 48.5×35.5 mm." Two eggs are considered to comprise a clutch. In Trinidad breeding has been noted in July and August.

Hellebreker's study (1945. *Zool. Meded. Leiden*, 24:243) of 574 (!) *Cochlearius* eggs in the Penard Collection is substantially in agreement with the observations of Belcher and Smooker. The color is described as bluish when fresh, fading to dirty white with age, and very slightly spotted at the large end. Hellebreker reports no unmarked eggs, nor any with "splashes" of color. Measurements (in mm.) of 50 eggs were: average, 50.25 × 35.25; minimum, 44.9 × 33.9, 49.1 × 33.2; maximum, 57.1 × 36.6, 49.4 × 38.9. The breeding season in Dutch Guiana is June and July.

Through the courtesy of Mr. Karl Plath the Chicago Natural History Museum recently acquired four eggs of this heron laid in the Brookfield Zoo by a captive bird that is believed to represent the nominate race. These eggs are unusual in several respects. All four, and two additional eggs (retained by the zoo) laid by the same bird, are pale bluish-white, without the slightest evidence of spotting or other marking, The six eggs were laid from December 20 to January 15, inclusive, as compared with the June–August breeding records of wild birds. Partial verification of the Belcher and Smooker inference that two eggs comprise a clutch is suggested by the paired spacing of the first eggs (December 20, 23; January 5, 9, 12, 15). Measurements of four eggs: 46.3 × 36.3 mm.; 46.0 × 35.8; 44.4 × 35.7; 45.2 × 36.2.—Emmet R. Blake, *Chicago Natural History Museum, Chicago 5, Illinois, January 30, 1956.*

The aftershaft in jacamars and puff-birds.—The presence of an aftershaft in the Jacamars (Galbulidae) and its alleged absence in the closely-related Puff-birds (Bucconidae) has long been used as an important character separating these two piciform families. The supposed absence of the structure in puff-birds apparently originated with the statement by Nitzsch (1840:94–95) who examined the species known today (Peters, 1948) as *Bucco tamatia*, *B. capensis*, *Nystalus chacuru* and *Malacoptila fusca*. Forbes' diagnosis of the family in the monograph by Sclater (1882) also indicated the aftershaft as absent. In subsequent publications Sclater (1891; 1909) used the same diagnosis. Ridgway (1914:371), apparently following Sclater, used "contour feathers without aftershafts" as a character separating the puff-birds from the jacamars. Beddard (1898:189) recorded that in the puff-bird *Malacoptila fusca* "the aftershaft is absent." Beddard's statement is probably the source of Stresemann's (1927–1934:839) notation that *Malacoptila* is without an aftershaft. Stresemann's statement is so worded as to imply that this is the only genus of jacamars and puff-birds entirely lacking an aftershaft.

In an attempt to resolve the seemingly differing opinions as to the occurrence of the aftershaft in the Bucconidae, ventral contour feathers from several species of puff-birds have been examined. Several members of the Galbulidae have been studied for comparison.

In all of the jacamars examined the aftershaft is present and originates as a single shaft from the proximal margin of the superior umbilicus. This single shaft subdivides to form a tuft of approximately 15 (12 to 17 counted) barbs. The barbules lack hamuli and this downy tuft constitutes the vane of the aftershaft. The junction of the hyporhachis with the rhachis of the main feather is discrete and well separated from the proximal barbs of the vane of the main feather.

In the puff-birds the condition of the aftershaft is somewhat different. Instead of arising from a single shaft there is a group of barbs, each arising separately from the proximal margin of the superior umbilicus. That these barbs are homologous to the well-formed aftershaft of the jacamars is indicated by their position, their number (approximately 12) and their direction, namely, parallel to the rhachis of the main feather, not lateral to it as with the barbs of the vane. There is not, however, a sharp break between the lateral barbs and those forming the aftershaft group. The most proximal lateral barbs originate progressively toward the ventral midline of the feather and thus gradually come into alignment with the aftershaft group. It may have been this situation which led Forbes to the conclusion that no aftershaft was present. A point of difference between the aftershaft barbs and the lateral vane barbs lies in the structure of the axis or shafts of these barbs. The shafts of the aftershaft group are fine, round filaments; those of the lateral barbs are relatively broad and flat.

Additional evidence that this group of barbs is homologous to a true aftershaft is found in the studies of Lillie and Juhn (1937) on the origin of the aftershaft. Their observations indicate that barbs arising in the center of the "ventral triangle," and having a vertical arrangement, are properly considered homologous with the aftershaft.

If, in view of this evidence, the aftershaft in the Galbulidae is regarded as homologous to the group of barbs described above in the Bucconidae, the latter group should be diagnosed as possessing an aftershaft. The marked and consistent differences in aftershaft structure however, still provide a mutually exclusive pair of diagnostic family characters.

The species examined were as follows: Galbulidae: *Galbalcyrhynchus leucotis, Brachygalba lugubris, Jacamaralcyon tridactyla, Galbula albirostris, Galbula galbula, Galbula tombacea, Galbula ruficauda, Galbula leucogastra, Galbula dea* and *Jacamerops aurea.* Bucconidae: *Notharcus macrorhynchos, Notharcus pectoralis, Notharcus tectus, Bucco macrodactylus, Bucco tamatia, Bucco capensis, Hypnelus ruficollis, Malacoptila striata, Malacoptila panamensis, Malacoptila mystacalis, Monasa atra* and *Chelidoptera tenebrosa.*

All specimens were examined with a 20× binocular microscope.

Literature Cited

Beddard, F.
1898 The structure and classification of birds. Longmans, Green, and Co., London.

Lillie, F. R. and M. Juhn
1937 The origin of the after-feather in fowl: a process of twinning. *Science,* 86:38–39.

Nitzsch, C. L.
1840 System der pterylographie. English translation by P. L. Sclater, 1867. Ray Society, London.

Peters, J. L.
1948 Check-list of birds of the world. Vol. 6. Harvard Univ. Press, Cambridge.

Ridgway, R.
1914 The birds of north and middle America. Part 6. *U.S. Nat. Mus. Bull.,* 50.

Sclater, P. L.
1882 A monograph of the jacamars and puff-birds, or families Galbulidae and Bucconidae. Porter, London.
1891 Catalogue of the birds in the British Museum. Volume 19. British Museum, London.
1909 Fam. Galbulidae. *In,* Wytsman, Genera Avium. V. Verteneuil and L. Desmet, Brussels.

Stresemann, E.
1927-1934 Aves. *In,* Kukenthal and Krumbach, Handbuch der Zoologie, vol. 7. Walter de Gruyter and Co., Berlin and Leipzig.

Charles G. Sibley, *Department of Conservation, Cornell University, Ithaca, New York, March 6, 1956.*

PROCEEDINGS OF THE THIRTY-SEVENTH ANNUAL MEETING

BY PHILLIPS B. STREET

The Thirty-seventh Annual Meeting of the Wilson Ornithological Society was held at Buffalo, New York, from Thursday, April 26, to Sunday, April 29, 1956. It was sponsored by the Buffalo Audubon Society, the Buffalo Ornithological Society and the Buffalo Society of Natural Sciences.

There were four sessions devoted to papers and two business meetings at the Buffalo Museum of Science. Motion pictures by members of the Local Committee were shown at the Museum on Thursday evening, and the Executive Council met at the Hotel Statler at the same time. The Annual Dinner was held at the Statler on Saturday evening, President Burt L. Monroe delivering the President's Address and Dr. Finn Salomonsen, Zoological Museum, University of Copenhagen, speaking on "The Birds of Greenland," with slides and motion pictures.

Early morning field trips were taken to the shore of Lake Erie, southwest of Buffalo, and to Grand Island in the Niagara River. The Sunday field trip included the Oak Orchard Swamp Wildlife Refuge and the Lake Ontario shore west of Rochester.

First Business Session

President Monroe called the meeting to order at 10:00 a.m., Friday, April 27. Welcomes were given by Mr. George F. Goodyear, President of the Buffalo Society of Natural Sciences, Miss Gertrude Webster, President of the Buffalo Audubon Society, and Mrs. Alice Ulrich, President of the Buffalo Ornithological Society. President Monroe responded. The minutes of the 36th Annual Meeting were approved as published in *The Wilson Bulletin* for September, 1955.

Secretary's Report

The secretary, Phillips B. Street, summarized the principal actions taken at the previous evening's Executive Council meeting as follows:

1. Council accepted invitations from (1) the Minnesota Ornithologists Union, the University of Minnesota, Duluth Branch, and the Duluth Bird Club to meet at Duluth from June 13–16, 1957, (2) the Brooks Bird Club to meet at Oglebay Park, Wheeling, West Virginia, April 24–27, 1958, and (3) the Kentucky Ornithological Society to meet at Kentucky Dam (tentative) in late April, 1959.
2. Keith L. Dixon was reelected editor of *The Wilson Bulletin.*

Treasurer's Report

The treasurer, Ralph M. Edeburn, submitted the following report on the finances of the Society:

Report of Treasurer for 1955

Balance as shown by last report, dated December 31, 1954 .... $ 3,913.14

General Fund

Receipts

Dues:		
Active	$ 3,531.00	
Sustaining	1,475.00	$ 5,006.00
Subscriptions to *The Wilson Bulletin*		522.00
Sale of back issues & reprints of *The Wilson Bulletin*		257.45
Gifts:		
Library Book Fund	$ 26.00	

Miscellaneous	41.70	67.70	
Payments for Foreign Postage		4.40	
Refund from Registration, Stillwater Meeting		96.93	
Miscellaneous Income		10.22	5,964.70
Total Receipts			$ 9,877.84

DISBURSEMENTS

The Wilson Bulletin—printing and engraving	$ 4,009.47	
The Wilson Bulletin—mailing and maintenance of mailing list	823.18	
Editor's Expense—clerical	100.00	
Treasurer's Expense—printing, postage, etc.	250.81	
Secretary's Expense—printing, and postage for annual meeting	334.84	
Committee Expense—printing and postage	62.16	
Purchase of books from Book Fund for Library	22.75	
Purchase of back issues and reprints	10.54	
Miscellaneous—other officers	68.86	
Total Disbursements		$ 5,682.61
Balance on hand in Twentieth Street Bank, Huntington, West Virginia, December 31, 1955		$ 4,195.23

ENDOWMENT FUND

Balance in Savings Account as shown by last report, dated December 31, 1954		$ 454.34
Receipts		
Interest on Investments, Savings and Dividends	$ 293.12	
Sale of U.S. Postal Savings Coupon Bonds (matured)	780.00	
Life Membership payments	750.00	$ 1,823.12
Total Receipts		$ 2,277.46
Disbursements		
Louis Agassiz Fuertes Research Grant	$ 100.00	
Purchase 20 shares Firemans Fund Insurance	1,335.00	
Total Disbursements		$ 1,435.00
Balance in Savings Account, Twentieth Street Bank, Huntington, West Virginia, December 31, 1955		$ 842.46
*Securities Owned**		
U.S. Savings Bonds, Series "G," dated September 1, 1943 (maturity value $1,000.00)	$ 1,000.00	
U.S. Savings Bonds, Series "G," dated December 20, 1944 (maturity value $1,500.00)	1,479.00	
U.S. Savings Bonds, Series "G," dated June 1, 1945 (maturity value $500.00)	489.50	
U.S. Savings Bonds, Series "G," dated July 1, 1945 (maturity value $900.00)	881.10	
U.S. Savings Bonds, Series "G," dated October 1, 1945 (maturity value $1,400.00)	1,370.60	
U.S. Savings Bonds, Series "F," dated February 1, 1947 (maturity value $2,000.00)	1,774.00	
U.S. Savings Bonds, Series "F," dated April 1, 1948 (maturity value $2,000.00)	1,722.00	
U.S. Savings Bonds, Series "F," dated October 1, 1948 (maturity value $1,450.00)	1,210.94	

U.S. Savings Bonds, Series "F," dated April 1, 1950 (maturity value $1,000.00)	809.00	
Total Value of Government Bonds	$10,736.14	
Massachusetts Investors Trust (123 shares at $32.84)	4,039.32	
Firemans Fund Insurance (50 shares at $66.00)	3,300.00	
Total Securities Owned		$18,075.46
Total in Endowment Fund,** December 31, 1955		18.917.92

*Bonds carried at redeemable value December 31, 1955 and stocks carried at closing prices December 31, 1955.

***In Reserve:*

Louis Agassiz Fuertes Research Fund (special gifts)	$ 325.00
S. Morris Pell Fund (special gift)	75.00

Respectfully submitted,
/s/RALPH M. EDEBURN,
Treasurer.

Research Grant Committee

Kenneth C. Parkes, chairman, reported that five applications for the Louis Agassiz Fuertes Research Grant were received, with two being outstanding, resulting in an exact tie vote. The Committee had recommended that Council either (1) award duplicate grants of $100, (2) award a split grant of $50 each, or (3) choose between the two and give a single award. Council voted to make an exception to the general rule and awarded duplicate $100 grants to John Burton Millar, University of Wisconsin, whose study is "An investigation of possible factors involved in the initiation of migration," and Lester L. Short, Jr., Cornell University, who is studying "Hybridization and isolating mechanisms in North American Flickers (*Colaptes*)."

An S. Morris Pell award for the encouragement of bird art of $25 was voted to Donald R. Altemus, State College, Pennsylvania.

Membership Committee

John M. Jubon, chairman, reported by letter that the names of 169 prospective new members enrolled since the 1955 meeting were posted for the inspection of members and to be elected at the final business meeting. On December 31, 1955, the Society had 106 life, 297 sustaining and 1216 active members, a total of 1619. 13 new life members have been added since January 1, 1955. There were 163 institutional subscriptions to *The Wilson Bulletin.*

Library Committee

H. Lewis Batts, chairman, reported by letter. During the past twelve months the Society has received gifts to the Library of 66 books, 214 reprints, 140 magazines, 33 bulletins, 22 pamphlets and one phonograph record. Ten additional books have been purchased by funds given by members. In all, 72 persons and 3 institutions have made gifts to the Society Library. In addition, the Library has received serial publications on birds from all over the world in exchange for *The Wilson Bulletin.* These exchanges now total 80 titles; 20 other serials are received as gifts.

The University of Michigan has done its part by keeping the accessions catalogued and the completed serial volumes bound up to date. It has also supplied the manpower and outbound postage for sending out loans to all members who have requested items. The University Museum of Zoology staff has also many times volunteered bibliographic research help to Society members who needed help. The University has continued to receive and store back stock of *The Wilson Bulletin* and to send out numbers, volumes, and sets on order from the Treasurer.

The annual list of books added to the Library was not published last September but will be published this year. At that time we also hope to publish a list of the serial holdings.

There have been many generous gifts, but the outstanding donor is Capt. Karl Haller of the U.S. Air Force, a member of the Society for 22 years. His gifts, 28 books since the last publication of the Society holdings, included such important and costly items as Peters "Check-list of Birds of the World" (7 vols.); Ridgway and Friedmann, "Birds of North and Middle America" (11 vols.); Bannerman's "Birds of the British Isles" (4 vols.); and Cory and Hellmayr, "Catalogue of Birds of the Americas" (19 vols.).

Conservation Committee

Robert A. Pierce, chairman, reported by letter. During 1955, three articles were prepared by the Conservation Committee for publication in *The Wilson Bulletin.* Two of these have been published; one on Poisons and Wildlife will appear shortly. A request was received from the British Waterfowl Trust for permission to reprint the article on waterfowl conservation by Frank Bellrose, Jr. and Thomas G. Scott. The writer wishes to express his sincere appreciation for the splendid cooperation which he received from each member of the Committee which, aside from your chairman, was composed of P. F. English, Lee E. Yeager, Thomas G. Scott and Frank Bellrose, Jr.

As most of the Society members know, there are a number of pressing current conservation problems. One of the most important at the moment is the invasion of wildlife refuges and National Forests by the armed forces and by commercial interests. One of the latest moves in this respect is the introduction of two bills, S. 3360 and H.R. 9965, by which the U.S. Army seeks Congressional approval for the transfer of 10,700 acres of the Wichita Mountains National Wildlife Refuge in Oklahoma for enlargement of Fort Sill. Previous attempts by the Army to secure this land have failed and the writer would like to point out that undoubtedly the vigorous individual efforts of some of the members of this organization were an important factor in encouraging Secretary McKay to refuse the Army's request for transfer of this land to Fort Sill. Your efforts must continue, however.

The Armed Services are attempting to take over all or parts of various other refuges, National Forest areas or Park areas. The plan to extend the photoflash bombing area to the edge of the Aransas National Wildlife Refuge in Texas with its unpredictable effects upon the Whooping Cranes is familiar to all. Public opposition appears to have stopped this latter project, although it is well to remember that the projects of some agencies never seem to die but only go into hiding for a time. The policy of making oil and gas leases on National Refuges does not appear to be a management technique which can enhance the value of these areas very greatly for wildlife but the writer does not know the present status of this policy.

Some good things have happened for conservation during 1955. Revision of the old mining law makes it possible to eliminate most fraudulent or invalid mining claims. A method of distributing the $13,500,000 surplus Federal Aid to Wildlife Restoration funds was authorized by Congress and the uses that can be made of the money were broadened somewhat. According to information reaching the writer, a revised plan of State and Federal cooperation may be proposed which will require the gathering of more adequate ecological data to support administrative decisions regarding introductions of exotic and native animals. This plan, if accepted and followed by the States, cannot help but improve this program. The plan cannot prevent the individual States from continuing their own programs, however, and this fact should serve to remind us that much conservation work is done at the State and local levels and that each of us can perform a service for conservation in our own States and localities.

Congressional action on various bills of importance to conservation has been influenced by the activities of various conservation groups and individuals. The writer wishes again to stress the importance of each individual's personal efforts in bringing matters of conservation importance to the attention of lawmakers and conservation officials.

Endowment Committee

In the absence of Robert T. Gammell, chairman, Leonard C. Brecher spoke briefly on the value of life memberships, stressing the fact that a life membership taken out in four installments during one's years of high earning power may be doubly appreciated upon retirement. He read the names of life members enrolled since January 1, 1955.

Temporary Committees

The President appointed the following temporary committees:

Auditing Committee

N. Bayard Green, Chairman
Lois Garrett
Hugh Land

Resolutions Committee

Mrs. Betty Carnes, Chairman
Maurice Graham Brooks
Pershing B. Hofslund

Nominating Committee

Aaron M. Bagg, Chairman
Karl H. Maslowski
A. W. Schorger

Second Business Session

The final business session was called to order at 10:00 a.m., Saturday, April 28.

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 to be in good order.

Report of the Resolutions Committee

BE IT RESOLVED that the Wilson Ornithological Society express its deep appreciation to the Buffalo Audubon Society, the Buffalo Ornithological Society and the Buffalo Society of Natural Sciences for their warm hospitality at this, our Thirty-seventh. Annual Meeting. Most especially we wish to thank Fred T. Hall and the hard-working members of the Local Committee for their most efficient handling of the many time-consuming details of this meeting.

The projection of our slides and films by Charles Simmons has been especially notable.

We have enjoyed the stimulating exhibits and well planned facilities of the Museum of Science. We are most grateful to the Museum staff and the Local Committee for making our Buffalo stay so pleasant and profitable.

BE IT FURTHER RESOLVED that the members of the Wilson Ornithological Society be urged in this critical time for conservation interests to express their opinions and desires to the appropriate legislative and administrative bodies.

Election of Officers

The Nominating Committee proposed the following officers for the coming year: President, John T. Emlen; 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, Harvey I. Fisher (term expires 1957), Leonard C. Brecher (term expires 1958), and Andrew J. Berger (term expires 1959).

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, April 27

Harold D. Mitchell, Buffalo, New York, *Ornithological Introduction to the Niagara Frontier*, slides.

Clark S. Beardslee, Kenmore, New York, *Birds' Migration Routes in the Niagara Frontier Area*, slides.

Frederick M. Helleiner, Toronto, Ontario, *Bird Observations on a Trans-Atlantic Crossing.*

Finn Salomonsen, Zoological Museum, University of Copenhagen, *The Greenland Bird Banding System*, slides.

James Baird, Norman Bird Sanctuary, Newport, Rhode Island, *Yellow-throated Warbler Breeding in Sycamores and Collected Along the Delaware River in New Jersey* (read by title).

Donald J. Borror and Carl R. Reese, Department of Zoology and Entomology, Ohio State University, *Vocal Gymnastics in Wood Thrush Songs* (presented on tape), slides.

William W. H. Gunn, Federation of Ontario Naturalists, Toronto, Ontario, *Some Warbler Songs on Tape*, tape.

Dean Amadon, American Museum of Natural History, *Some Problems in Preparing an Exhibit of Local Birds*, slides.

Josselyn Van Tyne, University of Michigan Museum of Zoology, *The Discovery of the Evening Grosbeak*, slides.

Elsa G. Allen, Laboratory of Ornithology, Cornell University, *Some Manuscript Sources in Early American Ornithology*, slides.

James Hartshorne, Laboratory of Ornithology, Cornell University, *The Voice of the Trumpeter Swan*, tape and slides.

Arthur A. Allen, Laboratory of Ornithology, Cornell University, *The Voice of the Whooping Crane*, tape and motion pictures.

Saturday, April 28

Robert L. Smith, Department of Conservation, Cornell University, *Some Factors Influencing the Colonization of Coniferous Plantations by Birds*, slides.

David A. West, Department of Conservation, Cornell University, *Problems in the Appraisal of Hybrid* Pheucticus *Grosbeaks*, slides.

Lester L. Short, Jr., Department of Conservation, Cornell University, *Hybridization Between Gilded and Red-shafted Flickers*, slides.

Charles G. Sibley, Department of Conservation, Cornell University, *Hybridization and Sexual Selection as Factors in the Evolution of Birds*, slides.

Oliver H. Hewitt, Department of Conservation, Cornell University, *Studies of the Newfoundland Willow Ptarmigan*, tape and slides.

Gerald R. Rising, Rochester, New York, *The New York State Waterfowl Census.*

Robert D. Burns, Michigan State University, Department of Zoology, *Movements of the Cardinal*, slides.

Maurice Graham Brooks, West Virginia University, *Diurnal Migration Along Certain Appalachian Ridges.*

Kenneth C. Parkes, Carnegie Museum, *Winter Survival of an Escaped Audubon's Caracara.*

Lawrence I. Grinnell, Ithaca, New York, *African Birdlife from Cape to Equator*, motion pictures.

Edward M. Brigham, Jr., Kingman Museum of Natural History, Battle Creek, Michigan, *Some Birds of Woody Island, Lake Bowdoin National Wildlife Refuge, Montana*, motion pictures.

Crawford H. Greenewalt, Wilmington, Delaware, *Slow-Motion Pictures of the Ruby-throated Hummingbird in Flight* (read by title), motion pictures.

Attendance

Members and guests who registered totalled 145. Eleven states, the Province of Ontario, Argentina and Denmark were represented.

From **Indiana**: 2—*Indianapolis*, Mildred Campbell, Mrs. S. G. Campbell.

From **Kentucky**: 4—*Anchorage*, Mr. and Mrs. Burt L. Monroe; *Louisville*, Mr. and Mrs. Leonard C. Brecher.

From **Massachusetts**: 3—*Amherst*, Jerry Brown; *Dover*, Mr. and Mrs. Aaron M. Bagg.

From **Michigan**: 11—*Alma*, Lester E. Eyer; *Ann Arbor*, Mr. and Mrs. Ralph Branch, Peter Stettenheim, Josselyn Van Tyne; *Battle Creek*, Mr. and Mrs. Edward M. Brigham, Jr., Lawrence H. Walkinshaw; *Jackson*, Robert A. Whiting; *Lansing*, Robert D. Burns; *Mt. Pleasant*, Nicholas L. Cuthbert.

From **Minnesota**: 1—*Duluth*, Pershing B. Hofslund.

From **New Jersey**: 1—*Tenafly*, Betty Carnes.

From **New York**: 78—*Albany*, Ralph S. Palmer, Mrs. Dayton Stoner; *Alleghany*, Stephen W. Eaton; *Armonk*, Kenneth D. Morrison; *Buffalo*, Agnes C. Abrams, Mr. and Mrs. Harold H. Axtell, Sylvia Booth Brockner, John H. Caul, Mr. and Mrs. Edward R. Cummiskey, Richard Drobits, Mary Louise Emerson, Rose W. Facklam, John S. Filor, Mrs. Hans H. Gros, Fred T. Hall, Bernard Hochmuth, Ellsworth Jaeger, Ralph Kaz, Mercedith Lovelace, Mrs. Lloyd Mansfield, Harold D. Mitchell, Bernard Nathan, Donald J. Powers, Eugenia Praemassing, Kathryn Praemassing, Mr. and Mrs. Malcolm M. Renfrew, Frances M. Rew, Edith M. Robson, James Savage, Albert R. Shadle, Charles E. Simmons, Mrs. Howard C. Smith, William R. Taber, Mrs. Margaret M. Teare, Heather G. Thorpe, Lena Turner, Mr. and Mrs. Edward C. Ulrich, Mrs. Elsie E. Webb; *Delmar*, Victor H. Calhane; *East Aurora*, R. D. Coggeshall; *Fredonia*, Willard F. Stanley; *Hamburg*, Mrs. John E. Bacon, Mrs. LeRoy Melberg; *Ithaca*, Hermon P. Adam, Mr. and Mrs. Arthur A. Allen, Millicent S. Fecken, Richard B. Fischer, Lawrence I. Grinnell, James M. Hartshorne, Mrs. Southgate Y. Hoyt, Edward L. Seeber, Lester L. Short, Jr., Charles G. Sibley, Robert L. Smith, David A. West, Maurice J. Zardus, Jr.; *Kenmore*, Clark S. Beardslee, Alice S. Dietrich, Philip S. Greene, Frances Rathbun, Gertrude G. Webster; *Manhasset*, Mary Anne Heimerdinger; *New York*, Dean Amadon, Mrs. C. N. Edge, Eugene Eisenmann; *Orchard Park*, Robert F. Andrle; *Rochester*, H. Everest Clements, Reginald N. Hartwell, Mr. and Mrs. Gerald R. Rising; *Waterloo*, Jason A. Walker; *Watertown*, Harold W. Hill; *Williamsville*, Marie A. Wendling.

From **Ohio:** 16—*Cleveland*, Mr. and Mrs. H. C. Dobbins, Adela Gaede, Warner Seely, Mildred Stewart; *East Cleveland*, Vera Carrothers; *Painesville*, Mrs. Robert V. D. Booth; *Poland*, Mr. and Mrs. Evan C. Dressel; *Steubenville*, Mr. and Mrs. Clinton S. Banks, Earl W. Farmer; *Toledo*, John M. McCormick, Mr. and Mrs. Albert R. Tenney, Robert H. Turner.

From **Pennsylvania:** 9—*Allport*, Elsie C. Erickson; *Butler*, Mr. and Mrs. Frank W. Preston; *Chester Springs*, Mr. and Mrs. Phillips B. Street; *Kane*, Sybil K. Kane; *Mt. Jewett*, Mrs. Florence Kane Johnson; *Pittsburgh*, Kenneth C. Parkes. George B. Thorp.

From **West Virginia:** 2—*Huntington*, Ralph M. Edeburn; *Morgantown*, Maurice G. Brooks.

From **Wisconsin:** 1—*Madison*, John T. Emlen.

From **Ontario, Canada:** 14—*Fort William*, A. E. Allin; *Guelph*, Alex T. Cringan. H. G. Mack, A. de Vos; *Hamilton*, Eric W. Bastin, R. G. C. MacLaren, George W. North; *Pickering*, Mr. and Mrs. J. Murray Speirs; *Toronto*, J. Bruce Falls, Mr. and Mrs. William W. H. Gunn, Frederick M. Helleiner, Mrs. Osborne Mitchell.

From **Argentina:** 1—*Buenos Aires*, William H. Partridge.

From **Denmark:** 1—*Copenhagen*, Finn Salomonsen.

POISONS AND WILDLIFE

A Contribution from the Wilson Ornithological Society Conservation Committee

The empirical title of this article is an admission of the broadest possible consideration, here, of the relationships of animal-control poisons to wildlife generally. Indeed, this discussion cannot be a coverage, however broad, of a subject handled only inadequately in many papers and texts; rather, it is an attempt to sketch the amazing scope and application of poisons used in control, and to contemplate their mass impact on mammals, birds, fish and other life esteemed by man.

In this attempt, the commentator wishes to be objective. Poisons, with affinities for both production and destruction of valuable crops, are obviously two-sided in significance; no discussion, even in a medium dedicated to resource appreciation and management, should overlook poison's role in the provision of man's food and fiber, to say nothing of his health and well-being. This, then, is neither approval nor denunciation of poisons *per se*; it is a plea for facts based on objective and controlled research; and moderation in the use of new, highly toxic poisons until such information is available.

Some agricultural remedies involving poisons are now so widely accepted that they are taken as a matter of course. The use of lead arsenate in potato-bug control is illustrative, though but one of scores of examples. Thousands of poison compounds—organic and inorganic, natural and synthetic—are known, but probably not over 100 are actually employed in insecticides. Others are being introduced at a rapid rate.

Herbicides, or plant-killing compounds, are newer, but they have a manifest potential in the field of plant control as great as insecticides and related poisons in animal control. Even less is known of their ultimate effects on birds and mammals than those of the older, longer-used animal-control poisons. Many of these effects are from the standpoint of cover, which also represents, directly or indirectly, an important source of wildlife food supply.

It is unfortunate, indeed, that insecticides and herbicides collectively—so dramatically successful for the specific purposes for which they were developed—constitute a serious threat to exceedingly valuable wild-animal life.

It would seem that the greatest threat to wildlife inherent in insecticidal and herbicidal poisons lies in their prodigiously increasing use, particularly in cases where their effects on wildlife have not been adequately determined. Some idea of the tremendous volume of poisons used is indicated by the following figures:

In the United States, largely in the control of cotton insects, 20,000,000 pounds of calcium arsenate and 30,000,000 pounds of lead arsenate are used annually.

In the United States, in 1952, about 85,000,000 pounds of DDT and 92,000,000 pounds of benzene hexachloride (BHC) were used, most of it being distributed by plane.

The amazingly rapid increase in the use of *synthetic* organic insecticides is indicated by these figures: 1940—287,500 pounds; 1942—2,217,000 pounds; 1944—16,205,000 pounds; and 1952—225,000,000 pounds. The increase from 1940 to 1952 was over 781 per cent, or an average increase of more than 66 per cent per year! These totals do not include *natural* organic and inorganic insecticides. The total volume of insecticides used in North America each year is about 300,000,000 pounds!

Figures for the total *area* to which insecticides are applied likewise are staggering. In broad summary, it can be said that insect-control poisons of one sort or another, up to about 60 pounds per acre, are applied annually to land that produces approximately one-half of our food, forage, and fiber, and a small part of our timber. An estimated 80,000,000 acres are annually involved!

Herbicides are newer, as stated. They affect wildlife chiefly by modifying, and sometimes destroying, the habitat. Both herbaceous and woody vegetation are involved, as are grasses and aquatic plants. Herbicides have not yet attained the use, either in volume or area, characteristic of insect-control poisons. Their potential, however, may be as far-reaching: field borders, fencerows, and indeed the fields themselves, are being sprayed with brush- or weed-killers in every state; and thousands of miles of roadsides, and great lengths of railroad- and transmission-line right-of-ways, are similarly treated. See a later statement concerning benefits.

Finally, there are plans for turning parts of the sagebrush plateaus of the West into grassland in the interest of more and better livestock range. This interest was exemplified in the 1956 Annual Meeting of the American Society of Range Management in Denver, when two half-day sessions were devoted to this subject. The first was entitled, "Control of Undesirable Vegetation"; the second was under the heading, "Possibilities and Economics of Improving Range Land Through Management, Improvements, Weed and Brush Control, and Reseeding." Another possible use for herbicides in the West, now in the testing stage, is in the control of pocket gophers on high-country range. The application lies in the killing of weeds, the preferred cover and food source of the pests. The ironical note is that weeds, now considered a major problem on western ranges, apparently gained their present dominance through the over-grazing of intermixed grasses, primarily by livestock! If accompanied by capacity-rated grazing pressure, herbicides may indeed be the expensive cure, or partial cure, to this instance of wide-scale misuse! No one knows what it will do to birds and mammals.

The history of economic and industrial development in America is replete with resource abuse. One needs only to point to the loss of one-fifth of the top soil from cleared lands; polluted waterways in every state; oil slicks along coastlines; the "cut out and get out" lumbering policy; fantastic waste of gas and oil in some drilling and pumping operations. There are scores of lesser examples. Broadly speaking, the use of insecticides to date has been relatively unrestricted, since frequency and volume of application are in almost all cases the prerogative of the operator. To be sure, dosage and directions for use, as provided by the manufacturers or agricultural bulletins, afford safeguards of very real value, but, properly perhaps, with emphasis on crop protection and economics rather than safety to game and fish. Therefore, only inadequate consideration has been given to wildlife interests, regardless of their economic, recreational, or aesthetic value. Exceptions have been the very valuable work of institutions and government agencies, often under pressure to provide, or approve, *quickly*, the needed poison for insect or pest control.

It will be of interest to note the use, and regulation of use, of herbicides, which obviously appear to be on the threshold of countrywide employment as vegetation controls. With specific or semi-specific preparations for most vegetative types—broad-leaved forbs, woody growths, grasses and sedges, and aquatics; with methods of application ranging from hand to airplane; with costs far lower than control by machine or hand labor; and with results more certain, or even selective, there is little doubt that use, if permitted, will increase in mushrooming proportions. There will certainly be proposals for region-wide programs of vegetation control—as per sagebrush eradication already referred to—in the interest of a particular group or industry. The ultimate loss to birds and other wildlife, in such events, will seemingly be in proportion to the net destruction of habitat. Transition from sagebrush to grazed grassland, as an example, does not promise improvement in the native fauna.

In appraising the relationships of poisons to wildlife, even in over-broad terms, there are a number of things for conservation folk to be thankful for: (1) insecticide loss to birds and other wildlife is due mainly to secondary poisoning, the result of eating poisoned insects and other life. Toxicity of poisoned insects to birds and mammals is generally lower (in some cases, much lower) than is the insecticide to insects. Lethal dosage from this source of ingested food is far less probable than from primary poisoning, such as the spectacular results obtained from strychnine-treated grain in blackbird control.

(2) The most highly toxic, non-antidotal poisons, such as sodium fluoroacetate (1080), are strictly controlled by governmental agencies and are released only under bond or other trust to responsible persons.

(3) There is considerable research into the effects of insecticides, though much less on the effects of herbicides, on wildlife. Most such studies are activated concurrently with, or after, the poisoning operation. California, Alabama, Wyoming, Washington, Connecticut, Ontario, and numerous other states and provinces have conducted, and still are conducting, valuable studies in this field.

(4) Control of vegetation with herbicides, at least under certain conditions, may be beneficial to wildlife, including game birds, according to a recent study in Wisconsin. In this case, the plant successional stage is changed to the advantage of Sharp-tailed Grouse. Any species profiting from the transition of dense woody cover to grass and weeds might be similarly affected. Somewhat similar results have been indicated on sprayed right-of-ways in New England. Minnesota has reported that aerial sprays are an aid to forestry. Fortunately, the interested agencies in this case appear to be making carefully controlled studies before launching a statewide program. They claim that: "Tests have proved conclusively that the herbicides used are not harmful to wildlife and fish." This presumably, is in reference to direct poisoning; there is no statement concerning the effect to wildlife of changes brought about by ". . . plantation release . . ." or ". . . control of fast-growing weeds and the suckers or sprouts of such broadleaf trees as aspen, birch, and oak . . ." This is deer food *par excellence.*

On the other hand, reasons for apprehension on the part of game conservationists grow out of certain characteristics of some of the poisons used. For example, hydrocarbons such as DDT, Toxaphene, and Dieldrin may be cumulative in their toxic effects. Thus, single exposures may not cause mortality, but repeated applications, in the same year, or in successive years, may attain lethal concentrations in game birds, and presumably in others. If not killed, physical damage to vital organs or processes may result. Wildlife populations may thus be affected by such insecticides in three ways —outright killing, delayed killing, or a decline in the reproductive rate of the population.

A precise evaluation of wildlife losses, direct and indirect, from control poisons is presently impossible, despite the certainty of attrition and the availability of a literature encompassing several thousand titles. The inability of even an informed analyst, to say nothing of this layman writer, to make such an evaluation is due to nothing more than the lack of results from controlled experimentation; for as stated, most wildlife-poison studies have been of an ". . . after the horse is stolen . . ." variety.

This discussion has been generalized purposely in an effort to be fair to both sides—both legitimate in primary objectives—of an intricate and controversial problem. But in a field as vast as that of insecticidal and herbicidal poisons, one as relatively new and unstudied, and one particularly lacking in the results of objective and controlled investigation, no empirical generalization can be made. The reviewer can only conclude: *There is probably no more needed or opportune field for wildlife research.*

As an obvious recommendation, therefore, the writer urges intensified investigational programs on the part of institutions and governmental agencies, and by wildlife agencies, to the end that factual information ample for sound, renewable, natural-resource management is made available. Such knowledge is not now at hand. The need for it will almost certainly become more acute before the conflict of interest inherent between wildlife values and even legitimate plant and animal control is resolved. Other control programs, involving wide-scale use of new, highly toxic, and inadequately tested poisons, may prove tragic indeed, if enacted.—Lee E. Yeager.

LETTER TO THE EDITOR

The review by Irby Davis of Eugene Eisenmann's "The Species of Middle American Birds" (1955. *Wilson Bull.*, 67:317–318) demands answering comment for a number of reasons. It would be unfortunate if this extremely valuable book did not reach the readership it deserves merely because it does not agree, with the personal views of the reviewer in one minor aspect, that of vernacular names.

Indeed, the overwhelming concern in this review is this matter of the selection of common names, and the very first sentence reads, "The main purpose of this little book is to provide a suggested list of English or common names for the benefit of persons visiting Mexico or any of the Central American countries." May I point out a few errors in this sentence? First, the basic purpose of this book is not to provide a list of common names; its purpose and great value is that it provides, *for the first time, a complete and up-to-date check list of the species of birds recorded in Middle America.* In doing so, Eisenmann has done a great service not only to *visitors* to this region, but to all students of the ornithology of the area. It is a complete species list as correct in its scientific nomenclature as is currently possible (with copious footnotes explaining alternate points of view), with a summary of the range of each species, including many unpublished or previously unorganized data; it includes an excellent regional bibliography. The same first sentence seems to imply that the emphasis is on Mexico, which is not true, nor is the book a handy guide for the traveller. It is not a guide at all. I find the rest of the review, while perhaps not as misleading as its opening, no less defensible.

For example, the reviewer makes this statement that should not go unchallenged: "It seems that we will never know just what constitutes a species." But among modern ornithologists, the species has a well-defined meaning. What we do not yet have in all cases is the factual knowledge that enables us to determine with finality where to put our species boundaries. The more knowledge we have, the more clear and stable will our species boundaries become. The species concept, however, should not be at issue here, nor should the reviewer question (he calls it futile) the goal of a single appropriate name for each species. The A.O.U. Check-list Committee has been striving towards this goal for species north of the Mexican border. Should another principle be applied south of it?

Perhaps the most surprising statement in the review is that "Species are lumped or split so frequently by taxonomists that the amateur field student should not be expected to change his common name for a bird, which he has long known, just because there has been a new technical grouping suggested, and his bird has now perhaps been made a race of some South American species that he has never heard of before." The inferences here are that taxonomists switch birds back and forth like an aimless, endless game of volleyball, that there is no progress towards the ultimate truth in taxonomy, and finally that there is something about the home grounds of the reviewer that makes a race found in Mexico more important in a pan-American species than races found elsewhere.

It may be, as the critic asserts, that some field students want separate names for every subspecies they think they can distinguish in the field. But the purported identification of subspecies is now deplored by all the experts, and there will be no subspecific vernaculars in the forthcoming A.O.U. Check-list. The book in question, furthermore, is a *species* list, and nothing more, although in itself it represents thousands of hours of scholarly work. A demand for names for all the thousands of subspecies seems contradictory from a critic who has just complained about the instability of the (far more stable) *species.* If subspecific vernaculars are ever wanted, Eisenmann has prepared the ground with truly pan-American specific names, which can be converted, with a single modifier, into subspecific names that indicate true relationships, a benefit heretofore generally lacking.

The bulk of the review in question dwells on Eisenmann's *choice* of vernaculars. The review gives the unwarranted impression that the names selected would be strange to current workers in Mexican ornithology. In fact, the names are those found in Blake's well-known "Birds of Mexico" (1953), the only manual and guide in its field, and a work to which every serious student must constantly refer. These names were also adopted in Paynter's "Ornithogeography of the Yucatan Peninsula" (1955), and agree with about 90 per cent of those in Edwards' "Finding Birds in Mexico." Most of the Mexican bird names had previously been used in Sutton's "Mexican Birds" (1951), and were largely drawn from the earlier monographs of Ridgway and Hellmayr. But Mexico was not the only country included in this list, and in choosing the most appropriate name for polytypic species ranging through several thousand miles, access to broad collections is required (which Eisenmann had and the reviewer did not have) and the occasional discarding of a name "long known" in Mexico may have been the only sensible solution.

The field of vernaculars is apparently charged with emotion. I will not comment at length on the reviewer's vague disparagement of the choices, beyond saying that the names particularly mentioned as unwarranted novelties introduced by Eisenmann were oddly enough not novelties at all. "Slaty-breasted Tinamou" dates back to Sutton's book and was adopted in the subsequent Mexican works mentioned. The same applies to "Spot-breasted Woodcreeper." The use of "Woodcreeper" as the general name for the Dendrocolaptidae goes back at least to 1929, when Frank M. Chapman adopted it in his well-known book "My Tropical Air Castle." This usage has been followed in the Mexican works mentioned and in many other papers on neotropical birds. The name "Woodhewer" translates the technical designation, but creates a misleading impression of destructiveness, while "Woodcreeper" well suggests the behavior and appearance of these birds.

The reviewer is obviously a traditionalist who would hew to the older names, and prefers perfunctory translations of the technical names, no matter how erroneous, misleading, or inappropriate. This attitude is inconsistent with his complaint that technical names show little stability. It is the belief of this writer, on the other hand, that, if anything, Eisenmann was over-cautious on the side of traditionalism. Surely, where Middle American common names are concerned, nothing is "long known." The great days of ornithology in this region lie ahead; for every student of today or reference of the past, surely a thousand will yet come. If changes are needed, better now than later. Eisenmann's list supplies a basis for pan-American uniformity of usage, a great step forward. It probably will never satisfy everyone in every detail, but it is a major contribution, and surely even its severest critic will find constant use for it, for years to come.—Robert S. Arbib, Jr.

A notice concerning decisions on the names for certain birds recently adopted by the International Commission on Zoological Nomenclature has been provided by the Secretary to the Commission, Francis Hemming.

NOTICE is given that the International Commission on Zoological Nomenclature has recently taken a series of important decisions on the names for certain birds regarding which applications to the Commission were published in October 1952 in Part 1/3 of volume 9 of the *Bulletin of Zoological Nomenclature.* Among the decisions so taken the following are of interest to American ornithologists:

(1) suppression of the generic name *Colymbus* Linnaeus, 1758, and acceptance of the generic name *Gavia* Forster, 1788, for the divers (loons) and of *Podiceps* Latham, 1787, for the grebes (*Opinion* 401);

(4) suppression for nomenclatorial purposes of the names by Linnaeus published in 1776 in the "Catalogue of Birds, Beasts, . . . in Edwards' Natural History" (*Opinion* 412);

(5) validation of the name *Columba migratoria* Linnaeus, 1766, for the Passenger Pigeon (*Direction* 18);

(6) validation of the generic names *Bubo* Dumeril, 1806, *Coturnix* Bonnaterre, 1790, *Egretta* Forster, 1817, and *Oriolus* Linnaeus, 1766, by the suppression of older homonyms (*Direction* 21);

(7) acceptance of *Gallinago* Brisson, 1760, and rejection of *Capella* Frenzel, 1801, as the generic name for the Snipe (*Direction* 39).

The foregoing *Opinions* and *Directions* are now in the press and will be published at an early date. All inquiries should be addressed to the Publications Officer, International Trust for Zoological Nomenclature (address: 41 Queen's Gate, London, S.W. 7, England).

In this third supplementary list of the books in the Library are all new titles received since the appearance of List B-2 in December, 1954. Members who would like reprints of Complete List 2 and its supplements may write to the Wilson Ornithological Society Library, Museum of Zoology, Ann Arbor, Michigan.

The Library this year has grown most gratifyingly, especially in its holdings of the major modern reference works—Ridgway and Friedmann; Cory and Hellmayr; Peters; Mackworth-Praed and Grant; Bannerman.

Names of donors to the Library are published in each issue of the *Bulletin*. Members living as far away as Sigfrid Durango (Sweden) and F. Haverschmidt (Surinam) have sent contributions. The exceptional generosity to the Library shown by H. Lewis Batts, Jr., and Karl W. Haller deserves the Members' special gratitude.

The Library Book Fund for purchase of new ornithological works has been nearly expended. Even small donations to this fund result in major improvements to the Library.

BOOKS: List B-3

Books added to the Wilson Ornithological Society Library since publication of List B-2 (*Wilson Bulletin*, 66, No. 4, December 1954:275–276; for Complete List 2, see *Wilson Bulletin*, 64, No. 3, September 1952:176–185).

Audubon, John J. (biog. of). Herrick, Francis H., Audubon the Naturalist. (2 vols.) 1917.

Bailey, Florence M., Handbook of Birds of the Western United States. (rev. ed.) 1927.

Bailey, Wallace, Birds in Massachusetts: When and Where to Find Them. 1955.

Bannerman, D. A., The Birds of the British Isles. (4 vols.) 1953–1955.

Beebe, [C.] William, The Bird: Its Form and Function. 1906.

Bermuda Book Stores, Birds of the Bermudas. Undated.

Buller, Walter L., Manual of the Birds of New Zealand. 1882.

Carr, W. H., Desert Parade. 1947.

Chamberlain, Frank W., Atlas of Avian Anatomy: Osteology, Arthrology, Myology. 1943 [1944].

Chapman, F. M., Handbook of Birds of Eastern North America. (2nd rev. ed.) 1932.

Cory, Charles B., C. E. Hellmayr, and B. Conover, Catalogue of Birds of the Americas. 1918–1949.

Coues, Elliott, Field Ornithology. 1874.

Dalrymple, B. W., Doves and Dove Shooting. 1949.

Dewar, Douglas, Himalayan and Kashmiri Birds. 1923.

Dharmakumarsinhji, R. S., Birds of Saurashtra, India. [1955].

Dobzhansky, Th., Genetics and the Origin of Species. (2nd rev. ed.) 1941.

Edwards, E. P., Finding Birds in Mexico. 1955.

Fehringer, Otto, Die Singvögel Mitteleuropas. [1922?].

Fisher, James, A History of Birds. 1954.

Fisher, James, Bird Recognition. (vol. 3) 1955.

Friedmann, Herbert, The Honey-guides. 1955.

Géroudet, Paul, La Vie des Oiseaux. (5 vols.) 1946–1954.

Gould, John (ed. Eva Mannering), Mr. Gould's Tropical Birds. [24 plates, with Gould's descriptive text] 1955.

Greene, W. T., Parrots in captivity. (3 vols.) 1883–1887.

Grinnell, J., and Margaret W. Wythe, Directory to the Bird-life of the San Francisco Bay Region. 1927.

Griscom, Ludlow, and Dorothy E. Snyder, The Birds of Massachusetts. 1955.

Hausman, L. A., Beginner's Guide to Attracting Birds. 1951.

Haverschmidt, F., List of the Birds of Surinam. 1955.

Hellmayr, C. E., *See* Cory *et al.*

Hendy, E. W., More About Birds. 1950.

Jaques, H. E., How to Know the Land Birds. 1947.

Lowe, Frank A., The Heron. 1954.

Lynes, H., Review of the Genus Cisticola. (including plates) 1930.

McGregor, Richard C., Index to the Genera of Birds. 1920.

Mackworth-Praed, C. W., and C. H. B. Grant, Birds of Eastern and North Eastern Africa. 1955.

Mannering, Eva (ed.), *See* Gould, John.

Matthews, G. V. T., Bird Navigation. 1955.

Mayr, Ernst, and E. T. Gilliard, Birds of Central New Guinea. 1954.

Mayr, Ernst, and E. Schüz (eds.). Ornithologie als biologische Wissenschaft. (Stresemann Festschrift). 1949.

Peters, James L., Birds of the World. (7 vols.) 1931–1951.

Peterson, Roger T., Wildlife in Color. 1951.

Pettingill, O. S., Jr., A Laboratory and Field Manual of Ornithology. (3rd ed.) 1956.

Ridgway, R., The Birds of North and Middle America. 1901–1919.

Ritter, W. E., The California Woodpecker and I. 1938.

Saunders, A. A., The Lives of Wild Birds. 1954.

Savory, Theodore H., Latin and Greek for Biologists. 1946.

Sibley, Charles G., A Synopsis of the Birds of the World. 1955.

Smith, Stuart, and Eric Hosking, Birds Fighting. 1955.

Sprunt, Alexander, Jr., Florida Bird Life. 1954.

Stokes, A. W., Population Studies of the Ring-necked Pheasants on Pelee Island, Ontario. 1954.

Storer, John H., The Web of Life. 1954.

Street, Phillips B., Birds of the Pocono Mountains, Pennsylvania. 1955.

Sutton, George M., Birds in the Wilderness. 1936.

Takatsukasa, N., Japanese Birds. 1941.

Tillisch, C. J., Falkejagten og dens Historie. 1949.

Wallace, George J., An Introduction to Ornithology. 1955.

Wetmore, Alexander, The Migrations of Birds. 1930.

Webb, Cecil S., The Odyssey of an Animal Collector. 1954.

White, T. H., The Goshawk. 1951.

ORNITHOLOGICAL LITERATURE

Recent Studies in Avian Biology. Edited by Albert Wolfson. University of Illinois Press, Urbana, 1955: $7 \times 10\frac{1}{4}$ in., ix–479 pp. $7.50.

Under the inspiration and guidance of Dr. Albert Wolfson, former chairman of the Committee on Research, the American Ornithologists' Union has issued a book summarizing recent researches in many phases of ornithology. Begun in 1948, manuscripts were accepted from 13 different authors in as many different fields from January, 1952, until April, 1955. Coverage of literature is principally for the period from about 1933, the date of the last summary of researches prepared by the A. O. U. (Fifty Years' Progress of American Ornithology 1883–1933), to about 1952. All articles are comprehensive treatments and contain extensive bibliographies, even though they vary in length from 13 to 71 pages.

Of interest is the shift in emphasis in modern ornithological research since 1933. Eight of the twelve major subjects discussed in the earlier summary—those dealing with territorialism, economics, museum collections and exhibits, photography and art, conservation and education—receive only incidental mention in this one. Perhaps some measure of the increased volume of research that is now appearing is indicated by the present summary for less than twenty years including two and two-thirds times as many words as the summary published in 1933 for the preceding fifty years.

The topics are arranged in a logical sequence and in spite of the large group of collaborators there is considerable uniformity in the organization of the various articles and in matters of style. Proof-reading and editing have been critical, and mechanical errors of a typographical or grammatical nature are practically absent. The compendium could well serve as a textbook for advanced classes.

Alden H. Miller starts the discussion with a definition of the biologic concept of the species and points out how the change from the old strictly morphological concept has stimulated the identifying of isolating mechanisms, the recognition of different degrees to which populations have attained species ranking, and an understanding of the mechanics of speciation. Defects in the use of birds in such studies are the difficulties inherent in obtaining large-scale breeding experiments, lack of large masses of specimens for study compared, for instance, with those available to the ichthyologist or entomologist, deterioration of plumage pigments in stored specimens, inadequate use of statistics, and over-enthusiasm in naming subspecies. Remedies are suggested.

Herbert Friedmann lists modern tendencies in taxonomic practice for uniting and reducing the number of families recognized, for monographic revisions of various groups, and for analysis and interpretation of genera and species from the phylogenetical and geo-historical approaches. Various systems of classification are compared and evaluated.

Alexander Wetmore reveals several points of special interest in paleontology: the uncertainty whether *Ichthyornis* ever possessed teeth, the view that penguins are the most specialized of living birds, the evolution of the ratites from flying ancestors, a cursorial vulture with only weak powers of flight, and a condor with a wing spread of 16 to 17 feet.

Harvey I. Fisher stresses the importance of internal anatomy for defining major taxonomic categories and laments on the lack of such necessary anatomical studies in the present century. He points out, however, the gradual development of the new field of "functional anatomy," wherein comparative studies of structures are emphasized along with detailed correlations of structure with function and environment. The literature of the last quarter century is reviewed on weights, the respiratory system, production of sound, comparative anatomy in relation to taxonomy, embryology of wild species, histology of the nervous system, mechanics of flight, and various other adaptive mechanisms.

John T. Emlen surveys bird behavior all the way from the elementary and obvious to the complex and involved, using as his basis the functions of the various behavior patterns. Our present knowledge of neural mechanisms is reviewed. In analyzing the nature and origin of behavior patterns he makes due acknowledgment of the modern ethological concepts developed by Lorenz, Tinbergen, and Thorpe, as well as the criticisms and different interpretations of Schnierla, Lehrman, and others.

In the treatment of bird navigation, Donald R. Griffin adequately disposes of the Coriolis Force, terrestrial magnetism, and infra-red vision in favor of ordinary vision. Three types of homing behavior in unfamiliar territory are described: I, a regular pattern of exploration until familiar landmarks are located; II, take-off and flight in the same direction to which the birds had previously been conditioned; and III, choosing of the correct direction homeward regardless of previous conditioning. Orientation from the sun is probably important with pattern II, while in pattern III, the most baffling of all, the sun may possibly be used both to tell direction and latitude. It is conjectured that the pecten in the eye may play some part in celestial navigation.

Donald S. Farner is primarily concerned with proximate factors for the annual stimulus of migration. Hypotheses in which the gonads, thyroids, and anterior pituitary assume major roles are found wanting. Lengthening photoperiods in the spring stimulate the anterior pituitary, thereby activating the gonads, and along with rising temperatures produce a favorable energy balance. Whether this excess of productive energy is used for molting, immediate initiation of nesting, or deposited as fat preparatory for migration may be under endocrine control of the anterior pituitary. There is strong indication, but not certainty, that nightly unrest of caged birds is a reliable index of the migratory state. Before migration actually occurs, the additional stimulus of critical changes in environmental factors appears to be required.

George H. Lowery, Jr., and Robert J. Newman, describe the accumulating evidence that in nocturnal migration small birds are distributed through the sky with remarkable uniformity. Topographical features are followed only when they offer "leading lines" which the birds are reluctant to cross. The migration peak on any day generally comes during the hour before midnight. It appears that further development of this important field will depend on harmonizing the often contradictory information obtained by telescope counting of bird silhouettes passing across the face of the moon and "chip counting" of birds migrating at lower elevations.

David E. Davis compiles information on the breeding biology of miscellaneous species and emphasizes the need for adequate statistical analysis of data collected.

L. V. Domm cites evidence that embryonic sex differentiation is directly determined by the relative intensity of androgenic and estrogenic hormone secretion and that the intensity of secretion of these hormones is normally controlled by the hereditary genes.

In the longest article in the book, Joseph J. Hickey gives a comprehensive survey of population problems in gallinaceous birds. This includes techniques for measuring population size and analysis of nesting successes, sex and age ratios, cycles, and regulatory factors. Seventy to eighty per cent of the females raise at least one young during any year. Mortality of the young averages 20 to 50 per cent in the first two months and in adults is higher in bob-white (77–84% per year) than in any other species. Sex ratios tend to be balanced during the first autumn after hatching but in monogamous species become skewed towards the male by the second autumn. Annual fluctuations involve increases with reproduction of less than 100 per cent and decreases with mortality of 50 per cent. North American grouse typically exhibit a 3.5 year cycle north of 55° latitude, but the 9.5 year cycle between 40° and 50° latitudes is less certain and may be due to random action of several environmental factors. California quail can stand only a 25 per cent hunting kill, but bob-white can take a kill of 40 to 55 per cent.

In a second article, Farner discusses problems involved in formulating life-tables. He emphasizes the importance of banding immature birds in order to accumulate a much larger mass of longevity and mortality data on birds of known age. Such data, as far as known, are summarized for a large number of species.

The final paper by Carlton M. Herman is a comprehensive review of the important diseases of wild birds. These diseases are produced by a variety of factors: ecto- and endo-parasites, bacteria and fungi, viruses, and nutritional inadequacies.

Criticisms of this book are difficult to find. The delay of three years or longer in the publication of some of the articles is regrettable. Some of the summaries are more complete and detailed than others, but on the whole, they attain a high standard of excellency. We find no mention in the Index of such important fields as ecology, genetics, social hierarchy, or song—fields in which there have been many recent advances. It is scarcely conceivable, however, that any serious bird student can afford not to have this book continually at hand and to have a thorough familiarity with its contents. Every young ornithologist should make this one of his first purchases.—S. Charles Kendeigh.

The Myology of the Whooping Crane, *Grus americana*. By Harvey I. Fisher and Donald C. Goodman. Illinois Biological Monographs (vol. 24, no. 2), Univ. Illinois Press, Urbana, December 30, 1955: $6^{11}/_{16} \times 10$ in., viii + 127 pp., 40 figs. $3.50 cloth, $2.50 paper.

Doctors Fisher and Goodman have performed a great service to ornithology by writing this monograph, not only because they present data on the myology and neurology of a rare species, but also because they describe the entire muscular system. No longer need the student refer to the inaccurate work of Shufeldt. Nearly all students of avian myology have been misled, at one time or another, by accepting at face value certain statements made by Shufeldt in his "Myology of the Raven" (1890). Hudson and Lanzillotti (1955. *Amer. Midl. Nat.*, 53:2) politely referred to this problem when they stated that Shufeldt's "description of the flexor digitorum sublimus makes it quite apparent that he did not find any such muscle."

Fisher and Goodman give the known history of the three specimens on which their report is based. They present detailed descriptions of the musculature of the following regions: skull and jaws; tongue; orbit and ear; wing; tail; leg; body wall; vertebral column. Synonymy of muscles is given except in the discussions of the myology of the tail and the pectoral and pelvic appendages, for which the synonymy was given earlier by Fisher (1946. *Amer. Midl. Nat.*, 35:tables 19, 23, and 42).

The authors state (p. 39): "Montagna (1945) [*Jour. Morph.*, 76:87–113] demonstrated that the digits of the avian hand are numbers II, III, and IV rather than I, II, and III as in most current literature. Thus is settled, at least to our satisfaction, the hundred-year-old controversy." They have proposed, after consultation with other anatomists, new names for certain muscles inserting on those digits; they list the old names and the new names on page 39.

"The Myology of the Whooping Crane" now becomes the standard reference for the complete myology of a species. Most myological studies, for several important reasons, deal with the pectoral and pelvic appendages. Consequently, I feel that it is important to point out certain probable omissions and misconceptions of muscle complexes in this otherwise excellent monograph.

Fisher and Goodman do not mention M. expansor secundariorum, a muscle widely used in taxonomic diagnoses. Beddard (1898. "Structure and Classification of Birds," p. 366) states that this muscle is present in the Gruidae and I found it in *Grus canadensis tabida*. It surely is present in *G. americana*. A small muscle closely associated with M. expansor secundariorum is Fürbringer's M. anconaeus coracoideus. This muscle I have described for the Sandhill Crane in two papers now in press; it probably is also present in the Whooping Crane.

M. flexor digitorum sublimus is not mentioned by this name in the paper, but it is described (pp. 65–67) as the "anterior part" of M. flexor carpi ulnaris. The muscle which Fisher and Goodman (p. 52) and Fisher (1946:584) describe as M. proscapulohumeralis is actually the external head of M. subscapularis. The muscle which Fisher (1946:587–588) described as "M. proscapulohumeralis brevis" in the Cathartidae is the proscapulohumeralis (=scapulohumeralis anterior) muscle in that group. Fisher and Goodman (p. 53) also describe a proscapulohumeralis brevis muscle in the Whooping Crane; Fisher informs me (letter dated May 5, 1955) that this muscle was "not found uniformly in the Whooping Cranes." This rudimentary muscle probably represents M. proscapulohumeralis in the cranes.

I believe that it is misleading to refer as these authors do to the *biceps slip* as the belly of M. tensor patagii longus. This is a matter of interpretation, but except when the contrary evidence is overwhelming it is obviously desirable to retain the traditional interpretation of muscles, especially for those which have been used in taxonomic diagnoses.

Fisher and Goodman seem to admit (pp. 89–90) some confusion in the descriptions of their muscles vastus lateralis, vastus medialis, and femoritibialis externus. Fisher (1946:Table 42) stated that his vastus lateralis was the same as the femoritibialis externus of Gadow and of Hudson; his vastus medialis, the same as their femoritibialis medius. Fisher and Goodman (Figs. 29 and 30) illustrate the vastus lateralis (=Gadow's femoritibialis externus) and the vastus medialis (=Gadow's femoritibialis medius) in *G. americana*. The relationships shown in the figures are typical for these muscles. Gadow's M. femoritibialis medius, therefore, is not "apparently lacking" in *G. americana*, as Fisher and Goodman suggest (p. 90). They describe that muscle under their name, M. vastus medialis, on pages 81 and 82.

The muscle which Fisher and Goodman (p. 90 and Fig. 31) describe as M. femoritibialis externus is probably best considered simply a distal head of their vastus lateralis, especially since this would obviate the necessity of lengthening its name to M. femoritibialis externus sensu Fisher nec Gadow. (Fisher did not use the term in his 1946 paper. He illustrated the muscle but did not name it.)

This monograph would be invaluable solely for the 40 excellent illustrations. There are, for example, two figures each of the brachial and sacral plexuses. One of the most significant features of this paper may prove to be the emphasis which is placed on intraspecific anatomical variation. Every taxonomist and anatomist should read and re-read the "Discussion" (pages 119–124) until the implications therein are fully understood. This is, indeed, the type of paper that one wishes one had written. —Andrew J. Berger

---

This issue of *The Wilson Bulletin* was published on September 24, 1956.

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

which will convene on the campus of

THE UNIVERSITY OF MINNESOTA, DULUTH BRANCH

DULUTH, MINNESOTA

June 13–16

Sponsors:

Minnesota Ornithologists Union
University of Minnesota, Duluth Branch
Duluth Bird Club

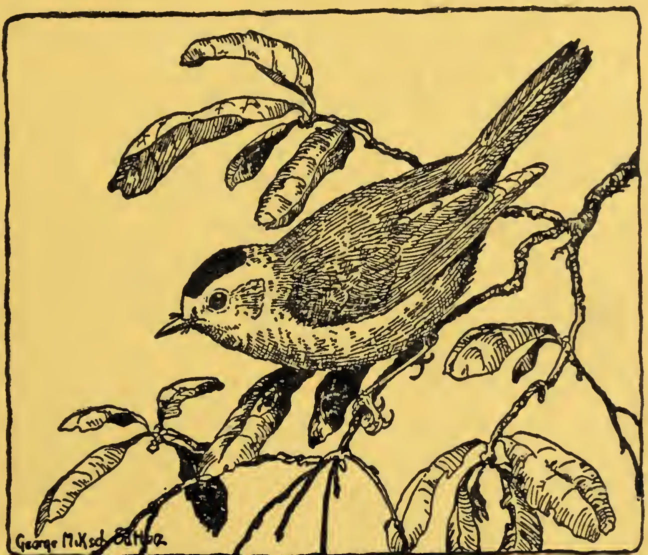
In 1958, the Society visits Oglebay Park, Wheeling, West Virginia, from April 24–27

Flj-W

December 1956

VOL. 68, No. 4 PAGES 273–384

The Wilson Bulletin



Published by

The Wilson Ornithological Society

at

Lawrence, Kansas

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 Central Tower, Battle Creek, Michigan.

Second Vice-President—Phillips B. Street, Route 1, Chester Springs, Pennsylvania.

Treasurer—Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia.

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 Comittee, 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.

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.

Entered as second class matter at Lawrence, Kansas. Additional entry at Ann Arbor, Mich.

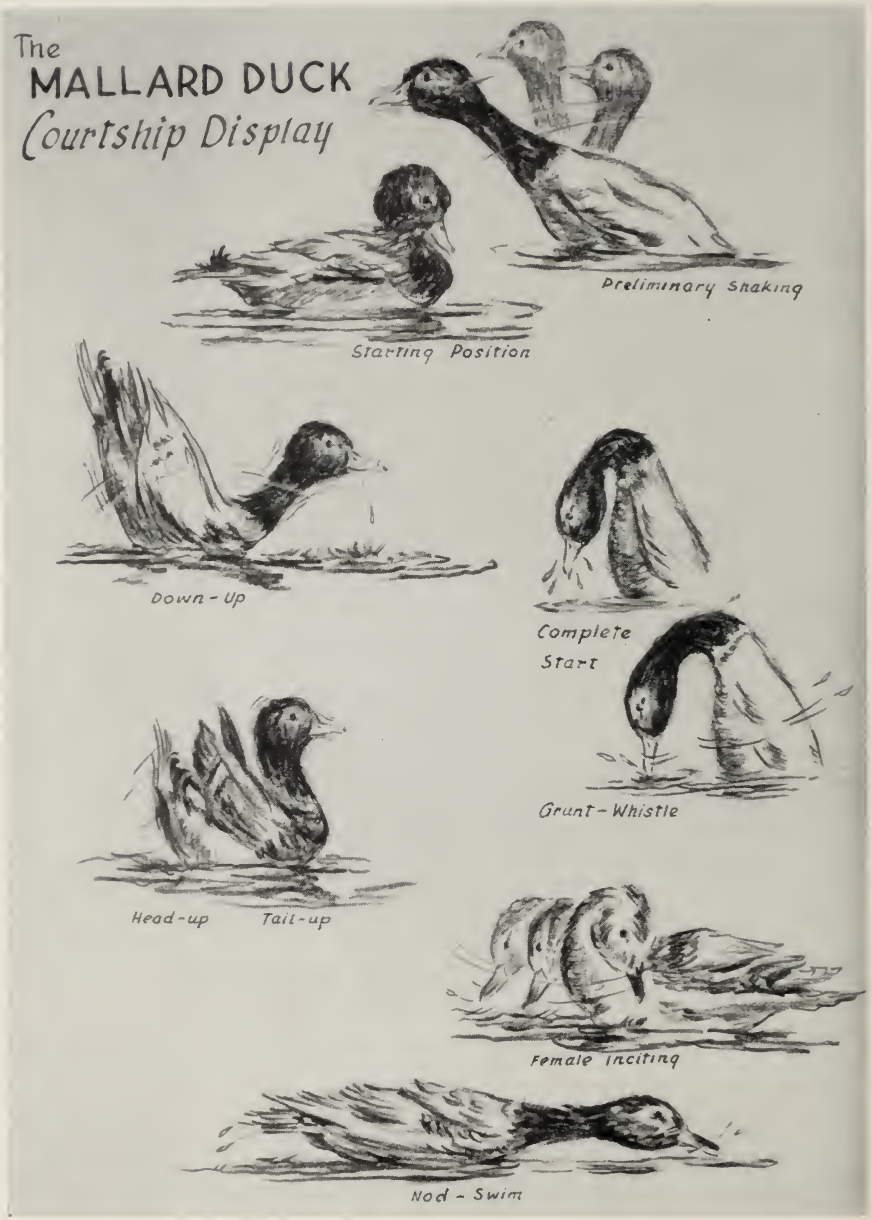
THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by The Wilson Ornithological Society

Vol. 68, No. 4 December 1956 Pages 273–384

CONTENTS


The
MALLARD DUCK
Courtship Display
Preliminary Shaking
Starting Position
Down - Up
Complete
Start
Grunt - Whistle
Head-up Tail-up
Female Inciting
Nod - Swim

SEASONAL PATTERNS IN THE EPIGAMIC DISPLAYS OF SOME SURFACE-FEEDING DUCKS

BY A. OGDEN RAMSAY

THE elaborate epigamic display of the Mallard Duck (*Anas platyrhynchos*) and related species of the Anatinae, has been studied intensively by Lorenz (1941, translated by C. H. D. Clarke and published, 1951–53) and by Delacour and Mayr (1945). The following observations describe the frequency of display during the year. These observations were made on birds maintained in the J. Rulon Miller Wildlife Refuge, McDonogh School, Maryland. This refuge consists of a spring-fed pond 150 × 250 feet in area and 18 inches deep and is surrounded by a six-foot fence erected approximately 30 feet from the pond. Most of the ducks present are pinioned. The hand-reared, full-winged Mallards, Black Ducks (*Anas rubripes*) and Wood Ducks (*Aix sponsa*) do not migrate, but Pintails (*Anas acuta*) and Shovellers (*Anas clypeata*) are apt to disappear in the course of the spring migration.

The birds were observed for one-hour intervals from 7:30 a.m. to 8:30 a.m. from the middle of September, 1952, to the middle of April, 1953. Observation periods of one-half hour also were kept in the spring of 1952. The data obtained were the number of displays of various types per bird per hour. The distribution of these frequencies was by no means normal and hence averages were not suitable. After trying several technics, it seemed that the most appropriate measure was the percentage of days on which there were more than five displays per hour. The tables give these percentages and indicate the significance of particular differences. It is recognized that this test is not very sensitive. I would like to express my appreciation to Mr. E. Carey Kenney for drawing the frontispiece, and to F. K. Hilton for drawing the graph. Dr. David E. Davis is responsible for the statistical analysis of the data.

Types of Displays

All of the species of surface feeding ducks show homologous movements in display. The most readily observed movements of the Mallard are shown in the frontispiece. These will be described briefly. Much more detailed descriptions have been made by Lorenz (1951–53) and by Delacour and Mayr (1945). In the following report the terminology followed will be that of Lorenz as translated by Clarke.

Preliminary head shake.—In the Mallard (Lorenz, 1951:164–182) and the Black Duck the males assemble in groups for social display. As excitement mounts, the feathers of the head become ruffled and the head is sunk on the body and shaken repeatedly. Then, if tension increases, one or more drakes rear up high out of the water and flick the head forward. If tension continues to increase, this will be followed by one of the three forms of display mentioned below. Simultaneous performance of the same movement by all members of a group has never been observed.

Grunt whistle.—The bird rears high out of the water with its head arched forward. As it rises it rakes its bill through the water. Then the bill is pressed to the breast and the bird sinks slowly back to the water. This display is accompanied by a characteristic courtship call which is distinctive for each species.

Head-up tail-up.—The head is thrown back in an arched position and then jerked abruptly upward and turned toward the female. The tail feathers are erected vertically and spread. The wing coverts are lifted: this exposes the speculum. In the Mallard this movement is invariably followed by the nod-swim. In the Black Duck the nod-swim does not always follow. Otherwise the display of the two species is the same.

Down-up movement.—". . . the drake thrusts his bill into the water as quick as lightning, and in the next movement jerks his head alone without lifting his breast, which is still low in the water. At the instant when the head is highest and the breast is deepest, there follows the whistle, just when there is greatest tension on the windpipe. In raising the bill a little fountain of water is often raised by the quick bill movement . . ." (Lorenz, 1951: 179). This movement is vestigial in the Gadwall (*Chaulelasmus streperus*) and absent in the Green-winged Teal (*Anas carolinensis*) and Pintail.

Nod-swim.—This is performed by both the male and female Mallard and Black Duck but is absent in the other species observed. The neck of the bird is stretched forward and it swims rapidly in a circle around the mate

TABLE 1

SOCIAL DISPLAYS OF 10 FEMALE MALLARDS DURING 1952–53

Values given are the percentage of days on which there were more than 0.2 displays per hour

Month	Days	Nod-Swim	Incite	Copulate	Nest Inspect.
September	17	18	12	0	0
October	31	13	29[1]	0	3
November	30	0[2]	7[1]	0	7
December	29	3	3	0	0
January	30	0	17[1]	13[1]	23[1]
February	28	0	7	28[2]	21
March	29	0	0	0	7
April	10	0	0	0	0

[1]This percentage is significantly different from the first preceding month's percentage at the 5 per cent confidence level.
[2]This percentage is significantly different from the second preceding month's percentage at the 5 per cent confidence level.

with the bill just clearing the water. In the males this movement appears as a post-copulatory display as well as in courtship movements.

Inciting.—The female follows her mate or intended mate; meanwhile she arches her neck and head toward the water and moves her head back and forth from the front to the side away from her mate and directed toward other males or rivals. It may be accompanied by short dashes of attack toward the rival. The females of all species incite.

Precopulatory display or "pumping."—". . . the precopulation display in both sexes consists of a bobbing up and down of the head, the bill touching the water at its lower course and always remaining nearly horizontal. Finally the female flattens herself, extends her neck and is mounted by the male." (Delacour and Mayr, 1945:18).

Mock preening.—This display is difficult to observe (Lorenz, 1951:72–73) and was not included in this study.

Variations in Social Displays by Months

Females.—Seasonal activities of the female Mallard are shown in Table 1. During the observations there were 10 females present. It was possible to record the activities of all the females fairly accurately, and the total was divided by 10 to give the activity per female per hour. It will be noted that inciting predominates in the female in the fall and winter. The descriptions of Lorenz (1951:167) and Delacour and Mayr (1945:18), suggest that inciting is connected with the establishment of the bond between the sexes. The female by this display announces her chosen sex partner and threatens any other male that may approach her. The female by this display also incites her mate to defend her from other males.

The females also do a great deal of nod-swimming in the fall. It seems likely that this behavior in the Mallard is analogous to the "charging" display of the American Coot (*Fulica americana*), as described by Gullion (1952: 86) and is a form of threat display. A female Mallard, while inciting, often makes short direct attacks in this position at males that may approach her. Both male and female Wood Ducks adopt a similar posture in attacking sexual rivals. A somewhat similar movement is described as threat-display and is the only epigamic display described for the Ruddy Shelldrake (*Tadorna ferruginea*) by Delacour and Mayr (1945:12).

The predominance of this display in the fall would also seem to indicate that in the female Mallard, the more aggressive or masculine tendencies are highest during that season. This supposition is supported by the fact that the females show some homosexual activity at this time. A number of female Mallards have been observed to mount and to copulate with other females. The more aggressive female did not grasp at the head of the ventral

TABLE 2
THE FREQUENCY OF DISPLAYS OF MALE DUCKS BY MONTHS
Values given are the percentage of days on which there were more than 0.2 displays per hour

Month	Days	Gadwall	Green-winged Teal	Mallard	Black Duck
September	17	0	0	0	0
October	31	0	19[1]	23[1]	16[1]
November	30	3	20	17	3[1]
December	29	0	7[1]	48[1]	10
January	30	20[1]	7	47	20[2]
February	28	32	39[1]	21[1]	4[1]
March	29	14[1]	24	4[1]	0
April	11	0	18[2]	0	0

[1]This percentage is significantly different from the first preceding month's percentage at the 5 per cent confidence level.
[2]This percentage is significantly different from the second preceding month's percentage at the 5 per cent confidence level.

female in a normal fashion but pecked at her head instead. Neither did the more sexually aggressive female nod-swim afterward. Homosexual unions were recorded on September 21 and October 16, 1951, and on October 21 and November 1, 1954. Other unions were observed but were not recorded.

Females may also sometimes be observed "pumping" together. This is recognized as a prelude or invitation to copulation.

Inasmuch as Lorenz (verbal communication, November 15, 1954) stated that he had never observed homosexual behavior in Mallards, it seems clear that the presence of an excess of females is the cause of this abnormality. We keep an excess of females in the refuge as a means of reducing the excessive sexual activity associated with captivity.

In the fall of 1954, for the first time, females laid a total of 28 eggs. Though they copulated in a normal fashion during this period (observed 17 times) none of the eggs was fertile. Females also show some interest in nesting sites in the fall, darting in and out of the nest boxes provided for them. The males show some definite but slight interest in nest sites in January, February and March.

In 1953 we experienced a warm, early spring; egg-laying started on February 13 and incubation on March 19. In 1955 egg-laying did not start until February 24 and the ducks dropped their eggs on the ice prior to its thawing.

Males.—Seasonal occurrence of epigamic display of males of several species of surface-feeding ducks is shown in Table 2 and Figure 1. This figure is based on data obtained by daily observations from mid-September, 1952, to mid-April, 1953. A separate data sheet was kept for each day and all forms of display were recorded. There were five male Mallards, two male Black

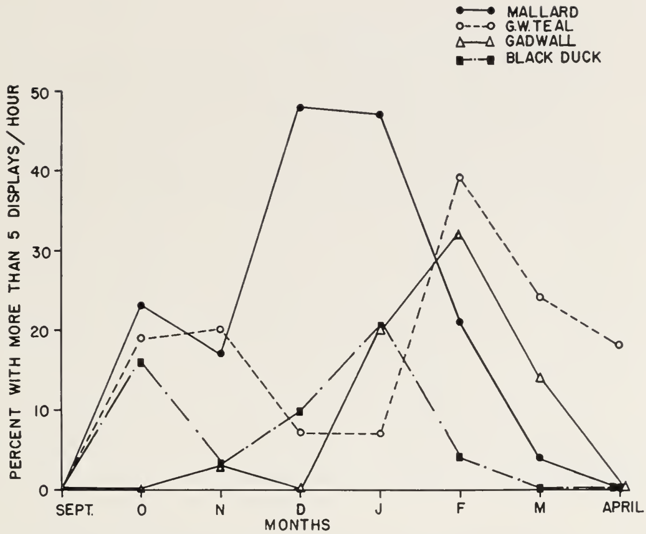


FIG. 1. The frequencies of displays by males in various months.

Ducks, one male Pintail, one male Green-winged Teal, and one male Gadwall under observation at this time. If two males of the same species were displaying, the display of both was recorded and then the total divided by two. If several males of a species were displaying, efforts were made to follow one male. It will be noticed that the several species have different periods of maximum display. The male Mallards started displaying in the fall and then reached a high level of intensity in December; the Black Duck had an autumn peak but most activity in January; the maximum for the Gadwall fell in February; the Green-winged Teal had peaks in fall and in spring.

In the male Pintail the sexual display of the male is directed at the female (Lorenz, 1952:10) and clearly seems to represent a form of sexual competition. During the spring of 1952, when there were two male Pintails present and no females, each male displayed more than five times per half-hour observation period 20 per cent of the time. In the absence of female Pintails, this display was directed at male and female Wood Ducks and one male formed a fertile union with one of these ducks. The next spring, with only one male and one female Pintail present, the male displayed more than five times per hour on only seven per cent of the days. Likewise, my solitary male Redhead (*Aythya americana*) seldom displays. When it lost its mate this male courted a female Mallard exclusively. The Green-winged Teal and Gadwall drakes display very actively in the absence of other males of their own species.

The data were considered from the viewpoint of temperature but no cor-

TABLE 3
DISPLAYS OF MALE AND FEMALE GREEN-WINGED TEAL
Values given are the percentage of days on which there were more than 0.2 displays per hour

		MALE		FEMALE	
Month	Days	Total Display	Tail-up	Total Display	Tail-up
September	17	0	0	0	0
October	31	19[1]	13	3	3
November	30	20[2]	3	3	0
December	29	7	3	0	0
January	30	23	13	7	7
February	28	43[2]	11	0	0
March	29	27	14	3	3
April	11	18[2]	9	9	9

[1]This percentage is significantly different from the first preceding month's percentage at the 5 per cent confidence level.
[2]This percentage is significantly different from the second preceding month's percentage at the 5 per cent confidence level.

relation was apparent that was not related to seasonal changes in frequency of display.

The display of the Green-winged Teal is similar to that of its European counterpart (*Anas crecca*) as described by Lorenz (1952:172–175) except for the fact that in the American species, the female responds to the preliminary shaking, grunt-whistle and head-up, tail-up displays of the male by also performing the head-up, tail-up display. Dr. Lorenz stated that he had never observed females to display in this fashion in *Anas crecca* or in any other species of waterfowl (verbal communication, Smithsonian Lecture, November 16, 1954). Meanwhile, the male and female slowly circle each other about one yard apart in a form of paired display. The males display alone as well as in the paired display but I have never observed the female to do so. The female occasionally goes through the preliminary head shaking movements (seven observations). As emphasized by Lorenz (1952:173), the male Teal displays at a very high level of intensity at the height of its courtship, 12 to 25 times in periods lasting from five to 10 minutes and separated by short rest periods. The females display at a much lower level of intensity, even when we compare homologous movement (Table 3). From Hochbaum's (1944:19–20) description it seems clear that he thinks that the display of the male Redhead and Canvasback (*Aythya valisneria*) is not competitive in the fall but that they engage in mutual or paired display in the spring.

SUMMARY

Numerical data are presented on seasonal differences in the epigamic display of several species of Anatinae.

In the female Mallard, inciting and nod-swimming predominate in the fall. These displays are concerned with the establishment of bonds between the sexes and with the establishment of territory. Females also showed some homosexual activity at this time but not after mid-November.

The periods of maximum display in the Gadwall, Mallard, Black Duck, and Green-winged Teal did not correspond. Peaks of activity were noted in the Mallard in December, the Black Duck and Green-winged Teal in January and the Gadwall in February.

Competition among males in displaying before the female was noted in the Pintail, Redhead and Gadwall, but not in the Mallard and Black Duck. A paired display was observed in the Green-winged Teal, in which the female responded to the display of the male by the head-up, tail-up display; meanwhile the male and female slowly swam about each other.

Literature Cited

Delacour, J. and E. Mayr
1945 The family Anatidae. *Wilson Bull.*, 57:3–55.

Gullion, G. W.
1952 The displays and calls of the American coot. *Wilson Bull.*, 64:83–97.

Hochbaum, H. A.
1944 The canvasback on a prairie marsh. Washington, D.C.: Amer. Wildlife Institute. xii + 201 pp.

Lorenz, K.
1951–53 Comparative studies on the behaviour of Anatinae. (Translated by C. H. D. Clarke from *Jour. f. Ornith.*, 89, 1941:194–294) *Avicultural Mag.*, 57:157–182; 58:8–17, 61–72, 86–94, 172–184; 59:24–34, 80–91.

McDonogh School, McDonogh, Maryland, June 29, 1955.

THE APPENDICULAR MYOLOGY OF THE SANDHILL CRANE, WITH COMPARATIVE REMARKS ON THE WHOOPING CRANE

BY ANDREW J. BERGER

UNTIL recently, very little had been published on the myology of the cranes. Fisher and Goodman (1955) described in detail the myology of the Whooping Crane (*Grus americana*); they also dissected one Little Brown Crane (*G. c. canadensis*). I began a myological study of the Sandhill Crane (*G. canadensis tabida*) at the suggestion of Dr. L. H. Walkinshaw, whose interest in the biology and taxonomy of the cranes is well known. For the first specimen of this subspecies, I am indebted to Dr. Wallace Grange of Babcock, Wisconsin. After the death of this captive bird, it was frozen immediately; I dissected it during the month of April, 1955. During February, 1956, two additional frozen specimens became available. These birds were killed by hunters during the latter part of October, 1955, in Jasper County, Indiana. For these specimens, I am indebted to Dr. Charles Kirkpatrick of Purdue University and to Russell Mumford of the University of Michigan.

Through the generosity of Dr. Fisher, I was permitted to study the Whooping Crane manuscript before I began my first dissection. After I had completed this work, Dr. Fisher and I discussed differences in interpretation of certain muscle complexes. These differences will be explained in the descriptions of the individual muscles, inasmuch as it was too late to make changes in the Whooping Crane manuscript.

There are two sets of muscle terminology currently in use in this country, that of Hudson (1937) and Hudson and Lanzillotti (1955) and that of Fisher (1946) and Fisher and Goodman (1955); I have included both sets of names. The muscles are discussed in the sequence used by Fisher and Goodman: they accepted Montagna's (1945) conclusions on the numbering of the hand digits, and, consequently, proposed new names for certain muscles (1955:39).

MYOLOGY OF THE WING

M. TENSOR PATAGII LONGUS (propatagialis longus)

Fisher and Goodman (1955:43) interpret the "elongately triangular belly" arising from the dorsal end of the furculum as belonging solely to M. tensor patagii brevis and state (p. 42) that "the only muscular origin" of the tensor patagii longus is that which "comes from the antero-palmar surface of M. biceps . . . ." In view of the traditional treatment of this complex by the British and German ornithologists, I believe that it is misleading to consider the slip from M. biceps brachii as M. tensor patagii longus (Fisher and Goodman, 1955: Fig. 17). Fürbringer and Gadow believed that both the tensor patagii longus and the tensor patagii brevis muscles were derivatives of M. deltoideus major; no one, to my knowledge, has suggested that either is a derivative of M. biceps brachii. In many birds (e.g., the cuckoos), the two tensors have a common origin and the bellies are separate only distally. In some birds, the two muscles are separate throughout.

Thus, there are two possible interpretations of this complex in the cranes. I prefer to interpret the belly arising from the furculum to be the fused bellies of Mm. tensores patagii longus et brevis (see also Mitchell, 1901: 641, "deltoides patagialis"). If one does not agree with this interpretation, then it is true, as Fisher and Goodman stated, that the only muscular origin for the tensor patagii longus is that derived from M. biceps brachii. This is, in part, an academic question, but it is important that the taxonomist recognize such differences of interpretation in myological studies so that these are not given erroneous taxonomic significance.

What Fisher and Goodman call the belly of M. tensor patagii longus is actually the *biceps slip*, a muscular slip widely used in taxonomic diagnoses. The biceps slip of Beddard is the *biceps propatagialis* of Gadow and Selenka (1891:255) and the *tensor accessorius* of Parker and Haswell (1947:441), Young (1950:427), and others.

In the Sandhill Crane, the origin of M. tensor patagii longus is essentially the same as that described for the Whooping Crane by Fisher and Goodman. The fleshy biceps slip (6-7 cm. long) arises from the coracoidal tendon of M. biceps brachii, becomes tendinous, and inserts on the elastic part of the tensor patagii longus tendon. A second origin is a small tendon, attached to the deltoid crest, which contributes to the tendons of insertion of both the tensor patagii longus and the tensor patagii brevis muscles. M. pectoralis, pars propatagialis, is a wide (2 cm.) aponeurosis, which is a continuation of the superficial layer of the fascial envelope which surrounds the insertion of M. pectoralis. This aponeurosis fuses with the distal end of the belly of the tensor patagii brevis and gives rise to parts of the tendons both of the tensor patagii longus and brevis.

The main area of insertion of the tensor patagii longus is on the extensor process of the carpometacarpus, but slips extend into the manus to fuse with its fascia and with the bases of the alula quills and their coverts. Fisher and Goodman (1955:68) stated that in the Whooping Crane, a part of M. abductor alae digiti II (= abductor pollicis) arises from the inserting tendon of M. tensor patagii longus. This is not true in the Sandhill Crane. I found no branches of the longus tendon extending to the elbow; such branches were found in *G. americana*, but not in *G. c. canadensis*, by Fisher and Goodman.

M. TENSOR PATAGII BREVIS (propatagialis brevis)

This muscle is weakly developed, having a belly about 9 cm. long and 2 cm. wide; the belly extends to the middle of the deltoid crest. It arises primarily from the dorsal end of the furculum, but has a small attachment to the acromion process of the scapula. Its main tendon is reinforced, as described above, by tendinous slips arising from the deltoid crest and from pars propatagialis of M. pectoralis.

The main tendon of insertion passes distad toward the elbow and expands into a thin band (2 cm. wide), which fuses, in part, with the tendon of origin of pars anconalis of M. extensor metacarpi radialis, and then passes proximad to attach to the distal end of the humerus, adjacent to the origin of pars anconalis. The rest of the brevis tendon (1 cm. wide) passes posteriad over the forearm muscles and extends the entire length of the forearm, sending slips to the bases of the feathers; distally, it attaches to the os ulnare. Fisher and Goodman (1955:43) state that in *G. c. canadensis* "the wide tendon continues posteriorly over the surface of the wing to insert on the tendon of origin of the wide anterior and superficial part [= M. flexor digitorum sublimus] of M. flex. carpi ulnaris." The tendon does not do so in *G. c. tabida* and it is difficult for me to see how the brevis tendon, located on the dorsal surface of the forearm, could pass posteroventrad through the secondaries and their coverts to insert on Mm. flexor digitorum sublimus or flexor carpi ulnaris, which are located on the posteroventral surface of the forearm.

Fisher and Goodman (1955:43) noted that in one specimen of the Whooping Crane "M. tens. pat. brevis . . . has a divided tendon of insertion; in the other birds the tendon is single." Unilaterally in one of my specimens of *G. c. tabida*, the tendon has three strong components connected by weak fascia. The most proximal of the three components, in part, passes proximad to insert on the lateral epicondyle (ectepicondylar process) of the humerus (without being connected with the tendon of M. extensor metacarpi radialis) and, in part, fuses with the middle band. The latter expands into a broad aponeurotic sheet, which passes posteriorly over Mm. extensor digitorum communis and flexor metacarpi radialis, and has attachments proximally to the tendon of M. scapulotriceps and to the lateral epicondyle (between the origins of Mm. extensor digitorum communis and extensor metacarpi radialis). This aponeurosis extends the entire length of the forearm, fuses with the antebrachial fascia, sends slips to the bases of the feathers, and attaches to the os ulnare. The most distal of the three components of the brevis tendon inserts on the tendon of pars anconalis of M. extensor metacarpi radialis, about 1 cm. proximal to the origin of its fleshy fibers.

M. PECTORALIS

In the Sandhill Crane this is a single muscle and is not divided, as in the Whooping Crane, into superficial and deep layers. Fasciculi from the deep surface of the belly, however, do insert by a broad aponeurosis on the tendon of origin of M. biceps brachii. In the Sandhill Crane, M. pectoralis arises from approximately the inferior third of the carina, from the posterior and anterolateral parts of the body of the sternum, and from nearly the entire length of the clavicle. I found no origin from the "tracheal enclosure." The muscle inserts on the ventral surface of the deltoid crest (pectoral crest of Shufeldt, 1890:70). Pars propatagialis is entirely aponeurotic; its attachments were described above (p. 283).

M. SUPRACORACOIDEUS

M. STERNOCORACOIDEUS

M. CORACOBRACHIALIS POSTERIOR

All are similar in origin and insertion to these muscles in the Whooping Crane (Fisher and Goodman, 1955:46–48).

M. LATISSIMUS DORSI

There are a few minor differences in this complex between *G. americana* and *G. canadensis tabida*. In the latter, the origin seems to be less extensive. In the Whooping Crane, pars anterior arises from (all?) the "thoracic" (= dorsal) vertebrae (Fisher and Goodman, 1955: 48). In the Sandhill Crane, it arises by an aponeurosis (anteriorly) and by fleshy fibers from the neural spines of the first four dorsal vertebrae; pars anterior is a thin fleshy band, about 5 cm. wide at its origin, and about 3 cm. wide (2 cm. in the captive bird) at midlength. Pars anterior has a fleshy insertion (5 cm. wide) on the humerus, beginning about 4 cm. distal to the junction of the deltoid crest and the articular head; this insertion is immediately posterior to the humeral attachment of M. triceps, scapular head (= M. scapulotriceps = M. triceps scapularis).

Pars posterior, in the Sandhill Crane, arises by an aponeurosis from the neural spines of the last three (Nos. 4, 5, and 6) dorsal vertebrae, from the fascia covering the anterior edge of M. extensor iliotibialis anterior (= sartorius), and by an aponeurosis attached to the anterior edge of the ilium. Pars posterior inserts on the humerus by a small, flat tendon, immediately proximal to the insertion of pars anterior, and posterior to the uppermost portion of the scapulotriceps anchor. In *G. americana* pars posterior "attaches to the deep side of the anterior part but also inserts on the humerus beneath the fleshy insertion of the anterior portion."

Fisher and Goodman (1955:48) state that the dermal component (M. latissimus dorsi metapatagialis) may or may not be present in the Whooping Crane. I found a minute dermal component bilaterally in one specimen, unilaterally in a second specimen, but not at all in a third specimen of the Sandhill Crane.

MM. RHOMBOIDEUS SUPERFICIALIS ET PROFUNDUS

These two muscles are similar in the two cranes, but the origins and insertions are less extensive in *G. c. tabida.* M. rhomboideus superficialis arises by an aponeurosis from the first five dorsal vertebrae. Fisher and Goodman (1955:51) point out that the entire aponeurosis of origin of this muscle "is a caudal extension of the aponeurosis of M. cucullaris, hals pt.." M. rhomboideus superficialis inserts on all but the caudal 3 cm. of the scapula in the Sandhill Crane. M. rhomboideus profundus arises from the neural spines of the last cervical and the six dorsal vertebrae; it inserts on the caudal 10 cm. of the scapula.

In both cranes, an unusual feature is that M. rhomboideus profundus is larger than M. rhomboideus superficialis.

M. CORACOBRACHIALIS ANTERIOR

This is a well developed fleshy muscle (about 6 cm. long) located on the ventral aspect of the shoulder; the belly does not cover the anterior edge of the humerus. It arises mostly by fleshy fibers from the dorsal surface of the head of the coracoid, anterior to the origin of M. biceps brachii, and from the deep surface of the biceps tendon. The insertion is as described by Fisher and Goodman (1955:51).

M. DELTOIDEUS MINOR

In *G. americana,* M. deltoideus minor has a single head; in *G. c. tabida* it arises inside the triosseal canal by two heads: a ventral head from the medial process (procoracoid) of the coracoid and from the coracoclavicular membrane; a dorsal head from the ventral margin of the acromion process of the scapula. (The ventral head corresponds, in part, to a small accessory head of M. supracoracoideus present in some birds; such an accessory head, when present, however, inserts on the tendon of M. supracoracoideus.) In *G. c. tabida,* the two heads fuse and insert distal and posterior to the insertion of M. supracoracoideus; none of the fibers insert on the tendon of that muscle. As in *G. americana,* M. deltoideus minor conceals anterodorsally the tendon of M. supracoracoideus.

M. PROSCAPULOHUMERALIS (scapulohumeralis anterior)

See the descriptions of Mm. subscapularis and "proscapulohumeralis brevis."

M. SUBSCAPULARIS

The muscle that Fisher and Goodman (1955:52–53) and Fisher (1946:584) call M. proscapulohumeralis is actually the external head (pars externa) of M. subscapularis.

M. subscapularis is similar in the two cranes and, in fact, exhibits the same general structure in all genera I have dissected. In *G. c. tabida* it arises by two typical heads: pars externa and pars interna. The inserting tendon of M. serratus anterior passes between the two heads. The external head arises from an area 3 cm. long on the lateral surface of the scapula, beginning immediately caudal to the glenoid lip. The internal head, which is larger, arises from the medial surface of the scapula over an area about 5 cm. long. Insertion is on the capital groove and internal tuberosity of the humerus (as described in detail for *G. americana* by Fisher and Goodman, 1955:53).

"M. PROSCAPULOHUMERALIS BREVIS"

As Fisher and Goodman (1955: 53) state, this muscle is "very easily overlooked, for it lies between the posterior edge of M. delt. major and the most proximal part of the scapular head of M. triceps." Furthermore, Fisher wrote (letter, May 5, 1955) that it "was not found uniformly in the Whooping Cranes." I found this muscle bilaterally in one specimen of the Sandhill Crane, unilaterally in a second, and not at all in a third. The muscle is so small and delicate, however, that it might be destroyed by shot or be so mutilated in handling a poorly preserved specimen that one might not be aware that a separate muscle was involved at all.

In the Sandhill Crane this is a minute band of fleshy fibers 3 cm. long and only about 2 mm. wide. It arises from the ventral edge of the scapula just caudal to the glenoid fossa and *anteroventral* to the origin of M. scapulotriceps. It inserts by fleshy fibers, and not by a tendon as in the Whooping Crane, on the humerus about 0.5 cm. proximal to the insertion of M. latissimus dorsi, pars posterior, and lateral to the origin of M. humerotriceps (= triceps, internal and external heads = triceps humeralis). The area of insertion is on the plane of the inferior margin of the pneumatic fossa of the humerus, but is entirely lateral to the humerotriceps muscle.

As mentioned above (p. 285), the muscle which Fisher and Goodman call M. proscapulohumeralis is actually the external head of M. subscapularis. Thus, the name M. proscapulohumeralis is available for the rudimentary muscle discussed here. In the cranes, however, this muscle does not exhibit the relationships of M. proscapulohumeralis as I have seen them in representatives of other orders. In most genera, it arises posterior to the origin of M. scapulotriceps and inserts in the pneumatic fossa of the humerus, between the internal and external heads of M. humerotriceps. No muscle in the cranes meets these specifications. However, either the origin or the insertion of a muscle may migrate phylogenetically.

Mitchell (1901:644; 1915:415) discussed the considerable variation in development of M. proscapulohumeralis in gruiform birds, though he did not investigate the genus *Grus*. He stated that this muscle inserts on the humerus "near the forked origin" of M. humerotriceps (= anconaeus humeralis), as I have seen it in other genera. He noted also that "in *Otis* it is much reduced, and is attached to the humeral anchor" of M. scapulotriceps (= anconaeus scapularis). Fürbringer (1902:547 and Figs. 258–260) also described and illustrated M. proscapulohumeralis in genera in which it does not insert in the pneumatic fossa. In *Ciconia* and *Pelecanus*, for example, the muscle inserts proximal and/or anterior to most of the origin of M. humerotriceps. It seems likely, therefore, that in the genus *Grus*, the small muscle which Fisher and Goodman call "M. proscapulohumeralis brevis" is actually M. proscapulohumeralis. Its area of origin seems to agree with the origin in other gruiform birds, but its insertion differs slightly from that previously reported.

The muscle which Fisher (1946:587) called "M. proscapulohumeralis brevis" in the Cathartidae is M. proscapulohumeralis in that group.

M. DORSALIS SCAPULAE (scapulohumeralis posterior)

This muscle is typical in origin and insertion. In *G. c. tabida* it arises from the posterior 9 cm. of the blade of the scapula. (see also M. expansor secundariorum and Fig. 1.)

M. SERRATUS POSTERIOR (serratus superficialis posterior)

In the origin of this complex there are minor differences between the Whooping Crane and the Sandhill Crane, and, in the latter, the muscle is not separated into a superficial and a deep layer. It is so divided in the Whooping Crane. In the Sandhill Crane, the main belly is rectangular in shape, being about 3 cm. long and 4.5 cm. wide at its origin, primarily from the shafts and uncinate processes of true ribs numbers 3, 4, and 5; there is some fascial origin also from rib number 6. The insertion is almost exclusively by an aponeurosis on the ventral edge of the posterior end of the scapula. In the Whooping Crane, the superficial layer arises from "ribs 4, 5, 6, and 7 and from fascia overlying the external layer of intercostal muscles." The deep layer arises from ribs 4, 5, and 6.

I found a large dermal component (= M. serratus superficialis metapatagialis) arising primarily from the lateral surface of true ribs numbers 4 and 5 and from the intercostal fascia. The belly terminates in the metapatagium opposite the posterior margin of the humeral feather tract. From this area, a fibrous tendon continues distad along the surface of M. expansor secundariorum almost to the elbow.

M. SERRATUS PROFUNDUS

This complex is similar in the two cranes. In the Sandhill Crane it arises by fleshy fasciculi from the lateral surface, near the angle, of true ribs numbers 1, 2, and 3, and from the transverse process of the last cervical vertebra.

M. SERRATUS ANTERIOR (serratus superficialis anterior)

As is true of the preceding two muscles, there are minor differences in origin between the Whooping and Sandhill cranes. In the latter, the serratus anterior is a small muscle arising by three fleshy slips, one each from the first three true ribs and from the fascia covering the intercostal muscles. The dense aponeurosis of insertion passes upward between the two heads of M. subscapularis and inserts on the ventral edge of the scapula, beginning a short distance caudal to the glenoid lip.

M. SUBCORACOIDEUS

This muscle has a single belly in the cranes. In *G. c. tabida* it is a very small triangular-shaped muscle, 4 cm. long and 1 cm. in maximum width at its origin from the anteromedial surface of the coracoid, just dorsal to the middle of that bone. The tendons of Mm. subcoracoideus and subscapularis insert adjacent to each other on the humerus, and in one wing they fused at the insertion.

M. BICEPS BRACHII

This muscle exhibits the same relative development in the two cranes. In *G. c. tabida* the small belly (about 14 cm. long) lies in the proximal two-thirds of the arm. The tendon is ossified near the distal end of the humerus, but not at the insertions on the radius and ulna. The larger tendon inserts on the radius. The biceps slip is present (see M. tensor patagii longus).

M. DELTOIDEUS MAJOR

This muscle is similar in the two species, but the dermal component described for *G. americana* (Fisher and Goodman, 1955:57) is absent in *G. c. tabida.* In the latter, the belly of deltoideus major is about 12 cm. long and extends slightly less than half way down the humerus. The fibers of insertion are in contact posteriorly with the humeral anchor of M. scapulotriceps. The primary origin of the deltoideus major is on the dorsolateral surface of the scapula, and there is a secondary origin, by a flat aponeurosis (7 mm. wide) from the blade of the scapula as described by Fisher and Goodman for the Whooping Crane. In the Sandhill Crane, this aponeurosis is attached about 3 cm. caudal to the posterior glenoid lip and the origin of M. scapulotriceps, and dorsal to the anteriormost fibers of M. dorsalis scapulae. I did not find an os humeroscapulare and Fisher and Goodman did not mention it.

M. TRICEPS (triceps brachii)

This complex is similar in the two cranes. In *G. c. tabida* there is a strong aponeurotic connection or anchor (1.5 cm. long and 1.5 cm. wide) between the anterior surface of the scapular head (= M. scapulotriceps) and the humerus. The humeral attachment of this band begins about 3 cm. distal to the head of the humerus and lies immediately anterior to the insertion of pars anterior of M. latissimus dorsi. M. humerotriceps arises from the entire inferior margin of the pneumatic fossa of the humerus and is not distinctly divided into an external and an internal head. A few fasciculi arise from the bicipital crest anterior to the area of insertion of M. dorsalis scapulae. An ossified tendon forms on the ventral margin of the belly near the middle of the arm. Fleshy fibers arise almost to the level of the distal end of the humerus, but the insertion on the ulna is exclusively by a wide tendon. The tendon of insertion does not contain a sesamoid. (See discussion of M. anconaeus coracoideus.)

M. BRACHIALIS

This muscle is typical in origin, relations, and insertion.

M. EXPANSOR SECUNDARIORUM

Fisher and Goodman did not mention this muscle, but it certainly must be present and well developed in *G. americana.*

In *G. c. tabida*, M. expansor secundariorum (Fig. 1) is a well developed, roughly triangular-shaped muscle about 10 cm. long and 3 cm. wide at its base posterior to the elbow. This is a smooth muscle, which inserts primarily on the calami of secondaries numbers 17 through 23 and on the skin containing several of the distal tertials; a fibrous band, connected primarily to the humero-ulnar pulley, attaches to number 16. The belly extends over one-third the way up the arm, where fasciculi are attached to the skin forming the dorsal layer of the metapatagium. The muscle has two tendons of origin. The distal origin is by a flat tendinous band attached to the medial epicondyle of the humerus, distal to the origin of M. pronator brevis; this origin, apparently, has not been described for the cranes previously. A second tendon is formed at the apex of the belly in the metapatagium. This tendon runs proximad through that skin fold and pierces the lowermost semitendinous fibers (which function as a pulley) of M. dorsalis scapulae, about 2 cm. from the insertion of that muscle. In the axilla, the tendon bifurcates about 3 cm. proximal to the pulley. The larger, ventral branch of the tendon has its major attachment to the medial corner of the sternocoracoidal process of the sternum; the smaller, dorsal branch passes dorsomesiad to attach to the ventral edge of the scapula, near its articulation with the procoracoid. Fürbringer (1902:572) called the tendon extending from the scapula to the sternum the "sterno-coraco-scapulare internum" ligament; Newton (1896: 608) called it simply the "sterno-scapular ligament."

M. ANCONAEUS CORACOIDEUS

This muscle was first described by Fürbringer (1902:576, and earlier papers). For a recent discussion of M. anconaeus coracoideus see Berger (1956:159). In the Sandhill Crane (Fig. 1), the belly of this muscle is about 4.5 cm. long, but only about 1 mm. in maximum width. It arises by a tendon from the "scapular" tendon of M. expansor secundariorum. Distally the belly of M. anconaeus coracoideus gives rise to a second tendon, which inserts on the tendon of M. scapulotriceps near the distal end of the humerus. This is a striated muscle, as previously noted by Fürbringer. Fisher and Goodman do not mention this muscle in the Whooping Crane.

M. EXTENSOR METACARPI RADIALIS

This muscle is similar in the two cranes. In the Sandhill Crane, pars anconalis is a spindle-shaped muscle (about 6.5 cm. long), whose fleshy fibers begin about 5.5 cm. from the proximal surface of the olecranon process and about 1 cm. distal to the area where a part of the tensor patagii brevis tendon fuses with the tendon of origin of pars anconalis. Two tendons, interconnected by fascia, are present. The anterior tendon represents one tendon of insertion of M. tensor patagii brevis; the posterior tendon, the ori-

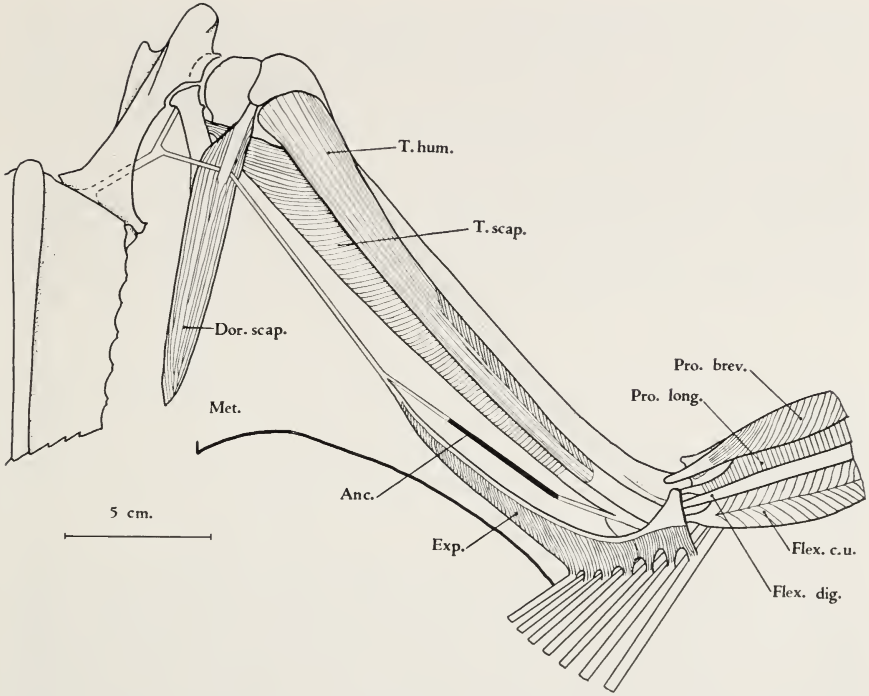


FIG. 1. Ventral view of certain muscles in the proximal region of the wing of *Grus canadensis tabida* to show relationships of Mm. expansor secundariorum and anconaeus coracoideus. The distal end of the humerus is distorted in order to show the triceps tendon and the origin of forearm muscles. Not shown is the fascial extension of the flexor digitorum sublimus tendon, which invests the superficial surface of M. flexor carpi ulnaris. Explanation of symbols: Anc., anconaeus coracoideus; Dor. scap., dorsalis scapulae; Exp., expansor secundariorum; Flex. c. u., flexor carpi ulnaris (humero-ulnar pulley not shown); Flex. dig., tendon of origin of flexor digitorum sublimus; Met., metapatagium; Pro. brev., pronator brevis; Pro. long., pronator longus; T. hum., humerotriceps; T. scap., scapulotriceps.

gin of pars anconalis. Both tendons are attached to the lateral epicondyle of the humerus. Pars palmaris is developed as illustrated for the Whooping Crane by Fisher and Goodman (1955: Fig. 16). The fleshy belly is about 7.5 cm. long. Pars anconalis and pars palmaris each give rise to separate tendons, which fuse to form a single ossified tendon of insertion. In addition to the usual insertion on the extensor process of the carpometacarpus, part of the tendon fuses with the tendon of M. extensor longus digiti II (= extensor pollicis longus), as in the Whooping Crane.

M. EXTENSOR DIGITORUM COMMUNIS

In the Sandhill Crane, this is a small, spindle-shaped muscle (8-9 cm. long), which is located in a little more than the proximal third of the forearm. The tendon bifurcates near the base of the pollex. The shorter branch inserts on the posterodorsal edge of digit II (= pollex), about 0.5 cm. from the proximal end of that bone. Fisher and Goodman

(1955: Fig. 20) illustrated this branch in the Whooping Crane, but described it (p. 60) as inserting on the "third finger." In *G. c. tabida* the longer tendon is ossified and inserts on the anterobasal corner of the proximal phalanx of digit III (of Montagna and Fisher and Goodman), or digit II (of Hudson), after passing through a fibrous pulley. I found no branch inserting on metacarpal II (I) as described and illustrated for the Whooping Crane by Fisher and Goodman (1955:60 and Fig. 20).

M. SUPINATOR BREVIS (supinator)

There are no important differences between the two species in the development of this muscle. In the Sandhill Crane the belly (about 8 cm. long) extends about one-third the length of the radius, i.e., nearly as far distad as M. pronator brevis. The muscle arises by a tendon from the lateral epicondyle of the humerus; some fleshy fibers also arise from the tendon of origin of M. extensor digitorum communis.

M. FLEXOR METACARPI RADIALIS (extensor carpi ulnaris)

This muscle exhibits similar relationships in the two cranes. In the Sandhill Crane it is a very small, spindle-shaped muscle 13 cm. long, but it is only about 0.5 cm. in maximum width. It arises from the distal end of the humerus in common with, and superficial to, the anconeus tendon. Fleshy fibers arise from this tendon 5 to 6 cm. from its humeral origin. As in the Whooping Crane, there is an aponeurotic attachment to the proximal end of the ulna. The muscle inserts near the base of the intermetacarpal space; the tendon of insertion is ossified.

M. PRONATOR BREVIS AND M. PRONATOR LONGUS (pronator sublimus and pronator profundus)

These two muscles have the same relationships as in *G. americana*. M. pronator longus (belly 10 cm. long) extends distad further than M. pronator brevis (belly 8 cm. long), but extends less than half way down the forearm. M. pronator brevis extends slightly more than one-third the length of the radius; it inserts primarily by an aponeurosis, beginning 4 cm. from the proximal end of the radius and extending to within 13.5 cm. of the distal end of that bone. The two muscles insert on about the same areas in *G. c. tabida* and *G. americana*: M. pronator longus over an area about 7 cm. long; M. pronator brevis over an area 4 to 5 cm. long.

M. EXTENSOR LONGUS DIGITI II (extensor pollicis longus)

This muscle exhibits the same relative development in the two birds. In the Sandhill Crane, it arises from the radius (for a distance of 6 cm.) and from the ulna (for a distance of only 2 cm.). The ulnar origin begins immediately distal to the biceps insertion. The small belly (about 13 cm. in overall length) is located in about the proximal half of the forearm; it is rounded distally, but is a flat muscle-sheet proximally and posteriorly. The tendon is ossified, except near the insertion, where it fuses with the tendon of M. extensor metacarpi radialis; the common tendon inserts on the extensor process of metacarpal II (I).

M. ANCONEUS (anconaeus)

This muscle is similar in the two species. In the Sandhill Crane it arises by a very large tendon, much larger than the tendons of Mm. extensor digitorum communis or supinator. The belly (about 13 cm. long) extends distad slightly more than half the length of the ulna, and thus inserts on somewhat more than the proximal half of that bone.

M. EXTENSOR LONGUS DIGITI III (extensor indicis longus)

Relative to the size of *G. americana* and *G. c. tabida* and to the development of this muscle in genera of other families, M. extensor longus digiti III might almost be considered rudimentary in the cranes. In the Sandhill Crane this muscle has a very small, spindle-shaped belly 12 cm. long but only about 3 mm. in maximum width. It arises from the posterior surface of about the distal half of the radius in the Sandhill Crane and from the "middle third" of this bone in the Whooping Crane (Fisher and Goodman, 1955:64). It inserts on the distal phalanx of digit III (II).

M. FLEXOR DIGITORUM PROFUNDUS

This muscle has similar relationships in the two species. The relatively poorly developed belly (10 cm. long) in the Sandhill Crane is limited to less than the proximal half of the ulna. It has a V-shaped origin at the inferior margin of the insertion of M. brachialis; the origin extends to the origin of M. flexor carpi ulnaris brevis. The tendon of insertion is ossified except where it passes around the distal end of the ulna and into the manus; it inserts on the anteroventral corner of the distal phalanx of digit III (II). Thus, this muscle inserts on that phalanx *proximal* to the insertion of M. flexor digitorum sublimus.

M. FLEXOR DIGITORUM SUBLIMUS

Fisher and Goodman do not discuss this muscle, though they describe it as the "anterior part" of M. flexor carpi ulnaris. Shufeldt (1890:141) and Fisher (1946:598) also interpreted this complex in a similar manner. This "anterior part" is the flexor digitorum sublimus muscle as I have seen it in other genera and as it is described by Gadow and Selenka (1891:278). Though it might be considered rudimentary in the cranes, it definitely is present. The situation is confused because most of the muscle-complex is tendon and aponeurosis.

The strong tendon of origin (Fig. 1) arises from the distal end of the humerus, posterior to the origin of M. pronator longus, as described for the Whooping Crane by Fisher and Goodman (1955:66). From the posterior edge of this tendon, a thin but extensive aponeurosis passes posteriad to attach to the ulna; distally, the tendon inserts, in part, on the anterobasal corner of the os ulnare (os cuneiform), but has several small slips, which pass into the manus to fuse with the deep fascia on the palmar surface. These relationships are found both in *G. americana* and *G. c. tabida.* The rudimentary, bipinnate, fleshy belly (about 10 cm. long) of the flexor digitorum sublimus muscle arises from the anterior surface of the aponeurosis and from the deep surface of the main humeral tendon. The fleshy fibers begin about 4 cm. distal to the humerus. The small, ossified tendon of insertion of the sublimus muscle is entirely separate from the main (humeral) tendon, which inserts on the anterior edge of the ulnare; the latter attachment represents an accessory insertion of this complex and is not found in all families of birds. The sublimus tendon becomes fibrous as it passes around the anterior surface of the ulnare (anterior to the tendon of M. flexor carpi ulnaris and posterior to the accessory tendon of the sublimus muscle) and into the manus, where again it becomes ossified. The tendon passes distad along the anterior surface of the carpometacarpus and inserts primarily on the anterior edge, about mid-length, of the distal phalanx of digit III (II), but there is a fascial continuation to the tip of that phalanx. The flexor digitorum sublimus tendon, therefore, has a more distal insertion than the flexor digitorum profundus tendon. Fisher and Goodman (1955:66–67) also described this insertion in their discussion of the "anterior part" of M. flexor carpi ulnaris; see also Fisher, 1946:606 and Fig. 13.

M. FLEXOR CARPI ULNARIS

If one excludes the anterior part (= M. flexor digitorum sublimus) as described by Fisher and Goodman (1955:65–67), this muscle exhibits about the same development in *G. americana* and *G. c. tabida.* In *Grus* and apparently in all other birds, M. flexor carpi ulnaris arises by a very strong tendon from the medial (internal) humeral condyle and immediately passes through a strong humero-ulnar pulley. I have never seen any departure from this relationship. In the Sandhill Crane the belly is relatively poorly developed. The bulk of the belly (total length about 15 cm.) is located in the proximal third of the forearm, though a small bundle of fleshy fibers accompanies the tendon almost to the distal end of the ulna. The strong, ossified tendon of insertion forms on the anterior surface of the belly at about the junction of the first and second fourths of the forearm; it inserts on the posterobasal portion of the ulnare. As in the Whooping Crane, the "superficial fasciculus of the posterior part" of M. flexor carpi ulnaris "attaches to the fascia over the bases of the feathers arising from the proximal two-thirds of the ulnar length" (Fisher and Goodman, 1955:67); in the Sandhill Crane, a small tendon forms from this posterior belly and also inserts on the base of the ulnare.

M. FLEXOR CARPI ULNARIS BREVIS (ulnimetacarpalis ventralis)

This is a well developed muscle, similar in the two cranes. In the Sandhill Crane the belly (about 12.5 cm. long) arises from slightly more than the distal half of the ulna. It has the typical relationships to the origin of M. flexor digitorum profundus.

M. ABDUCTOR ALAE DIGITI II (abductor pollicis)

This muscle, apparently, is similar in the two cranes. In each it has both a palmar and an anconal head. In the Sandhill Crane, as in all other genera I have dissected, the palmar belly arises from the tendon of insertion of M. extensor metacarpi radialis. Fisher and Goodman (1955:68) state that in *G. americana* this head arises from "the base of the extensor process" and by "tendinous fibers from the inserting tendon of M. tens. pat. longus." This is not true for the Sandhill Crane: the palmar head arises only from the tendon of M. extensor metacarpi radialis. There is a strong insertion of M. tensor patagii longus on the extensor process, but the tendon then fans out to become continuous with the deep fascia of the manus on both its dorsal and palmar surfaces. On both surfaces, this fascia passes superficially over the two heads of the abductor alae digiti II, but none of the fibers of this muscle arise from the tendon of tensor patagii longus.

The anconal head of the abductor alae digiti II arises from the extensor process; it inserts on the anterior corner of the base of digit II (pollex). The palmar head inserts by fleshy and tendinous fibers on the anterior edge of digit II in its basal half.

M. ADDUCTOR ALAE DIGITI II (adductor pollicis)

This muscle is well developed in the cranes. In the Sandhill Crane it arises by a flat aponeurosis about 1 cm. wide from metacarpal III (II). The bulky belly passes anteriad to insert on most of the posterior surface of digit II (pollex).

M. FLEXOR DIGITI IV (flexor digiti III)

This is a weakly developed muscle in the cranes. In the Sandhill Crane the belly is 3 cm. long and less than 0.5 cm. wide.

M. FLEXOR BREVIS DIGITI IV (flexor brevis digiti III)

This structure in the cranes is composed mostly of connective tissue (Fisher and Goodman, 1955:68). I agree with Hudson that it would be better to consider this not as a separate muscle, but simply as a distal part of the preceding muscle.

M. ABDUCTOR MINOR DIGITI III (abductor digiti II)

I have never seen such a muscle. In all birds that I have dissected, this structure is a ligament connecting the carpometacarpus with digit III.

M. FLEXOR METACARPI BREVIS

This muscle is absent in *G. americana* and in *G. c. tabida.* Hudson and Lanzillotti (1955:35 and 43) suggest that this name "be dropped from the literature" inasmuch as this muscle represents a distal head of M. extensor indicis longus (extensor longus digiti III). Data which I have obtained suggest that this head may be of taxonomic use in some families. I think, therefore, that it would be convenient to retain the name flexor metacarpi brevis for indicating the presence or absence of this small muscle.

M. INTEROSSEUS DORSALIS

This muscle is similar in the two cranes. In the Sandhill Crane, it inserts primarily on the base of the distal phalanx of digit III (II); a small tendon continues to the tip of the digit.

M. INTEROSSEUS VENTRALIS (interosseus volaris)

In *G. americana* this muscle inserts on "the posterior aspect of phalanx 2, about three-fourths of the way out its length" (Fisher and Goodman, 1955:69). The insertion is similar in *G. c. tabida*, but the tendon is also anchored to the base of the distal phalanx of digit III (II).

M. EXTENSOR BREVIS DIGITI II (extensor pollicis brevis)

This very small muscle (belly about 1.5 cm. long) is developed as illustrated for the Whooping Crane by Fisher and Goodman (1955: Fig. 18).

M. ABDUCTOR MAJOR DIGITI III (abductor indicis)

This muscle is similar in the two species. In the Sandhill Crane, the muscle is mostly tendinous, though a few fleshy fasciculi arise at the level of the pisiform process. The ossified tendon forms at about the junction of the proximal and middle thirds of the carpometacarpus; the insertion is typical. The very small, deep head, described for *G. americana* by Fisher and Goodman is present in *G. c. tabida.*

M. FLEXOR DIGITI II (flexor pollicis)

Similar in the two cranes, this small (1.5 cm. long), fleshy muscle arises from the base of the carpometacarpus and inserts on the posterobasal corner of digit II (pollex) in the Sandhill Crane.

M. FLEXOR METACARPI POSTERIOR (ulnimetacarpalis dorsalis)

This is a poorly developed muscle with a belly 3.5 cm. long. In general, it has the same relationships as described by Fisher and Goodman (1955:70), except that in *G. c. tabida* the two smaller heads are mostly tendinous bands.

Myology of the Leg

M. EXTENSOR ILIO-TIBIALIS LATERALIS (iliotibialis)

This extensive muscle is similar in the two cranes. In the Sandhill Crane it arises by an aponeurosis from the entire anterior iliac crest and from all but the caudal 1 cm. of the posterior iliac crest. Some of the origin posteriorly is by fleshy fibers. It is throughout a thin sheet of muscle, but the posterior edge is the thickest. As Fisher and Goodman (1955:76) pointed out, "the fibers in the center of the muscle are less than half as long as those of the anterior and posterior edges." The distal half of the central part of the muscle is aponeurotic and is fused with the underlying muscles. The extensor ilio-tibialis lateralis muscle conceals from superficial view the anterior and superior half of M. extensor ilio-fibularis (= biceps femoris), but it does not conceal the bellies of Mm. flexor cruris lateralis and flexor cruris medialis.

M. EXTENSOR ILIO-TIBIALIS ANTERIOR (sartorius)

In the Sandhill Crane, this muscle arises primarily by an aponeurosis shared with pars posterior of M. latissimus dorsi from the neural spine of the last dorsal vertebra and from the anterior 5 cm. of the median dorsal ridge of the synsacrum. In the Whooping Crane, there is no origin from the last dorsal vertebra. In general, however, the muscle exhibits the same configuration in the two cranes. In the Little Brown

Crane, Hudson (1937:17) found the origin from the "anterior edge of the ilium only." The insertion in the Sandhill Crane is as described by Fisher and Goodman (1955:79).

M. PIRIFORMIS (gluteus medius et minimus)

As stated by Fisher and Goodman (1955:79), this muscle is similar in the two cranes, but it is "more strongly developed" in *G. c. canadensis.* In *G. c. tabida* it is a triangular-shaped muscle, 2 cm. wide at its base (origin) and about 4 cm. long. It inserts on the femur by a flat tendon anterodistal to the insertion of M. gluteus profundus (= iliotrochantericus posterior).

M. GLUTEUS PROFUNDUS (iliotrochantericus posterior)

Similar in the two cranes, none of the fibers of this muscle arise directly dorsal to the acetabulum, this area being pre-empted by the origin of M. gluteus medius et minimus (= piriformis).

M. ILIACUS (iliotrochantericus anterior)

This muscle is similar in the two cranes. Its relationships to M. iliotrochantericus medius are described below. (See Fisher and Goodman, 1955: Figs. 29 and 30.)

M. ILIOTROCHANTERICUS MEDIUS

Gadow and Selenka (1891:142) and Hudson (1937:60, 69) reported that they did not find this muscle in the genus *Grus*, but Fisher and Goodman (1955:123) found it in *G. americana* and *G. c. canadensis.* I found it bilaterally in two specimens and unilaterally in a third specimen of *G. canadensis tabida.* This muscle and M. iliotrochantericus anterior are separate at their origins only; the bellies fuse distally and insert by a common, wide (1.5 cm.) aponeurosis. In the right hip of one specimen, the iliotrochantericus anterior and iliotrochantericus medius muscles are completely fused, so that this complex is represented by a single muscle-mass, arising from the same area, however, occupied by both muscles in the other dissections. The fusion of these two muscles is an example of the general tendency toward fusion of muscles which arise from adjacent areas and whose fibers are parallel. The common tendon inserts on the femur just distal to the insertion of M. iliotrochantericus posterior. Though there are two distinct tendons of insertion for the three iliotrochanterici muscles, there is an almost continuous line of insertion for a distance of 3 cm., beginning on the trochanter.

MM. VASTUS LATERALIS AND VASTUS MEDIALIS (femoritibialis externus and medius)

There are no significant differences in this complex between the two cranes; see, however, the discussion of "M. femoritibialis externus" below.

M. EXTENSOR ILIO-FIBULARIS (biceps femoris)

This muscle is similar in the two cranes. In the Sandhill Crane the well developed belly arises mostly by fleshy fibers from all but the posterior 1 cm. of the posterior iliac crest. The strong tendon inserts on the fibula 4 cm. distal to the proximal articular surface of that bone.

M. FLEXOR CRURIS LATERALIS (semitendinosus and accessorius semitendinosi)

This complex exhibits a similar configuration in the two cranes. In the Sandhill Crane the semitendinosus muscle arises from approximately the posterior 1 cm. of the posterior iliac crest. The raphe which separates the semitendinosus from the accessory semitendinosus continues downward between pars media and pars interna of M. gastrocnemius to become continuous with the tendon of that muscle; the raphe is ossified about the middle of the belly of M. gastrocnemius. In its course between the two heads of that muscle, the raphe is accompanied by a small fleshy belly, the "distal accessory" head of Fisher and Goodman.

As in the Whooping Crane, there are two distinct parts to the accessory semitendinosus muscle (Fisher and Goodman, 1955:83). The more proximal part inserts by fleshy fibers on the posterior surface of the medial condyle and the intercondylar region (popliteal region) of the femur, immediately proximal to the common origin of Mm. flexor hallucis longus, flexor perforatus digiti III, and flexor perforatus digiti IV, and the tendon of origin of M. gastrocnemius, pars media. The attachment to the femur is nearly transverse in direction, rather than vertical, as in many birds. The more distal part of the accessorius muscle (distal accessory head) passes lateral to the tendon of insertion of M. flexor cruris medialis (= semimembranosus) and does not insert on the belly of M. gastrocnemius, pars media, as it does in the Whooping Crane.

M. FLEXOR CRURIS MEDIALIS (semimembranosus)

This muscle is similar in the two cranes. The tendon of insertion is intimately fused with the raphe of the accessory semitendinosus and pars media of M. gastrocnemius, just before the latter fuses with the internal head of the gastrocnemius. The muscle inserts by a thin aponeurosis (2.5 cm. long and about 1.5 cm. wide) on the tibiotarsus, beginning about 3 cm. distal to the proximal end of that bone. In the Whooping Crane the tendon inserts "some five centimeters from the proximal end" of the bone.

M. CAUDOFEMORALIS (piriformis)

Fisher and Goodman (1955:85 and 123) emphasized the amount of variation they found in this complex. They found both pars caudofemoralis and pars iliofemoralis in two specimens of the Whooping Crane, but only pars iliofemoralis in a third specimen. In one dissection, they found three parts to the muscle.

I found both parts to this muscle in three specimens of the Sandhill Crane. Pars iliofemoralis is a very thin, triangular sheet of muscle, 2 cm. wide at its base, where it arises primarily by an aponeurosis from the ventral surface of about the middle third of the posterior iliac crest; the belly is approximately 6 cm. in length. It inserts by a fleshy band (about 5 mm. wide) on the lateral surface of the femur, beginning about 3.5 cm. distal to the trochanter and 1 cm. distal to the insertion of M. ischiofemoralis.

Pars caudofemoralis has a small spindle-shaped belly, 8 to 9 cm. long and only about 6 mm. in maximum width. It arises by a small tendon (3 cm. long, but only 0.5 mm. in diameter) from the fascia covering the depressor muscles of the tail; I found no direct bony attachment on the pygostyle. This tendon passes through a bony notch at the most caudal end of the projecting posterior iliac crest; the tendon is held in the notch by a ligament, which completes a fibro-osseous canal. The muscle inserts by a long, flat tendon (2 cm. long and 2 mm. wide) about 3 cm. distal to the trochanter and directly medial to the insertion of pars iliofemoralis.

M. FLEXOR ISCHIOFEMORALIS (ischiofemoralis)

This muscle is well developed in these cranes. In the Sandhill Crane it inserts on the femur about 1 cm. proximal to the insertion of M. caudofemoralis (see above). There is a striking difference in the relationships of the tendons of insertion of M. ischiofemoralis and the two parts of M. caudofemoralis in the Whooping Crane as described and illustrated by Fisher and Goodman (1955:86 and Figs. 30 and 31). They state that M. ischiofemoralis inserts "posterior to and between the insertions of the two parts of M. caudofem." In no genus have I seen the condition illustrated in Fisher and Goodman's Figure 31. In the Sandhill Crane, pars caudofemoralis inserts medial to pars iliofemoralis.

MM. ADDUCTOR SUPERFICIALIS ET PROFUNDUS (adductor longus et brevis)

These two muscles exhibit about the same relative development in the two cranes. M. adductor profundus is entirely fleshy at its origin in the Sandhill Crane and I did not find a conspicuous "heavy layer of tendon" covering the medial surface of this muscle such as Fisher and Goodman (1955:88) described for the Whooping Crane. The glistening muscular fascia is well developed, however.

M. AMBIENS

Fisher and Goodman (1955:88–89) called attention to the differences in termination of the ambiens tendon in *G. americana* and *G. c. canadensis*. In the former, the ambiens tendon serves as the "principal, if not sole, origin for M. flex. perf. dig. II, although there is strong fascial interconnection between the origins of Mm. flex. perf. dig. II, III, and IV, and in one instance there is actually a branch of the main ambiens tendon that goes to the tibiotarsus." In the Little Brown Crane, "M. ambiens connected distally to the small lateral head of M. flex. perf. dig. III. It had little connection with M. flex. perf. dig. II and none with M. flex. perf. dig. IV."

In the Sandhill Crane, I found that the ambiens muscle arises primarily by a flat tendon from the pectineal process. The small, spindle-shaped belly is 6 to 8 cm. long and less than 1 cm. in maximum width. Distally, a very small tendon (1 mm. wide) forms and has the usual course through the patellar ligament. The tendon then passes distad medial to the biceps tendon and serves as the primary origin for the lateral head of M. flexor perforatus digiti III; the ambiens tendon does not give rise to any other muscle.

M. FEMORITIBIALIS INTERNUS

There are minor differences between the Whooping and the Sandhill cranes in development of this muscle mass and I found variation in the pattern in the three specimens I dissected. In one right leg, the muscle was indistinctly divided into two heads. In another right leg, one long and two short heads were present; each gave rise to a tendon and the three tendons fused for a common insertion. In the other dissections, there were two distinct heads. The posterior or long head arises from the posteromedial surface of the femur, beginning a short distance proximal to the area of insertion of M. iliacus; the origin is fleshy as far as the medial condyle. The short or distal head arises from a small area (about 2 cm. long) on the anteromedial surface of the femur, just above the medial condyle. The small tendon from the latter head fuses with the patellar ligament and with the tendon of the long head; the combined tendon inserts on the medial corner of the tibiotarsus at the base of the inner cnemial crest.

"M. FEMORITIBIALIS EXTERNUS"

As Fisher and Goodman (1955:89–90) imply, there is some confusion concerning the muscle they consider under this name and their M. vastus lateralis. Fisher (1946: Table 42) stated that his M. vastus lateralis was a synonym for M. femoritibialis externus of Gadow and Selenka (1891:154) and Hudson (1937:20). This muscle was discussed earlier by Fisher and Goodman on page 81.

The muscle which Fisher and Goodman call "M femoritibialis externus," I believe is simply a distal head of their vastus lateralis (= femoritibialis externus). I considered this head a part of M. femoritibialis externus in the cuckoos (Berger, 1953:68 and Fig. 6); it was illustrated, but not given a special name. Mitchell (1901:647 and Text-fig. 79) also called attention to this distal part in gruiform birds. In the Sandhill Crane, the distal head of M. femoritibialis externus arises from the posterior and lateral surfaces of the distal half of the femur, posterior to the more distal origin of Fisher and Goodman's vastus lateralis. The tendon of the distal head fuses, in part, with the patellar ligament, but the strongest portion of the tendon passes distad to insert on the outer cnemial crest of the tibiotarsus.

Fisher and Goodman (*loc. cit.*) also state that Gadow and Selenka's (1891:155) "M. femoritib. medius is apparently lacking . . . or is fused to M. femoritib. ext." in the Whooping Crane. However, Fisher (1946: Table 42) placed his M. vastus medialis in synonymy with Gadow's femoritibialis medius, which Fisher and Goodman described on pages 81 and 82. The discussion by Gadow and Selenka (1891:155) of the origin of the femoritibialis complex is not entirely clear, but points out that the femoritibialis medius passes directly to the patella. and, in many birds, the fleshy fibers do insert on the proximal surface of that sesamoid (see Hudson, 1937:20; Berger, 1953:68).

M. OBTURATOR EXTERNUS

Fisher and Goodman (1955:90) said that "Hudson (1937:28) stated that M. obt. ext. had two distinct parts in *G. canadensis*; our dissection of this species showed the separation to be superficial only."

In the Sandhill Crane, also, this muscle may be a single mass or may be partially separated into two heads. It is a broad band of fleshy fibers with a nearly continuous origin from the anterodorsal and anteroventral margins of the obturator foramen. The belly conceals much of the tendon of M. obturator internus. The externus has a broad fleshy insertion (1 cm. wide) on both sides (proximal and distal) of the tendon of M. obturator internus.

M. OBTURATOR INTERNUS

This muscle is triangular in shape. It does not arise inside the pelvic cavity, as it does in *Porzana* and *Coua*. The fibers converge to a tendon, which emerges through the obturator foramen and inserts on the posterolateral surface of the femur, less than 1 cm. from the trochanter.

M. PSOAS (iliacus)

This is a flat, fleshy band about 4 cm. long and 0.5 cm. wide. It arises from the ventral edge of the ilium about 1 cm. anterior to the acetabulum. It inserts by fleshy fibers on the femur for a distance of 1 cm., beginning 1 cm. distal to the neck of the femur, just proximal and somewhat posterior to the origin of M. femoritibialis internus. Fisher and Goodman (1955:90) said that "the condition described by Fisher (1946:670) for the cathartid vultures is found" in the Whooping Crane.

M. GASTROCNEMIUS

The three heads of this complex are, in general, similar in the two cranes. The following specific points may be mentioned for the Sandhill Crane.

Pars externa arises from the lateral condyle of the femur. as described by Fisher and Goodman (1955:91). The tendon of origin is, in part, fused to the biceps loop.

Pars interna has an extensive origin from the medial surface of the inner cnemial crest and from the patellar ligament. In fact, the fibers of M. sartorius and part of those of pars interna insert and arise, respectively, from a tendinous raphe separating the two muscles.

Pars media arises by a flat tendon from the intercondylar (popliteal) area of the femur, just proximal to the common tendon of origin for the long flexors. Fleshy fibers begin about 3 cm. from the femoral origin of the tendon. In the left leg of one specimen, I found an *accessory medial head.* This head (5 cm. long, but less than 1 cm. wide at the origin) arises from the posterior surface of the medial condyle of the tibiotarsus. The belly passes lateral to the inserting tendon of M. semimembranosus and anterior to the tendon of the distal accessory belly of M. accessorius semitendinosi. The belly tapers to a minute tendon, which fuses with the fascia covering the deep surface of pars externa (gastrocnemius) in the area where this head fuses with pars media.

M. PERONEUS LONGUS

Similar in the two cranes, this is a well developed muscle, which conceals all of M. tibialis anterior. The strong tendon of insertion forms as ossified radiating bands on the superficial surface of the belly. The tendon inserts on the tendon of M. flexor perforatus digiti III, 4 cm. distal to the proximal end of the tarsometatarsus. (See also Mitchell, 1913:1053.)

M. TIBIALIS ANTERIOR

Similar in general configuration in the two cranes, the femoral head (whose tendon is ossified) is almost equal in bulk to the tibial head in the Sandhill Crane. The common, ossified tendon bifurcates at the insertion on the tarsometatarsus, about 2 cm. from the proximal end of that bone, but the two tendons insert adjacent to each other.

M. FLEXOR PERFORANS ET PERFORATUS DIGITI II

In general, this muscle is similar in the two cranes. In one specimen of *G. c. tabida*, the belly was not bipinnate. Fisher and Goodman (1955:94) found this muscle "not clearly bipinnate" on one side of a specimen of *G. c. canadensis*. The total length of the belly is about 8 cm.; fleshy fibers extend further distad in the anterior half of the belly. The tendon of insertion is calcified in the region of the crus and tarsometatarsus, but not over the intratarsal joint. Fisher and Goodman found fusion between the tendons of Mm. flexor perforans et perforatus digiti II and flexor perforatus digiti II in *G. c. canadensis* (see also Mitchell, 1901:653), but not in *G. americana*. I did not find such fusion in *G. c. tabida*. The tendon of M. flexor perforans et perforatus digiti II perforates the tendon of M. flexor perforatus digiti II and is perforated by the tendon to digit II of M. flexor digitorum longus, as described by Fisher and Goodman (1955:94).

M. FLEXOR PERFORANS ET PERFORATUS DIGITI III

This muscle has a small (10 cm. long) bipinnate belly. The tendon perforates and is perforated. Hudson (1937:42) and Fisher and Goodman (1955:97) found a vinculum connecting the tendon of this muscle with the tendon of M. flexor perforatus digiti III in *G. c. canadensis*, but Fisher and Goodman did not find such a vinculum in *G. americana*. This vinculum is present in *G. c. tabida*. The vinculum is short (about 0.5 cm. long), but strong, and is located about 3 cm. from the distal end of the tarsometatarsus.

M. FLEXOR PERFORATUS DIGITI IV

The origin and insertion of this muscle in the Sandhill Crane are similar to those described for the Whooping Crane by Fisher and Goodman (1955:96). My specimens also exhibited the peculiar lateral head, which passes distad lateral to the biceps tendon before fusing with the medial head. The bulk of the muscle lies medial to the biceps tendon. Mm. flexor perforatus digiti IV, flexor perforatus digiti III, and flexor hallucis longus have a common origin, fleshy and tendinous, from the intercondylar area of the femur. This common origin is located just distal to the insertion of the accessory semitendinosus muscle and lateral to the origin of pars media of the gastrocnemius.

M. FLEXOR PERFORATUS DIGITI III

In the Sandhill Crane, the posterior head arises as described for the Whooping Crane by Fisher and Goodman. The much smaller lateral head is, in part, a direct continuation of the ambiens tendon, but a long (7 cm.), flat tendinous band, attached proximally to the head of the fibula, fuses with the ambiens tendon, just proximal to the origin of the fleshy fibers of M. flexor perforatus digiti III. This tendinous band is intimately associated with the lateral head of M. flexor perforatus digiti II. The fleshy fibers of the lateral head of M. flexor perforatus digiti III begin about 8 cm. distal to the proximal end of the fibula. There is a well developed vinculum between the tendon of this muscle and the tendon of M. flexor perforans et perforatus digiti III. The tendon of insertion is perforated by both of the deep flexor tendons.

M. FLEXOR PERFORATUS DIGITI II

This muscle is as decribed for the Whooping Crane by Fisher and Goodman (1955: 97–98). Both heads are present in the Sandhill Crane. The lateral head (about 4.5 cm. long) arises by fleshy fibers from the patellar ligament and associated fascia and from the tendinous band mentioned above. This head is not connected with the ambiens tendon. The medial, or deep, head, about the same length, arises by a flat tendinous band from the femoral tendon of origin of M. flexor perforatus digiti III (part of the tendon is calcified). The inserting tendon of flexor perforatus digiti II is perforated by the tendon of flexor perforans et perforatus digiti II, although the bulk of the tendon inserts on the lateral side of the proximal phalanx, as described by Fisher and Goodman (1955:98).

M. FLEXOR HALLUCIS LONGUS

The origin of this muscle in the Sandhill Crane is the same as Fisher and Goodman (1955:98) described for the Whooping Crane. The relatively small belly (15 cm. long) extends about half way down the tibiotarsus, but it is one of the best developed muscles on the posterolateral aspect of the crus. The tendon of insertion in the Sandhill Crane differs in that it does not pass through a bony canal in the hypotarsus (see also Hudson, 1937:69); it does pass through such a canal in the Whooping Crane (Fisher and Goodman, 1955:99). Fisher and Goodman have pointed out that "in most birds there is some sort of a connection between" the tendons of Mm. flexor hallucis longus and flexor digitorum longus, "but Hudson (1937:48) did not find fusion of them in *Grus* [*c.*] *canadensis* (nor did we); he noted only a vinculum between them, as was the case in one of our Whooping Cranes." In one of my specimens of the Sandhill Crane, however, most of the tendon of flexor hallucis longus fused with the tendon of flexor digitorum longus in the distal one-fourth of the tarsometatarsus. Only a very small branch of the hallucis tendon continued directly to the hallux; this tendon was not ensheathed by the tendon of M. flexor hallucis brevis. Fisher and Goodman also were unable to demonstrate such a perforation of the brevis tendon in *G. americana.* In a second specimen of *G. c. tabida* the tendon of flexor hallucis longus did not fuse with the tendon of flexor digitorum longus, but they were connected by a strong vinculum (representing over half of the hallucis tendon), 4 cm. proximal to the distal end of the tarsometatarsus; the remainder of the hallucis tendon inserted on the hallux. In a third specimen, the two tendons were connected by a weak vinculum (2.5 cm. long). but the hallucis tendon retained its integrity throughout. Mitchell (1901:654) illustrated the considerable intergeneric variation in the pattern of these two deep plantar tendons in several gruiform birds.

M. FLEXOR DIGITORUM LONGUS

In the Sandhill Crane, the belly (13.5 cm. long) of this muscle is slightly shorter than the belly of M. flexor hallucis longus (15 cm.). The lateral head is the larger; the medial head is short and small. The tendon of this muscle alone passes through the single bony canal in the hypotarsus. The insertion is typical.

M. PERONEUS BREVIS

This muscle is poorly developed in the cranes (see Mitchell, 1913:1053). In the Sandhill Crane, the belly is 13.5 cm. long, but it is less than 0.5 cm. wide. The origin begins at the level of insertion of the biceps tendon, as in the Whooping Crane. The insertion is typical (see Fisher and Goodman, 1955:99–100).

M. EXTENSOR DIGITORUM LONGUS

The belly of this muscle is about 14 cm. long, but only 1 cm. in maximum width at the head of the tibiotarsus. The tendon of insertion passes through a bony canal at the distal end of the tibiotarsus, but it is held in place by a ligament on the proximal end of the tarsometatarsus. The general development is the same as described for the Whooping Crane by Fisher and Goodman (1955:100).

M. POPLITEUS

Typical in origin and insertion in the Sandhill Crane, this small muscle is about 2 cm. long and 1.3 cm. wide. It arises on the fibula, inserts on the tibiotarsus.

M. PLANTARIS

This is a very small muscle in the Sandhill Crane. Its belly is about 7 cm. long, but only about 0.7 cm. in maximum width at the proximal end of the tibiotarsus. The minute tendon inserts on the medial corner of the tibial cartilage.

The short toe muscles are very poorly developed in the Cranes (Fisher and Goodman, 1955:102), although I found remnants of the following eight muscles in both legs.

M. EXTENSOR HALLUCIS LONGUS

This is relatively a very small muscle, 5 to 6 cm. long and with a maximum width of but 2 to 3 mm. It seems to arise exclusively from the fascia covering the anteromedial surface of the intratarsal joint. The tendon inserts on the medial side, and not on the dorsal surface, of the distal phalanx of the hallux.

M. EXTENSOR PROPRIUS DIGITI III

This muscle is rudimentary. I found a few fleshy fibers on the anterior surface of the distal half of the tarsometatarsus, but much of the muscle seems to be represented by semitendinous fibers.

M. EXTENSOR BREVIS DIGITI IV

This muscle also is rudimentary. Tendinous and fleshy fibers arise from about the distal third of the tarsometatarsus. The tendon is about 1 mm. wide; it passes through a bony canal between the trochleae for digits III and IV to insert on the medial surface of the base of the proximal phalanx, digit IV.

M. ABDUCTOR DIGITI II

The 3 cm.-long belly is composed of fleshy and tendinous fibers. It arises from the medial surface of the distal end of the tarsometatarsus. The tendon inserts on the medial side of the base of the proximal phalanx of digit II.

M. FLEXOR HALLUCIS BREVIS

This is a minute muscle, 3 to 4 cm. long and with a maximum width of about 3 mm. It arises primarily from the medial surface of the hypotarsus. It has a thin, hair-like tendon about 0.3 mm. wide. It inserts on the base of the hallux and is not perforated by the tendon of M. flexor hallucis longus.

M. ADDUCTOR DIGITI II

This muscle is typical in origin and relationships. The belly is 4 cm. long and 4 mm. in maximum width. It arises at the proximal end of the tarsometatarsus, immediately inferior to the hypotarsal area. The hair-like tendon is about 0.3 mm. wide. It inserts on the dorsomedial surface of the base of the proximal phalanx, digit II.

M. LUMBRICALIS

This muscle shows the poorest development of any of the short toe muscles, and I did not find it in all dissections. When present, it consists of scattered fleshy and tendinous fibers, located at the distal end of the tarsometatarsus. These insert primarily on the cartilaginous pads for digits III and IV.

M. ABDUCTOR DIGITI IV

This is another minute muscle, having a length of about 4.5 cm. and a maximum width of 3 mm. The tendon is less than 0.5 mm. wide, but it expands distally and inserts on the lateral side of the base of the proximal phalanx of digit IV.

M. ADDUCTOR DIGITI IV

This muscle is not present in the Sandhill Crane, nor in the Whooping Crane (Fisher and Goodman, 1955:102).

Summary

Only two of the 47 major wing muscles are absent in *Grus americana* and in *G. canadensis tabida*: Mm. flexor metacarpi brevis (see page 292) and entepicondylo-ulnaris. Pars propatagialis M. cucullaris (= "dermo-tensor patagii" of Shufeldt, 1890, but not of Fisher, 1946: 574) also is absent. The os humeroscapulare (see page 287) is absent in both cranes. The following similarities of wing muscles in the two cranes deserve special mention: The biceps slip arises from the coracoidal tendon of M. biceps brachii and has a typical insertion on the tendon of insertion of M. tensor patagii longus. Mm. tensores patagii longus et brevis are represented by a single fused belly. M. scapulotriceps has a strong aponeurotic anchor extending from the anterior edge of the belly to the humerus. M. flexor digitorum profundus has a more proximal insertion on digit III (of Fisher) or digit II (of Hudson) than M. flexor digitorum sublimus. The latter muscle, though its belly is very small, is present and similar in each. M. proscapulohumeralis is present in both cranes. M. subcoracoideus has a single head. The tendon of insertion of M. serratus anterior passes between the two heads (pars externa and pars interna) of origin of M. subscapularis. M. deltoideus major has the usual origin from the dorsolateral surface of the scapula and also has an accessory tendinous origin from the scapula caudal to the glenoid fossa. M. expansor secundariorum is well developed in *G. c. tabida* and undoubtedly in *G. americana*. The rudimentary M. anconaeus coracoideus is present in *G. c. tabida* and probably in *G. americana*. M. adductor alae digiti II (adductor pollicis) is an exceptionally well developed muscle, whereas Mm. flexor digiti IV (III), abductor major digiti III (abductor indicis), and flexor metacarpi posterior are poorly developed. M. latissimus dorsi metapatagialis is inconstant in both species.

The following differences between *G. americana* and *G. c. tabida* were noted in the wing muscles: M. pectoralis is divided into a superficial and a deep layer in *G. americana*, but not in *G. c. tabida*. The origins of Mm. latissimus dorsi, rhomboideus superficialis, and rhomboideus profundus are less extensive in *G. c. tabida* than in *G. americana*. There is a dermal component to M. deltoideus major in *G. americana*, but I did not find one in *G. c. tabida*. M.

deltoideus minor apparently has a single head in *G. americana;* it has two heads in *G. c. tabida.* M. serratus posterior is divided into a superficial and a deep layer in *G. americana,* but not in *G. c. tabida.* There are minor differences in the origins of all three serrati muscles. M. abductor alae digiti II (abductor pollicis) has two heads in both cranes; the anconal head arises from the extensor process of the carpometacarpus, the palmar head from the tendon of insertion of M. extensor metacarpi radialis. Fisher and Goodman (1955:68) state that in *G. americana* the palmar head arises, in part, by "tendinous fibers from the inserting tendon of M. tens. pat. longus"; it does not do so in *G. c. tabida.*

I doubt the existence of any separate muscle which might be called "M. proscapulohumeralis brevis." I agree with Hudson and Lanzillotti (1955:43) that M. flexor brevis digiti IV (III) probably is best considered simply a distal part of M. flexor digiti IV (III); that M. abductor indicis brevis is a deep fasciculus of M. abductor major digiti III (abductor indicis); and that M. abductor minor digiti III (abductor digiti II) is a ligament—I know of no bird in which there is a muscle in this position.

The leg muscle formula in the Sandhill Crane is ABC($\pm$)DXYAmV. Mm. iliotrochantericus medius (C) and iliotrochantericus anterior are fused in some specimens. Hudson (1937:69) gave the formula for the Little Brown Crane (*G. c. canadensis*) as ABDXYAmV; I assume that the two iliotrochanterici muscles were fused in his specimen. In two specimens of the Whooping Crane, Fisher and Goodman found the formula to be ABCDXYAm; though they added V to the formula on page 124, they stated (page 97): "we did not find any vinculum between the tendons of M. flex. perf. dig. III and M. flex. perf. et perf. dig. III." In a third Whooping Crane, the formula was BCDXYAm.

The following features common to the Whooping and the Sandhill cranes deserve mention: The accessory semitendinosus muscle has two well developed heads. M. iliotibialis has a large aponeurotic portion in the center of its distal half. Mm. vastus lateralis (= femoritibialis externus) and vastus medialis (= femoritibialis medius) are similar in both cranes; M. vastus lateralis has two distinct heads of origin, one proximal and one distal.

In the Sandhill Crane the tendon of M. ambiens gives rise only to the lateral head of M. flexor perforatus digiti III; in the Whooping Crane the ambiens tendon serves as the "principal, if not sole, origin for M. flex. perf. dig. II." In the Sandhill Crane, M. flexor ischiofemoralis inserts on the femur proximal to the areas of insertion of both parts of M. caudofemoralis. In the Whooping Crane M. flexor ischiofemoralis inserts "posterior to and between the insertions of the two parts of M. caudofem." (Fisher and Goodman, 1955:86); this is a most unusual relationship for these tendons. Fisher and Goodman

(1955:94) found fusion of the tendons of Mm. flexor perforans et perforatus digiti II and flexor perforatus digiti II in *G. c. canadensis*, but not in *G. americana*; I did not find fusion of these two tendons in three specimens of *G. canadensis tabida*. In the Sandhill Crane, only the tendon of M. flexor digitorum longus passes through a bony canal in the hypotarsus; in the Whooping Crane the tendons of flexor digitorum longus and flexor hallucis longus pass through bony canals in the hypotarsus (Fisher and Goodman, 1955:99). I found considerable variation in the amount of fusion between the tendons of Mm. flexor digitorum longus and flexor hallucis longus (see page 299). Unilaterally in one Sandhill Crane, I found an accessory medial head, arising from the proximal end of the tibiotarsus, of pars media, M. gastrocnemius.

Literature Cited

Berger, A. J.

1953 On the locomotor anatomy of the Blue Coua, *Coua caerulea*. *Auk*, 70:49–83.

1956 The expansor secundariorum muscle, with special reference to passerine birds. *Jour. Morph.*, 99:137–167.

Fisher, H. I.

1946 Adaptations and comparative anatomy of the locomotor apparatus of New World vultures. *Amer. Midl. Nat.*, 35:545–727.

Fisher, H. I., and D. C. Goodman

1955 The myology of the Whooping Crane, *Grus americana*. *Illinois Biol. Monog.*, 24, 127 pp.

Fürbringer, M.

1902 Zur Vergleichenden Anatomie des Brustschulterapparates und der Schultermuskeln. *Jena. Zeitschr. f. Naturwiss.*, 26:289–736.

Gadow, H., and E. Selenka

1891 Vögel. *In* Bronn's Klassen und Ordnungen des Thier-Reichs. Leipzig.

Hudson, G. E.

1937 Studies on the muscles of the pelvic appendage in birds. *Amer. Midl. Nat.*, 18:1–108.

Hudson, G. E., and P. J. Lanzillotti

1955 Gross anatomy of the wing muscles in the family Corvidae. *Amer. Midl. Nat.*, 53:1–44.

Mitchell, P. C.

1901 On the anatomy of Gruiform birds; with special reference to the correlation of modifications. *Proc. Zool. Soc. London*, 1901:629–655.

1913 The peroneal muscles in birds. *Proc. Zool. Soc. London*, 1913:1039–1072.

1915 Anatomical notes on the Gruiform birds *Aramus giganteus* Bonap., and *Rhinochetus kagu*. *Proc. Zool. Soc. London*. 1915:413–423.

Montagna, W.

1945 A re-investigation of the development of the wing of the fowl. *Jour. Morph.*, 76:87–113.

Newton, A.

1896 A dictionary of birds. Adam and Charles Black, London. 1088 pp.

Parker, T. J., and W. A. Haswell
1947 A text-book of zoology. 6th ed., vol. 2. Macmillan & Co., London, 758 pp.
Shufeldt, R. W.
1890 The myology of the Raven (*Corvus corax sinuatus*). Macmillan & Co., London, 343 pp.
Young, J. Z.
1950 The life of vertebrates. Oxford Univ. Press, London, 767 pp.

Department of Anatomy, University of Michigan Medical School, Ann Arbor, Michigan, March 5, 1956

NEW LIFE MEMBER

Karl E. Bartel was born in Blue Island, Illinois, October 12, 1913, and now is employed by General Biological Supply House, Chicago. He has been interested in natural history since 1928. His bird watching developed into bird banding, and since 1933 he has banded over 30,000 individuals of 159 species. His interest is shifting now to wild flower photography, and to the building up of a series of wild flower slide lectures for rental purposes.

Mr. Bartel is a member of the American Ornithologists' Union, Illinois Audubon Society, Wisconsin Society of Ornithology, Nature Conservancy, Friends of our Native Landscape, Eastern, Western, and Inland Bird Banding associations, Wm. I. Lyon Bird Banding Council and the Chicago Ornithological Society. He is now President of the latter organization. In the picture he is holding a Red-bellied Woodpecker that he had just banded.

FOODS OF THE WILD TURKEY IN THE WHITE RIVER BOTTOMLANDS OF SOUTHEASTERN ARKANSAS

BY BROOKE MEANLEY

THE bottomland hardwoods of the lower Arkansas, White and Mississippi rivers, form one of the two best areas for the Wild Turkey (*Meleagris gallopavo silvestris*) in the state of Arkansas. The wilderness aspects of the area, inaccessibility of many sections, year around abundance of food, and an extensive refuge area along the lower White River provide conditions for maintaining a fairly stable turkey population. The Wild Turkeys found in this locality are apparently of a purer strain than those occurring in the south-central pine-hardwoods section of the state, a more accessible area in which there have been some introductions from game farms.

During the period 1950–1955, considerable information concerning the food of the turkeys in the White River bottomlands of Arkansas, Desha and Phillips counties in southeastern Arkansas was obtained and is here reported.

Habitat Types

The lower White River area is characterized by a typical southern bottomland hardwoods forest, which is subject to flooding almost every winter and spring. In this bottomland forest elevation and soils are the principal physiographic features that determine characteristic plant communities or forest types.

In low, poorly-drained flat areas the overcup oak (*Quercus lyrata*)–bitter pecan (*Carya aquatica*) type (Putnam, J. A., 1951. *Occ. Paper 116, Southern Forest Exper. Sta., U.S. Forest Service*) is predominant and relatively unimportant to the turkey.

The sweet gum (*Liquidambar styraciflua*)–water oaks (*Quercus* spp.) type (*ibid*) is found throughout much of the better drained part of the first bottoms, and, when not inundated, is widely used by the turkeys when foraging. Characteristic species of this type (Fig. 1) are sweet gum, water oak (*Quercus nigra*), Nuttall oak (*Quercus Nuttallii*), willow oak (*Quercus phellos*), American elm (*Ulmus americana*), sugarberry (*Celtis laevigata*), and green ash (*Fraxinus pennsylvanica*, var. *lanceolata*). Secondary species are red maple (*Acer rubrum*), cedar elm (*Ulmus crassifolia*), and southern red oak (*Quercus falcata*). Plants commonly found in the shrub strata of this forest are swamp privet (*Forestiera acuminata*), deciduous holly (*Ilex decidua*), haw (*Crataegus sp.*), and saplings of the several trees predominant in this type. Common lianas include greenbriar (*Smilax* spp.), grape (*Vitis* spp.), supplejack (*Berchemia scandens*), Virginia creeper (*Parthenocissus quinquefolia*), peppervine (*Cissus* sp.), and poison ivy (*Toxicodendron radicans*).

FIG. 1. Open, park-like woods of Sweet Gum—Water Oaks type in first bottoms of lower White River. Wild Turkeys sought food in such sites in winter and early spring. Photograph by Peter J. Van Huizen.

Sweet gum, sweet pecan (*Carya illinoensis*) or southern red oak are often predominant on well-drained first-bottom ridges. Boykin's dioclea (*Dioclea multiflora*), a leguminous vine that produces a large seed, is strikingly abundant on these ridges. This first-bottom ridge type is the finest for turkey use; and it is not flooded except by unusually high overflows, perhaps once in seven or eight years.

Cypress (*Taxodium distichum*) and tupelo gum (*Nyssa aquatica*) are characteristic trees of bayous that flow into the White, but these do not rate as food producing trees for the turkey in this area.

Ox-bow lakes that are dry in summer are characteristic of the White River bottoms. These lake beds characteristically are surrounded by cypress trees but the beds are grown to grasses, sedges and other herbaceous vegetation. Grasses in the dry lake beds are utilized heavily by turkeys in droughty summers. Many of the ox-bow lakes are close to the river and the turkeys work back and forth to sand bars where they also feed on seeds of grasses, as well as grasshoppers (Orthoptera) and other insects.

The size of the present turkey population in the southeastern Arkansas bottomlands area is unknown. The last three years (1952–53–54) have been dry and have therefore favored the turkey population along the lower White,

Fig. 2. Sand bar along the lower White River used in late summer and fall by Wild Turkeys feeding on crabgrass seeds. Photograph by Peter J. Van Huizen.

which is normally subject to considerable overflow during the late winter and spring. During the fall many sand bars are exposed by low water stages (Fig. 2). In August, 1954, one observer in a boat counted 112 turkeys feeding on sand bars along a 12-mile stretch of the river, beginning at the southern boundary of the refuge and running north. Other observers counted 10 separate broods, totalling 110 turkeys along a six-mile stretch of the river, from July 17 to July 20, 1954.

Foods Taken

A wide variety of plant and animal foods in the bottomlands are available to turkeys throughout the year. Fruits, seeds and herbaceous leaves form the great bulk of the turkey's food. Insects, while important on the basis of their frequency of occurrence in crops, gizzards and droppings, were consistently low in volume.

Crops of Wild Turkeys examined during the spring hunting season following a year when there is a good crop of sweet pecan mast usually contained from two or three to 15 whole nuts of this species (Fig. 3). During years of poor pecan mast, crops and gizzards were usually crammed full of sugar-

FIG. 3. Contents of the crop of a Wild Turkey collected in southeastern Arkansas in April, 1952. Food items include jack-in-the-pulpit leaves (upper left), poison ivy fruits and seeds (lower left), snails, sweet pecan nuts, scarabaeid beetles (center), grit and seeds of *Celtis* and *Berchemia* (right).

berry fruit, poison ivy fruit and seeds, oak mast, or perhaps some rather unusual plant food such as the catkins of cottonwood (*Populus deltoides*), flowers of the crossvine (*Bignonia capreolata*) and buttercup (*Ranunculus* sp.), or pods of vetch (*Vicia* sp.).

The seasonal abundance of food is further reflected in the turkey's diet as seen by an analysis of droppings gathered during June from bottomland woods in which blackberries or dewberries (*Rubus* sp.) were predominant; and in a series of droppings collected from sand bars and dry lake beds in the fall in which seeds of crabgrass (*Digitaria* sp.) and sprangletop grass (*Leptochloa panicoides*) respectively, were major foods on both a frequency of occurrence and volumetric basis. Snowbell (*Styrax americana*) had a high palatability rating in late summer and early fall with turkeys feeding along the river and in nearby dry lake beds. This woody shrub is usually found around the margins of old river bed lakes.

Orthoptera (mainly Acrididae and Gryllidae) and a number of slow-

Table 1

Principal Foods of the Wild Turkey on First Bottom Ridges along the White River in Arkansas
(Per cent occurrence)

April — 22 crops or gizzards		June — 60 droppings		Winter — 112 droppings	
PLANT:		PLANT:		PLANT:	
Celtis laevigata fruit and seeds	90	*Rubus* sp. seeds*	87	*Quercus* sp. mast	94
Carya illinoensis nuts	55	*Carex* sp. achenes and perigynia	58	Gramineae blades	78
Nyssa sylvatica fruit and seeds	55	*Quercus* sp. mast	53	*Toxicodendron radicans* seeds	60
Quercus sp. mast	50	*Panicum* sp. seeds	40	*Crataegus* sp. seeds	47
Crataegus sp. seeds	45	*Forestiera acuminata* seeds	37	*Carex* sp. seeds	21
Vitis sp. fruit	40	*Rumex acetosella* leaves	35	*Vitis* sp. seeds	20
Berchemia scandens seeds	40	*Celtis laevigata* seeds	35	*Celtis laevigata* seeds	18
Toxicodendron radicans fruit and seeds	36	Undet. herbaceous dicot leaves	25	Undet. herbaceous dicot leaves	18
Polygonatum sp. seeds	36	*Ranunculus* sp. seeds	15	*Nyssa sylvatica* seeds	14
Undet. galls	32	*Styrax americana* seeds	15	*Carya illinoensis* nuts	12
Undet. seeds	27	*Alopecurus* sp. glumes	13		
Arisaema sp. leaves	23	Gramineae blades	10		
Undet. herbaceous dicot leaves	23				
Ranunculus sp. seeds	18				
Vicia sp. pods	18				
Ilex decidua seeds	13				
ANIMAL:		ANIMAL:		ANIMAL:	
Scarabaeidae	18	Scarabaeidae	47	*Nezara viridula*	44
Coleoptera	18	Formicidae	28	*Arilus cristatus*	28
Gastropoda	13	Coleoptera	12	Scarabaeidae	20
				Undet. insects	13

* With the exception of grass seeds, which were deliberately taken, other seeds were usually the remains of what were fleshy fruits at the time of ingestion.

moving insects belonging to the Scarabaeidae and Hemiptera were found to be important in the turkey's diet. Two large hemipterans, the southern green stinkbug (*Nezara viridula*) and wheel bug (*Arilus cristata*), so abundant in the winter droppings of turkeys, occur commonly throughout the winter beneath the leaf mantle of the riverbottom hardwoods.

During the late summer and early fall such crop pests as the fall armyworm (*Laphygma frugiperda*), spotted cucumber beetle (*Diabrotica undecimpunctata*), and rice stinkbug (*Solubea pugnax*) occur abundantly among the grasses and sedges of dry lake beds where they are taken readily by turkeys.

Data presented below were based on an analysis of 1026 droppings and 22 crops or gizzards, supplemented by field observations.

Crops and gizzards were obtained from local hunters. Most of the droppings were collected on the White River National Wildlife Refuge by Peter J. Van Huizen, Manager, and Lloyd C. MacAdams, Patrolman. The droppings

Table 2

Principal Foods of the Wild Turkey on Sand Bars along the White River in Arkansas

(Per cent occurrence)

Summer — 200 droppings		Fall — 310 droppings	
PLANT:		PLANT:	
Digitaria sanguinalis seeds	75	*Digitaria sanguinalis* seeds	77
Celtis laevigata seeds	67	*Styrax americana* seeds	73
Styrax americana seeds	67	*Echinochloa crus-galli* seeds	66
Gramineae blades	14	*Vitis* sp. seeds	60
Panicum sp. seeds	10	*Panicum capillare* seeds	59
		Quercus sp. mast	24
		Leersia oryzoides glumes	24
		Digitaria (*ischaemum*) seeds	23
		Bumelia sp. seeds	20
		Panicum sp. seeds	18
		Solanum nigrum seeds	11
ANIMAL:		ANIMAL:	
Scarabaeidae	49	*Solubea pugnax*	52
Formicidae	45	Acrididae	40
Acrididae	27	Other Orthoptera	20
		Scarabaeidae	18
		Formicidae	10

Table 3

Principal Foods of the Wild Turkey in Dry Lake Beds along the White River in Arkansas

(Per cent occurrence)

Summer — 100 droppings		Fall — 244 droppings	
PLANT:		PLANT:	
Styrax americana seeds	98	*Leptochloa panicoides* seeds	100
Celtis laevigata seeds	72	*Carya illinoensis* nuts	65
Leptochloa panicoides seeds	66	*Bumelia* sp. seeds	52
Vitis sp. seeds	66	*Vitis* sp. seeds	52
Bumelia sp. seeds	16	*Echinochloa crus-galli* seeds	41
Gramineae blades	16	*Styrax americana* seeds	40
Digitaria sp. seeds	10	*Leersia oryzoides* glumes	29
		Toxicodendron radicans seeds	16
ANIMAL:		ANIMAL:	
Scarabaeidae	78	*Diabrotica undecimpunctata*	31
Gryllidae	74	Scarabaeidae	27
Acrididae	70	Orthoptera	23
Laphygma frugiperda	14	Gryllidae	21
Gastropoda	14	Undet. insects	15
Formicidae	12	*Laphygma frugiperda*	13
Solubea pugnax	10	*Solubea pugnax*	13
Pentatomidae	10		
Insect eggs	10		

were found by working behind flocks and checking fresh scratchings; by looking along paths in wooded areas and around water holes on logging roads frequented by turkeys; and in dry ox-bow lake beds and on sand bars.

The analysis of food materials was computed on a frequency of occurrence basis by habitat and period. Food items occurring in less than 10 per cent of the droppings, crops and gizzards in any series are not listed in this report (Tables 1–3).

Summary

A knowledge of turkey foods in the White River bottoms of southeastern Arkansas was obtained by an analysis of 1026 droppings and 22 crops and gizzards collected from various habitats during the period 1950–1955. Acorns, sugarberries, pecans, poison ivy fruit, blackberries and blades of grass were important foods in the first bottoms; seeds of crabgrass dominated droppings collected from sand bars in summer and fall; while in dry ox-bow lake beds, feathergrass seeds were the principal food in the fall, and styrax fruit in the summer.

Acknowledgments

The writer is indebted to Fish and Wildlife Service co-workers A. C. Martin and Johnson A. Neff for the identification of several food items, and to co-workers Charles C. Sperry, Vincent H. Reid and Peter J. Van Huizen for reviewing the manuscript. Anna Gilkeson Meanley assisted in the field work.

U.S. Fish and Wildlife Service, Alexandria, Louisiana, November 15, 1955

NEW LIFE MEMBER

Albert Schnitzer, a native of New Jersey, graduated from New York University in 1934. After teaching mathematics for a short time, he entered business and now runs a plant which specializes in stainless steel machinings. He married Eva Feder of Perth Amboy, New Jersey, with whom he shares a lively interest in the natural sciences. A bander for the past five years, he is shown here among his traps at his home at Elizabeth, New Jersey, where this March he and his wife banded 259 redpolls. His hobbies include botany and photography, and he has travelled extensively in Central America, South America, and in the Caribbean.

TWO PHYSIOLOGICAL CONSIDERATIONS IN BIRD MIGRATION

BY W. B. YAPP

The crossing of large expanses of sea by migrant birds has been known from time immemorial, and journeys of several hundred miles, such as those over the Mediterranean, over the North Sea from Europe to Great Britain, and over the Caribbean Sea, are commonplace. More recently it has become generally admitted that even the Atlantic is crossed quite often, even if not regularly. The evidence for Atlantic crossings from west to east has been reviewed by Alexander and Fitter (1955) and since their paper was published, the magazine *British Birds* has contained five new records of North American birds in Great Britain. The navigation which enables long sea crossings to be made, and the muscular and respiratory physiology which permits long flights to be sustained, are obviously of great interest. There is very little experimental evidence on either of these matters, and my purpose in this paper is to try to apply what little we do know, necessarily in a theoretical way, to the problem.

Williamson (1952 and 1954) has shown from a study of the weather maps that the most marked migration into Great Britain from northern Europe occurs in meteorological conditions which produce a steady east wind, and that the notable invasions of American birds occur with west winds. From these observations he has drawn the conclusion that, under conditions of strong wind over the sea, birds abandon their standard direction and fly downwind, so that they are brought more quickly to land. Clearly a strong wind, especially a cross wind, must have great effects on migrating birds, but for us to be able to assume that this particular type of reaction to cross winds always or generally occurs, we must be able to show, following current evolutionary theory, that it has such advantages over all other types of reaction that its production by natural selection is probable. The possibilities have never, so far as I know, been fully considered.

In the discussion which follows I use terms in the sense which they have in dynamics and air navigation. "Speed" is rate of change of position, that is, distance traveled per unit of time; "velocity" is speed in a particular direction, so that it is a vector; "course" is the direction in which the bird propels itself through the air; "track" is the line over the land which it follows as a result of its flight and of the wind, that is the resultant of its own velocity and that of the wind.

ACKNOWLEDGMENTS

I am grateful to Mr. A. R. Blake, Mr. A. R. Mead-Briggs, Dr. R. H. J. Brown, Sir James Gray, Mr. G. C. Lambourne, Dr. R. W. Murray and

Dr. G. W. Salt for reading a draft of this paper or for helpful discussion.

Possible Means of Orientation in Overseas Flights

A bird out of sight of land and subject to a cross wind may do one of four things.

1. If it can continue to orient itself, it may continue flying in its standard direction, that is, on the course which has been laid down for the species in the past, presumably by natural selection. In daylight it determines this by some navigational clues which may include landmarks and the sun; at night, or at least on a dark night in latitudes and seasons where the direction of the sun below the horizon cannot be seen, it would need other means of orientation, but what these may be we do not know. If it does continue to fly in this way, the velocity of the wind must be added to the bird's velocity through the air, and if we know both of these we can find its track by the vector triangle method. To take a simple example, a bird which started to cross the Skaggerak at the south of Norway on a southerly course (180°) and encountered an east wind (90°) with the same speed as its own, would travel on a track of 225° and so arrive on the Yorkshire coast instead of in Denmark. Following the normal navigational usage it is to this type of displacement, and to this only, that the term "drift" should be applied.

2. The bird might, as Williamson suggests, recognize from the appearance of the sea the direction of the wind, abandon its standard direction, and reorient itself so as to fly downwind. I am informed that wind-lanes, which would seem to be the most likely clue by which the bird could determine the direction of the wind when out of sight of land, are only formed at speeds above Beaufort Force 4 (minimum speed 13 m.p.h.). The direction of movement of waves is an unreliable guide, since it may persist long after the wind has died down.

3. It would seem, however, that if the bird could tell the direction of the wind it might also be able to determine the relation of this to its own standard direction, and so be able to maintain the latter approximately by flying at the necessary angle to the wind. This would be comparable to normal air navigation, in which the course of the aircraft is calculated so that the vector triangle of the course plus the wind gives the required track.

4. If it had no navigational clues, and were unable to determine either its standard direction or that of the wind, the bird might continue to fly in what, to use anthropomorphic language, appeared to it to be the direction in which it started. I know of no experiments on this sort of blind flying, but for human beings walking, swimming and driving an automobile, the result of trying to keep a straight course with the eyes shut is in fact a large open curve, which approximates to a circle, and it is likely that the same would be true of a bird in flight. A bird doing this would still be

subject to drift. If the radius of the curve were large, the resultant track would be approximately the same as in 1 (derived from the bird's velocity and that of the wind). If the radius of the curve were relatively small, the track would be effectively that of the wind. The point of arrival on land would be the same as in 2 (changing course to fly downwind); the bird would, however, take longer to get there, for while in 2 its ground speed is the sum of that of the wind and its own air speed, in 4 it is that of the wind alone, since it spends as much time flying against the wind as with it. The same result would be given if the bird frequently changed its course. If the radius of the curve were of the same order of magnitude as the length of the sea crossing, the track of the bird would be effectively random.

Of these possibilities, 4 would clearly be disadvantageous and it would seem that a moderate radius of the curve in which the bird flies would be the worst. 1, 2 and 3, if the wind were in any degree a following wind, would all take the bird across the sea, but the points of arrival would be different. If the arrival coast were straight and ran at right angles to the bird's standard direction, the shortest crossing in terms of time would be made by 1 and the longest by 2, but if the coast were irregular and had bays and promontories, either 1 or 2 or 3 might bring the bird more quickly to land, according to the particular configuration of the land and the velocity of the wind. Condition 2 is likely usually to take longer than 3 and would only not do so if a high-speed wind happened to take the bird to a promontory which jutted far out from the coast. With so much variation it seems unlikely that natural selection could in any way discriminate among these three different types of flight. If 1 (maintenance of standard direction) is ruled out as improbable, it still remains true that 2 (flying downwind) would seldom be more advantageous than 3 (determining course from wind direction). Only if it were consistently so would Williamson's hypothesis of its choice by natural selection be possible. Since 4 (attempting to maintain a straight course without clues), though the worst of the four reactions, might be expected to lead to a large number of successful crossings and demands no special abilities in the bird, it is the one which for the present, on the principle of economy of hypothesis, ought to be accepted.

Some Energy Relations of Overseas Flights

At the end of a long sea crossing migrant birds are often exhausted, and it would be interesting to know from what sort of fatigue they are suffering and how near to every possible physiological limit they have gone. Williamson (1952) has reported that a number of birds weighed as they arrived at Fair Isle, off the east coast of Scotland, were lighter than the same species at the same time of year trapped at Lista in Norway. While it is interesting that a loss in weight is probably demonstrable by weighing small numbers of trapped birds (though measuring such a variable quantity as the mass of a bird to four significant figures represents misplaced zeal), it would be more interesting still to know in what the loss consists and how near it goes in an average sea crossing to the theoretical and practical limit. The first of these, on which the second depends, could be determined only by chemical analyses of the bodies of migrating birds before and after their journey, but the following calculation, though approximate, may suggest the order of magnitude of the loss which might be expected.

There are several types of flapping flight, but it seems that in general in fast and moderately fast flight the up-stroke is passive, and this is true also of small birds in slow flight (see Brown, 1953, and the same author reported anonymously in *Nature*, 1955). Such flight means that the bird must fall during the up-stroke and rise again during the down-stroke, and it is easy to calculate the energy expended by the bird in maintaining itself in the air in this way. If any lift is contributed by the upstroke of the wings, as happens in larger birds in slow flight, there is a greater mechanical efficiency and less energy is needed.

Let the weight of the bird be x gms. weight, and let there be n wing beats per second. If downstroke and upstroke are of equal duration (as Brown, 1953, has shown to be true of the gull in fast flight) between two successive downstrokes the bird falls a distance

$$d = \tfrac{1}{2} \times \frac{g}{4n^2} \text{ cms.}$$

The work done during the upstroke to raise it again, is

$$f \times d = \frac{xg^2}{8n^2} \text{ ergs,}$$

and work done per second is

$$\frac{xg^2}{8n} \text{ ergs.}$$

The work done per hour is

$$\frac{3600xg^2}{4.2 \times 10^7 \times 8n} \text{ cals.}$$

This energy might be provided by the combustion of carbohydrate (probably chiefly glycogen) or of fat. Different carbohydrates have slightly different energy values (Benedict and Fox, 1925), but an average value seems to be 4100 calories per gram. I have not been able to find any figures for the efficiency of avian muscle, but the maximum for frog muscle is about 20 per cent and that for human muscle 22 per cent (Hill, 1939). In view of the closeness of these two figures for rather widely separated vertebrates, it is unlikely that bird muscle is greatly different. The efficiency depends on the speed of contraction of the muscle, and falls off fairly rapidly on each side of the optimum. It is unlikely that the bird can maintain the optimum steadily for very long periods, however much it may approximate to a steady rate of wing-beat. There is also a loss of energy because the aerodynamic efficiency of the wing-stroke is less than 100 per cent, although it seems impossible to calculate this (Brown, 1955). Further, some energy is needed to overcome air-resistance, although at speeds of up to about 30 m.p.h. this is likely to be small in comparison with that needed to maintain the bird in the air. It would seem to be safe, in trying to calculate the maximum amount of food material used in flight, to take all these points into account by giving the wing an over-all efficiency of half its maximum, or 10 per cent. The work done per hour therefore represents the consumption of

$$\frac{3600xg^2}{4.2 \times 10^7 \times 410 \times 8n} \text{ gms. carbohydrate.}$$

Meinertzhagen (1955) has recently published figures for the rate of wing-beat of many species. For small and medium sized birds 5 beats per second seems to be a fair average value to take for cruising speed. Meinertzhagen contends that birds on migration fly much faster than usual, so that a value of $n = 10$ would not be far wrong, but if we take the lower value we shall get a maximum consumption of the food stores.

If $n = 5$, the carbohydrate consumed $= 0.00503x$ gms., that is, 0.5 per cent of the mass of the bird is used up per hour. If the chief source of energy is fat, as has been claimed for the House Sparrow (*Passer domesticus*) by Kendeigh (1944), and as appears likely from the well-known deposition of fat prior to migration (see, for instance, Odum and Perkinson, 1951), the loss will be less. One gram of fat produces 9,500 cals. (Benedict and Fox, 1925), so that the work done per hour represents

$$\frac{3600xg^2}{4.2 \times 10^7 \times 950 \times 8n} \text{ gms. fat.}$$

If $n = 5$ as before, this $= 0.00217x$ gms., that is, 0.2 per cent of the mass of the bird is used up per hour.

Energy is also required for the maintenance of body temperature. Kendeigh (1944) has shown that in the House Sparrow this is, at 10°C external temperature, approximately $35x$ calories per hour, where x as before is the body weight in grams, which represents $0.0085x$ gm. of carbohydrate or $0.0037x$ gm. of fat. A small bird therefore uses its reserves nearly twice as rapidly to maintain its temperature as for flight. Since our figures for energy consumption have been maxima throughout, and since the air temperature will often be less than 10°C, this factor will almost certainly be exceeded as a rule. Most of the waste energy of the muscular contraction (we have taken this to be between 80 and 90 per cent) will be available for maintaining the temperature, and the total loss of reserve material appears to be of the order of 1 per cent of body weight per hour if it is carbohydrate, or 0.4 per cent per hour if it is fat.

If a bird crosses the North Sea from the Skaggerak to Fair Isle at an air speed of 30 m.p.h. with a following wind of 20 m.p.h., its ground speed will be 50 m.p.h., and its flight will take approximately six hours, so that it will lose some 6 per cent or 2.4 per cent of its mass according to whether it uses carbohydrate or fat. Williamson's experimental figures suggest that the loss is, in fact, more like 10 per cent. There are two possible sources of this extra loss. The bird may defecate during its crossing, and if we assume that it starts its flight immediately after feeding it certainly will do so, and it will lose water from the lungs and air sacs. Kendeigh found the total loss of moisture from his House Sparrows to be $0.005x$ gms. per hour for birds at rest at 10°C external temperature. This is approximately one and a half times the loss by combustion of fat under the same conditions, and, as in the combustion of fat the oxygen taken in very nearly balances the carbon dioxide given out, means that the bird is losing stored water over and above the metabolic water which represents the loss of oxidized material. Dawson (1954), who worked on the Brown and Abert towhees (*Pipilo fuscus* and *P. aberti*) found that at 39.5°C the birds drank more water than, as shown in a parallel experiment, they lost by evaporation. In flight, the evaporation of water will presumably be greater than when the bird is at rest, but by how much we do not know. If it rose to the level which both Kendeigh and Dawson found for birds at rest at an air temperature of 40°C, the loss for a six-hour flight would be about 10 per cent. Williamson's figures therefore appear to be remarkably close to the best theoretical forecast that one can make. (The evaporation of the water of course needs energy; for a loss of 0.015 gm. per hour it would be 8.6 cal. per hour. There is no means of telling how much of this has already been included in Kendeigh's figure of $35x$ cal. per hour for heat maintenance, but some of it will have been so included, and the addition of the rest does not greatly affect the magnitude of our result.)

If my interpretation is correct, the limits of a long flight may well be set by thirst rather than by hunger. Williamson (1954) has contended that on such flights, as for example in the west to east crossings of the Atlantic, it is a positive disadvantage for a bird to rest on a ship. The basis of this contention is that the bird will, if it flies on with a following wind, just about have exhausted its food reserves when it lands, so that anything which delays landfall is likely to be fatal unless food can be picked up during the rest. Even if for most of the species of birds concerned little food is likely to be available on board ship, water, in the form of dew or rain, will often be present, and a rest may therefore be very helpful to a bird suffering from thirst.

Odum and Perkinson (1951) have shown that the body-weight of White-throated Sparrows (*Zonotrichia albicollis*) is about 20 per cent less in October and November (after migration) than it is in April and May (before migration) and that almost all this loss is of fat. These birds have not made a long sea-crossing and presumably are not near exhaustion, so that larger losses could be borne before death would occur. We do not know how rapidly the fat can be metabolized. Wigglesworth (1949) found that when fruit flies (*Drosophila*) were flown to exhaustion, they could fly again, either after a rest with no food, or almost immediately after being given soluble carbohydrates. The period of flight following a rest (but before exhaustion again set in) was longer the longer the rest; after an hour it was about one-sixtieth of the duration of the previous flight. These observations agreed with analyses of the body composition which showed that during flight fat did not disappear. Presumably it was converted to carbohydrate, and so made available during the rest.

It is possible that the chemistry of bird flight might be similar, although it would be dangerous to argue from insects to birds without experiment. If it were, a rest on a ship would allow an exhausted migrant to change stored fat into carbohydrate, and so allow it to recover and fly further, quite apart from the provision of food or water. The muscular physiology of birds, although little is known about it, is unlikely to differ in principle from that of frogs and mammals. Here there are several sources of fatigue: chemical substances other than carbohydrate may fail, there may be too great an accumulation of lactic acid, the nerve-muscle junction may cease to act, or the central nervous coordination may be upset. Fatigue due to some of these may be abolished merely by rest, as happens especially in human sleep. To determine the chief cause of the fatigue of arriving migrants would need experimental work, but much might be learned by observation of the conditions under which they recover. Until more is known it cannot be assumed that a rest on a ship is harmful.

Literature Cited

Alexander, W. B. and R. S. R. Fitter
1955 American land birds in western Europe. *Brit. Birds*, 48:1–14.

Benedict, F. G. and E. L. Fox
1925 A method for the determination of the energy values of foods and excreta. *Jour. Biol. Chem.*, 66:783–799.

BROWN, R. H. J.
1953 The flight of birds. II. Wing function in relation to flight speed. *Jour. Exp. Biol.*, 30:90–103.
[BROWN, R. H. J.]
1955 [Discussion on animal movement.] *Nature*, 176:1060–1061.
DAWSON, W. R.
1954 Temperature regulation and water requirements of the brown and Abert towhees, Pipilo fuscus and Pipilo aberti. *Univ. Calif. Publ. Zool.*, 59:81–120.
HILL, A. V.
1939 The mechanical efficiency of frog's muscle. *Proc. Roy. Soc.* B, 127:434–451.
KENDEIGH, S. C.
1944 Effect of air temperature on the rate of energy metabolism in the English sparrow. *Jour. Exp. Zool.*, 96:1–16.
MEINERTZHAGEN, R.
1955 The speed and altitude of bird flight (with notes on other animals). *Ibis*, 97:81–117.
ODUM, E. P. AND J. D. PERKINSON, JR.
1951 Relation of lipid metabolism to migration in birds. Seasonal variation in body lipids of the migratory white-throated sparrow. *Physiol. Zool.*, 24: 216–230.
WIGGLESWORTH, V. B.
1949 The utilization of reserve substances in *Drosophila* during flight. *Jour. Exp. Biol.*, 26:150–163.
WILLIAMSON, K.
1952 Migrational drift in Britain in autumn 1951. *Scot. Nat.*, 64:1–18.
1954 American birds in Scotland in autumn and winter, 1953–54. *Scot. Nat.*, 66: 13–29.

DEPARTMENT OF ZOOLOGY AND COMPARATIVE PHYSIOLOGY, UNIVERSITY OF BIRMINGHAM, BIRMINGHAM, ENGLAND, JANUARY 11, 1956

THE WILSON ORNITHOLOGICAL SOCIETY LIBRARY

The following gifts have been recently received. From:

Andrew J. Berger—2 reprints
W. H. Burt—3 reprints
Frank N. Egerton, III—2 magazines
Herbert Friedmann—3 reprints, 1 book
Karl W. Haller—2 books, 1 pamphlet, 2 reprints
David W. Johnston—5 reprints
Daniel S. Lehrman—1 reprint
W. L. McAtee—7 reprints
Robert A. McCabe—4 pamphlets
Lyle D. Miller—19 magazines
Margaret M. Nice—14 reprints
William F. Rapp—6 reprints
S. Dillon Ripley—5 reprints
Alexander F. Skutch—1 reprint
J. Murray Speirs—1 reprint
Georg Steinbacher—2 reprints
Robert W. Storer—1 pamphlet, 3 reprints

GENERAL NOTES

Cape May Warbler in Oklahoma.—On May 7, 1955, in heavily-wooded bottom land of the Caney River, four miles north of Collinsville, Tulsa County, Oklahoma, L. Ray Bunch and I collected a male Cape May Warbler (*Dendroica tigrina*), apparently the first specimen for this state. The bird was singing and feeding industriously among the lower branches of a large pecan tree about 25 feet from the ground. With it were a male Myrtle Warbler (*Dendroica coronata*) and a male Yellow Warbler (*Dendroica petechia*). We saw no other Cape May Warbler. The specimen, now no. 2160 in the collection of the University of Oklahoma Museum of Zoology, was in full breeding plumage. It was very fat and its testes were enlarged (3 × 3.5 mm.). Dr. George M. Sutton verified our identification.

Nice and Nice (1924. *Univ. Okla. Stud.* No. 286:114), list the Cape May Warbler among those birds not reported in Oklahoma, but whose appearance is to be expected. Later, Nice (1931. *Publ. Univ. Okla. Biol. Surv.*, 3 [1]), in the last complete listing of the birds of this state does not mention the Cape May Warbler, nor is it shown in her list of additions to the 1931 publication (Nice. 1944. *Proc. Okla. Acad. Sci.*, 24:14–15). In the literature published since the latter date, I have found only one record of this bird being observed here. One was seen by R. C. Brummet in the Quartz Mountain State Park of Greer County and was reported by Baumgartner (1951. *Audubon Field Notes*, 5:264).—John S. Tomer, *4045 E. 27th St., Tulsa, Oklahoma, August 29, 1955.*

Black Ducks eat stunned fish.—A power generation plant on the shore of Lake Erie near Erie, Michigan, discharges its cooling water directly into the lake. On the morning of January 23, 1955, a cold, brisk wind was driving the warm discharge water out into the lake through a gap in the ice. Near the gap some 700 ducks, mostly Black Ducks (*Anas rubripes*), rested while nearer shore in a small cove of open water about 40 others were feeding.

In addition to the Black Ducks, the small group included single Mallard (*Anas platyrhynchos*) and Scaup (probably *Aythya marila*) males and single Canvasback (*Aythya valisineria*) and Pintail (*Anas acuta*) females and two Goldeneye (*Bucephala clangula*) females. The Goldeneyes and Canvasback were diving; the Scaup floated idly: but the Black Ducks were busy taking and eating small fish about three inches long which they seemed to be finding just below the surface.

F. H. Kortright (1942. "The Ducks, Geese and Swans of North America," page 167), reporting the results of the examination of the stomachs of 390 Black Ducks, lists approximately 1 per cent of the content as fishes. In contrast, Milton B. Trautman (1940. "The Birds of Buckeye Lake, Ohio," page 178) reports that Black Ducks ". . . ate gizzard shad with . . . avidity . . ." and refers to their ". . . picking up and swallowing the benumbed and recently killed shad."

It seems likely that the ducks I observed were harvesting fish that had been stunned or killed by the hot discharge water. Although fish may not be a normal food for Black Ducks, this observation seems to confirm that they have no aversion to it and will eat fish in quantity when the taking is made easy.—John M. McCormick, *1827 Richards Road, Toledo 7, Ohio, October 5, 1955.*

Comments concerning the age at which imprinting occurs.—It should be called to the attention of workers in the field of ethology that many of the differences that have been reported in the age at which imprinting most readily occurs could be the consequence of inbreeding. In wild precocial birds, such as ducks and geese, the phenomenon of imprinting is of great adaptive value, ensuring, as it does, that the young will respond properly to the parent at the same time at which they are physically capable of dispersal. Among altricial birds, needless to say, their physical inability to leave the nest makes the same mechanism less important. However, it will also be seen that the ability to be imprinted represents a highly maladaptive trait among domestic ducks and geese, as in such birds there would be a high likelihood of the occurrence of imprinting onto the wrong object. One would thus suspect the ability to be imprinted to be a rather labile trait which could be maintained only in the face of strong selection. As a consequence, inbreeding and domestication, with its concomitant and unnatural reduction of mortality, would tend to produce individuals differing greatly from the parent stock with respect to their imprintability. In this connection, it is well to recall the loss of broodiness in the white races of the domestic fowl (*Gallus gallus*). I would suggest that this could account for the differences in the sensitive periods and success of imprinting reported by several different workers: Fabricius (1951. *Proc. Tenth Internat. Ornith. Congr.*), E. H. Hess (1955. MS), K. Lorenz (1937. *Auk*, 54:245–273), M. M. Nice (1953. *Condor*, 55:33–37), and Ramsay and Hess (1954. *Wilson Bull.*, 66:196–206). —Peter H. Klopfer, *Osborn Zoological Laboratory, Yale University, New Haven, Connecticut, September 28, 1955.*

Little Gull taken in Indiana.—On December 22, 1955, William J. Barmore, Ted Chandik, Richard E. Phillips, and I found an adult Little Gull (*Larus minutus*) feeding with about 20 Bonaparte's Gulls (*Larus philadelphia*) in the harbor at Michigan City, LaPorte County, Indiana. The gulls were feeding among the drifting ice cakes in a relatively open channel. After repeated observations of the Little Gull as close as 10 feet I collected it. This constitutes the first specimen for Indiana (although there are numerous sight records) and evidently one of the few specimens for the United States. It was very fat and weighed 155.5 grams. The sex could not be determined. Two of the three small minnows removed from the gullet were identified by Dr. Reeve M. Bailey, University of Michigan, as *Notropis atherinoides* (Emerald Shiner).

Phillips and I had observed an adult Little Gull at the above place on January 27. 1955, but had been unable to collect it. It fed with an immature female Black-legged Kittiwake (*Rissa tridactyla*), which I collected, and a few Ring-billed Gulls (*Larus delawarensis*), but there were no Bonaparte's Gulls. The previous night the temperature had been at least —10° F. and the gulls were feeding in two small, warm water outlets of the Northern Indiana Public Service Company plant. Except where these outlets flowed into Lake Michigan, no other open water was visible.

The Little Gull skin and partial skeleton are deposited in the University of Michigan Museum of Zoology; the Kittiwake skin has been deposited in the Purdue University Wildlife Laboratory Collection.—Russell E. Mumford, *University of Michigan Museum of Zoology, Ann Arbor, Michigan, January 26, 1956.*

Evening Grosbeak nesting in Michigan.—Actual nesting records of the Evening Grosbeak (*Hesperiphona vespertina*) in Michigan are few. Wood (1951. *Univ. Mich. Mus. Zool. Misc. Publ.* no. 75:456) listed only two, although summer observations of adult birds were recorded from several areas. I would like to thank Dr. Lawrence H. Walkinshaw, who gathered most of the following information, for graciously turning it over to me for publication.

Dale and Marian Zimmerman observed about 50 grosbeaks July 25, 1952, along Highway M-77 at the Alger-Schoolcraft County line, 11 miles north of Seney. These birds were eating the fruits of wild cherry and *Amelanchier*; at least three birds were stubtailed young, barely able to fly, being fed by the adults (*Audubon Field Notes*, 6:284). From June 18 to 20, 1953, John and Ruth Bunnell, William A. Dyer, Peter Hovingh, Jr., James Ponshair, Walkinshaw, and the Zimmermans observed 11 to 12 birds per day at this site. The grosbeaks were coming to feed at a salt block behind Rustic Cabins Lodge. Grosbeaks came from the south, southeast, and northwest. Since more males than females were seen, the observers thought perhaps the birds were nesting nearby. These observers also found three male and one female Evening Grosbeak in the Dutch Fred Lake woods, two miles south of the Lodge.

In 1954, Dr. and Mrs. W. Powell Cottrille, Dyer, Vivian Mumford, Walkinshaw, and the writer made their headquarters at Rustic Cabins in late June. We found from five to 15 Evening Grosbeaks utilizing the salt block daily. On June 21, while working through a woods north of Dutch Fred Lake with Powell Cottrille and Walkinshaw, I noticed a rather conspicuous nest high up in a 90-foot sugar maple (*Acer saccharum*). It was found to be occupied and a forked tail projected over the nest rim. After considerable stick throwing, we finally flushed the incubating bird, a female Evening Grosbeak. She called as she flew from the nest. Cottrille climbed the tree on June 24, but was unable to approach closer than about 10 feet from the nest. It was constructed on top of an almost horizontal, slightly ascending, small branch, about eight feet from the trunk of the tree. The four greenish-blue eggs were quite heavily marked with brownish spots and blotches which averaged less than an eighth of an inch in diameter. The nest was 54 feet (measured) above the ground and was rather loosely constructed of twigs and small sticks, which ranged in size from one-sixteenth to one-fourth inch in diameter and from four to six inches in length. Finer twigs composed the lining and the nest was well shaded and mostly covered from above by a clump of leaves. It was still occupied on July 1, when last visited.

From June 14 to July 2, 1955, H. Lewis Batts, Jr., the Bunnells, the Cottrilles, Dyer, Eliot Porter, Josselyn Van Tyne, and Walkinshaw again visited the area. They saw Evening Grosbeaks daily, but found no nests. From these records it appears that the Evening Grosbeak may nest regularly in the region north of Seney.—RUSSELL E. MUMFORD, *University of Michigan Museum of Zoology, Ann Arbor, Michigan, April 1, 1956.*

The nest and egg of *Tachyphonus phoenicius*.—The Red-shouldered Tanager (*Tachyphonus phoenicius*) is a medium-sized tanager which inhabits the Guianas, northern Brazil, southern Venezuela, and eastern Peru. The male is glossy black on both the upper and under surfaces, and there is a bluish sheen to the upper parts; the upper lesser wing coverts are scarlet and the axillaries and underwing coverts pure white. The female is totally different, the general color of the upper surface being dusky brown, while the throat and middle abdomen are Isabelline white. Ten male specimens which I collected in Surinam average 21.38 grams, and three females weighed 21, 23 and 25 grams, respectively.

I have been unable to find a description of the nest and eggs of this species. The eggs were not listed in the collection of the British Museum (Ogilvie-Grant, 1912. "Catalogue of the Collection of Birds' Eggs in the British Museum," vol. 5), in the Nehrkorn collection (1910. "Katalog der Eiersammlung nebst Beschreibungen der aussereuropäischen Eier." Berlin), or in the Penard collection from Surinam (Hellebrekers, 1942. *Zool. Meded.*, 24:271–272). Neither H. Snethlage (1928. *Jour. f. Orn.*, 76:726–728) or E. Snethlage (1935. *Ibid.*, 83:21) mentions nests or eggs from Brazil.

Zimmer (1945. *Amer. Mus. Nov.* no. 1304:23) stresses the paucity of information concerning the habits of this species. In Surinam *Tachyphonus phoenicius* inhabits rather open, sandy savannas covered with scattered bushes. It is rather common in this habitat. On February 5, 1956, I flushed a female from a small clump of grass almost beneath my feet in an opening near the edge of a bush in a savanna near Zanderij (about 50 kilometers south of Paramaribo). The nest was on the ground at the edge of the clump and was rather well concealed; it contained a single slightly-incubated egg. The outer layer of the nest was composed of dry, rather broad grass stems and the inner cup was lined with very fine grasses. The nest was 6 cm. wide and its depth was 5 cm.

The egg was chocolate brown at its broad end, and this color was spread in smaller spots and blotches to the narrow end, where the ground color was greyish. The shell was not glossy. The egg measured 20.9 × 14.9 mm.—F. HAVERSCHMIDT, *P. O. Box 644, Paramaribo, Surinam, February 9, 1956.*

FIG. 1. Nest and egg of *Tachyphonus phoenicius*, Zanderij, Surinam, February 5, 1956.

Notes on the nesting of the Wandering Tattler.—The Wandering Tattler (*Heteroscelus incanus*) is a common nesting bird in Mount McKinley National Park, Alaska. During the course of my field work I have frequently encountered the birds along the smaller creeks, sometimes seeing downy young, and on three occasions finding nests. These nests are, so far as I know, the only ones found since the first one was discovered in 1923 (O. J. Murie, 1924. *Auk*, 41:231–237). This first nest was elaborate for a shore bird, but the other three were much simpler, two of them containing practically no nest material, and the fourth composed of barely enough stems to cover the bottom of the depression, and some loosely-laid stems and fine twigs which formed a token rim.

In the finding of the third nest on June 10, 1953, I learned that both birds share in the incubation of the eggs. On that occasion, I heard a tattler call two or three times near me and saw it on the margin of a gravel apron. Soon it moved slowly, with many stops, out on the gravel, and when it had reached about the middle of the gravel area a second tattler stood up beside it, and shortly flew away. It had been sitting on a clutch of eggs. The first tattler at once settled on the nest.

A further sharing of family responsibilities was observed after the eggs hatched. On the morning of June 29, a cool and cloudy day, I saw one of the parents brooding the young in the nest. The eggs had hatched sometime after I checked the nest on the preceding day. I left the parent undisturbed, and in half an hour returned with a camera. During my absence the family had left the nest, and the young were being brooded on the gravel about 30 yards from it. In a few minutes the tiny chicks scampered forth, and on twinkling feet scattered over the bar, 20 or 30 yards, in various directions in their active search for food. While the young foraged, the parent called at intervals, the calls serving perhaps to circumscribe the wanderings of the babies. The chicks called too, but so faintly and softly that the calls were hardly audible. In about five minutes the parent's calls became a little louder. It was evident that it was summoning the chicks. After a few of these louder calls, the parent squatted on the rocks and called more softly and coaxingly. At least three distinctive, soft calls were given, one of which reminded me of the loud, rolling call one frequently hears along the creeks. The young responded to the calls by feeding toward the parent and finally disappearing underneath her.

About 4:00 p.m. on the day the young left the nest I stopped to watch the tattlers again. Soon the parent in charge of the young called loudly, and walked a few feet away from the young. In a few moments the mate came flying up from the creek bottom and alighted about 20 yards from the rest of the family. It squatted on the rocks and called softly to the young, which responded and were soon brooded. The relieved bird flew down the creek, apparently to feed. Two hours later I again observed a parent take over the brooding task from its mate. The parents did no feeding while in charge of the young.

In the evening the adult with the young moved them from the gravel bar where they were hatched, down a 15-foot embankment grown up in willow brush (*Salix*) to the bars along Igloo Creek, a distance of about 100 yards. In moving the young the parent called loudly for a time from the top of a willow and then from a little spruce tree (*Picea*) part way down the slope. Then it flew down to the bar and called softly, and soon the young arrived.

Two days later the young were foraging actively in the new area. Part of the time they waded in an expanse of shallow water, picking insects off the surface. One chick captured an insect too large to swallow, so carried it ashore to pick apart. While I watched, the young fed for half an hour without being brooded.

On June 12, 1953, three of us flushed a Wandering Tattler from a nest on a bar about 30 feet from a small stream coming down one of the canyons cutting far back into Cathedral Mountain. On June 28 when I visited the nest area I found that a flood a few days earlier had dug a deep channel in the bar where the nest had been. This nest would have been safe from ordinary high water, for it was four or five feet above the surface of the creek, but the rise in the stream on this occasion was unusually high and destructive.—Adolph Murie, *National Park Service, Moose, Wyoming, March 12, 1956.*

Ringed Kingfisher at Austin, Texas.—On November 15, 1955, Eugene S. Tinnin showed me a bird at Barton Springs, Zilker Park, Austin, which I recognized immediately as a Ringed Kingfisher (*Megaceryle torquata*). I had recently seen this species, as well as all other North and Middle American kingfishers, except *Chloroceryle inda*, numerous times in tropical Mexico and in museum study collections.

At frequent intervals from November 16 through December 11 others familiar with the species in life—William S. Jennings of the Texas Game and Fish Commission, Mr. and Mrs. Fred S. Webster, Jr., and Armand Yramategui—also viewed the bird through binoculars and a 30× telescope at distances ranging from 30 feet to 80 yards.

I asked each person who studied the kingfisher to make his own notes and drawings of it without referring to illustrations or descriptions for aid. Mr. and Mrs. William D. Anderson, Frances J. Gillotti, Emma L. Purcell, and Mr. and Mrs. Fred S. Webster, Jr. complied. A summary of their extensive notes follows. The bird somewhat resembled nearby Belted Kingfishers (*Megaceryle alcyon*) but was larger and had a much heavier bill. Upperparts and chest were blue-gray; the tail was crossed by a number of white bars. Throat, collar, and a narrow band marking the lower border of the chest were white. The remainder of the underparts, including the crissum, was rufous. Webster described the call note as a "rusty *cla-ack* or *wa-ak*." Emma L. Purcell once watched the bird "dive into the water in the same manner as a Belted Kingfisher."

In addition to the fact that fish-eating kingfishers are seldom kept in captivity, the Austin individual showed no signs of having been caged.

The bird seen at Austin appears to be the northernmost Ringed Kingfisher on record. The next most northerly seems to have been one George B. Benners collected on the Rio Grande about one mile downstream from Laredo, Texas, June 2, 1888 (Witmer Stone, 1894. *Auk*, 11:177). Laredo is 219 airline miles southwest of Austin. I find only two other published reports of *Megaceryle torquata* in the United States. At the San Benito Resaca, Texas, 286 miles south of Austin, Luther C. Goldman discovered an individual on March 15, 1953. With C. E. Hudson he saw the bird again on March 19. (1953. *Audubon Field Notes*, 7:224). Lawrence Tabony watched another at Brownsville, Texas, 303 miles south of Austin, on August 29, 1952 (1952. *Audubon Field Notes*, 6:290).

Three of the four Ringed Kingfishers mentioned above were in female plumage; the sex of the individual seen at Brownsville is not stated. Perhaps females wander more often than males. Future observers of extralimital members of the species should note sex differences. Individuals with the rufous of the underparts extending over the chest and with the crissum white, are in adult male plumage.—EDGAR B. KINCAID, JR., *702 Park Place, Austin 5, Texas, March 14, 1956.*

Sandhill Cranes killed by flying into power line.—On March 22, 1954, I was watching Sandhill Cranes (*Grus canadensis*) on the North Platte River, four miles northeast of Hershey, Lincoln County, Nebraska. On the previous day we had counted and estimated 24,038 cranes roosting on a shallow, sandy stretch of river in this area. Most of them left the roost at daylight or shortly afterwards, flying to old cornfields to the south, southeast and southwest. In the evenings, just prior to dark, they flew back to the river, roosting on sand bars or in shallow water.

The morning of March 22 was clear with no fog. At 8:45 a.m. as I drove along an east-west road about one mile south of and parallel to the river where the cranes roosted, I came upon five Sandhill Cranes, all but one dead, lying in and at the south edge of the road. The fifth bird died during the day. A two-wire power line ran east and west 20 feet north of the highway. The wires, both on the same plane, were about 30 feet from the ground. Apparently before it was entirely light, these low-flying cranes had flown into the power line in passing southward from their roost. They were still warm when I found them. One bird had a wing sheared off; one lost a wing and leg; another lost both legs. All five were saved as specimens. W. E. Eigsti and I examined the stomachs, weighed the birds, froze them and shipped two to Dr. Josselyn Van Tyne, University of Michigan, Museum of Zoology and three to Dr. George H. Lowery, Jr., Louisiana State University.

The stomachs had the following contents: (1) 13 kernels of corn; several weed seeds; some fine gravel. (2) 28 kernels of corn; corn hulls, sand; fine gravel. (3) 8 kernels of corn; corn hulls, weed seeds; coarser gravel. (4) 3 kernels of corn; corn hulls. (5) 5 kernels of corn; many oat hulls; gravel.

Two of the birds were males and three, females. Walter J. Breckenridge spent several days on this same area during late March, 1945. On March 28 he collected ten specimens, five males and five females. The average weight of these seven males was 3936.28 grams (range, 3402–4337) or 8 lbs., 10.8 oz. (7 lbs., 8 oz.–9 lbs., 9 oz.). The eight females averaged 3241.37 grams (2835–3856) or 7 lbs., 2.3 oz. (6 lbs., 4 oz.–8 lbs., 8 oz.).

The wing spans of five males taken by Breckenridge averaged 184.1 cm. (177.8–191.8) and those of six females averaged 168.8 cm. (152.4–182.9).

Thus all 15 specimens, ten collected by Breckenridge on March 28, 1945, and five that I found dead on March 22, 1954, were all Lesser Sandhill Cranes (*Grus canadensis canadensis*).—LAWRENCE H. WALKINSHAW, *1703 Wolverine-Federal Tower, Battle Creek, Michigan, March 1, 1956.*

Lark Sparrow collected in Rhode Island.—On November 12, 1955, at Newport, Newport County, Rhode Island, a Lark Sparrow (*Chondestes grammacus*) was observed feeding with Savannah Sparrows (*Passerculus sandwichensis*) along the edge of a field adjacent to Newport's famed Ocean Drive. Since there was no previous specimen record for Rhode Island, the bird was collected. It was a male with the skull fully ossified; it weighed 31.7 gms. and was very fat. Its apparent good physical condition makes all the more curious the molt that the bird was undergoing.

The feathers over most of the body appeared fresh, but those of the posterior half of this sparrow were found to be in various stages of molt and replacement. The upper tail coverts on the bird's left side were fully grown and were slightly worn and ragged. There was one small feather on this side that was beginning to break out of the sheath. The upper tail coverts on the right side were all sheathed and about one-half grown. Two adjacent rectrices, lying to the right of the central pair, were normal in length but were worn, although not excessively. The remaining rectrices were all about the same length, sheathed and about one-half grown. All of the undertail coverts and many of the contour feathers on the right flank were still in sheaths and about one-half grown. There were fewer sheathed feathers on the left flank.

The specimen (JB no. 146) was identified by Dr. John W. Aldrich as the Eastern Lark Sparrow (*C. g. grammacus*).—JAMES BAIRD, *Norman Bird Sanctuary, Newport, Rhode Island, March 22, 1956.*

Records of the Buff-breasted Sandpiper from Alabama.—Buff-breasted Sandpipers (*Tryngites subruficollis*) were never collected in Alabama prior to 1955, although H. S. Peters took one near Pensacola, Florida, a short distance east of the Alabama border on September 2, 1936, and T. D. Burleigh took another from Deer Island, Mississippi, a few miles west of the state line, on September 6, 1940. A. H. Howell's "Birds of Alabama," published in 1924, does not list this species as occurring in Alabama. The only known records are those of Henry Stevenson, who noted them near Northport, in

Tuscaloosa County, on September 7 and September 24, 1938, and again near Stroud, in Chambers County, on August 10, 1952.

In the late afternoon of September 14, 1955, Eugene Cypert, E. A. Byford, W. M. Depreast, and the writer were observing shorebird migrants in the Garth Slough vicinity of the Wheeler National Wildlife Refuge. This locality lies some five miles east of Decatur, Alabama, in Morgan County. At that stage of water it consisted of several hundred acres of mud flat, interspersed with channels. Cypert observed five Buff-breasted Sandpipers feeding in short grass on a high portion of mud flat and tentatively identified nine or ten others at a greater distance. Since Thomas A. Imhof was at that time rewriting "Birds of Alabama," and since no specimen was on record for the state, one was collected from the small flock. Later a study skin was prepared and submitted to the U.S. Fish and Wildlife Service; the identification was confirmed by Dr. J. W. Aldrich.

The Garth Slough locality was revisited September 15 but no more of these birds were seen. Byford, on September 23, reported seeing two more in the same vicinity.—Thomas Z. Atkeson, *Wheeler National Wildlife Refuge, Decatur, Alabama, April 1, 1956.*

The Muscovy Duck in the Pleistocene of Panamá.—During the dry seasons of 1950 and 1951 Dr. C. Lewis Gazin, Curator of Vertebrate Paleontology in the U.S. National Museum, excavated several Pleistocene fossil localities on the Azuero Peninsula on the Pacific side of the Republic of Panamá. In 1951, among abundant remains of ground sloths at El Hatillo, near the highway one and one-half miles west of Pesé, Province of Herrera, he obtained one bone of a bird, the distal two-third of a right ulna (U.S. Nat. Mus. no. 21312). This I have identified as from a Muscovy Duck, *Cairina moschata* (Linnaeus). Dr. Gazin considers the spring deposit from which this bone was obtained as Upper Pleistocene. The bone is stained light brown in color and is somewhat mineralized. It marks the first definite report of an avian fossil from Central America. The Muscovy Duck, well known in domestication, ranges in the wild in suitable habitats in the tropical lowlands from Sinaloa and Tamaulipas in northern México southward along both coasts of Central America and South America to Perú and Argentina. The species is locally common in lagoons and marshes in Panamá today where it is known to hunters as the *pato real.*

Cairina moschata has been found previously in cave deposits of supposed Pleistocene Age in southern Brazil so that it seems to have had an extended range over a long period of time.—Alexander Wetmore, *Smithsonian Institution, Washington 25, D.C., May 3, 1956.*

ORNITHOLOGICAL NEWS

The Wilson Ornithological Society is indebted to Dr. Josselyn Van Tyne for his careful compilation of the list of serial publications in the Society's Library appearing in this issue. It is hoped that the publication of this list will stimulate members to fill out series which are incomplete and will result in increased use of the Library.

The Conservation Department of Cornell University is conducting a research project concerned with hybridization in surface-feeding ducks, including the Mallard, Pintail, Black Duck, Gadwall, Green-winged Teal, Blue-winged Teal, and Shoveller. The purpose of this study is to obtain further information on the relationships within this controversial group, using behavioral data, relative fertility determinations, and possibly other physiological techniques. It is hoped that the greatest possible number of hybrid crosses among these species may be studied, and we are in need of first generation male hybrids of known parentage for this purpose. Any aviculturist who happens to possess such birds, and who is willing to lend them for this project should contact Charles G. Sibley or Paul A. Johnsgard, Department of Conservation, Cornell University, Ithaca, New York.

A new list of sales publications has been compiled by the New York State Museum and is available without charge on request to the Museum at Albany 1, New York. The revised list includes a considerable number of zoological bulletins, circulars, handbooks, etc., that were formerly considered out of print and have been available only through dealers. The stock of some of these items is small; in such cases, preference will be given to orders from libraries of universities, foundations and other organizations.

LETTER TO THE EDITOR

A recent article on distribution of the Dickcissel by Dr. A. O. Gross (1956. *Auk*, 73:66–70) disregards several major contributions to his topic printed in a New York State magazine (Spiker, 1950. *Kingbird*, I (1):6; Stoner, 1951. *Kingbird*, I (2):12; Tabor and Benton, 1951. *Kingbird*, I (3):57). This points once again to the need for more complete recording of available ornithological literature.

Dr. Stratton, editor of the *Zoological Record*, has written to ask that I attempt to persuade editors of such journals to forward copies of their magazines to Col. W. P. C. Tenison, British Museum (Natural History), Cromwell Road, London SW 7, England. They would also be pleased to have copies of back numbers so that the literature contained therein may be recorded.—Gerald R. Rising, Editor, *The Kingbird*

72 Allen's Creek Road
Rochester 18, New York

WILSON SOCIETY LIBRARY

Serial Publications

The serial publications of the Wilson Ornithological Society Library are catalogued, bound, and shelved by the University of Michigan Museum of Zoology in the Bird Division's library rooms. Except for certain rare items that should not be subjected to the risks of transportation, these serials, like the books, are mailed out on request to members of the Society, the University paying postage one way and the borrower paying the return. Some volumes of journals have been completed by combining issues owned by the Society with issues in the University's holdings; a bound volume contributed in part by the Society is, of course, available *in toto* to the Society's members. Secondly, serials contributed to the Society's Library which duplicate serials already owned by the University are usually placed in storage cupboards and separately catalogued; recording of these duplicates is not yet up to date. Thirdly, new gifts of serials are constantly received. Fourthly, some serials are scatteredly represented and appear only in the Library's author catalog. Thus, certain periodicals are more completely available to Members than the following list of the Society's holdings would indicate; and a few titles may be available that are not represented in the list. Members should send inquiries to the Library about their needs; when a particular reference is required, it is well to give it in full, since the Library may have a reprint or a "tearsheet" of the reference listed under author. Members with serials available as gifts to the Library are requested to state whether these may be exchanged or sold by the Library should they prove to be "surplus duplicates" (i.e., not needed as replacements for worn, damaged, or lost copies).

All serials currently received are indicated in the list by dots following a date and serial number. Unless otherwise stated, such titles are complete to date from the issue specified. Degrees of completeness of series are roughly represented by "scattered," "in part," "incomplete."

Acta Zoologica Fennica (Bird Papers). 1927, No.3. . . .

Agassiz Association. *See* Swiss Cross

A[gassiz] A[ssociation] Bulletin. 1890–1891, Vols.1–2, in part

Agassiz [Association] Journal. 1885, Vol. 1, in part

Agassiz Bulletin. 1885, one issue

Agassiz Chapter. 1886, 2 issues

Agassiz Companion ("Literary Companion" *and* "Agassiz Record"). 1886–1890, scattered issues

Agassiz Notes. 1885–1886, Vol.1, in part

Agassiz Record. *See* Agassiz Companion

Agassiz Record (Iowa). 1888, Vol.1, in part

Alauda. 1947, Vol.15. . . . (+)

Amateur Naturalist. 1904–1908, Vols.1–4, in part

American Biology Teacher. 1938–1941, Vols.1–4

American Bird-House Journal. Scattered Issues

American Falconer. 1942–1944, Vols.1–2

American Game Conference, Transactions. 1934, 20th

American Magazine of Natural Science. Scattered issues

American Midland Naturalist. 1940, Vol. 23. . . . (+)

American Museum of Natural History, Bulletin (Bird Papers). 1949, Vol.93. . . . (+)

American Museum Novitiates (Bird Papers). 1949, No.1395. . . . (+)

American Naturalist. Scattered issues

American Ornithology. 1901–1906, Vols. 1–6, in part

American Osprey. 1890, Vol.1 (complete set)

American Pigeon Journal. 1947, one issue

American Society of Curio Collectors, Yearbook. 1909

American Zoologist and Home Journal of Science. 1896, 2 issues

Animal Behaviour. *See* Bulletin of Animal Behaviour

Animal Kingdom. 1946. . . . (incomplete)
Apteryx. 1905, Vol.1, Nos.1–2
Aquila. 1943, Vol.50. . . . (+)
Archives suisses d'ornithologie. 1941, Vol. 1. . . .
Ardea. 1931, Vol.20. . . .
Ardeola. 1954, Vol.1. . . .
Atlantic Naturalist. (*formerly* Wood Thrush). 1945, Vol.1. . . .
Atlantic Slope Naturalist. 1903, Vol.1, in part
Audubon Bulletin. *See* Illinois Audubon Society
Audubon Field Notes. 1947, Vol.1. . . .
Audubon Magazine (Forest and Stream Publ. Co.). 1887–1888, Vol.1, in part
Audubon Magazine (*formerly* Bird-Lore). 1939. . . . (+)
Audubon Warbler. 1941, Vol.4. . . . (incomplete)
Auk. 1939, Vol.56. . . . (+). (*Plus* Bulletin Nuttall Ornithological Club, 1876–1883, complete.)
Aus der Heimat. 1936, 2 issues
Avicultural Magazine. 1946, Vol.52. . . .
Aviculture (*now merged with* Avicultural Magazine). Scattered issues
Avifauna. 1895, Vol.1, Nos.1–2
Battle Creek Nature News. 1931, one issue
Bayern. *See* Ornithologischen Gesellschaft
Bay State Oologist. 1888, Vol.1, in part
Bear Hill Advertiser. 1903, 2 issues
Beiträge zur Fortpflanzungsbiologie der Vögel. 1929, Vol.5. . . .
Beringer und Freunde der Schweiz, Vogelwarte Sempach, Mitteilungen. 1938–1939, Heft 1–2
Biological Leaflet. 1933, No.1. . . .
Biological Society of Washington, Proceedings (Bird Papers). Scattered issues
Biologische Abhandlungen. 1952, No.1. . . .
Bird-Banding. 1930, Vol.1. . . . (incomplete). (*See also* Northeastern Bird-Banding Association, Bulletin.)
Bird Banding Notes. 1922, No.2. . . . (incomplete)
Bird-Lore. *See* Audubon Magazine
Bird-Lovers' League Magazine. 1935, 3 issues
Bird News (California). 1909, Vol.1, in part
Bird News for the School (*later* "Bird News," publ. by Brookline Bird Club). 1942, 3 issues
Bird Study. 1954, Vol.1. . . .
Bird Survey of the Detroit Region. *See* Detroit Audubon Society
Birds and Nature [*with varying title*]. 1897–1916, in part
Birds of Long Island. 1939–1950, in part
Bittern (Maine). 1890–1891, Vol.1, in part
Bittern (Iowa). 1901, Vol.1, No.1
Bluebird (Missouri Audubon Society). 1939–1950, in part
Blue Bird ("Junior Audubon Monthly"; *later* "Nature and Culture" *and various titles*). 1914–1920, scattered issues
Blue-Jay. 1942, Vol.1. . . .
Bokmakierie. 1950, Vol.3. . . .
Bologna, Università, Istituto Zoologico, Ricerche di Zoologia Applicata alla Caccia. 1930, No.1. . . .
Bologna, Università, Laboratorio di Zoologia Applicata alla Caccia, Supplemento alle Ricerche di Zoologia Applicata alla Caccia. 1949, Vol.2. . . .
Bonner Zoologische Beiträge. 1950, Vol. 1. . . .
Boston Society of Natural History, Occasional Papers. 1904–1941, scattered issues
Boston Society of Natural History, Bulletin. 1915–1936, scattered issues
Bowdoin Scientific Station, Annual Report and Bulletin. 1936, No.1. . . .
British Birds. 1946, Vol.39. . . . (+)
British Columbia, Provincial Museum of Natural History Report for 1914
British Ornithologists' Club, Bulletin. 1945, Vol.66. . . .
British Trust for Ornithology. Various publications
Brodie Club, Proceedings. 1937, No.1. . . .
Brookline Bird Club. *See* Bird News for the School
Buckeye State Collector. 1887, 2 issues
Bulletin of Animal Behaviour. 1938–1951 (complete set, except for the rare No. 4)
Bulletin Ornithologique. 1956, Vol.1, No.1
Buzzard. 1926–1927, Vol.1

Califor Naturalist Club, Bulletin. 1916. Vol. 1, No.1

California Academy of Science Proceedings. 1900–1926, scattered issues

California Art and Nature. 1901–1902, in part

California Traveller and Naturalist (*later* Traveller and Naturalist). 1892–1893, in part

California, University of, Publications in Zoology (Bird Papers). Listed under author in W.O.S. Library Book List

Call-Notes (*formerly* Huntington Chat). 1950, one issue

Canada, Provancher Society of Natural History. *See* Provancher Society of Natural History

Canadian Alpine Journal. 1912. one issue

Canadian Field-Naturalist (*formerly* Ottawa Naturalist). Scattered issues

Canadian Sportsman and Naturalist. 1881–1883, Vols.1–3, in part

Cardinal. 1927–1943 (incomplete)

Carolina Bird Club. *See* Chat

Cassinia. 1890, No.1. . . .

Cěskoslovenský Ornitholog. 1936–1948, Vols.3–15 (incomplete)

Chat (North Carolina Bird Club; Carolina Bird Club). 1937, Vol. 1. . . .

Chicago Academy of Sciences, Bulletin of the Natural History Survey. 1907, No.6

Chicago Natural History Museum (*formerly* Field Museum of Natural History). Zoological Series. 1896. . . . (being completed by member of the Society). *See also* Fieldiana.

Chicago Naturalist. 3 issues.

Cleveland Academy of Natural Science. Proceedings. 1874

Cleveland Bird Club. Various publications

Cleveland Museum of Natural History, Scientific Publications. Two issues

Club van Nederlandsche Vogelkundigen, Orgaan. *See* Limosa

Collector (*formerly* Young Collector; Des Moines). 1881–1882, in part

Collector (Pekin, Illinois). 1893, Vol.1, in part

Collectors' Journal. 1901, one issue

Collectors' Monthly (California). 1911. 3 issues

Collectors' Monthly (Connecticut). 1890–1892, in part

Collectors' Monthly (New York). *See* Natural History, New York

Collector's Monthly (Philadelphia). 1886, Vol.1, No.1

Collectors Note Book. 1904–1905, in part

Collectors' Standard. *See* The Mohawk Standard

Collectors' Star. 1888, No.2

Colorado Museum of Natural History, Proceedings. One issue

Columba. 1951, one issue

Comparative Oology. *See* Santa Barbara. California, Journal of Museum of Comparative Oology

Condor. 1940. Vol.42. . . .

Conservación en las Americas. *See* Pan American Union

Conservation, Miscellaneous pamphlets and periodicals on the subject

Contributions to North American Ornithology. 1901–1904, Vol.1. in part

Cooper Ornithological Club. Bulletin. *See* Condor

Curio. 1890, one issue

Curio Bulletin (*formerly* Curio Collector). 1910–1914, in part

Curio Collector. *See* Curio Bulletin

Curio Exchange. 1900–1901, in part

Curio Informant. 1889, Vol.1, No.1

Curiosity Collector. 1889, one issue

Curlew (*predecessor of* Wilson Bulletin). 1888–1889 (complete set)

Danish Review of Game Biology. 1945, Vol. 1. . . .

Danske-fugle. 1920–1937, Vols.1–4 (complete?)

Dansk Ornithologisk Forenings Tidsskrift. 1946, Vol.40. . . . (+)

Danske Vildtundersøgelser. 1953, Part 1. . . .

Delaware Valley Ornithological Club. *See* Cassinia

Delta Waterfowl Research Station. Various publications

Detroit Audubon Society, Bird Survey of the Detroit Region. 1945 [No.1]. . . . (Also various publications)

Dickcissel (*formerly* Sioux City Bird Study Club Review). 1934, Vol.1. . . . (in part)

Duckological (Ducks Unlimited, Canada). Publications, 1938. . . .

Eastern Bird Banding Association. Bulletin. 1941–1947, Vols.4–10, in part

Ecological Society of America. Bulletin. 1943, 3 issues

Edward Grey Institute of Field Ornithology. Various publications

Elepaio. 1946, Vol.6. . . .

El Paso Bird Study Club. *See* Roadrunner

Emergency Conservation Committee. Various publications, 1929. . . .

Empire State Exchange. 1889–1892 (incomplete)

Emu. 1942, Vol.42. . . . (+)

Essex County Ornithological Club. Bulletin. 1921, one issue

Evening Grosbeak Survey News. 1950, No. 1. . . .

Exchange (Illinois). 1889, Vol.1

Exchange (Michigan). 1885, one issue

Exchangers' Aid (*later* Exchanger and Collector). 1885, 2 issues

Exchangers' Monthly (*later* Mineralogist's Monthly). 1885–1890, Vols.1–5

Fair Isle Bird Observatory. Various publications, 1950. . . .

Falconry News and Notes. 1953, Vol.1. . . .

Falke, Der. 1954, Vol.1. . . . (incomplete)

Fauna och Flora. 1951. . . .

Feathers. 1939, Vol.1. . . .

Federal Aid in Wildlife Restoration. *See* Pittman-Robertson Program

Federation of Ontario Naturalists, Bulletin. 1954, No.66. . . .

Field and Forest. 1875–1878, Vols.1–3, in part

Field Museum of Natural History. *See* Chicago Natural History Museum *and* Fieldiana

Fieldiana (Zoology). 1945, Vol.31. . . .

Field Ornithology. 1938–1941, Vols.1–3

Fish and Wildlife Service. Various publications

Flicker. 1937, Vol.9. . . . (+)

Florida Audubon Bulletin. *See* Florida Naturalist

Florida Game and Fish. 1940–1947, Vols. 1–4

Florida Naturalist (*formerly* Florida Audubon Bulletin). 1946, Vol.20. . . . (+)

Flying Feathers. *See* Ohio Cardinal

Forest and Field. 1892, Vol.1

Forest and Stream. 1921–1923, in part. (Only issues containing important ornithological material can be shelved in the Library.)

France, Société Ornithologique de, Mémoires. 1953, No.5, Pt.1. . . .

Gameland. 1894–1896, 2 issues

Game-Research papers. *See* Riistatieteellisiä Julkaisuja

Game Research News Letter (University of Wisconsin). 1937, No.12

Garner and Naturalists' Gazette. 1891, in part

Genève. Bulletin de la Société Zoologique de. 1907–1932, Vols. 1–4

Georgia Ornithological Society. Occasional Publications. 1938, No.1. . . . (*See also* Oriole.)

Gerfaut, Le. 1931, Vol.21. . . . (incomplete)

Gleanings from Nature. Scattered issues

Golden State Scientist. 1886, Vol.1, No.1

Goshawk. 1948, Vol.1. . . . (incomplete)

Göteborgs Museum, Årstryck. 1930. . . . (incomplete)

Grant Cook Bird Club, Youngstown, O. *See* Ohio Cardinal

Guide to Nature. Scattered issues

Gull. 1940, Vol.22. . . . (+)

Harvard, Museum of Comparative Zoology, Bulletin. 1940. . . . (+)

Hawaiian Naturalist. 1944, Vol.1, Nos.1–2

Hawk and Owl Society. Bulletin. 1932–1935, Vols.1–5 (complete set)

Hawk Mountain Sanctuary Association. Annual Report. 1938, No.1. . . . ; *also* miscellaneous publications

Hawkeye Ornithologist and Oologist. 1888–1889, Vols.1–2, in part

Heron. 1930, 1932, Nos. 1–2 (complete set)

Hobby Reporter. 1942, 2 issues

Hoosier Naturalist. *See* Kansas City Scientist

Hornero, El. 1935, Vol.6. . . .

Hummer. 1899, Vol.1, in part

Humming Bird. 1891, Vol.1, No.1
Hunting and Fishing. 1937, one issue
Huntington Chat. *See* Call Notes
Ibis. 1933. . . . (+)
Illinois Audubon Society, Audubon Bulletin. 1916, No.1. . . .
Illinois Natural History Survey. Various publications
Illinois State Academy of Science, Transactions. 1942
Indiana Academy of Science, Proceedings. 1894–1895
Indiana Audubon Society, Mary Gray Bird Sanctuary Bulletin. 1946, No.1
Indiana Audubon [Bulletin *and*] Year Book [*later* Quarterly]. 1920, No.1. . . . (incomplete)
Ink Spot. *See* Ornilore
Inland Bird Banding News. 1940, Vol.12 . . . . (+)
Intermediate Naturalist. *See* Ontario Field Biologist
International Committee for Bird Protection [*and* Preservation]. Bulletin. 1927–1935, Nos.1–4
International Office for the Protection of Nature, Report. 1947
International Ornithological Congress, Proceedings. 10th, 11th (for 1950, 1954)
Iowa Academy of Science(s), Proceedings. 1894, Vol.2. . . .
Iowa Bird Life (*formerly* Iowa Ornithologists' Union Bulletin). 1931, Vol.1. . . .
Iowa Cooperative Wildlife Research Unit, Quarterly Report. 1941–1948, in part
Iowa Ornithologist (*later* Western Ornithologist). 1894–1900, Vols.1–5 (incomplete)
Iowa Ornithologists' Union Bulletin. *See* Iowa Bird Life
Iowa, University, Service Bulletin. 1923–1926, in part
Iowa, University, Bulletin from the Laboratories of Natural History (*later* Studies in Natural History). 1888, Vol.1. . . . (incomplete)
Irena. 1941, Nos.1, 2 (complete set)
Jack-Pine Warbler. 1927, Vol.5. . . . (incomplete)
Jacobs, J. Warren. *See* Gleanings from Nature
Journal für Ornithologie. 1932. . . . (incomplete)
Journal of the Museum of Comparative Oology. *See* Santa Barbara, California
Junior Division of the Detroit Audubon Society, Bulletin. *See* Detroit Audubon Society
Kansas Academy of Science, Transactions. Vol.1, 1872. . . .
Kansas City Scientist (The [Hoosier] Naturalist). 1885–1891, Vols.1–5
Kansas Naturalist. 1902, one issue
Kansas Ornithological Society Bulletin [*originally* Reports]. 1950, Vol.1. . . .
Kentucky Ornithological Society, WPA Radio Programs, Nature Series. 1941
Kentucky Warbler. 1939, Vol.15
Kenya Colony. *See* Stoneham Museum
Kingbird. 1950, Vol.1. . . .
Kócsag. 1928–1938, Vols.1–11
La Plata, Museo, Obra del Cincuentenario. 1936, Vol.1, Pt.2
Larus. 1947, No.1. . . .
Leningrad [Proceedings of the Society of Naturalists of Leningrad]. 1947–1952, Vols.69–71 (ornithological sections)
Limosa. 1930, Vol.3. . . . (*See also* Orgaan der Club van nederlandsche Vogelkundigen.)
Linnaean News-Letter. 1951. . . . (incomplete)
Linnaean Society of New York, Proceedings. 1888, No.1. . . . (in part)
Linnaean Society of New York, Transactions. 1882, No.1. . . .
Literary Companion. *See* Agassiz Companion
London Bird Report, Supplement to London Naturalist. 1952, No.15
Long Island Bird Club. *See* Birds of Long Island
Loon, 1889, Vol.1 (except No.6)
Louisiana Conservation News. 1928–1929, 3 issues
Louisiana State University, Museum of Zoology, Occasional Papers. 1938, No.1. . . . (incomplete)

Maine Audubon Society Bulletin. *See* Maine Field Naturalist

Maine Field Naturalist (*formerly* Maine Audubon Society Bulletin). 1948. Vol. 4. . . .

Maine Ornithological Society, Journal. 1899–1911. Vols.1–13, in part

Maine Ornithologist and Oologist. 1890–1891. Vols. 1–2, in part

Mary Gray Bird Sanctuary Bulletin. *See* Indiana Audubon Society

Maryland Birdlife. [*with varying title*]. 1945–1950, Vols.1–6, in part

Maryland, Natural History Society *and* Ornithological Society. *See* Maryland Birdlife

Massachusetts Audubon Society. *See* Bird News for the School

Massachusetts Audubon Society Bulletin. 1917, Vol.1. . . . (incomplete)

Massachusetts Audubon Society, Records of New England Birds. 1945. Vol.1. . . .

Massachusetts, State Board of Agriculture, Annual Report of the State Ornithologist [*or* of Division of Ornithology]. 1909 (for 1908) –1923 (for 1922). Also various publications

Meriden Bird Club Reports. 1912, No.2

Michigan Academy of Science, Arts and Letters (Bird Papers). 1924–1937, Nos. 23–39

Michigan Audubon Society. *See* Jack-Pine Warbler

Michigan Department of Conservation. Various publications

Michigan Ornithological Club, Bulletin. 1897–1905, Vols.1–6 (complete set)

Michigan. University, Museum of Zoology Miscellaneous Publications. Listed under author

Michigan, University, Museum of Zoology Occasional Papers (Bird Papers). 1916. . . .

Migrant. 1930, Vol.1. . . . (incomplete)

Milwaukee Naturalist. 1886, Vol.1, in part

Mineralogist's Monthly. *See* Exchangers' Monthly

Minnesota Ornithology, Journal of. 1936–1937, Vol.1 (complete set)

Missouri Audubon Society News-Letter. *See* Bluebird

Mohawk Standard. 1887/88, one issue

More Game Birds in America. 1933. . . .

Murrelet. 1930, Vol.11. . . .

Museum (Albion, N.Y.). 1894–1900, Vols. 1–6 (incomplete)

Museum (Philadelphia). 1885. Vol.1, No.1

Museum of Comparative Oology, Journal. *See* Santa Barbara, California

National Association of Audubon Societies. Various publications

National Audubon Society, Research Report. Some issues

National Bird Defense League. 1942. 3 issues

Native Life. 1921–1922. Vols.1–2

Natural History (New York; *formerly* Collectors' Monthly). 1893. Vol.1

Natural History (A.M.N.H.). 1940. . . . (incomplete)

Natural Science Journal. 1897, Vol.1 (complete set)

Natural Science News. 1895–1896, Vols.1–2

Naturalist (Austin, Texas). 1894, Vol.1, in part

Naturalist (Mackinaw, Illinois). 1894, Vol. 1, No.1

Naturalist (Kansas City, Missouri). *See* Kansas City Scientist

Naturalist (Oregon City, Oregon). *See* Oregon Naturalist

Naturalist and Collector. 1895, Vol.1, Nos. 1–3

Naturalist in Florida. 1884, Vol.1, No.1

Naturaliste canadien, Le. 1894–1941, Vols. 21–58, in part

Naturalist's Bulletin. 1888, Vol.1, No.1

Naturalists' Companion. 1885–1887, Vols.1–2 (incomplete)

Naturalists' Journal. 1884–1885, Vols.1–2 (incomplete)

Nature and Art. 1898, Vol.1, No.1

Nature and Culture. *See* Blue Bird

Nature [Club] Bulletin. 1938–1939

Nature Notes (Peoria. Illinois). 1936–1942. Vols. 1–9 (incomplete)

Nature Study (New York). 1908. Vol.4. in part

Nebraska Bird Review (*formerly* Nebraska Ornithologists' Union Letter of Information). 1933, Vol.1. . . .

Nebraska Ornithologists' Union, Proceedings. 1899–1915, in part

Nederlandsche Vogelkundigen, Orgaan der Club van. 1913–1928. in part

New England Bird Life, Bulletin of. 1942–1944, Vols.6–8

New England Faunal Studies. 1947, No.1

New England Zoological Club, Proceedings. In part

New Hampshire Bird News (*formerly* N. H. Audubon Society Bulletin; *then* Newsletter). 1943, Vol.14. . . . (+)

New York State University, Bulletin of the Schools [Bird Day Number]. 1922. . . .

New York State Conservation Commission, Annual Report. 1925, 1927

New York Zoological Society, Contributions. *See* Zoologica

New York State College of Forestry at Syracuse University, Bulletin. *See* Roosevelt Wild Life Bulletin *and* Roosevelt Wild Life Annals

New Zealand Bird Notes. *See* Notornis

Nidiologist. 1893–1897, Vols.1–4 (except Vol.1, No.2)

Night Heron. 1933–1937, Vols.1–7 (incomplete)

Norsk Ornithologisk Tidsskrift. 1927, Vol.8 (ser.3)

North American Fauna. 1889, No.1. . . .(incomplete)

North American Naturalist. 1896, Vol.1, No.1

North American Wildlife Conference. Transactions. 1938–1941, 3rd–5th

North Carolina Audubon Society, Annual Reports. 1904–1907, 2nd, 4th, 5th

North Carolina Bird Club (*later* Carolina Bird Club). *See* Chat

North Dakota Bird Notes. 1931–1939

North Dakota Outdoors. 1941–1948, Vols.3–11, in part

Northeastern Bird-Banding Association, Bulletin. 1925–1929, in part. (*See also* Bird-Banding.)

North Platte Bird Club Publications. 1935–[?1941], Nos.1–4

Nos Oiseaux. 1935, Vol.13. . . .(incomplete)

Notes on Rhode Island Ornithology. 1900, Vol.1, 2 issues

Notornis (*formerly* New Zealand Bird Notes). 1943, Vol.1. . . .

Notulae Naturae (Bird Papers). 1939. No. 29. . . .

Nuttall Ornithological Club, Bulletin. *See* Auk

Nuttall Ornithological Club. Various publications. The Memoirs are listed under author in W.O.S. Library Book List.

Observer (Outdoor World; Practical Microscopy). 1890–1897, Vols.1–8

Ohio Cardinal (*formerly* Flying Feathers). 1950, Vol.1. . . .

Ohio Journal of Science. 1940–1947, Vols. 40–47

Ohio Naturalist. 1901–1904, Vols.2–4, in part

Ohio State Museum Science Bulletin. 1928, Vol.1, No.1

Ohio Wildlife Research Station. Various publications

L'Oiseau et la Revue Française d'Ornithologie. 1936, Vol.6. . . . (+)

Old Curiosity Shop (Ohio, New York, and California). 1882–1890, Vols.1–9 (complete set)

Ontario Field Biologist (*formerly* Intermediate Naturalist). 1953, No.8. . . .

Ontario Museum of Zoology, Royal. *See* Toronto

Ontario Natural Science Bulletin. 1905–1912, in part

Oologist (Utica, N.Y.). *See* Ornithologist and Oölogist

Oologist (*formerly* Young Oologist; Albion, N.Y.). 1890–1941, Vols.7–18 (scattered)

Oologist's Advertiser. 1890. Vol.1. 3 issues

Oologists' Correspondence Club Quarterly Circular. *See* Oologists' Exchange & Mart.

Oologist's Exchange. 1888–1889. Vols.1–2, in part

Oologists' Exchange & Mart. (*formerly* Oologists' Correspondence Club Quarterly Circular). One issue

Oologist's Journal. 1891–1892. Vols.1–2

Oologists' Record. 1939, Vol.19. . . . (+)

Oregon Naturalist (Eugene, Oregon). 1891, Vols.1–2

[Oregon] Naturalist (Oregon City. Portland, Palestine). 1894–1898, in part

Oriole (Georgia Ornithologists' Society). 1939, Vol.4. . . . (+)

Ornilore (*formerly* Ink Spot). 1938, Vols. 1–2, in part

Ornis Fennica. 1924, Vol.1. . . .(incomplete)

Ornitholog. *See* Cěskoslovenský Ornitholog

Ornithologische Abhandlungen. 1949, No. 1. . . .

Ornithologische Beobachter. 1929, Vol.27 . . . . (+)

Ornithologische Berichte (*formerly* Ornithologische Monatsberichte). 1930–1950, in part

Ornithologische Mitteilungen. 1948, Vol. 1. . . .

Ornithologische Mitteilungen der Vogelwarte "Lotos." 1936

Ornithologische Monatsberichte. *See* Ornithologische Berichte

Ornithologischen Gesellschaft in Bayern, Anzeiger. 1919, Vol.1. . . .

Ornithologischen Gesellschaft in Bayern, Verhandlungen. 1903–1940, Vols.4–22, in part

Ornithologischen Vereins München, Jahresbericht. 1901, 1903, Nos.2, 3

Ornithologist. 1885, Vol.1

Ornithologist and Botanist. 1891–1892 (complete set)

Ornithologist and Oölogist. 1879–1893, Vols.5–18, in part

Osprey. 1896–1902, Vols.1–6, in part

Ostrich. 1942, Vol.13. . . .

Ottawa Naturalist. *See* Canadian Field-Naturalist

Outdoor Nature Club Bulletin. 1937. 2 issues

Owl (Ridgewood [New Jersey] Audubon Society). 1949, Vol.1. . . . (incomplete)

Owl (Glen Falls, N. Y.). 1886–1888, in part

Pacific Coast Avifauna. Listed under author in W.O.S. Library Book List

Palisades Nature Leaflets. 1940. 2 issues

Pan American Union. Various publications, 1946. . . .

Panorama of Science. *See* Smithsonian Series

Passenger Pigeon (Wisconsin Society for Ornithology). 1939, Vol.1. . . .

Peking Natural History Bulletin (*joins with* Yenching University Department of Biology Bulletin). 1930–1941, Vols.5–16, in part

Pennsylvania Game News. 1947, Vol.18. . . .

Petrel. 1901, Vol.1

Phainopepla. 1928–1932, Vols.1–4 (complete set)

Philadelphia Academy of Natural Sciences. *See* Notulae Naturae

Pittman-Robertson Program. Various publications, 1941. . . .

Princeton University, Bulletin of the Bird Club. 1901, Vol.1, No.1

Pro Natura. 1948, Vol.1, No.1

Prothonotary. 1935, Vol.1. . . .

Provancher Society of Natural History of Canada, Annual Report. Scattered issues

Provinciaal Utrechtsche Genootschap van Kunsten en Wetenschappen. 1939–1948

Quebec Society for the Protection of Birds. Annual Report. Scattered issues

Random Notes on Natural History. 1884–1886, Vols.1–3

Rassegna Faunistica. 1934–1935, Vols.1–2, in part

Raven. 1930, Vol.1. . . .

Records of Walks and Talks with Nature. 1912–1914. Vols.5–6, in part

Redstart. 1941, Vol.9. . . . (+)

Revue Française d'Ornithologie. 1926–1928, Vols.10–12

Rhinebeck Bird Club, Annual Report. 1916–1917. Nos. 2–3

Ridgway Ornithological Club, Bulletin. 1887. No.2

Riistatieteellisiä Julkaisuja. 1948. No.1. . . .

Ring. 1954. No.1. . . .

Rivista Italiana di Ornitologia. 1954. one issue

Roadrunner. 1942, one issue

Rockland Audubon Observer. 1947, Vol. 1. . . .

Roosevelt Wild Life Annals (Bird Papers). 1932, 1936, 3 issues
Roosevelt Wild Life Bulletin. 1921, Vol.1, No.1. . . . (incomplete)
Royal Ontario Museum of Zoology. *See* Toronto
St. Louis Bird Club Bulletin. Scattered issues
San Diego Society of Natural History, Transactions (Bird Papers). 1919–1947, Vols.3–11
San Diego Zoological Society, Bulletins. 1943, No.19
Santa Barbara, California, Journal of the Museum of Comparative Oology. 1919–1922, Vols.1–2
Schenectady Bird Club, Bulletin. 1943–1945, Nos.1–4
Schweizerischen Vogelwarte Sempach, Reports. 1933. . . . (scattered)
Science Observer (Vineland, New Jersey). 1888, Vol.1, No.3
Science Record (*formerly* Scientific and Literary Gossip). 1882–1884, in part
Scottish Ornithologists' Club. *See* Fair Isle Bird Observatory
Seattle Wren. 1933–1941, Vols.1–9, in part
Sioux City Bird Study Club Review. *See* Dickcissel
Smithsonian Series, Panorama of Science. 1951
Snowy Egret. 1930–1938, Vols.5–13, in part
Société nationale d'acclimatation de France, Bulletin. *See* Terre et la Vie
Sophia. 1936, Vol.9
South Australian Ornithologist. 1925, Vol. 8. . . . (incomplete)
South Dakota Bird Notes. 1949, Vol.1. . . .
Spy Glass. 1891, Vol.1, No.1
Staten Island Institute of Arts and Sciences, Proceedings. Vol.7 for (1932–1934)
Stoneham Museum, Report. 1949
Stories from Nature. 1897–1898, Vol.1
Stormy Petrel. 1890, Vol.1, in part
Studies in Natural History. *See* Iowa University
Sunny South Oölogist. 1886, Vol.1, Nos.1–2
Suomen Riista. 1946, No.1. . . .
Swiss Cross. 1887–1889, Vols.1–5, in part
Sylvia. 1936–1948, Vols.1–10
Syracuse University Bulletin. *See* Roosevelt Wild Life Bulletin
Taxidermist (Massachusetts). 1908, No.4
Tennessee Academy of Science, Journal [*formerly* Transactions]. 1914–1948 (incomplete)
Terre et la Vie (*formerly* Bulletin de la Société nationale d'acclimatation de France). 1945, Vol.92 . . .
Texas Game, Fish and Oyster Commission, Annual Report. 1938/39
Texas Ornithological Society, Newsletter. 1953, No.1. . . .
Three Kingdoms. 1898, Vol.1, in part
Tidings from Nature. 1885–1886, Vols.1–2, in part
Toledo Naturalists' Association, Annual Bulletin. 4 issues
Tori. 1947, Vol.12. . . . (+)
Torreia. 1953, No.20
Toronto, Royal Ontario Museum of Zoology, Bulletin (Bird Papers). 1928. . . .
Toronto, Royal Ontario Museum of Zoology, Contributions (Bird Papers). 1928, No.1. . . . (incomplete)
Toronto, Royal Ontario Museum of Zoology, Occasional Papers (Bird Papers). 1935, No.1. . . . (incomplete)
Toronto University Studies, Biological Series. 1907–1935, in part
Traveller and Naturalist. *See* California Traveller and Naturalist
Tschammendorf. Bericht der Ornith. Ring-Station. 1938, No.1
Urner Ornithological Club. 1946, Vol.1. . . . (incomplete)
United States departmental official publications. Various
U.S. Fish and Wildlife Service. Various publications
U.S. National Museum, Bulletin (Bird Papers). Listed under author in W.O.S. Library Book List.
U.S. National Museum, Proceedings (Bird Papers). Listed under author in W.O.S. Library Book List
[U.S.] Smithsonian Institution, Miscellaneous Collections. Scattered issues
Utah Audubon News. 1949, Vol.1. . . .

Valley Naturalist. 1878–1880, Vols.1–2, in part
Vår Fågelvärld. 1942, Vol.1. . . .
Vereins Sachsischer Ornithologen, Mitteilungen. 1927–1938, Vols.2–5
Vereins Schlesischer Ornithologen. Berichte. 1930–1934, Vols.16–19, in part
Vermont Botanical and Bird Club Joint Bulletin (*formerly* Vermont Bird Club Bulletin). 1934, No.16. . . . (+)
Victorian Naturalist. 1931, Vol.48. . . . (incomplete)
Vildtbiologisk Station Kalo, Meddelese. 1950, No.1. . . .
Vögel der Heimat. 1946, Vol.16. . . .
Vogel ferner Länder. 1930–1935, Vols.4–9, in part
Vogelfreund. *See* Vogelring
Vogelring (*formerly* Vogelfreund). 1930–1942, in part
Vogeltrekstation [Texel], Jaarverslag. 1950. . . .
Vogelwarte, Die (*formerly* Vogelzug). 1930, Vol.1. . . .
Vogelwelt, Die. 1949, Vol.70. . . .
Vogelzug, Der. *See* Vogelwarte
Warbler (Des Moines Audubon Society). 1944, Vol.1. . . . (incomplete)
Warbler (Floral Park, N.Y.). 1903–1910, Vols.1–6 (Vol.7, 1913, needed for complete set.)
Weekly Oologist and Philatelist. 1891–1892, Vols.1–2, in part
West American Scientist. 1885–1918, Vols. 1–22, in part
Western Naturalist (Topeka, Kansas). 1903, Vol.1, No.1
Western Naturalist (Madison, Wisconsin). 1887–1888, Vols.1–2, in part
Western Ornithologist. *See* Iowa Ornithologist
Western Reserve Naturalist. 1893, Vol.1, Nos.1–2
Western Tanager. 1937–1940, Vols.3–7, in part
Western Wild Life Call. 1913, No.1
Wildlife Review. 1935, No.1. . . .
Wilson Bulletin. 1894. . . . (*See also* Curlew.)
Wisconsin Arbor and Bird Day Annual. 1904
Wisconsin Conservation Department. Miscellaneous publications
Wisconsin Naturalist (Milwaukee). 1897–1901, Vols.1–9, in part
Wisconsin Naturalist (Madison, Wisconsin). 1890–1891, Vol.1, Nos.1–8
Wisconsin, University. Various publications.
Wood Thrush. *See* Atlantic Naturalist
Yacho (Wild Birds). 1952, Vol.17, Nos.1–2
Yamashina's Institute for Ornithology and Zoology. Miscellaneous Reports. 1952, No.1. . . .
Yenching University, Department of Biology Bulletin. *See* Peking Natural History Bulletin
York County Bird Club Bulletin. 1944, 2 issues
Yosemite Natural History Association Bulletin. No.1, undated
Yosemite Nature Notes. 1925–1942. Vols. 4–21, in part
Young Collector. *See* Collector
Young Naturalist (Chicago). 1886. Vol.1, No.1
Young Naturalist (Galesburg, Illinois). 1884, Vol.1, in part
Young Oologist. See Oologist (Albion, N. Y.)
Young Ornithologist. 1885–1886, Vol.1, in part
Youth's Magazine. 1893, Vol.1, in part
Zoologica (Bird Papers). 1946, Vol.31. . . . (+)
Zoological Record: Aves. 1944. . . . (+)
Zoologist. Scattered issues

ORNITHOLOGICAL LITERATURE

Travels and Traditions of Waterfowl. By H. Albert Hochbaum. The University of Minnesota Press, Minneapolis, 1955: 6 4/5 x 10 in., x + 301 pp., 26 figs., 2 tables and numerous sketches. $5.00.

This is the best book on bird migration since Thompson's classic, "Problems of Bird-Migration," published 30 years ago. Although the title suggests that waterfowl are the sole subject of the book, the scope is broader. In fact, the text includes 145 species of birds, which embrace those observed as transients, those studied by other investigators which contribute to the author's thesis, and those studied intimately by the author.

The book is based largely upon observations of waterfowl and other birds in and around the Delta Waterfowl Research Station at the southern end of Lake Manitoba, Canada. In addition to material drawn from years of field observation, the author has used information from 495 papers to provide substance for his interpretation of waterfowl behavior and migration. The contents are presented in three parts: "Travels of Waterfowl," "Migrations of Waterfowl," and "Traditions of Waterfowl."

The background for an understanding of bird migration is developed in Part I. Hochbaum's thesis that birds, particularly waterfowl, orient themselves in flight by means of environmental cues, experience, and memory, is not new, but never before has it been set forth so lucidly and diligently. The author sets the pattern for waterfowl migration over vast distances by discussing the formation of flight trails about the Delta Marsh. There he observed that waterfowl used certain favored routes in flying from one part of the marsh to another. Young ducks, just awing, were believed to have learned these routes from experience in response to the pattern of water, marsh, and field.

Other factors forming a background for bird migration are discussed in chapters dealing with: "The Visual World," "The Function of Memory," "The Aerial Environment," and "Awareness of Time and Space." A most original and interesting series of experiments, made with hooded birds tossed upward into the air, is discussed. These experiments point up the ability of birds to remain aloft in flight even though the ground is invisible. Because the hooded birds failed to orient their flight with wind, unless it blew in strong gusts, it was deduced that migrants without visual contact with the earth could be displaced geographically without being aware of such displacement.

Part II deals with waterfowl in migration as described and evaluated under the following chapter titles: "The Cycle of Migration," "Flight Trails South," "Homeward Migration," "The Classification of Waterfowl Travel," "The Dimensions of Travel," "The Influence of Bad Weather," "Overseas Migration," "Magnetic and Radio Fields," and "Awareness of Direction."

Through these chapters the point is repeatedly made that waterfowl initiate migration under anticyclonic (high pressure) conditions with fair skies and favorable winds. This is not always the case. One of the largest migrations of waterfowl ever recorded in the Mississippi Flyway occurred on October 31-November 2, 1955, with cyclonic (low pressure) conditions which brought a heavy overcast and snow showers to a vast section of the flyway. Moreover, the exodus of large numbers of waterfowl from Illinois has frequently been associated with cyclonic conditions. It is apparent that the effect of anticyclonics and cyclonic conditions upon waterfowl migration need to be studied more fully.

Hochbaum, in summarizing a discussion of waterfowl orientation in migraton, reached this conclusion (p. 212): "The evidence at hand suggests that adult waterfowl travel as experienced birds over a familiar range. By reference to the sun, as to a compass, or to environmental patterns, like those presented by waves, they may hold a direct course for some distance without visual reference to a familiar landscape. The studies of Matthews and Kramer (yet to be repeated with waterfowl) suggest that the sun may serve as the cue to the direction of home when the bird is displaced from familiar surroundings, but that such awareness hinges on the bird's distance from home."

Part III deals with the meaning of tradition in waterfowl behavior. The chaper titles are: "Biological Traditions," "Building New Traditions," "Traditional and Racial Isolation," and "Broken Traditions."

Both the author and the publisher deserve plaudits for the attractiveness of the book. Hochbaum's writing is colorful and pleasant to read; he is a most literate wildlife writer. In addition, his many excellent drawings portray the living marsh as well as various facets of waterfowl behavior. The paper is of good quality, the printing sharp and clear, and typographical errors negligible.—FRANK C. BELLROSE.

THE ART OF FALCONRY (DE ARTE VENANDI CUM AVIBUS). By Frederick II of Hohenstaufen. Translated and edited by Casey A. Wood and F. Marjorie Fyfe. Reprinted. Charles T. Branford Company, Boston, 1955: $8\frac{1}{2} \times 11$ in., cxii–644 pp. 186 plates (two in color). $20.00.

Often referred to as "the noblest of arts," falconry was born in and emerged from the mists of remote antiquity. It was practiced by and was familiar to the peoples of China, ancient India, Assyria, Sumeria, and the other provinces of Babylonia, Egypt, and Persia thousands of years before Rome, the locale of this book, came into existence.

When the sport reached its climax in the West during the Middle Ages, Frederick II of Hohenstaufen (1194-1250), Holy Roman Emperor, King of Sicily and Jerusalem, became the most brilliant and most versatile exponent of the art of educating birds for the chase. But aside from the fact that he was an expert falconer, he was also an erudite ornithologist, well-informed forester, and an accomplished writer on all natural history subjects. Thus this volume becomes not only a complete manual of instruction on all phases of falconry (it is truly the "falconer's bible") but it takes its place as a scientific monograph of substantial value in ornithology.

Casey Albert Wood, member of the Wilson Ornithological Society from 1924 and elected member of the American Ornithologists' Union from 1921 until his death in 1942, spent his last ten years of work (in collaboration with his niece, F. Marjorie Fyfe) on a reproduction and translation of 'De Arte Venandi cum Avibus', chiefly at Rome and in the Vatican Library. There he made this and other translations from mediaeval Latin, and others from Arabic. That the translators did a magnificent job is evidenced by the prodigious and authoritative book, first appearing in 1943. It is unfortunate that Dr. Wood did not have the rare pleasure of seeing this final product of his monumental undertaking.

The original six books comprising Frederick's treatise on falconry were intended by him to be entirely scientific and general; hence he did not discuss many dramatic details, tell any hunting stories, or make many references to living men or places. They contain no effort to glamorize or romanticize the sport.

The translators adhere precisely to the text as Frederick wrote it, but they do clarify, through the use of copious footnotes, any items which may appear to be unidentifiable, obscure or ambiguous. For example, where the text reads: "In some white species of carrion eaters that have black feathers at the extremities of their wings, the saffron yellow of the mandibles extends to the middle of the head," the footnote explains: "This is the Egyptian carrion vulture (*Neophron percnopterus*)".

Generally there is a remarkable accuracy of the Emperor's descriptions but oversights or inconsistencies, where found, are pointed out. For instance, the text reads: "Certain land birds take their food on the wing, others on the ground. Some (for instance, swallows and siskins) devour their prey in the air." The footnote comments: "Why siskins (*sirone*) are associated (as examples of this habit) with swallows is strange, since the former rarely if ever act in this fashion." And some other intriguing references, which even the translators make no attempt to clarify, present a real challenge to the ornithologists of today.

Book One is an account of the structure and habits of birds with especially strong chapters on plumages, moults, and behaviour (these are invaluable to falconers who might also be serious-minded ornithologists) and migrations. Book Two covers the different kinds of falcons used in hunting, their care, manning, and equipment while Book Three refers to training aspects. Books Four, Five and Six set forth the rudiments of crane hunting with gyrfalcons, heron hawking with the saker falcon, and waterfowl hunting with the peregrine. There are several chapters of appended material, two of which covering the favorite birds of the chase and an annotated roster of birds probably well-known to the Emperor might be styled brief, incomplete, descriptive accounts of northern- and mid-European birds, with a sprinkling of the avifauna of the Near East and Far East.

The book warrants close inspection by all who are interested in any phase of bird study. It is fascinating reading and its excellent printing and illustrations invite an artistic appreciation of its informative contents. Its beauty and richness overcome and outweigh its bulkiness.—Burt L. Monroe, Sr.

Louisiana Birds. By George H. Lowery, Jr. Louisiana State University Press, 1955: 8¾ × 6⅜ in., xxxii + 556 pp., 40 plates (12 in full color) by Robert E. Tucker, 81 photographs, 147 figures in text. $5.00.

The stated purpose of this book is ". . . to introduce the people of Louisiana to the absorbing subject of ornithology." This purpose is reflected in the discussion in the early chapters of such topics as bird habitats in Louisiana; how to identify birds; feathers, plumages and molts; the bird skeleton; migration; the economic value of birds. Each of these chapters develops the topic adequately while being short enough to hold the interest of the non-technical reader. More detail is presented than is found in pocket-size field guides, although the species accounts which follow are brief in comparison to the treatment in conventional state bird books. In keeping with the approach, subspecies are omitted from the discussion.

The text throughout is very readable; while the personal element weights some accounts, it adds to the interest of the book. The account of the author's attempts at removal of English Sparrows should be read by everyone concerned with the control of any vertebrate species. Occasionally the author lapses into more technical language and uses a term the special meaning of which is not defined. One such instance is ". . . selection and defense of territories" on p. 71. At several points Dr. Lowery has taken the opportunity to explain the purposes of the serious student of ornithology; the chapter which discusses the activities of the Louisiana State Museum of Zoology is notable in this respect.

The drawings and paintings by Robert E. Tucker serve adequately as aids to identification, although in every case he has not captured the configurations or attitudes which are helpful in some groups. I feel that he has been most successful with the woodpeckers and finches.

The book has been produced handsomely, a condition which makes the price seem all the more remarkable. In addition to accomplishing his stated purpose, Dr. Lowery has written a book which will be useful to ornithologists beyond the borders of his state.—Keith L. Dixon

Incubation Periods Through the Ages. By Margaret M. Nice. *Centaurus*, 3:311–359, 1954 (International Magazine of the History of Science. Copenhagen. This article printed in English.)

A search in the literature for the origin of erroneous incubation periods still being listed in recent publications took the author back 2300 years in recorded history. (Some evidence of the diligence of her search: 188 references cited and translations of several passages from German, French, Italian, Latin and Greek). The detective-like manner in which this quest was pursued provides a stimulating review, in brief, of the history of biology, particularly ornithology. Much of this material was presented in another article, (Nice, M. M. 1954. Problems of incubation periods in North American birds. *Condor*, 56:173–197)—the present paper emphasizing Old World aspects of the problem. A table of contents and numerous sub-headings make for easy reading. Occasional examples of man's weakness for a good story are offered for the same reason (but not with the same intent) and add a bit of salt. For example, a tale quoted in 1610 as "factual" describes a heat-of-friction method of incubation employed by certain gulls or skuas, these enterprising birds repeatedly dropping eggs from heights above the water until hatched by the heat obtained in falling through the air! Many errors in present-day incubation periods were found to be attributable to "copying of assumptions made by important people." Mrs. Nice concludes that there is need for a little skepticism and less blind reliance on authority—in short, more original investigation is in order.—Robert W. Nero.

Life Histories of Central American Birds. Families Fringillidae, Thraupidae, Icteridae, Parulidae and Coerebidae. By Alexander F. Skutch. Cooper Ornithological Society, Berkeley, California; Pacific Coast Avifauna Number 31, 1954: 7 x 10 1/2 in., 448 pp., 68 figures, 1 color plate. Illustrated by Don Eckelberry. $10.00

With patience and a keen eye and ear an outstanding field biologist has produced with his fluent pen under expert editorship the most important information on the life cycle of any vertebrate group inhabiting Central America. Criticisms of the book would have to be largely in the nature of differences of opinion and sometimes of interpretation.

After a brief introduction to events leading to the production of this book and to a description of its scope and form, there begin the life histories of 41 species divided by families as follows: Fringillids, 9; tanagers, 13; icterids, 11; warblers, 5; honeycreepers, 3. Each account begins with a few paragraphs describing the species' obvious characteristics, often both generic and specific, its geographic and habitat distribution, and introductory glimpses into interesting and important behavior patterns. In some instances the reader must follow the author through descriptions which build to perfection the proper setting for the bird's activities. These descriptions are not out of place. Only a few readers will have been to Central America and would know about weather and status of vegetation on a Christmas Day which ". . . dawned clear and cloudless, with a brisk, chilling breeze driving down the valley . . . from the high summits of the Cordillera . . . The thickets . . . aglow with a profusion of white, yellow and red blossoms . . ."

Information included under each species is divided into various sections: food, anting.

voice, dominance, nest building, eggs, incubation, nestlings, subsequent broods, and others. For some species plumages and molts are described in considerable detail, including the approximate age of the individual at the time of the first molts and the appearance of the birds during the period of molt. One cannot, and I believe would not wish to, read only the material under certain section headings and expect to have a complete picture of that phase of the bird's habits. The information, taken almost entirely from the author's accumulated field notes, is for each species an informative and easily read account but it contains in one paragraph references to events which occurred over many years and fascinating digressions from the specific subject. These bring clarification of meaning and purpose to the point of discussion. Series of observations and synoptic material on nesting activities are presented in tabular form; but these are at a minimum and serve only to leave intact the story form and to permit clear examination of data for easy analysis. At the end of each species section is a summary; and at the end of each family section appears a summary of information on the family as a whole.

Throughout the book the reader is aware that here are included in meticulous detail discussions of avian ecology, behavior (some of it comparative behavior), and descriptions of the author's techniques in the field, the latter being in the reviewer's opinion of nearly equal importance to the data gathered on the subjects.

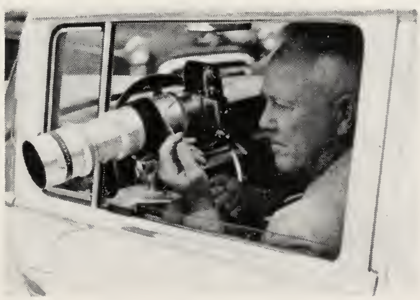
References to the literature indicate a thorough knowledge of the field on a world-wide basis; these are listed at the end of the book under "Literature Cited". The index is divided into two sections: the first, a list of common names of the birds; the second, a list of scientific names of birds to which reference is made. Each species is not treated in the same detail, and, of course, the knowledge of no species is complete. The gaps are clear, however, and will serve as focal points for future study.

The photographs are of great value and show careful consideration in choice. The color plate of the Golden-masked, Silver-throated, Blue, and Scarlet-rumped Black Tanagers is a highly pleasing frontispiece. Each of the other species included is illustrated admirably well in black and white by the pen and ink drawings of Don Eckelberry. Usually only a single bird is portrayed but three plumages are illustrated of the Variable Seedeater, and both male and female of several other birds.

No ornithologist working with birds of the Western Hemisphere should be without access to this monumental work or to the other writings of Alexander Skutch.—Dwain W. Warner.

NEW LIFE MEMBER

Fenn M. Holden was awarded a degree in engineering by the University of Michigan in 1908, and he worked subsequently in the automobile business in the Detroit area. Following his retirement in the 1930's, he resumed a boyhood interest in bird watching. Mr. Holden, who spends his summers in Michigan and winters in Florida, has developed a keen interest in photographing birds. He is shown here using a 400 mm. lens.



THE WILSON ORNITHOLOGICAL SOCIETY

MEMBERSHIP ROLL

***Founder **Life Member *Sustaining Member Others—Active Members

Abbott, Major Jackson Miles, 814 - 13th St., Alexandria, Virginia 1948
Abraitys, Vincent, Sergeantsville, New Jersey 1956
Ackermann, Fred J., 1298 Edanola Ave., Lakewood 7, Ohio 1956
Adams, Alexander B., Bradfordwoods, Pennsylvania 1956
Adams, Ralph M., 6796 SW 21st St., Miami, Florida 1956
Adams, William Hensley, Jr., Wildlife Bldg., Auburn, Alabama 1951
Adelson, Richard Henry, 34 Wensley Drive, Great Neck, L.I., New York 1938
Adler, Max, 612 Arlington Rd., Bangor, Michigan 1956
*Afsprung, Arthur E., 3308 Bishop St., Cincinnati 20, Ohio 1948
Agee, C. Phillip, R.D. #7, Lincoln, Nebraska 1956
*Aldrich, John Warren, 21 W. Spring St., Alexandria, Virginia 1930
*Alexander, Donald C(hild), 16 Pleasant St., Nahant, Massachusetts 1937
Alexander, Gordon, Dept. of Biology, University of Colorado, Boulder, Colorado 1936
Alexander, Maurice M(yron), Dept. of Forest Zoology, New York State College of Forestry, Syracuse 10, New York 1945
Alexander, R. C., 19207 Charleston Ave., Detroit 3, Michigan 1949
Allen, A(rthur) A(ugustus), Fernow Hall, Cornell University, Ithaca, N.Y. 1914
Allen, Robert P(orter), Box 205, Tavernier, Florida 1947
Allin, Dr. A(lbert) E(llis), Provincial Laboratory, Fort William, Ontario 1943
Allyn, Dr. P(aul) Richard, 709 Myers Building, Springfield, Illinois 1944
*Alperin, Irwin M., 187 Cedar Lane, Babylon, New York 1939
Altemus, Edward Lee, Lafayette Ave., Fort Washington, Pennsylvania 1954
Altsheler, Mrs. Yancey R(oberts), 2326 Dundee Road, Louisville 5, Kentucky 1954
Amadon, Dean, American Museum of Natural History, Central Park West at 79th St., New York 24, New York 1935
Anderson, Anders H(arold), 3221 E. Kleindale Rd., Tucson, Arizona 1937
Anderson, Mrs. David L., 13851 Clinton Blvd., Lakewood 7, Ohio 1955
Anderson, Frank G., Dept. of Sociology, University of Maryland, College Park, Maryland 1951
*Anderson, John M., R.R. #3, Winous Point, Port Clinton, Ohio 1938
Anderson, Milton R(obert), Wildlife Conservation Inc., 20 Spruce St., Boston 8, Massachusetts 1954
Anderson, Walter M., 2109 S. 58th Court, Cicero 50, Illinois 1956
Anderson, William Deans, 3100 Beverly Rd., Austin 3, Texas 1950
Andrews, Mrs. J. Clinton, Three Stoney Alley, Nantucket, Massachusetts 1947
Andrews, James Clinton, Three Stoney Alley, Nantucket, Massachusetts 1947
**Annan, Ormsby, 270 Birch St., Winnetka, Illinois 1956
Anthes, Clarence A., 707 N. Moreland Blvd., Waukesha, Wisconsin 1939
Anthony, Jesse D., 722 - 1st Ave., East, Grand Rapids, Minnesota 1944
Antibus, Fred, 6139 North Oxford, Indianapolis 20, Indiana 1956
Arbib, Robert S(imeon), Jr., 231 West Lena Ave., Freeport, New York 1947
Armington, Sven, Blanchegatan 18, Stockholm, Sweden 1948
*Armstrong, Virginia, Old Concord Rd., South Lincoln, Massachusetts 1939
Arnett, John Hancock, Jr., Harrisburg State Hospital, Harrisburg, Penn. 1944
Arnold, Elting, 4914 Dorset Ave., Chevy Chase 15, Maryland 1941
Arny, Samuel A., 6515 Willston Drive, Apt. 2, Falls Church, Virginia 1947
**Aronoff, Dr. Arthur Edward, 11 Fifth Avenue, New York 3, New York 1948
Ashton, Randolph, 800 Crown St., Morrisville, Pennsylvania 1941
Atkeson, Thomas Zephaniah, P.O. Box 1643, Decatur, Alabama 1953
Austin, Mrs. Harold C., 1116 Mandana Rd., Oakland 10, California 1950
Austin, John Brander, School of Geology, Sewanee, Tennessee 1947
Austin, Dr. Oliver L., 28 Fairview Ave., Tuckahoe 7, New York 1930
*Avery, John A(rthur), 3411 S. Westnedge, Kalamazoo, Michigan 1952
Axtell, Harold H., Buffalo Museum of Science, Humboldt Park, Buffalo 11, New York 1950

**Bagg, Aaron Moore, Farm St., Dover, Massachusetts 1948
Baepler, Donald H(enry), Dept. of Zoology, University of Oklahoma, Norman, Oklahoma 1955
Baier, Mrs. John, 111 "C" St., Martinez, California 1949
Bailey, Alfred Marshall, Museum of Natural History, City Park, Denver 6, Colorado 1928
*Bailey, Harold H(arris), Rockbridge Alum Springs Biological Laboratory, Route 2, Goshen, Virginia 1908
Baily, A(lbert) Lang, Davenport Public Museum, 704 Brady St., Davenport, Iowa 1953
*Baird, James, Norman Bird Sanctuary, Third Beach Rd., Newport, R.I. 1954
**Baker, Bernard W., R.R.#1, Judson Rd., Spring Lake, Michigan 1938
*Baker, John H(opkinson), 1130 Fifth Avenue, New York, N.Y. 1930
Baker, Maurice F(rank), 19 Austinville Rd., Decatur, Alabama 1947
Baker, Paul S(eamon), 21 Woodlot Lane, Huntington, Long Island, N.Y. 1946
Baker, Rollin Harold, The Museum, Michigan State University, East Lansing, Michigan 1938
Baker, William C(alvin), 559 Euclid St., Salem, Ohio 1931
Baldwin, Mrs. Amy G., 6335 Kimbark Ave., Chicago 37, Illinois 1943
Baldwin, Paul H., Dept. of Zoology, Colorado A.&M. College, Fort Collins, Colorado 1956
Ball, Henrietta (Sophia), 1213 South Third, Lafayette, Indiana 1951
Ball, Kathleen E., 11719 - 133rd St., Edmonton, Alberta, Canada 1946
*Balsom, Mrs. Amos Parker, 2209 E. Stratford Court, Milwaukee 11, Wisconsin 1949
Banks, Clinton S(eeger), 202 Wilma Ave., Steubenville, Ohio 1945
Banta, Edna, Mary Gray Bird Sanctuary, Route 6, Connersville, Indiana 1945
Barber, Mrs. Harold A., 23863 Fordson Dr., Dearborn, Michigan 1952
Barber, Lucy, Box 6092 Station A, Charleston 2, West Virginia 1950
Barber, Sarah C., Box 6092 Station A, Charleston 2, West Virginia 1950
Barbour, Llewellyn P(helps), 4780 Wood St., Willoughby, Ohio 1948
Bard, Fred George, Provincial Museum, Normal School, Regina, Saskatchewan, Canada 1946
Barrett, Lewis Le Roy, 2737 Ulysses St., N.E., Minneapolis 18, Minnesota 1949
**Bartel, Karl E(mil) Edgar, 2528 West Collins St., Blue Island, Illinois 1934
Bartleson, Fred D(urant), Jr., Route 3, Box 550, Ft. Myers, Florida 1952
*Bartlett, Guy, 1053 Parkwood Blvd., Schenectady 8, New York 1938
Bartlett, Wesley H., 122 South Ridgley, Algona, Iowa 1936
Bartsch, Paul, "Lebanon" Gunston Hall Rd., Lorton, Virginia 1894
Bastin, Eric W(alter), #43 Inglewood Dr., Apt. 2, Hamilton, Ontario, Canada 1951
Batchelder, Edgar M(arden), 56 Orchard St., Marblehead, Massachusetts 1941
**Batts, H(enry) Lewis, Jr., 1211 Glenwood Ave., Kalamazoo, Michigan 1946
Baumgartner, Frederick Milton, Dept. of Zoology, A.&M. College, Stillwater, Oklahoma 1935
*Baxter, William, Jr., Route #2, Middletown, Delaware 1945
Baylor, L(eslie) M(ilton), 1912 Tyler Rd., Boulder, Colorado 1954
Bayly, Bob, 1759 Franklin Blvd., Eugene, Oregon 1956
Beals, Everett K(err), 1310 N. 11th St., Manhattan, Kansas 1953
Beardslee, Clark Smith, 132 McKinley Ave., Kenmore 17, New York 1942
Beardsley, M(argaret) Hortense, 330 N. Chestnut St., Ravenna, Ohio 1941
Bebb, Forrest, 1300 Boston Ave., Muskogee, Okla. 1955
Bebb, Maurice R(obert), 1234 Fondulac St., Muskogee, Oklahoma 1955
Bedard, Marcel A., P.O. Box 157, Rainy River, Ontario, Canada 1956
Beebe, William, 33 West 67th St., New York, N.Y. 1944
Beecher, Mrs. Barbara J., 330 Elm St., Bennington, Vermont 1956
Beecher, William J(ohn), Chicago Natural History Museum, Chicago 5, Ill. 1948
Behle, William H(arroun), Dept. of Biology, University of Utah, Salt Lake City 1, Utah 1935
Behrens, Harry Carl, Box 1055, Rapid City, South Dakota 1950
*Belcher, Paul Eugene, 98 Grandin Rd., Akron 13, Ohio 1938

Belfore, Stanley Alexander, 890 S. 6th St., Lindenhurst, Long Island, N.Y. ... 1953
Bell, Henry III, 824 - 23rd St., Golden, Colorado ... 1946
Bell, Mrs. William F., 210 Carden Avenue, Nashville 5, Tennessee ... 1954
Bellrose, Frank, Jr., Illinois Natural History Survey, Havana, Illinois ... 1935
Benne, Bart L., 338 N. Van Brunt, Kansas City, Missouri ... 1956
Bennett, A. F., 701 W. Main St., Denison, Texas ... 1955
Bennett, Esther V(orena), 704 W. Mill, Carbondale, Illinois ... 1954
Bennett, Holly Reed, 2457 Orchard St., Chicago 14, Illinois ... 1949
Bennett, Joseph A., 28 Berkeley Rd., Maplewood, New Jersey ... 1956
Bennett, Mary A(llison), 623 E. Carroll St., Macomb, Illinois ... 1933
Benson, Seth, 645 Coventry Rd., Berkeley 7, California ... 1930
Bent, Mrs. M. V., 310 Cherry Lane, Wynnewood, Pennsylvania ... 1955
Benton, Allen H(aydon), Department of Biology, New York State College for Teachers, Albany, New York ... 1953
**Berger, Andrew J(ohn), Dept. of Anatomy, University of Michigan, Ann Arbor, Michigan ... 1940
Berger, Daniel D(avid), 510 E. MacArthur Rd., Milwaukee 17, Wisconsin ... 1953
Bergerud, Tom, 8226 Oakmere Rd., Bloomington, Minnesota ... 1956
**Bergstrom, E(dward) Alexander, 37 Old Brook Rd., West Hartford 7, Conn. 1943
*Berkowitz, Albert Clarence, 1912 Grand Ave., Des Moines 14, Iowa ... 1946
Betts, Amelia J(eanette), Baldwin City, Kansas ... 1953
Biaggi, Virgilio, Jr., College of Agriculture, Mayaguez, Puerto Rico ... 1945
Biggs, Joseph Daniel, 2351 - 25th St., Washington 20, D.C. ... 1949
Binford, L(aurie) C(harles), Museum of Zoology, Bird Division, University of Michigan, Ann Arbor, Michigan ... 1954
Birch, Robert Lee, Dept. of Biology, West Virginia University, Morgantown, West Virginia ... 1950
*Bird, Dick, 2721 Assiniboine Ave., Regina, Saskatchewan, Canada ... 1949
Birkeland, Henry, Roland, Iowa ... 1934
Black, Charles T(heodore), Route 1, Box 480, East Lansng, Michigan ... 1935
**Blain, Dr. Alexander W(illis), 2201 Jefferson Ave., East, Detroit 7, Michigan 1902
Blake, Charles H(enry), Woodland Way, Lincoln, Massachusetts ... 1950
Blake, Emmet R(eid), Chicago Natural History Museum, Chicago 5, Illinois 1939
Blake, Mrs. Henry S., 1933 Westwood Dr., Topeka, Kansas ... 1950
Blanchard, Harold H(ooper), 32 Calumet Rd., Winchester, Massachusetts ... 1946
*Blanchet, Helen, 1406 Southfield Rd., Lincoln Park, Michigan ... 1954
**Bleitz, Donald Lewis, 1001 N. McCadden Place, Los Angeles 38, California ... 1948
Bliese, John C(arl) W(illiam), Nebraska State Teachers College, Kearney, Nebraska ... 1951
*Blossom, Philip M(oss), 2818 Parkland Dr., Orlando, Florida ... 1949
Bock, Walter J(oseph), Biological Laboratories, Harvard University, Cambridge 38, Massachusetts ... 1953
Bodsworth, Fred, 294 Beech Ave., Toronto 8, Ontario, Canada ... 1956
Bolen, Homer R., S.E. Missouri State College, Cape Girardeau, Missouri ... 1953
**Bond, James, 1900 Race St., Philadelphia 3, Pennsylvania ... 1945
Bond, Richard M(arshall), Kings Hill, St. Croix, U.S. Virgin Islands ... 1936
Bond, Richard R(andolph), Dept. of Biology, Salem College, Salem, West Virginia ... 1955
*Booth, Mrs. Robert V. D., 1085 Bank St., Painesville, Ohio ... 1949
Borell, Adrey Edwin, Soil Conservation Service, 321 New Custom House, Denver 2, Colorado ... 1936
Borror, Donald J(oyce), Dept. of Zoology, Ohio State University, Columbus 10, Ohio ... 1927
Boughner, W. C., Apt. 9, 66 E. Cliff St., Somerville, New Jersey ... 1956
*Boulton, Rudyerd, 3234 Reservoir Rd., N.W., Washington 7, D.C. ... 1942
Bourdo, Eric Albert, Jr., Ford Forestry Center, L'Anse, Michigan ... 1951
Bowdish, Beecher S(coville), 16 Van Horn St., Demarest, New Jersey ... 1921
Bowen, Robert Marvin, 5011 Leeds Ave., Baltimore 27, Maryland ... 1947
Bower, Mrs. F. L., RFD 1, Lee's Hill Rd., Basking Ridge, New Jersey ... 1954

Bowers, J. Basil, 975 Juanita, Campbell, California 1942
*Boyd, Elizabeth M(argaret), Mount Holyoke College, South Hadley, Mass. .. 1941
Boyd, Hugh J., Severn Wildfowl Trust, The New Grounds, Slimbridge, Glouchestershire, England 1946
Boyd, Ivan L., Dept. of Biology, Baker University, Baldwin, Kansas 1951
Boyer, George Frederick, Bosham House, Bosham, near Chichester, Sussex, England 1949
Boyer, G(ertrude) Paula, 420 E. 2nd Ave., Roselle, New Jersey 1953
*Brackbill, Hervey G(roff), 2620 Poplar Dr., Baltimore 7, Maryland 1942
Bradburn, Donald Muir, 461 Pine St., New Orleans 18, Louisiana 1950
Braden, Paula Lou, 1526 New York Ave., Brooklyn 10, New York 1953
*Bradley, Homer L., Long Lake National Wildlife Refuge, Moffitt, North Dakota 1939
*Branch, Mrs. Margaret G(amble), 1324 Wells St., Ann Arbor, Michigan 1952
Branum, Florence P(auline), 117 N. Ewing St., Lancaster, Ohio 1946
Brauner, Joseph, 3350 San Marino St., Los Angeles 6, California 1942
Braunschweig, Mrs. Lee W(elsh), 712 E. Montgomery Ave., North Wales, Pennsylvania 1953
**Brecher, Leonard C(harles), 1900 Spring Dr., Louisville 5, Kentucky 1939
Brecht, Grace Elizabeth, 1328 Clinton Ave., Irvington 11, New Jersey 1949
*Breckenridge, Walter J(ohn), Museum of Natural History, University of Minnesota, Minneapolis 14, Minnesota 1929
Breiding, George H(erbert), Naturalist, Oglebay Institute, Wheeling, W.Va. .. 1942
Brewer, Richard Dean, Dept. of Zoology, Vivarium Bldg., University of Illinois, Champaign, Illinois 1949
Brigham, Edward M(orris), Jr., Kingman Memorial Museum, Battle Creek, Michigan 1931
Brigham, Edward M(orris), III, Route 5, Box 19, Battle Creek, Michigan 1950
Brinckerhof, Remsen, 156 Sherwood Place, Englewood, New Jersey 1953
Bristow, Harry Sherman, Jr., 210 Washington Ave., Cedars-Wilmington, Dela. 1942
Broadbooks, Harold E(ugene), 1525 E. 3rd, Hermiston, Oregon 1948
Brockschlager, Mary Elizabeth, 518 E. Fourth St., Cincinnati 2, Ohio 1948
Brodkorb, Pierce, Dept. of Biology, University of Florida, Gainesville, Florida 1951
*Brody, Dr. Gerald L(ee), University Hospital, Ann Arbor, Michigan 1954
Broley, Charles L(avelle), Delta, Ontario, Canada 1946
**Brooks, Maurice Graham, Division of Forestry, Morgantown, West Virginia .. 1927
Broun, Maurice, Route 2, Kempton, Pennsylvania 1935
Brown, Clarence D., 222 Valley Rd., Montclair, New Jersey 1938
Brown, E(lmer) E(vans), Davidson College, Davidson, North Carolina 1945
Brown, Jerram L., Museum of Vert. Zool., Life Science Bldg., Berkeley 4, Calif. 1950
Brown, N(orman) Rae, Faculty of Forestry, University of New Brunswick, Fredericton, New Brunswick, Canada 1945
Brown, Woodward H(art), 4815 Ingersoll Ave., Des Moines 12, Iowa 1949
Browning, Helen G., 206 W. Oak St., Louisville 3, Kentucky 1952
Bruce, James A(ddison), 565 E. Spring St., Wooster, Ohio 1952
*Brueggemann, Anna L(ouise), 584 Sheridan Ave., Columbus 9, Ohio 1943
**Bruns, James Henry, 1820 Jefferson Ave., New Orleans, Louisiana 1941
Bryan, Dr. Burton Donald, 162 French St., Fall River, Massachusetts 1949
*Bryens, Oscar McKinley, 231 S. Main St., Three Rivers, St. Joseph County, Michigan 1924
Buchanan, Forest Wendell, Amsterdam, Ohio 1939
Buchheister, Carl W., 1130 Fifth Ave., New York 28, New York 1943
Buckland, George H(enry) E(dward), Box 343, Route 1, Batavia, New York 1949
**Bucknell, Donald N(eedham), 134 Wonham, Ingersoll, Ontario, Canada 1953
Buckstaff, Ralph Noyes, 1039 N. Main St., Oshkosh, Wisconsin 1941
Bull, John L., Jr., 1148 Virginia St., Far Rockaway, New York 1952
Bunnell, John R., 1920 Baltimore Ave., Cincinnati 25, Ohio 1953
Bures, Joseph August, 148 N. 3rd St., West Newton, Pennsylvania 1946
Burland, Lee J(ohnson), Snook Apartments, Castleton-on-Hudson, New York 1939
Burlingame, Mrs. Virginia S(truble), 812 S. 8th St., Bozeman, Montana 1946

Burner, Florence H(elen), 5350 Reisterstown Rd., Baltimore 15, Maryland 1948
Burnham, Gladys L(ou), Dept. of Biology, Clarendon Junior College, Clarendon, Texas 1954
Burns, Robert David, Dept. of Zoology, Michigan State University, East Lansing, Michigan 1948
Burr, Irving W(ingate), 1141 Glenway, West Lafayette, Indiana 1945
Burr, Margaret, 943 Summit Ave., St. Paul 5, Minnesota 1952
Burt, William Henry, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1928
Burton, Donald E(rnest), 171 Strathearn Rd., Toronto 10, Ontario, Canada 1953
Burtt, Benjamin P., 109 Haffenden Rd., Syracuse 10, New York 1956
Burtt, Harold E., 2163 N. Starr Ave., Columbus 12, Ohio 1953
Bushman, John, University of Utah, Dugway, Utah 1951
Butchart, Mrs. G. Reeves, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1943
Butler, Thomas S., 10302 Knob Oak Dr., Houston 24, Texas 1956
Butsch, Robert Stearns, University Museum, University of Michigan, Ann Arbor, Michigan 1947
*Brydon, N(orman) F., Essex Rd., Essex Falls, New Jersey 1955
Byers, Mrs. George W(illiam), 2905 San Rafael, Tampa, Florida 1951
Bytzko, Anne, 13563 Arlington, Detroit 12, Michigan 1948
Cade, Tom, 526 Gayley, Los Angeles 24, California 1950
Cagle, Fred R., Dept. of Zoology, Universtiy of Tulane, New Orleans 15, Louisiana 1942
Cahalane, Victor H(arrison), 80 Fernbank Ave., Delmar, New York 1933
Calef, Robert, 734 East University, Ann Arbor, Michigan 1954
Calvert, Earl Wellington, R.R. #2, County Home, Lindsay, Ontario, Canada 1937
Calvin, Robert L(eal), MTD #11, New Castle, Pennsylvania 1951
Campbell, Louis W(alker), 4531 Walker Ave., Toledo 12, Oho 1926
Campbell, Mildred F(lorence), 29 N. Hawthorne Lane, Indianapolis 19, Indiana 1938
Canfield, Mrs. Donald T(rent), 903 Fifth St., West Lafayette, Indiana 1952
Carl, Harry G., 2304 Davie St., Davenport, Iowa 1949
Carmony, D(onald) Duane, Room 837, International House, University of California, Berkeley 4, California 1953
**Carnes, Mrs. Herbert E., 25 Kenwood Rd., Tenafly, New Jersey 1944
Carpenter, Charles C., Dept. of Zoology, University of Oklahoma, Norman, Oklahoma 1951
Carpenter, Floyd S., 2402 Longest Ave., Louisville 4, Kentucky 1934
Carroll, Col. Robert P., 213 Maiden Lane, Lexington, Virginia 1942
**Carrothers, Vera, 14704 Alder Ave., East Cleveland 12, Ohio 1938
Carson, L(enwood) B(allard), 1306 Lincoln St., Topeka, Kansas 1948
Carter, Dennis L(ee), Dept. of Zoology, Science Hall, Iowa State College, Ames, Iowa 1947
Carter, Mrs. E. W., Route 2, Perrysburg, Ohio 1946
*Cartwright, Bertram William, c/o Ducks Unlimited (Canada), 201 Bank of Commerce Bldg., Winnipeg, Manitoba, Canada 1930
Cassel, J(oseph) Frank(lin), Dept. of Zoology, North Dakota Agricultural College, Fargo, North Dakota 1940
Cater, Milan B(rison), P.O. Box 15, Clifton Forge, Virginia 1944
**Chalif, Edward Louis, 37 Barnsdale Rd., Short Hills, New Jersey 1947
*Chambers, W(illie) Lee, R.R. #1, Box 294, Topanga, California 1909
Chapelle, Major Francis O(berlin), MSC, U.S. Army Hospital, West Point, New York 1954
Chapin, James P(aul), c/o IRSAC, Bukavu, (dip-spic) Belgian Congo 1945
Chapin, John L(ander), Physiology Dept., University of Colorado, Medical School, Denver 7, Colorado 1947
Chapman, Blanche Hammond, 1325 S. 19th St., Birmingham, Alabama 1953
Chapman, Floyd B(arton), 392 Walhalla Rd., Columbus 2, Ohio 1932
*Chapman, Herman Floraine, 712 South Dakota Ave., Sioux Falls, South Dakota 1947

Chapman, Lawrence B., R.F.D., Hubbardston, Massachusetts 1940
Chariot, George E., Jr., 1069 W. Prairie, Decatur, Illinois 1956
Chase, Henry B., Jr., 517 Decatur St., New Orleans 16, Louisiana 1932
*Chell, Thomas Ross, 1220 Beck Lane, Lafayette, Indiana 1952
Choate, Ernest A., 411 Rodman Ave., Jenkintown, Pennsylvania 1954
Chutter, Mildred C., Box 229, Athens, Ohio 1936
Clark, Mrs. Ben P., 948 Forrest Ave., Gadsden, Alabama 1952
Clark, George A(lfred), Jr., 1 West Campus, Easton, Pennsylvania 1955
**Clarkson, Mrs. Edwin O., Wing Haven, 248 Ridgewood Ave., Charlotte 7, North Carolina 1940
Clay, William M(arion), Dept. of Biology, University of Louisville, Louisville 8, Kentucky 1947
Clement, Roland C(harles), 26 Brookfield Rd., Riverside 15, Rhode Island 1941
**Clements, H(iram) Everest, 49 Stoneham Rd., Rochester 10, New York 1949
*Clow, Marion, Box 163, Lake Forest, Illinois 1929
Cobb, Broughton, 25 East End Ave., New York, N.Y. 1949
Coffey, Ben Barry, Jr., 672 N. Belvedere, Memphis 7, Tennessee 1927
Coffey, Lula C(ooper), 672 N. Belvedere, Memphis 7, Tennessee 1952
Coggeshall, Robert D., Billington Rd., East Aurora, New York 1956
Coghill, Dr. Robert D., 503 Simpson Ave., Lake Bluff, Illinois 1951
Cogswell, Howard L(yman), Dept. of Biological Sciences, Mills College, Oakland 13, California 1944
**Cole, Richard D., 615 Lake Dr., Towson 4, Maryland 1949
Cole, Mrs. Richard D., 625 Valley Lane, Towson 4, Maryland 1955
*Cole, Mrs. Whiteford R., Jr., 1746 Sulgrave Rd., Louisville 5, Kentucky 1956
Collias, Nicholas E(lias), 181 Clinton Ave., Tiffin 10, Ohio 1945
Collier, Gerald, 3634 N. Muscatel Ave., Rosemead, California 1956
Collins, Henry H., 136 Parkview Ave., Bronxville 8, New York 1952
Colwell, Mrs. Ruth C., 3825 E. Highland Dr., Seattle, Washington 1956
Coman, Dr. D(ale) R(ex), 4625 Osage Ave., Philadelphia 43, Pennsylvania 1954
Comfort, James F., 27 N. Iola Dr., Webster Groves 19, Missouri 1947
Compton, Lawrence Verlyn, Biological Division, Soil Conservation Service, Washington 25, D.C. 1923
**Conboy, Mrs. John William, 417 Studebaker St., Mishawaka, Indiana 1954
Congdon, Dr. R(ussell) T(hompson), Medical Arts Bldg., Wenatchee, Wash. 1944
Conkey, John H., 11 Chestnut St., Ware, Massachusetts 1947
Conn, Robert Carland, 755 Ross Lane, Bound Brook, New Jersey 1945
Conrad, Charles L(ouis), 137 N. 11th St., Wheeling, West Virginia 1937
Cook, Fannye A(dine), Apt. 4 B, 827 N. State St.; Jackson, Mississippi 1923
Cook, W. Lawrence, 3757 Nottingham, Houston 5, Texas 1955
Coombes, Robert Armitage Hamilton, The Zoological Museum, Tring, Hertfordshire, England 1936
Cope, James B(onwill), Earlham College, Richmond, Indiana 1949
Cors, Paul B(eaumont), 722 Woodside Ave., Ripon, Wisconsin 1952
*Cottam, Clarence, Welder Wildlife Foundation, P.O. Box 1104, Sinton, Texas 1929
Cottrell, George William, Jr., 70 Lake View Ave., Cambridge 38, Massachusetts 1941
Cottrille, Dr. W(illiam) Powell, 6075 Brown's Lake, Jackson, Michigan 1949
Cottrille, Mrs. W. Powell, 6075 Brown's Lake, Jackson, Michigan 1950
Cox, George W., Vivarium Bldg., Wright & Healey Sts., Champaign, Illinois 1954
Coy, Roy E., St. Joseph Museum, St. Joseph, Missouri 1953
*Crawford, Alan, Jr., White Horse Rd., Devon, Pennsylvania 1949
*Creager, Joe C(lyde), L. A. Cann Rd., Drawer 1267, Ponca City, Oklahoma 1947
Crichton, Vincent, Chapleau, Ontario, Canada 1948
Crockett, David B., 3933 Kirkland Court, Route 3, Pontiac, Michigan 1955
Croft, Joseph E., 2366 Gladstone Ave., Louisville 5, Kentucky 1956
Crone, Anne B., 74 Village Hill Rd., Belmont 78, Massachusetts 1955
Crowell, John B., Jr., 201 A Holden Green, Cambridge 38, Massachusetts 1952
Crowley, Larry, 1212 Cascade, Boulder, Colorado 1955
Cruickshank, Allan Dudley, R.D. # 1, Box 1590, Rockledge, Florida 1939

Cullen, Peter, 5115 Graceland, Indianapolis 8, Indiana 1956
Cumming, Fairman Preston, 824 Sutton Hill Rd., Nashville 4, Tennessee 1950
Cummings, G(eorge) Clark, 61 Broadway, New York 6, New York 1952
Cunningham, James W., 3009 E. 19th Terrace, Kansas City, Missouri 1935
Cunningham, Nance C., 702 Marshall, Houston 6, Texas 1950
Cunningham, Richard L(ynn), 21 S. 56th St., Belleville, Illinois 1953
Curtis, Mrs. Vee K(aelin), 2412 Cohasset Rd., Chico, California 1950
Cuthbert, Nicholas L., Biology Dept., Central Michigan College, Mt. Pleasant, Michigan 1950
*D'Angelo, Angelo R(alph), 809 Palisade Ave., Union City, New Jersey 1949
Dalglish, K. Campbell, 1156 Bay St., Toronto 5, Ontario, Canada 1953
*Dallas, Ltjg. Donald E., Jr., BTU-IN, NAAS Whiting Field, Florida 1953
Dana, Edward Fox, 57 Exchange St., Portland 3, Maine 1939
Darby, Richard T(horn), Prospect St., Sherborn, Massachusetts 1948
*Darden, Mrs. Colgate W(hitehead), Jr., University of Virginia, Charlottesville, Virginia 1943
*Dater, Eleanor E., 259 Grove St., Ramsey, New Jersey 1949
Davant, Mary, 861 N. McLean Blvd., Memphis 7, Tennessee 1952
Davey, Dr. Winthrop N(ewbury), University Hospital, Ann Arbor, Michigan 1941
Davidson, Mrs. W. F., 332 Summit Avenue, St. Paul 2, Minnesota 1953
Davidson, William Mark, 1504 Bodell St., Orlando, Florida 1933
Davis, Clifford Vernon, Dept. of Zoology & Entomology, Montana State College, Bozeman, Montana 1945
Davis, David E(dward), School of Hygiene and Public Health, Johns Hopkins University, Baltimore 5, Maryland 1940
Davis, Howard Henry, Esq., Little Stoke, Patchway, Bristol, England 1947
Davis, John, Hastings Natural History Reservation, Carmel Valley, California 1939
Davis, L(ouie) Irby, Box 988, Harlingen, Texas 1933
Davis, Paul A(nthony), 829 Grant St., Gary, Indiana 1953
Davis, Russell S., Clayton, Illinois 1947
Davis, Wayne Harry, Museum of Natural History, University of Illinois, Urbana, Illinois 1953
Davis, W(illiam) B., Dept. of Wildlife Management, College Station, Texas 1938
Davis, Dr. William Franklin, St. Lukes Hospital, 11311 Shaker Blvd., Cleveland 4, Ohio 1947
Davis, W. Marvin, Faculty Exchange, University of Oklahoma, Norman, Okla. 1956
Dawn, Walter H(enry), Bulls Island, Awendaw, South Carolina 1945
Dear, Lieut. Col. L(ionel) S(extus), P.O. Box 146, Port Arthur, Ontario, Canada 1939
Dechen, Mrs. Lillian Orvetta, 14 Summer St., Port Dickinson, Binghamton 6, New York 1939
Decker, James H., 1101 Finkbine Park, Iowa City, Iowa 1951
Deevey, Edward S(mith), Jr., Osborn Zoological Laboratory, Yale University, New Haven 11, Connecticut 1948
DeGarmo, William Russell, Kents Hill, Maine 1946
DeGroot, Dudley Sargent, Athletic Branch, S.A.D., USAREUR, APO 245, c/o Postmaster, New York, New York 1948
Dehner, Rev. Eugene W(illiam), St. Benedict's College, Atchison, Kansas 1944
Deininger, Leo A., 2583 E. 130th St., Shaker Heights 20, Ohio 1956
**Delacour, Jean Theodore, Los Angeles County Museum, Exposition Park, Los Angeles 7, California 1944
Denham, Reginald F(rancis), 100 Central Park, South, New York 19, New York 1948
Denton, J(ames) Fred, 1510 Pendleton Rd., Augusta, Georgia 1935
**Desmond, Hon. Thomas C(harles), Box 670, Newburgh, New York 1942
*De Schauensee, Rodolphe Meyer, Devon, Pennsylvania 1945
Devitt, Otto Edmund, Box 916, Richmond Hill, Ontario, Canada 1935
Devlin, Joseph M(ark), 218 S. 43rd St., Philadelphia 4, Pennsylvania 1953
*Dick, John Henry, Dixie Plantation, Meggett, South Carolina 1949
Dickerman, Robert W(illiam), University of Minnesota, Minneapolis, Minn. 1955

*Dickerson, Mrs. Stanley S., 222 DeVoe Ave., Spotswood, New Jersey 1956
Dickinson, J(oshua) C(lifton), Jr., Dept. of Biology, University of Florida, Gainesville, Florida 1939
Dickinson, Mrs. William Winston, 2006 Reid Ave., Bluefield, West Virginia 1942
Dingle, Edward von Siebold, Huger, South Carolina 1921
Disler, Walter C(larence), R.F.D. No. 1, LaGrange, Ohio 1954
Dittemore, Lester P., 1207 Byron Ave., Topeka, Kansas 1950
Dixon, J(ames) B(enjamin), R.D. 3, Box 1343, Escondido, California 1936
Dixon, Keith L(ee), Dept. of Wildlife Management, A&M College of Texas, College Station, Texas 1946
Doan, Mrs. Blanche Evans, Apt. 13, 1228 S. 29th St., Birmingham 5, Alabama 1947
*Doering, Hubert R., 242 East Walton Place, Chicago 11, Illinois 1945
Dogger, James R., Box 5215, State College Station, Raleigh, North Carolina 1954
Domm, Lincoln V(alentine), Dept. of Anatomy, Stritch School of Medicine, Loyola University, 706 S. Wolcott Ave., Chicago 12, Illinois 1936
Donald, Mary F(rances), 6918 Belmont Lane, Milwaukee 11, Wisconsin 1951
Donegan, Marie, 920 E. Ann St., Ann Arbor, Michigan 1953
Dorney, Robert Starbird, Box 191, Ladysmith, Wisconsin 1949
Dorsey, George A., Darlington School, Rome, Georgia 1956
*Douglass, Donald W., Game Division, Michigan Dept. of Conservation, Lansing 26, Michigan 1929
Dowling, Paul Bruce, A. A. Busch Wildlife Area, Weldon Springs, Missouri 1950
Down, Edward H., 28 Lynton Mead, Totteridge, London N 20, England 1956
Dressel, Evan C., Western Reserve Rd., R.D. # 1, Poland, Ohio 1956
*Dresser, Mrs. James, Jr., 9620 Von Thaden St., Wichita, Kansas 1951
*Drinkwater, Howard F(rank), Old Road, Whitehouse, New Jersey 1954
Drum, Margaret, 217 South St., Owatonna, Minnesota 1937
Drury, William H(olland), Jr., Drumlin Farm, South Lincoln, Massachusetts 1951
Duffield, Mrs. John W., 1472 Eskridge Way, Olympia, Washington 1948
*Duffy, J(ohn) J(oseph), Jr., 7219 Richwood, Little Rock, Arkansas 1950
**Dugan, Dr. William Dunbar, 221 Pierce Ave., Hamburg, New York 1945
DuMont, Philip A(tkinson), 4114 Fessenden St., N.W., Washington 16, D.C. 1928
Dunbar, Robert J(ohn), 106 Glendale Lane, Oak Ridge, Tennessee 1952
Duncan, Robert, 1151 Fulton Ave., San Antonio 1, Texas 1956
Dundas, Lester Harvey, Rice Lake Wildlife Refuge, McGregor, Minnesota 1943
Dunn, Lawrence E., R.F.D., Gate, Oklahoma 1956
Dunning, John Stewart, Granby, Connecticut 1951
Dunstan, Girvin Raleigh, 5030 Huron River Dr., Route 1, Dexter, Michigan 1950
DuPré, William A., Box 1202, Rome, Georgia 1956
Durango, Sigfrid, Taby, Sweden 1952
Dushkoff, Mrs. H(allie) W(egel), 3074 Dale Ave., Columbus 9, Ohio 1953
Dusi, Julian L(uigi), Dept. of Zoology & Entomology, Alabama Polytechnic Institute, Auburn, Alabama 1941
Dyer, William A., 402 John St., Union City, Michigan 1947
Dzubin, Alex, 317 Field Husbandry Bldg., University of Saskatchewan, Saskatoon, Saskatchewan, Canada 1956
**Eastman, Whitney H(askins), 4450 West Lake Harriet Blvd. (10), Minneapolis 5, Minnesota 1941
Eaton, Stephen W(oodman), Dept. of Biological Sciences, St. Bonaventure University, St. Bonaventure, New York 1942
Eckelberry, Don R(ichard), 4 Foster Lane, Babylon, L. I., New York 1948
Eddy, Garrett, 4515 Ruffner St., Seattle 99, Washington 1947
**Edeburn, Ralph M(ilton), Dept. of Zoology, Marshall College, Huntington 1, West Virginia 1947
Edge, Mrs. Charles N(oel), 1215 Fifth Ave., New York 29, New York 1931
Edwards, Ernest P(reston), Box 611, Amherst, Virginia 1947
*Edwards, James L., 27 Stanford Place, Montclair, New Jersey 1947
*Edwards, Dr. K(enneth) F(rederick), 169 Hillendale Ave., Kingston, Ontario, Canada 1953

**Edwards, Robert L(omas), 46 Lincoln Ave., Waltham, Massachusetts ... 1945
Edwards, R(oger) York, Wildlife Sect. Parks & Recreation, Division B. C. Forestry Service, Victoria, British Columbia, Canada ... 1948
Egerton, Frank N(icholas) III, 1511 Caswell Place, Durham, North Carolina 1952
Eichler, Herbert Philip, Colonel Greene Rd., Yorktown Heights, New York 1949
Eiseman, Ralph M(ilton), 7928 Colfax Ave., Chicago 17, Illinois ... 1955
**Eisenmann, Eugene, 300 Park Ave., New York 22, New York ... 1942
Ekblaw, Dr. George Elbert, 511 W. Main St., Urbana, Illinois ... 1914
Ekdahl, Conrad H(oward), Box 1246, Daytona Beach, Florida ... 1949
*Eklund, Carl M(ilton), Rocky Mountain Laboratory, Hamilton, Montana ... 1945
Elder, William H(anna), Wildlife Conservation Bldg., University of Missouri, Columbia, Missouri ... 1938
Elkins, Mrs. Hervey B., 303 Mill St., Belmont, Massachusetts ... 1951
Ellarson, Robert S(cott), 424 University Farm Place, Madison 5, Wisconsin 1948
Elliott, Richard M., 1564 Vincent St., St. Paul 8, Minnesota ... 1940
Ely, Charles A., Dept. of Zoology, University of Oklahoma, Norman, Oklahoma 1956
Emerson, David L(owell), 155 Burt St., Taunton, Massachusetts ... 1939
**Emerson, Guy, 16 East 11th St., New York 3, New York ... 1938
Emerson, William S(tevenson), c/o American Potash & Chemical Co., 201 W. Washington Blvd., Whittier, California ... 1953
*Emilio, S(hepard) Gilbert, Route 4, Laconia, New Hampshire ... 1929
*Emlen, John Thompson, Jr., Dept. of Zoology, University of Wisconsin, Madison 6, Wisconsin ... 1936
English, P. F., Agricultural Education Bldg., University Park, Pennsylvania ... 1934
Ennis, J(ames) Harold, Cornell College, Mt. Vernon, Iowa ... 1942
Ephraim, William A., 530 Riverdale Ave., Yonkers, New York ... 1952
Erickson, Elsie C., Box 114, Allport, Pennsylvania ... 1951
Erickson, John G(erhard), 2515 Thomas Ave., S., Minneapolis 5, Minnesota ... 1949
Erickson, Mary M(arilla), Santa Barbara College, University of California, Goleta, California ... 1930
Ernst, Mrs. Roger, 170 Sargent Rd., Brookline, Massachusetts ... 1951
Errington, Paul L(ester), Iowa State College, Ames, Iowa ... 1932
Eschelman, Dr. Karl F(erdinand), 8 North Dr., Buffalo 16, New York ... 1951
Esten, E(milia) Virginia, 4340 North Illinois St., Indianapolis 8, Indiana ... 1954
Evans, Monica A(nn), Trowbridge House, Kalamazoo College, Kalamazoo, Michigan ... 1955
Evans, Mrs. Richard B., Mount Royal Manor, Apt. 608, Duluth, Minnesota ... 1956
Evenden, Fred G(eorge), Jr., 1336 Fitch Way, Sacramento 21, California ... 1948
Everett, Constance Antoinette, 206 Ninth St., N.E., Waseca, Minnesota ... 1948
Eyer, Lester E., 515 College St., Alma, Michigan ... 1954
Eynon, Alfred E., 424 University Farm Place, Madison 5, Wisconsin ... 1947
Eyster, Marshall Blackwell, Dept. of Biology, Box 545, Southwestern Louisiana Institute, Lafayette, Louisiana ... 1947
Fales, John H(ouse), 1917 Elkhart St., Silver Springs, Maryland ... 1939
Falls, J. Bruce, 14 Tottenham Rd., Don Mills, Ontario, Canada ... 1948
*Fargo, William G(ilbert), 506 Union St., Jackson, Michigan ... 1923
*Farmer, Earl Wilson, 611 N. 4th St., Steubenville, Ohio ... 1946
Farrand, H. F., 7 Guest Lane, Wilmington 3, Delaware ... 1950
*Fawks, Elton, Box 112, Route 1, East Moline, Illinois ... 1951
Fedore, Robert Ruyan, 3650 Roosevelt Rd., Jackson, Michigan ... 1949
Feenaty, L(eland) N(ewman), 510 N. Meridian St., Apt. 101, Indianapolis 4, Indiana ... 1953
Feighner, Lena Veta, 105 Rowland, Kansas City, Kansas ... 1935
**Feigley, Margaret D(enny), 544 Chestnut St., Winnetka, Illinois ... 1944
Feinberg, Ezra J(ohn), 60 E. 42nd St., New York 17, New York ... 1955
Fennell, Chester M(artin), 19239 Coffinberry Blvd., Fairview Park 26, Ohio 1949
Fichter, Edson Harvey, 256 S. 11th Ave., Pocatello, Idaho ... 1948
Fillebrown, T(homas) S(cott), P.O. Box 27, Woodstock, Vermont ... 1951

Findley, James S(mith), Dept. of Biology, University of New Mexico, Albuquerque, New Mexico 1953
Findley, J(ohn) Scott, 1201 S. Center Ave., Sioux Falls, South Dakota 1949
Fischer, Richard B(ernard), Stone Hall, Cornell University, Ithaca, New York 1942
Fish, William Ralph, 608-A Kearsarge Ave., China Lake, California 1950
Fisher, Harvey I(rvin), Dept. of Zoology, Southern Illinois University, Carbondale, Illinois 1949
Fisler, George F., Dept. of Zoology, University of California, Berkeley 4, Calif. 1954
Fleming, Richard C., Route 1, Bangor, Michigan 1956
Fleugel, James Bush, 1104 American National Bank Bldg., Kalamazoo, Mich. 1942
*Flexner, Dr. John Morris, Dept. of Medicine, Grace New Haven Community Hospital, New Haven, Connecticut 1948
Flinton, Laurel, Jr., 1288 Lloyd George Ave., Crawford Park, Verdun, Quebec, Canada 1952
Foote, Maurice E(dwin), 269 Lawrence St., Ravenna, Ohio 1932
Fordham, Stephen Crane, Jr., Delmar Game Farm, Delmar, New York 1948
Foster, J(ohn) Bristol, 136 Dawlish Ave., Toronto 12, Ontario, Canada 1950
*Foster, John H(awley), P.O. Box 204, Wayne, Pennsylvania 1952
*Foster, Thomas Henry, West Road, Bennington, Vermont 1950
Fox, Adrian C., Box 521, Benjamin Franklin Square, Washington 4, D.C. 1937
Fox, Elmer L., 1053 Gladmer Place, Regina, Saskatchewan, Canada 1956
Fox, Robert P., 311 Beale St., Wollaston 70, Massachusetts 1953
Francis, George R(eid), 382 Hillsdale Ave., E., Toronto 12, Ontario, Canada 1949
Franz, David R., 5237 Castor Ave., Philadelphia 24, Pennsylvania 1956
Frazier, F(rancis) P(earsall), 424 Highland Ave., Upper Montclair, New Jersey 1953
Fredrickson, Richard William, Apt. 6-D, Sunnyside, Lawrence, Kansas 1947
*Fries, Waldemar Hans, Little Compton, Rhode Island 1947
Frost, Herbert Hamilton, Ricks College, Rexburg, Idaho 1947
Frye, O. Earle, Jr., Game & Fresh Water Fish Commission, Tallahassee, Florida 1940
Fulhage, Irma, Oklahoma Baptist University, Shawnee, Oklahoma 1954
Fuller, A(nne) Verne, Western Michigan College of Education, Kalamazoo, Michigan 1952
Fulton, Terry T., Palmyro, Wisconsin 1956
Furman, Dr. Robert H(oward), 624 N.E. 18th, Oklahoma City 16, Oklahoma 1955
Futcher, J(ohn) S(tanley), 1011-14th Ave., N., Minneapolis 11, Minnesota 1951
*Gabrielson, Ira N(oel), R.D. #1, Box 349, Oakton, Virginia 1913
Gaede, Adela, 3903 E. 176th St., Cleveland 28, Ohio 1951
Galati, Robert, Biological Station, Lake Itasca, Minnesota 1955
Gale, Larry R(ichard), 262 Harrod Ave., Frankfort, Kentucky 1948
Galley, John E(dmond), 1610 W. Holloway Ave., Midland, Texas 1945
**Gammell, Dr. R(obert) T(heodore), Kenmare, North Dakota 1943
**Ganier, Albert F(ranklin), 2112 Woodlawn Dr., Nashville 5, Tennessee 1915
Gardner, Kenneth V., 329 Walnut St., Indiana, Pennsylvania 1952
Garlick, Gordon Mark, R.R. #1, Box 408, Lake Orion, Michigan 1951
Garrett, Mary Lois, 1709 Chestnut St., Kenova, West Virginia 1942
Garrison, David L(loyd), Old Lexington Rd., Lincoln, Massachusetts 1940
Garrity, Devin A(dair), 682 Forest Ave., Rye, New York 1949
Gasche, Mrs. Arthur L., 1297 N.E. 103 St., Miami Shores 38, Florida 1956
Gashwiler, Jay S., U.S. Fish & Wildlife Service, Third Floor, Snell Hall, Oregon State College, Corvallis, Oregon 1944
Gates, Doris B(erta), Nebraska State Teachers College, Chadron, Nebraska 1948
Geale, Beverley B., 109 Glenview Ave., Toronto, Ontario, Canada 1956
Gensch, Robert Henry, 105 Clark Ave., Billings, Montana 1939
George, John L(othar), Division of Conservation, Vassar College, Poughkeepsie, New York 1939
Gerstell, Richard, 355 North West End Ave., Lancaster, Pennsylvania 1939
Gibson, George G(ordon), 62 Davisville Ave., Toronto 7, Ontario, Canada 1949
Gier, Herschel T(homas), Dept. of Zoology, Kansas State College, Manhattan, Kansas 1937

*Gifford, Dr. Harold, 3636 Burt, Omaha 3, Nebraska 1936
Gilbert, Kathryn Helen, 714 - 1st Ave., W., Grand Rapids, Minnesota 1945
Gill, Geoffrey, 24 Overlook Dr., Huntington, L. I., New York 1950
*Gilliard, Ernest Thomas, American Museum of Natural History, Central Park, W., at 79th St., New York 24, New York 1949
Gilmore, William A. T., 49 St. James Place, Hamilton, Ontario, Canada 1956
Gilreath, M. Ruth, R.R. #1, Travelers Rest, South Carolina 1952
Glick, Bruce, Box 185, State College, Mississippi 1949
Glore, W(alter) S(cott), Jr., 350 Maple Ave., Danville, Kentucky 1947
Glover, Fred A(rthur), 2211 Holmes Run Drive, Falls Church, Virginia 1947
Gluck, S. Norris, 305 Beauregard St., Charleston, West Virginia 1955
Goebel, Herman J(ohn), 7852 - 80th St., Brooklyn 27, New York 1946
*Goelet, Robert G., 546 Fifth Ave., New York 36, New York 1953
**Goetz, Christian John, 3503 Middleton Ave., Cincinnati 20, Ohio 1930
Good, Ernest E(ugene), Dept. of Zoology & Entomology, Ohio State University, Columbus 10, Ohio 1937
Goodman, John David, Biology Dept., University of Redlands, Redlands, Calif. 1944
Goodpasture, Mrs. Ernest W., 9716 Elrod Rd., Kensington, Maryland 1950
Goodwin, Clive Edmund, 38 Walsh Ave., Weston, Ontario, Canada 1952
Goodwin, Margaret S(hippen), 38 Oakbourne Rd., West Chester, Pennsylvania 1953
Gorham, Dean B., 407 N. Main St., Decatur, Illinois 1953
Goslin, Charles R(ussell), 726 E. King St., Lancaster, Ohio 1940
*Graber, Richard R., 205 N. Denver, El Dorado, Kansas 1949
Grace, Mrs. Charles J., Hilton Rd., Slingerlands, New York 1953
Grant, Cleveland P(utnam), 245 Davis St., Mineral Point, Wisconsin 1928
Grayce, Robert L., 141 Main St., Rockport, Massachusetts 1946
Graves, Mrs. Kenneth D., 2505 Cornwallis Ave., Roanoke, Virginia 1956
**Greeley, Fred(erick), Illinois Natural History Survey, Urbana, Illinois 1942
Green, Mrs. Charlotte Hilton, 3320 White Oak Rd., Raleigh, North Carolina 1952
Green, N(orman) Bayard, Zoology Dept., Marshall College, Huntington, W. Va. 1943
Greenhalgh, Clifton M., P.O. Box 326, Murray, Utah 1939
Greenwalt, Leon, 911 S. Seventh St., Goshen, Indiana 1953
Greer, Theodore R., Joy, Illinois 1956
Gregory, Robert S., Route 1, Morrisville, Indiana 1956
Gregory, Stephen S(trong), Box N, Winnetka, Illinois 1922
Grewe, Al(fred) H., Dept. of Zoology, University of Minnesota, Minneapolis, Minnesota 1953
Griffee, W(illet) E., 510 Yeon Bldg., Portland 4, Oregon 1947
Griffin, Larry, Box 3850, Virginia Tech. Station, Blacksburg, Virginia 1956
Griffin, William W(elcome), 3232 Pine Ridge Rd., NE, Atlanta, Georgia 1946
*Grimes, S(amuel) A(ndrew), 4627 Peachtree Circle, E., Jacksonville 7, Florida 1924
Grimm, William C(arey), Blueberry Park, Route 3, Greenville, South Carolina 1939
**Grinnell, Lawrence I(rving), 710 Triphammer Rd., Ithaca, New York 1939
**Griscom, Ludlow, Museum of Comparative Zoology, Cambridge 38, Mass. 1937
Groesbeck, William M(aynard), 376 Seneca Rd., Hornell, New York 1947
*Groskin, Horace, 210 Glenn Rd., Ardmore, Pennsylvania 1937
Gross, Alfred Otto, 11 Boody St., Brunswick, Maine 1927
Grow, Raymond J., 513 W. Fifth Ave., Apt. 7, Gary, Indiana 1951
Grube, G(eorge) E(dward), 132 Park St., Elizabethtown, Pennsylvania 1948
Gruenewald, Robert Franklin, Clifton, Illinois 1948
Guhl, A(lphaeus) M(atthew), Dept. of Zoology, Kansas State College, Manhattan, Kansas 1948
Guillaudu, Robert L., 3759 Keller Ave., Alexandria, Virginia 1956
Gullion, Gordon W(right), Box 291, Austin, Nevada 1947
Gumbart, William B., P.O. Box 1936, New Haven 9, Connecticut 1952
Gunderson, Harvey Lorraine, Museum of Natural History, University of Minnesota, Minneapolis 14, Minnesota 1941
Gundy, Samuel C(harles), 409 Harvard Blvd., Lincoln Park, West Lawn, Penn. 1950

*Gunn, W(illiam) W(alker) H(amilton), 178 Glenview Ave., Toronto 12, Ontario, Canada ... 1945
Gunther, Dr. Klaus, Berlin Lankwitz, Wasunger Weg 14, Germany ... 1952
Guy, Mrs. Mary M(yrberg), R.R. #1, Lafayette, Indiana ... 1953
Hadeler, Catherine W(ilma), 116 Dell Park Ave., Dayton 9, Ohio ... 1945
Haga, R(yoichi), West 25, Odori, Sapporo-Shi, Hokkaido, Japan ... 1953
Hagan, Mrs. Mable L(ucille), 2540 E. 16th St., Tulsa 4, Oklahoma ... 1955
*Hagar, Mrs. Jack, Box 508, Rockport, Texas ... 1930
*Hagar, Joseph A., Pleasant St., Marshfield Hills, Massachusetts ... 1949
Hague, Florence S., Sweet Briar College, Sweet Briar, Virginia ... 1931
Hailman, Jack P., 4401 Gladwyne Drive, Bethseda 14, Maryland ... 1956
Haines, Bertram W., 4630 Manordene Rd., Apt. D, Baltimore 29, Maryland ... 1952
Haines, Robert L(ee), 54 E. Main St., Moorestown, New Jersey ... 1947
Haines, T. P., 1395 Adams St., Apt. E, Macon, Georgia ... 1941
Halberg, Mrs. Henry N., 136 Arborway, Jamaica Plain 30, Massachusetts ... 1953
*Hall, Fred T., Buffalo Museum of Science, Humboldt Park, Buffalo 11, N. Y. 1937
*Hall, George A(rthur), Jr., Dept. of Chemistry, West Virginia University, Morgantown, West Virginia ... 1946
Hall, Mrs. Gladys A(reta), 912 Douglas Ave., Kalamazoo 52, Michigan ... 1947
Halladay, Ian R(ussel), 218 Belsize Dr., Toronto 12, Ontario, Canada ... 1948
**Haller, Karl W., AO-864839 (Box 488), 3083d Avn Dep Gp FAFS, Fairfield, California ... 1934
Hallman, Roy Cline, P.O. Box 37, St. Andrew Station, Panama City, Florida 1928
*Hamann, Carl F(erdinand), Maple Lane, Aurora, Ohio ... 1947
Hamerstrom, Mrs. Frances, Plainfield, Wisconsin ... 1948
Hamerstrom, Frederick N., Jr., Plainfield, Wisconsin ... 1934
*Hamilton, Charles W(hiteley), 2639 Fenwood Rd., Houston 5, Texas ... 1948
Hamilton, G(olden) Dale, 2550 Murray St., Shreveport, Louisiana ... 1953
Hamilton, Terrell Hunter, Biological Laboratories, 16 Divinity Ave., Cambridge 38, Massachusetts ... 1952
Hamilton, William J(ohn), Jr., Dept. of Conservation, Cornell University, Ithaca, New York ... 1933
Hamilton, William J(ohn), III, Museum of Vertebrate Zoology, University of California, Berkeley, California ... 1953
Hammond, Merrill C(lyde), Lower Souris Refuge, Upham, North Dakota ... 1939
Hampe, Irving E., 5559 Ashbourne Rd., Halethorpe, Baltimore 27, Maryland 1945
Hancock, James W(illiam), Route 1, Madisonville, Kentucky ... 1946
Handley, Charles O(verton), 6571 Roosevelt Ave., Charleston 4, West Virginia 1925
Handley, Charles O(verton), Jr., Division of Mammals, U.S. National Museum, Washington 25, D.C. ... 1941
Hanlon, Robert William, Dept. of Biology, St. Augustine College, Nassau, Bahamas ... 1953
*Hann, Harry W(ilbur), 427 Church St., Ann Arbor, Michigan ... 1930
Hanna, Wilson Creal, 712 North 8th St., Colton, California ... 1936
Hanson, Stanley George, 1540 NW 28th St., Oklahoma City, Oklahoma ... 1954
Hardy, C(ecil) Ross, 6201 East Anaheim Rd., Long Beach 14, California ... 1940
Hardy, Frederick C., Box 101, Somerset, Kentucky ... 1948
Hardy, John William, Museum of Natural History, University of Kansas, Lawrence, Kansas ... 1952
Harford, Dr. Henry M(inor), 1400 Vermont St., Quincy, Illinois ... 1946
Harger, Elsworth M(ilton), Box 97, Houghton Lake Heights, Michigan ... 1955
Hargrave, Lyndon L(ane), Box 505, Benson, Arizona ... 1952
Harper, Francis, 115 Ridgway St., Mount Holly, New Jersey ... 1930
Harrington, H. Warren, Jr., 19 Holborn St., Milton 86, Massachusetts ... 1956
Harrington, Dr. Paul, 813 Bathurst St., Toronto 4, Ontario, Canada ... 1948
*Harriot, Samuel C(arman), 200 W. 58th St., New York 19, New York ... 1934
*Harris, S. Arthur, 1308 W. Minnehaha Parkway, Minneapolis, Minnesota ... 1951
Harris, William G(eorge) F., 147 Hillside St., Milton 86, Massachusetts ... 1951
Harrison, H(arold) H(olmes), 1102 Highland St., Tarentum, Pennsylvania ... 1941

Harte, Ken(neth) J., 30 Brunswick Ave., Troy, New York 1953
Hartford, Dr. W(alter) K(enneth), 1111 N. Lee St., Oklahoma City 3, Okla. 1955
Hartman, Frank A(lexander), Hamilton Hall, Ohio State University, Columbus 10, Ohio 1941
Hartshorne, Charles, 2075 Ridgewood Dr., NE, Atlanta 7, Georgia 1953
**Hartshorne, James M(ott), 502 Veterans Place, Ithaca, New York 1955
Hartley, Harold S., 602 Randolph St., Northville, Michigan 1951
Hatch, C(lara) Grenville, 3127 Alika St., Honolulu 17, T. H. 1948
Hauser, Mrs. Doris C., 302 Green St., Fayetteville, North Carolina 1955
Hausler, Mrs. M., 7348 S. Paxton Ave., Chicago 49, Illinois 1936
Havemeyer, Henry O(sborne), Mountain Side Farm, Mahwah, New Jersey 1930
Haven, Stoner B., 1064 E. Linden, Richmond Heights 17, Missouri 1956
Haverschmidt, F(rancois), P.O. Box 644, Paramaribo, Surinam, Dutch Guiana 1946
Hawk, Grover C., R.F.D. #1, Hedrick, Iowa 1951
Hawkins, Mrs. A(gnes) M., R.R. #4, Box 752, Phoenix, Arizona 1954
Hawksley, Oscar, Biology Dept., Central Missouri State College, Warrensburg, Missouri 1948
Hayman, Robert G(ene), R.R. #1, Carey, Ohio 1952
Hays, Herbert E., Museum of Natural History, University of Kansas, Lawrence, Kansas 1956
Hazard, Frank Orlando, Wilmington College, Wilmington, Ohio 1946
Hazard, Norwood C(ady), 2815 Sheridan St., Davenport, Iowa 1949
Hebard, Frederick V(anuxem), 1500 Walnut St. Bldg., Philadelphia 2, Penn. 1940
Heckler, Sydney B., 1207 N. 7th St., St. Louis 6, Missouri 1942
Hedges, Harold C(harles), Route 2, Lake Quivira, Kansas City 3, Kansas 1940
Heffelfinger, George W(right) P(eavey), Jr., 315 Hosmer Blvd., Tuxedo, Manitoba, Canada 1948
Hefley, Harold M(artin), Panhandle A&M College, Goudwell, Oklahoma 1942
Heimerdinger, Mary A(nne), Dept. of Biol., Wittenberg College, Springfield, Ohio 1955
Heiser, J(oseph) M(atthew), Jr., 1724 Kipling St., Houston 6, Texas 1939
Heitman, Alfred W., 802 Range St., Manistique, Michigan 1953
*Helbert, Dr. Hollen G(arber), 338 Monticello Ave., Harrisonburg, Virginia 1952
Helfer, Louise, 111 Ninth St., Watkins Glen, New York 1938
Helleiner, Frederick M., 207 Cottingham St., Toronto, Ontario, Canada 1952
Helms, Carl W., 1313 University Ave., Boulder, Colorado 1952
Henderson, Judith B., 58 Meadow Lane, Grosse Point 36, Michigan 1956
Hengst, Mrs. James M., 2111 Park Hill Dr., Columbus 9, Ohio 1948
Henry, C. J., Seney National Wildlife Refuge, Seney, Michigan 1933
Hensley, M(arvin) Max, Dept. of Zoology, Michigan State University, East Lansing, Michigan 1947
Henwood, Mrs. Ethel May, 306 West Michigan, Urbana, Illinois 1941
Herman, Carlton M., Patuxent Research Refuge, Laurel, Maryland 1946
Herzog, David, 4111 Yosemite Ave., St. Louis Park 16, Minnesota 1956
Hewitt, Oliver H., Fernow Hall, Cornell University, Ithaca, New York 1943
Hibbard, Edmund Arthur, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1950
Hickey, J(oseph) J(ames), 424 University Farm Place, Madison 5, Wisconsin 1940
**Hicks, Lawrence Emerson, 8 Chatham Rd., Columbus, Ohio 1925
Hicks, Thomas W(illiam), 1225 Benton Ave., Springfield, Missouri 1949
Hiett, Lawrence D(avidson), R.D. #1, Box 187, Grand Rapids, Ohio 1929
Higgins, Thomas Francis, 85 Cornell St., Williston Park, New York 1947
Hight, Gordon L(ee), Jr., P.O. Box 1626, Rome, Georgia 1954
Hill, Herbert Oliver, 11021 Braddock Dr., Culver City, California 1938
*Hill, Julian Werner, 1106 Greenhill Ave., Wilmington 56, Delaware 1935
Hill, Raymond W., 3316 Kenmore Rd., Shaker Heights, Cleveland 22, Ohio 1941
Hillmer, Davis B., 8228 Woodward Ave., Detroit 2, Michigan 1926
*Hinds, Frank J., Biology Dept., Western Michigan College of Education, Kalamazoo, Michigan 1955

Hinshaw, Thomas D(oane), 1827 San Juan Ave., Berkeley 7, California 1926
Hipple, Byron T., Jr., 114 Chestnut St., Albany 10, New York 1952
Hochbaum, Hans Albert, Delta Waterfowl Research Station, Delta, Manitoba, Canada 1942
Hock, Raymond J(ames), Arctic Aeromed. Lab, APO 731, Seattle, Washington 1946
Hodges, James, 824 Warren St., Davenport, Iowa 1946
**Hoffmann, L(ukas), Station Biologique de la Tour du Valat, Le Sambuc, B. d. Rh., France 1955
Hoffmeister, Linus C(hristian), 504 W. Ripa Ave., Lemay 23, Missouri 1939
Hofslund, Pershing B(enard), Biology Dept., Duluth Branch, University of Minnesota, Duluth, Minnesota 1944
Hoiberg, Arnold, Route 3, Box 226, El Dorado, Arkansas 1951
**Holden, Fenn M(itchell), Box 428, Grayling, Michigan 1947
Holden, Raymond, Whippoorwill Hill, N. Newport, New Hampshire 1956
Holland, Harold May, Box 615, Galesburg, Illinois 1915
Hostetter, D(avid) Ralph, Eastern Mennonite College, Harrisonburg, Virginia 1937
Hough, Mrs. Eleanor Sloan, 1515 Mariposa Ave., Boulder, Colorado 1941
**Houston, C(larence) Stuart, Box 278, Yorkton, Saskatchewan, Canada 1948
Hovingh, Peter, Jr., Allendale, Michigan 1954
Howard, Julian A., Wildlife Refuge, Wichita Mountains, Cache, Oklahoma 1951
Howell, Joseph C., Dept. of Zoology & Entomology, University of Tennessee, Knoxville 16, Tennessee 1938
Howell, Thomas R(aymond), Dept. of Zoology, University of California, Los Angeles 24, California 1947
Hoyt, Mrs. Southgate Y., Box 54, "Aviana," Etna, New York 1952
Hubbell, Mrs. Frances, 114 Wolfe St., Alexandria, Virginia 1956
Huenecke, Howard S(everin) Des Lacs National Wildlife Refuge, Kenmare, North Dakota 1952
Hughes, Gilbert C., III, Box 732, Florida State University, Tallahassee, Florida 1952
Hughes, Wallace, 305 Mayo, Tallahassee, Florida 1947
Hukill, Maud, 505 N. Adams St., Ypsilanti, Michigan 1954
Humphrey, Philip Strong, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1948
Hundley, Marion Lee, 28337 Peppermill Rd., Farmington, Michigan 1950
Hunnewell, Louisa, 848 Washington St., Wellesley, Massachusetts 1951
Hunt, L(awrence) Barrie, 203 S. 16th St., Richmond, Indiana 1954
Hunt, Ormond Edson, Rathmor Rd., Bloomfield Hills, Michigan 1937
Huntington, Charles Ellsworth, Dept. of Biology, Bowdoin College, Brunswick, Maine 1950
Hurley, John B(eatty), 401 S. 17th Ave., Yakima, Washington 1937
Hurrie, David, 8-c Devonshire Apartments, Brockville, Ontario, Canada 1952
*Hutchinson, Arthur E., 2640 Glendessary Lane, Santa Barbara, California 1940
Imhof, Thomas A(nthony), 307 - 38th St., Fairfield, Alabama 1950
Ivie, Mrs. Kathryn R., 721 N. Main St., Sandwich, Illinois 1956
Ivor, H. Roy, R.R. #1, Erindale, Ontario, Canada 1945
Jabinson, Marguerite N., 1503 N. Pennsylvania Ave., Apt. 31, Indianapolis 2, Indiana 1946
Jacisin, Robert J., 1331 Beverly Rd., Port Vue, McKeesport, Pennsylvania 1956
Jackson, C(icero) F(loyd), University of New Hampshire, Durham, N. H. 1936
**Jaeger, Ellsworth, 470 Bird Ave., Buffalo 13, New York 1956
Jahn, Laurence Roy, 129 Juneau St., Horicon, Wisconsin 1950
James, Douglas Arthur, Dept. of Zoology, University of Arkansas, Fayetteville, Arkansas 1946
James, Pauline, Biology Department, Pan American College, Edinburg, Texas 1952
Janssen, Robert B., Apt. G, Bldg. 35, Benjamin Harrison Village, Indianapolis, Indiana 1952
Janvrin, Dr. Edmund R(andolph) P(easlee), 38 E. 85th St., New York 28, N. Y. 1942
Jaques, Florence Page, 10 East Oaks Rd., North Oaks Farms, St. Paul 13, Minn. 1950

Jaques, F(rancis) L(ee), East Oaks Road, North Oaks Farms, St. Paul 13, Minnesota 1939
Jehl, Dr. Joseph R., Jr., 385 Grove St., Clifton, New Jersey 1953
Jenkins, James H(obart), School of Forestry, University of Georgia, Athens, Ga. 1939
Jenkinson, Mary Caroline, Box 715, Bryson City, North Carolina 1952
Jenner, William A., 7908 Kipling Parkway, SE, Washington 28, D.C. 1933
Jensen, Mrs. Ove F., R.F.D. #2, Maple City, Michigan 1948
**Jeter, Horace Hearne, 4534 Fairfield Ave., Shreveport, Louisiana 1950
Johnson, Albert George, Route 2, Box 318, Hartland, Wisconsin 1947
Johnson, Carl M(ilton), 1500 - 7th St. N.E., Rochester, Minnesota 1954
Johnson, Daniel P., 147 Winter St., Hyannis, Massachusetts 1951
Johnson, Mrs. Florence K., Winterbrook, Mt. Jewett, Pennsylvania 1956
Johnson, Harris, R.D. #1, Box 11, Warren, Pennsylvania 1951
Johnson, John C(hristopher), Jr., Biology Dept., K.S.T.C., Pittsburg, Kansas ..1955
Johnson, J(ohn) O(scar), 112 - 7th St., SE, Watertown, South Dakota 1948
Johnson, Mabel C., 30 Westfield Rd., West Hartford, Connecticut 1946
Johnson, Robert A(nthony), Route 2, Gosport, Indiana 1930
Johnson, William M(cNutt), R.D. #6, Knoxville, Tennessee 1939
Johnston, Mrs. Bette, 158½ N. Rose, Mt. Clemens, Michigan 1953
Johnston, David Ware, Dept. of Biology, Mercer University, Macon, Georgia .. 1943
Johnston, Letitia, 3231 N. Hartford, Tulsa, Oklahoma 1956
Johnston, Richard F., Dept. of Biology, New Mexico A&M College, Las Cruces, New Mexico 1949
Jones, Fred M(inson), P.O. Box 1864, Williamsburg, Virginia 1951
Jones, Harold C(harles), 216 Stewart Ave., SW, Atlanta, Georgia 1929
Jones, John C(ourts), 5810 Namakagan Rd., Washington 16, D.C. 1931
Jones, S(olomon) Paul, 509 West Ave., North, Waukesha, Wisconsin 1921
Jones, Vincent C(lement), 2703 Upshur St., Apt. 2, Mt. Rainier, Maryland 1951
Jorae, Irene Frances, Central Michigan College of Education, Mt. Pleasant, Michigan 1942
*Jordan, John N., 52 Brock Ave., North, Montreal, W., Quebec, Canada 1951
Joseph, Stanley R(obert), R.D. #8, York, Pennsylvania 1952
Jubon, John M., P.O. Box 16, E. Millstone, New Jersey 1951
*Juhn, Mary, Cedar Lane, Beltsville, Maryland 1954
Jung, Clarence S(chram), 6383 N. Port Washington Rd., Milwaukee 9, Wisc. 1921
Jurica, E., St. Procopius College, Lisle, Illinois 1940
Kahl, (Marvin) Phillip, 122 E. 47th St., Indianapolis 5, Indiana 1953
Kahn, Mrs. Reuben L., 8 Ruthven Place, Ann Arbor, Michigan 1938
*Kalmbach, Edwin Richard, 1601 Mariposa Ave., Boulder, Colorado 1926
Kane, Sybil K., 107 Edgar St., Kane, Pennsylvania 1956
Karns, Ronald R(aymond), 1234 Louisiana Ave., Akron 14, Ohio 1955
Kaspar, John L(oren), 392 - 23rd St., Oshkosh, Wisconsin 1947
Kebbe, Chester E., 5414 NE Emerson St., Portland, Oregon 1956
Keeley, Katherine, 503 Greenlawn Dr., Apt. 103, Hyattsville, Maryland 1950
Keeton, Luther F., 80 Eastland Dr., Memphis, Tennessee 1952
*Kelker, George H., School of Forestry, Utah State Agricultural College, Logan, Utah 1938
*Keller, Richard T(homas), 2241 Nelson Dr., Schenectady 9, New York 1943
*Kelley, Neil Thomas, 13137 Balfour, Huntington Woods, Michigan 1951
Kelsey, Homer Stone, Skyview Acres, R.D. #1, Pomona, New York 1945
Kelsey, Paul Manning, R.D. #1, State Road, Dryden, New York 1948
Kelso, Leon H(ugh), 1370 Taylor St. NW, Washington 11, D.C. 1930
Kemnitzer, Allen E(dward), 969 Five Mile Line Road, Webster, New York 1949
Kemsies, Emerson, Dept. of Zoology, Biology Bldg., University of Cincinnati, Cincinnati, Ohio 1948
Kenaga, Eugene E., 1629 Isabella Rd., Midland, Michigan 1949
Kendeigh, S(amuel) Charles, Vivarium Bldg., University of Illinois, Champaign, Illinois 1923
Kennedy, Bruce A(lbert) H(amilton), 389 W. Tenth St., Columbus 1, Ohio .. 1947

Kennerly, Thomas E., Jr., Dept. of Biology, Baylor University, Waco, Texas 1951
Kent, Tom, 302 Richards St., Iowa City, Iowa 1951
Kenyon, Karl W(alton), U.S. Fish & Wildlife Service, Branch of Wildlife Research, 8923 - 236th St., SW, Edmonds, Washington 1948
Kersting, Cecil Carl, 1365 Lakeshore Dr., Muskegon, Michigan 1950
*Kessel, Brina, Dept. of Biological Sciences, University of Alaska, College, Alaska 1946
**Kieran, John, 1360 Midland Ave., Bronxville 8, New York 1942
Kildow, T(homas) Monroe), Box 910, Tiffin, Ohio 1948
Kilham, Dr. Lawrence, 7815 Aberdeen Rd., Bethesda 14, Maryland 1952
Killip, Dr. Thomas, III, 525 East 68th St., New York 21, New York 1946
Killpack, Merlin L(eo), Union High School, Roosevelt, Utah 1950
Kimball, Mary Boydston, 809 Main St., Sistersville, West Virginia 1950
King, John Arthur, Roscoe B. Jackson Memorial Lab., Box 847, Hamilton Station, Bar Harbor, Maine 1947
*Kincaid, Edgar, Jr., 702 Park Place, Austin, Texas 1951
Kirby, Robert P(hilip), 1995 N. Main St., Decatur, Illinois 1955
*Kirk, Lester K(ing), 19520 Bretton Dr., Detroit 23, Michigan 1954
Kirkpatrick, Charles M., Dept. of Forestry, Purdue University, West Lafayette, Indiana 1948
Kirsher, William K., 571 Fulton Ave., Sacramento 21, California 1956
Kirtley, Mrs. Virginia Carter, Mitchellville, Maryland 1955
Kleen, Richard L., St. Michaels, Maryland 1955
Kletzly, Robert C(harles), Conservation Commission, Box 390, Beckley, West Virginia 1948
Klonick, Allan S., 111 Rowland Parkway, Rochester 10, New York 1941
Klopfer, Peter H., Osborn Zoological Lab., Yale University, New Haven, Conn. 1955
Knorr, Owen A(lbert), 1918 Mariposa, Boulder, Colorado 1954
Knowlton, Dana S., 720 Leland Ave., Plainfield, New Jersey 1956
Kolb, C(harles) Haven, Jr., 5915 Meadow Rd., Baltimore 6, Maryland 1937
*Kortright, Francis H(erbert), 633 Eastern Ave., Toronto 8, Ontario, Canada 1943
Kossack, Charles W(alter), 715 S. Division St., Barrington, Illinois 1945
Kramar, Nada, 927 - 15th St., NW, Washington 5, D.C. 1947
Kramer, Mrs. Quintin, 8717 Wissahickon Ave., Philadelphia 28, Pennsylvania 1953
Kramer, Theodore C(hristian), 1307 Granger Ave., Ann Arbor, Michigan 1939
Kraus, Douglas L(awrence), Dept. of Chemistry, University of Rhode Island, Kingston, Rhode Island 1942
Krause, Herbert, 1811 - 1st Ave., S, Sioux Falls, South Dakota 1953
Krebs, Mrs. R. W., 1272 Alfred St., Baton Rouge 12, Louisiana 1946
Krehbiel, Adolf J., 221 Jefferson St., Clayton, New Mexico 1955
Krug, Howard H(enry), Chesley, Ontario, Canada 1944
Krumm, Kenneth, Lacreek National Wildlife Refuge, Martin, South Dakota 1948
Kugel, Agnes R(ose), Grand Rapids Junior College, Grand Rapids, Michigan 1946
Kuhn, Kenneth H(erbert), 3837 N. 61st St., Milwaukee 16, Wisconsin 1949
Kuitert, Louis Cornelius, Agricultural Experiment Station, University of Florida, Gainesville, Florida 1938
Kunkle, Donald E., 29 Edgewood Rd., Bloomfield, New Jersey 1956
Kyllingstad, Henry C(arrell), Arab States Fundamental Educational Centre, Sirs-el-Layyan, Menoufia, Egypt 1940
Labisky, Ronald F(rank), Sect. of Wildlife Research, Nat. Hist. Surv., Natural Resources Bldg., Urbana, Illinois 1956
La Budde, George Diefenthaeler, 741 N. Milwaukee St., Milwaukee, Wisconsin 1954
Lacey, Mifton H., Box 614, Canton, Ohio 1939
*Lagler, Karl F., Dept. of Fisheries, University of Michigan, Ann Arbor, Michigan 1941
Lamore, Donald Hart, 2 C Garden Way, Greenbelt, Maryland 1942
Lancaster, Douglas A(lan), Museum of Zoology, Louisiana State University, Baton Rouge, Louisiana 1949
Land, Hugh Colman, 3372 - 8th St. Rd., Huntington, West Virginia 1950

Landing, James E., 510 E. 11th St., Michigan City, Indiana 1956
Langston, Ronald E., 48 Kirkwood Lane, Greenville, South Carolina 1956
Lanyon, Wesley E(dwin), Dept. of Zoology, Miami University, Oxford, Ohio 1955
**Laskey, Mrs. Frederick Charles, 1521 Graybar Lane, Nashville 4, Tennessee 1928
Laudenslager, May S., 5108 Waukesha Rd., Washington 16, D.C. 1953
Laurence, Richard R(obert), 320 Kingston Court, SW, Knoxville 16, Tennessee 1953
Lawrence, Mrs. Louise de Kiriline, The Loghouse, Pimisi Bay, Rutherglen, Ontario, Canada 1946
*Lawson, Ralph, 5 Carpenter St., Salem, Massachusetts 1951
*Lea, Dr. Robert B(ashford), 165 N. Liberty St., Elgin, Illinois 1940
Leavitt, Benjamin Burton, Dept. of Biology, University of Florida, Gainesville, Florida 1947
Leedy, Daniel L(oney), U.S. Fish & Wildlife Service, Branch of Wildlife Research, Washington 25, D.C. 1936
LeFebure, Mrs. Joyce, 2300 E. Co. Rd., E. White Bear Lake 10, Minnesota 1953
*Lengemann, Martha A., 360 Cedar St., Imlay City, Michigan 1946
Leonard, Dr. James P(atrick), 1605 Arlington Ave., Davenport, Iowa 1951
Leopold, A(ldo) Starker, Museum of Vertebrate Zoology, Berkeley 4, Calif. 1940
Leopold, Frederic, 111 Clay St., Burlington, Iowa 1950
Lester, Joseph Evans, R.D. #1, Aliquippa, Pennsylvania 1952
Letson, Orrin W(olcott), 4215 E. Second Place, Tulsa, Oklahoma 1955
Levi, Herbert W., Museum of Comparative Anatomy, Harvard University, Cambridge 38, Massachusetts 1949
Levy, Alice K(lund), 2624 Montrose Ave., Montrose, California 1941
Lewis, C. Bernard, The Science Museum, Institute of Jamaica, Kingston, Jamaica, B. W. I. 1947
*Lewis, James E., 817 Franklin Ave., Youngstown, Ohio 1953
Lewis, Harrison F(lint), West Middle Sable, Shelburne County, Nova Scotia, Canada 1939
Lewis, Thomas J., Jr., 904 W. 6th St., Davenport, Iowa 1956
Lewis, William O(wen), Box 22, Ivy, Virginia 1953
Lewy, Alfred, 2051 East 72nd Place, Chicago 49, Illinois 1915
Lieftinck, John E(dmund), c/o Goodyear S. A., Luxembourg City, Luxembourg 1945
Lien, Mrs. Boyd M., 5148 - 29th Ave., South, Minneapolis 17, Minnesota 1944
**Ligas, Frank J., P.O. Box 38, Dania, Florida 1951
Ligon, J(ames) Stokley, P.O. Box 950, Carlsbad, New Mexico 1948
Lincoln, Charles W., 392 Highland Ave., Upper Montclair, New Jersey 1953
Lincoln, Frederick Charles, Fish & Wildlife Service, Washington 25, D.C. 1914
Lindauer, Millard R., 130 Home St., Valley Stream, L. I., New York 1949
Linsdale, Jean M(yron), Jamesburg Route, Carmel Valley, California 1928
*Linton, M(orris) Albert, 315 E. Oak Ave., Moorestown, New Jersey 1941
Lippert, George E., Brown Road, Albion, New York 1955
Lippincott, Elizabeth R., Church St., R.D. #1, Moorestown, New Jersey 1956
Livingston, Philip A(tlee), 620 Manor Rd., Narberth, Pennsylvania 1953
Lloyd, C(lark) K., 11 North Elm St., Oxford, Ohio 1925
Lloyd, Hoyes, 582 Mariposa Ave., Rockcliffe Park, Ottawa, Ontario, Canada 1922
Lockwood, Dr. Robert Minturn, Veterans Administration Hospital, McKinney, Texas 1949
Loetscher, Frederick W(illiam), Jr., 507 W. Main, Danville, Kentucky 1946
Longley, William H(oward), P.O. Box 362, Kasson, Minnesota 1943
Loomis, Mrs. Lester R., R.R. #2, Box 157-T, Hammond, Louisiana 1942
Loring, George G(ardner), Bridge St., Manchester, Massachusetts 1949
**Lory, Mrs. William T., 3538 Wenonah Ave., Berwyn, Illinois 1944
Love, Bob, 1222 - 15th St., Port Huron, Michigan 1956
Lovell, Harvey B., 2346 Dundee Rd., Louisville 5, Kentucky 1936
**Low, Seth Haskell, R.D. #2, Gaithersburg, Maryland 1931
**Lowery, George H(ines), Jr., Museum of Zoology, Louisiana State University, University, Louisiana 1937
Lowther, James K., 3683 Hutchinson St. #47, Montreal 2, Quebec, Canada 1956

Lowther, Malcolm Alfred, 22599 Kane Ave., Detroit 23, Michigan 1944
Luckenbach, Mrs. Bert A., 1548 Lehigh Parkway S., Allentown, Pennsylvania 1956
**Ludwig, Dr. Frederick Edwin, 2864 Military St., Port Huron, Michigan 1941
Lueshen, Mrs. John, Wisner, Nebraska 1952
Lukens, William Weaver, Jr., Upper Gulph Rd., Radnor, Pennsylvania 1947
*Lunk, William A., 2849 Whitewood, Pittsfield Village, Ann Arbor, Michigan 1937
Luther, Mrs. Frederic, 4515 Marcy Lane, Apt. 239, Indianapolis 5, Indiana 1935
Luthy, Ferd. Jr., 1310 N. Institute, Peoria, Illinois 1937
*Lyman, Mrs. Clara Cross, Route 5, Box 590, Wayzata, Minnesota 1944
Mabus, Mrs. Mildred M(axine), R.D. #1, Sesser, Illinois 1955
MacArthur, Robert H., Newfane, Vermont 1956
Mack, H(orace) G(ordon), c/o Gilson Mfg. Co., Ltd., Guelph, Ontario, Canada 1937
MacKenzie, Mrs. Charles, 425 Tatepaha Blvd., Faribault, Minnesota 1951
MacKenzie, Dr. Locke Litton, 829 Park Ave., New York 21, New York 1947
MacLaren, Dr. R. G., Hamilton General Hospital, Barton St., Hamilton, Ontario, Canada 1956
MacLeod, Charles Franklyn, Biol. Lab., Forestry Dept., Laval University, Quebec, Quebec, Canada 1949
MacMullan, R(alph) Austin, Houghton Lake Heights, Michigan 1940
MacQueen, Mrs. Peggy Muirhead, 2551 Ave. N, NW, Winter Haven, Florida 1940
Magath, Dr. Thomas Byrd, Mayo Clinic, Rochester, Minnesota 1935
Magner, J(ohn) Marshall, 516 Bacon Ave., Webster Groves 19, Missouri 1948
Mahan, Harold D., 582 E. Drayton, Ferndale 20, Michigan 1953
Maher, William Joseph, Museum of Vertebrate Zoology, University of California, Berkeley 4, California 1951
Mahlburg, Milton William, 1109 Grant Ave., Rockford, Illinois 1949
*Mainster, Raymond Waite, 3716 Croydon Rd., Baltimore 7, Maryland 1949
*Mallory, Dr. Dwight H(arcourt), 17 Sherwood St., Brockville, Ontario, Canada 1946
Mandigo, Gordon C., 600 South Bowen St., Jackson, Michigan 1954
Manners, Edward Robert, 216 New Broadway, Brooklawn, New Jersey 1942
Manning, T. H., 37 Linden Terrace, Ottawa, Ontario, Canada 1950
*Mannix, Mrs. J. R., 3899 E. 176th St., Cleveland 28, Ohio 1947
Manville, Richard H(yde), New York Zoological Society, 185th St. & Southern Blvd., New York 60, New York 1941
*Mara, Robert M(ichael), Apt. 303, 560 Parkview Dr., Detroit 14, Michigan 1949
Margolin, A(braham) S(tanley), Phoenix College, Phoenix, Arizona 1944
Marks, Jack Loran, 115 City Hall, Portland 4, Oregon 1949
Marshall, Dr. A. J., Dept. of Zoology and Comparative Anatomy, St. Bartholomew's Hospital Medical College, Charterhouse Square, London, E. C. 1, England 1950
Marshall, Terrell, 372 Skyline Dr., Park Hill. North Little Rock, Arkansas 1944
*Marshall, William H(ampton), 300 Coffey Hall, University of Minnesota, St. Paul 1, Minnesota 1942
Martin, Dr. Donald B(eckwith), 2948 Oakford Rd., Ardmore, Pennsylvania 1954
Martin, J. E., 1716 Dorchester Place, Oklahoma City 16, Oklahoma 1955
Martin, Paul S(chultz), Box 532, West Chester, Pennsylvania 1946
*Marvel, Carl S(hipp), 404 W. Pennsylvania Ave., Urbana, Illinois 1949
*Maslowski, Karl H(erbert), 1034 Maycliff Place, Cincinnati 30, Ohio 1934
Mason, C(harles) N(athan), Sr., 6432 - 31st St., NW, Washington 15, D.C. 1947
Mason, Esther, 2523 Montgomery St., Louisville 12, Kentucky 1941
Mathis, Mrs. Vernon P., 308 Kinne St., Apt. 71-C, Syracuse 6, New York 1955
Mayfield, G(eorge) R(adford), Vanderbilt University, Nashville, Tennessee 1917
*Mayfield, Harold F(ord), River Rd. R.D., Waterville, Ohio 1940
**Mayr, Ernst, Museum of Comparative Zoology, Harvard College, Cambridge 38, Massachusetts 1933
**Mazzeo, Rosario, 114 The Fenway, Boston, Massachusetts 1947
*McAlister, J(ames) Don, 1723 Cardiff Rd., Columbus 21, Ohio 1949
McAtee, Waldo Lee, 3 Davie Circle, Chapel Hill, North Carolina 1911
**McCabe, Robert A(lbert), 424 University Farm Place, Madison, Wisconsin 1942
McClure, H(owe) Elliott, 406 Med. Gen. Lab., APO 343, San Francisco, Calif. 1942

McConoughey, Frank Perry, 1547 Northland Ave., Lakewood 7, Ohio 1951
McCormick, John M., 2356 Cheltenham Rd., Toledo 6, Ohio 1951
McCue, Dr. Earl Newlon, Box 104, Morgantown, West Virginia 1941
McCullagh, Dr. E(rnest) Perry, 2020 E. 93rd St., Cleveland, Ohio 1937
McCullough, C(lyde) Robert, Burton, Ohio 1953
McDonald, Malcolm E., 1850 Wilder St., Reno, Nevada 1936
McEntee, Mrs. Howard G., 490 Fairfield Ave., Ridgewood, New Jersey 1948
McFarquhar, Charles C., 302 Sutherland Dr., Leaside, Toronto, Ontario, Canada 1956
*McGaw, Mrs. G. Hampton, 18 Beech St., Woodsville, New Hampshire 1945
McGeen, Dr. Daniel S., 707 Community National Bank Bldg., Pontiac, Michigan 1944
McKay, Arlie K(yle), R.D. #2, Box 184, Baytown, Texas 1949
McKeever, Christopher Killian, Box 146, Water Mill, New York 1948
McKinley, Daniel L(awson), Stephens Hall, University of Missouri, Columbia, Missouri 1948
McKinley, Dr. George G(ael), 104 N. Western Parkway, Louisville 12, Kentucky 1945
*McKinney, Mrs. Walter, 2932 S. Woodward Blvd., Tulsa 14, Oklahoma 1945
McKnight, Edwin T(hor), 5038 Park Place, Friendship Station, Washington 16, D.C. 1936
McLaughlin, Frank W., Ewing Ave., Franklin Lakes, New Jersey 1953
McLeod, John Allen, Jr., 113 East Hendrix St., Greensboro, North Carolina 1951
*McMath, Robert R., McMath-Hulbert Observatory of the University of Michigan, Lake Angelus Rd., North, R.D. #4, Pontiac 4, Michigan 1934
McNabb, Mary Katherine, Box 427 A, Route 4, Springdale, Arkansas 1954
McQuate, Nelda Jean, 374 Riverside Dr., Tiffin, Ohio 1953
McTarnaghan, Mary A., R.D. #1, Batavia, New York 1956
Meacham, Frank B., State Museum, Raleigh, North Carolina 1945
Mead, Frank Waldreth, 2035 N E-6 Terrace, Gainesville, Florida 1948
*Meade, Dr. Gordon M(ontgomery), 1427 Eye St. N.W., Washington, D.C. 1938
Meanley, Brooke, P.O. Box 1365, Alexandria, Louisiana 1950
Meara, Joseph Fisher, 440 S. Harding Rd., Columbus 9, Ohio 1953
Medina, Don(ald) R(aul), 364 Roswell Ave., Long Beach, California 1955
Mehner, John F., 222 Clifford St., Lansing 12, Michigan 1949
Mellinger, E(nos) O(ren), Savannah N. W. Refuge, Box 4008, Port Wentworth, Georgia 1939
**Melone, Theodora G(ardner), Geology Library, Pillsbury Hall, University of Minnesota, Minneapolis 14, Minnesota 1947
Meltvedt, Burton W., Paullina, Iowa 1930
**Meng, Heinz Karl, State Teachers College, New Platz, New York 1943
*Mengel, Mrs. Robert M., 15 Countryside Lane, Lawrence, Kansas 1948
*Mengel, Robert M(orrow), Museum of Natural History, University of Kansas, Lawrence, Kansas 1937
*Menninger, Phil B., 1724 Collins Ave., Topeka, Kansas 1949
Meredith, Col. Russell Luff, 2500 - 2nd Ave., S., Great Falls, Montana 1946
Meritt, James Kirkland, 16 Ellen Lane, Scotia 2, New York 1944
*Mers, W(illiam) H(enry), 1659 Marlowe Ave., Cincinnati 2, Ohio 1949
Mery, Mrs. Sophia C., 345 Boston Ave., SE, Bartlesville, Oklahoma 1955
Messner, Clarence John, 308 McKinley, Grosse Pointe 30, Michigan 1944
*Metcalf, H(omer) N(oble), Dept. of Horticulture, Montana State College, Bozeman, Montana 1944
Mewaldt, L(eonard) R(ichard), Dept. of Natural Science, San Jose State College, San Jose 14, California 1947
Meyer, Henry, Wisconsin State College, Whitewater, Wisconsin 1939
*Meyerriecks, Andrew J(oseph), Biological Laboratories, Harvard University, Cambridge 38, Massachusetts 1948
Meyers, Glenn A., Grand Ave., Box 104, Grimsby Beach, Ontario, Canada 1956
**Meyers, Kenneth Lewis, 2222 Far Hills Ave., Dayton 9, Ohio 1949
Michaud, Howard H(enry), 824 N. Chauncey St., West Lafayette, Indiana 1938
Michaux, Mrs. Frank W., 1607 Bluff St., Wichita Falls, Texas 1947
Michener, Mrs. Harold, 418 N. Hudson Ave., Pasadena 4, California 1950
Middleton, William R(obert), 106 N. Lincoln Ave., Wenonah, New Jersey 1953

Mikkelson, Mrs. Herbert G., Box 142, Minnetonka Beach, Minnesota 1948
Miles. Mrs. Eleanor B., 2134 Kendall Ave., Madison 5, Wisconsin 1943
Millar, John B., Dept. of Zoology, University of Wisconsin, Madison, Wisconsin 1956
Miller, Alden H(olmes), Museum of Vertebrate Zoology, Berkeley 4, Calif. 1930
Miller, Mrs. Alice, 1150 Brewer Rd., Leonard, Michigan 1944
Miller, Mrs. Clarence Heath, 1354 Herschel Ave., Cincinnati 8, Ohio 1941
*Miller. Clark. Inwood, West Virginia 1953
Miller. Clinton F(ranklin) A(mmon), 324 S. 22nd St., Allentown, Pennsylvania 1953
**Miller. Douglas Scott, 122 Lawrence Ave., E., Toronto, Ontario, Canada 1939
Miller. Irene E., 2901 Lee Ave., Little Rock, Arkansas 1955
**Miller, Loye H(olmes), Museum of Vertebrate Zoology, University of California, Berkeley 4, California 1939
Miller. Lyle L(eVerne), 5795 Mill Creek Blvd., Youngstown 12, Ohio 1947
Miller, Robert R(aymond), 1424 Liberty St., Allentown, Pennsylvania 1954
**Mills, Herbert H., Arrowhead Farms, R.D. #3, Bridgeton, New Jersey 1951
*Minich, Edward C., 1047 Fairview Ave., Youngstown 2, Ohio 1923
Minor, William F(aulkner), Carolina Apts., Fayetteville, New York 1955
Miskimen, Mildred, Dept. of Physiology, Miami University, Oxford, Ohio 1950
**Mitchell, Harold Dies, 378 Crescent Ave., Buffalo 14, New York 1936
Mitchell, Mrs. Osborne, c/o Brazilian Traction, Light & Power Co., Ltd., 25 King St. West, Toronto 1, Canada 1933
Mitchell, Robert W(etsel), 2369 Texas Ave., San Antonia, Texas 1955
*Mitchell, Dr. Walton I(ungerich), 398 Vassar Ave., Berkeley 8, California 1893
Mockford, Edward L(ee), 3916 Millersville Dr., Indianapolis, Indiana 1946
Mohler, Levi L(app), 602 Michael, Boise, Idaho 1942
Monk, Harry C(rawford), 406 Avoca St., Nashville 5, Tennessee 1920
**Monroe, Burt L(eavelle), Sr., Ridge Rd., Anchorage, Kentucky 1935
Monroe, Burt L(eavelle), Jr.. Ridge Rd., Anchorage, Kentucky 1946
Monroe, Mrs. Robert A(nsley), 1424 Tugaloo Dr., S. W., Knoxville 19, Tenn. 1952
Monson, Gale, 1003 Ninth Ave., Yuma, Arizona 1933
Moore, Mrs. McBrayer, 335 W. Lexington St., Danville, Kentucky 1950
Moore, Milton C(yril), 501 Lincoln Ave., NW, Apt. 3, Canton 8, Ohio 1954
Moore, Robert B(yron), 1332 Knollwood Dr., Baton Rouge, Louisiana 1947
**Moore, Robert Thomas. Meadow Grove Place, Flintridge. Pasadena 2. Calif. 1939
Moran, James Vincent, 3822 Daves Pl., Apt. 302, Washington, D.C. 1943
Moreno, Abelardo, Museo Poey, Catedra "U", Escuela de Ciencias. University of Havana, Havana, Cuba 1949
Morrison, Kenneth Douglas, Mountain Lake Sanctuary, Lake Wales, Florida 1937
Morrow, Mrs. John. Jr., 1320 N. State St., Chicago 10, Illinois 1949
Morse, Douglas H., Star Route, Lisbon, Maine 1956
*Morse, Margarette Elthea, 122 W. South St., Viroqua, Wisconsin 1921
Mosby, Henry Sackett, 1300 Hillcrest Dr., Blacksburg, Virginia 1951
Mossman, H(arland) W(infield), 2902 Columbia Rd., Madison 5, Wisconsin 1948
*Muckley, Mrs. R. L.. Apt. 9-A, 1335 Astor St., Chicago 10, Illinois 1950
*Mudge, Edmund W., Jr., 5926 Averill Way, Dallas, Texas 1939
*Mueller, Mrs. Florence N., 4408 Pine St., Omaha 5, Nebraska 1951
Mueller, Helmut Charles, 2756 N. Palmer St., Milwaukee 12. Wisconsin 1949
Muhlbach, W(alt) L(auritz), 2127 Ashby Ave., Berkeley 5, California 1951
Mumford, Russell E(ugene), Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1949
Munter, Rear Admiral W(illiam) H(enry), 4518 - 52nd Ave., NE, Seattle 5, Washington 1933
Murie, Adolph, Moose, Wyoming 1932
Murie, O(laus) J(ohan), Moose, Wyoming 1934
Murphy, Paul C(harles), 935 Goodrich Ave., Apt. 10, St. Paul 5. Minnesota 1944
Murray, Bertram George, Jr., 807 Mountain Ave., Bound Brook. New Jersey 1954
Murray, Rev. J(oseph) J(ames), 6 White Street, Lexington, Virginia 1931
Murray, Lucy H(unter), Regina College, Regina, Saskatchewan. Canada 1954
Musselman, T(homas) E(dgar), 124 South 24th St., Quincy. Illinois 1940
Myers, Buford M(acMartin), Jr., 2104 Gen. Pershing St., New Orleans 15.

Louisiana ... 1948
Myers, Richard F., 31 "R" St., Columbia, Missouri ... 1952
Neal, Mrs. Charles, Box 133, Demorest, Georgia ... 1946
Neff, Johnson Andrew, Bldg. 45, Denver Federal Center, Denver 2, Colorado 1920
Nelson, Charles E(llsworth), Jr., 124 Oxford Rd., Waukesha, Wisconsin ... 1937
Nelson, Gid E(dmund), Jr., Alabama College, Montevallo, Alabama ... 1953
**Nelson, Theodora, 315 East 68th St., New York 21, New York ... 1928
Nero, Robert William, Saskatchewan Museum of Natural History, Regina, Saskatchewan, Canada ... 1947
*Ness, Robert David, 17 Five Points Rd., Rush, New York ... 1951
Nessle, James P., R.F.D. 1, Waterville, Ohio ... 1936
Nesslinger, Carlita L., 103 Caldwell Rd., Forest Home, Ithaca, New York ... 1956
*Netting, M(orris) Graham, Carnegie Museum, Pittsburgh 13, Pennsylvania ... 1941
Nevius, Mrs. Richard, R. #1, Greeneville, Tennessee ... 1940
New, John G., Science Dept., St. Univ. Teachers College, Oneonta, New York 1946
Newberry, A(ndrew) Todd, 70 Rock Spring Rd., West Orange, New Jersey ... 1952
Newman, Robert J(ames), 312 West Roosevelt St., Baton Rouge, Louisiana ... 1950
Ney, William O., Jr., 608 W. Broadway, Ponca City, Oklahoma ... 1955
Nice, L(eonard) B., 5725 Harper Ave., Chicago 37, Illinois ... 1932
**Nice, Mrs. Margaret Morse, 5725 Harper Ave., Chicago 37, Illinois ... 1921
*Nichols, Charles K(etcham), 212 Hamilton Rd., Ridgewood, New Jersey ... 1933
*Nichols, John Treadwell, American Museum of Natural History, 79th St. & Central Park W., New York 24, New York ... 1941
Nicholson, Donald J(ohn), 1224 Palmer St., Orlando, Florida ... 1945
*Nickell, Walter Prine, Cranbrook Institute of Science, Bloomfield Hills, Mich. 1943
*Nielsen, Mrs. B. W., Route #1, Box 808, Kauffman Ave., Red Bluff, California 1945
Nielsen, Joseph A(ustin), 253 Warren St., Brooklyn 2, New York ... 1954
Nighswonger, Paul F., Route 9, Alva, Oklahoma ... 1950
Nolan, James R., 14 Edgewood Rd., Peekskill, New York ... 1954
Nolan, Val, Jr., Indiana University School of Law, Bloomington, Indiana ... 1953
Noland, Mrs. Hulbert V., 57 Indian Hills Trail, Louisville 7, Kentucky ... 1956
Nordquist, Theodore C., 2701 York Ave., N., Robbinsdale 22, Minnesota ... 1941
Nork, Theodore J., 451 Wrightwood Ave., Chicago 14, Illinois ... 1947
Norman, Edward d'Aubigny, 181 Stage Harbor Rd., Chatham, Massachusetts 1951
Norman, James L(ee), 2617 Elgin, Muskogee, Oklahoma ... 1948
Norris, Robert Allen, 1918 Hahn Avenue, Aiken, South Carolina ... 1941
Norse, William J., 531 W. 211th St., New York 34, New York ... 1939
North, George W(ebster), 249 Charlton Ave., Hamilton, Ontario, Canada ... 1941
Northrop, Mrs. Harson A., 358 East Main St., Owatonna, Minnesota ... 1952
Northrop, Myron, 9304 Sylvan Hills Rd., North Little Rock, Arkansas ... 1945
Novaes, Fernando (da) C(osta), Museu Pareanse, Emilio Goeldi, Belem, Para, Brazil ... 1953
**Nowland, Paul J., 700 Equitable Bldg., Wilmington, Delaware ... 1950
Nye, Frederick F., Jr., P.O. Box 451, McAllen, Texas ... 1943
Oberholser, Harry Church, 2933 Berkshire Rd., Cleveland Heights, Cleveland 18, Ohio ... 1894
O'Callaghan, Terence C., Maromala R. D., Bay of Islands, Northland, New Zealand ... 1954
*Odum, Eugene P(leasants), Dept. of Zoology, University of Georgia, Athens, Georgia ... 1930
Oeming, Albert F., Sub. P. O. 23, Edmonton, Alberta, Canada ... 1956
Ogden, E. Gordon, Box 1045, Alfred, New York ... 1956
Ogilvie, Phillip W., Museum of Natural History, University of Kansas, Lawrence, Kansas ... 1956
Olds, Betty L., 1144 Lafayette SE, Grand Rapids 7, Michigan ... 1956
*Olsen, Dr. Richard E., 3325 Franklin Rd., Route 3, Bloomfield Hills, Michigan 1938
*Olson, Mrs. Simon, 33 Harvard Dr., Lake Worth, Florida ... 1942
Olson, Mrs. Monrad J., Box 595, Watford City, North Dakota ... 1946
O'Neil, Norah Selby, 1311 Bonham St., Commerce, Texas ... 1949
*O'Reilly, Ralph A., Jr., Box 132, Davisburg, Michigan ... 1936

Orians, Rev. Howard L(ester), 2209 Hollister Ave., Madison 5, Wisconsin ... 1947
Ott, Frederick L(ouis), 1358 N. 63rd St., Wauwatosa 13, Wisconsin ... 1941
Overing, Robert, R.D. #4, Raleigh, North Carolina ... 1930
Owen, Oliver S., 333 N. 14th St., Milwaukee, Wisconsin ... 1956
Owre, Oscar T., Dept. of Zoology, University of Miami, Coral Gables, Florida 1935
Packard, Christopher M., Portland Museum of Natural History, 22 Elm St., Portland, Maine ... 1951
Packard, Fred Mallory, 24 Elizabeth Lane, R.D. #2, Fairfax, Virginia ... 1949
Packard, Robert Lewis, Museum of Natural History, Lawrence, Kansas ... 1954
Paine, Robert T(reat), III, 2 Hubbard Park, Cambridge 38, Massachusetts ... 1951
Palmer, Ralph S(imon), New York State Museum, State Education Bldg., Albany 1, New York ... 1934
*Palmquist, Clarence O(scar), 834 Windsor Rd., Glenview, Illinois ... 1945
Pangborn, Mark W(hite), 25 E. 56th St., Indianapolis, Indiana ... 1948
*Parkes, Kenneth Carroll, Carnegie Museum, Pittsburgh 13, Pennsylvania ... 1946
Parks, Richard Anthony, 2303 Pembrook Place, NE, Atlanta, Georgia ... 1942
Parmelee, David F(reeland), 533 Harding, Iron Mountain, Michigan ... 1949
Partridge, William H., Belgrano 363, Caseros F. C. S. M., Buenos Aires, Argentina, S. A. ... 1953
Patten, Bradley M., 2126 Highland Rd., Ann Arbor, Michigan ... 1953
Payne, Rinda Mary, Box 320, Route #4, Portland, Maine ... 1956
Paynter, R(aymond) A(ndrew), Jr., Museum of Comparative Zoology, Harvard University, Cambridge 38, Massachusetts ... 1946
*Pearson, Mrs. Carl E., 632 N. Stone Ave., LaGrange Park, Illinois ... 1954
Peelle, Miles L., 1039 College St., Adrian, Michigan ... 1940
Peffer, Mrs. Thomas A., 49 West Depot St., Hellertown, Pennsylvania ... 1954
Penner, Lawrence R., Dept. of Zoology & Entomology, University of Connecticut, Storrs, Connecticut ... 1940
Perkins, Mrs. Mary Loomis, 1305 S. 52nd St., Omaha 6, Nebraska ... 1946
Peterle, Tony J(ohn), Rose Lake Wildlife Exp. Station, East Lansing, Michigan 1951
Peters, Arthur L(illibridge), 325 South Fourth St., Delavan, Wisconsin ... 1954
Peters, Harold S(eymour), 968 Cumberland Rd., NE, Atlanta 6, Georgia ... 1924
Peters, Stuart S., Dept. of Mines & Resources, St. Johns, Newfoundland ... 1952
Petersen, Arnold J(erome), 712 W. Third St., Northfield, Minnesota ... 1949
Petersen, Peter C., 620 E. 30th St., Davenport, Iowa ... 1951
Peterson, Alfred, Box 201, Brandt, South Dakota ... 1931
Peterson, Mrs. C(harles) E(mil), Madison, Minnesota ... 1936
**Peterson, Roger Tory, Neck Rd., Old Lyme, Connecticut ... 1942
Petroskey, Helen Martha, Box 7, Hiram, Ohio ... 1949
**Pettengill, Olin Sewall, Jr., Wayne, Maine ... 1930
Pettit, Lincoln C(oles), Box 217, Hiram, Ohio ... 1948
Peugh, Marguerite M(ary), Apartado 16, Montemorelos, Nuevo Leon, Mexico 1951
**Phelps, William H(enry), Apartado 2009, Caracas, Venezuela, S. A. ... 1940
**Phillips, Allan Robert, 113 Olive Rd., Tucson, Arizona ... 1934
*Phillips, Homer Wayne, 2110 Morse St., Houston 19, Texas ... 1947
Phillips, Richard S(tuart), 834 Liberty St., Findlay, Ohio ... 1944
Phillips, William B(utterworth), 166 E. 96th St., New York 28, New York ... 1951
Pielou, William P(ercival), 1549 Ann St., East Lansing, Michigan ... 1954
*Pieratt, J(ames) F(rancis), 809 West Otoe, Ponca City, Oklahoma ... 1953
Pierce, Fred J(ohn), Winthrop, Iowa ... 1947
*Pierce, Robert Allen, 1222 - 80th St., West Des Moines, Iowa ... 1941
*Pirnie, Miles David, Conservation Bldg., Michigan State University, East Lansing, Michigan ... 1928
Pittman, James Allen, Jr., 12 West Dr., Bethesda 14, Maryland ... 1945
Plath, Karl, 114 S. East Ave., Oak Park, Illinois ... 1942
*Poole, Cecil A(very), 1764 Topeka Ave., San Jose 26, California ... 1942
*Poor, Hustace Hubbard, 7 Colonial Court, New Canaan, Connecticut ... 1935
*Porter, Dr. Eliot F(urness), Route 1, Box 33, Santa Fe, New Mexico ... 1947
Porter, Richard Dee, Dept. of Wildlife Mgmt., Texas A&M College, College Station, Texas ... 1950

Porter, T(homas) Wayne, Dept. of Zoology, Michigan State University, East Lansing, Michigan 1938
Potter, Mrs. Allen V., 1916 Norvell Rd., R.D. #1, Grass Lake, Michigan 1956
Potter, David M., 1557 Timothy Dwight College, Yale University, New Haven 11, Connecticut 1946
*Potter, Mrs. George C., 2111 Malvern Rd., Charlotte 7, North Carolina 1948
Potter, Julian K(ent), 437 Park Ave., Collingswood 7, New Jersey 1915
Potter, Louis Henry, R.D. #1, West Rutland, Vermont 1941
**Pough, Richard H(ooper), 33 Highbrook Ave., Pelham 65, New York 1938
Praemassing, Eugenia M., 87 Linden Ave., Buffalo 14, New York 1956
Praemassing, Kathryn M., 87 Linden Ave., Buffalo 14, New York 1956
*Prather, Millard F(illmore), P. O. Box 599, Fairfield, Alabama 1910
Prescott, Kenneth Wade, Kansas City Museum, 3218 Gladstone Blvd., Kansas City, Missouri 1946
Preston, Frank W(illiam), Box 149, Butler, Pennsylvania 1948
Prior, Gertrude, Sweet Briar, Virginia 1956
Prosser, Capt. Albert L(aurence), Box H, 116 Main Street, Springvale, Maine 1955
Prucha, Alma H., 1716 N. Prospect Ave., Milwaukee 2, Wisconsin 1942
Pruitt, Mrs. William O., Jr., Arctic Aeromedical Laboratory, Ladd Air Force Base, Fairbanks, Alaska 1948
Puett, May Wilson, P. O. Box 2183, Greenville, South Carolina 1950
Puleston, Dennis, Brookhaven National Laboratory, Upton, New York 1955
Pusey, Catherine, 921 N. Anthony Blvd., Fort Wayne 3, Indiana 1953
*Putman, William L(loyd), Dominion Entomological Laboratories, Vineland Station, Ontario, Canada 1945
Putnam, Mrs. Evelyn J., 1407 Woodland Ave., Duluth, Minnesota 1951
Putnam, Loren Smith, Dept. of Zoology, Ohio State University, Columbus 10, Ohio 1942
Quam, Mrs. Mary Battell, 102 Cedar Hollow Rd., Paoli, Pennsylvania 1944
*Quay, Thomas L., Zoology Dept., North Carolina State College, Raleigh, North Carolina 1939
Quay, W(ilbur) B(rooks), Dept. of Zoology, University of California, Berkeley 4, California 1949
Quilliam, Mrs. H(elen) R(ose), R.R. #1, Kingston, Ontario, Canada 1953
Quimby, Don C., Dept. of Zoology & Entomology, Montana State College, Bozeman, Montana 1942
*Ragusin, Anthony V(incent), P.O. Box 496, Biloxi, Mississippi 1937
Rahe, Carl W., 9005 Tioga Ave., Cleveland 5, Ohio 1931
Ramisch, Marjorie V(iola), Book Repair, 1027 Hamilton Ave., Cleveland 14, Ohio 1943
Ramsay, A(lfred) Ogden, McDonogh School, McDonogh, Maryland 1949
Rand, Austin L., Chicago Natural History Museum, Roosevelt Rd. & Lake Shore Dr., Chicago 5, Illinois 1950
Randall, Clarence B(elden), 38 S. Dearborn St., Chicago, Illinois 1949
Randall, Robert Neal, 928 - 16th St., Bismarck, North Dakota 1939
Randle, Worth S., 5332 Hollywood Blvd., Los Angeles 27, California 1949
Rapp, William F(rederick), Jr., 430 Ivy Ave., Crete, Nebraska 1941
Raymond, Richard C., 29 Overhill Rd., Scarsdale, New York 1953
Rea, Gene, 251 Leland Ave., Columbus 2, Ohio 1948
Read, Bayard W(hitney), Upper Dogwood Lane, Rye, New York 1949
*Rebmann, G. Ruhland, Jr., 729 Millbrook Lane, Haverford, Pennsylvania 1941
Reed, Parker Crosby, 27 Hayes Ave., Lexington, Massachusetts 1949
Reeder, Clara Maude, 1608 College Ave., Houghton, Michigan 1938
Rees, Dr. Earl Douglas, 1504 North Main St., Findley, Ohio 1946
Reese, C(arl) R(ichard), 266 East Dunedin Rd., Columbus 14, Ohio 1948
Reese, Mrs. Hans H., 3421 Circle Close, Shorewood Hills, Madison, Wisconsin 1941
*Rehfisch, Carol, 335 Delgado, Santa Fe, New Mexico 1949
Reichert, Elsa, Mirakel Repair Company, 14 West First St., Mt. Vernon, N. Y. 1950
Reilly, E(dgar) M(ilton), Jr., R.D., Old Chatham, New York 1946
Renfrew, Mrs. Malcolm M., 104 Saratoga Rd., Buffalo 21, New York 1956

Rett, Egmont Z(achary), Museum of Natural History, Santa Barbara, Calif. 1940
Reuss, Alfred Henry, 2908 Edison St., Blue Island, Illinois 1936
Reynard, George B., 728 Parry Ave., Palmyra, New Jersey 1950
Reynolds, Mrs. L. Bruce, 4020 South Toledo, Tulsa 5, Oklahoma 1955
Reynolds, William Pius, 1330 Foulkrod St., Philadelphia 24, Pennsylvania ... 1948
Rice, Dale W(arren), U.S. Fish & Wildlife Service, Bldg. 45, Denver Federal Center, Denver, Colorado 1946
Rice, Orville O(wen), 1663 West 28th St. Terrace, Topeka, Kansas 1953
Rich, Mrs. Eva, 150 W. 80th St., New York 24, New York 1952
Richards, Tudor, Hurricane Rd., Keene, New Hampshire 1951
*Richardson, Dr. E(dgar) P(reston), 734 Glynn Court, Detroit 2, Michigan 1954
Richdale, Lancelot Eric, 23 Skibo St., Kew, Dunedin SW 1, New Zealand 1945
Richter, Carl H., 703 Main St., Oconto, Wisconsin 1947
Richter, Dr. G(eorge) William, 231 E. Main St., Canfield, Ohio 1954
Ricker, W(illiam) E(dwin), Pacific Biological Station, Nanaimo, British Columbia, Canada 1943
Riesz, Richard P(arrish), 114 Franklin St., Apt. 5-A 2, Morristown, New Jersey 1955
Riggs, Carl D(aniel), Dept. of Zoology, University of Oklahoma, Norman, Oklahoma 1943
Riggs, Jennie, 3313 Fairmont Drive, Nashville 5, Tennessee 1952
Rimsky-Korsakoff, V(ladimir) N(icholas), 220 Middle Rd., Sayville, L. I., New York 1951
Ripley, S(idney) Dillon, II, Peabody Museum, New Haven 11, Connecticut ... 1946
Rising, Gerald R(ichard), 72 Allen's Creek Rd., Rochester 18, New York ... 1953
Rising, James D., 4406 Sunrise Dr., Kansas City, Missouri 1956
*Ritchie, Dr. Robert C., Mansfield Farms, R.R. #2, King, Ontario, Canada ... 1942
**Robbins, Chandler S(eymour), Patuxent Research Refuge, Laurel, Maryland 1941
**Robbins, Eleanor C(ooley), Patuxent Research Refuge, Laurel, Maryland 1936
Roberts, Harold D., 610 Harrison St., Black River Falls, Wisconsin 1946
Roberts, Neddie O'Moore, 915 Boyd Ave., Baton Rouge, Louisiana 1956
Robertson, Mary J., R.D. 2, Box 83c, Homestead, Florida 1954
Robins, C(harles) Richard, 3300 N. Third St., Harrisburg, Pennsylvania 1949
Robinson, Peter J., 333 Crossman St., Jamestown, New York 1956
Robinson, Thane S., Museum of Natural History, University of Kansas, Lawrence, Kansas 1952
Rocheleau, David H., 131 Benton St., Cheboygan, Michigan 1954
Roe, John F., Pride, Louisiana 1956
Roesler, Mrs. M. Stuart, June Rd., Cos Cob, Connecticut 1949
Roesler, M. Stuart, June Rd., Cos Cob, Connecticut 1949
**Rogers, Charles Henry, East Guyot Hall, Princeton, New Jersey 1903
Rogers, John P., Wildlife Bldg., University of Missouri, Columbia, Missouri .. 1956
Rogers, Major Gerald T., 543 N. Beachview Dr., Fort Walton Beach, Florida 1956
Rogers, K(ay) T(rowbridge), Dept. of Zoology, Oberlin College, Oberlin, Ohio 1952
**Rogers, Mabel T., 436 N. Beach St., W., Daytona Beach, Florida 1947
*Rogers, Mrs. Walter E., 911 E. North St., Appleton, Wisconsin 1931
Rooney, James P., 1514 South 12th Ave., Yakima, Washington 1947
**Root, Oscar M(itchell), Brooks School, North Andover, Massachusetts 1940
Root, Richard Bruce, 265 Ann St., Plymouth, Michigan 1953
Rorimer, Mrs. J. M., 6910 Point of Rocks Rd., Sarasota, Florida 1938
Rosche, Richard Carl, 48 Dartmouth Ave., Buffalo 15, New York 1953
Rose, W(illiam) C(umming), 710 W. Florida Ave., Urbana, Illinois 1949
Rosewall, O(scar) W(aldemar), Dept. of Zoology, Louisiana State University, Baton Rouge 3, Louisiana 1931
Rositzky, Simon, 1605 Ashland Blvd., St. Joseph, Missouri 1953
*Ross, C(harles) Chandler), 710 Wolcott Drive, Philadelphia 18, Pennsylvania 1937
Ross, Hollis T., 29 South 2nd St., Lewisburg, Pennsylvania 1956
Ross, James B., 2408 Westminster Way, NE, Atlanta 7, Georgia 1949
**Ross, Mrs. Mary R(eeve) Spear, 455 E. Ridge St., Marquette, Michigan ... 1953
**Rudd, Dr. Clayton G(lass), 315 Medical Arts Bldg., Minneapolis 2, Minnesota 1944
Ruder, Clara Louise, 520 Franklin St., Wausau, Wisconsin 1954

Ruettger, Mrs. Ruby T., 3011 SW 19th Terr., Miami 45, Florida 1954
Ruhland, Mary Lou, 216 N. State St., Apt. 5, Ann Arbor, Michigan 1956
Russell, Stephen M(ims), 267 East Valley, Abingdon, Virginia 1952
Rutter, Russell James, Box 794, Huntsville, Ontario, Canada 1950
Ryder, Ronald A., c/o Utah Coop. Wildlife Research Unit, Utah State Agricultural College, Logan, Utah 1952
Ryel, Lawrence A(twell), Ogenaw State Game Refuge, St. Helen, Michigan 1951
Sabin, Walton B., 652 Kenwood Ave., Slingerlands, New York 1945
Samson, Dale D(umont), 613 Carrolton Blvd., West Lafayette, Indiana 1951
Sanborn, Alvah W., Pleasant Valley Sanctuary, Lenox, Massachusetts 1951
Sandy, Tirzah M., University Hospital, Redwood & Greene Sts., Baltimore 1, Maryland 1950
Sather, John Henry, Western Illinois State College, Macomb, Illinois 1956
Satter, John M., 4500 Millersville Rd., Indianapolis 5, Indiana 1955
Satterly, J(ack), 100 Castlewood Rd., Toronto 12, Ontario, Canada 1947
Sauer, Gordon C(henoweth), 425 E. 63rd St., Kansas City 10, Missouri 1949
Saugsted, N(els) Stanley, R.D. 4, Minot, North Dakota 1939
*Saunders, Aretas A(ndrews), Box 141, Canaan, Connecticut 1934
Saunders, George B(radford), Fish & Wildlife Service — 623 Peachtree, Seventh Bldg., Atlanta 23, Georgia 1926
**Savage, James, Buffalo Athletic Club, Buffalo, New York 1939
*Savery, Don(ald) B(rooks), 8630 Chilson Rd., Brighton, Michigan 1953
Sawyer, Dorothy, 500 Orwood Place, Syracuse 8, New York 1937
Schaich, Charles A., 1301 Walnut St., Reading, Pennsylvania 1951
*Scheidel, Mrs. Bessie M., 94 Wetzel Rd., Pittsburgh 9, Pennsylvania 1956
Schley, Mrs. F. B., 1352 Peacock Ave., Columbus, Georgia 1952
Schlonga, A(ndrew) M(atthew), 511 Thornton St., Leavenworth, Kansas 1952
Schneider, Evelyn J., 2207 Alta Ave., Louisville 5, Kentucky 1935
Schnell, Jay H(eist), 1696 Paper Mill Rd., Meadowbrook, Pennsylvania 1953
**Schnitzer, Albert, 922 Lakeside Place, Elizabeth 3, New Jersey 1953
Schoenbauer, Clara K., 5319 Greenway Dr., Hyattsville, Maryland 1952
**Schorger, A(rlie) W(illiam), 168 N. Prospect Ave., Madison, Wisconsin 1927
**Schultz, Albert B(igelow), Jr., 1117 Broadway, Hewlett, New York 1954
Schumm, William George, 302 C St., LaPorte, Indiana 1944
Schuster, Evelyn E., 111 N. Houghton Ave., Manistique, Michigan 1953
Schwab, Larry T(idd), 169 Main St., Kingwood, West Virginia 1953
Schwartz, Charles Walsh, 131 Forest Hill, Jefferson City, Missouri 1950
*Schwartz, Paul A(lvin), Apartado 1766, Caracas, Venezuela, S. A. 1952
Schwilling, Marvin D., Box 62, Pleasanton, Kansas 1951
Sciple, George W., P.O. Box 1095, Emory University, Georgia 1951
Scotland, Minnie B(rink), 42 Continental Ave., Cohoes, New York 1938
Scott, D. M., Dept. of Zoology, University of Western Ontario, London, Ontario, Canada 1950
Scott, Frederic R(obert), 115 Kennodale Lane, Richmond 26, Virginia 1947
*Scott, Peter, The New Grounds, Slimbridge, Gloucestershire, England 1947
Scott, Thomas G(eorge), Section of Game Research and Management, Illinois Natural History Survey, Urbana, Illinois 1936
Scott, W(alter) E(dwin), 1721 Hickory Dr., Madison 5, Wisconsin 1938
Seaman, George Albert, P.O. Box 472, Christiansted, St. Croix, Virgin Islands 1950
Seeber, Edward L(incoln), 213 Columbia St., Ithaca, New York 1944
Seibert, Henri C., Ohio University, Athens, Ohio 1941
Seibert, Robert F(rederick), 17 Canoe Brook Rd., Short Hills, New Jersey 1954
Seiter, Floyd B., 59124 Main St., Box 113, New Haven, Michigan 1956
Serbousek, Lillian, 1226 Second St. SW, Cedar Rapids, Iowa 1935
Shackleton, Mrs. Walter H., Route 1, Box 76 A, Prospect, Kentucky 1947
Shackleton, Walter H., Route 1, Box 76 A, Prospect, Kentucky 1947
Shaftesbury, Archie D., Women's College, University of North Carolina, Greensboro, North Carolina 1930
Shannon, Mrs. Francis P., 3021 Eagle Pass, Louisville, Kentucky 1949
Sharp, Ward M., 206 Forestry Bldg., Penn. State University, University Park,

Pennsylvania 1936
Shaub, Benjamin Martin, 159 Elm St., Northampton, Massachusetts 1948
Shaver, Jesse M(ilton), 1706 Linden Ave., Nashville 12, Tennessee 1922
*Shearer, Dr. A(mon) R(obert), Box 428, Mont Belvieu, Chambers County, Texas 1893
*Sheffield, O(ren) C(onway), 817 West Houston, Tyler, Texas 1954
**Sheffler, W(illiam) J(ames), 4731 Angeles Vista Blvd., Los Angeles 43, Calif. 1954
Shellenberger, Emmett L(ee), Akron Museum of Natural History, 500 Edgewood Ave., Akron 7, Ohio 1954
Shetler, Stanwyn G(erald), Dept. of Botany, Cornell University, Ithaca, N. Y. 1949
*Shires, James E., 3902nd Support Sq., Offutt AFB, Nebraska 1951
Shobo, Maruto, 334, 42 Nakagomon-cho, Nishinokyo, Nakakyo-Ku, Kyoto, Japan 1956
Short, Wayne, 1130 Fifth Ave., New York 28, New York 1941
Shuler, James B(ernard), Jr., 43 Kirkwood Lane, Greenville, South Carolina 1954
Sibley, Charles G(ald), Fernow Hall, Cornell University, Ithaca, New York 1942
Sibley, Fred C(harles), R.D. #1, Alpine, New York 1953
Sick, Dr. Helmut M., Avenida Nilo Pecanha 23 III, Rio de Janeiro, D. F., Brazil 1951
Sieh, James G(erald), Biology Bldg., Okoboji, Iowa 1948
*Simmons, Mrs. Amelia C., 2742 N. Maryland Ave., Milwaukee 11, Wisconsin 1943
**Simmons, Edward McIlhenny, Avery Island, Louisiana 1942
**Simmons, Grant Gilbert, Jr., Lake Ave., Greenwich, Connecticut 1949
Simon, Stephen Wistar, Blue Mount Rd., Monkton, Maryland 1947
Singleton, Albert Roland, 3968 Marburg Ave., Cincinnati 9, Ohio 1948
Siverling, Mrs. Signa I., Bowbells, North Dakota 1952
Sjodahl, Sven Erik, 7013 Noble Ave., Cincinnati 24, Ohio 1949
Skelton, Mrs. Kathleen Green, Middleton, Delaware 1949
Skutch, Alexander F(rank), San Isidro del General, Costa Rica 1944
Slack, Mabel, 1004 Everett Ave., Louisville 4, Kentucky 1934
*Smith, Allen G(ordon), Box 603, Brigham City, Utah 1949
Smith, Alta, P.O. Box 516, 516 Cedar Ave., Lakeside, Ohio 1956
Smith, Dr. A(rthur) F(rancis), 621 Third St., Manning, Iowa 1934
Smith, Bess M(ay), P.O. Box 337, Arcadia, Oklahoma 1955
*Smith, Emily D., 19651 Glen Una Dr., Los Gatos, California 1948
*Smith, Harry M(adison), 1602 State St., Columbus, Indiana 1936
Smith, Marion L(ucille), 429 S. Willard St., Burlington, Vermont 1949
Smith, Orion O., 2911 Springcreek, Rockford, Illinois 1936
Smith, Rhoda N., Route #1, Box 85, Ontonagon, Michigan 1956
Smith, Robert L(eo), Route #1, Reynoldsville, Pennsylvania 1945
*Smith, Roy Harmon, 883 Bryce Rd., Kent, Ohio 1936
Smith, Sara L., High School, Forbus St., Poughkeepsie, New York 1956
Smith, Thomas Price, Woolridge Ave., Pewee Valley, Kentucky 1951
Smith, Wendell Phillips, Kensington Ave., North Wilkesboro, North Carolina 1921
Snapp, Mrs. R. R., 310 W. Michigan, Urbana, Illinois 1940
Snead, Mrs. Idalene F., 845 South 42nd St., Birmingham 6, Alabama 1956
Snow, Mrs. C. S., 2211 Chester Blvd., Richmond, Indiana 1950
Snyder, Dana Paul, Dept. of Zoology, University of Massachusetts, Amherst, Massachusetts 1949
*Snyder, Dorothy E(astman), 452 Lafayette St., Salem, Massachusetts 1951
Snyder, L(ester) L(ynne), Royal Ontario Museum of Zoology, Queen's Park at Bloor St., Toronto 5, Ontario, Canada 1929
Sommers, Roderic W., 38 Franklin St., Medford 55, Massachusetts 1956
Sooter, Clarence Andrew, U.S. Public Health Service, P.O. Box 625, Greeley, Colorado 1940
**Sorrill, Mrs. Anna Marie, 1501 Kentucky St., Quincy, Illinois 1950
Southern, William, 513 E. Brook, Norman, Oklahoma 1954
Spangler, Iva M., 128 E. Foster Parkway, Fort Wayne, Indiana 1939
Sparkes, Vera E., 2417 Lyndale Ave., N., Minneapolis 11, Minnesota 1951
Speirs, Mrs. Doris Huestis, "Cobble Hill," R.D. #2, Pickering, Ontario, Canada 1936
Speirs, J(ohn) Murray, "Cobble Hill," R.D. #2, Pickering, Ontario, Canada 1931

**Spencer, Haven Hadley, 2645 Bedford Rd., Ann Arbor, Michigan 1946
**Spencer, O(live) Ruth, 1030 - 25th Ave. Court, Moline, Illinois 1938
*Sperry, Charles Carlisle, 1455 S. Franklin St., Denver 10, Colorado 1931
Spofford, Walter R(ichardson), II, Dept. of Anatomy, Syracuse Medical College, Syracuse 10, New York 1942
Stabler, Robert M(iller), Colorado College, Colorado Springs, Colorado 1939
Staebler, Arthur E(ugene), Biology Department, Fresno State College, Fresno, California 1937
Stahl, Marjoretta Jean, Kimberly, West Virginia 1942
Stallcup, William B., Biology Dept., Southern Methodist University, Dallas, Texas 1951
Stamm, Mrs. Frederick W., 2118 Lakeside Dr., Louisville 5, Kentucky 1947
Stanley, Allan John, 1009 NE 17th St., Oklahoma City, Oklahoma 1955
Stanley, Eliot H., 1009 NE 17th St., Oklahoma City, Oklahoma 1955
Stark, Wilma R(uth), 2200 - 19th St. NW, Washington 9, D.C. 1939
Starr, Dr. Robert R., 700 Leslie Ave., Glasgow, Kentucky 1956
Starrett, William C(harles), Illinois State Natural History Survey, R.D. #2, Havana, Illinois 1933
Stasz, C(larence) E(mil), 179 Edgewood Ave., Audubon 6, New Jersey 1953
Stauffer, Dr. Ralph Stanley, 170 W. Washington St., Hagerstown, Maryland 1949
Stearns, Edwin I(ra), Jr., 601 Lake Ave., Wilmette, Illinois 1945
Steel, William C., 551 Morningside Dr., Miami Springs, Florida 1952
Steffen, Earnest William, 1000 Maplewood Dr., Cedar Rapids, Iowa 1944
Steilberg, Robert H., P.O. Box 502, Elizabethtown, Kentucky 1949
Stein, Robert C., Dept. of Biology, Ursinus College, Collegeville, Pennsylvania 1951
Steirly, Charles C., Waverly, Virginia 1954
*Stettenheim, Peter, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1951
Stevens, Charles E(lmo), Jr., 615 Preston Place, Charlottesville, Virginia 1947
Stevens, O. A., State College Station, Fargo, North Dakota 1926
Stevenson, Henry M(iller), Dept. of Zoology, Florida State University, Tallahassee, Florida 1943
Stevenson, James O(sborne), Fish & Wildlife Service, Dept. of the Interior, Washington 25, D.C. 1933
Steward, Orville M(ilton), P.O. Box 19, Fordham Branch, Bronx 58, New York 1950
Stewart, James R(ush), Jr., 844 Natchez, Shreveport, Louisiana 1954
*Stewart, Mildred, 2219 Devonshire Dr., Cleveland 6, Ohio 1949
Stewart, Paul A(lva), 8640 North State St., Westerville, Ohio 1925
*Stewart, Robert Earl, Patuxent Research Refuge, Laurel, Maryland 1939
St. Jacques, N(ormand) F(rederick), 70 Wright Ave., Burlington, Vermont 1955
Stillwell, Jerry E., R.D. #2, Fayetteville, Arkansas 1935
*Stine, Perna M., c/o Mrs. Chester Scherer, R.D. #6, Olney, Illinois 1931
**Stoddard, Herbert Lee, Sherwood Plantation, Route 5, Thomasville, Georgia 1916
**Stokes, Allen W., Dept. Wildlife Management, Utah State Agricultural College, Logan, Utah 1950
**Stoner, Mrs. Dayton, 399 State St., Albany 6, New York 1945
Stoner, Emerson A(ustin), 285 East L St., Benicia, California 1947
Stophlet, John J(ermain), 2612 Maplewood Ave., Toledo 10, Ohio 1934
Storer, Robert Winthrop, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1938
**Storer, Tracy I(rwin), Division of Zoology, University of California, Davis, California 1928
Stotts, Vernon D., Box 44, Stevensville, Maryland 1956
Straw, Richard M(yron), Division of Natural Science, Los Angeles State College, 855 N. Vermont Ave., Los Angeles, California 1947
**Street, Phillips B(orden), Route #1, Chester Springs, Pennsylvania 1946
Street, Thomas M., State Dept. of Health, Bureau of Vector Control, 2151 Berkeley Way, Berkeley 4, California 1940
**Strehlow, Elmer William, Box 1443, Milwaukee 1, Wisconsin 1941
Stringham, Dr. Emerson, Box 986, Kerrville, Texas 1940

***Strong, Dr. R. M., 5716 Stony Island Ave., Chicago 37, Illinois .... Founder
Stuart, Mrs. Glen, R.D. #1, Wakita, Oklahoma 1954
Stull, W. D., R.D. #1, Delaware, Ohio 1952
Stupart, Barbara, 48 Russell Hill Rd., Toronto, Ontario, Canada 1952
Stupka, Arthur, Route #1, Gatlinburg, Tennessee 1935
**Sturgeon, Myron T., Dept. of Geography & Geology, Ohio University, Athens, Ohio 1934
Sturges, Franklin W., 1587 Brooklane, Corvallis, Oregon 1955
Sullivan, R. A., 2645 E. 130th St., Cleveland 20, Ohio 1956
Summers, Lawrence, Dept. of Chemistry, University of North Dakota, Grand Forks, North Dakota 1956
Sundell, Robert A(rnold), 94 Main St., Frewsburg, New York 1951
*Suthard, James G(regory), 1881 Raymond Ave., Long Beach 6, California 1936
Suthers, Roderick A(tkins), 129 Griswold St., Delaware, Ohio 1954
**Sutton, George Miksch, Dept. of Zoology, University of Oklahoma, Norman, Oklahoma 1920
Svardson, Dr. Gunnar, Ödmardsvägen 17, Bromma, Sweden 1949
Swanson, Gustav A., Fernow Hall, Cornell University, Ithaca, New York 1927
Swedenborg, Ernie D(avid), 4905 Vincent Ave. S, Minneapolis 10, Minnesota 1929
*Swetland, David W., S. O. M. Center Rd., Chagrin Falls, Ohio 1953
Swinebroad, Jeff, Dept. of Botany & Zoology, Douglas College, Rutgers University, New Brunswick, New Jersey 1953
Sywalksi, Robert J., 852 Joseph Ave., Rochester 21, New York 1956
*Taber, Wendell, 33 Lexington Ave., Cambridge 33, Massachusetts 1936
Tabert, Rev. Larry, Apartado Postal 380, Veracruz, Mexico 1956
Tabler, Mrs. William B., 6 Glen Hill Rd., Louisville 7, Kentucky 1947
Tabor, Ava Rogers, 305 Canal Blvd., Thibodaux, Louisiana 1940
Tallman, William S(weet), Jr., 4 Linden Place, Sewickley, Pennsylvania 1940
Talvila, Elmer, 111 Natal Ave., Toronto 13, Ontario, Canada 1954
Tanger, John Carroll, Jr., 518 Carlisle St., Hanover, Pennsylvania 1954
Tanghe, Leo J(oseph), 852 Stone Rd., Rochester, New York 1943
Tanner, James Taylor, Dept. of Zoology, University of Tennessee, Knoxville 16, Tennessee 1937
Tashian, Richard E(arl), 413 West 117th St., New York 27, New York 1949
**Taylor, Dr. Arthur Chandler, 309 N. Drew St., Appleton, Wisconsin 1929
Taylor, Mrs. Charlotte M(orley), 4667 Irowood, Saginaw, Michigan 1954
*Taylor, Joseph William, 590 Allen's Creek Rd., Rochester 18, New York 1946
Taylor, Dr. R(obert) L(incoln), 810 Highland Dr., Flintridge, Pasadena 3, California 1947
Teachenor, Dix, 1020 West 61st St., Kansas City, Missouri 1923
*Teale, Edwin Way, 93 Park Ave., Baldwin, L. I., New York 1948
Terney, George E., 109 Hillendale Rd., Pittsburgh 37, Pennsylvania 1956
Terres, John K(enneth), Apt. 3-D, 345 East 57th St., New York 22, New York 1955
Terrill, Lewis McIver, Ulverton R.D. #1, Melbourne, Quebec, Canada 1948
Thomas, Edward S(inclair), 319 Acton Rd., Columbus 14, Ohio 1921
Thomas, Landon B(aillie), 1006 Blaine St., Edgerton, Wisconsin 1947
Thomas, Lester S(t. John), Richboro Rd., Churchville, Pennsylvania 1954
Thomas, Mrs. Rowland, 410 E. Green St., Morrillton, Arkansas 1937
Thompson, E(van) G(wynne), 586 Gulf Bldg. Extension, Houston 2, Texas 1956
Thompson, Marie E(vadne), 2717 Parkview Ave., Kalamazoo, Michigan 1953
Thompson, Max C., Udall, Kansas 1956
Thompson, William Lay, 9710 TU, WRAMC, Washington 12, D.C. 1952
Throne, Alvin L., Wisconsin State College, Milwaukee 11, Wisconsin 1949
**Thorne, Oakleigh, II, 1707 Hillside Rd., Boulder, Colorado 1947
**Thorp, George B(oulton), Carnegie Institute of Technology, Pittsburgh, Pa. 1935
*Todd, Mrs. Elizabeth D., 918 West Main St., Kalamazoo 48, Michigan 1939
Todd, W(alter) E(dmond) Clyde, Carnegie Museum, Pittsburgh 13, Pa. 1911
Tomer, John S(haffer), 4045 E. 27th St., Tulsa, Oklahoma 1954
*Tomkins, Ivan Rexford, 1231 E. 50th St., Savannah, Georgia 1931

Tordoff, Harrison B(ruce), Museum of Natural History, University of Kansas, Lawrence, Kansas 1947
*Townes, George F(ranklin), Masonic Temple, Greenville, South Carolina 1953
*Townsend, Elsie White, Dept. of Biology, Wayne University, 4841 Cass Ave., Detroit, Michigan 1938
Trainer, John E(zra), Dept. of Biology, Muhlenberg College, Allentown, Pennsylvania 1952
**Trautman, Milton B(ernhard), Ohio State Museum, Columbus, Ohio 1932
Travis, Vaud A(ncil), Jr., 1611 Monta St., Muskogee, Oklahoma 1955
*Traylor, Melvin Alvah, Jr., 759 Burr Ave., Winnetka, Illinois 1947
**Tucker, Mrs. Carll, Penwood, Mount Kisco, New York 1928
Tucker, James M(itchell), Paoli, Indiana 1953
Tucker, Robert Edward, 315 N. Cooper St., Jonesboro, Louisiana 1942
Turner, Dr. Robert H(arold), 2218 Cherry St., Toledo 8, Ohio 1953
Twomey, Arthur C(ornelius), Carnegie Museum, Pittsburgh 13, Pennsylvania 1936
Tyrrell, W. Bryant, 246 Park Ave., Takoma Park 12, Maryland 1947
Uhler, Francis Morey, Patuxent Research Refuge, Laurel, Maryland 1931
Ulrich, Mrs. Edward C., 193 LaSalle Ave., Buffalo 14, New York 1952
Ulrich, Edward C., 193 LaSalle Ave., Buffalo 14, New York 1952
Underdown, Henry T., 8216 Manor Rd., Elkins Park, Philadelphia 17, Pa. 1952
Updegraff, Mrs. Paul Walter, 324 Emelyn, Norman, Oklahoma 1955
Urban, Emil K., 1305 Vermont St., Lawrence, Kansas 1956
Ussher, Richard Davy, R.R. #1, Morpeth, Ontario, Canada 1947
Vaiden, M(eredith) G(ordon), Rosedale, Mississippi 1937
Van Cleve, G(eorge) Bernard, 323 S. Fairmont St., Pittsburgh 32, Pennsylvania 1954
Van Covering, Jack, 6150 Commerce Rd., R.D. #1, Orchard Lake, Michigan 1939
Van Deusen, Hobart M(erritt), 12 Highland Ave., Montclair, New Jersey 1941
Van Riper, George, Christiansted, St. Croix, Virgin Islands 1956
Van Tets, G(errard) F(rederick), Acadia Camp, University of British Columbia, Vancouver, British Columbia, Canada 1955
**Van Tyne, Josselyn, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1922
Vane, Dr. Robert F(rank), 600 Dows Bldg., Cedar Rapids, Iowa 1946
**Vaughan, William C(oleman), Locust Grove Farm, River Rd., Youngstown, New York 1941
Vaurie, Dr. Charles, American Museum of Natural History, 79th St. and Central Park West, New York 24, New York 1946
Vincent, Brother I.F.S.C., Saint George High School, 350 Sherman Ave., Evanston, Illinois 1949
Vollmar, Mrs. R(hea) Lewis, 6138 Simpson Ave., St. Louis 10, Missouri 1941
Von der Heydt, James A(rnold), Box 156, Nome, Alaska 1947
Vore, Marvin E(lmer), 1128 N. 8th Ave., West Bend, Wisconsin 1947
*Wachenfeld, Mrs. William A., 787 E. Clarke Place, Orange, New Jersey 1954
Wagner, Mrs. C(ary) R., South Lane Farm, Utica, Ohio 1947
Wagner, Helmuth O., c/o Orientbuchhandlung Friesenplatz, Antwerpenerstrasse 6–12, (22c) Köln, Germany 1945
Walker, Charles F(rederic), Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1939
**Walker, Jason A(lison), 89 Church St., Box 456, Waterloo, New York 1949
**Walkinshaw, Dr. Lawrence Harvey, 1703 Central Tower, Battle Creek, Mich. 1928
Wallace, Edith Adell, 620 Van Buren St., Gary, Indiana 1945
Wallace, George J(ohn), Dept. of Zoology, Michigan State University, East Lansing, Michigan 1937
Wallace, Roy, 63 DuPont St., Toronto 5, Ontario, Canada 1952
*Waltho, Edmund William, 140 Balliol St., Toronto 7, Ontario, Canada 1956
Wanamaker, John F(rederick), Principia College, Elsah, Illinois 1955
Wandell, Willet N(orbert), Route 3, Urbana, Illinois 1944
Wangensteen, Mrs. Owen H., 2832 River Rd. West, Minneapolis 6, Minnesota 1949
*Wanless, Harold R(ollin), 704 S. McCullough St., Urbana, Illinois 1940
Ward, Mrs. Gertrude L(uckhardt), Earlham College, Richmond, Indiana 1953

Warkley, John C., 700 South Beech St., Casper, Wyoming 1955
Warter, Stuart L., 1619 Pennsylvania Ave., Miami Beach 39, Florida 1956
Warters, Mary Ellen, 5115 Woodland Ave., Des Moines 12, Iowa 1950
Wasserfall, William, 22 Roycrest Ave., Willowdale, Ontario, Canada 1956
Watson, Frank Graham, Stony Acres, Route #2, Westport, Connecticut 1937
Watson, James Dewey, Jr., R.D. #2, Box 258, Chesterton, Indiana 1945
Watson, Robert J(ames), Box 75, Blacksburg, Virginia 1943
Watt, Mrs. Leafie Baldwin, P.O. Box 655, De Barry, Florida 1952
Wayland-Smith, Robert, 137 Kenwood Ave., Oneida, New York 1952
Weaver, Mrs. Alice Helen Brown, 1434 Crain St., Evanston, Illinois 1948
*Weber, Louis M(arkus), 340 Crest Dr., Sherman, Missouri 1941
Webster, Clark G(ibbons), Patuxent Research Refuge, Laurel, Maryland 1948
Webster, J(ackson) Dan, Hanover College, Hanover, Indiana 1939
Weise, Charles M(artin), Dept. of Zoology, Univ. of Wisconsin, Milwaukee 11, Wisconsin 1949
Weiser, Virgil Leonard, 1106 Third St., N., Fargo, North Dakota 1946
Weller, Milton Webster, Wildlife Conservation Bldg., University of Missouri, Columbia, Missouri 1950
Wellman, Mrs. Cora B(yard), Bank Village, Greenville, New Hampshire 1951
Wells, LaRue, 807 W. Liberty, Ann Arbor, Michigan 1953
Welty, Carl, Route #1, Beloit, Wisconsin 1948
Wernicke, Mrs. J(ulius) F., R.D. #6, Box 39, Pensacola, Florida 1944
Weschgel, Alice M., 1144 Lafayette St., SE, Grand Rapids 7, Michigan 1956
West, David A., Dept. of Conservation, Fernow Hall, Cornell University, Ithaca, New York 1955
West, Mrs. E. M., 1625-S Clayton Ave., SE, Chattanooga 11, Tennessee 1950
West, Henry C(lopton), 4660 E. 42nd St., Indianapolis 18, Indiana 1953
Weston, Henry G(riggs), Jr., San Jose State College, San Jose 14, California 1947
Wetherbee, David K(enneth), 11 Dallas St., Worcester, Massachusetts 1947
**Wetmore, Alexander, U.S. National Museum, Washington 25, D.C. 1903
*Weydemeyer, Winton, Fortine, Montana 1930
Weyer, Albert E., Firestone Plantations Co., Harbel, Liberia, West Africa 1949
Weyl, Edward Stern, 3827 The Oak Rd., Philadelphia 49, Pennsylvania 1927
Whelan, Mary Elizabeth, 310 Amity St., Muskegon, Michigan 1951
Whitaker, Mrs. Lovie, c/o Dr. John R. Whitaker, School of Journalism, University of Oklahoma, Norman, Oklahoma 1947
Whiting, Rober A(rchie), 2521 Cobb Rd., Jackson, Michigan 1947
Whitman, J(ames) Douglas, R.D. 1, Jordan, New York 1956
Whitney, Dr. Nathaniel R(uggles), Jr., 4350 Meadowwood Dr., Rapid City, South Dakota 1942
**Wickstrom, George M(artin), 2293 Harding Ave., Muskegon, Michigan 1951
Wiens, John A(nthony), 428 Chautauqua, Norman, Oklahoma 1954
Wiggin, Henry T(aylor), 151 Tappan St., Brookline 46, Massachusetts 1941
Wilcox, LeRoy, Speonk, Long Island, New York 1944
*Wilder, Theodore G(arfield), 125 Oxford Rd., Waukesha, Wisconsin 1948
Wiles, Dr. Harold O(liver), 537 Campbell Ave., Kalamazoo, Michigan 1936
Wiley, Richard H., Jr., 210 Pleasantview Ave., Louisville 6, Kentucky 1956
Wilkowski, William W(alter), 1235 Craft Ave., Kalamazoo, Michigan 1943
*Williams, George G., The Rice Institute, Houston, Texas 1945
Williams, Laidlaw O(nderdonk), R.R. #1, Box 152, Carmel, California 1930
Williams, Raymond E., 1036 S. Bradshowe Ave., Monterey Park, California 1950
Williamson, Francis S. L., Arctic Health Research Center, P.O. Box 960, Anchorage, Alaska 1955
Willis, Cornelius G(rinnell), 1 Carter Ave., Sierra Madre, California 1948
Willis, Myra G., 1720-6th Ave., SE, Cedar Rapids, Iowa 1944
Willms, A. George, Route #2, Urbana, Illinois 1950
Willoughby, John E., 106 Worden, Ann Arbor, Michigan 1954
*Wilson, Archie F(rancis), 390 Hartshorn Dr., Short Hills, New Jersey 1937
Wilson, Gordon, 1434 Chestnut St., Bowling Green, Kentucky 1920
Wilson, Harold Charles, Ephraim, Wisconsin 1938
Wilson, John Elder, R.D. #2, Clayton, New York 1948

Wilson, Nixon A., 522 N. Third St., Bardstown, Kentucky ... 1954
Wilson, Rowland S(teele), CDR, USN, Box F, USNLO, GIB, Navy 214, FPO, New York ... 1941
**Wineman, Andrew, 150 Michigan Ave., Detroit, Michigan ... 1934
**Wing, Harold F(rancis), Route #3, Jackson, Michigan ... 1941
Wing, Leonard W(illiam), 3875 Vorhies Rd., Ann Arbor, Michigan ... 1924
Wistey, Mrs. A. L., South English, Iowa ... 1944
Witmer, S(amuel) W(enger), 1608 S. 8th St., Goshen, Indiana ... 1948
Wolf, Mark A(dam), 2609 Jefferson Ave., Midland, Michigan ... 1955
Wolfarth, Floyd Parker, 133 High St., Nutley, New Jersey ... 1950
Wolfe, Col. L(loyd) R(aymond), Route 1, Kerrville, Texas ... 1951
Wolfson, Albert, Dept. of Zoology, Northwestern University, Evanston, Ilinois 1944
Wolk, Robert G(eorge), Dept. of Conservation, Fernow Hall, Cornell University, Ithaca, New York ... 1952
Wolters, Hans E., Nikolaus-Becker-Strasse, (22c) Geilenkirchen Bei Aachen, Nordrhein-Westfalen, Germany (British Zone) ... 1952
Wood, Dr. Harold B(acon), 3016 N. Second St., Harrisburg, Pennsylvania ... 1932
Wood, Merrill, Dept. of Zoology & Entomology, Pennsylvania State University, University Park, Pennsylvania ... 1945
Wood, Robert C(raig), 1007 Los Trancos Rd., Menlo Park, California ... 1953
Woolfenden, Glen E(verett), Dept. of Biology, Box 195, University of Florida, Gainesville, Florida ... 1954
Woolfenden, Mrs. J. T., 4600 Firestone Ave., Terrace 6, Dearborn 2, Michigan 1951
Worley, John G(raves), 160 Charleston St., Cadiz, Ohio ... 1936
Worthley, Mrs. Elmer G(eorge), Owings Mills, Maryland ... 1955
Wright, A(lbert) J(ay), c/o Bache & Co., Ellicott Square, Buffalo, New York 1952
Wright, Audrey Adele, 1312 Hepburn Ave., Louisville 4, Kentucky ... 1941
Wright, Bruce S(tanley), Northeastern Wildlife Station, University of New Brunswick, Fredericton, New Brunswick, Canada ... 1948
Wright, Lt. Col. Dana M(onroe), Box 36, St. John, North Dakota ... 1943
Wright, Mrs. D. O., Route 13, Box 236, Birmingham, Alabama ... 1955
Wright, Jean M(cClellan), 3444 Cornell Place, Cincinnati 20, Ohio ... 1954
Wright, Philip L(incoln), Montana State University, Missoula, Montana ... 1940
Wright, Robert L., 16766 Lindsay Ave., Detroit 35, Michigan ... 1956
Wykoff, Jack N., Box 518, Earlham College, Richmond, Indiana ... 1955
*Wylie, William L(ewis), Zpswich River Sanctuary, Perkins Row, Topsfield, Massachusetts ... 1947
Yeager, Lee E(mmett), Colorado Wildlife Research Unit, Colorado A&M College, Fort Collins, Colorado ... 1939
Yealy, Dr. W(endell) Holmes, 427 Springcreek Dr., Webster Groves 19, Mo. 1952
*Yeatter, R(alph) E(merson), Illinois Natural History Survey, Urbana, Illinois 1932
Yohe, Merrill Austin, New Oxford, Pennsylvania ... 1954
Young, J. Addison, II, 60 Argyle Ave., New Rochelle, New York ... 1942
Young, James B(oswell), 514 Dover Rd., Louisville 6, Kentucky ... 1937
Young, Howard F(rederick), Dept. of Biology, Wisconsin State College, La Crosse, Wisconsin ... 1947
*Youse, James Richard, Lava Beds National Monument, Tulelake, California ... 1949
Zaenglein, Ralph J., 402 Willard St., Maryville, Tennessee ... 1952
Zel, Mrs. Louisa M(agnus), Calle Trece No. 915, Havana, VEDADO, Cuba ... 1953
**Zimmerman, Dale, 480 N. Almont St., Imlay City, Michigan ... 1943
Zimmerman, Harold A(lexander), 2218 N. Linden St., Muncie, Indiana ... 1954
Zimmerman, James H(all), 2114 Van Hise Ave., Madison 5, Wisconsin ... 1947
Zimmerman, John L(ester), 7447 Stanwich Dr,, Houston 17, Texas ... 1951
Zinn, Miss Libbie, 525 Rivard Blvd., Grosse Pointe, Michigan ... 1954
Zizka, Paul, Box 136, Abington, Connecticut ... 1956
Zurcher, Olga Celeste, 1253 Union St., Clearwater, Florida ... 1948
Zusi, Richard L(aurence), 928 S. Forest, Ann Arbor, Michigan ... 1953

Members are urged to report errors in the membership roll to the Treasurer, Ralph M. Edeburn.

INDEX TO VOLUME 68, 1956

This index includes, in addition to names of species and authors, references to the following topics: anatomy, behavior, conservation, food habits, fossils, geographic localities, migration, nesting, plumages, predation, voice, and weights. Also included are references of biological significance to mammals and reptiles. Names of new forms described in this volume are printed in **boldface** type.

This issue of *The Wilson Bulletin* was published on January 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 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

which will convene on the campus of

THE UNIVERSITY OF MINNESOTA, DULUTH BRANCH

DULUTH, MINNESOTA

June 13–16

Sponsors:

Minnesota Ornithologists Union
University of Minnesota, Duluth Branch
Duluth Bird Club

In 1958, the Society visits Oglebay Park, Wheeling, West Virginia, from April 24–27

Date Due

~~JAN 5 1962~~
~~JUL 27 1962~~
~~JAN 24 1964~~
~~FEB 7 '68~~
~~MAR 1973~~
~~JUN 1974~~
~~JUN 1974~~
~~MAY 1975~~
~~MAY 1975~~
~~Reserve B. 19~~
~~Reserve B.10~~
~~spring 76 19~~
MAY 05 1998