The Wilson Bulletin

PUBLISHED BY THE WILSON ORNITHOLOGICAL SOCIETY
WEST VIRGINIA U. · MORGANTOWN, W. VA.

VOL. 79, No. 1, MARCH 1967 PAGES 1–128

THE WILSON ORNITHOLOGICAL SOCIETY

FOUNDED DECEMBER 3, 1888

Named after ALEXANDER WILSON, the first American Ornithologist.

Membership dues per calendar year are: Sustaining, $10.00; Active, $5.00.

THE WILSON BULLETIN is sent to all members not in arrears for dues.

THE JOSSELYN VAN TYNE MEMORIAL LIBRARY

The Josselyn Van Tyne Memorial Library of the Wilson Ornithological Society, 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, reprints, and ornithological magazines from members and friends of the 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 contribution, 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. William A. Lunk, University Museums, University of Michigan, is Chairman of the Committee. The Library currently receives 104 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 Josselyn Van Tyne Memorial Library, University of Michigan Museum of Zoology. Ann Arbor, Michigan." Contributions to the New Book Fund should be sent to the Treasurer (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 newly acquired books are listed periodically.

THE WILSON BULLETIN

The official organ of the Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Morgantown, West Virginia. The subscription price, both in the United States and elsewhere, is $5.00 per year, effective in 1965. Single copies, $1.25. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at $1.25 each) and may be ordered from the Treasurer. Special prices will be quoted for quantity orders.

All articles and communications for publications, books and publications for reviews should be addressed to the Editor. Exchanges should be addressed to The Josselyn Van Tyne Memorial Library, Museum of Zoology, Ann Arbor, Michigan.

Second class postage paid at Lawrence, Kansas, U.S.A.

PRINTED IN U.S.A. Allen Press Inc., Lawrence, Kansas

THE
WILSON BULLETIN

A Quarterly Magazine
of
Ornithology

GEORGE A. HALL
EDITOR

ORNITHOLOGICAL LITERATURE EDITOR
OLIN SEWALL PETTINGILL, JR.

Volume 79
1967

Published
by
THE WILSON ORNITHOLOGICAL SOCIETY

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY
Published by The Wilson Ornithological Society

Vol. 79, No. 1 MARCH 1967 Pages 1–128

CONTENTS

GENERAL NOTES

Dean Amadon, *Birds around the World: A Geographical Look at Evolution and Birds*, reviewed by Harold Mayfield; Maurice Brooks, *The Appalachians*, reviewed by Ernest P. Edwards; A. W. Johnson, *The Birds of Chile and Adjacent Regions of Argentina, Bolivia, and Peru*, reviewed by Claes Chr. Olrog; Harold C. Hanson, *The Giant Canada Goose*, reviewed by Charles D. MacInnes; Arthur S. Einarsen, *The Black Brant: Sea Goose of the Pacific Coast*, reviewed by Karl W. Kenyon; Henry Hill Collins, Jr. and Ned R. Boyajian, *Familiar Garden Birds of America*, reviewed by W. J. Breckenridge.

VARIATION IN CENTRAL AMERICAN FLICKERS

Lester L. Short, Jr.

While investigating hybridization and its effects on flicker populations, I undertook a general study of variation in the two North and Middle American species, *Colaptes auratus and C.* (*Nesoceleus*) *fernandinae.* For reasons presented elsewhere (Short, 1965*a*) the five major groups of *C. auratus*, namely the *auratus*, *cafer*, *chrysoides*, *chrysocaulosus*, and *mexicanoides* groups, are considered conspecific. (A vernacular name for this assemblage is difficult to arrive at; perhaps "Black-breasted Flicker" best describes and distinguishes *C. auratus.*) The present paper deals with variation in the allopatric Central American *mexicanoides* subspecies group of *Colaptes auratus.* This group is currently comprised (Peters, 1948) of the races *mexicanoides* and *pinicolus*, which are usually regarded (Peters, 1948; Blake, 1953; Eisenmann, 1955; Miller, et al., 1957) as part of the "species" *Colaptes cafer.* I have elsewhere dealt with variation in the allopatric, West Indian *chrysocaulosus* subspecies group of *C. auratus* (Short, 1965*b*), and variation in the *mexicanoides* group will be treated similarly. Mensural and plumage features of this widespread species of flicker are highly variable, and their plumage patterns lend themselves to study because they are composed of discrete elements such as bars, spots, and patches.

MATERIALS AND METHODS

The study of Central American flickers was hampered by lack of specimens from various areas within this region of diverse terrain and habitats. For the sake of comparison with other populations of flickers, attention was focused primarily on late winter, spring and early summer specimens, i.e., those taken roughly during the breeding season. Seasonal variation was considered, and specimens collected at other times of the year were also included in the analysis when no seasonal variation was noted. Only adult flickers are considered here, as variation in the juvenal plumage of *Colaptes auratus* will be discussed elsewhere. The total number of adult specimens from which data in the report were gathered is 160. These include 90 males and 70 females from Mexico (Chiapas), Guatemala, El Salvador, Honduras, and Nicaragua.

Sample sizes were insufficient to make locality by locality comparisons. Available specimens were therefore grouped into five composite samples, although this procedure is admittedly less desirable. Figure 1 depicts localities represented by specimens used in this study, and also shows the segregation of composite samples. These will hereafter be designated the Chiapas, Guatemala, El Salvador, Honduras, and Nicaragua samples.

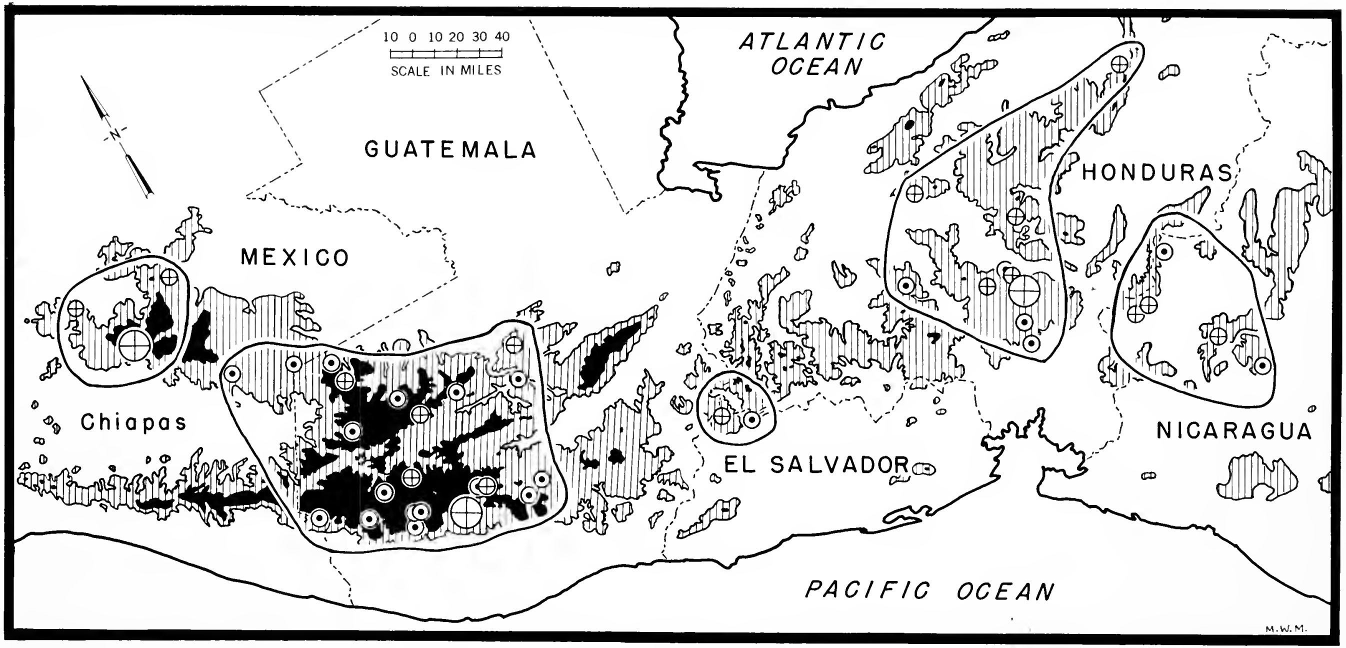


Fig. 1. Central America showing localities represented by flicker specimens used in this study. Localities represented by three or more specimens are marked with a cross, while circles enclosing a spot denote localities represented by one or two specimens. Composite samples described in the text as Chiapas, Guatemala, El Salvador, Honduras, and Nicaragua samples come from the five regions (from left to right, respectively) enclosed within the heavy lines. Areas over 2,000 meters in elevation are shown in black, while areas between 1,000 and 2,000 meters in elevation are indicated by vertical lines. The map, including the contour intervals was drawn from the American Geographical Society 1 : 1,000,000 maps.

The composite Nicaraguan sample was secured in the mountains of northern Nicaragua, with specimens principally from San Rafael del Norte (total Nicaraguan sample = 8♂♂, 5♀♀). The Honduran sample mainly represents east-central Honduras, and includes moderate-sized samples from Subirana, Rancho Quemado, Cantoral, El Hatillo, and the vicinity of Tegucigalpa (total sample = 25♂♂, 20♀♀). The El Salvador sample comes principally from Los Esesmiles, Department of Chalatenango (total sample = 7♂♂, 6♀♀). This composite sample, representing the small highland area of El Salvador, includes the only flickers available from central Honduras to east-central Guatemala; it is effectively a "West Honduran" sample.

The Guatemalan composite sample (33♂♂, 33♀♀) is principally derived from central and west-central Guatemala, with the following major localities: Lake Atitlán area, Momostenango, Nebaj, and San Mateo. It also includes the eastern-most Chiapan localities Comitán, 25 miles SE Comitán, and Volcan de Tacaná. The Chiapas sample (7♂♂, 6♀♀) comes from three areas in the central Chiapas highlands (Ocosingo, Pueblo Nuevo, San Cristóbal de las Casas). The diversity within samples, particularly the Guatemalan sample, somewhat restricts comparisons. The statistics presented below for the composite samples reflect their variability, and are valid for the specimens being analyzed.

Standard taxonomic procedures were used in the investigation. Measurements taken were: wing length (chord), tail length, bill length (from nostril, except as noted) and tarsal length. Data concerning some 30 quantitative and qualitative characters were utilized in this study. Information derived from study of some 5,000 specimens of flickers and their relatives (both sexes and all age groups) provided a broad basis for considering variation in Central American flickers.

ECOLOGY AND BEHAVIOR

Little is known of the ecology and behavior of the *mexicanoides* group of flickers. The birds occur primarily in open pine forest and pine-oak woodland at various altitudes. Although generally found at elevations over 5,000 feet in Guatemala (Griscom, 1932; Land, 1962), they at least occasionally descend to much lower altitudes. Dickey and van Rossem (1938) reported flickers occurring in El Salvador down to 2,400 feet, and a female specimen in the American Museum of Natural History (No. 326633) was taken at 2,050 feet in Honduras. These flickers are similar to other North American flickers (*Colaptes auratus*) in habits and behavior. They sufficiently resemble the *cafer* subspecies group that most workers (see citations above) consider them as part of *Colaptes "cafer."* Dickey and van Rossem (1938:309) write of *mexicanoides* as follows: "There appears to be little or no difference, in the ecological niche occupied, between these El Salvador flickers and their northern congeners. In call notes, habits, choice of nesting sites, and appearance in life, they are scarcely, if at all, to be distinguished from *Colaptes cafer.*" Wetmore (1941:547) found Guatemalan *mexicanoides* like "typical flickers in appearance," but considered their calls "quite different from the

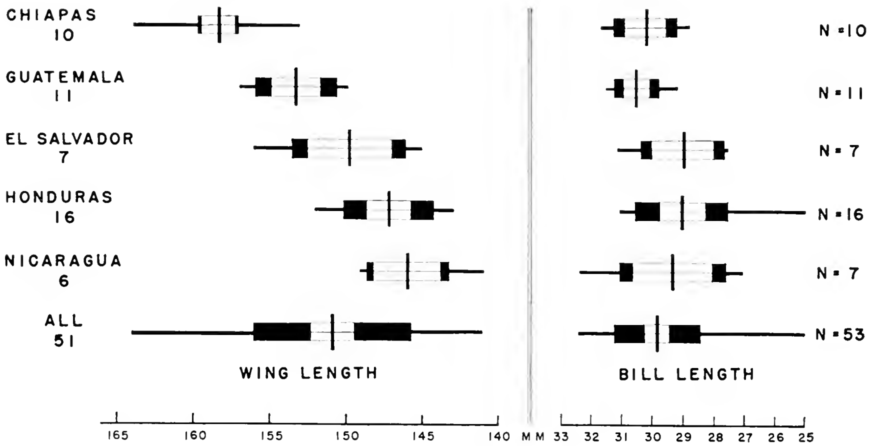


FIG. 2. Analysis of wing length and bill length in male Central American flickers. The dark vertical lines indicate the means, and the horizontal lines the ranges of variation in the samples. The white rectangle includes two standard errors around the mean, and each black rectangle includes one standard deviation on both sides of the mean.

notes of the northern species." Further observations of the behavior and ecology of Central American flickers, comprising the southernmost (and an allopatric) population of *Colaptes auratus*, should be encouraged.

CHARACTER ANALYSIS

Wing Length

Variation in wing length is considerable, individual variation being pronounced to the extent that female sample means are in several instances greater than those of males. The geographical variation is clinal, with northwestern birds (Chiapas) having wings averaging 9–12 millimeters longer than those of southeasternmost flickers (Nicaragua). The cline for males (Fig. 2) has its steepest gradient between Guatemala and El Salvador, while that for females is steepest from El Salvador to Honduras. The longest-winged male is from Chiapas and the shortest-winged male from Nicaragua; the female with the longest wings is from Guatemala and that with the shortest wings from Honduras. Nicaraguan and Honduran birds do not overlap Chiapas specimens in wing length, but do overlap measurements of Guatemalan birds. El Salvador flickers are intermediate between those from Honduras and Guatemala, and their variation is sufficient to overlap extreme samples from Nicaragua and Chiapas. Females have wings averaging but slightly shorter than those of males.

Tail Length and Tail: Wing Ratios

There is a general cline of decreasing tail length from northwest to southeast, with the tails of Chiapas birds averaging only 5–8 millimeters longer than those of Nicaraguan flickers (Fig. 3). The cline is less marked than that for wing length. El Salvador birds (both sexes) average closer to Chiapan flickers than do those from Guatemala. Despite the small size of the Nicaraguan samples, both male and female ranges overlap those of

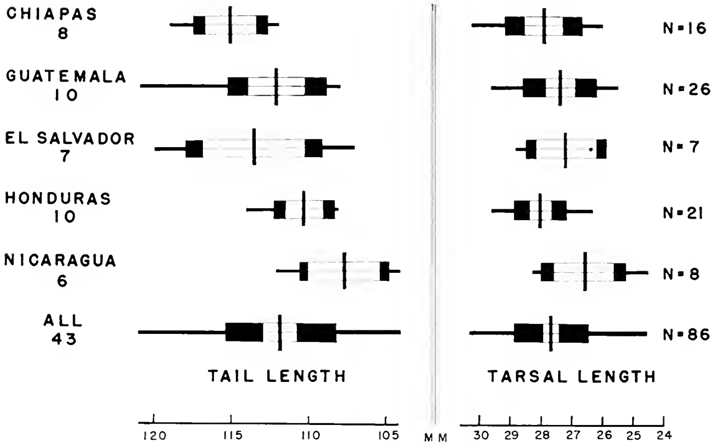


Fig. 3. Analysis of tail length and tarsal length in male Central American flickers. The dark vertical lines indicate the means, and the horizontal lines the ranges of variation about the means. The white rectangle includes two standard errors around the mean, and each black rectangle includes one standard deviation on both sides of the mean.

the Chiapas samples. The southeastern flickers tend to have proportionally longer tails than those from Chiapas and Guatemala, as the Honduran-Nicaraguan birds show tail length 4.5–6% and wing length about 7% shorter than those of Chiapan flickers. Females' tails average less than 1% shorter than those of males.

Bill Length

This feature is variable in flickers, and the Central American birds are no exception. The more southeastern flickers have slightly shorter bills, but the average difference in samples of both sexes is only a little over one millimeter (Fig. 2). The small Chiapan and Nicaraguan female samples are virtually alike in bill length. Particular attention was devoted to this character, for a chief characteristic of Dickey and van Rossem's (1928) race *pinicolus* is its shorter bill. Their measurements of the culmen from its base (op. cit., p. 131) are:

pinicolus —7 ♂♂ (El Salvador) —38.9–41.6 mm, mean 40.1 mm
mexicanoides—4 ♂♂ (Chiapas) —42.4–44.6 mm, mean 44.0 mm

I obtained the following measurements of the culmen (from the base):

Chiapas —6 ♂♂—41.7–43.3 mm, mean = 42.73 mm
Guatemala —6 ♂♂—42.8–44.4 mm, mean = 43.35 mm
El Salvador —5 ♂♂—38.8–41.9 mm, mean = 40.78 mm
Honduras —7 ♂♂—39.4–42.5 mm, mean = 41.31 mm
Nicaragua —7 ♂♂—38.6–43.4 mm, mean = 40.63 mm

El Salvador birds, from data for both kinds of measurements, do indeed appear to have shorter bills than those from Guatemala and Chiapas. However, the sample from El Salvador is small, and flickers from farther southeast are variable enough to overlap considerably with northwestern birds. In fact, the Nicaraguan sample for the bill length from nostril measurement (Fig. 2 for males; females also show this) and for culmen length from the base of the bill, *completely* overlaps measurements of the Chiapan birds. Considering the great variability of bill length in flickers, the difference between El Salvador and Guatemalan-Chiapan flickers is minor. Individual variation dependent upon psychological and/or food availability factors results in variation in bill wear. An example of such effects is shown by comparison of two flickers for various bill measurements:

Specimen	a. bill length (from nostril)	b. bill length (exposed culmen)	c. bill length (culmen from base)	c. minus a
♂ Univ. Calif. Los Angeles 18375 (El Salvador)	30.8 mm	37.7 mm	41.9 mm	11.1 mm
♂ Univ. Calif. Mus. Vert. Zool. 115400 (Chiapas)	28.8 mm	37.0 mm	43.3 mm	14.5 mm

Thus, the "shorter billed" Chiapas flicker (taken April 7) has a much longer bill base and a worn bill, while the "longer-billed" El Salvador bird (taken February 19) exhibits a shorter bill base and longer bill tip. Because of the effects of wear, minor bill length differences are hence rendered unsatisfactory for defining populations of flickers. Bills of females average 3–4% shorter than those of males.

Tarsal Length and Ratios

Considerable individual variation in tarsal length was evident, and means for the Chiapan to Honduran samples are within a millimeter or so of each other (Fig. 3) with great overlap. Despite a significant difference between Honduran and Nicaraguan samples, overlap of both with other samples lessens its importance. Tarsal length thus shows no apparent geographic variation in the northwestern four samples, but appears to diminish between Honduras and Nicaragua. The tarsi of females average 1–2% shorter than those of males. Due to the greater variation in bill length, and considerable variation in tarsal length, ratios of tarsal length : bill length are highly variable. The total range for 110 adults is 0.79–1.08, the same as the range for the single Guatemalan sample.

Wing Shape and Length of 10th Primary

The non-migratory Central American flickers have relatively shorter, more rounded wings than their relatives to the north, including *C. a. mexicanus.* In fact, their wings are shaped very like those of the *chrysocaulosus* subspecies group (also non-migratory) of the West Indies (Short, 1965*b*). The more rounded shape of the wings in *mexicanoides* is caused by its generally short central primaries (P5–P8), and its fairly long outer (P9, P10) and inner (P1–P4) primaries. The fourth primary is almost as long as P8 in this form, not considerably shorter as in more northern races of *C. auratus.* The third primary is considerably longer than P9, P2 is as long as or (usually) longer than P9, and P1 may be as long as P9.

The tenth primary is closely similar in length among individuals of the various samples. El Salvador and Honduran birds have this primary the same size or longer than those of Guatemalan and Chiapan birds, while the tenth primaries of Nicaraguan flickers are barely shorter. Mean P10 lengths and sample sizes are as follows (measurements in millimeters):

	Chiapas	Guatemala	El Salvador	Honduras	Nicaragua
♂	41.80 (5)	40.56 (9)	42.60 (5)	41.33 (9)	39.14 (7)
♀	–	39.11 (18)	42.60 (5)	40.38 (8)	39.60 (5)

Lack of a cline in P10 length renders this primary proportionally longer in the shorter-winged southeastern populations.

Mean measurements of the ninth primary follow (these measurements are taken from the tip of the feather to the skin around the base of the feather):

	Chiapas	Guatemala	El Salvador	Honduras	Nicaragua
♂	96.60 (5)	93.83 (6)	95.60 (5)	90.63 (8)	90.14 (7)
♀	–	94.07 (14)	96.3 (4)	88.63 (8)	90.40 (5)

Birds from El Salvador have longer ninth primaries, like Chiapan and Guatemalan birds. However, the longer tenth primary in El Salvador flickers renders that sample more like birds from Honduras than those from Nicaragua in the P10 : P9 ratio. A "*t*" test of the difference in the length of P9 between Guatemalan-Chiapan and Honduran-Nicaraguan flickers gave "*t*" values indicating a highly significant difference ($P = 0.001$ or less) for both sexes.

Breast Spotting

As noted by Lafresnaye (1844) in describing *mexicanoides*, this form has more transverse, bar-like spots than northern flickers. Only one of 91 adults had spots deeper than broad. Depth and width of a "normal" central breast spot were measured in each specimen. Averages for the five samples ranged as follows:

	Range of average breast spot depth	Range of average breast spot width
♂♂—	3.7–4.3 mm	5.4–6.1 mm
♀♀—	3.7–4.4 mm	5.4–7.5 mm

Chiapan flickers have rounder spots than those of the other samples (mean difference between spot depth and spot width = 1.37 mm in 15 Chiapan adults, and 2.15 mm for 79 adults from southern Chiapas to Nicaragua). Females tend to have broader spots than do males. More breast spots are visible per unit area in *mexicanoides* than any other subspecies group except *chrysocaulosus*.

The strong tendency toward barring in this form is also indicated by the fact that the lower abdomen was barred in all but two of 77 adults checked for this feature. The other two birds showed chordate bars, and none exhibited spots. As in other flickers the females tend to be more strongly barred than males.

Breast Patch

Like the *chrysoides* and *chrysocaulosus* subspecies groups, *mexicanoides* has a deep round, rather than narrow, crescentic breast patch. The depth of the patch is variable, and the northwestern samples (Chiapas-Guatemala) in particular show very deep breast patches. A statistical treatment of the data is presented in Figure 4 (males only). The difference between the northwestern two and southeastern three samples is considerable, of the order of 12–18%, compared with only a 6–7% wing length difference between the extreme samples. Besides this geographic variation, *mexicanoides* exhibits a rather considerable sexual difference in breast patch depth.

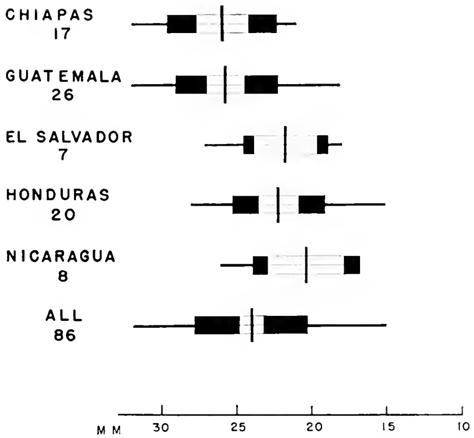


FIG. 4. Analysis of breast patch depth in male Central American flickers. The measurement is of the maximum depth of the breast patch. Vertical lines denote means, horizontal lines indicate the ranges of variation within the samples. Each white rectangle includes two standard errors around the mean, and each black rectangle includes one standard deviation on both sides of the mean.

Malar Patch

The male malar patch in *mexicanoides* is variable in color, from red mixed with considerable black, to red. An anterior area before the red-black portion is colored cinnamon-rufous, and averages 11% (sample means 9–13%) of the total malar region. Utilizing malar color scores fully described elsewhere (Short, 1965*a*), the specimens were assigned scores of "2"–"4" (briefly, "2" = 25–75% red, rest black; "3" = about 1–24% black; and "4" = all red). Considerable individual variation was encountered, especially in the northwestern samples. The following scores were attained by 87 males: "2" = 12, "3" = 73, "4" = 2.

Females generally have cinnamon-rufous malar patches, with black or red visible on the surface in 18 of 39 adults (46%). Shafts of the females' malar feathers are black at their bases. Gray color is lacking in malars of 79% (29 of 39) of the females, and when present is found only in traces (up to 15% of malar area in one Honduran female). Eight of the ten birds showing gray color are from the southeastern three samples. Only one of 36 males showed gray color amid the cinnamon in the anterior part of its malar patch, and that male is from Honduras. The southeastern flickers thus show less black in the male malar patches and more gray traces in those of females.

Back Barring

Perhaps the most striking feature of *mexicanoides* is its much broader back barring. Statistical treatment of data for back bar depth of all adults follows:

	N	$\overline{X} \pm 2$ SE	SD	Range	Coeff. Var.
♂♂	88	3.65 ± 0.10 mm	0.45 mm	2.3–4.8 mm	12.33%
♀♀	68	3.65 ± 0.10 mm	0.41 mm	2.6–4.6 mm	11.23%

There is no sexual difference in *mexicanoides*, though females of other subspecies groups of *Colaptes auratus* have broader bars than males. Back bar depth is much greater than in all other forms of *C. auratus*, including the *chrysocaulosus* group. There is no apparent geographic variation in this character.

Test (1940) showed that *mexicanoides* has broader dark back bars than other North American flickers, and pointed out that the light brown interspaces between the dark back bars of *mexicanoides* are of the same width or narrower than the dark bars (in contrast to the situation in other forms of *Colaptes auratus*, which have interspaces always broader than the bars). He also noted that the interspaces are often two shades of brown, being duskier near the black bars and more cinnamon-rufous away from them. This imparts a tri-colored effect to the back color, an effect not noted in other North American flickers. Bars on the upper wing coverts of *mexicanoides* are also broader than in other North American flickers.

The number of dark bars on the back feathers is also greater in *mexicanoides.* The number of complete and incomplete (bars noted as ⅓, ½, ⅔ complete or incomplete) bars was counted on an upper back feather of 76 adults. No sexual difference was evident, the male mean being 2.51 and that for the females 2.46 (means for more northern flickers vary between 1.4 and 2.1). Sample means clustered around 2.5, and no geographic variation was noted. The dark bar at the tip of each back feather was not counted. These bars are small, but of sufficient depth so that some breeding birds with worn feathers still possess them (in contrast, flickers from farther north have narrower black tips, nearly always worn off by the breeding season).

Back Color

The backs of these flickers are rich, cinnamon brown to rufous brown, marked with dark bars which are often (especially in southeastern populations) buff-bordered. Chiapan birds average darker than the others, and show less variability. Guatemalan flickers are highly variable, and exhibit the light and dark extremes of *mexicanoides.* Samples from El Salvador, Honduras, and Nicaragua contain mostly lighter colored birds, but a few Honduran individuals match the darkest Chiapan flickers. Females do not differ from males in back color. Seasonal variation is considerable, the back color being much darker in fall birds than in those taken during the breeding season.

Rump Markings

North American flickers generally exhibit a white rump patch. This patch is, however, partly obscured by spots or bars in occasional individuals of the *auratus*, *cafer*, and *chrysoides* subspecies groups, while the *chrysocaulosus* and *mexicanoides* groups generally have spotted and/or barred rumps. Scores were assigned as follows:

Score	Condition of rump markings
0	White, no markings
1	1–6 spots or bars
2	More than 6 bars or spots, but rump largely white
3	Many markings, but one or several areas of white with no marks
4	Barred and/or spotted throughout

Central American flickers generally have rump patches scoring "2" or "3," but scores range from "1" to "4." Females consistently show higher scores, as in all populations of *Colaptes auratus.* Geographic variation is slight, and principally involves reduction of markings in the southeastern populations. Nicaraguan flickers especially exhibit less barring or spotting in their rumps, and seven of the ten individuals scoring "1" come from Nicaragua and Honduras. The lowest number of marks found was two, in a Nicaraguan flicker. The average score for all Central American males was 2.63 ($N =$

87, SE = 0.03, SD = 0.84), and for all females 2.92 ($N = 68$, SE = 0.11, SD = 0.87). These compare with scores of 3.48–3.95 for samples of Cuban and Grand Cayman populations representing the *chrysocaulosus* group. Part of this difference is due to the rather smaller markings in *mexicanoides* compared with *chrysocaulosus*, but the latter obviously has a more heavily marked rump (only 19% of all *mexicanoides* score "4," while 84% of *chrysocaulosus* do so). Higher scoring individuals tend to have more barring and less spotting on their rumps. About half the specimens of *mexicanoides* examined showed markings predominantly bar-like, while the others exhibited spots only.

Upper Tail Covert Pattern

Variation in upper tail covert pattern in *Colaptes auratus* has been figured by Chapman (1891) and Short (1965*b*). Although considerable variation exists in the *cafer* and *auratus* subspecies groups, there is less variation in the *chrysoides, chrysocaulosus,* and *mexicanoides* groups. The patterns exhibited have been categorized as all black, V-striped, horseshoe-tipped, and barred (20 examples of these patterns are figured in Short, 1965*b*). The patterns grade into each other, and innumerable intermediate conditions are possible. Although many individuals of the northern populations (*auratus* and *cafer* subspecies groups) show black, V-striped, and horseshoe-tipped patterns, these are uncommon and barred patterns nearly universal in the other subspecies groups. Considering only the large, central upper tail coverts and their patterns in *mexicanoides*, 93% of the 115 individuals examined for this feature showed various barred patterns, and fully 67% exhibited a single pattern (simple, barred pattern). Six additional barred patterns were noted, while five different horseshoe-tipped, six V-striped, and one all black patterns were also observed. Although enough patterns were evident to indicate that *mexicanoides* has the potential for development of all major types, the number of individuals actually showing patterns other than of the barred type was small. Only four individuals showed no trace of the barred type of pattern. Nine birds exhibited *two* patterns of the same or different types, either by having the central coverts bi-patterned (feathers with one pattern basally, and another distally), or by showing asymmetry (one covert with one pattern, the other with another pattern). No geographical variation was noted, nor was there an indication of a sexual difference in patterns in these flickers.

Amount of Black in Tail

The extent of the black color at the tip of the tail was determined by use of three measurements: 1) the length of the black area from the tail tip toward the tail base; 2) the length of the black area on one central rectrix from its tip toward its base; and, 3) the extent of black along the shaft of the outer rectrix (rectrix 5) from its tip toward its base. Mean values for these in males are: 1) total extent—39.29 mm, 2) R1—43.12 mm, and, 3) R5—9.87 mm. There is considerable individual variation, but geographic variation is not marked. The latter is suggested by the data, and confirmed by statistical treatment of data for black in the outer rectrix (the measurement showing greatest variation among the five samples). Applying an analysis of variance test to the data from the four largest samples (all but El Salvador), an F value of 3.09 was attained, yielding $P = 0.05$–0.10. The difference is not highly significant, for the chances are one in ten to one in 20 that all four samples are drawn from the same population. Comparable results were obtained from data for females which showed about 2% less black than males. Since this is nearly equivalent to the size difference between the sexes, there appears to be no sexual difference in the extent of black in the tails of these flickers.

Tail Barring

Barring in the tail of *mexicanoides* tends to be less prominent than in more northern populations of *Colaptes auratus*, and much less than in the *chrysocaulosus* group (Short, 1965*b*). An exception is the inner (central) rectrix, which is as heavily barred as in *chrysocaulosus*, and more strongly barred than in the other groups. Thus, rectrix one has an average of 3–5 bars in *mexicanoides* (mean 4.10 for 42 males and 4.53 for 43 females from all samples), compared with 4–5 bars in *chrysocaulosus* and (usually) 1–2 bars in populations of the other groups. The outer rectrices, however, average 2.25 bars in 71 male *mexicanoides*, and 3.04 in 51 females (compared with 7–8 bars in *chrysocaulosus* and 3–5 bars in the *auratus* and *cafer* groups). Females tend to be more barred than males, both on rectrix 1 and 5. Rectrices 2–4 are unbarred, or with the barest traces of a bar on number 2. No geographic variation was evident in this character.

Nuchal Patch

The *auratus* and *chrysocaulosus* subspecies groups possess a red nuchal patch generally lacking in the other groups. Some individuals of the *mexicanoides* group show a partial nuchal patch, and Test (1940) noted the presence of a patch in three of 31 *mexicanoides* he examined. Individuals were scored for the nuchal patch character as previously described (Short, 1965*a*). Briefly, a full nuchal patch is scored "0," a restricted, but unbroken one—"1," a broken patch with several areas of red—"2," a trace or traces of red in one or several feathers—"3," and the nuchal patch entirely absent—"4." All 64 females examined lacked red in the nuchal area, thus scoring "4." One-quarter of the males (20 of 80) showed some indication of red nuchal coloring, with four individuals scoring "2" and 16 scoring "3." The mean score for all males was 3.71 (SE = 0.06). As might be expected with a feature found in only a small part of the population, sample sizes are not adequate to demonstrate geographic variation, or the lack of it, in the nuchal patch character for males. The number of males scoring "2" and "3" in each sample is as follows: Chiapas—6/17, Guatemala—3/27, El Salvador—2/7, Honduras—5/21, and Nicaragua—4/8.

Throat Color

The throat of *mexicanoides* is gray, about as in the *cafer* group, but slightly darker. Signs of brown or tan color were observed on the throats of 25 of 112 adults taken from late winter to early summer. This approach to the mixed tan and gray throats of most juvenile flickers was not noted in the other subspecies groups. More females than males showed tan or brown coloring (17 of 55 females, 8 of 57 males—a Chi-square test shows this difference to be significant at the $P = 0.01$ level), and the only two individuals showing nearly as much brown and tan as gray were females. The tendency for brown or tan color to develop appears more pronounced in the southeastern populations. All eight males showing such color came from the southeastern three samples, while 12 of the 17 females do so. All four Nicaraguan females show brown or tan coloring, and two of these are the birds with the most extensive development of these colors. Chiapan and Guatemalan samples include no males and but five females with such tan or brown coloring. It is likely that the mixed colors of the throats of these southernmost flickers, and those of juvenile birds as well, reflect a past condition when both gray and tan colors had developed, but before stabilization of one or the other had taken place. Fall birds show still more brown and tan present. Seasonal variation involves wear and fading, causing the throat to become grayer through the fall, winter, and spring.

Color of Ear Coverts

The ear covert area includes the auricular feathers and feathers of the subocular region (forward to the bill). This entire area is generally colored like the throat in all forms of *Colaptes auratus*, and is thus gray in *mexicanoides*. Apparently genetic control of the coloring of this area is relatively independent of that involved with throat color, as indicated by studies of hybridization (Short, 1965*a*). Although tan color is present in the otherwise gray ear coverts of some *mexicanoides*, it never approaches comprising 50% of the ear-covert area. Unlike the case of throat color, more males than females (17 of 80♂♂, 10 of 63♀♀) show tan or brown color, although the difference is not significant. Geographical variation is not evident, for Honduran and Chiapan samples contain greater numbers of individuals with tan or brown traces, while only one Nicaraguan (of 12), two Salvadoran (of 13), and eight Guatemalan (of 55) individuals exhibit such traces. Southeastern samples thus contain proportionally as many birds with brown and tan traces as do the northwestern samples.

Color of Under Wings and Tail (= "Shaft" Color)

Shaft color in *mexicanoides* varies from orange to (rarely) salmon-pink. As in other populations of *C. auratus*, there is no sexual difference in this character. Shaft color was scored as in studies of hybridization in flickers (Short, 1965*a*). The scores attained were "3," "3.5," and "4." A score of "4" denotes the salmon-pink color normally found in the *cafer* subspecies group. A score of "3" indicates orange shaft color, as found in some hybrids between the *auratus* and *cafer* subspecies groups. The intermediate orange-salmon color was scored "3.5." The mean score for 159 adults taken from late winter to summer was "3.26," with two standard errors = 0.06 and one standard deviation = 0.37. Means for the two sexes considered separately were: ♂♂ (90) = "3.29," ♀♀ (69) = "3.26."

Four birds showed yellowish in certain feathers. Three of these have very pale shaft color overall, and one (Mus. Comp. Zool. No. 121036) has yellowish-orange in rectrices 3–5 on the right side, while the same feathers are orange-pink on the left side. This yellow tendency is probably related to dietary factors and effects of fading as discusssed elsewhere (Short, 1965*a*). No individual of *mexicanoides* exhibited a symmetrical pattern of bright yellow-orange shaft color in one, several or all remiges and rectrices, as typically found in hybrids between the *auratus* and *cafer* groups. Mean shaft color scores ranged from "3.06" for Honduras to "3.46" for Nicaragua. No clinal variation is evident, but Honduran flickers seem to be more uniformly orange-shafted than those from elsewhere. In the other four samples, from 40 to 70% of the individuals scored "3.5" and "4," and, overall, 50% (51 of 102) of the birds in all four samples exhibited such scores. However, only 7% (3 of 41) of Honduran birds scored "3.5" or "4." The Honduran sample is thus significantly different in this respect from the others, including the Nicaraguan sample (in which nine of 13 birds scored "3.5" or "4"). The meaning of this difference in unclear.

Crown Color

There is some variation in crown color in *mexicanoides*, with southeastern birds tending to have paler, more cinnamon-rufous crowns and northwestern flickers exhibiting more rufous-chestnut coloring. There is overlap even between individuals of the extreme (Nicaraguan and Chiapan) samples. Variation in color of the crown with respect to hybridization between the *cafer* and *auratus* subspecies groups has been discussed elsewhere (Short, 1965*a*). There is no evidence of gray traces in the crowns of specimens of *mexicanoides*; all thus score "4" (typical non-gray, usually brown, crown of *cafer* subspecies group). However, *mexicanoides* has a rufous, rather than the brown, crown of the *cafer* group (an approach toward *mexicanoides* is evident in some *mexicanus* individuals, and in *rufipileus* of the *cafer* subspecies group, as well as in all races, especially *tenebrosus*, of the *chrysoides* group). Traces of red coloring were evident in the crowns of four Honduran, one Chiapan, and one El Salvador males (traces in six of 48 males, or 13% of all males). Test (1940) reported red in the crowns of three of 17 *mexicanoides* males. The red, when present, appears primarily in the lores and secondarily in the feathers of the forehead. The crown feathers become lighter in color over the course of the year, following the annual molt. There are no apparent sexual differences in this feature.

Character Index Analysis

In order that all forms of *Colaptes auratus* be treated in a standard manner for comparison of character (or hybrid) index values, the same scoring system utilized in the study of hybridization between the *cafer* and *auratus* subspecies groups (Short, 1965*a*) was applied to *mexicanoides*. The six index characters are: crown color, throat color, ear covert color, extent of nuchal patch, malar color (males) and shaft color. Scores for each character ranged from "0" for the extreme *auratus* group condition, to "4" for the condition found in the *cafer* subspecies group (races *collaris*, *cafer*). Possible character index values thus range in males (six characters) from 0 for an individual registering the *auratus* condition in all characters to 24 for a bird having a *cafer*-like condition of each character. The corresponding values for females (five characters) range from 0 to 20.

Character index values ranged from 19–23 in 87 males of *mexicanoides* and from 17–20 in 63 females. The means with two standard errors are: males—21.46 ± 0.20, and females—18.79 ± 0.18. Of course, variation in index values is dependent upon variation in the separate characters making up the index. Thus, males vary considerably due to variation in nuchal, malar, and shaft color. Females exhibit less variation in index values because they lack one feature variable in males (malar character), and because they show no nuchal variation. Crown color is non-variable in both sexes, as far as hybrid index scoring is concerned (crown color varies in other ways, as noted above). Crown color of *mexicanoides* is assigned a score of "4," as in the *cafer* group, because the rufous-chestnut color exhibited is closer to the browns of that group than to the grays of the *auratus* group. Sample means varied from 21.22 to 21.81 for males, and from 18.25 to 18.94 for females. In terms of those characters important in describing effects of hybridization between the *cafer* and *auratus* groups, *mexicanoides* indexes near the former.

DISCUSSION

The variation encountered within the *mexicanoides* group of populations, as indicated by available specimens, is largely clinal. For most characters major clinal "steps" are not evident. The El Salvador sample, representing the area intermediate between the extreme Chiapan and Nicaraguan populations, is variously intermediate between them in most features. In some characters, such as tail length, P10 : P9 ratio and breast spotting, the El Salvador sample is closest to the adjacent Guatemalan birds, while in others (e.g., depth of breast patch and bill length) it is closer to those from Honduras. Nicaraguan flickers are not represented by an adequate sample, but certainly appear to differ in average features from birds farther to the north.

If no flickers occurred in the intervening area between Chiapas and Nicaragua, the differences between birds in these extreme regions would merit separate subspecific treatment for them. However, these extreme populations are connected by intermediate populations. Furthermore, for most features, variants in the Guatemalan, and even the Chiapan samples, overlap with one or more birds in the small Nicaraguan sample.* This fact, plus the clinal nature of variation for many characters, and the considerable variation encompassed within each of the larger samples (Honduras, Guatemala), militate against subspecific recognition of the Nicaraguan population.

Dickey and van Rossem (1928) described the race *pinicolus* from El Salvador. Those authors were unable to appreciate the variation and clines in *mexicanoides*, for they saw no Nicaraguan and Honduran specimens (op. cit., p. 131). As noted above, the El Salvador population is variously intermediate between those of Honduras and Guatemala (and hence between Nicaraguan and Chiapan populations), and this intermediate population does not merit a trinomial name. Stone (1932:316) was unable to distinguish *pinicolus* from *mexicanoides* and I follow Stone in considering *pinicolus* a synonym of *mexicanoides*. The subspecies group *mexicanoides* is thus comprised of the single subspecies *mexicanoides*.

The diagnostic features of this subspecies group are:

1) wings more rounded than in other subspecies groups (except *chrysocaulosus* group)
2) breast markings generally broad, bar-like
3) breast patch deeper, less crescentic (as in *chrysocaulosus* and *chrysoides* subspecies groups)
4) malar patch mixed red and black in males and cinnamon-rufous in females
5) back bars deeper, more numerous than in other groups of *Colaptes auratus* (similar to pattern found in the South American flicker subgenus *Soroplex*)
6) back tends to be tricolored (buff, brown, and black), especially in the southeastern populations
7) rump patch moderately obscured by spots and or bars, nearly to the extent found in the *chrysocaulosus* group

---

* Additional (4 ♂♂, 11 ♀♀) Nicaraguan specimens recently examined in the British Museum enhance this overlap.

8) "shaft" color generally orange to orange-salmon, less pink than in the *cafer* subspecies group
9) crown deep rufous-chestnut in color, approached but not attained by certain populations of the *cafer* group

Characteristics of the subspecies *mexicanoides* are those of the *mexicanoides* subspecies group.

The Central American flickers, although distinctive, show certain color pattern resemblances to the *cafer* and *chrysoides* subspecies groups. These include:

1) all have a basically "brown" crown
2) all have a gray throat
3) all have a predominantly red malar patch in males

Additionally, *mexicanoides* shares with the *cafer* group the generally reddish color of the "shafts." In certain respects noted above, *mexicanoides* resembles the *chrysoides* and *chrysocaulosus* groups more than it does the *cafer* group. In still other features it shows resemblances to the *chrysocaulosus* group, but not to the *cafer* and *chrysoides* groups. *Mexicanoides* is least similar to the *auratus* group. The significance of these resemblances and differences in terms of the past history of flickers will be discussed elsewhere. It is apparent, however, that the distinctive features of the *mexicanoides* group preclude the inclusion of the subspecies *mexicanoides* in the subspecies group *cafer*, with which it is generally associated. The subspecies of the *cafer* group (*cafer, collaris, nanus, mexicanus*, and *rufipileus*) generally exhibit clinal variation, and not even the well-differentiated race *rufipileus* approaches the level of morphological distinctiveness evident in *mexicanoides.* The Central American flickers show the effects of long isolation from other North American flickers. While *mexicanoides* appears not to have differentiated to the species level, its features warrant its equal status within *Colaptes auratus* as a subspecies group along with the *auratus, chrysocaulosus, cafer*, and *chrysoides* subspecies groups.

SUMMARY

The North American flicker, *Colaptes auratus*, is represented in Central America by a population exhibiting distinctive morphological features. Variation within the Central American population, occupying the highlands of Chiapas, Guatemala, El Salvador, Honduras, and northern Nicaragua, is mainly clinal. Clines for the various characters appear to be concordant, from northwest to southeast; however, the number of specimens available was inadequate to show variation, or lack of it within major areas with diverse topography, such as Honduras. The northwestern birds (Chiapas) tend to be larger, darker, and less barred below than those from the southeastern populations. The clinal nature of the variation, overlap among individuals of the extreme populations, and intrasample variation do not permit recognition of a second subspecies in the *mexicanoides* group of flickers. The race *pinicolus* Dickey and van Rossem is held invalid, for the

El Salvador population is intermediate between those of Chiapas and Nicaragua.

Characteristics of the *mexicanoides* subspecies groups of *Colaptes auratus* are presented. This group shows similarities with each of these subspecies groups: *chrysocaulosus, cafer*, and *chrysoides.* It differs in a number of important ways from the *cafer* group, and merits equal status with the four other subspecies groups (*auratus, cafer, chrysocaulosus*, and *chrysoides*) of *C. auratus.*

ACKNOWLEDGMENT

The opportunity to continue my investigations of flickers, including the present one, was provided by a fellowship award from the Chapman Memorial Fund Committee of the American Museum of Natural History, where much of the work was done. Drs. Dean Amadon and Wesley E. Lanyon and the staff of the museum were most helpful. Dr. Charles G. Sibley provided assistance and encouragement during early phases of my flicker investigations. The Karl P. Schmidt Committee of the Chicago Natural History Museum in 1961 gave me a travel grant, and the Louis Agassiz Fuertes Research Grant Committee of the Wilson Ornithological Society in 1956 provided me with a Fuertes award, for both of which I am grateful. Dr. Kenneth C. Parkes was especially helpful with suggestions benefiting the manuscript.

I wish to thank the following individuals and institutions for the loan of specimens essential to this investigation, and for assistance rendered during visits to certain of the institutions: American Museum of Natural History (Dr. Dean Amadon), Dickey Collection of the University of California at Los Angeles (Dr. Thomas R. Howell), Museum of Vertebrate Zoology of the University of California at Berkeley (Dr. Alden H. Miller), Carnegie Museum (Dr. Kenneth C. Parkes), Chicago Natural History Museum (Mr. Emmet R. Blake) Florida State Museum of the University of Florida (Dr. Oliver L. Austin, Jr.), Moore Laboratory of Zoology of Occidental College (Dr. J. W. Hardy), Museum of Comparative Zoology of Harvard University (Dr. Raymond A. Paynter, Jr.), Philadelphia Academy of Sciences (Mr. James Bond), and the U.S. National Museum (Mr. Herbert G. Deignan).

LITERATURE CITED

Blake, E. R.
1953 Birds of Mexico. Univ. of Chicago Press, Chicago, Ill.

Chapman, F. M.
1891 On the color-pattern of the upper tail-coverts in *Colaptes auratus. Bull. Amer. Mus. Nat. Hist.*, 3:311–314.

Dickey, D. R., and A. J. van Rossem
1928 Further descriptions of new birds from El Salvador. *Proc. Biol. Soc. Washington*, 41:129–131.
1938 The Birds of El Salvador. *Field Mus. Nat. Hist., Zool. Ser.*, 23, No. 406.

Eisenmann, E.
1955 The species of Middle American birds. *Trans. Linnaean. Soc. New York*, 7:1–128.

Griscom, L.
1932 The Distribution of the Bird-life in Guatemala. *Bull. Amer. Mus. Nat. Hist.*, 64:1–439.

Lafresnaye, F. de
1844 Oiseaux neuveaux du Mexique. *Rev. Zool.*, 7:41–43.

LAND, H. C.
1962 A collection of birds from the Sierra de las Minas, Guatemala. *Wilson Bull.*, 74:267–283.

MILLER, A. H., H. FRIEDMANN, L. GRISCOM, AND R. T. MOORE
1957 Distributional Check-list of the Birds of Mexico. Part II. *Pacific Coast Avifauna*, 33.

PETERS, J. L.
1948 Check-list of Birds of the World. Vol. 6. Harvard Univ. Press, Cambridge, Mass.

SHORT, L. L., JR.
1965*a* Hybridization in the flickers (*Colaptes*) of North America. *Bull. Amer. Mus. Nat. Hist.*, 129:307–428.
1965*b* Variation in West Indian flickers (Aves, *Colaptes*). *Bull. Florida State Mus.*, 10:1–42.

STONE, W.
1932 The birds of Honduras with special reference to a collection made in 1930 by John T. Emlen, Jr., and C. Brooke Worth. *Proc. Acad. Nat. Sci. Philadelphia*, 34:291–342.

TEST, F. H.
1940 Analysis of plumage coloration in the flickers, avian genus *Colaptes*. Ph.D. thesis (unpubl.), Univ. California, Berkeley.

WETMORE, A.
1941 Notes on the birds of the Guatemalan highlands. *Proc. U.S. Natl. Mus.*, 89:523–581.

AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK, NEW YORK (*FORMERLY*, BUREAU OF SPORT FISHERIES AND WILDLIFE, WASHINGTON, D.C.), 3 AUGUST 1965

THE DOUBLE-SCRATCH AS A TAXONOMIC CHARACTER IN THE HOLARCTIC EMBERIZINAE

C. J. O. Harrison

THE Holarctic buntings of the sub-family Emberizinae are a relatively uniform group of species, mainly birds of scrub or open plains, with a bill adapted for seed-eating, mostly with a streaked brown plumage and bright specific colouring which is often confined to the head and breast. Morphologically they show little differentiation and it is therefore of interest that they appear to be divisible into two groups by a behavioural character, the presence or absence of which does not appear to be determined by, or correlated with, their immediate needs or surroundings. This is the use of the double-scratch in feeding, shown by many of the North and Central American species.

The double-scratch is a rapid backward kick performed simultaneously with both feet which are scraped along the surface of the ground, scratching back the superficial layer and exposing what is beneath. If the movement is watched closely in a relatively long-legged species it will be seen that at the commencement the bird is standing with bill pointing down, apparently looking for food on the ground immediately below the head. Without moving from the spot it then gives a small hop in which both feet are brought forward, apparently almost to the spot that it was previously looking at. This movement also tilts the body axis upwards so that the head is raised a little. Immediately after the first hop brings the feet forward a second hop occurs in which the feet are hardly raised but are brought smartly back to their former position, the claws scratching the surface and throwing back some of the superficial material. This restores the body axis to its original position so that at the end of the movement the bill is pointing down at the place where the scratching occurred. This will presumably enable the bird to observe immediately anything which has been exposed.

If no edible items are exposed the movement may be repeated in a rapid series, the bird remaining in the one place. If the substrate is not too hard or compressed the bird may rapidly excavate a sizable hollow. This behaviour is of obvious advantage to a species feeding in the fallen litter under trees or shrubs or on bare ground, particularly in the winter months when relatively little plant or animal food may be visible at the surface.

Among the Emberizinae this scratching movement appears to be confined to American species. It was observed in the Song Sparrow (*Melospiza melodia*), Swamp Sparrow (*M. georgiana*), Tree Sparrow (*Spizella arborea*), Fox Sparrow (*Passerella iliaca*), Rufous-naped Sparrow (*Zonotrichia capensis*), juncos (*Junco* spp.), and towhees (*Pipilo* spp.). Records of scratching in literature are rather sparse and appear more often as casual comments in popular accounts, but it is also recorded in the following species, Black-throated Sparrow (*Amphispiza bilineata*), Olive Sparrow (*Arremonops rufivirgata*), and Green-tailed Towhee (*Chlorura chlorura*), (Wetmore et al., 1964) and for the White-throated Sparrow (*Zonotrichia albicollis*) (Peters and Burleigh, 1951). The scratching habits are so marked in this group of species that Vaurie (*in* Thomson, 1964) refers to "large feet for scratching" as a typical character of the Emberizinae.

This ability to scratch in feeding appears to offer an isolating character for a group of species within the Emberizinae which roughly comprises those species sometimes referred to as New World sparrows. In addition to the double-scratch the general characters of the group are a streaked brown plumage with relatively subdued specific signal characters, usually consisting of stripes or patches of varying colour on head and breast; sexual monomorphism; no eclipse nonbreeding plumage; hopping locomotion; and song usually a repetitive phrase delivered from a perch. It certainly includes the following genera—*Spizella, Melospiza, Passerella, Zonotrichia, Amphispiza,* and *Arremonops*—and is expected to include *Passerculus, Ammodramus, Passerherbulus, Ammospiza, Pooecetes, Chondestes,* and *Aimophila.* Related but slightly divergent genera are *Junco,* with more uniform and sober coloured plumage; and *Pipilo* and *Chlorura,* consisting of larger birds, mostly with more uniform colouring, though with conspicuously coloured markings in some species.

Of the remaining Holarctic species there are two groups. One is the longspurs of the genera *Calcarius* and *Rhynchophanes.* These are birds of open country or tundra. They are terrestrial and normally walk or run, but may hop occasionally. The long hind claw is associated with terrestrialism and a walking gait. As far as is known they do not double-scratch. They show marked sexual dimorphism, the males being boldly patterned and coloured on the head and breast, the females dull in colour with a brown-streaked plumage. The male has a winter eclipse plumage like that of the female. Song is usually delivered in flight. There are four Nearctic species, one of which, the Lapland Longspur (*Calcarius lapponicus*) also occurs in the Palearctic.

The Snow Bunting (*Plectrophenax nivalis*) an arctic species with a Holarctic distribution, may be a specialised offshoot of this longspur group. It is sexually dimorphic, the female being browner and more streaked, the male having a striking black and white breeding plumage and an eclipse-type nonbreeding plumage. It is terrestrial, usually running or walking, and does not use the double-scratch. Its relative lack of heavy pigmentation and denser plumage would appear to be the result of adaptation to arctic conditions.

Another odd species that might belong in this group, or else shows similar but parallel divergence, is the Lark Bunting (*Calamospiza melanocorys*), which shows marked sexual dimorphism, the breeding male being black with a white wing patch while the female is brown-streaked. The male has a nonbreeding eclipse plumage. Like the longspurs it is a mainly terrestrial species of open country but would appear to be much more prone to perch than these. There appears to be no useful information on gait and double-scratching.

The other main group of species is that of the typical Old World buntings of the genus *Emberiza*. These species share with the longspurs the sexual dimorphism, with a brightly patterned head and breast in the male, and an inconspicuous brown-streaked plumage in the female. The male has an eclipse nonbreeding plumage. As a group they differ in being much more arboreal, occupying a similar range of habitats to those occupied by the New World sparrows. They do not use the double-scratch in feeding. Witherby et al. (1938) state that the normal locomotion of these birds is a hop, but a subsequent series of observations (Woods, 1946; Alexander, 1946, 1947, 1948; Ellis, Rayner, and Williams, 1948; Macpherson, 1949; Wallace, 1957) showed that in at least eight of these species walking or running occurred as well as hopping when the birds were on bare ground. The song is a repetitive phrase delivered from a perch or rock.

There is also a monotypic genus in Asia. The Crested Bunting (*Melophus lathami*) differs from species of the genus *Emberiza* in that the male has a distinct crest (although an incipient crest is present in the Rustic Bunting (*E. rustica*), and a black plumage with brown wings. It is much more terrestrial in its behaviour and the very inadequate comments in literature appear to infer that it normally walks. It mounts to a low perch to sing. It would appear to be a specialised offshoot of *Emberiza*, and in some respects forms a parallel to the Lark Bunting of North America.

DISCUSSION

It is customary to regard the Emberizinae as a group originating within the complex radiation of nine-primaried oscines in the New World. The longspurs must therefore be considered as a specialised group derived from these, while the Old World genera are usually regarded as forms arising from an invasion of New World forms.

In view of the probable phylogeny of these groups it is difficult to understand the distribution of the double-scratch as a character of behaviour in these species. As a form of feeding behaviour it is obviously of value to a ground-feeding species and might be expected to be of greatest use to a terrestrial bird. It is, however, apparently absent in the more terrestrial species and present in more arboreal birds. In addition it is present in one large group of species on one continent and absent from a related group apparently occupying similar niches on another. We cannot therefore dismiss the pattern of presence and absence of this character as evidence of adaptation to environment. Since the character is common to a large group of closely related species, the New World sparrows, which show ecological and morphological diversity to a limited degree only, it can be suggested that it may be inherited through a common ancestor. It is, however, absent from the related longspurs and Old World buntings which might have been expected to have also arisen from this ancestral stock. It seems improbable that it should be lost in derived groups which would have equal need of it, and that its present distribution is purely accidental.

Another possible explanation would involve reversing the general view on evolutionary spread and suggesting that the New World forms might represent an adaptive radiation from an invasion of Old World bunting stock, and that the ability to use the double-scratch represented a new and further evolutionary development lacking in an earlier group.

There is a third explanation which would fit both the present view on the evolution of these groups and at the same time explain the distribution of the double-scratch as a behaviour character. Double-scratch is absent from the longspurs although these are a mainly North American group obviously related to the New World sparrows. The major behavioural difference between these two groups, and the one which appears relevant, is that of locomotion. The sparrows usually hop and the longspurs usually walk or run.

There appears to be a direct correlation between hopping and the use of double-scratch in feeding. The description of this scratching already given shows clearly that it is directly derived from hopping. It seems possible that this is true of the scratching methods of feeding when these occur in any of the Passeriformes. Double-scratching occurs in the wydahs (Viduinae), in some of the thrushes (Turdinae), and babblers (Timaliidae), and probably in other groups. In each case it is associated with species in which hopping is the usual mode of locomotion. There is no evidence of this type of scratching in species which normally walk such as the larks (Alaudidae), wagtails (Motacillidae), starlings (Sturnidae), and crows (*Corvus* spp.). There is not an absolute correlation. The Blackbird (*Turdus merula*) is a species which both hops and runs. Gibbs and Hartley (1957) refer to one digging first with one foot then the other. One may, however, assume that there is a direct morphological adaptation enabling a bird that hops to scratch in this fashion, and that a change from hopping to walking as the normal mode of progress involves structural changes that result in the loss of the ability to use the double-scratch in feeding. It can therefore be supposed that the evolution of the longspur group in bare open country involved the development of walking and loss of hopping as the normal mode of locomotion and this in turn involved the loss of the double-scratch associated with hopping.

The Old World buntings are similar to the New World sparrows but they also show very close links with the longspurs in plumage. Their dual mode of locomotion, which might be inferred to indicate partial adaptation by an arboreal group to terrestrialism, could also be interpreted as indicating the relics of terrestrialism in a group which has secondarily evolved a more arboreal mode of life. It can therefore be proposed as a hypothesis that the Old World buntings in their evolution from the New World sparrow stock have passed through a phase similar to that shown by the longspurs, or share a common ancestry with them; and that during this phase they have lost the ability to use the double-scratch in feeding and have not re-evolved it.

Such a derivation would be a reasonable conclusion since the spread of Nearctic Emberizidae into Eurasia would be most likely to have occurred via a northern land-bridge or short sea crossing and would have occurred most easily if the invading stock was adapted to tundra-like conditions and able to exist near the ice-cap. The notion of a common ancestry of longspurs and Old World buntings could be further argued with reference to the close similarity between the Lapland Longspur as the present Eurasian longspur, and the buntings of the Little Bunting (*E. pusilla*)—Reed Bunting (*E. schoeniclus*)—Rustic Bunting (*E. rustica*) subgroup.

SUMMARY

The Holarctic buntings of the subfamily Emberizinae can be divided into two groups by the presence or absence of a behavioural character, the use of the double-scratch in feeding. The double-scratch is a rapid backward kick of both feet by which the superficial layer of the substrate is scraped back. It may be repeated in one place until a hollow is made. Within this group this scratching movement is confined to New World sparrows, juncos, and towhees, being known for nine genera and suspected for another seven. These species also show certain common characters of morphology and behaviour as do those of the other groups subsequently mentioned. There are two main groups within the remaining species. The terrestrial Longspurs, with a Holarctic distribution, have a walking locomotion and lack the double-scratch. The Snow Bunting may be related to these, and the Lark Bunting shows similar characters. The other main group is that of the Eurasian Old World buntings, and the monotypic Crested Bunting. These birds usually hop but may walk, and do not use the double-scratch in feeding although occupying similar niches to the New World sparrows. The Old World species are usually regarded as derivatives of New World stock. It is suggested that the double-scratch is associated with hopping locomotion and may be lost by birds that walk; and that the Old World buntings have evolved via a terrestrial walking form similar to the longspurs, and in the process have lost, and failed to re-evolve, the double-scratch mode of feeding.

LITERATURE CITED

ALEXANDER, W. B.
- 1946 Gait of Corn Bunting. *Brit. Birds*, 39:53.
- 1947 Gait of Yellow Bunting. *Brit. Birds*, 40:256.
- 1948 The gait of buntings. *Brit. Birds*, 41:96.

ELLIS, J. C. S., G. W. RAYNER, AND E. M. WILLIAMS
- 1948 The gait of buntings. *Brit. Birds*, 41:286–287.

GIBB, J., AND P. H. T. HARTLEY
- 1957 Bird foods and feeding habits as subjects for amateur research. *Brit. Birds*, 50:278–291.

MACPHERSON, A.
- 1949 Gait of buntings. *Brit. Birds*, 42:32.

PETERS, H. S., AND T. D. BURLEIGH
- 1951 The birds of Newfoundland. Houghton Mifflin, Boston.

THOMSON, A. L.
- 1964 A new dictionary of birds. Nelson, London.

WALLACE, D. I. M.
- 1957 Little Buntings in Middlesex. *Brit. Birds*, 50:208–209.

WETMORE, A. et al.
- 1964 Song and garden birds of North America. Nat. Geogr. Soc. Washington.

WITHERBY, H. F. et al.
- 1938 The handbook of British birds. Vol. 1. Witherby; London.

WOODS, H. E.
- 1946 Gait of Corn Bunting. *Brit. Birds*, 39:348.

BRITISH MUSEUM (NATURAL HISTORY) CROMWELL ROAD, LONDON, ENGLAND, 8 OCTOBER 1965

MOVEMENTS OF FEMALE RUFFED GROUSE DURING THE MATING SEASON[1]

Robert B. Brander

Knowledge of sexual relationships in the Ruffed Grouse (*Bonasa umbellus*) is inchoate. Displays related to mating have been described (Allen, 1934; Bump et al., 1947), but two basic questions remain unanswered in the literature. Is the hen attracted to the site of the cock's drumming performance. and do the cock and hen form a pair-bond that is more than transitory?

Hens, and cocks to a lesser degree, are seldom observed because of their cryptic behavior within dense vegetation. For this reason, reports on mating behavior have been deductions supported either by general observation in the field or by extrapolation of observations on captive birds.

Bent (1932, p. 146) did not comment on pair-bonding, but he did speculate that the cock leaves its drumming log and seeks out the hen. Roberts (1932, p. 380) apparently favored the "opinion" that the Ruffed Grouse is polygynous. Leopold (1933, p. 104) considered the mating behavior to be similar to that of the Ring-necked Pheasant (*Phasianus colchicus*), in which each male has its own separate group of hens. Grange (1948, p. 192) did not know whether Ruffed Grouse pair or are polygamous, but he "guessed" that they pair for the season, while Edminster (1954, p. 231) stated that the Ruffed Grouse is promiscuous in its breeding habits. Lack (1940) developed a classification for pair-formation in birds and placed the Ruffed Grouse among those species in which the sexes meet solely for copulation and in which the female goes to the solitary male at its display site.

Allen (op. cit.), after 15 years of study of captive Ruffed Grouse, presented evidence which allows interpretation of the duration of the pair-bond. To complete the sequence of events described by Allen—synchronization of mating cycles, dominance, copulation—would require, it seems to me, at least a few days. Pair-bonding would not be a transitory affair and polygyny is indicated.

Bump et al. (op. cit.), after a long-term study of captive birds, observed the reactions on which Allen's conclusions were based. They did not believe that a synchronizational period is necessary to ensure fertilization of eggs. It seemed probable to them that the female in the wild would seek out the male in his territory; if they were both in the proper stage, copulation would take place; if not, the hen would retire to return later or to move on to another drumming male. Because of a postulated evenness of the sex ratio

---

[1] Paper No. 5842, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul, Minnesota 55101.

and the dispersed nature of the mating birds, the likelihood of a hen moving on to another male would be slight, and this, they reason, would be tantamount to "enforced monogamy."

These observations and studies have yielded valuable information but as Lack noted many years ago (1940), studies on the mating behavior of captive Ruffed Grouse do not necessarily apply to wild birds. However, only recently (see Marshall and Kupa, 1963) was the technique of radio-telemetry adapted for use on Ruffed Grouse and thereby made possible the study of that bird's behavior under field conditions. I have used the telemetric method to obtain data on the basic question of pair-bonding in Ruffed Grouse. These are, I believe, the first field data on this behavior.

This study was done during the spring of 1963 at the Cloquet Forest Research Center, University of Minnesota. Gullion et al. (1962) have described briefly the soils, topography, and vegetation of the Station. In general, peat soils supporting black spruce (*Picea mariana*), balsam fir (*Abies balsamea*), and larch (*Larix laricina*) are found in the lowlands; the aspens (*Populus spp.*), white birch (*Betula papyrifera*), white spruce (*Picea glauca*), and jack and red pines (*Pinus banksiana* and *P. resinosa*) predominate on the loamy-sand uplands.

METHODS

Because cocks seldom left their drumming-activity centers (the immediate area around a drumming log according to Gullion et al., 1962), the problem of pair-bonding was best attacked through a study of the movements of hens. Radio-tracking was initiated in February so that home range boundaries were well defined before the breeding season began. I succeeded in radio-tracking three hens (all immatures) through their mating activities and onto their nests. An additional hen (an adult) was tracked but I failed to find her nest.

The birds were taken in "lily-pad" traps and leg bands were affixed as detailed by Gullion (1965). A radio-transmitter package modified from that of Marshall and Kupa (1963) as described by Brander (1965) was then attached. Both the performance of the female birds in flight and their participation in social behavior indicated that the movements to be described are not significantly different from those of unmarked birds.

As a rule, three precise locations were determined daily for each bird. Precision was of an order which allowed placement of a bird within a quadrat 33 feet square (0.025 acres). Locations were taken at mid-morning, mid-afternoon, and during the night-roost period. Transmitter signals were also monitored several times during the day so that the general location of a bird was under rather constant surveillance.

The locations of all drumming-activity centers were also known. At least

TABLE 1
CALCULATED DATES OF FIRST EGG AND OESTRUS FOR THREE HENS

Bird number	Date on nest	Number eggs	First egg	Oestrus
1826	23 May	9	9 May	3– 6 May
1944	19 May	6	11 May	5– 8 May
1828	24 May	8	13 May	7–10 May

two cocks within the study area were associated with drumming-activity centers but did not engage regularly in drumming performances.

For purposes of evaluation, I used information in the literature to calculate the probable dates on which certain responses by the hens might occur. On the average, Ruffed Grouse lay two eggs each three days until the clutch of 9 to 14 eggs is complete (Bump et al., 1947). Knowing the number of eggs laid by a certain date, one may derive the date of first egg. Bump et al. (op. cit.) also determined that captive hens were in oestrus three to seven days prior to the laying of the first egg, the shorter period being more frequent. The onset of oestrus was abrupt and if the hen were mated promptly, oestrus ceased almost at once, but otherwise it lasted for three to five days. [Oestrus is a term usually reserved for the class Mammalia (Bullough, 1961) but Allen (1934) and Bump et al. (1947) apply it to the Ruffed Grouse and I follow their usage.]

Using this information, I calculated the date of first egg for the three hens and the dates that each hen might have been in oestrus. The results are presented in Table 1.

Location and movement maps for the theoretical oestrous period were constructed. These maps and interpretations are now considered for each bird in turn.

RESULTS

Hen No. 1826.—The movement pattern of this bird from the morning of 1 May to the morning of 10 May is given in Figure 1. Actually, the mating season for this hen was adumbrated by her response to drumming activity, first on 25 April then on 27 and 28 April. On each of these dates she moved a short distance in the direction of a drumming-activity center but returned to her established winter range, a well defined area of 26 acres. The drumming of DR1 (Fig. 1) and another male in that area were, apparently, the stimuli involved. Nothing more than movement response was indicated.

Then, on 1 May, she made a long northerly movement toward an activity center but returned to her winter range that same evening. She did not approach the drummer (DR2) which, probably, elicited her movement response. On 3 May she again made a move to the north, and this time approached the drumming log of DR2. After spending the night in a larch stand 500 feet west of his log, she returned to her winter range. This was followed the next day (5 May) by a shorter northerly probe and retreat. The next move, on 6 May, was unalterably to the north. Supposedly, 6 May was the

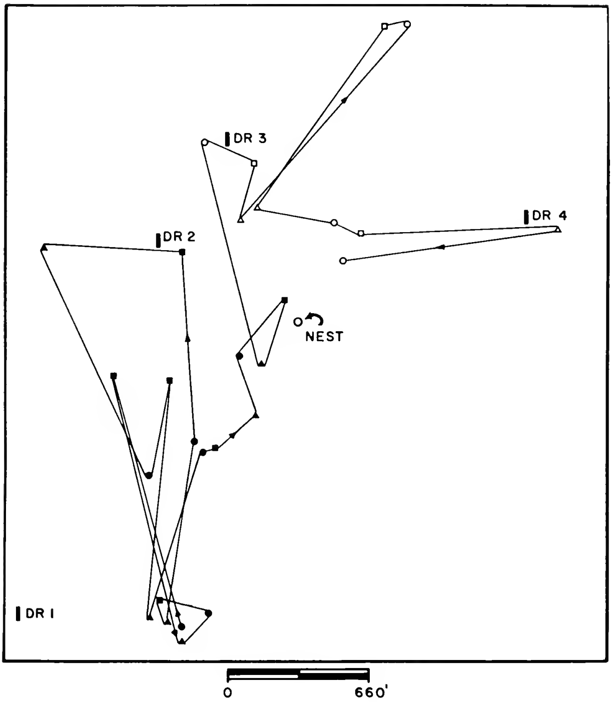


FIG. 1. Immature female, No. 1826. Movements and locations during oestrus, 1–11 May. The 1 May location is in the southwestern part of the figure. DR and black rectangle indicates a drumming male. Circles, squares, and triangles represent mid-morning, mid-afternoon, and night-roost locations respectively.

last day of oestrus (Table 1). Open symbols are employed in Figure 1 for locations thereafter (7, 8, 9, and 10 May).

She had already visited the activity center of one drummer (DR2) and then began another series of visits. On 7 May she visited the center of DR3. This northeasterly movement with return on 8 May was especially interesting since there were no active drummers in that area but a tree planting crew using a tractor was there. I think that her movement to within a few feet of this operation represented a response to a false stimulus, the tractor, which was roughly analogous to that of a response to drumming. Bump et al. (1947, p. 263–264) report several instances where grouse, of unspecified sex, responded to tractor and wood chopping sounds. A final overt response to drumming activity occurred the following day (9 May) when she moved eastward and remained overnight within the activity center of DR4. On 10 May she returned to the habitat in which she was to nest. Indications are that the first egg was laid on that date.

Also, indications are that oestrus began seven days prior (3 May) to the first egg and ended the day before. Calculated oestrous dates and egg laying rates as described in Bump et al. (op. cit.) seem reasonably valid when applied to hen number 1826.

According to Bump et al. (op. cit., p. 267) oestrus in captives ceases almost im-

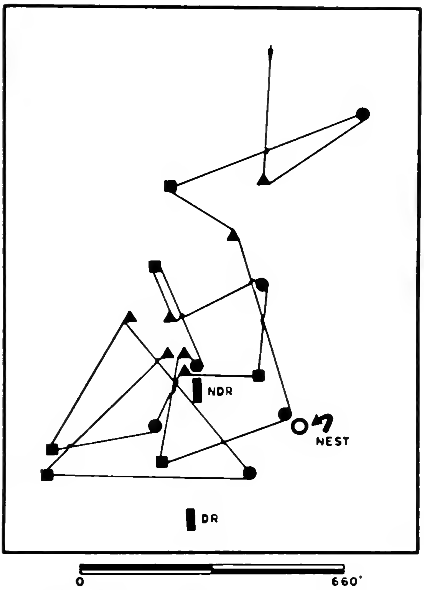


FIG. 2. Immature female, No. 1828. Movements and locations during oestrus, 4–11 May. The 4 May movement is from the north (arrow). DR and black rectangle indicate a drumming male while NDR indicates a less persistent drummer. Other symbols are as in Fig. 1.

mediately after copulation. Assuming that wild grouse react similarly, I interpret the mating behavior of hen No. 1826 as follows: (1) oestrus, per se, commenced on 6 May; she responded to a drumming male on that date but did not copulate; (2) she responded to another male on 7 May and again did not copulate; (3) she responded to a false stimulus on 8 May; (4) successful copulation occurred on 9 May after she had responded to the third male within her range. This hen, without question, was attracted to the activity centers of drumming cocks, and sounds produced by the cocks were the proximate stimuli which elicited her response. The pair-bond was transitory, probably of a duration no longer than a few hours. Because the cocks continued to drum after the hen had left their respective activity centers and, I presume, continued to attract hens, this mating behavior is properly termed *promiscuous*. Even if the assumption of a single copulation were not warranted, the behavior remains promiscuous.

Hen No. 1828.—The mating season for this bird was foreshadowed on the morning of 25 April when she moved toward the sound of drumming activity. However she remained within her tightly defined winter range (7 acres) until 4 May. Figure 2 shows her movements from that date through the oestrous season.

She moved into a drumming activity center on 6 May and it seems certain that oestrus commenced on that date. Her movements indicated a responsiveness to drumming at least through 10 May. The persistent drumming of an adult cock (DR, Fig. 2) probably signaled the hen's departure from the winter range, but a much less persistent drummer (NDR) along her path of movement may have secured her attention also.

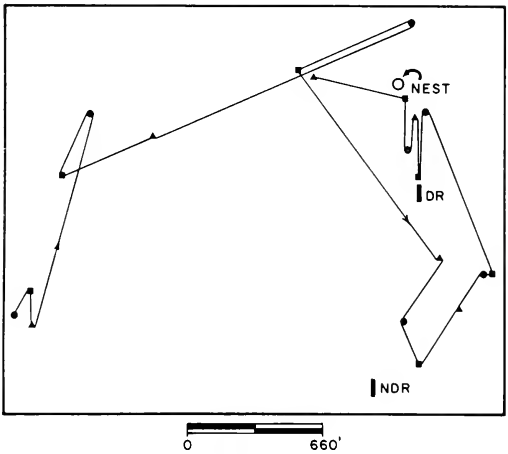


FIG. 3. Immature female, No. 1944. Movements and locations during oestrus, 4–11 May. The 4 May location is in the southwestern part of the figure. See Fig. 1 for explanation of symbols.

I interpret her mating behavior as follows: (1) oestrus, per se, commenced on 6 May; (2) copulation probably occurred on 9 or 10 May. This hen, as with number 1826, was unquestionably attracted by the sound of a drumming cock. While the map of her movements and locations during the oestrous period may suggest a pair-bond of some duration, particularly with NDR, observations during that period indicated that lengthy juxtaposition of the sexes was circumstantial. Because the cocks continued to drum after the hen had established her nest, this behavior was promiscuous.

Hen No. 1944.—Hen number 1944 was radio-marked on 26 April. An overt response to drumming was noted on 29 April when she moved toward an activity center which included two males. Another precursory response was noted on 1 May. Figure 3 shows her movements from 4 May through the oestrous period.

The long movement to the northeast and into the range of a drumming male (DR in Fig. 3) probably marked the first day of oestrus; which was identical with the postulated onset date for hens 1826 and 1828—6 May. After spending two days within audible range of the drummer, she returned to his activity center on 9 May and then into her nesting habitat on 10 May. A "non-drumming" male (NDR, Fig. 3) might have influenced the hen's movements, but I was reasonably sure that this did not occur.

The mating behavior of hen No. 1944 is interpreted as follows: (1) oestrus, per se, commenced on 6 May; (2) copulation probably occurred on 9 or 10 May.

As with the other hens, No. 1944 was attracted by the sound of drumming to the activity center of a cock. No more than a transitory pair-bond developed and the behavior of both cock and hen indicated promiscuous mating.

DISCUSSION

A basic question on the behavior of Ruffed Grouse was answered when hens were observed responding positively to drumming cocks. The question of the duration of the pair-bond was not answered conclusively, but the

TABLE 2
PATTERNS OF MATING BEHAVIOR IN FEMALES AS RELATED TO TIME

Bird number	Behavior pattern			
	Pre-oestrus		Oestrus	
	Adumbration	Prelude	Mating	Copulation
1826	25 April	1 May	6 May	9 May
1828	25 April	4 May	6 May	9 or 10 May
1944	?	24 April	6 May	9 or 10 May

evidence is highly suggestive that the sexes meet solely for copulation and that the mode of sexuality is promiscuous.

Promiscuity is a generic term which does not adequately depict the intricate pattern made manifest in the movements of the three hens. Actually, four *levels* of response are apparent in the pattern and these I term: *adumbration*: passive restlessness to drumming; *prelude*: overt restlessness to drumming; *mating*: proximal movement; *copulation*: nidification. Mating and copulatory phases comprise oestrus per se.

Onset dates for each of the phases are given in Table 2. The patterns of responsiveness for the hens are strikingly similar and suggest that stimuli, internal and external, are also arranged in a precise pattern. There is other evidence that this is so. Data provided by Gullion (unpublished MS.) from a four-year study, also at Cloquet, Minnesota, indicate that the period of most intensive drumming activity is precisely fixed in time. In his study, males exposed to extremely variable annual meteorological and phytophenological conditions still reached a peak in their drumming activity within 3 days of 29 April. The peak was on 26 April in 1963, which coincides with the adumbration phase of the behavior that I describe.

An inflexible pattern of mating has adaptive significance for birds faced with extremes in wintering conditions. The periods of net loss in energy storage must be balanced in the animal by periods of net gain. For northern species these periods are rather rigidly fixed. The stress of winter begins in early November, ends in early April, and is followed in quick order by the stresses of mating, egg-laying, incubation, and care of young. Except for a brief respite in April, these all may be periods of net losses in energy. A scant two to three months remain for the hen to recoup her losses. Therefore, a prolonged mating season becomes a luxury ill-afforded to endemic northern species, and an inflexible breeding season which results from rigid behavioral patterns should not be unexpected in the Ruffed Grouse of northern Minnesota.

SUMMARY

A radio-telemetric system was used to obtain data on sexual relationships in the Ruffed Grouse. The hen was attracted to the site of the cock's drumming performance but no more than a transitory pair-bond developed. A promiscuous mating habit was indicated.

The movements of hens suggested varying levels of response to the stimuli of mating, and responses were precisely fixed among hens and in time. Such an inflexible pattern of mating has adaptive significance for Ruffed Grouse which winter in the rigorous climate of northern Minnesota.

ACKNOWLEDGMENT

This paper is a contribution from a project supported by National Science Foundation Grant No. GB-1345. The data from the current research on Ruffed Grouse at the Cloquet Forest Research Center and the techniques developed therein were essential to this project. William H. Marshall and Gordon W. Gullion provided these data and participated in many ways during the field work. Phillip Schladweiler, James Forbes, and David Peterson were able field assistants. Frederick Greeley and David K. Wetherbee offered valuable criticism of the manuscript.

LITERATURE CITED

Allen, A. A.
1934 Sex rhythm in the Ruffed Grouse (*Bonasa umbellus* Linn.) and other birds. *Auk*, 51:180–199.

Bent, A. C.
1932 Life histories of North American gallinaceous birds. *U.S. Natl. Mus. Bull.* 162.

Brander, R. B.
1965 Factors affecting dispersion of Ruffed Grouse during late winter and spring on the Cloquet Forest Research Center, Minnesota. Ph.D. Thesis, Univ. of Minnesota.

Bullough, W. S.
1961 Vertebrate reproductive cycles. John Wiley and Sons, Inc., New York.

Bump, G., R. W. Darrow, F. C. Edminster, and W. F. Crissey
1947 The Ruffed Grouse. New York State Conserv. Dept., Albany.

Edminster, F. C.
1954 American game birds of field and forest. Chas. Scribner's Sons, New York.

Grange, W. B.
1948 Wisconsin grouse problems. Wisconsin Conserv. Dept., Madison.

Gullion, G. W.
1965 Improvements in methods for trapping and marking Ruffed Grouse. *J. Wildl. Mgmt.*, 29:109–116.

Gullion, G. W., R. T. King, and W. H. Marshall
1962 Male Ruffed Grouse and thirty years of forest management on the Cloquet Forest Research Center, Minnesota. *J. Forestry*, 60:617–622.

Lack, D.
1940 Pair-formation in birds. *Condor*, 42:269–286.

Leopold, A.
1933 Game management. Chas. Scribner's Sons, New York.

Marshall, W. H., and J. J. Kupa
1963 Development of radio-telemetry techniques for Ruffed Grouse studies. *Trans. North Amer. Wildl. Conf.*, 28:443–456.

Roberts, T. S.
1936 The birds of Minnesota. Vol. I. Univ. of Minnesota Press, Minneapolis.

DEPARTMENT OF FORESTRY AND WILDLIFE MANAGEMENT, UNIVERSITY OF MASSACHUSETTS, AMHERST, MASSACHUSETTS, 4 DECEMBER 1965.

NEW LIFE MEMBER

Dr. Donald J. Borror, of Columbus, Ohio is a new Life Member of The Wilson Ornithological Society. Dr. Borror holds degrees from Otterbein College, and The Ohio State University, and is currently Professor of Zoology and Entomology at Ohio State. Ornithologists know Dr. Borror as one of the pioneers in the recording of bird songs and the analysis of these recordings by audiospectrographic means. He is the author of numerous papers on bio-acoustics, and has also published several phonograph records of bird songs. He has also co-authored a popular textbook in entomology, and has published many papers on that subject. He is a member of the AOU, the Entomological Society of America, Society of Systematic Zoology, and the American Association for the Advancement of Science. Dr. Borror is married, and has one son, who following in his father's footsteps, is a professor of zoology.

WEIGHTS OF BIRDS FROM ALABAMA AND NORTH CAROLINA

Paul A. Stewart and Robert W. Skinner

In Alabama and North Carolina from 1958 to 1963 we weighed 363 birds of 102 species and 2 hybrids. Some of the birds were collected in pesticide-bird studies of the U.S. Fish and Wildlife Service; others were collected in a program of the Alabama Department of Conservation to build up an educational collection of bird skins; the remainder were banded and released. In Alabama, most of the birds were collected in Montgomery County, but some were taken at locations scattered over the State. All of the North Carolina collections were made at the Hydrologic Experiment Station near Asheville. Our list of birds for which weights were obtained contains 63 species and 2 hybrids not weighed by Norris and Johnston (1958. *Wilson Bull.* 70:114–129) who collected in Georgia and South Carolina. It seems desirable, therefore, to publish these additional data on bird weights from the southeastern United States. Because of the smallness of the sample in individual categories, no deductions are attempted.

METHODS

The birds collected in Alabama by the senior author were taken in bait traps and were immediately either killed or weighed and released; those taken in North Carolina were mist-netted and immediately killed. The specimens taken by the junior author were shot. All birds killed by both authors were placed in plastic bags and in refrigeration soon after collection. Weights were taken when the birds were removed from refrigeration 2–60 days later. Presumably it might have been desirable to have weighed the birds immediately after capture. Based chiefly on studies with mammals, Banks (1965. *J. Mammal.* 46:110), however, concluded that, with specimens kept in refrigeration up to three months, "the change in weight caused by freezing is negligible." The hours when the birds were captured varied but were not recorded. The smaller birds were weighed on a Chatillon spring balance provided by the U.S. Fish and Wildlife Service; larger birds were weighed on a double-beam balance. In most cases individual weights were taken only to the nearest 0.5 g.

The birds collected for skins were aged by checking the degree of ossification of the skull or by plumage characters. They were sexed by examination of the gonads. Because it was difficult to avoid cross-contamination, the birds collected for chemical analysis of pesticide residues were not dissected for aging and sexing, but, like the birds banded and released, were aged and sexed by external characters when possible. Sex or age were not obtained for some birds. Detailed data are presented in Table 1.

TABLE 1

WEIGHTS (GRAMS) OF BIRDS WITH SPECIES, AGE, SEX, DATE AND STATE OF COLLECTION

Common Loon (*Gavia immer*)—Female, adult, 28 April, Alabama: 2,891.6.

Horned Grebe (*Podiceps auritus*)—Male, immature, 15 February, Alabama: 515.0. Female, immature, 17 March, Alabama: 384.0.

Gannet (*Morus bassanus*)—Male, immature, 17 March, Alabama: 2,948.3. Female, adult, 17 March, Alabama: 3,061.7.

Canada Goose (*Branta canadensis*)—Female, adult, 21 December, Alabama: 3,855.5. Female, adult, 29 December, Alabama: 3,628.7.

Lesser Snow Goose (*Chen hyperborea*)—Male, adult, 16 October, Alabama: 1,814.4.

Mallard (*Anas platyrhynchos*)—Male, adult, 8 December, Alabama: 1,170.0; 1,345.0; 1,372.0. Female, adult, 8 December, Alabama: 1,180.0; 1,393.0.

Black Duck (*Anas rubripes*)—Male, adult, 6 December, Alabama: 1,200.0.

Mallard × Black Duck—Unsexed, adult, 8 December, Alabama: 1,370.0.

Pintail (*Anas acuta*)—Male, adult, 28 December, Alabama: 802.0.

American Widgeon (*Mareca americana*)—Male, adult, 1 December, Alabama: 558.0. Male, adult, 27 December, Alabama: 789.0. Male, adult, 29 December, Alabama: 713.0. Female, adult, 6 December, Alabama: 696.0.

Wood Duck (*Aix sponsa*)—Male, adult, 26 December, Alabama: 587.0.

Canvasback (*Aythya valisineria*)—Male, adult, 29 December, Alabama: 1,086.0.

Lesser Scaup (*Aythya affinis*)—Female, adult, 29 December, Alabama: 499.0.

Bufflehead (*Bucephala albeola*)—Female, adult, 12 December, Alabama: 389.0.

Hooded Merganser (*Lophodytes cucullatus*)—Male, adult, 26 December, Alabama: 748.5. Female, adult, 26 December, Alabama: 518.0.

Mississippi Kite (*Ictinia misisippiensis*)—Male, adult, 7 May, Alabama: 260.0. Female, adult, 24 August, Alabama: 297.7.

Cooper's Hawk (*Accipiter cooperii*)—Female, adult, 30 January, Alabama: 609.5.

Red-tailed Hawk (*Buteo jamaicensis*)—Male, immature, 27 August, Alabama: 963.9. Male, immature, 14 December, Alabama: 878.8. Male, immature, 27 January, Alabama: 949.9. Female, immature, 2 November, Alabama: 1,190.7. Female, immature, 19 November, Alabama: 1,190.7. Female, immature, 9 December, Alabama: 1,105.6. Female, immature, 16 December, Alabama: 1,389.1. Female, immature, 20 January, Alabama: 1,190.7. Female, immature, 26 February, Alabama: 907.2. Female, immature, 7 March, Alabama: 1,048.9. Female, immature, 9 March, Alabama: 1,162.3.

Red-shouldered Hawk (*Buteo lineatus*)—Male, adult, 1 December, Alabama: 491.6. Male, immature, 19 October, Alabama: 680.4. Female, immature, 23 November, Alabama: 878.8. Female, adult, 14 December, Alabama: 595.3. Female, adult, 5 January, Alabama: 567.0. Female, immature, 29 November, Alabama: 708.7. Female, adult, 16 January, Alabama: 708.7. Female, adult, 25 April, Alabama: 680.4.

Broad-winged Hawk (*Buteo platypterus*)—Male, adult, 13 July, Alabama: 340.2. Unsexed, unaged, 20 April, Alabama: 311.0.

Golden Eagle (*Aquila chrysaetos*)—Female, immature, 28 January, Alabama: 4,365.8.

Marsh Hawk (*Circus cyaneus*)—Male, adult, 17 November, Alabama: 396.9.

American Kestrel (*Falco sparverius*)—Male, adult, 29 December, Alabama: 103.0. Male, adult, 28 January, Alabama: 107.0. Female, adult, 18 September, Alabama: 118.0. Female, adult, 29 September, Alabama: 125.0. Female, adult, 20 October, Alabama: 111.0. Female, adult, 9 December, Alabama: 117.0. Female, adult, 8 January, Alabama: 123.0;

TABLE 1 (*Continued*)

WEIGHTS (GRAMS) OF BIRDS WITH SPECIES, AGE, SEX, DATE AND STATE OF COLLECTION

113.0. Female, adult, 12 January, Alabama: 134.0. Female, adult, 26 January, Alabama: 131.0. Female, adult, 28 January, Alabama: 124.0. Female, adult, 18 March, Alabama: 119.0.

Coot (*Fulica americana*)—Unsexed, adult, 11 December, Alabama: 617.0.

Killdeer (*Charadrius vociferus*)—Female, adult, 8 January, Alabama: 104.0; 114.5. Unsexed, adult, 9 January, Alabama: 104.0.

Black-bellied Plover (*Squatarola squatarola*)—Male, adult, 4 January, Alabama: 198.0.

Common Snipe (*Capella gallinago*)—Male, adult, 4 January, Alabama: 86.0.

Least Sandpiper (*Erolia minutilla*)—Female, adult, no date, Alabama: 20.0.

Herring Gull (*Larus argentatus*)—Unsexed, adult, 17 March, Alabama: 1,234.0.

Ring-billed Gull (*Larus delawarensis*)—Male, adult, 15 February, Alabama: 499.0. Male, immature, 15 February, Alabama: 464.0. Female, immature, 15 February, Alabama: 432.0.

Royal Tern (*Thalasseus maximus*)—Female, adult, 15 February, Alabama: 492.0.

Mourning Dove (*Zenaidura macroura*)—Male, adult, 4 January, Alabama: 120.0.

Barn Owl (*Tyto alba*)—Male, adult, 8 January, Alabama: 567.0.

Screech Owl (*Otus asio*)—Female, adult, 7 January, Alabama: 130.0.

Great Horned Owl (*Bubo virginianus*)—Male, adult, 6 February, Alabama: 1,291.0. Female, adult, March, Alabama: 1,590.0.

Barred Owl (*Strix varia*)—Female, adult, 22 January, Alabama: 708.7. Unsexed, adult, 23 January, Alabama: 785.5.

Short-eared Owl (*Asio flammeus*)—Male, adult, 3 February, Alabama: 340.2. Female, adult, 15 January, Alabama: 368.5; 452.5. Unsexed, adult, 25 November, Alabama: 368.5.

Red-headed Woodpecker (*Melanerpes erythrocephalus*)—Female, adult, 30 May, Alabama: 72.0.

Yellow-bellied Sapsucker (*Sphyrapicus varius*)—Male, adult, 12 January, Alabama: 47.3.

Downy Woodpecker (*Dendrocopos pubescens*)—Female, adult, 17 March, Alabama: 21.0.

Acadian Flycatcher (*Empidonax virescens*)—Unsexed, adult, 8 July, North Carolina: 13.0. Unsexed, adult, 10 July, North Carolina: 10.0; 12.0.

Least Flycatcher (*Empidonax minimus*)—Male, adult, 28 April, Alabama: 10.0.

Blue Jay (*Cyanocitta cristata*)—Male, adult, 7 May, Alabama: 75.0.

Tufted Titmouse (*Parus bicolor*)—Unsexed, immature, 9 July, North Carolina: 19.0; 19.0.

Brown-headed Nuthatch (*Sitta pusilla*)—Male, adult, 4 January, Alabama: 11.0.

Long-billed Marsh Wren (*Telmatodytes palustris*)—Male, adult, 22 January, Alabama: 11.0.

Short-billed Marsh Wren (*Cistothorus platensis*)—Male, adult, 22 January, Alabama: 8.0.

Catbird (*Dumetella carolinensis*)—Male, adult, 24 April, Alabama: 35.0. Female, adult, 4 June, Alabama: 33.0.

Brown Thrasher (*Toxostoma rufum*)—Male, adult, January, Alabama: 81.0. Female, adult, 27 December, Alabama: 79.0.

Robin (*Turdus migratorius*)—Female, adult, 11 February, Alabama: 87.0.

Wood Thrush (*Hylocichla mustelina*)—Male, adult, 8 July, North Carolina: 44.0. Male, adult, 10 July, North Carolina: 46.0. Female, adult, 8 July, North Carolina: 45.0; 48.0. Female, adult, 9 July, North Carolina: 43.5; 45.0; 47.6.

TABLE 1 (*Continued*)

WEIGHTS (GRAMS) OF BIRDS WITH SPECIES, AGE, SEX, DATE AND STATE OF COLLECTION

Hermit Thrush (*Hylocichla guttata*)—Female, adult, January, Alabama: 32.0. Female, unaged, 11 February, North Carolina: 32.0.

Veery (*Hylocichla fuscescens*)—Male, adult, 9 July, North Carolina: 31.0. Male, adult, 10 July, North Carolina: 26.5; 29.5.

Golden-crowned Kinglet (*Regulus satrapa*)—Male, adult, 4 January, Alabama: 5.0.

Ruby-crowned Kinglet (*Regulus calendula*)—Male, adult, 8 April, Alabama: 8.0.

Water Pipit (*Anthus spinoletta*)—Male, adult, 4 January, Alabama: 24.5; 24.5; 25.0. Male, adult, 8 April, Alabama: 34.0; 37.0.

Cedar Waxwing (*Bombycilla cedrorum*)—Male, adult, 8 April, Alabama: 34.0; 37.0. Female, adult, 8 April, Alabama: 35.0. Unsexed, adult, 1 February, Alabama: 35.0.

Loggerhead Shrike (*Lanius ludovicianus*)—Male, adult, 3 February, Alabama: 38.0. Male, adult, 10 March, Alabama: 49.0.

Starling (*Sturnus vulgaris*)—Unsexed, unaged, 7 January, Alabama: 71.0; 71.5; 73.0; 73.0; 73.0; 73.5; 75.0; 75.5; 76.5; 77.0; 77.0; 77.0; 77.5; 78.0; 79.0; 79.0; 79.5; 79.5; 80.0; 80.0; 80.0; 80.5; 81.0; 81.0; 81.0; 82.0; 82.0; 82.0; 82.5; 83.0; 83.0; 84.5; 84.5; 85.0; 88.5.

Solitary Vireo (*Vireo solitarius*)—Female, immature, 9 July, North Carolina: 16.0.

Red-eyed Vireo (*Vireo olivaceus*)—Male, adult, 9 July, North Carolina: 15.0; 17.0. Female, adult, 10 July, North Carolina: 13.0; 14.0.

Black and White Warbler (*Mniotilta varia*)—Unsexed, immature, 8 July, North Carolina: 8.0; 8.0; 9.0; 9.0; 10.0; 10.5; 11.0; 11.5.

Worm-eating Warbler (*Helmitheros vermivorus*)—Unsexed, immature, 10 July, North Carolina: 12.0; 12.5; 12.5.

Blue-winged Warbler (*Vermivora pinus*)—Male, adult, 27 April, Alabama: 9.0.

Brewster's Warbler (*Vermivora chrysoptera* × *Vermivora pinus*)—Male, adult, 26 April, Alabama: 9.0.

Orange-crowned Warbler (*Vermivora celata*)—Female, adult, 11 February, Alabama: 9.0.

Nashville Warbler (*Vermivora ruficapilla*)—Male, adult, 26 April, Alabama: 8.0.

Black-throated Blue Warbler (*Dendroica caerulescens*)—Male, adult, 8 July, North Carolina: 11.0. Unsexed, immature, 10 July, North Carolina: 8.5.

Black-throated Green Warbler (*Dendroica virens*)—Female, adult, 21 January, Alabama: 9.0.

Chestnut-sided Warbler (*Dendroica pensylvanica*)—Female, adult, 26 April, Alabama: 9.5. Unsexed, immature, 8 July, North Carolina: 9.5; 10.0.

Bay-breasted Warbler (*Dendroica castanea*)—Male, adult, 2 May, Alabama: 12.0.

Blackpoll Warbler (*Dendroica striata*)—Male, adult, 6 May, Alabama: 12.0.

Pine Warbler (*Dendroica pinus*)—Male, adult, 4 January, Alabama: 12.0. Female, adult, 4 January, Alabama: 12.5.

Ovenbird (*Seiurus aurocapillus*)—Male, adult, 9 July, North Carolina: 17.5; 19.0. Female, adult, 9 July, North Carolina: 17.0; 17.5; 17.5; 18.0; 18.5. Unsexed, immature, 9 July, North Carolina: 16.0; 16.0; 16.0; 16.5.

Kentucky Warbler (*Oporornis formosus*)—Male, adult, 8 July, North Carolina: 13.0. Female, adult, 9 July, North Carolina: 13.0. Unsexed, immature, 9 July, North Carolina: 13.0.

Yellow-breasted Chat (*Icteria virens*)—Male, adult, 13 May, Alabama: 25.0.

TABLE 1 (*Continued*)

WEIGHTS (GRAMS) OF BIRDS WITH SPECIES, AGE, SEX, DATE AND STATE OF COLLECTION

Hooded Warbler (*Wilsonia citrina*)—Male, adult, 9 July, North Carolina: 11.0; 11.5.

Canada Warbler (*Wilsonia canadensis*)—Male, adult, 5 May, Alabama: 10.0. Female, adult, 8 July, North Carolina: 10.0; 11.0.

House Sparrow (*Passer domesticus*)—Male, adult, 4 January, Alabama: 37.5; 37.5; 39.0; 39.0; 40.0.

Eastern Meadowlark (*Sturnella magna*)—Male, adult, 27 December, Alabama: 116.0. Female, adult, 11 February, 90.0. Female, adult, 27 December, Alabama: 85.0.

Western Meadowlark (*Sturnella neglecta*)—Male, adult, 28 February, Alabama: 112.0. Female, adult, 3 February, Alabama: 99.0.

Redwinged Blackbird (*Agelaius phoeniceus*)—Male, adult, 11 February, Alabama: 71.0. Male, adult, 14 February, Alabama: 65.0. Male, immature, 9 January, Alabama: 62.0; 64.0; 64.0; 65.0; 65.5; 66.0; 67.0; 67.0; 68.0; 68.5; 68.5; 68.5; 68.5; 69.0; 69.0; 69.0; 70.0; 71.0; 71.0. Female, adult, 22 December, Alabama: 41.0; 45.0; 46.8; 50.0.

Orchard Oriole (*Icterus spurius*)—Male, immature, 29 April, Alabama: 22.0.

Baltimore Oriole (*Icterus galbula*)—Female, adult, 6 May, Alabama: 40.0.

Rusty Blackbird (*Euphagus carolinus*)—Male, adult, 17 January, Alabama: 62.6. Male, adult, 5 February, Alabama: 66.0. Female, adult, 5 February, Alabama: 54.5.

Common Grackle (*Quiscalus quiscula*)—Male, adult, 17 December, Alabama: 130.0. Male, adult, 1 January, Alabama: 135.0. Male, adult, 27 January, Alabama: 112.0. Female, adult, 12 January, Alabama: 109.0.

Brown-headed Cowbird (*Molothrus ater*)—Male, adult, 6 January, Alabama: 42.0; 44.0; 44.0; 45.0; 45.0; 46.0; 47.0; 48.0; 48.0; 49.0; 49.0; 49.0; 50.0; 50.0; 50.0; 50.0; 50.0; 50.0; 51.0; 51.0; 51.0; 51.0; 51.5; 52.0; 52.0; 52.4; 52.5; 53.0; 54.0; 54.0; 54.0; 55.0; 56.0; 56.0; 56.5; 58.5; 58.5; 60.0. Female, adult, 22 December, Alabama: 40.1; 41.5; 44.2; 44.8. Female, adult, 6 January Alabama: 34.0; 35.0; 35.5; 37.5; 37.5; 37.5; 37.5; 39.0; 40.0; 40.5; 41.0; 42.0; 42.5.

Scarlet Tanager (*Piranga olivacea*)—Male, adult, 8 July, North Carolina: 29.5. Female, adult, 10 July, North Carolina: 27.5; 29.0. Female, immature, 10 July, North Carolina: 28.0.

Cardinal (*Richmondena cardinalis*)—Female, adult, 8 July, North Carolina: 40.0. Female, immature, 10 July, North Carolina: 35.0.

Rose-breasted Grosbeak (*Pheucticus ludovicianus*)—Female, adult, 2 May, Alabama: 43.0. Male, adult, 30 April, Alabama: 46.0.

Indigo Bunting (*Passerina cyanea*)—Male, adult, 8 July, North Carolina: 12.5; 15.5. Female, adult, 8 July, North Carolina: 13.0; 13.0.

Purple Finch (*Carpodacus purpureus*)—Male, adult, 26 January, Alabama: 24.4. Female, adult, 26 January, Alabama: 22.5; 23.6; 25.3; 25.9; 26.1; 26.4; 26.7; 26.9; 27.0; 27.2; 27.2; 27.3.

American Goldfinch (*Spinus tristis*)—Male, adult, 11 February, Alabama: 14.0. Male, adult, 17 March, Alabama: 13.0.

Rufous-sided Towhee (*Pipilo erythrophthalmus*)—Male, adult, 8 July, North Carolina: 42.0.

Savannah Sparrow (*Passerculus sandwichensis*)—Female, adult, 4 January, Alabama: 23.0. Female, adult, 9 January, Alabama: 17.0. Female, adult, 26 February, Alabama: 16.0.

TABLE 1 (*Continued*)

WEIGHTS (GRAMS) OF BIRDS WITH SPECIES, AGE, SEX, DATE AND STATE OF COLLECTION

Grasshopper Sparrow (*Ammodramus savannarum*)—Male, adult, 10 March, Alabama: 13.0.

Sharp-tailed Sparrow (*Ammospiza caudacuta*)—Female, adult, 22 January, Alabama: 14.0.

Seaside Sparrow (*Ammospiza maritima*)—Male, adult, 22 January, Alabama: 20.0; 22.0; 22.0. Female, adult, 22 January, Alabama: 19.0.

Vesper Sparrow (*Pooecetes gramineus*)—Male, adult, 26 February, Alabama: 25.0.

Slate-colored Junco (*Junco hyemalis*)—Male, immature, 4 January, Alabama: 17.5.

White-crowned Sparrow (*Zonotrichia leucophrys*)—Male, adult, 28 February, Alabama: 30.0

White-throated Sparrow (*Zonotrichia albicollis*)—Male, adult, 8 April, Alabama: 28.0. Female, adult, 17 March, Alabama: 25.0; 38.8; 41.5. Unsexed, adult, 12 January, Alabama: 29.4.

Fox Sparrow (*Passerella iliaca*)—Male, adult, 12 January, Alabama: 38.8; 41.5. Male, adult, 27 December, Alabama: 42.0.

Song Sparrow (*Melospiza melodia*)—Male, adult, 3 February, Alabama: 25.0.

U.S. DEPARTMENT OF AGRICULTURE, AGRICULTURAL RESEARCH SERVICE, ENTOMOLOGY RESEARCH DIVISION, OXFORD, NORTH CAROLINA AND ALABAMA DEPARTMENT OF CONSERVATION, MONTGOMERY, ALABAMA. 22 SEPTEMBER 1965.

FOODS OF THE BLACK-BELLIED TREE DUCK IN SOUTH TEXAS[1]

Eric G. Bolen and Billy J. Forsyth

The abundance and economic importance of many North American waterfowl have lead to comprehensive studies of their food habits (see Cottam, 1939, Martin and Uhler, 1951, and others). Similar information for protected and less common species is often scattered and derived from infrequent samples, and moreoften, entirely wanting. However, food habits data from a limited series of samples gain value when these stem from local populations of an uncommon species. Presented here are the results of food analyses from a restricted population of the Black-bellied Tree Duck (*Dendrocygna autumnalis*) nesting in South Texas.

METHODS

Tree ducks collected for food habits studies and other analyses (Bolen, 1964) were taken at Lake Corpus Christi in Live Oak and San Patricio Counties, Texas. The data reported were obtained from 22 stomachs and 11 crops analysed in the following manner:

> The contents of the entire stomach, including grit, or crop were immersed in water to measure the total volume by displacement. The materials were next oven dried and separated. A visual estimate of volume by per cent of each item was made using a grid system; the relative volume in milliliters was then calculated from the total volume. Grit and food items were next weighed and filed in a reference collection. Data were kept on separate file cards for each stomach and crop studied. This proved an accurate yet rapid method for handling the materials (Forsyth, 1965).
>
> U.S. Standard Sieves were used to separate grit materials. Each size class was then weighed and this figure expressed as a percentage of the total sample from all stomachs.

Both stomach and crop contents were used to compute the volumes of each food item. However, these data are separated into the larger categories of plant and animal foods (Table 1) for comparisons with other studies where foods were analysed from stomach or crop samples alone. Differences in the contents of these organs result from the retention of the harder animal parts in the stomach well after the softer plant materials have passed into the lower digestive tract: foods found in the crop are more likely retained without a selection favoring either plant or animal items. Computation of each food's frequency of occurrence was based only on stomach contents.

In this study all but 1 of the 22 birds collected were adults in fully matured plumage. The remaining bird was a young-of-the-year capable of flight yet

---

[1] Contribution No. 103, Rob & Bessie Welder Wildlife Foundation, Sinton, Texas.

TABLE 1

PERCENTAGE OF PLANT AND ANIMAL ITEMS FOUND IN THE STOMACHS AND CROPS OF BLACK-BELLIED TREE DUCKS

Type of food	Stomachs (22)		Crops (11)		Total	
	ml	%	ml	%	ml	%
Plant	56.7	86.8	134.7	94.4	191.4	92.0
Animal	8.6	13.2	8.0	5.6	16.6	8.0
Total	65.3	100.0	142.7	100.0	208.0	100.0

still in drab juvenal plumage. The food items in this bird were enough like those of adults collected during the same month (September) to be included in the tabulations.

PLANT FOODS

Plant foods made up 92 per cent of the diet. Of these, the cultivated grain, *Sorghum vulgare*, constituted nearly half of the total food volume (Table 2). Wild and cultivated strains of Bermudagrass (*Cynodon dactylon*) collectively ranked secondmost in volume. Seeds of cultivated Bermudagrass, while inseparable from the wild strain, are likely less important since this hybrid produces few inflorescences (Gould and Box, 1965). Tree ducks ingest both sorghum and Bermudagrass in large quantities, often to the point that the crop is distended and visible immediately after feeding.

The incidence of corn (*Zea mays*) in our samples resulted from birds feeding in stockyards rather than feeding directly in cornfields. Corn is not a common field crop in South Texas. However, the importance of corn as a tree duck food no doubt increases elsewhere in the bird's range where this crop is widely cultivated. Bent (1925) accordingly mentions that the Black-bellied Tree Duck has earned the name, "pato maizal," or cornfield duck because of the depredation it supposedly inflicts on corn crops in Mexico.

Two species of millet, *Echinochloa colonum* and *E. crusgalli*, were found. These constituted about 6 per cent of the total food volume. Both plants are often associated with Bermudagrass in moist pasture habitats; grazing tree ducks alternately strip seeds from the millets and Bermudagrass where these grasses are both available.

Smartweeds, *Polygonum lapathifolium* and *P. longistylum*, together made up less than 1 per cent of the total food volume.

At Lake Corpus Christi, shoreline beds of water stargrass (*Heteranthera liebmanni*) are favored feeding and loafing places for Black-bellied Tree Ducks in late summer. Two growth forms of this plant are evident. One occupies mudflats and lake margins in dense, carpet-like stands. Its aquatic counterpart exhibits longer stems and leaves and grows in deeper water. These differences are likely adaptive responses to changing water levels. Seeds of water stargrass (6 per cent of the total volume) presumably came from the shallow-water stands since these are more apt to flower than aquatic beds of the same plant. Moreover, Black-bellied Tree Ducks typically wade in shallow areas rather than venture into deeper water for food. Elsewhere, Martin and Uhler (1951) reported that water stargrass may become a noxious weed detrimental to other, more desirable plants; they considered it of slight importance as a waterfowl food.

All plant foods found in either crops or stomachs consisted of seeds only. There was little or no suggestion of leaves, stems, or root systems in the samples. However, hand-reared tree ducks readily accept the leafy parts of common vegetables as food items.

ANIMAL FOODS

Earlier references to Black-bellied Tree Duck foods appear as observational data only (see Phillips, 1922; Bent, 1925; Kortright, 1942; Delacour, 1954; and Bolen et al., 1964). Only plant foods are mentioned in these reports. However, animal foods made up at least 8 per cent of our sample. Mollusks and insects were represented, both groups often occurred in volumes so small as to be immeasurable.

A single gastropod species, *Physa anatina*, was identified from crop materials; 16 individual snails of this species were found in the crop of a single bird. Only small, unidentifiable bits of shell were usually present in stomach contents. Thus, in Table 2, the mollusk foods are lumped without further classification. We believe, however, that these are gastropod forms, and probably *Physa*.

Insects composed the balance of the animal food volume. About one-half of the insects, by volume, could not be identified. The remainder included the following orders and families: Hemiptera (unidentified immature forms), Neuroptera (larva of Myrmeleontidae), Coleoptera (Cicindelidae, Carabidae, and Tenebrionidae), and Diptera (larva of Stratiomyidae). A flour beetle, *Tribolium castanatus*, was identified from a crop filled with Bermudagrass seeds. Insects are undoubtedly taken, perhaps passively, by birds feeding in stands of water stargrass or when grazing in pastures.

FREQUENCY OF OCCURRENCE

Plant foods occurred in all (100 per cent) of the stomachs. Ten (15.5 per cent) stomachs contained some form of animal materials.

The frequency of individual food items is shown in Table 2. Bermudagrass

TABLE 2
VOLUME AND FREQUENCY OF FOOD ITEMS FOR THE BLACK-BELLIED TREE DUCK IN SOUTH TEXAS. SAMPLE SIZE IN PARENTHESIS; *T* = TRACE

Item	Volume (ml)				Occurrence—22 stomachs	
	Stomachs (22)	Crops (11)	Total	%	No.	%
Cynodon dactylon	13.2	48.0	61.2	29.5	10	45.5
Sorghum vulgare	17.9	82.5	100.4	48.3	7	31.8
Echinochloa spp.	9.8	2.0	11.8	5.7	4	18.2
Polygonum spp.	0.6	–	0.6	0.2	6	27.3
Heteranthera liebmanni	12.2	1.0	13.2	6.3	5	22.7
Zea mays	3.0	1.2	4.2	2.0	1	4.5
Mollusca (*Physa anatina*)	2.3	8.0	10.3	5.0	8	36.4
Insecta	6.3	T	6.3	3.0	5	22.7
Total	65.3	142.7	208.0	100.0	–	–

and sorghum again showed prominence as tree duck foods in South Texas. Other plants appeared 18 to 27 per cent of the time. Corn, for reasons already mentioned, was found in only 1 (4.5 per cent) of the 22 stomachs.

Animal foods were found as often as most of the individual plant foods. Mollusks occurred in 36 per cent of the stomachs and insects in nearly 23 per cent.

SEASONAL FOOD TRENDS

The Black-bellied Tree Duck population near Lake Corpus Christi represents an expansion of their northern range (Bolen, et al., 1964). Here the birds arrive irregularly in March or April and remain in large flocks near cattle feedlots. They loaf on the shores of nearby farm ponds, but fly to the stockyards at dawn and dusk for food. No stomach collections were taken during this period for this reason. Instead, birds were collected following their spring dispersal to the lake proper. The distribution of these collections was as follows: 5 birds taken in May, 6 in June, 4 each in July and August, and 3 in September. These are inadequate for steadfast conclusions, but they indicated with field observations, a shifting trend in foods well geared to plant phenology (Table 3).

Bermudagrass is the staple food in May. Stockyards receive further utilization but native grasses begin drawing flocks of tree duck to pastures near Lake Corpus Christi. In June, as the field crops ripen, sorghum enters the diet. By late June and early July the sorghum harvest is underway and field wastes lead to an abundance of this tree duck food. Stubble flights are initiated; the birds embark on a daily schedule to the grain fields that lasts into fall. Birds collected in July showed the most varied diet because

TABLE 3
SUMMARY OF SEASONAL FOOD TRENDS FOR THE BLACK-BELLIED TREE DUCK IN SOUTH TEXAS. DATA COMBINED FROM CROP AND STOMACH ANALYSES (1963) AND FIELD OBSERVATIONS (1962–1965)

Month	Major food	Comment
March and/or April	Stock foods	Arriving birds congregate at stockyards; foods exclusively grains until birds disperse
May	Bermudagrass	Flocks graze in pastures stripping seed heads; some millets taken and some continued use of stockyards
June	Sorghum	Grain harvest begins; birds start flights to fields
July	Sorghum & variety of native food plants	Smartweeds, etc., but mainly sorghum
August	Sorghum & water stargrass	Stubble flights continue; pairs with young broods in beds of water stargrass
September	Sorghum & water stargrass	Stubble flights prominent in entire tree duck population, including flying young-of-the-year; large groups loafing in water stargrass during mid-day hours; similar pattern continues into fall

of the addition of smartweeds and the continued use of various grasses. Water stargrass is late in setting seed and accordingly showed a distinctive seasonal occurrence in the tree duck diet; it was found in birds taken during late August and September.

No seasonal trend was shown in the occurrence of animal foods: these prevailed with equal frequency throughout the sampling period.

GRIT

Grit varied from 0.8 to 2.4 grams per stomach. The mean weight was 1.4 grams for the 22 stomachs analysed. Grit was of both opaque and translucent materials of considerable size variation (Table 4). Well over one-half of the grit, by weight, passed through a No. 10 U.S. Standard Sieve (less than 2000 microns). About 5 per cent was large enough to catch in a No. 4 sieve (4760 microns). Besides the mineral contents, 1 stomach contained 2 pieces of worn, smooth glass and another held a single No. 6 lead shot.

SUMMARY

The foods of the Black-bellied Tree Duck in South Texas were, by volume, 92 per cent plant materials. Of these, sorghum and Bermudagrass predominated in both

TABLE 4
SIZE AND WEIGHT DISTRIBUTION OF 30.5 GRAMS OF GRIT MATERIALS FROM 22 BLACK-BELLIED TREE DUCK STOMACHS

U. S. standard sieve number	Mesh size (microns)	Weight (g)	Per Cent
4	4760 and larger	1.5	4.9
8	2380	4.3	14.1
10	2000	1.2	3.9
16	1190	11.8	38.7
20	840	6.4	21.0
–	less than 840	5.3	17.4
	Total	30.5	100.0

volume and percentage frequency. Other food plants included smartweeds, millets, water stargrass, and a single incidence of corn. Plant foods consisted only of seeds and did not include vegetative structures.

Animal foods (8 per cent by volume) consisted of insects and mollusks. Each of these occurred about as often as the major plant foods. The snail, *Physa anatina*, seemed singularly important.

Tree duck food habits change with the advance of the growing season. There is an initial period of "artificial" feeding on stockyard grains after the spring migration. This changes to Bermudagrass in May, then to sorghum in mid-summer. Daily stubble flights to sorghum fields continue into fall but the late summer diet is supplemented by water stargrass.

Grit from tree duck stomachs averaged 1.4 grams per bird and showed considerable size variation.

ACKNOWLEDGMENTS

We are indebted to both the Rob and Bessie Welder Wildlife Foundation and the Frank M. Chapman Memorial Fund of the American Museum of Natural History for support of this study. Clarence Cottam, W. Caleb Glazener, Jessop B. Low, and Franklin C. Henze made many contributions. The following authorities kindly identified or confirmed our identifications of the items indicated: Leland Chandler and Willard Whitcomb (insects), Anne W. Speers (mollusks), Francis M. Uhler (seeds), and Arthur H. Holmgren and Fred B. Jones (plant taxonomy). The Soil Conservation Service provided the use of soil sieves for grit measurements.

LITERATURE CITED

BENT, A. C.
1925 Life histories of North American wild fowl. Part II. *U.S. Natl. Mus. Bull.* 130.

BOLEN, E. G.
1964 Weights and linear measurements of Black-bellied Tree Ducks. *Texas Jour. Sci.*, 16:257–260.

BOLEN, E. G., B. MCDANIEL, AND C. COTTAM
1964 Natural history of the Black-bellied Tree Duck in southern Texas. *Southwestern Naturalist*, 9:78–88.

Cottam, C.
1939 Food habits of North American diving ducks. *Tech. Bull.* 643, U.S. Dept. Agr., Washington, D.C.

Delacour, J.
1954 The waterfowl of the world. Vol. I. Country Life, Ltd., London.

Forsyth, B. J.
1965 December food habits of the Mallard (*Anas platyrhynchos*) in the Grand prairie of Arkansas. *Proc. Arkansas Acad. Sci.*, 19:74–78.

Gould, F., and T. W. Box
1965 Grasses of the Texas Coastal Bend. Texas A&M Univ. Press, College Station, Texas.

Kortright, F. H.
1942 The ducks, geese, and swans of North America. The Stackpole Co., Harrisburg, Pa.

Martin, A. C., and F. M. Uhler
1951 Food of game ducks in the United States and Canada. Research Report 30, U.S. Fish & Wildl. Serv., Washington, D.C.

Phillips, J. C.
1922 A natural history of the ducks. Vol. I. Houghton Mifflin Co., Boston, Mass.

ROB & BESSIE WELDER WILDLIFE FOUNDATION, SINTON, TEXAS (PRESENT ADDRESS: DEPARTMENT OF AGRONOMY AND RANGE MANAGEMENT, TEXAS TECHNOLOGICAL COLLEGE, LUBBOCK, TEXAS (BOLEN) AND DEPARTMENT OF ZOOLOGY, UNIVERSITY OF ARKANSAS, FAYETTEVILLE, ARKANSAS (FORSYTH)), 11 JANUARY 1966.

WIND DRIFT, LEADING LINES, AND DIURNAL MIGRATION

HELMUT C. MUELLER AND DANIEL D. BERGER

PERSONAL discussions with a number of North American students of bird migration indicate that there is considerable confusion and misunderstanding of the concepts of wind drift and leading lines. Recently, Murray (1964) published a review in which he refutes wind drift, at least insofar as it applies to the migration of Sharp-shinned Hawks (*Accipiter striatus*) in the northeastern United States. The present review is an attempt to: (1) define and show the implications of theories of wind drift and leading lines, in particular as to how they affect hawk migration; (2) discuss some of the evidence for the theories; and (3) show that the theories are consistent with the observations of hawk migration in the northeastern United States and show that Murray's (1964) hypothesis is inadequate. This paper is in part an attempt to extract generalizations from the available evidence. However, generalizations are rarely valid for all species and situations; and, further, generalizations based on little data are often shown to be unwarranted when more evidence becomes available.

WIND DRIFT: DEFINITION

Trowbridge (1895, 1902) may have been the first to discuss explicitly the influence of wind drift on bird migration. The theory received further analysis and support from Baxter and Rintoul (1918). There are a great number of recent works concerned with drift, and we slight many excellent papers by mentioning only Rudebeck (1950) and Williamson (1955) as examples. Lack and Williamson (1959) have defined drift as the "Displacement of a migrant from its normal route by the wind, . . ." We do not like this definition because of the implications of the adjective "normal." It is our belief that, at least for many species of migrants, drift is a normal phenomenon. We maintain that the route taken by a bird is the result of: (1) the "standard direction" (Thomson, 1953) of migratory flight; (2) wind drift, which may influence some birds more than others; and (3) at least in the case of many diurnal migrants, the topography. Data from banded birds suggest that most birds return to the same summer area year after year (Nice, 1937; Werth, 1947; Austin, 1949; Löhrl, 1959) and also that many birds return to areas in which they have previously spent the winter (Wharton, 1941; Petersen, 1953; Schwartz, 1963; Mewaldt, 1964). We know of no data, except possibly those from some species of waterfowl (see e.g. Hochbaum, 1955, p. 110–111), which offer good evidence for the hypothesis that an individual bird follows the identical migratory route year after year. We have banded over 50,000 birds at the Cedar Grove Ornithological Station and have recaptured only three migrants in a subsequent season. Thus it appears that the end points of the migration are fixed and that the path pursued by a bird between these two points varies considerably from year to year. This idea was stated explicitly by Baxter and Rintoul (1918) and gains further support from current studies of the recoveries of banded birds (Mueller and Berger, in press, *a,b*). Since we believe that the route of a migratory bird normally is determined in part by drift, we prefer to define drift simply as *the displacement of a bird due to wind.*

LEADING LINES: DEFINITION AND CHARACTERISTICS

Effects of the underlying terrain on the flight of diurnal migrants have been noted by many observers. For the moment we shall restrict our attention to effects of the terrain on the direction of flight. Land birds apparently are reluctant to fly out over water and sea birds appear to be reluctant to fly in over land (van Dobben, 1953; Svärdson, 1953). Similarly, birds of open country seem to be reluctant to fly out over wooded areas and forest birds apparently are reluctant to fly out over treeless terrain (Deelder and Tinbergen, 1947; Malmberg, 1955). An isolated area of suitable habitat can attract and change the course of a diurnal migrant, acting as a "leading point" (Malmberg, 1955).

Far more important and interesting is the phenomenon of the "leading line." The leading line or *Leitlinie* was first defined by Geyr (1929). In the process of translation into Dutch, English, and other languages the meaning and definition of *Leitlinie* was altered. Some translations, such as the "diversion line" of Lack and Williamson (1959), have misleading connotations and cannot be applied readily to all types of leading lines. Geyr (1963) has authorized the following translation and definition: "Leading lines are topographical features, usually long and narrow, with characteristics that induce migrating birds to follow them. The birds are influenced by these lines in choosing their direction of flight, being so to speak led by them."

The most common type of leading line is a boundary between suitable and unsuitable habitat. The most striking example of this is a coastline, where the aversion that land birds have for water results in a concentration of migrants along the coast (Rudebeck, 1950; Mueller and Berger, 1961). Habitat boundaries, such as the edge between a forest and an open field or marsh, also act as leading lines (Geyr, 1963; van Dobben, 1955; Allen and Peterson, 1936).

Another type of leading line is that which provides conditions which expedite the passage of the birds. An outstanding example of this is the mountain ridge, which deflects the horizontal wind and provides updrafts for soaring birds (Robbins, 1956; Ulfstrand, 1960). The abundance of food along coasts and rivers may aid the passage of migrants that feed while migrating (von Westernhagen, 1957; Hurrel, 1955).

Lastly, there appear to be leading lines which do not border unfavorable habitat or offer any obvious advantage to the migrant except that they approximately parallel the flight direction of the bird. Examples of this include river valleys (Svärdson, 1953) and dunes and dykes (van Dobben, 1953). Thus, there is apparently a tendency for birds to follow leading lines, quite apart from the aversion of the bird to hostile habitat, or the attraction of updrafts, food abundance, or other conditions which might aid migration. Land migrants coming inland from flight over bodies of water have been observed to turn and fly along the coast (van Dobben, 1953; Lack, 1962; Williamson, 1962; Mueller and Berger, in preparation). Leading lines may help a bird orient during migration and may help it avoid excessive wind drift (Svärdson, 1953; van Dobben, 1955; Nisbet, 1957; Williamson, 1962).

EFFECTIVENESS OF LEADING LINES

A bird is, of course, not compelled to follow a leading line: it can cross, or turn back from, the line. The effectiveness of a leading line varies; some of the variables involved are listed below:

(1) The linearity of the leading line. Straight, well defined, and uninterrupted lines are most effective. An irregular and dissected coast, for example, leads few birds while a straight coastline with little variance in habitat type is highly effective (Rudebeck, 1950).

(2) The length of the leading line. The longer the line, the greater the number of birds that might encounter and follow the line.

(3) The angle formed between the leading line and the direction of flight of the bird. The greater the angle, the less the tendency for the bird to follow the line (Deelder, 1949; Svärdson, 1953).

(4) The prominence of the leading line. The coast of the ocean is obviously more effective than the shore of a narrow embayment; an abrupt, high ridge is more effective than a low, gentle slope.

(5) The bird's motivation to migrate. The higher the migratory impulse, the lower the attractiveness of the leading line (Rudebeck, 1950; Thomson, 1953).

(6) The geographic location in relation to the bird's origin and destination. Birds seem to react more strongly to the coastline in Norway, where sea crossing is undesirable, than in Holland, where sea crossing is a normal part of migration (Nisbet, 1957).

(7) Wind direction. Chaffinches (*Fringilla coelebs*) cross the Dutch

coast and head out over the English Channel in greater numbers in a tailwind than in a headwind (Deelder, 1949). The opposite is true for hawks crossing a strait or bay (Rudebeck, 1950; Stone, 1937).

(8) The time of day. Hawks appear to be less willing to cross water later in the day than they are early in the morning (Rudebeck, 1950).

(9) The height of flight. The greater the altitude of flight, the less the bird is influenced by leading lines (Deelder and Tinbergen, 1947; Rudebeck, 1950).

Chaffinches react to the Dutch coastline when it is up to 5 km away and when its surface subtends an angle of less than 50′ (Deelder and Tinbergen, 1947). Rudebeck (1950) has observed hawks flying parallel to the Swedish coast, but some distance from it. Birds might thus follow, or parallel, a leading line at quite some distance from the line, and an observer on the line might be unaware of such a parallel flight.

HEIGHT OF FLIGHT

The height of flight of diurnal migrants influences not only their reaction to leading lines but also their probability of being observed. Some of the factors which influence height of flight are listed below:

(1) Wind direction. Birds fly higher in a tailwind and lower in a headwind or crosswind (Trowbridge, 1902; Deelder and Tinbergen, 1947: Rudebeck, 1950).

(2) Wind speed. Birds fly lower in strong winds (Deelder and Tinbergen, 1947).

(3) The underlying terrain. Sea birds fly higher over land than over the sea, land birds fly higher over the sea than over land (Svärdson, 1953). Forest birds fly higher over open, than over wooded, terrain (Deelder and Tinbergen, 1947). Hawks fly much higher over cities than over wooded terrain (Trowbridge, 1902).

(4) Leading lines. Birds flying along a leading line usually fly quite low (Deelder and Tinbergen, 1947). Hawks have been observed to descend to lower altitudes when they encounter a coast (Allen and Peterson, 1936). These observations suggest that the leading line might induce lower flight.

(5) Visibility. Chaffinches fly lower in fog and heavy rain (Deelder and Tinbergen, 1947).

EVIDENCE OF DRIFT

Most of the data in support of the theory of wind drift provide indirect evidence; it is exceedingly difficult to observe drift in progress. Before one can evaluate a direct observation which seems to indicate drift one must be certain of the following: (1) that the bird was actually migrating, (2) the standard migratory direction of the bird. (3) that the bird was not being influenced by topography. These conditions are almost impossible to meet. Whether or not a bird is actually migrating can be determined only subjectively no matter how well the migratory habits of the species observed are known. and no matter how experienced the observer. The standard migratory direction can only be inferred from the distribution of band recoveries or from observations of birds in flight, both of which are influenced by drift and topography. Attempts to determine the standard direction by experimental means may produce misleading results (see Kramer, 1950: Matthews. 1961). Absolutely featureless terrain does not exist. and the possibility that a bird is being influenced by topography cannot be dismissed completely.

With the above difficulties in mind. we submit below some observations which might be interpreted as offering some direct evidence of drift. Over the past several years we have collected 14 observations of hawks flying over relatively featureless terrain. away from obvious leading lines, and during the time of year when the species is normally migrating. Each of the hawks moved in a relatively constant direction for a considerable distance and was thought to be migrating. The 14 observations were of the following species and individuals: three Marsh Hawks (*Circus cyaneus*), seven Red-tailed Hawks (*Buteo jamaicensis*). four Rough-legged Hawks (*Buteo lagopus*), and more than 500 Broad-winged Hawks (*Buteo platypterus*). Two of the Red-tailed Hawks were flying south on a calm autumn day. The Broad-winged Hawks were moving southward on an autumn day in a light northerly wind. Of the remaining individual observations. four birds were moving downwind in an inappropriate direction (at least 90° from the "expected direction" of north in spring, south in autumn). Another three birds were moving upwind in an inappropriate direction, and two birds were moving upwind in the appropriate direction. Only three birds. two low flying Marsh Hawks and one low flying Rough-legged Hawk. were observed to quarter the wind. Each of these three birds was moving in essentially the appropriate direction. The above observations suggest that some hawks fly up- or downwind. Maximum drift can occur if birds fly downwind. Considerable displacement can also occur if the birds fly into the wind. Further observations of migration away from leading lines are needed.

Rainey (1960) analyzed photographically the flight of two European Storks (*Ciconia ciconia*) over a brief interval of time and concluded that the birds were being drifted by the wind. However. the date and location of observation were not given, and it is impossible to state whether or not the birds were migrating. Lack (1960) concluded that his radar observations offered evidence for the wind drift of migrating birds. He usually found no differences in the flight directions over land and over sea of both nocturnal and diurnal migrants.

WIND DRIFT THEORY

The lack of good, direct evidence does not prevent the elucidation of the mechanisms of drift by theoretical means. For purposes of discussion we can consider drift to be of three types: (1) Downwind drift. The birds simply fly downwind. This mode of flight has been suggested by Williamson (1955) and, somewhat differently, by Mueller and Berger (1961). (2) Free drift. The bird flies through the air in the standard migratory direction. The flight path, or track, relative to the earth is a resultant of the standard migratory direction and the wind. Lack (1960) presents evidence from radar observations which suggests that this type of drift is common over the North Sea. (3) Compensated drift. The bird attempts to compensate partially for drift by altering its direction of flight through the air so that its path relative to the earth more nearly approximates the standard migratory direction. This presumably would be very difficult without reference to landmarks. Leading lines and a low altitude of flight would aid attempts at compensation. Flight at high altitudes and with a paucity of suitable landmarks would make compensation difficult. Lack (1960), in writing of the diurnal migrations of Starlings (*Sturnus vulgaris*), concluded with: "Evidently, however, they can correct for drift over the land only when flying low, since radar observations in 1959 suggested that drift normally was as extensive over the land as over the sea."

Birds utilizing updrafts in flight are extremely subject to drift. In the presence of a horizontal wind, with its resulting shear, thermal updrafts are tilted downwind. Birds which soar in circles, such as hawks of the genus *Buteo*, are subject to considerable drift in the relatively slow ascent in an updraft. The direction taken in the rapid glide when the bird leaves the updraft varies with the wind direction and the orientation of leading lines. The mean flight direction resulting from several ascents and descents is not easy to discern. The flight direction in one part of such a flight pattern often is very different from the mean flight direction. More than a few students of hawk migration have been misled by this phenomenon. A detailed discussion of the action of wind drift on birds that soar in circles can be found in Rudebeck (1950).

At higher horizontal wind velocities birds no longer soar in circles. In an earlier paper (Mueller and Berger, 1961) we suggested that, at higher wind velocities, updrafts form into longitudinal strip-like cells of updrafts and downdrafts, oriented up- and downwind (see also Woodcock, 1942). Under these conditions it is considerably easier for a bird to fly up- or downwind.

than it would be for it to fly across the wind direction, and thus presumably the effects of wind drift would be increased.

Space prohibits the citation of all of the papers utilizing wind drift in the analysis of migration data. The indirect evidence for the theory of wind drift is considerable. There appears to be only one attempt at refutation of the theory, that of Murray (1964), an analysis of which follows.

WIND DRIFT AND SHARP-SHINNED HAWK MIGRATION ALONG THE NORTHEASTERN COAST OF THE UNITED STATES

In his review of studies of Sharp-shinned Hawk migration along the Atlantic coast, Murray (1964) states that: "Trowbridge (1895, 1902), Stone (1922), and Allen and Peterson (1936) hypothesized on the basis of their observations that: (1) Sharp-shinned Hawks normally migrate inland; (2) northwesterly winds drift ("lateral displacement" of Lack and Williamson, 1959) the hawks to the coast; and (3) once at the coast they continue along the coast." Our interpretation of the works of Trowbridge, Stone, and Allen and Peterson differs from that of Murray. We find that: (1) only Allen and Peterson mention the concept of a normal inland route, and it is not essential to our concept of wind drift. (2) Although Stone (1922) suggests the possibility of hawks flying along the coast, he apparently abandoned this idea in a later publication (Stone, 1937). Only Trowbridge (1895, 1902) directly mentions hawks following the coast. We quote from Trowbridge (1902): "They then turn westward and follow the Connecticut shore until they have reached New York and New Jersey, where they gradually separate and pass on southward." It would seem that Trowbridge, Stone, and Allen and Peterson were aware that hawks did not follow the coasts exactly and invariably. Murray argued that the above hypotheses were not supported by the data and offered "an alternative hypothesis that explains all of the observations."

Murray states his hypothesis in this form: "The published evidence supports the view that Sharp-shinned Hawk migration proceeds on a broad front in a generally southwestward direction (in the northeastern United States) at an altitude that makes observation difficult, and that the observed 'concentrations' or 'flights' are manifestations of the diversion line phenomenon." There is evidence that Sharp-shinned Hawks often migrate at a considerable height (Allen and Peterson, 1936), but the remaining components of Murray's hypothesis are unsupported by published evidence. The "diversion line phenomenon" is simply a variant of the leading line, in which only a portion of the birds follow the line, the remainder crossing the line. Murray's hypothesis is apparently based on the observations of a number of Dutch workers on the flight behavior of the Chaffinch and summarized by van Dobben (1953).

The "diversion line" for hawks at Cape May differs from the Chaffinch-diversion lines in Holland in the following important characteristics: (1) It is very short; (2) Birds decrease rather than increase in numbers as one proceeds "downstream" along the line, in fact the numbers of birds appear to be at a maximum at the beginning of the diversion line; (3) The angle between the presumed migratory direction and the diversion line exceeds 90°, or, in other words, the diverted birds appear to be flying in the wrong direction along the line; (4) More birds fly out over, and across the water barrier in a head wind and more birds are "diverted" in a tail wind. These differences suggest that the concentration of hawks at the tip of Cape May is due to something other than the Murray-van Dobben model of the diversion line.

Murray postulates a broad front movement, apparently not concentrated by wind drift. Thus, we would expect similar numbers of hawks to occur over the entire northeastern United States. Local "concentrations" are thus merely the result of a *partial* diversion of the stream of migrants passing overhead. If we know the length of the "diversion line" we should be able to get a *partial* estimate of the numbers of birds passing overhead, and, since it is a broad-front movement, an estimate of the entire population. At Cape May, an all-autumn count taken in 1935 largely within one mile of the beginning of the "diversion line" yielded a total of 8,026 Sharp-shinned Hawks (Allen and Peterson, 1936). Probably not all of the hawks passing Cape May were counted, and, as Murray indicates, only a portion were diverted. However, let us conservatively estimate that all of the Sharp-shinned Hawks that passed over the one mile "front" at Cape May were counted in the autumn of 1935. The available information on the breeding distribution of the Sharp-shinned Hawk, and the distribution of suitable habitat, offer no reasons to believe that these hawks are more common to the northeast of Cape May than they are anywhere else in northern North America. The continent is about 2,500 miles wide. We would thus expect the North American Sharp-shinned Hawk population to be at least 20 million birds. Peterson (1948, p. 65) has estimated the total population of birds of the continent north of Mexico to number about 12 to 20 billion. It seems unlikely that one out of every 600 to 1,000 birds in North America is a Sharp-shinned Hawk. Indeed, it seems unlikely that one out of every 6,000 to 10,000 birds in North America is a Sharp-shinned Hawk. It is more reasonable to believe that the hawk observations at Cape May are of *concentrations* of birds, and that on the average, seen and unseen, more Sharp-shinned Hawks fly over Cape May than over most other localities.

We present below our tentative analysis of the migrations of Sharp-shinned Hawks along the northeastern coast of the United States, based on the concepts of leading line and wind drift. Concentrated flights of hawks occur only in a few localities along the Atlantic coast because the frequent embayments, marshes, irregularities, urban, and industrial areas make most of the coast a poor leading line. Both Cape May and Cape Charles are at the southern tips of huge, gradually narrowing peninsulas. The tapering forms of the Delaware-Maryland-Virginia peninsula and the New Jersey peninsula tend to funnel southbound, water-shy, diurnal migrants, in spite of the absence of good leading lines along the coasts. Concentrations of Sharp-shinned Hawks are not obvious north of Cape May and Cape Charles because (1) the frequent marshes, embayments, and tidal areas are unsuitable habitat for the hawks and they fly relatively high, and (2) the irregular borders between land, marsh, water, etc., do not form good leading lines, and hawks arriving at the coast are continually being dispersed inland. Allen and Peterson (1936) have shown that the hawks arrive at Cape May Point at considerable altitude, and that the flights north along Delaware Bay are rapidly dispersed because the hawks avoid crossing marshes and tidal creeks.

The tendency for a hawk to attempt or avoid a given water crossing is affected by a number of factors, including the bird's motivation to migrate, the time of day, and, perhaps most importantly, the wind direction. Allen and Peterson (1936) found that, at Cape May, Sharp-shinned Hawks crossed Delaware Bay when the wind was blowing from somewhere between ENE and SW and avoided the water crossing on NW to NE winds. Birds crossing Delaware Bay from Cape May often flew very high, "usually from 500 feet to the limit of vision" (Allen and Peterson, 1936). Birds avoiding the crossing also arrived at Cape May Point at a rather high altitude, dropped to a lower altitude, and moved north along the bay side of the cape (Allen and Peterson, 1936). Usually, the greatest numbers of hawks were seen at Cape May on northwesterly winds (Allen and Peterson, 1936; Stone, 1922, 1937). Good flights often occurred on southerly winds but, at least in 1935, these invariably occurred on days immediately following days of northwesterly winds. This suggests that essentially all of the major flights (excepting only two, which occurred on northerly winds) recorded by Allen and Peterson in 1935 were correlated with northwesternly winds. We believe that this correlation can be reasonably well explained by our version of the concept of wind drift. Stone (1922, 1937) also found that hawk flights at Cape May were correlated with northwesterly winds, indicating that the data of Allen and Peterson for 1935 were not peculiar.

Rusling (1937) found that the greatest flights of Sharp-shinned Hawks at Cape Charles, Virginia, in the autumn of 1936 occurred on northeasterly winds, and only small flights occurred on northwesterly winds. Murray (1964) considered Rusling's (1937) evidence and conclusions an excellent

TABLE 1
HAWK FLIGHTS ON THE MID-ATLANTIC COAST IN 1936

Date	Wind	Cape May		Cape Charles		Hooper Island	
		Rank	Hawks	Rank	Hawks	Rank	Hawks
25 Sept.	N–NE	1	300	6	363	1	800
13 Oct.	NE–ESE	2	174	9	246	9	75
29 Sept.	NE–ENE	3	150	10	177	–	Few
2 Oct.	N–NE	4	140	1	1,177	–	2
11 Sept.	Var.	5	120	–	*	–	*
19 Sept.	NW	6	110	–	*	–	*
26 Sept.	E–NE	7	100	5	418	3	700
10 Sept.	NE	8	100	–	*	–	*
5 Nov.	N	9	90	–	24	–	0
13 Sept.	N	10	90	–	*	–	*
4 Oct.	ENE	–	30	2	865	–	2
5 Oct.	ENE	–	18	3	714	–	0
3 Oct.	NE	–	80	4	612	–	30
1 Oct.	W–N	–	8	7	359	–	0
14 Oct.	E	–	16	8	322	–	14
24 Oct.	NE–N	–	70	–	160	2	800
31 Oct.	NW	–	5	–	4	4	600
21 Sept.	NW–N	–	20	–	*	5	300
10 Oct.	SW–W	–	0	–	0	6	200
1 Nov.	SW	–	0	–	1	7	125
9 Nov.	NE	–	3	–	?	8	100
17 Oct.	W	–	0	–	6	10	75
12 Oct.	NW	–	30	–	134	–	0
18 Oct.	NW	–	40	–	98	–	40
30 Oct.	NW	–	0	–	5	–	50

* No data available. The data in this table are from Rusling (1937).

argument against wind drift, particularly when compared with observations from Cape May and Hooper Island, where hawks are known to occur predominately on northwesterly winds. However, in the autumn of 1936, six of the ten largest flights of Sharp-shinned Hawks at Cape May and five of the ten largest flights at Hooper Island occurred on days with northeasterly winds (Table 1). The fact that nine of the ten largest flights at Cape Charles occurred on northeasterly winds is not remarkable when compared with the above. At least the three greatest counts of Sharp-shinned Hawks for 1936 occurred on northeasterly winds in all three of the above localities (Table 1). It is remarkable that the highest counts of Sharp-shinned Hawks at Hooper Island and Cape May occurred on northeasterly winds rather than, as in previous years, on northwesterly winds. It is further interesting that only 2,269 Sharp-shinned Hawks were seen at Cape May in 1936 (Rusling, 1937), as compared with 8,206 in 1935, 5,675 in 1932, and 10,000 in 1931 (Allen and Peterson, 1936). Strong northwesterly winds and clear skies prevailed on only three days during September and October 1936 at Cape Charles (Rusling, 1937). These conditions usually produce great numbers of hawks at Cape May and, presumably, at Hooper Island (Allen and Peterson, 1936). On all of these days relatively few Sharp-shinned Hawks were seen at Cape May, Hooper Island, and Cape Charles, but greater numbers were seen at Cape Charles than at the other two localities on two of the three occasions (Table 1). In all, 1936 seems to have been a very unusual autumn for hawk migration along the mid-Atlantic coast of the United States. It would be interesting to see the characteristics of the Sharp-shinned Hawk migration at Cape Charles in a more usual year.

Because of the configurations of the peninsulas, we would expect concentrations of hawks at Cape May and Cape Charles in autumn if three conditions prevail: (1) reasonable numbers of hawks exist on, or arrive on, the New Jersey and Delaware-Maryland-Virginia peninsulas, (2) the birds migrate in some southerly direction, and (3) the birds exhibit some reluctance to cross bodies of water. We have previously discussed the third factor and the second safely can be assumed to occur. The first factor, however, can be analyzed only indirectly. The interaction of wind and leading lines in affecting the flight paths of hawks in the areas north of the New Jersey and Delaware-Maryland-Virginia peninsulas undoubtedly plays a major role in determining the abundance of hawks on the peninsulas. The strong leading lines provided by the Appalachian ridges lie but a short distance to the west of the Atlantic coast; and, farther to the north, the Great Lakes and the Gulf of St. Lawrence probably affect the flight paths of hawks. The frequent embayments on the coast and gaps in the ridges of the Appalachians add further complications. More observations of hawk migration at localities north and west of the coastal concentration points are needed before all questions can be answered. However, it is interesting to note that 4,611 Sharp-shinned Hawks, or 67 per cent of the total observed at Cape Charles, were counted in the two periods between 1 and 5 October, inclusive, and 12–15 October, inclusive. Both of these periods began with, or were preceded by, at least one day of westerly winds over the entire region (Rusling, 1937). We believe that this suggests that wind drift may have been a factor in bringing hawks to the Delaware-Maryland-Virginia peninsula, and, once there, they continued southward to Cape Charles, producing concentrations at the cape for several subsequent days.

In addition to the above, we would expect differences in the flights at Cape May and Cape Charles because (1) the New Jersey peninsula has a relatively broad base whereas the Delaware-Maryland-Virginia peninsula has a relatively narrow connection with the mainland, (2) Chesapeake Bay is longer and generally wider than Delaware Bay, and (3) Cape Charles is about four times as long as Cape May and is extremely narrow at several points considerable distances from the tip.

In conclusion, we fail to see how Murray (1964) has produced any evidence which can be used to argue that wind drift is not a factor in producing concentrations of Sharp-shinned Hawks at selected points on the coast of the northeastern United States. The alternative hypothesis proposed by Murray is unsupported by, and inconsistent with, the available evidence.

SUMMARY

This paper attempts to: (1) define the concepts of wind drift and leading lines, (2) present the characteristics of each of these phenomena, (3) elucidate the various factors influencing wind drift and leading line behavior, and (4) document the above with a brief review of the literature of migration. In addition, the hypothesis of Murray (1964) is critically evaluated as an alternative to wind drift theory and rejected as being inconsistent with available information.

ACKNOWLEDGMENTS

This paper began as the discussion section of an early draft of a research report on Sharp-shinned Hawk migration at Cedar Grove, Wisconsin (Mueller and Berger, in press, *b*). Financial support for the latter study was provided by the National Science Foundation (Grant GB-175). We are indebted to Professor John T. Emlen for advice and assistance in various aspects of the study.

LITERATURE CITED

Allen, R. P., and R. T. Peterson
1936 The hawk migrations at Cape May Point, New Jersey. *Auk*, 53:393–404.
Austin, O. L.
1949 Site tenacity, a behaviour trait of the Common Tern (*Sterna hirundo* Linn.) *Bird-Banding*, 20:1–39.
Baxter, E. V., and L. J. Rintoul
1918 The birds of the Isle of May: a migration study. *Ibis*, 6, *ser.* 10:247–287.
Deelder, C. L.
1949 On the autumn migration of the Scandinavian Chaffinch, (*Fringilla c. coelebs L.*). *Ardea*, 37:1–88.
Deelder, C. L., and L. Tinbergen
1947 Waarnemingen over de vlieghoogte van trekkende Vinken, *Fringilla coelebs* L., en Spreeuwen, *Sturnus vulgaris* L. *Ardea*, 35:45–78.
Dobben, W. H. van
1953 Migration in the Netherlands. *Ibis*, 95:212–234.
1955 Nature and strength of the attraction exerted by leading lines. *Acta XI Congr. Internatl. Ornith. Basel*:165–166.
Geyer von Schweppenburg, H. Frieh.
1929 Zugstrassen-Leitlinien. *J. Ornith., Ergänzungsband* II:17–32.
1963 Zur Terminologie und Theorie der Leitlinie. *J. Ornith.*, 104:191–204.

HOCHBAUM, H. A
1955 Travels and traditions of waterfowl. U. Minnesota Press, Minneapolis.
HURREL, H. G.
1955 Simultaneous migration watches for Swifts in the British Isles. *Acta XI Congr. Internatl. Ornith. Basel*:640–642.
KRAMER, G.
1950 Weitere Analyse der Faktoren, welche die Zugaktivität des gekäfigten Vogels orientieren. *Naturwiss.*, 37:377–388.
LACK, D.
1960 Migration across the North Sea studied by radar. Part 2. The spring departure 1956–59. *Ibis*, 102:26–57.
1962 Radar evidence on migratory orientation. *Brit. Birds*, 55:139–158.
LACK, D., AND K. WILLIAMSON
1959 Bird-migration terms. *Ibis*. 101:255–256.
LÖHRL, H.
1959 Zur Frage des Zeitpunktes einer Prägung auf die Heimatregion beim Halsbandschnäpper (*Ficedula albicollis*). *J. Ornith.*, 100:132–140.
MALMBERG, T.
1955 Topographical concentration of flight lines. *Acta XI Congr. Internatl. Ornith. Basel*:161–164.
MATTHEWS, G. V. T.
1961 'Nonsense' orientation in Mallard and its relation to experiments in bird navigation. *Ibis*, 103a:211–230.
MEWALDT, L. R.
1964 California sparrows return from displacement to Maryland. *Science*, 146: 941–942.
MUELLER, H. C., AND D. D. BERGER
1961 Weather and fall migration of hawks at Cedar Grove, Wisconsin. *Wilson Bull.*, 73:171–192.
in press, *a*. "Navigation" of hawks: evidence from spring migration observations and band recoveries.
in press, *b*. Migration of Sharp-shinned Hawks: analysis of data from Cedar Grove, Wisconsin.
in preparation. Analysis of concentrations of nocturnal migrants along a coastline.
MURRAY, B. G., JR.
1964 A review of Sharp-shinned Hawk migration along the northeastern coast of the United States. *Wilson Bull.*, 76:257–264.
NICE, M. M.
1937 Studies in the life history of the Song Sparrow. I. *Trans. Linnaean Soc. New York*, 4:1–247.
NISBET, I. C. T.
1957 Passerine migration in South Scandinavia in the autumn of 1954. *Ibis*, 99: 228–268.
PETERSEN, E.
1953 Orienteringsforsøg med Haettemage (*Larus r. ridibundus* L.) og Stormmage (*Larus c. canus* L.) vinterkvarteret. *Dansk Ornithol. Forenings Tidsskrift*, 47:153–178.
PETERSON, R. T.
1948 Birds over America. Dodd, Mead, New York.

Rainey, R. C.
1960 Applications of theoretical models to the study of flight-behavior in locusts and birds. *Symposia Soc. for Expl. Biol.*, XIV:122–139.
Robbins, C. S.
1956 Hawk watch. *Atlantic Naturalist*, 11:208–217.
Rudebeck, G.
1950 Studies on bird migration. *Var Fagelvärld*, Supplementum I.
Rusling, W. J.
1937 The study of the habits of diurnal migrants, as related to weather and land masses during the fall migration on the Atlantic coast, with particular reference to the hawk flights of the Cape Charles (Virginia) region. Unpublished manuscript in the library of the National Audubon Society, New York.
Schwartz, P.
1963 Orientation experiments with Northern Waterthrushes wintering in Venezuela. *Proc. XIII Internatl. Ornith. Congr.* 481–484.
Stone, W.
1922 Hawk flights at Cape May Point, N. J. *Auk*, 39:567–568.
1937 Bird studies at old Cape May, Vol. 1. Delaware Valley Ornith. Club, Acad. Nat. Sci. Philadelphia.
Svärdson, G.
1953 Visible migration within Fenno-scandia. *Ibis*, 95:181–211.
Thomson, Sir A. L.
1953 The study of the visible migration of birds. *Ibis*, 95:165–180.
Trowbridge, C. C.
1895 Hawk flights in Connecticut. *Auk*, 12:259–270.
1902 The relation of wind to bird migration. *Amer. Nat.*, 36:735–753.
Ulfstrand, S.
1960 Migration of African kites *Milvus migrans* (Bodd.)—*M. aegyptius* Sharpe & Bouvier, and Wahlberg's Eagles *Aquila wahlbergi* Sund., at Lake Tanganyika. *Kungl. Fysiografiska Sällskapets I Lund Förhandlingar*, 30:31–39.
Werth, I.
1947 The tendency of Blackbird and Song Thrush to breed in their birthplaces. *Brit. Birds*, 40:328–330.
Westernhagen, W. von
1957 Planbeobachtungen des Vogelzuges Herbst 1955. *Mitt. Faun. Arbeitsgem. Schleswig-Holsteins.* 10:17–55.
Wharton, W. P.
1941 Twelve years of banding at Summerville, S. C. *Bird-banding*, 12:137–147.
Williamson, K.
1955 Migrational drift. *Acta XI Congr. Internatl. Ornith. Basel*:179–186.
1962 The nature of 'leading line' behavior. *Bird Migration* 2:176–182.
Woodcock, A. H.
1942 Soaring over the open sea. *Sci. Mon.*, 55:226–232.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF WISCONSIN, MADISON, WISCONSIN, AND THE CEDAR GROVE ORNITHOLOGICAL STATION, ROUTE 1, CEDAR GROVE, WISCONSIN. (PRESENT ADDRESS: (MUELLER), DEPARTMENT OF ZOOLOGY, UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL, NORTH CAROLINA.). 13 JANUARY 1966

THE CONTEXTS OF SONGS IN BLACK-THROATED GREEN AND BLACKBURNIAN WARBLERS

Douglass H. Morse

Some recent studies of the family Parulidae demonstrate that in several species there is more than one type of male song: these song types evidently result from different motivations (Ficken and Ficken, 1962, 1965; Morse, 1966).

The purposes of this investigation were to observe a situation where two or more closely related species are found within a homogenous, floristically simple habitat in order to determine the motivations of their songs, the relationship of the songs to the environment, and the degree of effect that the congeners have upon each others' songs. In the northeastern United States Black-throated Green Warblers (*Dendroica virens*) and Blackburnian Warblers (*D. fusca*) are characteristically birds of the conifers, and while they may be found in mixed forests, it is in the coniferous forests that they reach their highest densities. Here they sometimes form the most prominent element of the local avifauna. Several other *Dendroica* warblers also occur in these forests. The pure spruce forests probably represent one of the simplest of arboreal habitats to support such an impressive array of closely related species of breeding birds.

It appears probable that the existing ecological and behavioral relationships between Black-throated Green and Blackburnian warblers are the result of a past history of intense interactions between themselves and the other closely related sympatric species. As song appears to be an important part of warbler communication during the breeding season, an examination of vocalizations of these birds appeared to be a fruitful subject for study.

These studies were made in the spring and summer from 1962 to 1965. Most of the work was done on Hog Island (Todd Wildlife Sanctuary), Bremen, Lincoln County, Maine, with additional work being done in several other areas in Maine, including the adjacent mainland and other coastal islands in Lincoln County. Further brief observations were made at Tremont, Hancock County, and Webster, Androscoggin County.

Most of the area studied on Hog Island is a mature red and white spruce (*Picea rubens* and *P. glauca*) forest, with the larger trees reaching a maximum height of 18 to 25 meters. The hurricanes of 1954 and winds of following years have severely damaged the forest on many parts of the island, but most of the work in this paper was conducted in relatively undisturbed areas. The growth of such a spruce forest is quite dense and results in considerable difficulties in studying and following birds. The warblers of similar stands

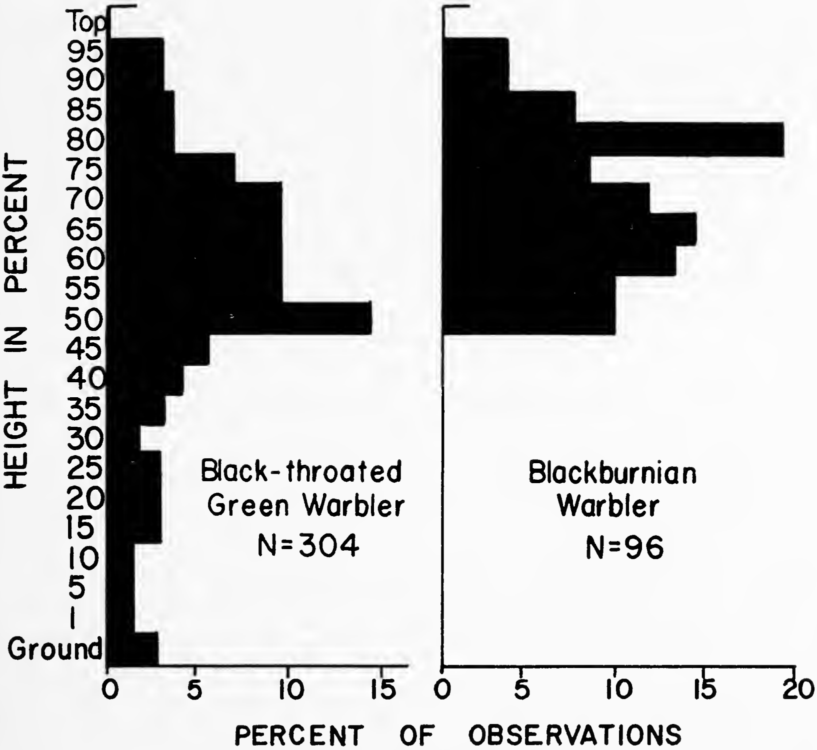


Fig. 1. Foraging height.

of trees were studied briefly in other areas, and they were studied also in mixed white pine (*Pinus strobus*)—deciduous forests on the mainland.

SPACE OCCUPIED IN THE HABITAT

The foraging area of both species (and other spruce-woods warblers) was figured and discussed by MacArthur (1958), who found that Blackburnian Warblers usually foraged at greater heights in the spruce forest than did Black-throated Green Warblers. In my study area, Blackburnian Warblers foraged higher than did any other species present, and Black-throated Green Warblers worked directly below them (Figure 1), with the other two congeners, Magnolia (*D. magnolia*) and Myrtle (*D. coronata*) warblers, usually foraging noticeably lower. While the centers of foraging of all species studied differed, there was considerable overlap in each instance. Cape May (*D. tigrina*) and Bay-breasted (*D. castanea*) warblers, two other spruce-woods species treated by MacArthur, were absent in the principal study area.

In addition to some songs that were given when the birds were foraging, both species did a large percentage of their singing in a stationary or nearly stationary position from the top, or the tip of a high exposed limb, of a spruce tree. Both species sang for considerable periods in this sort of situation, remaining motionless except for "fidgeting" in the immediate vicinity of their song perch. Fidgeting here refers to an action in which an individual frequently flicks its wings and tail, hops about very deliberately within a limited area, and regularly pecks at the foliage, though apparently not feeding. These movements are frequently accompanied by songs and chipping notes. The term will be used in this sense throughout this paper.

RELATIVE DENSITY OF THE TWO SPECIES

The relative density of from two to three and one-half Black-throated Green Warblers to one Blackburnian Warbler found by Cadbury and Cruickshank (1937) in their long series of breeding-bird censuses on one part of this island probably is an accurate estimate of the present population. Frequent counts of the number of Black-throated Green and Blackburnian warbler songs heard along a transect through the middle of this forest suggested a similar or even greater ratio. Since their principal foraging areas are above the Black-throated Green Warblers, Blackburnian Warblers did not have as great an area in these spire-shaped trees in which to forage as did Black-throated Green Warblers, and this factor may account for part of the difference in density. Let us take an 18 meter spruce for an example, and assume that the Black-throated Green Warblers did the majority of their foraging at a height of between 5.4 and 12.6 meters (30–70 per cent of the height of the tree), and Blackburnian Warblers foraged from 9.0 to 16.2 meters (50–90 per cent of the height of the tree). Black-throated Green Warblers would then have approximately two and one-half times as great a volume of both bark surface and foliage in which to forage if this tree with its foliage had a normal radius of 3.4 meters at the minimum height here considered, 5.4 meters.

SONG PATTERNS

Both the Black-throated Green and Blackburnian warblers in this population possess two distinct song patterns, a male of either species typically rendering either one or the other, depending upon the motivation involved. To remain consistent with the literature, Black-throated Green Warbler songs are referred to as Type A Songs and Type B Songs (see Nice and Nice, 1932; Stein, 1962). Peterson (1947) described the Type A Songs as *zoo zee zoo zoo zee* and the Type B Song as *zee zee zee zee zoo zee.* Since the two Blackburnian Warbler songs are given in contexts essentially similar to those of the Black-throated Green Warbler, they will also be referred to as Type A

Songs and Type B Songs, but this designation is not intended to imply that these songs are necessarily homologous to those of Black-throated Green Warblers. Peterson (1947) described the Blackburnian Warbler Type A Song as *zip zip zip zip titi tseeeeee* and the Type B Song as *tizip tizip tizip tizip zizizizizizizizi.*

Songs classified as intermediate between Type A and Type B, comparable to "Intermediate Song" of the Yellow Warbler (*Dendroica petechia*) (Morse, 1966), were not recorded from either species. While the Yellow Warblers sometimes sang Intermediate Songs while switching from one major song pattern to the other, Black-throated Green and Blackburnian warblers were not observed to do this. Occasionally a bird of either species would sing only part of a song pattern and then become silent. At the end of the breeding season many aberrant songs were heard, including some songs that were approximately intermediate to the two major patterns. However, these songs were not heard during the breeding season. Blackburnian Warblers occasionally rapidly alternated their two basic song patterns, but Black-throated Green Warblers were not observed to do so.

STRATIFICATION OF SONGS

A noticeable stratification of individuals singing either of the two song patterns into distinct parts of the habitat occurred in the Black-throated Green Warbler (Fig. 2). The Type A Song was strongly associated with the treetops and almost all Type A Songs were given from a high elevation. This song was usually given while the bird was nearly stationary in the treetops, but sometimes it was given while the singer alternately foraged. Type B Songs were strongly associated with a lower position (moderate height) during most of the season, and in contrast to Type A Songs were usually given while the bird was actively foraging. Early in the season during the period in which males were setting up territories and acquiring mates, stationary birds in high exposed positions frequently gave Type B Songs, probably acting as an advertising song.

The two basic song patterns of Blackburnian Warblers (Fig. 3) occurred in situations rather similar to those of Black-throated Green Warblers. Type A Songs were also most frequently given while stationary in the top of spruces, and Type B Songs were most frequently sung while foraging. However, the tendency for this species to forage higher than any other species in the study area led to a superficial difference from Black-throated Green Warblers in that there was a strong tendency for the Type B Song (the foraging song) to be given from a considerable height. The two songs sometimes were even alternated by a single bird at a high elevation. There also was a strong tendency for this species to sing Type B Songs while in a

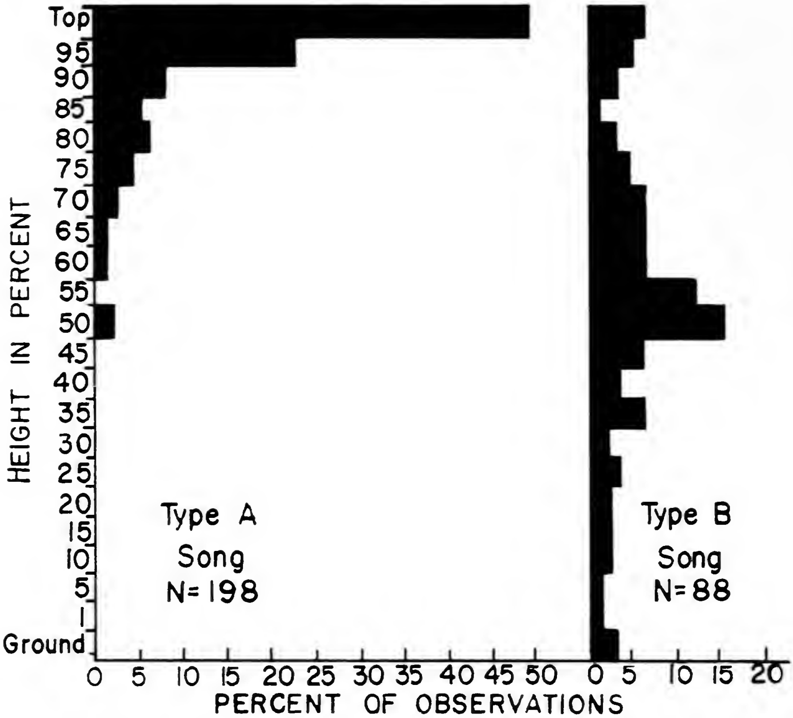


FIG. 2. Singing height of Black-throated Green Warbler.

stationary position early in the season in conjunction with its apparent role as an advertising song at that time. The heavy incidence of Type B Song recorded in or near the top of the trees is attributable to this effect in both Black-throated Green and Blackburnian warblers.

BEHAVIOR ACCOMPANYING THE SONGS

Black-throated Green Warbler Type A Songs were most frequently heard from stationary birds in exposed positions that appeared to sing this pattern as a territorial proclamation. These songs were also associated with activities related to direct territorial defense. Whenever a male Black-throated Green Warbler became conspicuous to other Black-throated Green Warblers at close range (except in the case of apparently unmated birds), they responded with Type A Songs from a prominent position, even if they had previously been singing Type B Songs. This song (sometimes muted) followed fights and chases between male Black-throated Green Warblers and also the less frequent interspecific fights or chases with Parula (*Parula americana*), Myrtle, or Blackburnian warblers (Table 1). "Muted Songs" almost always followed

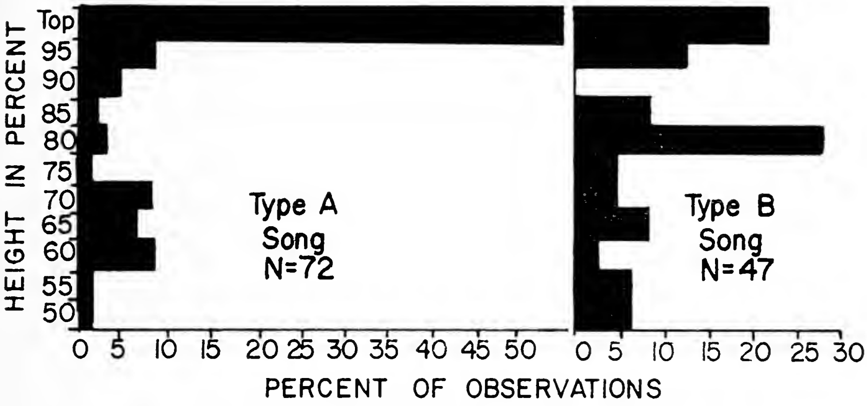


Fig. 3. Singing height of Blackburnian Warbler.

the same contexts as normal volume songs did, though usually being given in particularly strong or long encounters. In the course of a single fight between two male Black-throated Green Warblers, both Muted Type A Songs and Muted Type B Songs were heard. During such encounters, frequent "Metallic Double Chips" were given between Type A Songs, and at times of most intense aggression and excitement the song was sometimes even temporarily suspended. These chips, which are of a distinctly metallic character, are usually given rapidly in groups of two.

Type B Songs frequently appeared directed toward females in one way or another. On the few occasions that the male was seen singing in the direct company of a female of the same species, Type B Songs were always given (Table 1). These meetings probably occurred upon the frequent other occasions when males dropped out of sight to lower positions from treetop singing perches and changed from Type A to Type B patterns. Type B Songs are the typical foraging songs, and most foraging is performed at the height where females are most frequently encountered and where nesting occurs (see Cruickshank, 1956). Metallic Double Chips never accompanied this song, a characteristic noted also by Nice and Nice (1932). Occasional individuals that sang Type B Songs while stationary in the treetops for several minutes at a time into mid-June appeared to be unpaired birds. A noticeable decrease of this behavior occurred during early June.

Blackburnian Warbler Type A Songs usually were correlated with activities quite similar to those of Black-throated Green Warblers while singing Type A Songs (Table 2), occurring in both interspecific and intraspecific situations. A larger fraction (40.0 per cent) of the strong or long encounters were interspecific in this species than in Black-throated Green Warblers (22.4 per cent). Blackburnian Warblers tended to remain in one position while singing

TABLE 1
APPARENT CONTEXT FOR SOME SONGS OF MALE BLACK-THROATED GREEN WARBLERS*

Activity	Number of responses
Type A Song	
Fight with male Black-throated Green Warbler	32 (8 muted)
Extremely close contact with male Black-throated Green Warbler	4
Close contact with male Black-throated Green Warbler	many
Song suspended and only metallic double chips given accompanying fight with male Black-throated Green Warbler	2
Fight with male Blackburnian Warbler	4
Extremely close contact with male Blackburnian Warbler	2
Fight with male Myrtle Warbler	1 (muted)
Extremely close contact with male Myrtle Warbler	2 (1 muted)
Fight with male Magnolia Warbler	1
Fight with male Parula Warbler	1
Interference of observer	2
Type B Song	
Following copulation with female Black-throated Green Warbler	1
Following courtship of female Black-throated Green Warbler	2 (1 muted)
Extremely near female Black-throated Green Warbler	3 (1 muted)
Continual singing early in the season from an exposed perch	many
	$N = 57$

* Upon one occasion, after two male Black-throated Green Warblers fought they alternated Muted Type A and Muted Type B Songs.

Type A Songs somewhat longer than did Black-throated Green Warblers, averaging 4.8 minutes per singing station, while Black-throated Green Warblers averaged 3.9 minutes per singing station. Blackburnian Warbler encounters with Parula Warblers, as well as with Black-throated Green Warblers, were observed. Under circumstances resulting in high aggression, frequent chipping, occasionally of a double nature, was given. The birds sometimes foraged at this time.

In this species also, Type B Songs were the ones given in the immediate presence of females (Table 2). Individuals consistently singing this song for long periods of time in the treetops were probably birds that had not obtained a mate. Two birds sang in such a manner through most of June, though most ceased this pattern by early June. Only on very rare occasions (two observations) were the chips heard accompanying Type B Songs.

DISCUSSION

The contexts in which both species sing Type A Songs and Type B Songs suggest that the Type A Songs are given in situations where there is a high attack tendency or a conflict of attack and escape tendencies. Type B Songs

TABLE 2
APPARENT CONTEXT FOR SOME SONGS OF MALE BLACKBURNIAN WARBLERS

Activity	Number of responses
Type A Song	
Fight with male Blackburnian Warbler	4
Extremely close contact with male Blackburnian Warbler	8
Close contact with male Blackburnian Warbler	many
Fight with male Black-throated Green Warbler	4 (2 muted)
Extremely close contact with male Black-throated Green Warbler	2
Extremely close contact with male Parula Warbler	2
Type B Song	
Following copulation with female Blackburnian Warbler	1
Following female Blackburnian Warbler	1
Extremely close contact with female Blackburnian Warbler	1 (muted)
Continual singing early in the season from an exposed perch	many
	$N = 23$

appear to be given under circumstances in which these tendencies are less strongly activated, and in which *sexual* tendencies may be high. Type A Songs appeared to be the territorial songs and were usually delivered from exposed perches while nearly stationary. Type B Songs were typically foraging songs and were also given in the presence of females. They were also given as apparent advertising songs early in the season from exposed positions.

The contexts of the Type A Songs of the Black-throated Green and Blackburnian warblers most closely resemble those that accompanied the Yellow and Chestnut-sided (*Dendroica pensylvanica*) warbler Unaccented Ending Songs (see Morse, 1966), all of these songs usually being given in the close presence of other males of the same species. Type B Songs occurred in contexts suggesting those in which Yellow and Chestnut-sided warblers sang Accented Ending Songs; however, there appeared to be no distinction made by Black-throated Green and Blackburnian warblers in response to other closely related species nesting in the same areas. The difference between a response of a Black-throated Green Warbler male to another male of its species and to one of some other species was not marked, both intraspecific and interspecific hostile activities usually being accompanied by the same song pattern (Type A Song). In several populations in Maine, Yellow Warblers responded to their most closely related sympatric species, the Chestnut-sided Warbler, with the same song pattern that they directed toward the female.

The factors governing the singing of a particular song pattern differ somewhat in the two cases. The level of hostile behavior among spruce-woods

Dendroica warblers probably is considerably more intense than it is between Yellow and Chestnut-sided warblers, and the problem of frequent interspecific interaction may be more important than is that of simple recognition. The habitat separation between Yellow and Chestnut-sided warblers is more clearly delimited than it is between the spruce-woods *Dendroica* species, only limited habitat overlap occurring in the populations studied. Black-throated Green and Blackburnian warblers both utilize very similar habitats, having their principal foraging and nesting areas at slightly different heights (Cruickshank, 1956) and parts of the trees, and foraging somewhat differently (see MacArthur, 1958), but nevertheless overlapping considerably in all these characteristics. Many more closely related species are found in the spruce forests than in the favored wet bushy habitat of the Yellow Warbler. Thus, a high level of interspecific interaction among the birds of the spruce forest may result in stronger attack or escape tendencies than occur in Yellow or Chestnut-sided warblers.

The slight difference in context accompanying a particular song pattern or foraging in these two species may be partly attributable to the difference in the part of the habitat foraged by them. The stratification of birds singing the two song types was less marked in Blackburnian Warblers than in Black-throated Green Warblers, and the former spent most of their time within an area in which it was customary to give either song or to forage. They were thus exposed to a slightly different set of stimuli at this height than were Black-throated Green Warblers both in the treetops and at lower heights. This difference in foraging height is in turn probably enforced by interactions between the two species.

The context of muted songs in both of these species, based upon a limited number of observations (see Tables 1 and 2), was slightly more predictable than in Yellow Warblers (see Morse, 1966). The difference is perhaps a result of the heavy incidence of interspecific interactions in the spruce forest.

The higher ratio of interspecific fights and chases to intraspecific ones in the Blackburnian Warbler in comparison to the Black-throated Green Warbler was probably largely the result of the lower density of the Blackburnian Warbler in the study area. The somewhat longer periods of stationary singing in Blackburnian Warblers may also be the result of this low density. No noticeable difference in the intensity and duration of hostile activities was noted between the two species.

Because of their particular foraging station, Black-throated Green Warblers would experience more potential conflicts with Magnolia and Myrtle warblers than would Blackburnian Warblers. However, the foraging of Magnolia Warblers (pers. obs.) and Myrtle Warblers (MacArthur, 1958) is not as similar to Black-throated Green Warbler foraging as is Blackburnian Warbler foraging, and much of the Black-throated Green Warbler foraging is performed above the major foraging areas of Magnolia and Myrtle warblers. Fewer Black-throated Green Warbler encounters with Magnolia and Myrtle warblers were noted than between Black-throated Green and Blackburnian warblers. Magnolia and Myrtle warblers also were not as abundant as were Black-throated Green and even Blackburnian Warblers in the study area. Thus Blackburnian Warblers expend more energy in interspecific encounters (at least their fights and chases) in this forest than do Black-throated Green Warblers.

It is not definite whether the warblers of this forest are utilizing limited food sources at this season, but they definitely interfere with each other in the procurement of quite similar food sources. Thus they fulfill requirements for competition laid out by Birch (1957). The most important competitor of the Blackburnian Warbler in this forest probably is the Black-throated Green Warbler, the only species of warbler it frequently comes into contact with, and which forages in a manner suggestive of, though not identical to, its own species. Conversely, Blackburnian Warblers probably are the most important competitors of Black-throated Green Warblers in this forest, but because of their lower density their effect is quantitatively less important than the effect that Black-throated Green Warblers have upon Blackburnian Warblers. This pattern will necessarily be modified depending upon the local species compositions, but it appears likely that these two species have more foraging similarities than do any other *Dendroica* warblers in the spruce forests of the northeast.

SUMMARY

Songs and accompanying behavior of Black-throated Green and Blackburnian warblers were studied in Maine from 1962 to 1965. Work was concentrated in a climax spruce forest containing two additional species of *Dendroica*, Magnolia and Myrtle warblers. Blackburnian Warblers foraged higher than did other species, with Black-throated Green Warblers directly below them. Both possess Type A and Type B Songs, usually singing Type A Songs in the presence of other singing warblers of either their own or other species. These vocalizations appeared to be the territorial songs and were usually delivered from exposed perches while nearly stationary. Metallic Double Chips often accompanied Type A Songs. Type B Songs were typically foraging songs and were also given in the presence of females. They were also given as apparent advertising songs early in the season from exposed positions. Type A Songs were apparently sung when a high attack tendency or a conflict of attack and escape tendencies existed; Type B Songs occurred when these tendencies were less strongly activated, and when sexual tendencies were high. The slight difference in context accompanying certain responses in the two species may be partly attributable to their differences in foraging height. Black-throated Green Warblers were more abundant than Blackburnian Warblers in the study area, and a greater portion of their hostile activities were intraspecific. Both species probably were the other's most important competitor.

ACKNOWLEDGMENTS

I wish to thank Drs. M. S. and R. W. Ficken for timely discussion and criticism of the manuscript. The National Audubon Society kindly permitted the study to be conducted on Hog Island. This study was partially supported by the National Science Foundation (GB-3226).

LITERATURE CITED

BIRCH, L. C.
1957 The meanings of competition. *Am. Naturalist*, 91:5–18.

CADBURY, J. M., AND A. D. CRUICKSHANK
1937 Climax red and white spruce forest. *Bird Lore*, 39:384 (and subsequent years through 1958).

CRUICKSHANK, A. D.
1956 Nesting heights of some woodland warblers in Maine. *Wilson Bull.*, 68:157.

FICKEN, M. S., AND R. W. FICKEN
1962 The comparative ethology of the wood warblers: a review. *Living Bird*, 1: 103–122.
1965 Comparative ethology of the Chestnut-sided Warbler, Yellow Warbler, and American Redstart. *Wilson Bull.*, 77:363–375.

MACARTHUR, R. H.
1958 Population ecology of some warblers of northeastern coniferous forests. *Ecology*, 39:599–619.

MORSE, D. H.
1966 The context of songs in the Yellow Warbler. *Wilson Bull.* 78:444–455.

NICE, M. M., AND L. B. NICE
1932 A study of two nests of the Black-throated Green Warbler. *Bird-banding*, 3:95–105, 157–172.

PETERSON, R. T.
1947 A field guide to the birds. Houghton Mifflin Co., Boston.

STEIN, R. C.
1962 A comparative study of songs recorded from five closely related warblers. *Living Bird*, 1:61–71.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF MARYLAND, COLLEGE PARK, MARYLAND, 1 DECEMBER 1965

DAMAGE BY GOLDEN-FRONTED AND LADDER-BACKED WOODPECKERS TO FENCE POSTS AND UTILITY POLES IN SOUTH TEXAS

JOHN V. DENNIS

WOODPECKER damage to utility poles is a matter of serious economic concern in many parts of North America. The problem dates back into the last century, and periodically has received serious attention from ornithologists and utility engineers. An early study by McAtee (1911) showed that poles treated with a preservative as well as untreated poles are attacked, and that at least eight species of woodpeckers are responsible for damage.

However, neither McAtee nor other early writers seem to have recognized the situation existing in south Texas where two pole-damaging species of woodpeckers occupy the same habitat. Most writers blame the Golden-fronted Woodpecker (*Centurus aurifrons*) (Fig. 1) for the extensive damage that occurs. Sennett (1878*a*), for example, reported that utility poles were a favorite nesting place of the Golden-fronted and that "hardly a pole" was free of their holes. He concluded that telegraph pole excavations by this species were made "in search of a large species of borer that works in dry wood" (Sennett, 1878*b*).

The only other resident woodpecker of the lower Rio Grande Valley is a sparrow-sized bird, the Ladder-backed Woodpecker (*Dendrocopos scalaris*). Sennett (1878*a*) implied that this species also nested in utility poles. Simmons (1925), writing of the region of Austin, Texas, states that "when suitable trees are not to be found" the Ladder-backed nests in cedar fence posts or telegraph poles. McAtee (1911) and Pearson et al. (1936) mentioned the Ladder-backed in connection with utility pole nesting. Until recently the Golden-fronted has received much more blame for utility pole damage (Bendire, 1895; McAtee, 1911; Friedmann, 1925; Simmons, 1925; Pearson et al., 1936; Quillin in Bent, 1939).

The present paper attempts to define the roles played by the Ladder-backed and Golden-fronted woodpeckers in regard to utility pole and fence post damage in Texas from about Victoria and San Antonio southward. Other objectives are to describe damage and to explore reasons for attack. These are subjects discussed earlier by Dennis (1964), but which have now been examined further. Methods of preventing attack are beyond the scope of the present paper and will not be covered.

Observations in south Texas now cover three nesting seasons as well as appreciable periods during the non-nesting season. During the winters of 1960–1961 and 1961–1962, observations were made in parts of the Lower

FIG. 1. Female Golden-fronted Woodpecker at nest hole in a small electric distribution pole. Hole is about six feet from the ground.

Rio Grande Valley and south Texas where both the Golden-fronted and Ladder-backed are abundant. During the late winter and spring of 1965, the writer with Robert L. Rumsey of the Southern Forest Experiment Station. established a number of tests in south Texas for the purpose of comparing susceptibility of certain woods and treated versus non-treated woods to attack by Golden-fronted and Ladder-backed woodpeckers. This work was part of a much wider program to find better methods of protecting wooden utility poles from damage by woodpeckers. The program is under the direction of the Southern Forest Experiment Station at Alexandria, Louisiana, and is financed by several electric utility companies and a lumber company.

HABITAT AND NUMBERS

In Mexico the Ladder-backed is said to be found "virtually country-wide in arid districts," and the Golden-fronted in "dry districts with sparse or second-growth timber" (Blake, 1954). In Texas the two are almost always associated with the mesquite-dominated chaparral that extends northward from Mexico into the hot, arid, southern, central, and western parts of the State. Although land clearing has destroyed vast areas of mesquite, it seems probable that more mesquite scrubland exists today than at the time of Sennett's writings in 1878. Since mesquite spreads with intensive grazing, it is not surprising that it has become established widely over the more arid rangeland of Texas. Brooks (1933), writing of the Brownsville region, mentions the rapid invasion of mesquite over the once wide coastal prairies.

Oaks and mesquite are the species usually mentioned as affording habitat for the two species. Simmons (1925), besides listing oaks and mesquite. states that the Golden-fronted is partial to pecan groves and the Ladder-backed to cottonwoods and hackberry. In extremely dry and treeless sections of the Southwest the Ladder-backed is found closely associated with yucca and agave. Grinnell and Swarth (1913) state that the birds nest in the dried stalks of these plants in desert regions of southern California. Bancroft (1930) reports that a race of the Ladder-backed in lower California confines its nesting to the saguaro cactus.

Neither the Ladder-backed nor Golden-fronted has adapted to the more intensively cultivated parts of the Rio Grande Valley and Texas coast, but both have responded to shade tree plantings. The Golden-fronted, in particular. has responded to man-created environments, and shows a strong affinity for introduced palm trees.

Both Sennett (1878*b*) and Bendire (1895) found that the Ladder-backed was much less numerous than the Golden-fronted in the Lower Rio Grande Valley. While their conclusions may be accurate, it should be emphasized that the larger, more colorful and vocal Golden-fronted often displays in the open.

easily conveying an exaggerated impression of its numbers. The less conspicuous Ladder-backed, on the other hand, is apt to be overlooked. In a random selection of Christmas Bird Counts, the writer has noted that total numbers of the two were about the same at 12 localities in Texas reporting both species—187 Golden-fronted Woodpeckers and 182 Ladder-backed Woodpeckers (Cruickshank et al., 1958). These recent results agree with those obtained by the writer, who found the two species to be about equally numerous throughout south Texas.

ROLE OF THE LADDER-BACKED VERSUS THE GOLDEN-FRONTED

Special attention was given to the comparative roles played by the Ladder-backed and Golden-fronted Woodpeckers in damage to poles and posts. It was concluded that the Golden-fronted rarely initiates attack, but rather appropriates and enlarges holes already made by the smaller Ladder-backed. Supporting evidence may be summarized as follows:

1. Golden-fronted Woodpeckers have appeared as occupants of sites where Ladder-backs were actively at work earlier in the same nesting season.
2. There is no evidence of damage to utility poles or crossarms in towns and cities in the Rio Grande Valley where the Golden-fronted is reasonably common and the Ladder-backed is rare or absent.
3. Golden-fronteds are rarely seen working on utility poles. They spend much of their time on poles, but this time is utilized chiefly in such activities as guarding nesting sites, "loafing," searching for food in checks, and taking part in courtship displays. Ladder-backs, however, when seen on poles or fence posts, are rarely engaged in anything but hole excavating activity.

LOCATION OF DAMAGE

Each of the several species of woodpeckers that attack utility poles has its special mode and place of attack; the Pileated (*Dryocopus pileatus*) concentrates on the mid- and upper-mid portions of transmission poles; the two flickers (*Colaptes cafer* and *C. auratus*) on lower portions of the pole, often close to the ground; and other pole-damaging species have equally rigid zones of attack (Dennis, 1964).

The Ladder-backed conforms to this pattern by concentrating its attack at special localized points on poles, fence posts, and other structures. However, it exceeds all other pole-damaging species in the wide diversity of its attack. Among its targets are every wooden utility pole attachment, road marker posts, sign posts, fencing boards, wooden railings, and clapboard on houses. Furthermore, the writer has been told by utility engineers within the Ladder-backs' range that lead sheathing on overhead cables is sometimes damaged.

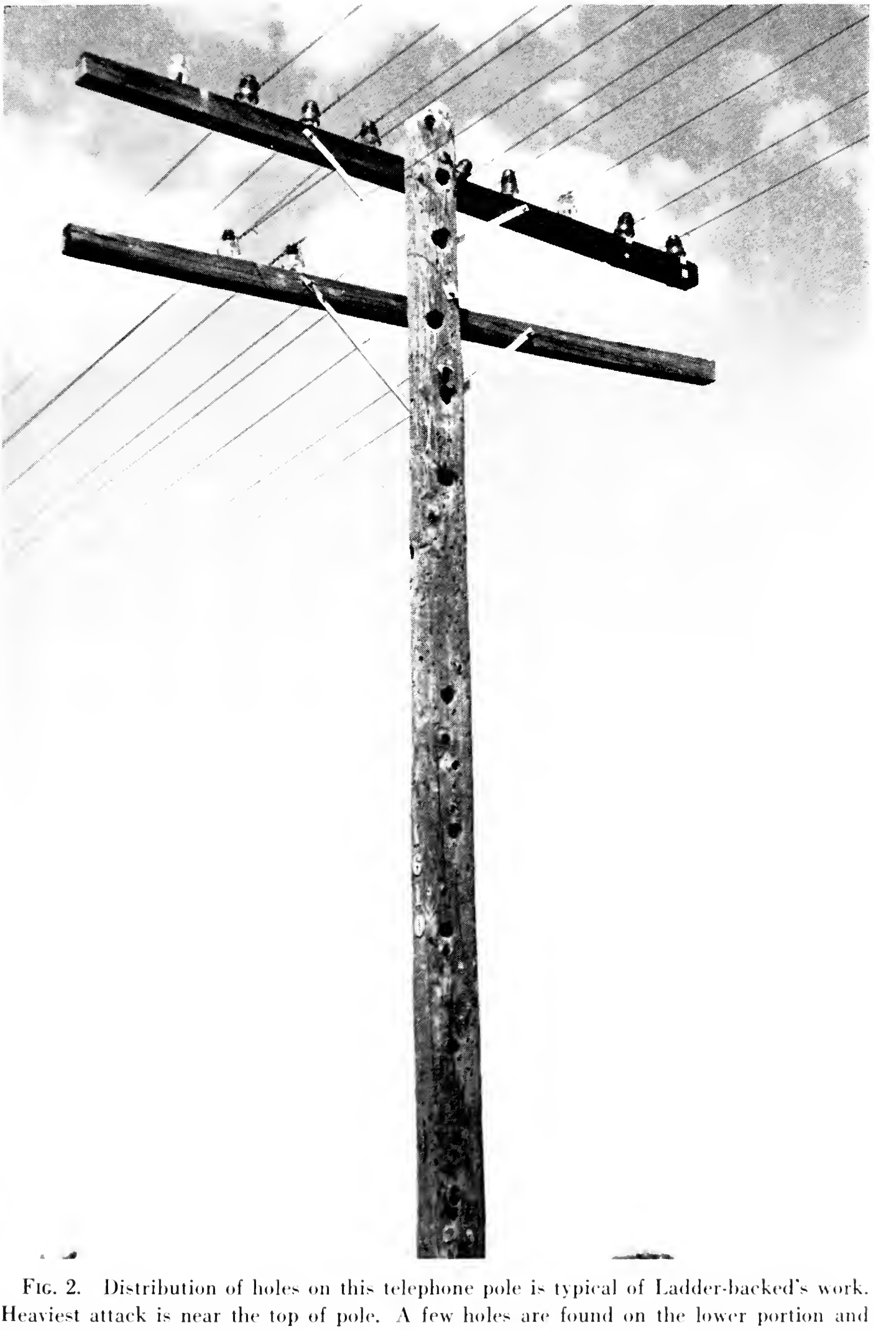


FIG. 2. Distribution of holes on this telephone pole is typical of Ladder-backed's work. Heaviest attack is near the top of pole. A few holes are found on the lower portion and beginning almost from the ground level.

Attack on utility pole structures by the Ladder-backed is characterized by heavy damage to crossarms and braces, and frequent heavy damage to the top 2 or 3 feet of the pole. Damage sometimes extends from ground level to the top of the pole (Fig. 2). Attack on crossarms and braces always originates on the underside, never the sides or top. Typically, a crossarm is drilled at a site on the underside from 6 to 18 inches from the end. The purpose of this drilling is apparently the excavation of a roosting or nesting hole. Rarely are these holes completed. Often the bird "misjudges" the dimensions of the crossarm and breaks "windows" in one or both sides, or breaks a hole in the top. In other cases, the bird appears to tire of its work and discontinues after drilling only an inch or two. In the rare instances that a cavity is completed, the tunnel always leads from the entrance toward the pole—never away from the pole. Completed cavities in crossarms are from 6 to 10 inches in length.

Attack on fence posts is much like that on utility poles. Roosting and nesting holes are largely confined to the top few inches of the post, and many more are started than are completed. Damage to utility poles and fenceposts can be described best under three headings: (1) small poles with crossarms (electric distribution and telephone poles), (2) large poles with crossarms (electric transmission poles), and (3) fence posts.

Small poles.—A total of 155 small poles in seven separate electric distribution lines were checked for location of damage and severity of damage in relation to habitat. The poles had been in service from 4 to 19 years and ranged from 20 to 40 feet tall; each had a single crossarm attached. With the exception of one line in which the treatment was pentachlorophenol, all poles were treated with creosote. Poles were southern pine and crossarms were penta-treated Douglas fir. All but a few poles were damaged (only holes 2 inches or more in diameter were tallied). The heaviest damage occurred through dense mesquite shrub, where poles had an average of 3 holes each. Lightest damage—0.5 hole per pole—was found in a line through small bottomland hardwoods along the Rio Grande. Damage was intermediate where lines passed through habitats with predominately large hardwood, and mixed oaks and mesquite.

One hundred and seven pressure-treated, southern pine telephone poles were examined on six different lines. The poles ranged from 15 to 30 feet tall and had two to three crossarms. Only 0.8 hole per pole was found where lines were surrounded by solid stands of oak; in contrast an average of 2.5 holes per pole occurred in lines through mesquite scrub. Severity of damage was about the same as on the electric distribution lines.

Combining data from telephone and electric distribution lines, about 26 per cent of all holes were in the top foot of poles, 30 per cent were at the crossarm level, 30 per cent were in crossarms, and the remainder below the crossarms.

Overall, 80 per cent of the damage was in the top 3 feet and in the crossarms.

Large poles.—Several kinds of transmission pole constructions are found in south Texas. The poles are southern pine, pressure-treated with creosote, and typically 55 feet in height. The various braces and crossarms are penta-treated Douglas fir. In April 1965, 30 consecutive 2-pole, H-frame structures of a transmission line west of Falfurrias were checked for woodpecker damage. As was the case with the smaller poles, this line seemed to be a typical example of the kind of woodpecker damage to be expected where adjacent habitat supports a large population. Habitat along this line consisted of dense mesquite scrub.

Approximately 75 per cent of the larger holes were found in X- and V-brace structures, only 24 per cent in the pole, and 1.6 per cent in the crossarms. This is in marked contrast to the heavy damage typically found in crossarms on electric distribution lines and telephone lines. That Douglas fir crossarms on this line and other transmission lines examined have been free or nearly free of attack defies explanation. Whether a factor, such as elevation from the ground or the thickness of the crossarm, plays a role in degree of attack on the different structures in unknown. However this may be, the damage to the pole itself on transmission lines has seldom been found to be severe and is largely confined to the top few feet.

Fence posts.—Although several species of woodpeckers attack both utility poles and fence posts, attack upon creosoted pine fence posts for the purpose of making roosting and nesting holes seems to be a highly restricted habit that is perhaps confined to only the Ladder-backed Woodpecker. Numerous instances were found in which the Golden-fronted had occupied holes in creosoted pine fence posts, but from all evidence, such holes were originally the work of the Ladder-backed.

Creosoted pine posts have been used on a large scale in south Texas only during the last 10 to 20 years. The traditional fence posts of the region are red cedar (*Juniperus virginiana*) and mesquite (*Prosopis juliflora*) which are naturally resistant to decay. Pressure-treated creosoted pine, however, is becoming more popular as a fence post material. Pressure-treated penta-pine posts also are beginning to make an appearance. Red cedar, the most widely used fencepost material, is virtually immune to woodpecker attack. Occasionally a roosting or nesting hole is found in a red cedar post, but upon examination the post is usually found to be in an advanced state of internal decay. More often, a few "probe holes," which rarely penetrate any deeper than the sapwood, are found in sound posts. In response to an inquiry to the U.S. Forest Products Laboratory at Madison, Wisconsin, John W. Rowe (pers. comm., 5 April 1961) furnished the following information regarding possible reasons why red cedar is so seldom attacked by woodpeckers:

> "Woodpeckers apparently attack wood either to find insects or when they hear a hollow sound such as might come from either heartwood rot or shake (the ease of hollowing out for nesting?). These *Juniperus* species contain a high percentage of heartwood which is rich in toxic extracts . . . They are considered fairly resistant to attack by microorganisms and fungi, and are probably also fairly resistant to insect attack . . . The heartwood is thus resistant to rot, and in addition is relatively hard and does not commonly form shake cavities. This should all tend to render these *Juniperus* spp. relatively unattractive to woodpeckers."

Mesquite fence posts, readily recognized by their crookedness, are also widely used in south Texas. They are somewhat more subject to woodpecker attack than red cedar. Roosting and nesting holes are sometimes found, and if the post has a marked lean or crook, the hole is invariably on the undersurface. Solid posts without decay seem to be avoided. Mesquite posts generally seem to be free of small "probe" holes and miscellaneous damage. However, in some parts of south Texas, for example along the highway between Alice and George West, attack upon mesquite posts is quite common.

By far the heaviest attack is upon creosoted pine. Wherever such fence lines were checked in mesquite-scrub habitat, there was evidence of damage similar to that found on utility poles, specifically holes near the top, widening of checks, minor surface peck marks and scaling. The ratio of completed to uncompleted holes does not vary strikingly from that found on utility poles and crossarms. For example, in a check of 50 distribution poles and 60 crossarms at the Welder Refuge near Sinton, only 5 per cent of all holes were completed roosting and nesting cavities (Dennis, 1964). On 525 creosoted pine fence posts at the Laguna Atascosa National Wildlife Refuge near San Benito, Texas, 11 per cent of all holes were completed roosting and nesting cavities. The poles and crossarms had been in place approximately four years and the fence posts about seven years.

A higher percentage of poles than posts is attacked. In areas of severe damage it is not uncommon for 100 per cent of utility pole structures to show signs of attack. The incidence is lower in fence posts which are spaced closer together. For example, in a part of the Laguna Atascosa Refuge where every utility pole showed substantial damage, only 17 per cent of the fence posts contained damage. The fence posts were one rod apart while the utility poles were approximately 500 feet apart.

Approximately 16 per cent of 1,887 creosoted pine posts in six lines at the Laguna Atascosa Refuge were damaged. Furthermore, 2.5 per cent contained completed roosting or nesting holes. The posts had been in place from two to seven years.

Damage was most severe on fence lines where there were either solid stands of mesquite-scrub or mesquite-scrub bordered by grassland. Less damage was found on lines where at least one side of the fence line was bordered by a cultivated field. Wherever fence lines departed from chaparral, woodpecker damage ceased within 40 to 50 yards.

RELATIONSHIP OF DAMAGE TO WOOD TREATMENT

C. T. Day, a utility engineer in Sonora, Mexico, (in McAtee, 1911) describes woodpeckers "getting fat" on creosote and the inside of poles being "entirely eaten away." Although this may be an exaggerated account, the idea that creosote makes a pole more susceptible to woodpecker damage has persisted.

A program to test this theory was established at the Laguna Atascosa National Wildlife Refuge with the cooperation and assistance of the U.S. Fish and Wildlife Service. In February 1965, 58 pressure-treated creosoted southern pine posts and 42 untreated southern pine were placed about 20 yards apart along edges of existing fence rows or along clearings through dense chaparral growth. In most instances treated and untreated posts were alternated.

After approximately two months, the posts were examined for signs of attack. Of the untreated posts, 7.3 per cent contained holes or sign of attack and 36.2 per cent of the treated posts contained holes or sign of attack. The extent and degree of damage varied little between treated and untreated posts. None contained completed nesting holes. For the most part, holes went straight into the post for varying distances and did not extend downward. In some cases, attack was limited to a few peck marks or the scaling-off of thin layers at surface of the post.

The fact that the creosoted posts sustained approximately five times as much damage in the first two months suggests that there is a basis for the belief that the wood preservative in some way contributes to making a pole more vulnerable to woodpecker attack. This does not necessarily imply, however, that creosote per se is the attractant. Changes in wood structure during the treating process may be a factor in making a pole more vulnerable. For example, Wood et al. (1960) speak of defects in poles, such as shakes, "that are induced by conditioning and preservative treatment."

Poles and posts with small internal cavities in the form of ring separations in the wood (or shakes) have often been thought to be particularly susceptible to woodpecker attack. In the letter from John W. Rowe quoted earlier, it was suggested that the presence of either heartwood rot or shake made for conditions that stimulated woodpecker attack. This is a theme amplified upon by Dennis (1964), who believed that woodpeckers primarily attack poles to make roosting and nesting cavities, but, because of the presence of shake and other internal defects, are stimulated to make far more holes than they would in natural tree sites.

It should be added that there is much yet to be learned about a possible connection between the preservative treatment and the susceptibility of a pole to woodpecker attack. Testing has barely begun on this aspect of the problem and any conclusions will have to await long-term results with many more test poles. In April 1965, the number of test posts in the experiment at the Laguna Atascosa Refuge was doubled.

RELATIONSHIP OF DAMAGE TO RESONANCY EFFECTS

Other fence post experiments at Laguna Atascosa were designed to test resonancy or sound effect. McAtee (1911), who expressed the belief that "hum of the wires" had something to do with attracting woodpeckers to utility poles, was repeating a widely held assumption that has persisted to this day. Recent writers have discounted the role of hum or vibration and have substituted other reasons that seem more convincing (Turcek, 1960; Dennis, 1964).

Observations along electric distribution and telephone lines in south Texas, as well as of posts bearing metal signs, have shown that the Ladder-backed frequently selects sites close to metal attachments as places to commence hole drilling. So pronounced is this tendency that attack is often limited almost entirely to the immediate proximity of a metal attachment and is absent elsewhere. A number of examples may be mentioned.

1. In a sample of 17 poles in a heavily damaged electric distribution line, 88 per cent of holes were opposite metal attachments.
2. In a sample of 50 poles in a heavily damaged telephone line, all holes were opposite metal attachments on the crossarms.
3. At Laguna Atascosa Refuge about 2.5 per cent of the creosoted pine posts bear official metal U.S. Fish and Wildlife Service boundary marker signs. In a fence line containing 525 posts, 13 with signs attached sustained a damage rate of 84.6 per cent; the 512 posts without metal signs sustained a damage rate of 15.4 per cent.

This tendency to attack locations opposite metal attachments was tested on a small scale in fence post experiments at the Laguna Atascosa Refuge. A slit 5 inches deep was sawed into the top of 10 creosoted pine fence posts. A 5-inch square of sheet metal was inserted into each slit. Posts containing the hidden metal plates were placed in test strips with 30 unaltered creosoted pine fence posts. As with the other test posts, placement was made in late February and posts were checked in late April. Of the 30 unaltered posts, six (20 per cent) had been attacked; of the 10 posts with metal plates, seven (70 per

FIG. 3. A flat metal plate has been inserted into a groove cut into the top of this creosoted pine fence post. A woodpecker has drilled a hole to the plate. Small holes are scattered about near the large hole.

cent) showed attack. Figure 3 shows attack at a post with a hidden metal plate.

DISCUSSION

The Ladder-backed Woodpecker has been depicted as a tremendously active species whose energies are often directed toward (to us) destructive ends. While its motivation may come chiefly from a drive to excavate roosting and nesting holes, this purpose often seems to be forgotten in the frenzy with which the bird attacks objects or sites responding with a metallic or hollow ring. Many of these sites, such as fencing boards and railings, could not possibly serve as receptacles for nest hole cavities. Even sites of proper dimensions, such as crossarms, may be rendered useless from a functional standpoint by overly energetic drilling that punctures the sides or roof. In spite of many failures and false starts, the Ladder-backed, nevertheless, apparently completes enough cavities for its own use, and at the same time provides nesting sites for other hole-nesters, e.g., House Sparrow (*Passer domesticus*), Bewick's Wren (*Thryomanes bewickii*), Ash-throated Flycatcher (*Myiarchus cinerascens*), and Golden-fronted Woodpecker.

The larger Golden-fronted, to be sure, is probably compelled to enlarge the holes it appropriates. But regardless of elevation or whether the site is in a fence post, X-brace, or pole, the Golden-fronted is as adaptable as the Ladder-backed and readily appropriates the site for roosting or nesting.

Evidence that the preservative treatment makes the pole more susceptible to woodpecker attack is highly hypothetical and needs to be weighed against other factors. There are many regions of North America where woodpecker damage to creosoted or penta-treated poles is unknown. In south Texas, damage by the Ladder-backed seems to be correlated more closely with metallic resonancy than with any of the factors that may be related to the preservative treatment. Utility companies in south Texas, nevertheless, can take comfort from the fact that neither the preservative treatment nor the resonancy characteristics of the pole necessarily make it irresistible to a woodpecker. Habitat appears to be of prime importance. In oak woods supporting large Ladder-backed populations attack may be light or nonexistent. With the presence of suitable natural sites, the birds are apparently under no compulsion to attack utility poles or fence posts.

SUMMARY

The Golden-fronted Woodpecker has usually been blamed for utility pole and fence post damage in south Texas. It is now suggested that the Golden-fronted rarely initiates attack—its role is one of appropriating and enlarging holes already made by the smaller Ladder-backed Woodpecker. Although a wide variety of man-made structures come under attack, the heaviest damage by far is to creosoted pine. In an experiment with pine fence

posts, it was found after two months that creosote treated posts sustained five times as much damage as non-creosoted ones. The role, if any, played by creosote or other wood preservatives in possibly making wood more susceptible to attack is unclear.

Lack of suitable trees for roosting and nesting sites appears to be a highly important factor in making utility poles and fence posts more subject to attack. Heaviest attack is found on lines running through chaparral dominated by mesquite. Attack is also influenced by resonancy factors. Poles and posts exhibiting metallic resonancy or internal hollowness are selected over ones without such features.

ACKNOWLEDGMENTS

The writer is indebted to William F. Mann, Jr., Project Leader in Timber Management Research, Southern Forest Experiment Station, Alexandria, Louisiana, for his support and encouragement. Robert L. Rumsey, in charge of research on woodpecker damage problems, assisted in field work and collaborated closely on many aspects of this study. His help in editing this manuscript is greatly appreciated. Kirk Key helped in field work and supplied the illustrations that accompany this paper. Without the assistance of those mentioned, and other personnel of the Station, it would have been impossible to have completed the experimental part of this study.

A further debt of appreciation goes to U.S. Fish and Wildlife Service personnel at the Laguna Atascosa National Wildlife Refuge. The writer is especially grateful to the cooperation supplied by Richard J. Hitch, the Refuge Manager.

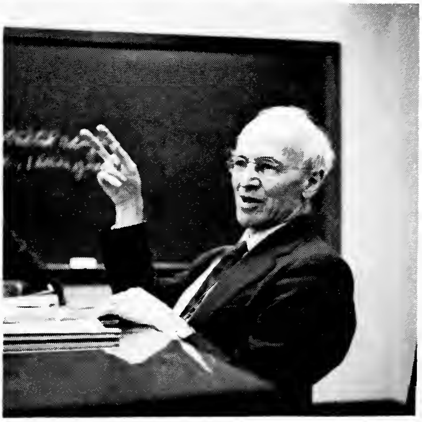
LITERATURE CITED

Bancroft, G.
1930 Breeding birds of central lower California. *Condor*, 32:20–49.
Bendire, C.
1895 Life histories of North American birds. *U.S. Natl. Mus. Special Bull.* No. 3.
Bent, A. C.
1939 Life histories of North American woodpeckers. *U.S. Natl. Mus. Bull.* 174.
Blake, E. R.
1954 Birds of Mexico. University of Chicago Press, Chicago.
Brooks, A.
1933 Some notes on the birds of Brownsville, Texas. *Auk*, 50:59–63.
Cruickshank, A. D. and other editors
1958 58th Christmas bird count. *Audubon Field Notes*, 12:63–250.
Dennis, J .V.
1964 Woodpecker damage to utility poles: with special reference to the role of territory and resonance. *Bird-Banding*, 35:225–253.
Friedmann, H.
1925 Notes on the birds observed in the lower Rio Grande Valley of Texas during May, 1924. *Auk*, 42:537–557.
Grinnell, J., and H. S. Swarth
1913 An account of the birds and mammals of the San Jacinto area of Southern California. *Univ. California Publ. in Zoology*, 10:197–406.
McAtee, W. L.
1911 Woodpeckers in relation to trees and wood products. *U.S. Dept. Agric. Biol. Surv. Bull.* 39.

Pearson, T. G. and other editors
1936 Birds of America. Garden City Publishing Co., Garden City, N.Y.
Sennett, G. B.
1878*a* Notes on the ornithology of the Lower Rio Grande of Texas from observations made during the season of 1877. *Bull. U.S. Geol. and Geogr. Surv.*, 4:1–66.
1878*b* Further notes on the ornithology of the Lower Rio Grande of Texas from observations made during the spring of 1878. *Bull. U.S. Geol. and Geogr. Surv.*, 5:371–440.
Simmons, G. F.
1925 Birds of the Austin region. University of Texas Press, Austin.
Turcek, F. J.
1960 On the damage by birds to power and communication lines. *Bird Study*, 7:231–236.
Wood, L. W., E. C. O. Erickson, and A. W. Dohr
1960 Strength and related properties of wood poles. ASTM Wood pole Research Program, American Society for testing Materials.

BOX 389, LEESBURG, VIRGINIA, 7 DECEMBER 1965.

NEW LIFE MEMBER



A recent addition to the Life Members of The Wilson Ornithological Society is Dr. Charles Hartshorne, Professor of Philosophy at The University of Texas. A distinguished scholar in his professional field, Dr. Hartshorne has published several books and nearly 200 papers in the area of philosophy. He is, however, seriously interested in ornithology, and has published several papers in that field, particularly about bird song. He is a Field Associate of the Cornell Laboratory of Ornithology, as well as a member of the AOU, the AAAS, and the Texas Ornithological Society. His interest in ornithology has been complimented by an interest in travel, and he has made ornithological observations on all six continents and on many of the oceanic islands. Dr. Hartshorne is married and has one daughter.

AGONISTIC BEHAVIOR IN THE AMERICAN GOLDFINCH[1]

Ellen L. Coutlee

The term "agonistic behavior," used here in its strict sense, includes both aggressive and submissive displays. This behavior has been observed in the American Goldfinch (*Spinus tristis*) by several authors, but there is little agreement among them. Some have indicated that agonistic behavior occurs in connection with territoriality and defense of nest sites (Drum, 1939; Batts, 1948; Roberts, 1942; and Stokes, 1950). Others, including Sutton (1959) and Walkinshaw (1938), have not observed agonistic encounters, and Sutton describes disputes over nesting territories as "playful." The present investigation of the American Goldfinch seeks to clarify these conflicting viewpoints. It includes a description and analysis of movements, calls, and displays involved in agonistic behavior, and a discussion of its influence on social hierarchy and territoriality.

MATERIALS AND METHODS

Field work was conducted at or near the University of Michigan Biological Station, Pellston, Michigan during the summer of 1961, and at the Edwin S. George Reserve near Pinckney, Michigan in the summer of 1962. Wild birds were studied with 7 × 50 binoculars, since most individuals quickly became accustomed to the presence of a human being nearby. Approach to within ten or twenty feet was possible without noticeable changes in normal behavior patterns.

In August, 1961, five nestling goldfinches (two males and three females) were captured near the University of Michigan Biological Station. The birds were about ten days of age when taken from the nest and were hand-reared on a "paste" composed of boiled egg yolk, pablum, and milk. After being confined to a small cage (50 × 50 × 60 cm) during August and September, they were moved to a flight cage (1 × 1 × 1.3 m) on 1 October. Observations of agonistic behavior were made on this group of birds until 11 April 1962. At this time, a male and female were separated from the rest of the birds and placed in a small cage (50 × 50 × 50 cm) for the duration of the breeding season.

DISPLAYS

Head-up.—In the Head-up Display, the bird faces its opponent with neck slightly extended, body feathers neither fluffed nor sleeked, and legs extended somewhat (Fig. 1). This posture is maintained for one or two seconds and is

---

[1] Contribution No. 129 of the Department of Biology, Wayne State University.

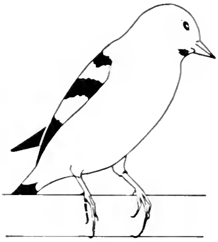


FIG. 1. Head-up Display showing mild aggression.

often given by the victor just after an agonistic encounter. Since a bird giving this display may either attack its opponent or return to quiet perching, feeding, or preening, the display may be interpreted as showing evidence of a weak tendency to attack.

Carpals-raised.—A slightly more intense display has been observed during which the neck is retracted, the carpal bones are raised as the wrist is rotated outward, and the body feathers are somewhat sleeked (Fig. 2). The legs may or may not be extended, and the beak is sometimes opened. This often results in a posture similar to that of normal perching, but with the primaries held about two millimeters away from the contour feathers. Birds giving the Carpals-raised Display are likely to attack opponents.

Head-forward.—In its lowest intensity, the Head-forward Display involves facing the opponent with legs flexed, neck extended, and beak closed. The body feathers are usually sleeked to some extent and the wings may be rotated slightly as in Carpals-raised (Figs. 2 and 3). If the bird shows a greater tendency to attack, one or both wings are raised, the neck is extended and lowered, and the beak is pointed at the opponent. When only one wing is raised, it is usually the one further from the attacked individuals. The high intensity Head-forward Display is characterized by retracting the neck and raising the wings, during which they are spread and/or fluttered. The beak is

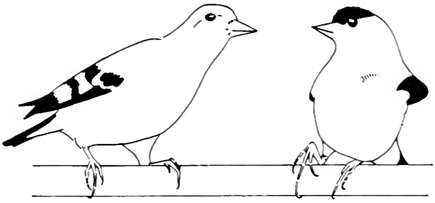


FIG. 2. Agonistic encounter. Note facing of opponent by both birds. Low intensity Head-forward by female to left. Male on right shows Crown-raised and leaning away (fear). Carpals-raised and wing opposite opponent raised (aggression).

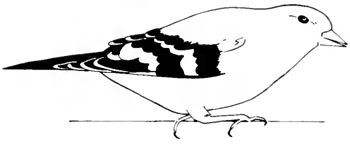


FIG. 3. Low intensity Head-forward (slightly more aggressive than female, Fig. 1), opponent to right. Horizintal posture, feathers sleeked, bird faces opponent with long axis of body directed toward it.

opened, the body feathers are sleeked, the tail is raised slightly and fanned, and the legs are flexed (Fig. 4). In many cases, this action is accompanied by one or two harsh, grating *caws* on the part of the aggressor. This may be followed by hopping or sidling rapidly toward the opponent, the long axis of the body oriented directly toward it. Tail-flicking, during which the closed rectrices are moved rapidly in an arc or circle, often accompanies head-forward displays. Neither the pivoting behavior nor the fluffing of the contour feathers of an attacker, as noted in the European Goldfinch (*Carduelis carduelis*) (Hinde, 1955–56), were seen in the American Goldfinch.

Body contact.—In some cases, aggressive birds pecked at or plucked feathers from other individuals. The pecking was directed toward the point nearest the aggressor, usually the head or side of the attacked individual. This was especially evident in the young captive birds from 30 to 60 days of age. This period marked the first appearance of attacking behavior and it was

FIG. 4. Agonistic encounter. Both birds in extreme Head-forward with wings raised, beaks open. Female to left with wings fluttering, tail fanned, neck withdrawn.

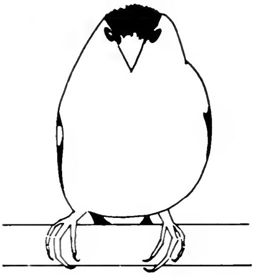


FIG. 5. Submissive posture, aggressor to left. Note leaning away, crown raised, beak pointed downward.

not accompanied by preliminary displays. In this case, it seemed to be initiated merely by the close proximity of other individuals. This spontaneous pecking decreased considerably as the birds matured and is seldom seen in adult individuals. When pecking does occur in adults, it is usually preceded by one of the displays described above.

Supplanting.—The supplanting attack occurs in both wild and captive individuals. The aggressor flies directly toward another bird, alighting in its place or one to two centimeters away. The perched individual almost invariably flies just before the attacker reaches the perch. In some instances, the attacked individual merely moves a few centimeters away along the perch. Flight away from the hostile bird often results in aggressive chases. During these, the submissive individual is supplanted as soon as it alights, being chased rapidly from perch to perch. This may be continued for several seconds until the aggressor perches quietly or the chased individual refuses to fly.

Vertical flights.—After Head-forward Displays, wild birds were often observed to make flights of three to five meters straight up into the air. These vertical flights were characterized by rapid wing-fluttering by both individuals. The birds were less than fifteen cm apart with legs and feet extended, beaks

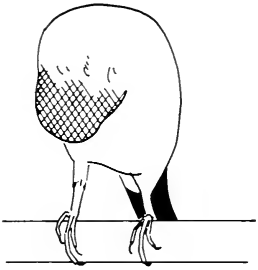


FIG. 6. "Displacement breast preening," front view.

open, and necks extended toward each other. At the completion of the encounter, the birds usually flew off with undulating flight. They sometimes chased each other, utilizing flapping flight and darting in and out through the dense foliage. These encounters occurred during the breeding season either on the feeding grounds or in nesting areas.

Avoidance reactions.—Since many of the agonistic postures are subtle, their identification sometimes depends solely on the reactions of submissive birds. These "avoidance" reactions are often inconspicuous. One of the best indications of avoidance is lateral presentation of the body to the aggressor; conversely, when a bird is likely to attack frontal presentation is the rule. As in the case in many fringillids (Hinde, 1955–56), submissive birds often assume a somewhat crouched posture, the legs being flexed to a greater extent than during normal perching. This is sometimes accompanied by a slight fluffing, especially of the crown feathers. Also indicative of submission is leaning away from an aggressor (Figs. 2 and 5). The head and/or tail are often bent away from the opponent. Keeping the neck withdrawn with the beak pointed downward (Fig. 5) again shows avoidance. Various combinations of these postures may be utilized.

Displacement activities.—Displacement activities, apparently unrelated behavior occurring before, during, or after agonistic encounters, are evident in the goldfinch and seem to indicate conflicting drives. As discussed previously (Coutlee, 1963), preening increases when agonistic behavior is at a peak. This preening, although including all regions of the body, is often concentrated near the head. Beak-wiping and head-scratching in particular are often observed during agonistic encounters. These movements are executed very rapidly by aggressive individuals just before or after displays and by submissive individuals after flight from an aggressor.

When conflicting drives of fear and feeding or fear and attack occur, the birds often assume a sleeked posture with legs extended, and neck extended

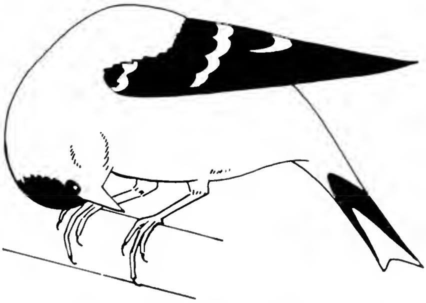


FIG. 7. "Displacement breast preening," side view.

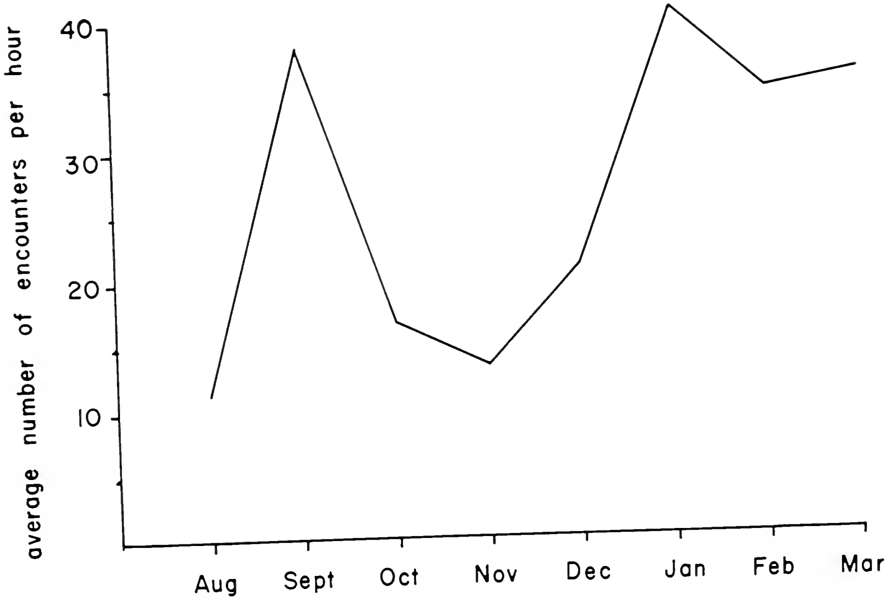


FIG. 8. Total aggressiveness for each month as evidenced by the average number of encounters per hour of observation (40 hr of observation).

and arched so that the beak points downward toward the abdomen (Figs. 6 and 7). This ritualized posture may be termed "displacement breast preening" and in caged birds it is sometimes followed by actual preening or pecking at the anal ring or crissum. During preening, however, the feathers are fluffed rather than sleeked. In wild birds, this same posture was seen when perching near a caged bird, prior to flight to the cage. In several cases, this was followed by pecking at the perch, and preening was never observed in this connection.

The agonistic displays described above have been observed, for the most part, under laboratory conditions. They occurred apparently at random in all parts of the cage. There are very few conflicts at the food source, in contrast to the behavior noted for the House Finch (*Carpodacus mexicanus*) (Thompson, 1960) and Chaffinch (*Fringilla coelebs*) (Marler, 1956). Aggression was noted at times toward an individual holding a leaf or nesting material, but in other instances two or three individuals pecked at the same object with no hostility. Supplanting was noted a few times in wild birds at feeding areas, but this only occurred during the nesting season when aggression was generally more evident. Agonistic behavior observed in connection with territoriality is discussed below.

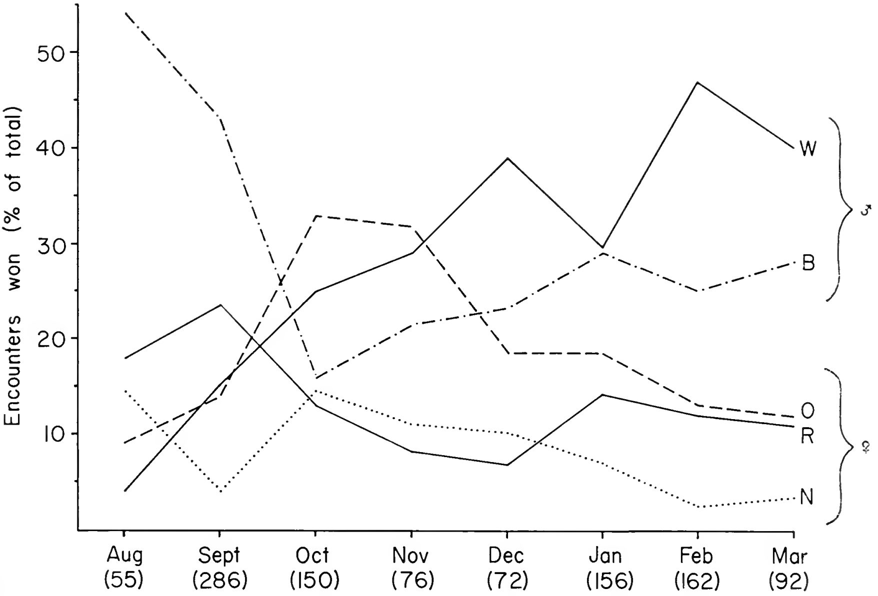


Fig. 9. Percentage of total encounters won by each caged bird for an eight-month period. Numbers in parentheses show total number of encounters per month (40 hr of observation).

AGGRESSIVENESS

Agonistic behavior in caged birds, under artificial conditions of lighting (12 hours light: 12 hours dark) was investigated. The intensity of this behavior each month, as indicated by the average number of encounters per hour of observation, is shown in Figure 8. Only eight months are included here. This permits consideration of only the months during which all five birds were together. Agonistic behavior was first observed on 24 August 1961 (30 days of age). Aggression was quite vigorous at this time and the number of encounters reached a peak during September, conceivably due to the crowding effect of the small cage. Transfer to a flight cage on 1 October was followed by a decrease in the number of encounters which was sustained throughout the winter months. Breeding plumage was attained quite early, perhaps as a result of the relatively long photoperiod during the winter. By January, early molt had produced an approximation of adult plumage. An increase in agonistic behavior was noted at this time and continued through 15 June when laboratory observations were terminated.

The relative aggressiveness of each bird was measured by tabulating the number of encounters won by each individual during one month as a percent-

TABLE 1

COMPARISON OF OBSERVED ENCOUNTERS WITH EXPECTED ONES

Month	Total encounters	Male-Male		Female-Female		Male-Female	
		Exp.	Obs.	Exp.	Obs.	Exp.	Obs.
August	55	6	7	17	15	33	33
September	286	29	37	86	72	172	177
October	150	15	11	45	22	90	101
November	73	7	9	22	24	44	40
December	72	7	14	22	17	43	41
January	157	16	55	47	33	94	69
February	162	16	66	49	13	97	83
March	92	9	19	28	10	55	63

age of the total number of encounters recorded for the month (Fig. 9). Individuals O, R, and N (as identified by color bands) were female, while W and B were male. Aggression during the first three months was quite variable, with individual hostility varying each month. After November, however, a definite trend is noted with males becoming more aggressive and females less. This trend becomes stabilized in January and remains constant throughout February and March. As pair bonds became stronger after separation of the birds into pairs in April, the females appeared to become more aggressive. For example, of the 50 encounters observed between paired individuals B and O, the female was the victor in 30 cases.

In order to determine the effect of sex on the incidence of agonistic encounters, the encounters were grouped as "male-male," "female-female," or "male-female." Assuming random meetings with three females and two males, the probable distribution of the types of encounters can be determined. For instance, any one female would be involved, during a given encounter, with one of two males and two other females. In other words, she would have equal chances of meeting with a male or a female. Likewise, a male would be expected to meet one of the three females in 75 per cent of his encounters. In Table 1, the actual number of encounters in each category each month is compared with this theoretical random number. It can be seen that observed values closely approximate those expected from August through November, while differences found in December are amplified through January, February, and March. Calculation of chi-square with a level of significance of 0.05 for two degrees of freedom shows that the encounters for the first four months can be considered as random. After this time, however, the encounters are definitely non-random. Variation from the expected values from December through March indicates an abnormally high percentage of male-male encounters, accompanied by a decrease in female-female and male-female encounters. If mere sex recognition through coloration were the criterion for determining encounters, then non-random aggressiveness should have been observed earlier, since the sexes were quite noticeably different in plumage during both October and November as well as the following months. Since these caged birds attained breeding plumage by January, it is probable that the change in behavior is a reflection of change in physiology as the breeding season approaches. These changes probably also occur in wild populations during competition between males for mates and/or territories at the beginning of the breeding season.

SOCIAL HIERARCHY

Social hierarchy, or "peck-order," was determined by examining conflicts between specific caged birds with regard to encounters won by each. A bird was considered to win an encounter when its activity evoked either a submissive display or flight by its opponent. Utilizing the information gained from the analysis of agonistic behavior between the sexes, encounters were grouped according to their occurrence during random or non-random months. Tables 2 and 3 show the combined data for these two periods. Individual birds are arranged according to apparent dominance as discussed below. The outcome of a conflict between any given pair of individuals shows considerable variation. For example, as seen in Table 2, B was the victor over W in 36 instances. W defeated B 28 times, however, even though B was on the whole the more dominant. The general trend is toward a straight-line hierarchy with males dominant to females. This may be represented as follows for the first four months:

TABLE 2

ENCOUNTERS WON BY EACH BIRD FOR RANDOM MONTHS

	B	W	O	R	N
B		36	54	63	41
W	28		43	21	13
O	32	14		45	27
R	33	17	13		39
N	19	4	6	19	

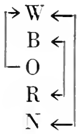
The number of encounters won by any given individual over each other bird is noted for the random months August through November. The table is read from left to right, the victors in the column to the left, losers along the top (e.g., B was the victor over W 36 times during the four-month period). Total encounters—567.

B (male)
W (male)
O (female)
R (female)
N (female)

As is evident by comparison with Fig. 9, the position in the hierarchy is influenced to some extent by the general aggressiveness of any one individual. Thus B, victor in a large percentage of encounters during August and September, appears as the dominant individual, while N is definitely subordinate, being the least aggressive of the group. On the other hand, the degree of individual aggression each month cannot be considered as entirely indicative of position in the hierarchy since, for example, O was generally more aggressive than W during the entire period, but appears beneath him in the hierarchy.

It must be remembered that this arrangement represents only an approximation of hierarchy for four months. Analysis of each month also shows frequent reversals in which individuals that are generally dominant are defeated by lower-ranking birds. In addition, triangles are often found in month-by-month analyses. For instance, in November O was dominant to R and R to B, but B was dominant to O. In other months, no dominance could be determined between two individuals, since they each won the same number of conflicts.

A similar analysis of non-random months gives the distribution shown in Table 3. The same trend is noted, with males dominant to females. In this case, however, a larger number of reversals was observed, and the group cannot be considered to possess straight-line dominance. The following arrangement gives an indication of the general trend, with arrows showing triangular relationships (→) or lack of dominance (↔):



It will be noted here that the shifts occurring in the group all involve conflicts between the sexes. Thus, although the number of male-female conflicts is less than expected during these months (Table 1), changes in the hierarchy are confined to these encounters. This is perhaps an indication of an impending shift from male to female dominance during the breeding season. These findings are in accordance with Hinde's observation (1955–56) that fringillid females are generally dominant to males during the breeding season. Since the photoperiod was kept constant throughout the entire study with no increase in day length corresponding to natural increases in the spring, full

TABLE 3

ENCOUNTERS WON BY EACH BIRD FOR NON-RANDOM MONTHS

	W	B	O	R	N
W		133	16	34	19
B	32		31	26	48
O	27	14		20	20
R	12	26	6		20
N	18	8	7	2	

The number of encounters won by any given individual over each other bird is noted for the non-random months December through March. Total encounters—519.

breeding condition apparently was not realized by the caged birds. After initial investigation of cotton and excelsior supplied from April through June, the caged birds showed no inclination to use them for nesting purposes.

Paired females were observed to initiate vertical aggressive flights against their mates in the field, but supplanting of his mate by the male was observed to about an equal degree.

It may be concluded, then, that social hierarchy in the goldfinches studied tends toward male dominance in the winter and female dominance during the breeding season. These relationships are highly unstable, however, with many reversals and unpredictable outcomes. In general, the position in the hierarchy corresponds to relative aggressiveness of each individual.

TERRITORIALITY

The question of territoriality in the American Goldfinch is a controversial one. The possession of a territory is denied by Pitelka (1942) and Roberts (1942), those who agree on its occurrence differ in their analysis of its manifestation (Walkinshaw, 1938; Drum, 1939; Batts, 1948; Stokes, 1950; Nickell, 1951; Sutton, 1959), and some refrain from taking a stand at all (Nice, 1939).

In none of the papers mentioned above is the word "territory" used in the strict sense as a "defended" area. Perhaps this lack of consistency explains a portion of the controversy over territoriality in the goldfinch. If the ultimate criterion for territory-holding is overt defense, especially against members of the same species, then many of the descriptions of "territory" must be rejected as actually representing only the area most frequented by the birds in question.

Territoriality in the goldfinch does seem to exist to a limited extent, but its boundaries and methods of defense certainly render it a confusing phenomenon at best. This is probably due to the extremely social nature of the species and the tendency to forage in flocks throughout the nesting season. A discussion of conflicts observed in breeding areas may aid in a partial understanding of this aspect of goldfinch behavior.

Formation and extent of territory.—The exact period of territory establishment is a controversial issue. Walkinshaw (1938) and Stokes (1950) indicate that territories are formed just before nest building begins. Drum (1939) contends that they are established "early in the nesting season" well before actual nest construction is under way. During observation periods by the author both in 1961 and 1962, several nests of a few fibers wrapped around forked branches were begun and then abandoned before the final nest was constructed. These differences of opinion thus may merely be a result of failure to find the inconspicuous partial nests, and territory may actually be formed well in advance of building of the final nest. In any case, pair formation seems to occur while the birds are in large flocks before or shortly after their arrival at the breeding grounds. This would indicate that a territory, if present, serves not to attract a mate but to insure isolation of a nesting pair.

In my own observations before nesting began, males were seen to give "song-flight" around favorite perching places, frequently large trees near feeding areas. These were followed by long bounding flights or chases between the males. Song-flight was terminated when the birds reached a distance of 50 to 100 meters from the point of its initiation. Two males which were captured and color-marked on 5 July 1962, were found at nests being constructed 15 and 65 meters, respectively, from the banding site on 14 July. In addition, one of these birds was seen to chase a second male from a dense dogwood clump where the final nest was constructed two weeks later. These observations suggest that, in these males, territory was formed at least two weeks before nest construction began. A female marked on 4 July was discovered nesting one mile distant on 9 July. This would indicate either that this female had not yet become associated with a definite nesting territory, or that if territorial tendencies existed, she still ranged a considerable distance from the prospective nesting area.

Although Walkinshaw (1938) found feeding areas within or near the territories, Drum (1939) observed that the birds travelled long distances to feed, and Sutton (1959) mentions the occurrence of both situations. In order to determine the extent of range in the goldfinches at the George Reserve, I banded and color-marked 28 birds from two weeks before to one week after nesting began. Twenty-one of these individuals were captured near a field where an abundance of ripe thistles (*Cirsium* sp.) and *Tragopogon* attracted large numbers of foraging goldfinches. Observations after nesting was under way showed that, although the birds did at times feed within ¼ mile of the nest, they also returned to the field where they were first captured, about ½ mile distant. Since (1) goldfinches could be found feeding there at almost any time of the day, (2) only about ¼ of them were marked, and these differently, (3) flights to and from the feeding area were in various directions, and (4) of eight pairs nesting in a marsh ½ mile away, three individuals were found at the feeding area, it can be inferred that this field remained as an important foraging place for a large population of goldfinches even though nesting territories had been established.

Defense by the male.—True song, considered as an effective warning signal against other members of the same sex (Nice, 1941; Lack, 1943), was uttered only by males. It consists of an extended series of rapid notes similar to an un-accented *per-chic-o-ree* as given during flight, but at a faster tempo. This "twittering" is interrupted at frequent intervals by "squeals," sliding notes either rising or falling in pitch; "sweet" notes, abruptly terminated squeals; and a rapid warble, described as "canary-like" by Drum (1939), Stokes (1950), Walkinshaw (1938), and others. The entire song is quite variable in both sequence and duration and is very loud. It is usually given from high trees near the nests but may also occur with flapping flight, resulting in the "song-flight" mentioned above. Stokes (1950) indicates that song in the American Goldfinch is "certainly associated more with courtship than with territory establishment," basing this conclusion on the fact that males sang in flocks more than when alone and sang most frequently during courtship and before nest building had started. In the males under consideration here, however, loud, complex songs were frequently heard during the early stages of nest construction. In addition, lone males often sang loudly from high perches near partially completed nests. Since the sound carried for considerable distances and pairs had already been formed, song at this stage can probably be considered as advertising in function although it may, in addition, be a factor in maintenance of the pair bond.

During both summers of observation, circular flights of the male as described by Drum (1939) were noted in the vicinity of the nest sites. These were usually of the bounding type accompanied by a sharp *per-chic-o-ree*, but sometimes song-flight was given. These flights seemed to advertise the territory boundaries, but intruding males apparently were approached only when very close to the nest. The territory-holder then chased them using rapid flapping flight and emitting loud warbles and squeals as he darted in and out of the dense shrubbery near the nest.

Drum (1939) did not find males alighting within their own territories.

but they either circled them or perched near them in high trees. This was not the case among the birds studied in 1961 and 1962. These birds *did* show a tendency to perch and sing in trees at the edges of the area circumscribed by their circular flights. In addition, they perched quite frequently near the nest, especially during nest construction. This occurred whether or not the female was present. Males often perched quietly or preened in the tops of shrubs slightly higher than the nest tree and but 1½ to 3 meters away. Song was never heard from these perches, although soft warbles and squeals were sometimes given. Since no aggressive chases were begun from these perches, this behavior may indicate an interest in the nest itself rather than an expression of territoriality. Since the male is quite conspicuous, however, mere prominence may serve to intimidate other males.

Defense by the female.—Female goldfinches also show a tendency toward territoriality, but it is confined to the immediate vicinity of the nest. During nest construction, they fly to distances of ¼ to one mile away to gather nest materials, then return to the nest site, remaining near the nest when within their mate's territory. Close synchronization of the breeding cycles within any given population produces wide-spread nest construction with most of the females occupied with building at the same time. During incubation and brooding, females remain on or near the nest almost continuously and are fed by the male. Consequently, the females have little contact with each other after nesting begins. In combination with male territoriality, this leads to little intraspecific conflict involving the females during nesting. Other females alighting within about 5 meters of the nest are chased away, but this is usually evident only during nest building. The female appears to be generally more aggressive than the male during nesting, but since she seldom meets other goldfinches, this aggression is necessarily directed toward her mate or other species.

INTERSPECIFIC CONFLICTS

American Goldfinches caged with House Finches and Indigo Buntings (*Passerina cyanea*) showed little conflict with these species. Some aggression was observed, however, usually resulting in submissive displays or retreat of the goldfinches. On a few occasions, Head-forward threat displays were given toward House Finches, sometimes causing them to retreat. In most cases, however, the goldfinches were supplanted by these larger birds, either at the food dish or on the perches. The same was true of the buntings, again of larger size. Wild birds were seen feeding with Indigo Buntings without conflict, indicating that forced close association in aviaries may have resulted in the encounters between these species.

Interspecific conflicts among wild goldfinches primarily involved females, and they usually occurred near the nest site. Conflicts observed in feeding areas at the George Reserve were confined to displays or chases by the females, directed toward Chipping Sparrows (*Spizella passerina*) which frequented the area.

During the early stages of nesting (construction of the nest through incubation of the eggs) the females were quite aggressive and chased Cedar Waxwings (*Bombycilla cedrorum*) and Catbirds (*Dumetella carolinensis*) from the vicinity of the nest. Smaller species, however, such as the Yellow Warbler (*Dendroica petechia*), American Redstart (*Setophaga ruticilla*), Yellowthroat (*Geothlypis trichas*), and Swamp Sparrow (*Melospiza georgiana*), were ignored even when they perched or sang near occupied goldfinch nests. As the breeding season progressed and young were being brooded or fed, the females became much more tolerant of the presence of other species, and conflicts were seldom seen.

In only one instance, during the early part of the nesting period, was a male seen to chase a bird of another species from a territory. A Cedar Waxwing alighted about 5 meters above the nest in a tree frequented by the male goldfinch. It was chased immediately from this perch by the goldfinch.

Supplanting or chasing of American Goldfinches by other species was not observed under field conditions.

DISCUSSION

Many of the components of the agonistic displays described above can also be seen in other, unrelated, behavior patterns. For example, wing-raising, lowering and extension of the neck, tail-flicking, and flexing of the legs may be recognized as components of take-off or flight intention movements. Hence, their presence in agonistic displays probably indicates the readiness to fly at an opponent. Some of these postures (for instance, flexing of the legs) are also seen in submissive individuals, and again probably indicate flight intention, in this case as an escape mechanism. Retraction of the neck is a preliminary to pecking and often occurs in agonistic encounters. This movement is completed if the opponent is actually attacked. These apparent relationships are similar to those described by Hinde (1955–56), Marler (1956), Dilger (1960), Thompson (1960), and others for other fringillids.

Avoidance reactions show tendencies toward calming of the aggressive individual through adoption of submissive postures. Keeping the side of the body toward the hostile bird not only shows lack of return aggression but presents a relatively well-protected surface to the attacker. The vulnerable head region is placed to the side as the aggressor faces the submissive bird, and the wing feathers are closest to its beak. Since pecking is directed toward the nearest part of an attacked bird, lateral presentation is definitely advantageous and any pecks delivered fall on the relatively impermeable wings. Submissive birds often bend the head and neck away from the attacker. This response has been described for many species and is considered by Moynihan (1955) to be an intention movement of escape or avoidance. Of course, facing away from an aggressor serves to protect the eyes and facial region. In addition, the highly-contrasting black cap of the male is concealed, perhaps further contributing to the negative stimulus being presented.

Evidence of conflicting drives was shown during all agonistic displays. As suggested by Hinde (1955–56), hostile birds which do not actually peck show both fear and aggression. This seems to be the case in the goldfinch, since aggressive birds are often hesitant to attack, resulting in the displays described above. Raising of the crown feathers occurs in many cases in association with agonistic encounters and may be performed by either individual. This action seems to indicate fright or submission, since it often occurs while leaning away or turning the head away. It has also been seen repeatedly in birds captured in the field, when they are held in the hand during banding.

The agonistic displays in the American Goldfinch are, for the most part, characteristic of a large number of fringillids (e.g. Lesser Goldfinch (*Spinus psaltria*) (Linsdale, 1957); European Goldfinch, Greenfinch (*Chloris chloris*), Canary (*Serinus* sp.) (Hinde, 1955–56); Chaffinch (Marler, 1956)). The Head-up and Head-forward displays are often observed in birds which subsequently attack their opponents. There are differences, however, in the intensity and degree of utilization of these displays in the goldfinch when compared with other species. The extreme Head-forward Display was rarely seen during the winter but increased in occurrence as the breeding season advanced. Even when the birds approached full reproductive condition, however, these displays occurred infrequently, and both wild and caged birds fed in flocks with a minimum of conflict throughout the breeding season.

The submissive postures are also much more subtle than those found in some other fringillids. For example, the extreme "fluffed-submissive" posture of the Chaffinch (Marler, 1956) and European Goldfinch (Hinde, 1955–56) is almost non-existent in the American Goldfinch. It was only observed in subordinate individuals when extremely high intensity aggressive displays were given toward them.

The low intensity of the agonistic displays utilized by the American Goldfinch as compared with most other fringillids that have been studied may, of course, be due either to a genetically weak tendency to attack or to extremely effective appeasement or avoidance patterns (including passivity of the attacked individual). Although the displays are often subtle, it seems unlikely that they are not correctly interpreted by other individuals of the species. Even a relatively low-intensity threat movement (i.e. Head-up or Carpals-raised) often causes flight of another bird. As noted above, submissive individuals usually lean away or turn the head away from the aggressor. This action serves to reduce the area of the conspicuous color patterns normally presented in attack postures (for example, the sharply contrasting black cap of the male) and thereby may inhibit the tendency of another bird to attack. Appeasement postures not only effectively control the action of the attacker by inhibiting its tendency to attack, but also cause no disturbance to other individuals nearby. In birds of a highly social nature, such as the goldfinch, this would certainly be advantageous to flock integrity during such activities as communal feeding. Linsdale (1957) has noted very little agonistic behavior in the Lawrence's Goldfinch (*Spinus lawrencei*) and suggests that inherently strong flocking tendencies may be responsible for this inhibition.

Displacement beak-wiping and head-scratching are often noted before, during, and after agonistic encounters and may be performed by either participant, as in most other passerines. In addition, the "displacement breast preening" posture is quite common in agonistic encounters and also appears in any "fearful" situation (close presence of an observer, approach to food dish already occupied by a superior, etc.). Although it is similar to the "displacement breast preening" of the Hawfinch (*Coccothraustes coccothraustes*), European Goldfinch (Hinde, 1955–56), and Greenfinch (Hinde, 1954), and is sometimes followed by preening, it may also be followed by pecking at the perch. It would seem that this movement may be derived from motor patterns related to feeding (fixation of seed or flower stalk directly below the body, pecking), preening (of abdomen, crissum, and anal ring), fleeing (extension of legs, sleeking of feathers), or a combination of these. The posture occurs only during situations characterized by conflicting drives of approach and flight.

It has been noted that House Finches (Thompson, 1960) and Chaffinches (Marler, 1956) show increased aggressive behavior at the food source. Marler (1957) found the same increase in aggression when a pair of siskins (*Spinus spinus*) was provided with a limited food source. In contrast, the captive goldfinches studied by the author showed almost no aggression at the food source throughout the winter months, even though all five often perched together on the small food dish (12 cm diameter) with but 1 to 5 cm separating each bird from its neighbor. Agonistic behavior at the food source increased as the breeding season advanced, but the number of encounters in all parts of the cage also increased at this time. It would seem, therefore, that although in the goldfinch agonistic behavior is usually provoked by a factor such as violation of individual distance, which may occur at any point in space, the drives associated with feeding and/or flocking reduce this tendency to attack.

Although Roberts (1942) and Pitelka (1942) found no territoriality in the populations of American Goldfinches which they studied, the author has observed territoriality in the wild birds she studied, in accordance with the finding of Drum (1939). Since pair formation occurs while the birds are still in winter flocks, and since they usually forage in neutral areas which may be as far as ½ mile from nest sites, the goldfinch territory functions mainly as a nesting area. The nests are fairly evenly spaced and, in the birds studied, were never less than 35 meters apart. This spacing is maintained by the males, each advertising and defending his territory by song flight. Occasional aggressive chases or actual fighting also occur within 5 meters of the nest. Linsdale (1957) has observed similar song flights and chases by male Lawrence's and Lesser goldfinches in the area immediately surrounding the nest. The female American Goldfinch may chase other birds, but usually this occurs only when they approach the nest site during early stages of nesting. The lack of rigid territorial defense in goldfinches as compared with other fringillids may be a result of their tendency to feed in neutral areas some distance from the nest. The selective advantage gained by holding a large territory including a food supply would thus be reduced. Conder (1948) indicates that the territory of the European Goldfinch becomes smaller after the eggs are laid. Since song flights and aggressive chases in the American Goldfinch decrease as the season progresses, its territorial boundaries seem merely to disintegrate rather than to actually recede.

Social hierarchy in the goldfinch is by no means a simple peck-right. The predictability of outcomes of encounters in stable straight-line or triangular hierarchies such as are found in domestic chickens (*Gallus gallus*) Schjelderup-Ebbe, 1922; Masure and Allee, 1934), Chaffinches (Marler, 1955), or Oregon Juncos (*Junco oreganus*) (Sabine, 1959) is lacking. Instead, during the winter months there are frequent reversals and unstable triangular relationships which may shift considerably from month to month. Shoemaker (1939) has found similar peck-dominance organization in captive flocks of Canaries, with daily or weekly fluctuations as well as some fairly stable relationships. This instability would suggest either great variation in aggressive drive or a lack of individual recognition. It seems unlikely that aggressive drive would be so variable since external conditions were constant and the internal milieu would be expected to be fairly stable at this time of year. Individual recognition would certainly be facilitated by the individual differences in calls and songs noted during the breeding season. During the winter months, however, vocalization in captive birds is at a minimum and it may be that this results in a lack of recognition which leads in turn to the observed instability of social structure. On the whole, males are dominant to females during the winter, but since the sexes remain distinguishable throughout the year (at least to human eyes) this dominance would not necessarily depend on *individual* recognition.

As the breeding season approaches, females appear to become dominant to their mates. This occurrence is similar to that found in the Brambling (*Fringilla montifringilla*), Chaffinch, European Goldfinch, Greenfinch, Hawfinch (Hinde, 1955–56), and Canary (Hinde, 1955–56; Shoemaker, 1939), and also seems to occur in the Lawrence's Goldfinch and Lesser Goldfinch (Linsdale, 1957). Since female goldfinches do not encounter males other than their mates while actually incubating eggs or brooding young, and since the birds usually forage in flocks without conflict, there is little opportunity to observe agonistic encounters between females and males other than their mates during nesting.

SUMMARY

A study of behavior patterns in the American Goldfinch was conducted from March, 1961, through July, 1962. Observations of both caged and wild birds were integrated, and agonistic and related social behavior were discussed.

An analysis of displays observed during agonistic encounters indicate that Head-up, Carpals-raised, Head-forward, supplanting, and vertical flights are associated with aggressive drives. Fluffed and crouched postures, turning the head away, or leaning away show avoidance. Displacement activities include beak-wiping, head-scratching, and "displacement breast preening."

Encounters between caged birds were analyzed according to their implications with regard to aggressiveness and social hierarchy. Agonistic encounters were observed more frequently under crowded conditions and during the early portion of the breeding season than when adequate space was provided or during winter months. Males were generally more aggressive than females during the winter, with an apparent reversal at the onset of the breeding season.

The social hierarchy consists of a highly unstable peck-dominance, showing many reversals and triangular relationships, but with a tendency toward male dominance in winter months, female dominance during the summer.

Both sexes exhibit territoriality to a limited extent, at least at the beginning of nesting. An area of about 10 meters in diameter around the nest site is defended against other members of the species by chasing and fighting by the male, with display flights accounting for defense of an area about 30 meters in diameter surrounding the nest. The birds were found to range considerable distances from the nesting territories to forage. The female appears to be more often involved in conflicts with other species, apparently due to her increased aggressiveness during nesting combined with her isolation from other goldfinches.

The author's findings are compared with other recent studies of the behavior of fringillids.

ACKNOWLEDGMENTS

The author is deeply indebted to Dr. William L. Thompson for his encouragement, suggestions, and supervision during the study. In addition, Dr. Olin S. Pettingill, Jr. offered invaluable aid and direction during the summer of 1961. The Department of Biology at Wayne State University and the Department of Zoology at the University of Michigan provided necessary equipment. Field work was made possible through assistance from the National Science Foundation during the summers of 1961 and 1962.

LITERATURE CITED

Batts, H. L., Jr.
1948 Some observations on the nesting activities of the Eastern Goldfinch. *Jack Pine Warbler*. 26:51–58.
Conder, P. J.
1948 The breeding biology and behaviour of the Continental Goldfinch (*Carduelis carduelis carduelis*). *Ibis*. 90:493–525.
Coutlee, E. L.
1963 Maintenance behavior of the American Goldfinch. *Wilson Bull.*, 75:342–357.
Dilger, W. C.
1960 Agonistic and social behavior of captive redpolls. *Wilson Bull.*, 72:114–132.
Drum, M.
1939 Territorial studies on the Eastern Goldfinch. *Wilson Bull.*, 51:69–77.
Hinde, R. A.
1954 The courtship and copulation of the Greenfinch (*Chloris chloris*). *Behaviour*, 7:207–232.
1955–56 A comparative study of the courtship of certain finches (Fringillidae). *Ibis*, 97:706–745; 98:1–23.
Lack, D.
1943 The life of the Robin. H. F. and G. Witherby, Ltd., London.
Linsdale, J. M.
1957 Goldfinches on the Hastings Natural History Reservation. *Amer. Midland Nat.*, 57:1–119.
Marler, P.
1955 Studies of fighting in Chaffinches. (1) Behaviour in relation to the social hierarchy. *Brit. Jour. Animal Behaviour*, 3:111–117.
1956 Behaviour of the Chaffinch (*Fringilla coelebs*). *Behaviour, Supplement*. No. 5.
1957 Studies of fighting in Chaffinches. (4) Appetitive and consummatory behaviour. *Brit. Jour. Animal Behaviour*, 5:29–37.
Masure, R. H., and W. C. Allee
1934 The social order in flocks of the Common Chicken and the Pigeon. *Auk*. 51:306–327.
Moynihan, M.
1955 Types of hostile display. *Auk*. 72:247–259.
Nice, M. M.
1939 "Territorial song" and non-territorial behavior of goldfinches in Ohio. *Wilson Bull.*, 51:123.
1941 The role of territory in bird life. *Amer. Midland Nat.*, 26:441–487.

NICKELL, W. P.
1951 Studies of habitats, territory, and nests of the Eastern Goldfinch. *Auk*, 68: 447–470.

PITELKA, F. A.
1942 High population of breeding birds within an artificial habitat. *Condor*, 44: 172–174.

ROBERTS, H. D.
1942 Some observations on the nesting habits of the Eastern Goldfinch (*Spinus tristis tristis*). (Unpublished MS, Univ. of Mich. Biological Station.)

SABINE, W. S.
1959 The winter society of the Oregon Junco: intolerance, dominance, and the pecking order. *Condor*, 61:110–135.

SCHJELDERUP-EBBE, T.
1922 Beitrage zur Socialpsychologie des Haushuhns. *Zeitschr. f. Psychol.*, 88: 225–252.

SHOEMAKER, H. H.
1939 Social hierarchy in flocks of the canary. *Auk*, 56:381–406.

STOKES, A. W.
1950 Breeding behavior of the goldfinch. *Wilson Bull.*, 62:107–127.

SUTTON, G. M.
1959 The nesting fringillids of the Edwin S. George Reserve, Southeastern Michigan (II). *Jack Pine Warbler*, 37:37–50.

THOMPSON, W. L.
1960 Agonistic behavior in the House Finch. Part I: Annual cycle and display patterns. *Condor*, 62:245–271.

WALKINSHAW, L. H.
1938 Life history studies of the Eastern Goldfinch. *Jack Pine Warbler*, 16:3–11.

DEPARTMENT OF BIOLOGY, WAYNE STATE UNIVERSITY, DETROIT 2, MICHIGAN. (PRESENT ADDRESS: DEPARTMENT OF LIFE SCIENCES, UNIVERSITY OF CALIFORNIA, RIVERSIDE, CALIFORNIA 92502.), 7 SEPTEMBER 1965

GENERAL NOTES

Cavity "excavation" by Cliff Swallows.—It is not unusual to find Cliff Swallows (*Petrochelidon pyrrhonota*) associating with Bank Swallows (*Riparia riparia*). At the onset of the nesting season, large numbers of Cliff Swallows may be found in or near Bank Swallow colonies, especially if the colony is in a high bank. There they flutter back and forth in front of burrow entrances, cling to the bank near burrows, and sometimes enter burrows. In view of the fact that Cliff Swallows are known to modify the nests of other birds for their own purposes, it is not surprising to find them building their jugs among or even in the burrows themselves. Indeed, this phenomenon has been reported by a number of authors. (For a review of Cliff Swallow nesting associations, see W. M. Mayhew, 1958. *Condor,* 60:21.) Usually, Cliff Swallows either use the burrow as found or modify the entrance more or less extensively by partially sealing it with mud or adding the entrance tube of a jug. It should be noted that reported modifications have always been additive, and we know of no previous report of Cliff Swallows excavating.

East of Lawrence, Kansas, the southern bank of the Kansas River is a steep, sandy cliff about three-fourths km long and three to five m high (depending on the river level) during most of the breeding season. Certain of the exposed strata are subject to intensive colonization by Bank Swallows (perhaps 1500 pairs in 1962 and at least 2000 pairs in 1964, when the colony split into two distinct portions). Cliff Swallows frequent this site both in the spring and in mid-summer following the breeding season and prior to fall migration. In years when Bank Swallows nest late and are still actively breeding in mid-summer, the Cliff Swallows display the same interest in the holes that is normal in spring. However, no attempts at nesting by Cliff Swallows were noted until 1962. On 1 June, one of us found a partially formed cup that was not in association with a burrow. Unfortunately, a few days later that portion of the bank slumped, destroying the cup. No attempt was made to renew construction. The colony was not observed in 1963.

In 1964, we observed the colony from 23 June to 10 August. At the time of first observation, the river was receding after a period of heavy rain. Bank Swallows began digging on 24 and 25 June. This was evidently a second effort, as later examination revealed abandoned burrows of the year, crushed eggs and nests, and one crushed adult. On 29 June, nine Cliff Swallow nests were found within five meters of each other. Most of them were partial jugs extending from or surrounding burrow entrances. One was simply a partially walled off burrow. Subsequently, two more Cliff Swallow nests were found about 10 m from the first. One of these was in an eroded slit in the bank and had required considerable vertical construction to seal the opening. In addition, a nest probably belonging to a Cliff Swallow, was found at the end of an enlarged, but otherwise unmodified, 0.5 m tunnel. The ceiling and walls of many Bank Swallow burrows near the jugs had been rubbed smooth, indicating entrance by the larger birds. Bank Swallows seldom, if ever, rub against the walls of their tunnels, and marks left from digging are clearly evident even after the breeding season.

More interesting than these nests were a number of large, semispherical chambers in the vicinity of the first nine jugs (Figs. 1 & 2). These ranged from 14 to 19 cm wide by 15 cm high at the opening. Entrances to nearby Bank Swallow burrows ranged from 7–9 cm by 5–9 cm. The walls of the large cavities were covered with numerous, fine, horizontal lines. On the ceilings, these lines were completed to form a pattern of concentric circles. Some of the cavities were surrounded by partially completed jugs.

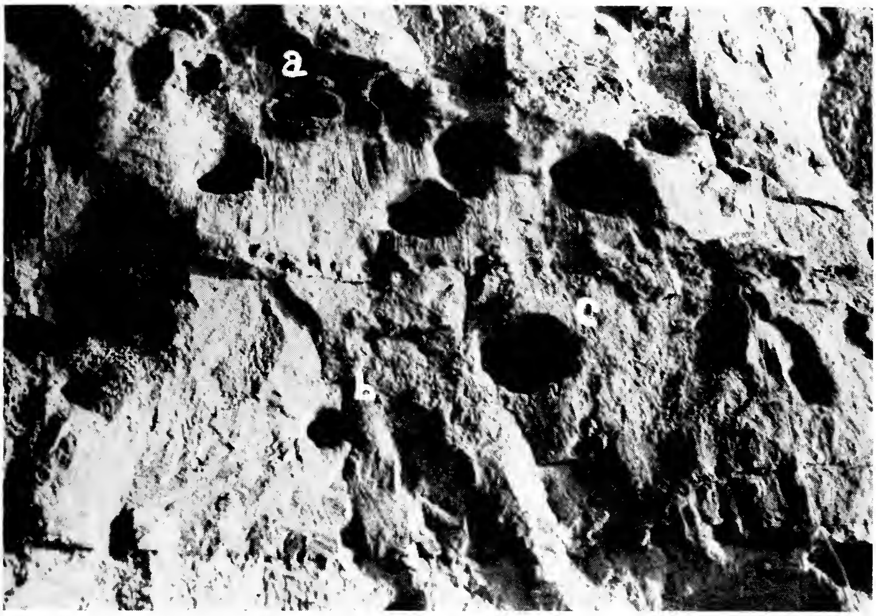


FIG. 1. A portion of the Bank Swallow colony showing: (a) a partially completed Cliff Swallow jug; (b) entrance to Bank Swallow burrow; (c) Cliff Swallow chamber.

Most, however, had no added mud. We learned later that some of the completed jugs were built around similar cavities. During the next few days, jug construction continued. Even though mud was abundant within a few meters of the nests, there were frequent attempts to steal pellets from other jugs.

Although we did not witness the initial stages of construction, we did observe Cliff Swallows behaving in a manner that would explain the structure of the spherical cavities. Several cavities were never closed off, and a few of these were occupied by birds that appeared to be unmated. At various times, these birds were observed to peck and, rarely, scratch at the walls and floors of their chambers. These motions did not appear to be very effective. On several occasions, a bird was seen to go to the center of the chamber and rotate rapidly while beating its wings, the primaries sweeping sand from the walls and ceiling. This "dancing" action would explain the fine, circular markings previously mentioned. At the time of our observations, the ceilings of the chambers were several centimeters above the birds' heads when they were standing erect and could be reached only with the tips of the primaries. More frequently, rotation was not accompanied by wing flapping. Rather, the breast was pressed and rubbed against the wall. One bird was observed pressing its breast against the wall near the entrance as if it were trying to push an irregular portion of wall out of the cavity. At no time was an attempt made to remove any portion of the wall by forming pellets and carrying them off. It is probable that both the sandiness and dryness of the substrate would have made any attempt to do so futile. Nor was there any good evidence of such slashing motions as are used by Bank Swallows.

We can be confident, to the point of certainty, that Cliff Swallows were not responsible

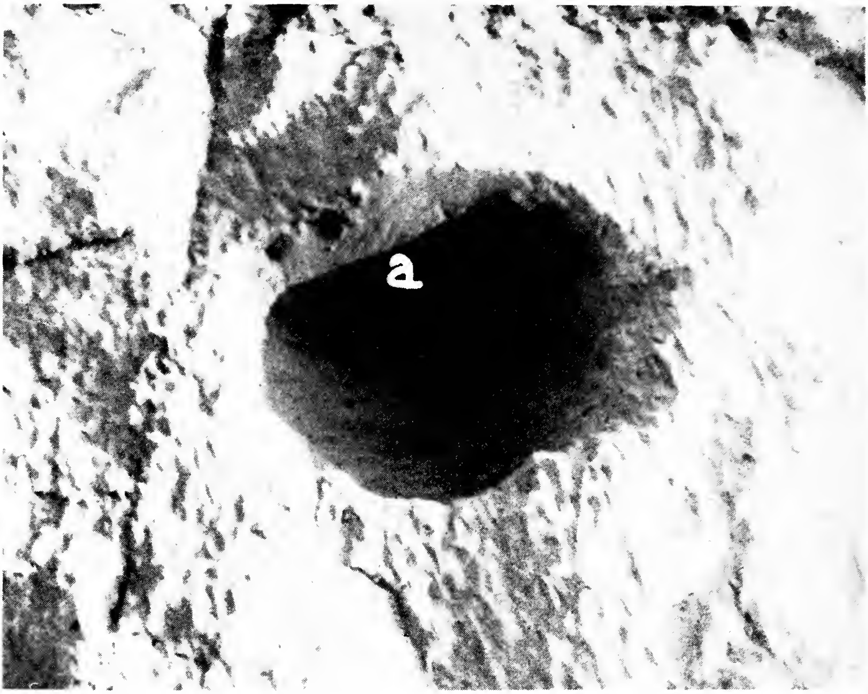


Fig. 2. An enlargement of "c" in Figure 1. Although the print is somewhat grainy, some of the fine lines left by beating wings are visible above "a."

for the initial stages of excavation. Neither in our observations nor in the literature is there anything to indicate that Cliff Swallows can, or will, attempt to begin a tunnel. As none of the large cavities had tunnels extending from the rear, they probably were not modified entrances to Bank Swallow burrows. Two possibilities remain: starts abandoned by Bank Swallows, and Bank Swallow nesting chambers exposed by slumping.

Bank Swallows make many false starts that are later abandoned. These may penetrate the bank a few millimeters or several centimeters. If these were used by Cliff Swallows, modification would have been extensive. Indeed, it is difficult to understand how so much enlargement could have been made by the techniques described without severe damage to wing and breast feathers. Of course, in the early stages the birds could have used the more rigid basal portion of the primaries and perhaps even the bony structure of the wing.

Exposed nesting chambers would require far less lateral modification. These chambers are sometimes exposed when a bank slumps in precisely the right plane. We have mentioned evidence for such slumping. The fact that all spherical cavities and jugs built around them were in close proximity strongly suggests such an origin. However, Bank Swallow nest chambers are never very high, being limited by the height to which the bird can slash with its bill. Thus, although these cavities would approximate the lateral dimensions of the spherical cavities, the vertical dimensions would be only half those described. Furthermore, exposed, unmodified nest chambers do not show the described pattern of fine lines, but rather the heavier slash marks of the Bank Swallow's bill.

In either case, it is evident that Cliff Swallows modified the pre-existing structure. More important, the initial modification was subtractive, requiring some form of earth removal. Jugs were completed for only those cavities occupied by mated pairs.

Breeding success for the two types of nests was distinct. Whereas most of the sealed tunnels fledged young, several of the partial jugs and jugs sealing large cavities were destroyed by heavy rains on 11 and 12 July. Although none of the destroyed nests was found to contain nesting material, a smashed egg was found beneath one. The presence of eggshells beneath sealed tunnels with nests indicated hatching took place in these on 13 and 14 July.

This work was supported, in part, by a Faculty Research Grant from Middlebury College, Middlebury, Vermont.—ABBOT S. GAUNT AND SANDRA L. GAUNT, *Department of Biology, Middlebury College, Middlebury, Vermont, 27 December 1965.*

An instance of "white wing-barring" in the Common Crow.—On 2 October 1965, near Rockville, Montgomery County, Maryland, two Common Crows (*Corvus brachyrhynchos*) with white wing markings were seen flying together by Mr. James F. Dawe, who secured one of them. The specimen (USNM No. 481596) was prepared as a study skin; one wing was removed, spread, and prepared separately. Unfortunately, determination of its sex was impossible because the carcass was eviscerated by the collector.

The specimen is a bird of the year as indicated by its worn primaries and rounded, rather than truncate outer rectrices (Emlen, 1936. *Condor*, 38:99–102). Except for white in the remiges of both its wings, it is normal in color throughout. White occurs mainly on the inner vane of primaries 1 to 9 and secondaries 1 to 8; the outer vane of primaries 5 to 8 exhibits some white toward the base of the feathers along the rhachis (Fig. 1). There is little relative difference in the size of the white area of the various remiges, although the streak of the inner primaries (1 to 3) and outer secondaries (1 to 4) is proportionally longer than in other remiges. The overall pattern of white in the wing is that of an interrupted broad bar or patch, which is visible only when the wing is spread (Fig. 1). This would have rendered the patch conspicuous in flight, but not when the bird was at rest.

The occurrence of white bars or patches on the wings of various European corvids (especially *Corvus corone* and *C. monedula*) has been abundantly reported by British authors (see literature cited by J. M. Harrison, 1957. *Bull. British Ornith. Club*, 77:84–85, and ibid., 131–133). Although albino or partly albino Common Crows (*Corvus brachyrhynchos*) are not rare (see Gross, in Bent, 1946. *U.S. Natl. Mus. Bull.*, 191:235–236), we have found only one record (Warne, 1926. *Bird-Lore*, 28:110–116) of a crow with the white restricted to broad wing-bars or patches. Harrison (loc. cit., 131–133) suggested that this phenomenon is of evolutionary significance, and stated (loc. cit., p. 85) that the pattern "must of course be genetic and pied patterned genes must have come from somewhere in the long evolutionary ancestral history of the corvine forms." He further suggested that study of variant corvids "may well one day disclose important contributory evidence of their evolutionary history." As he noted, patterns involving white wing markings occur in a number of corvid genera, although only *Cyanopica*, *Dendrocitta*, *Podoces* and, especially, *Pica*, exhibit patterns very similar to that of the aberrant *Corvus brachyrhynchos* discussed herein. It seems logical that if these effects are indeed genetic, then recurrent mutation (possibly enhanced by inbreeding in local

Fig. 1. Left wing of Common Crow (USNM No. 481596) showing white markings in the primaries and secondaries.

colonies, as J. M. Harrison suggested) may be responsible for the occasional occurrence of individuals exhibiting an ancestral wing-barring condition.

There is some doubt concerning genetic control of wing-barring in these variants. C. J. O. Harrison (1963. *Bull. British Ornith. Club*, 83:41–50) has discussed the relation of certain abnormal plumage features of corvids to periods of unsatisfactory or insufficient diet; under these conditions melanin may not be produced in growing feathers, resulting in the production of unpigmented (white) bars. The white wing markings of the *Corvus brachyrhynchos* specimen we studied are much broader than the narrow bars caused by dietary factors, if such bars are always like those figured by C. J. O. Harrison (loc. cit., p. 45). Sage (1964. *Bull. British Ornith. Club*, 84:25–30) strongly argues that symmetrical, broad wing-bars are indeed genetically caused. However, Warne's (loc. cit.) captive Common Crow was entirely black for five years, and only then did white wing markings begin to develop. These gradually increased in size until the wings were "about half white" (loc. cit., p. 116), although Warne gave no indication of the length of time this involved. This observation suggests that at least some instances of wing-barring may be attributable to nongenetic causes. Proof of dietary influence on development of symmetrical white wing-bars was provided by Fritz, Hooper, Halpin, and Moore (1946. *Jour. Nutrition*, 31:387–396; cited by Sage, loc. cit., p. 27), who demonstrated that a diet deficient in lysine caused symmetrical white wing-bars to appear in bronze-wing turkey poults. Further study is needed to determine the cause of this phenomenon in these corvids.

We are indebted to J. M. Harrison for providing several literature references.—Lester L. Short, Jr. (*Present address: American Museum of Natural History, New York*) and Roxie C. Laybourne, *Bureau of Sport Fisheries and Wildlife, U.S. Department of Interior, U.S. National Museum, Washington, D.C., 18 February 1966.*

Comparative foraging behavior of *Myiozetetes similis* and *M. granadensis* in Costa Rica.—The study of food-competition among tropical sympatric congeners is most interesting in light of recent speculations on the diversity of tropical species (Klopfer and MacArthur, 1961. *Amer. Nat.*, 95:223–226; MacArthur and Levins, 1964. *Proc. Natl. Acad. Sci.*, 51:1207–1210; and Klopfer, 1962. "Behavioral Aspects of Ecology," Prentice-Hall, Inc., Englewood Cliffs, New Jersey). Two species that have received some attention are the flycatchers *Myiozetetes similis*, Social Flycatcher, and *M. granadensis*, Gray-capped Flycatcher. Skutch (1960. "Life Histories of Central American Birds," part II, *Pacific Coast Avifauna*, 34:403–446) studied *Myiozetetes* in Costa Rica and concluded (p. 405) that "the chief difference in the mode of foraging in these two species is that the Vermilion-crown [*similis*] very often picks up things from the ground, as on a lawn, close-cropped pasture or bare shore, either darting down from a rock or other low perch or else actually hopping over the ground; whereas I have not seen the Gray-cap [*granadensis*] hop over the ground, and it darts down to the ground from a rock or other low perch far more rarely than the Vermilion-crown."

During July and August, 1965, I studied the foraging behavior of *similis* and *granadensis* in four areas of Costa Rica: the tropical dry-forest area of Las Cañas (Guanacaste Province) and the wet-forest areas of Puerto Viejo (Heredia Province), Palmar Sur (Puntarenas Province), and Turrialba (Cartago Province). Only *similis* was found in Guanacaste; both species occurred in the other areas.

Both species are found in semi-open to open situations. They are especially abundant in areas under cultivation and have adapted to suburban situations. Away from towns they are commonly found along streams and at forest edges; neither species inhabits deep forests (Skutch, op. cit., p. 403; Slud, 1964. *Bull. Amer. Mus. Nat. Hist.*, 128:247–248).

The frequency of observations of various perch heights is tabulated in Table 1. Both *similis* and *granadensis* preferred the higher perches, and little difference could be found between the two species in their perch-height distributions. However, comparison of the perch-height in relation to tree-height (see Table 2) reveals that *similis* perches about 25 per cent more often in the upper half of the tree than *granadensis*. This difference appears also to be reflected in the direction of their foraging flights. *M. similis* (76 total observations) was observed to flycatch above the horizontal (perch level) about 14.2 per cent more often than *granadensis* (43 total observations), while *granadensis* was observed flycatching at perch level about 18.3 per cent more often than *similis*. Probably this behavior results from the decreased field of view of the upper strata that a low perching bird experiences. Conversely, *similis* flycatches above the level of the perch more often than *granadensis* because of the greater field of view overhead afforded by the higher perches.

Both species were found to be very similar in their preferences for flycatching targets. They would most often capture insects in the air (72 per cent of 118 observations in

TABLE 1
PERCH-HEIGHT PERCENTAGES IN *MYIOZETETES*

Height (ft)	1–3	4–6	7–9	10–12	13–15	16–18	19–22	22
similis (267 obs.)	1.9	8.2	11.2	12.4	7.9	12.7	8.6	37.1
granadensis (138 obs.)	1.4	17.4	11.6	8.0	10.1	6.5	10.9	34.1

TABLE 2
PERCH-HEIGHT/TREE-HEIGHT PERCENTAGES IN *MYIOZETETES*

Percentage	0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	100
similis (115 obs.)	0	0	2.6	11.3	9.6	13.9	13.9	15.6	15.7	17.4
granadensis (78 obs.)	0	10.3	6.4	9.0	23.0	19.2	9.0	7.7	10.3	5.1

similis; 77 per cent of 175 observations in *granadensis*), would occasionally descend to the ground (20 per cent and 17 per cent, respectively), and would rarely capture insects by flycatching to foliage (8 per cent and 6 per cent). Similarly, both species preferred shorter foraging flights, although flights of up to 40 or 50 feet were observed.

I observed both species feeding at localized food sources. In Palmar Sur these sources were the berries of *Ficus goldmanii* and the Royal Palm (*Roystonea*); in Puerto Viejo the sources were mistletoe berries (*Struthanthus*). The only antagonistic behavior I observed between these species took place at one of these localized food sources.

Competition from noncongeners did not seem to be great. *Tyrannus melancholicus* was most like *Myiozetetes* in habitat preference and foraging behavior. However, at each site studied except Cañas (and here both *similis* and *granadensis* were uncommon) *melancholicus* was less common than either of the two species of *Myiozetetes*. Other flycatchers (e. g., *Megarhynchus pitangua* and *Pitangus sulphuratus*) foraged in the higher canopy and were uncommon. At Puerto Viejo several small flycatchers of the genera *Elaenia*, *Contopus*, and *Myiarchus* (plus two unidentified, small flatbilled species) foraged commonly in the lower strata, thus probably accounting for the fewer numbers of observations of *similis* and *granadensis* in these strata.

In conclusion, the foraging behavior of *M. similis* and *M. granadensis* is very similar, but *similis* does appear to spend more time in the upper strata than *granadensis*. It must be pointed out that foraging behavior can change during the year in correlation with the seasonal abundance of food and the time at which young are being fed. Only a year-round study can fully elucidate food-competition relationships between these two species.

I wish to thank Drs. George H. Lowery, Jr. and Robert J. Newman, and Mr. Larry L. Wolf for reading the manuscript. I especially want to thank the Organization for Tropical Studies for making this study possible, and particularly Dr. Daniel Janzen and Mr. José Sarukhan for the help they gave me with this study.—JOEL CRACRAFT, *Museum of Zoology, Louisiana State University, Baton Rouge, Louisiana. (Present address: Department of Zoology, Columbia University, New York, New York 10027)*, *11 March 1966.*

Attack behavior of a Loggerhead Shrike.—Bent (1950. *U. S. Natl. Mus. Bull.* 197) gives an extensive summary of shrike feeding behavior in which it is stated that shrikes do not use their feet as talons but characteristically depend upon the bill for seizing and carrying prey. The feet are used somewhat in holding prey to the perch during feeding and some individuals may exchange their prey between bill and feet while in flight. An exception to this general behavior was observed by myself in several encounters between a Loggerhead Shrike (*Lanius ludovicianus*) and old-field mice (*Peromyscus polionotus*).

During a live-trap study of small mammals in South Carolina I had trouble with a shrike which occasionally pursued mice after release from the trap. The shrike would swoop directly from its perch, which was within 50 yards of most trap locations and hover over a released mouse, vocalizing in a flurry of wispy high register notes. The maneuver was very rapid and always caught me by surprise. The mice always recognized when the shrike was overhead because they would crouch suddenly and usually roll over on their side or back. Seldom did any of the 644 individual mice handled during this study freeze in this manner in the absence of the shrike even when I pursued them to their nest tunnels. The alarm reaction in the presence of shrikes is evidently not unusual with small animals. At mist-netting stations in the same area, captured Savannah Sparrows (*Passerculus sandwichensis*) would appear unusually excited whenever a shrike approached. This behavior was especially evident when Dr. R. A. Norris held a captured shrike within view of several captive sparrows.

On 1 January 1958, after about 8 sorties as described above, the shrike finally attacked one mouse with its feet. The mouse was lifted a few inches off the ground and dropped but no capture was made since I interfered. In the next two or three days I was able to protect the released mice only by standing between them and the shrike. On 27 January I released an adult male mouse which weighed 13 g. It had traveled for about two yards when the strike swooped down and grasped the mouse in its feet. The shrike flew 30 yards to a plum tree (*Prunus* sp.) with the mouse suspended in its feet. Throughout the initial attack the shrike's bill was not used in any way to handle the mouse. Once on its perch the shrike immediately struck two or three times at the mouse which was held under the foot. It then flew about 40 yards to its customary perch in a chinaberry tree (*Melia azedarach*) with the mouse still clutched in its feet. Since I had pursued the shrike, it almost immediately flew off again and passed within 35 yards of the site of initial contact. Here the mouse was dropped from a height of about five yards. During the entire episode about 85 yards were traversed in a triangular flight pattern. The shrike appeared to leave both perches with the mouse clutched in its feet and at no time in flight was there an attempt at transfer to the beak. The shrike's head and bill were conspicuously in view during most of the incident. Curiously, though, the shrike's feet and the mouse were not visible after the first perch. I would have expected to see a 13 g load suspended in full view.

On 18 March the same mouse was retrapped. Its tail from just beyond the base was missing. It is possible the tail had been injured or removed during the observed attack.

Previous encounters of this shrike with mice other than those which I witnessed were unlikely. The loggerhead feeds less on mice than does the Northern Shrike (*L. excubitor*) and in the old-field habitat no natural opportunity for shrike-mouse encounters would occur since normally the indigenous mice are nocturnal and shrikes diurnal.—Larry D. Caldwell, *Biology Department, Central Michigan University, Mt. Pleasant, Michigan 48858, 4 February 1966.*

Unusual behavior of the Yellow-headed Blackbird.—Between 7:30–8:00 PM on 2 August 1962 at the Delta Waterfowl Research Station, Delta, Manitoba, I observed the following unusual sexual behavior of the Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*).

A dead, immature, male Yellow-headed Blackbird was lying on its breast atop the screen of an eight foot high flight cage used for waterfowl studies. Another immature male Yellow-headed Blackbird flew to the dead bird and assumed a copulatory position. The head of the live bird was above that of the dead one and the cloacal regions of the two birds were in close proximity. While over the dead bird, the live bird's neck and head were outstretched and bent slightly forward. Its wings were also extended and fluttered for the duration of the mountings. The tail was thrust downward.

This copulatory position was assumed four times, the duration of each mounting varying between 15–30 seconds. Between the mountings the bird would fly about near the flight cage. After the final mounting the bird flew toward the marsh and disappeared. Subsequent observations of the dead bird and vicinity revealed no further activity.

Nero (1963. *Wilson Bull.*, 75:376–413), stated that, Red-winged Blackbird males (*Agelaius phoeniceus*), in addition to attacking male experimental dummies, frequently also attempted to copulate with them. Allen (1934. *Auk*, 51:180–199) states that a male Yellow-breasted Chat (*Icteria virens*) repeatedly attempted coition with the flat skin of a male Yellow-breasted Chat which was mounted on a branch. Griffin (1959. *Auk*, 76:238–239) recorded apparent homosexual behavior between two living birds, a Brown-headed Cowbird (*Molothrus ater*) and a House Sparrow (*Passer domesticus*) in which the House Sparrow attempted copulation.

Although McCabe and Hale (1960. *Auk*, 77:425–432) and Linsdale (1938. *Am. Midland Nat.*, 19:1–206) state that first year male Yellow-headed Blackbirds are nonbreeders, this inexperienced bird was probably reacting to the peculiar conditions of a strong environmental stimulus and an overpowering sexual drive.—JERRY R. LONGCORE, *Department of Fisheries & Wildlife, University of Michigan, Ann Arbor, Michigan, 4 February 1966.*

An aggressive display by a Tufted Titmouse.—On 4 February 1964, near Knoxville, Tennessee, I saw a Tufted Titmouse (*Parus bicolor*) give an aggressive display. The bird was hammering on a cluster of hazelnuts while perched at a height of about 3 feet on the trunk of a small, fallen tree. It was approached to within a few feet by two other titmouses. It dropped its cluster of hazelnuts, lowered its head and began to vibrate its slightly raised wings with an especially hard side to side shaking of the tail and at the same time giving a scold note. The approaching titmouses left the immediate area without coming any closer to the displaying individual. Once they were gone the display stopped but the remaining titmouse continued to scold for a few minutes after they were gone. The bird then flew down to the ground and picked up the cluster of hazelnuts, flew back to the same small tree trunk and started hammering on them again.

Brewer (1961. *Wilson Bull.*, 73:348–373) states that behavior resembling the wings-raised and head-forward postures described above are occasionally seen in the Carolina Chickadee (*Parus carolinensis*) and Black-capped Chickadee (*Parus atricapillus*). Laskey (1957. *Bird-Banding*, 28:135–145) reports a similar threatening posture in the Tufted Titmouse. The bird crouches down with spread wings, head thrust forward and emits rasping notes. Dixon (1949. *Condor*, 51:110–135) referring to the Plain Titmouse (*Parus inornatus*) states that they have a threatening posture which may be accompanied by wing vibrations. Odum (1941. *Auk*, 58:518–535) reports a similar display in the Carolina Chickadee.—GARY O. WALLACE, *Department of Zoology and Entomology, University of Tennessee, Knoxville 37916, 22 February 1966.*

Cape May Warbler in Costa Rica.—According to Slud (1964. *Bull. Amer. Mus. Nat. Hist.*, 128:322), the Cape May Warbler (*Dendroica tigrina*) seems not to have been recorded in Central America before the early 1950's. In seven full years of field work in Costa Rica, Slud found this warbler only twice: near Barranca beside the Pacific coast in late November; and near Turrialba on the Caribbean slope, where he saw a number of individuals in December. I did not meet the Cape May Warbler in Costa Rica before the spring of 1963, when on the Barba massif I saw fleetingly a warbler which was apparently this species. On the morning of 9 May 1964, while watching a nest of the Scarlet-thighed Dacnis (*Dacnis venusta*) in an open grove of slender, second-growth trees near Las Cruces, I saw the only Cape May Warbler that I have positively identified in this country, and apparently the only one that has been recorded by anyone in the spring. Las Cruces is a few miles south of San Vito de Java on the Pacific slope of Costa Rica near the Panamanian border, at an altitude of about 4,000 feet.

This Cape May Warbler, a male in full breeding plumage, clung to slender, moss-covered, upright branches, well up in the trees, from which he plucked larvae or other small creatures, which he carried to a perch to devour. He also gleaned much from the foliage in the treetops. When not foraging, he rested for considerable periods on horizontal twigs. He was present in the same small grove of trees every day (with one possible exception) for the next week. I last saw him there on the sunny morning of 15 May, when he sang a pretty little song over and over. By this date, nearly all the migrants from the north had already left.—ALEXANDER F. SKUTCH, *El Quizarrá, San Isidro del General, Costa Rica, 3 March 1966.*

Feeding reactions of Myrtle Warblers toward wax-moth larvae dyed various colors.—Experiments were conducted in which a simultaneous choice of artificially colored wax-moth larvae was offered to caged Myrtle Warblers (*Dendroica coronata*) to establish whether the colors of larvae commonly found in nature (green, brown, and yellow) would be preferred over less common colors (red, orange, blue, and violet). No such preference was found. Instead, there was a great deal of variation in response, although the birds generally avoided red. Three of the ten birds did have a preference, each for a different color (brown, yellow, and red). The other birds chose the various colored larvae more or less randomly.

The three birds which usually chose a particular color showed a much stronger preference during the first half of each exposure period than during the second half, which probably reflected a decrease in the relative availability of larvae of the preferred colors.

The birds did not differ in the length of time required to select the colored larvae as compared with the time required to select the undyed larvae during a base line. There was no indication of imitation, social facilitation, dominance at the food dish, or increased aggressiveness as associated with starvation.

This research was supported by the National Science Foundation (GB-891 and GB-3226).—JANET S. CHAPPELL AND ROBERT W. FICKEN, *Department of Zoology, University of Maryland, College Park, Maryland, 17 March 1966.*

Tongue deformity in immature Robin.—In late July, 1965, near Ithaca, New York, an immature Robin (*Turdus migratorius*) was picked up and brought to the Cornell Laboratory of Ornithology, exhibiting a most unusual condition.

The tongue had penetrated the flesh and skin between the rami of the mandible, and was hanging freely about an inch below the "chin." As shown in the accompanying photographs, taken by W. R. Spofford, it was encrusted with hardened saliva, mucous, and dirt. The bird was very thin, and it might be assumed that so long as it had been fed by parents, there was little difficulty in eating, but once it was on its own, the lack of functional tongue was undoubtedly a handicap.

The hole through which the tongue had emerged was bordered with thickened tissue, and attempts to pull the tongue back into the oral cavity (after cleaning it off) were unsuccessful until the hole was lengthened and the tip cut off. The bird succumbed in 24 hours, probably having become too emaciated.

A somewhat similar tongue abnormality has been described and pictured by Maser (1966. *Auk*, 83:281), and described by Edeburn, (1967, *Wilson Bull.*, 79:120).

One could only speculate as to whether the defect was congenital or had been caused by a feeding mishap.—Sally Hoyt Spofford, *"Aviana," Etna, New York, 23 January 1966.*

Abnormal Tongue in a Robin.—On 26 May 1965, a student brought a live young Robin (*Turdus migratorious*), with a curiously misplaced tongue, to my office. Instead of the tongue being in the mouth, it protruded through the chin feathers between the rami of the lower mandible. (See Spofford, 1967, *Wilson Bull.*, 79:119 for photograph of this rare phenomenon). My first thought was that when capturing the active young bird the tongue had punctured the floor of the mouth, but a careful examination of the mouth gave no evidence of injury as was stated in the case of the Reef Heron (Maser, 1966. *Auk*, 83:481). After anesthetizing the bird we attempted to return the tongue to its normal position, but were unable to do so. Each time the tongue was forced back into the mouth cavity, feathers were present in the mouth. My conclusion was that the tongue had developed in this abnormal position.

Judging by the plumage, the young bird must have recently left the nest and was being fed by the parents. It seemed to be as healthy and active as any young robin. How it would succeed after leaving parental care could well be a different story.

The specimen is preserved in the Marshall University Collection.—Ralph M. Edeburn, *Marshall University, Huntington, West Virginia 25701, 12 November 1966.*

THE PRESIDENT'S PAGE

Charles H. Rogers, of the Princeton Museum of Zoology, and Alexander Wetmore, of the Smithsonian Institution, share a particular distinction in the Wilson Ornithological Society. Both Mr. Rogers and Dr. Wetmore joined the Society in 1903. This means that they have been members of this organization longer than anyone else presently listed in our membership roll. I wrote to both gentlemen to express congratulations for all of us on the distinction which they share, along with our thanks for their continued interest in the Society. I also asked for any comments they might have, on any subject.

In a telephone conversation early in January, Mr. Rogers described his lively interest in three timely matters. He spoke about the 1966 Christmas Bird Count at Princeton, N.J., for which he was leader and compiler for the 46th consecutive year. Actually, since he has participated in every census from the first one in 1900, this latest one was his 67th Christmas Count. Two other subjects of special interest to Mr. Rogers were (1) the inshore occurrence of Dovekies, in late-1966, along the Atlantic coast, and (2) the spread of House Finches from the New York City area during the past 25 years, since birds of this species were released near New York.

Dr. Wetmore wrote: "I recall the thrill that came to me with arrival of the first number of our *Bulletin* in March 1903, not only for its news of *Leucostictes*, previously only a name, but also my name on the membership roll of my first ornithological society! This connection has been a steady source of satisfaction to me. In my opinion our editors and other officers concerned have kept the *Bulletin* abreast of the times, changing emphasis as the method and emphasis in our science have changed. Format and content to me seem excellent. I would hope that we may continue in future as we have in the past."

In February 1859, Thoreau wrote: "Measure your health by your sympathy with morning and spring. If there is no response in you to the awakening of nature, if the prospect of an early morning walk does not banish sleep, if the warble of the first bluebird does not thrill you, know that the morning and spring of your life are past. Thus you may feel your pulse."

Similarly, it seems to me, Charles H. Rogers and Alexander Wetmore have indicated, indirectly, criteria by which we can judge to what extent we retain a youthful excitement about ornithology. How lively an interest do we have in the changing aspects of bird-life around us? How flexible are we in keeping abreast of contemporary ornithology—in "changing emphasis as the method and emphasis in our science" change? Thus we may feel our ornithological pulses.

It seems clear that the ornithological pulses of two gentlemen who joined this Society in 1903 were never more lively and vigorous!

Aaron M. Bagg

ORNITHOLOGICAL NEWS

Our Past President, Albert F. Ganier has been named the "Tennessee Conservationist of The Year," and on 3 December 1966 was awarded the "Governor's Award" by Governor Frank G. Clement.

In February 1967 the University of Oklahoma Press published the book, "Oklahoma Birds" by George M. Sutton, another Past President.

Those members anticipating attending the Annual Meeting in New Hampshire might well consider consulting two books by two other of our Past Presidents. Maurice Brooks', "The Appalachians" (see p. 123) will serve to put the White Mountains in their proper perspective, and "The Bird Watcher's America" edited by Olin Sewall Pettingill, Jr., contains a very informative chapter, "In Northern New Hampshire" written by Tudor Richards, President of the host organization for this meeting.

The name of Anders H. Anderson of 3221 E. Kleindale Road, Tucson, Arizona 85716 was inadvertently omitted from the Membership List published in Volume 78. Both the Treasurer and the Editor are aware that there are probably a number of mistakes, and perhaps further omissions from the published list. If your name has been mispelled, or your address is in error we have no way of knowing this unless you inform us of the error.

We have been informed of the death on 2 August 1966 of one of the oldest members of the WOS, Mr. Harold M. Holland of Galesburg, Illinois who had been a member since 1915.

The Council of the South African Ornithological Society announces that the Third Pan African Ornithological Congress will be held in Kruger National Park in March 1969. Further information can be obtained from: The Hon. Secretary S.A.O.S., c/o Percy FitzPatrick Institute, University of Capetown, Rondebosch, C.P. South Africa.

The Secretary of the International Commission on Zoological Nomenclature announces the possible use of the plenary powers by the International Commission in Case Number 1773, Neotype for *Opopsitta marshalli* Iredale, 1946. (See *Bull. Zool. Nomencl.*, 23:pt. 6. 30 December 1966.) Comment should be sent in duplicate, citing Case Number, to the Secretary, c/o British Museum (Natural History), Cromwell Road, London S.W.7, England.

A very concrete way in which the membership of the Society can help to improve *The Bulletin* would be to make contributions (of any size) to a Color Plate Fund. We would like to use more colored illustrations in *The Bulletin*, but the cost of the color work precludes having more than one a year. At present we have several fine paintings for ultimate publication.

ORNITHOLOGICAL LITERATURE

Birds Around the World: A Geographical Look at Evolution and Birds. By Dean Amadon. Natural History Press, Garden City, New York, 1966: 5¾ × 8⅜ in., xii + 175 pp., 30 line drawings. $3.95.

Scientists write mostly for one another. Some specialists are scarcely intelligible except to others in the same specialty. Conversely, many popularizers are less than competent technically. Therefore, I always feel a sense of gratitude when a first-rate biologist takes up a scientific topic for an audience not as well versed in it as he. Amadon has done so here.

He considers why the various kinds of birds are found where they are. In doing so, he discusses evolution and ecology with singular freedom from the jargon that often makes these topics so formidable to the uninitiated. In some passages his treatment is extremely elementary, but in others, as when he examines critically the rival ecological systems for classifying areas, his presentation will be of interest to more sophisticated readers also. The examples are frequent and well-chosen. They are drawn most often from North America, but include many also from other parts of the world. Particularly global in scope are the examples in the chapters on the distribution of certain orders of birds and on the avian peculiarities of the major biogeographic regions of the world.

The illustrations are simple in the extreme but serve their purpose.

Although every critical reader will find a few statements he would like to debate with Amadon, I found none that detracted from his main points. I have a mild objection to the implication on page 14 that the first species of bird evolved in Bavaria, where the remains of *Archaeopteryx* were excavated. On page 42, I would like to have seen him distinguish between water as such in food and water available through the chemical breakdown of food. Finally, I wish he had picked a more distinctive title; in view of all of the recent permutations of the words *bird* and *world* in book titles, I am afraid this one will be hard to remember by name. However, these are minor suggestions that I mention merely in the hope they will be helpful to someone.

The book is so short (a truly interested reader will read it in one sitting) and so clear and plain-spoken that I believe it will be read by many people who would not ordinarily take up a book-length work on this subject. Although not written for children, it is suitable reading for a bright teen-ager with an interest in birds. It ought to be useful also as collateral reading for an elementary class in ornithology. It will be a worthy addition to many ornithological libraries.—Harold Mayfield.

The Appalachians. By Maurice Brooks. Houghton Mifflin Co., Boston, 1965: 6 × 8¾ in., xvii + 346 pp., 40 pp. of photos (8 in col.); 24 drawings by Lois and Louis Darling; endpaper map by Samuel H. Bryant. $6.95.

This book is a detailed and personalized account of the natural history and related aspects of the physiographic feature known as the Appalachian Mountains. It is the first in an announced series of books, entitled collectively "The Naturalist's America," to be edited by Roger Tory Peterson and John A. Livingston. The series proposes, in the words of the publisher, "to recapture the inquiring spirit of the old naturalists."

There are, of course, several possible approaches to an account of the extensive subject of the Appalachians. Maurice Brooks has utilized a varied approach—first a general discussion of the entire mountain chain in terms of background, geological history, and roads and trails, then a series of vignettes with varied emphases—a geographic unit, a group of mountain peaks, a type of habitat such as glade, cove, shale barren, or cave, a taxonomic group of plants such as ferns, orchids, or heaths, a taxonomic group of animals, and so on.

In this way he conducts the reader on a pleasantly varied tour of the Appalachian Mountains, sustaining reader interest while avoiding a stereotyped cataloguing of data as he proceeds. There is some repetition of material. For example, a particular type of plant or animal may be discussed in some detail in one chapter, and at least mentioned in two or three other chapters. This is not objectionable, however, and, perhaps because of this approach, almost any one of the chapters can stand alone as a satisfying unit.

In this day of prolonged and sometimes bitter conservation struggles, this book employs what may seem a "low-key" approach to the problems of preservation and conservation of the living things and other features in these mountains. A number of instances of destruction and exploitation are cited, but the text throughout indicates that the region is still extremely fascinating, and the author takes a generally optimistic view of the future. There is no clear indication that the publisher and the author have deliberately attempted either to include or to exclude a strong conservation message.

The drawings, one with each chapter heading, are beautifully executed and very appropriate. The photographs, bound in four groups, are excellent and help to transmit the "feel" of the Appalachians. The book is pleasingly composed and put together, and there are virtually no typographical errors.

Maurice Brooks has begun the series auspiciously with his engaging and informal, yet expertly informative, presentation of a subject on which he is one of the nation's outstanding authorities.—Ernest P. Edwards.

The Birds of Chile and Adjacent Regions of Argentina, Bolivia, and Peru. Volume I. By A. W. Johnson. Platt Establecimientos Gráficos S.A., Buenos Aires, 1965: $6\frac{1}{4} \times 9\frac{1}{4}$ in., 398 pp., 100 col. pls. by J. D. Goodall, many photos. $19.50. (May be ordered from the Pierce Book Co., Winthrop, Iowa, or Nada Kramer, 927 15th St., Washington, D.C.)

When the first volume of "Las Aves de Chile" was published in 1946, followed in 1951 by the second, the three authors (J. D. Goodall, A. W. Johnson, and R. A. Philippi) produced a most important work, the first of its type on South American birds, except for that of R. C. Murphy's "Oceanic Birds of South America." Two supplements to the original work, one in 1957 and the other in 1964, have been issued, and the present book in English bases its data principally on the Spanish editions. It is not, however, a mere translation, but includes much more additional information.

Chile, with her relatively poor avifauna (379 known species, of which 298 are breeders, 77 migratory or stragglers from other countries, and 4 introduced) is characterized by many endemic genera and species, chiefly among ovenbirds and tapaculos but also including birds of prey and shorebirds. Isolated on the west by the Pacific and on the east by the high Andean ranges, Chile is, from this point of view, one of the most interesting areas in the Neotropical Region, sharing some of these endemic elements only with Argentina in the south and Peru in the extreme north.

The nesting biology of Chilean birds has been studied for many years by the author of this book and his co-authors of Las Aves de Chile: keen field ornithologists, who did not avoid hardships in looking for nesting localities all over the country, from 15,000 feet in the Andes down to the Pacific coast and islands, from the northern deserts to the cloud forests in the south and the rough archipelagos around the Straits of Magellan.

There are very few nesting localities left to look for, and in this volume (covering penguins through jaegers) the only unknown nesting haunts are those of *Oceanites gracilis, Oceanodroma markhami, Oceanodroma hornbyi, Plegadis ridgwayi, Phalcoboenus australis, Falco kreyenborgi* and *Rallus limicola.* Especially valuable are the reports on the nesting habits and eggs of *Heteronotta atricapilla, Merganetta armata, Buteo ventralis, Buteo albigula, Pluvianellus socialis* and *Phegornis mitchelli.* The eggs of *Pluvianellus* have, however, been collected before. In 1940 the late Percy Reynolds showed me a clutch of two taken not far from the Bay of San Sebastian, Tierra del Fuego.

The great value of the book comes primarily from its data on nesting biology and also some feeding habits. Its data on distribution are rather relative. Within Chile the data on distribution are mostly up to date, although in the neighboring countries they are not. From the Chilean check-list some forms have been left out—e.g., *Pygoscelis papua ellsworthy, Oceanites o. oceanicus,* and *Gallinago (stricklandi) jamesoni.* The classification of several groups as well as the scientific names are somewhat outdated. Some statements in the chapters on migrations are misleading. For example, those species which breed in Chile and migrate to Peru and Bolivia the author calls "migrants from the warmer parts of South America." Equally misleading is his statement about "winter migrants from the extreme south." Most species migrate from the Straits of Magellan, western and central Tierra del Fuego along both sides of the Andes to northern Chile and Peru and northwestern Argentina and Bolivia, while the birds from eastern Tierra del Fuego migrate to northeastern Argentina, Uruguay, and southeastern Brazil. The southernmost populations of Tierra del Fuego all seem to migrate along the Pacific coast up to central Chile.

These remarks are of little significance and are no reflection on the value of this work. The author and his cooperating ornithologists are beyond doubt the best field men operating in South America and deserve congratulations. Though the price of the book is high, it is well worth it.—Claes Chr. Olrog.

The Giant Canada Goose. By Harold C. Hanson. Southern Illinois University Press, Carbondale, 1965: xxiv + 266 pp., 74 figs. (photos), 31 tables, 5 maps, 2 graphs. $9.75.

This book is a major contribution to the study of the Canada Geese. Its scope ranges far beyond the title, covering in detail all the Canada Geese with which the author is personally familiar. I found the text pleasant reading, particularly because of the careful organization. The style is enhanced by the author's judicious use of the first person, and the clear separation of his own opinion from the rest of the text. The reader may, if he wishes, take issue with Dr. Hanson's opinions point by point, without, as often happens, being forced to suspect the data on which the opinion is based. The arguments are supported by a large body of quantitative data. Although there are several places where the author himself decries a shortage of exact information, when one considers the logistic difficulties of studying Canada Geese in the field, the contents of this book stand as a tribute to the ingenuity and indefatigable energy of the author.

Dr. Hanson has long been a pioneer in the investigation of the dynamics of goose populations. The present work brings together many of the author's previous publications and recently collected data. Dr. Hanson presents a convincing case for inclusion of ecological and behavioral characteristics of the species in the consideration of population dynamics. He has also demonstrated the utility of the separation of yearling and, where possible, two-year-old age classes from those geese often simply classed as "adult."

I particularly recommend the chapter on productivity and the regulation of populations to every serious student of wildlife populations.

The most controversial section of this book concerns the taxonomy of the Giant Canada Goose. I once heard a remark attributed to Jean Delacour concerning the taxonomy of Canada Geese: "You have to have a 'feeling' for the geese." It is quite evident that Dr. Hanson has such a feeling, but he has failed to convey it at least to this reader. He has, in my opinion, presented a convincing case from an ecologist's point of view that the Giant Canada Goose *should* be considered a distinct entity, but he has left me in considerable doubt that it *can* be separated to the satisfaction of most taxonomists. I find it unfortunate that the forthcoming paper on taxonomy and evolution of Canada Geese to which Dr. Hanson refers several times did not precede the present work, since I suspect that it will clarify many of the present difficulties. Also, the definition of *Branta canadensis maxima* would have been easier had the author possessed more material on the race *B. c. moffitti.* The latter is, from Dr. Hanson's description, the most similar to *maxima*, yet comparisons between these two are scanty. Also, Dr. Hanson has presented a complex picture of variation between different populations of *maxima* with no attempt to explain this or to reconcile it with the difficulties of separating *maxima* from other subspecies.

I particularly enjoyed the first chapter of the book. The history of discovery of a form is often omitted from scientific publication, particularly when the discovery was made by laymen. Here the history is graphically and sympathetically presented, and at the same time contributes to the rest of the book by showing in convincing fashion that the Giant Canada Goose exists in fact, as well as legend.

The format of the book is not consistent with the high scientific standards. Quantitative data are presented in large complex tables which frequently contain so much information that they are hard to follow. The addition of graphical forms would add much to the clarity of the presentation, particularly in the taxonomic sections. There are a large number of high quality black-and-white photographs. However, these are grouped in two sets, and many are poorly supported in the text. Some of the subject matter is highly repetitive, to the point that one photograph is used twice (Fig. 9, upper, and Fig. 34, lower). The print is large, clear, and easily read, and the text is well laid out. I found only two errors in printing. In Table 26 (p. 181) the last column of figures is displaced one row upwards, and in Figure 19 it appears that two of the four titles refer to the wrong photographs.

In summary, this is an important work, and an indispensable addition to the library of all students of waterfowl. It represents a milestone in the study of Canada Geese, but, as the author himself makes plain, it is by no means the last word.—CHARLES D. MACINNES.

THE BLACK BRANT: SEA GOOSE OF THE PACIFIC COAST. By Arthur S. Einarsen. University of Washington Press, Seattle, 1965: 6 × 9¼ in., xviii + 142 pp., 17 figs. (photos), 4 charts, 8 tables, many drawings by H. C. Smith. $5.00.

A wintry breeze off Dungeness Bay lashed dry yellow grass in the reddening rays of a late afternoon sun as Art Einarsen led us to the edge of the Strait of Juan de Fuca. Nearby a flock of Black Brant wheeled low over Dungeness Spit and settled near a favorite eelgrass bed. Art chatted steadily on the subject of Black Brant, waterfowl conservation in general, and in particular shared with us his current plans. Included were a management program for ducks and geese on several hundred acres of nearby marshland and the "brant book." These were retirement projects to which Art gave his seemingly boundless resources of enthusiasm and energy.

He completed the book and, judging from the reviews, it satisfied the objectives that he had set for it. Sample statements from 10 published reviews reveal that his work appeals to the sportsman, the professional, and the amateur conservationist: It is an "important contribution to conservation literature" (*Audubon Magazine*); . . . he avoided "tedious technical argot [in] presenting fascinating information" (*Seattle Times*); he "assembled all available information about black brant" (Wildlife Management Institute); . . . "The author writes in a style that seems to lie somewhere between science and literature" (*Science*); the book may . . . "Prevent this species . . . from slipping into the category of threatened species" (*Living Wilderness*); . . . "The book local gunners have needed for years" (*The Vancouver "Sun" Courier*); . . . "Einarsen has done a true service in drawing together published literature . . . [and] material from his own unpublished journals . . ." (*Journal of Wildlife Management*).

The "Black Brant" fulfills two primary purposes: (1) To promote the perpetuation of this species through wise conservation measures, and (2) to combine a lifetime of personal experience and observations with published data on the natural history and ecology of the Black Brant. Because of its broad appeal to various groups interested in the out-of-doors, I believe the author was successful. Because he indicates certain aspects of the Black Brant's biology that require further study, ornithologists should find this book a useful cornerstone on which to base future studies of this interesting sea goose. Wildlife biologists will find it a useful reference for general data on breeding habits, migration, abundance, physical characteristics, food habits, behavior, and conservation needs.

From the beginning of his life to its end, Art Einarsen was a dedicated naturalist and conservationist. His book, reflecting these attributes, is a valuable contribution to wildlife literature and a fitting tribute to a productive career.—KARL W. KENYON.

FAMILIAR GARDEN BIRDS OF AMERICA. By Henry Hill Collins, Jr. and Ned R. Boyajian. Harper and Row, New York, 1965: 6½ × 9½ in., x + 309 pp., 12 col. pls., numerous pen and ink drawings. $7.95.

The tremendous variety of bird books that have been published in recent years attests to the wide interest that has developed in the study. Each author and publisher hope that their particular coverage of the subject will fill a need not specifically filled by those already in print. These books vary from the highly specialized and detailed treatment of all phases of the life history of a single species; through the elaborate treatment, in several instances in two large volumes, of every single species that has been recorded in individual states; then on through the attempts to select these few species considered to be the ones the casual observer should know. The present volume is one in the last category and for the persons who stick closely to gardens and city parks it has a considerable amount of reliable information.

Most of the species are eastern woodland birds with a very few species representing the Far West and South. In this respect it is obviously aimed at the largest possible reader public. The users of this volume must carefully avoid any contact with ponds, lakes, or streams, since it does not treat any of the water-bird families, and any hawks and owls that appear will have to be disregarded. It covers the pigeons-doves, hummingbirds, woodpeckers, crows and jays, titmice, nuthatches, creepers, wrens, mockingbirds-thrashers, thrushes, starlings, wood warblers, weaver finch, blackbirds, tanagers, and the finches. For those who are looking for more information on the habits of these birds beyond the recognition features pointed out in the identification manuals this will be quite satisfying. For the most part the information is accurate, there being numerous quotations from well-known ornithological writers. A few statements could be questioned. On page 38, flickers are erroneously credited with migrating at night; and on page 39, the author, commenting on the flicker being preyed upon by the Peregrine Falcon, states that the flicker's feathers "will soon adorn his nest." The fact is the falcon plucks its prey *before* bringing it in to the nest. In describing the flight of the Gray Jay he states that "it seldom flaps except when making one of its rare long flights." True, Gray Jays often glide to lower elevations but whenever they make level flights or must gain elevation their flapping flight is quite normal and Blue Jay-like.

The author occasionally makes too definite statements apparently based on one individual's reported observations. On page 21, the hummingbird's "heart beats 615 times per minute" and, on page 23, the young are "fed 5 times an hour." Both of these actually would be subject to considerable variation.

One amusing slip finds the Dickcissel, which occasionally winters in the North, as "half-hearty" instead of "half-hardy." Again with the same species it is a bit jarring to one's ecological sense to find a Dickcissel hopping under a garden gate with a Cardinal and Indigo and Painted buntings as it is on Plate XI.

The twelve colored plates by John Yrizarry are a bit smooth and rounded but are richly colored and rather competently drawn. The backgrounds in Plates II and XII are a bit hard to interpret. The numerous delicate pencil drawings by Nina Williams scattered through the text are pleasing and accurate in detail although many of the sparrows and some others have standardized, smoothly rounded contours somewhat lacking in the character of the species.

In spite of the above criticisms, and within the limited scope which the publishers admit for this somewhat specialized volume, this book does contain a good deal of information on habits of these birds.—W. J. BRECKENRIDGE.

This issue of *The Wilson Bulletin* was published on 1 March 1967.

The Wilson Bulletin

PUBLISHED BY THE WILSON ORNITHOLOGICAL SOCIETY
WEST VIRGINIA U. · MORGANTOWN, W. VA.

VOL. 79, No. 2, JUNE 1967 PAGES 129–256

The Wilson Ornithological Society

Founded December 3, 1888

Named after ALEXANDER WILSON, the first American Ornithologist.

President—Aaron M. Bagg, Farm Street, Dover, Massachusetts.

First Vice-President—H. Lewis Batts, Jr., Dept. of Biology, Kalamazoo College, Kalamazoo, Michigan.

Second Vice-President—William W. H. Gunn, Apt. 1605, 155 Balliol Street, Toronto, Ontario.

Secretary—Pershing B. Hofslund, Dept. of Biology, Duluth Branch, University of Minnesota, Duluth, Minnesota.

Treasurer—C. Chandler Ross, Academy of Natural Sciences, 19th and Parkway, Philadelphia, Pennsylvania.

Elected Council Members—Stephen W. Eaton (term expires 1967); Jeff Swinebroad (term expires 1968); Kenneth C. Parkes (term expires 1969).

Membership dues per calendar year are: Sustaining, $10.00; Active, $5.00.
The Wilson Bulletin is sent to all members not in arrears for dues.

The Josselyn Van Tyne Memorial Library

The Josselyn Van Tyne Memorial Library of the Wilson Ornithological Society, 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, reprints, and ornithological magazines from members and friends of the 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 contribution, 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. William A. Lunk, University Museums, University of Michigan, is Chairman of the Committee. The Library currently receives 104 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 Josselyn Van Tyne Memorial Library, University of Michigan Museum of Zoology, Ann Arbor, Michigan." Contributions to the New Book Fund should be sent to the Treasurer (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 newly acquired books are listed periodically.

The Wilson Bulletin

The official organ of the Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Morgantown, West Virginia. The subscription price, both in the United States and elsewhere, is $5.00 per year, effective in 1965. Single copies, $1.25. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at $1.25 each) and may be orderd from the Treasurer. Special prices will be quoted for quantity orders.

All articles and communications for publications, books and publications for reviews should be addressed to the Editor. Exchanges should be addressed to The Josselyn Van Tyne Memorial Library, Museum of Zoology, Ann Arbor, Michigan.

Second class postage at Lawrence, Kansas, U.S.A.

PRINTED IN U.S.A. Allen Press, Inc., Lawrence, Kansas

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY
Published by The Wilson Ornithological Society

Vol. 79, No. 2 JUNE 1967 Pages 129–256

CONTENTS

GENERAL NOTES

Birds commonly found as wave attendants in tne high canopy: VERDITER FLYCATCHER (top); GREEN IORA (middle right); GREATER GREEN LEAFBIRD (lower right); SCARLET MINIVET, male and female (lower left). Painting by Boonsong Lekakul.

THE COMPOSITION OF MIXED SPECIES FLOCKS IN LOWLAND AND SUB-MONTANE FORESTS OF MALAYA[1]

H. Elliott McClure

Observation that a quiet tropical forest will suddenly teem with a mass of busy noisy birds only to resume its quiet when they have gone on has been commented upon by many observers who have experienced this phenomenon. Winterbottom (1943, 1949) reported on such flocks in Northern Rhodesia, Stanford (1940) discusses those in Burma, Davis (1946) made a detailed study of Brazilian mixed species flocks, Short (1961) discussed those of Oaxaca, Mexico, and Moynihan (1962) discussed at length such flocks in Panama. Each author in turn reviewed previous or contemporary publications. Systems of classification have been set up for categorizing the species habituating such flocks and theories have been presented concerning the evolution of this flocking behavior, the benefit to the species involved, and the social organization within them.

This is a report of observations of mixed species flocks in western Malaya.

LOCALE

Bird parties or waves were under observation in the tropical rain forest in the vicinity of Kuala Lumpur, Malaysia between January 1959 and June 1963. The bulk of the studies were made in dipterocarp forests of the Gombak watershed east of the city at Mile 13 and Mile 22. A few waves were noted in a secondary lowland forest at the Subang Reserve 15 miles northwest of Kuala Lumpur.

The Mile 13 study area was in selectively cut (many dipterocarps removed) forest along 2½ miles of a logging road from an altitude of 500 to 1000 feet (Fig. 1). About one-half of this distance was along the Gombak River tributaries and the remainder on the hillsides above the streams. The forest was typical of the low uplands with a complex of nearly 200 species of trees per acre. Dipterocarps, including over a hundred species of *Shorea*, *Hopea*, *Dipterocarpus*, *Anisoptera*, *Vatica*, *Cotylelobium*, *Parashorea*, *Pentacme*, *Balanocarpus*, and *Dryobalanops*, dominated the association with overtopping *Shorea*, *Anisoptera*, and *Dipterocarpus* on the ridges. It is a three-storied forest with four stories evident in many places. More than two hundred species of birds inhabited the area.

The Mile 22 study area was at the Genting Sempah Jungle Reserve just below the divide of the central range (Fig. 2). It was at an elevation of

---

[1] This is the third of a series, "Avian Bionomics in Malaya." (McClure, 1964; McClure and bin Othman, 1965). This work done as a part of avian studies at the U.S. Army Research Unit, Institute of Medical Research, Kuala Lumpur, Malaysia.

Fig. 1. The sub-montane forest at Gombak, Mile 13, Altitude 800 feet, after the primary dipterocarps had been removed.

FIG. 2. Primary sub-montane dipterocarp forest at 2,000 feet, Mile 22 Gombak.

2000 feet and in primary hill dipterocarp forest dominated by 50 species of *Shorea*, *Hopea*, *Dipterocarpus*, *Anisoptera*, *Vatica*, and *Balanocarpus*. As in the lower area there were as many as two hundred species of trees to the acre. This is a three- or four-storied forest with *Shorea* and *Anisoptera* giants up to 200 feet high overtopping the lower crowns. The avifauna was as diverse as on the lower slopes.

The third study area at Subang was in 30-year-old secondary forest at an altitude of 150 feet (Fig. 3). It is partially swampy and dominated by young 50- to 80-foot *Shorea*, *Palaquium*, *Dyera*, and *Endospermum*. The avifauna included more than 100 species.

METHODS

Once each week between 1 January 1959 and 1 December 1960 from 0700 to 1200 hours the birds recognizable by call or by sight were tallied along the 2½ mile route (Mile 13) through the forest. The tallies were made while walking at a speed of about one mile per hour (round trip 5 miles). No effort was made to distinguish birds that were counted twice. When a feeding flock was encountered an attempt was made to count and identify as many individuals as possible.

At Mile 22 a platform was built in a giant *Anisoptera laevis* in the first

FIG. 3. Secondary swamp forest at Subang. Lower story dominated by Bertam palms.

crotch of limbs 140 feet above the ground. The entire crown of the tree was above the platform and extended above the surrounding canopy except for trees of equal height at its level and for the canopy extending over the hillside above it. In this location the observer was "captive" while each wave of birds passed around and beneath him. At Mile 13 the observer passed through the wave and beneath it. The difference in viewpoint contributed to the differences in the resulting tallies. Observations from the platform were made once each week from 0600 to 1200 between September 1960 and June 1963.

At Subang the observation route extended through the forest for half a mile and tallies were made along it between 0800 and 0900 twice each week from January to December 1962.

FLOCK COMPOSITION IN THE GOMBAK WATERSHED

During the five-year period of July 1958–July 1963, 197 observations were made in the Gombak watershed, totaling nearly 1000 hours, and in that time 154 mixed species feeding flocks or bird waves were intercepted and tallied. Nearly 6000 birds and a total of 102 species were noted in association in these flocks. In most habitats of the tropical rain forest species are numerous and populations sparse. This was true of the mixed flocks in

TABLE 1
THE COMPOSITION OF BIRD WAVES IN THE GOMBAK WATERSHED

Family	No. of Waves		No. of Birds		Ave. Birds Per Wave		No. of Species	
	M 13	M 22	M 13	M 22	M 13	M 22	M 13	M 22
Columbidae	–	2	–	4	–	2.0	–	1
Psittacidae	3	3	18	4	6.0	1.3	1	1
Cuculidae	28	20	53	26	1.9	1.3	8	5
Trogonidae	1	–	1	–	1.0	–	1	–
Meropidae	3	1	7	1	2.3	1.0	1	1
Capitonidae	3	24	3	140	1.0	5.8	3	5
Picidae	17	21	31	35	1.8	1.7	8	4
Eurylaimidae	3	–	10	–	3.3	–	3	–
Laniidae	6	4	12	26	2.0	6.5	2	1
Oriolidae	27	3	48	3	1.8	1.0	1	1
Dicruridae	35	7	67	10	1.9	1.4	2	1
Campephagidae	53	75	333	559	6.3	7.4	6	4
Pycnonotidae	38	34	144	274	3.8	8.1	14	9
Aegithinidae	66	77	404	848	6.1	11.0	5	6
Timaliidae	40	46	335	247	8.4	5.4	7	8
Muscicapidae	40	57	92	192	2.3	3.4	10	7
Sylviidae	34	60	160	367	4.7	6.1	4	3
Turdidae	–	2	–	2	–	1.0	–	1
Paridae	5	1	7	2	1.4	2.0	1	1
Sittidae	8	31	14	53	1.7	1.7	1	1
Zosteropidae	2	7	25	54	12.5	8.0	1	1
Dicaeidae	11	5	34	9	3.0	1.8	3	4
Nectariniidae	19	20	48	32	2.5	1.6	6	9
Ploceidae	1	–	2	–	2.0	–	1	–
Totals	74	80	2,983	2,911	34.0	32.7	89	75

the Gombak Valley; probably more than 102 species were associated in them during a year's time, but the average number of birds counted per species was only three per flock.

During the day as a wave moves through the forest it encounters many sedentary species, many that are involved in other flock activities and many that are traveling in directions divergent to that of the wave. In most instances during such encounters the extraneous species appear to join the flock in searching for food. During these brief activities all of the species are in mutual competition for food or derive mutual benefits from the search for it. The 102 species which were observed to mingle in the Gombak watershed are listed in the appendix. Table 1 summarizes this long list by families.

In the following discussions it has been necessary to treat the observations

TABLE 2

SUMMARY OF THE MONTHLY OBSERVATIONS OF MIXED SPECIES FLOCKS IN THE GOMBAK WATERSHED

		Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
No. days of observation	M13	8	7	6	6	6	5	4	5	4	9	7	7	74
	M22	14	12	8	5	3	10	13	9	11	12	13	13	123
No. flocks	M13	5	1	1	1	3	6	6	4	11	19	10	7	74
	M22	2	4	3	4	1	9	14	10	12	8	9	4	80
No. species	M13	20	5	8	5	11	17	34	18	29	50	35	22	88
	M22	7	17	15	21	5	30	36	36	37	20	23	22	75
No. species per flock	M13	8.5	5.0	8.0	5.0	5.0	4.7	10.8	8.3	6.5	11.0	8.2	7.8	7.6
	M22	6.5	6.7	9.2	4.2	5.0	10.6	10.7	12.4	13.5	6.8	7.9	14.1	9.8
Total birds	M13	223	32	15	17	56	192	300	132	390	1,111	309	206	2,983
	M22	33	109	76	95	12	358	564	448	485	311	221	199	2,911
No. birds per flock	M13	42.6	32.0	15.0	17.0	19.0	26.5	50.0	37.0	35.4	54.3	30.9	28.0	34.2
	M22	16.5	27.2	25.5	23.8	12.0	39.0	40.1	44.4	50.7	37.3	39.3	37.2	32.7
No. birds per species	M13	3.2	4.4	1.6	1.4	2.4	2.5	3.0	3.1	2.5	3.1	2.3	1.9	2.7
	M22	2.5	2.5	2.7	2.8	2.4	3.3	3.4	3.2	3.9	4.2	3.6	3.3	3.3

TABLE 3
COMMON SPECIES IN WAVES IN THE GOMBAK WATERSHED AS NOTED AT MILE 13 AND MILE 22

Species	Times observed		Total	Rank
	Mile 13	Mile 22		
Yellow-headed Green Leafbird	52	52	104	1
Green Iora	15	56	71	2
Scarlet Minivet	14	54	68	3
Arctic Leaf Warbler	26	39	65	4
Fiery Minivet	31	32	63	5
Common Nun Babbler	30	31	61	6
Bar-winged Flycatcher-shrike	16	43	59	7
Flyeater	7	47	54	8
Spotted Fantail Flycatcher	9	38	47	9
Fairy Bluebird	19	28	47	10
Lesser Green Leafbird	11	31	42	11
Velvet-fronted Nuthatch	8	31	39	12
Grey-headed Flycatcher	13	22	35	13
Greater Green Leafbird	5	28	33	14
Paradise Flycatcher	21	11	32	15
Verditer Flycatcher	5	26	31	16
Racquet-tailed Drongo	29	0	29	17
Black-headed Oriole	27	2	29	18
Chestnut-breasted Malcoha	16	9	25	19
Scaly-breasted Bulbul	0	22	22	20
Striped Tit Babbler	3	17	20	21
Chestnut-back Scimitar Babbler	5	15	20	22
White-bellied Crested Babbler	8	12	20	23
Black-naped Blue Flycatcher	1	17	18	24
Lesser Graybird	2	13	15	25

at Mile 13 and Mile 22 separately because of the differences in study methods, however hill flocks or waves may include all of the variables indicated and may even include the species differential as noted at Subang. Other observers have ascribed importance in flock associations to call, color, and feeding habits. These are touched upon in the present studies without conclusions since the tropical forest habitat does not lend itself to ready experimentation for conclusive evidence about such a complex of relationships as exists in these flocks.

COMPOSITION OF FLOCKS AT MILE 13

During 23 months (Jan 1959–Dec 1960) 74 observations were made along the logging trail. A total of 74 waves were intercepted, and 89 species and 2983 individuals were recorded. The average number of birds counted per wave was 34, species seen was 7.6, and number of birds per species 2.7. None of these figures can be considered more than averages from the field observations because the terrain, vegetation, and depth of the waves made accurate and full accounting of the participants impossible for one observer.

Table 2 lists the data by month concerning these observations. During the period April through September, 17 waves were noted while 57 were seen in the remaining six months. A breakdown by families of the 89 species represented in the flocks is given in Table 1. Dicrurids were represented in 47% of the flocks, campephagids in 71%, pycnonotids in 51%, aegithinids in 89%, timaliids in 54%, muscicapids in 54%, and sylviids in 47%. No one species was seen in every feeding flock. This may have been the result of an actual difference in the composition of some flocks or the observer may have overlooked them. Because of the prominence of campephagids and aegithinids in these flocks they should be designated as Minivet-Leafbird Waves.

Nine species appeared in more than 25% of the flocks: Yellow-headed Green Leafbird, Fiery Minivet, Scarlet Minivet, Common Nun Babbler, Racquet-tailed Drongo, Black-headed Oriole, Arctic Leaf Warbler, Paradise Flycatcher, and Fairy Bluebird. Twenty species appeared in 12% or more of the flocks and 60 additional species were seen occasionally. Table 3 lists the species noted regularly in the waves at Miles 13 and 22. Common names given follow McClure (1963).

By tallying individuals away from feeding flocks, Moynihan (1962) and Davis (1946) attempted to determine if certain species tended to join flocks more than others. Similar observations were made at Mile 13 which was a linear tally area permitting the observer to see birds unrelated to flocks as well as with them. The numbers tallied are compared for 36 species in Table 4. Several of the species listed in Table 4 as "Regular Attendants" to feeding flocks at Mile 13, where the habitat had been disturbed by timber cutting, were much more closely associated with waves at Mile 22, where the canopy was unbroken. In the undisturbed forest the Scarlet and Fiery minivets, Lesser, Greater and Yellow-headed Green leafbirds, Common Nun Babblers, Spotted Fantail Flycatchers and Flyeaters are probably rarely seen away from flocks.

The interspecific contacts within mixed species flocks were many, such contacts (by sight, sound, and touch) increasing by the square of the numbers of individuals involved. The species moved among each other, competed for food, stole food from their own and other species, touched each other, heard the calls of each species, and saw the colors of each species, their patterns of flight and other movements.

TABLE 4

SPECIES APPEARING IN MIXED FLOCKS AT MILE 13 AND THEIR NUMERICAL RELATIONSHIP TO THOSE NOTED AWAY FROM MIXED SPECIES

			Total birds seen	
	No. of flocks	Ave. per flock	in flocks	outside flocks
70 to 100% tallied in mixed flocks—Habitual attendants				
White-bellied Crested Babbler	8	7.2	58	2
Arctic Leaf Warbler	26	5.4	141	19
40 to 69% tallied in mixed flocks—Usual attendants				
Chestnut-breasted Malcoha	16	1.7	27	37
Grey-and-buff Woodpecker	7	1.6	11	11
Crow-billed Drongo	11	1.4	15	20
Black-winged Flycatcher-shrike	13	1.4	18	16
Bar-winged Flycatcher-shrike	16	2.1	34	19
Ashy Minivet	8	4.5	36	31
Hairy-backed Bulbul	8	3.5	28	41
Green Iora	15	2.8	42	26
Chestnut-backed Scimitar Babbler	5	1.4	7	4
Paradise Flycatcher	21	1.6	33	20
Velvet-fronted Nuthatch	8	1.7	14	8
10 to 39% tallied in mixed flocks—Regular attendants				
Raffles Malcoha	9	1.1	10	17
Red-rumped Trogon	16	1.7	27	37
Crimson-winged Woodpecker	8	1.4	11	20
Black-headed Oriole	27	1.8	48	102
Large Racquet-tailed Drongo	29	2.0	58	414
Fiery and Scarlet Minivets	45	5.4	242	492
Red-eyed Brown Bulbul	11	2.6	29	135
White-throated Bulbul	5	2.8	14	38
Lesser Green Leafbird	13	4.1	53	90
Greater Green Leafbird	5	2.8	14	45
Yellow-headed Green Leafbird	52	4.8	252	468
Fairy Bluebird	19	2.4	46	228
Lesser Red-headed Tree Babbler	8	3.7	30	85
Common Nun Babbler	30	7.1	215	420
Spotted Fantail Flycatcher	9	1.9	17	30
Grey-headed Flycatcher	13	2.2	29	194
Verditer Flycatcher	5	1.4	7	18
Flyeater	7	2.1	15	114
Sultan Tit	5	1.4	7	21
Orange-bellied Flowerpecker	5	2.8	14	34
1 to 9% tallied in mixed flocks—Accidental attendants				
Streaked Bulbul	5	1.6	8	108
Little Spiderhunter	10	1.9	19	691
Lesser Yellow-eared Spiderhunter	8	1.7	14	184

TABLE 5

THE NUMERICAL RELATIONSHIPS BETWEEN SPECIES IN FEEDING FLOCKS AT MILE 13

	1	2	3	4	5	6	7	8	9	10	11
1. Yellow-headed Green Leafbird		9	6	25	32	10	32	19	23	38	21
2. Minivets (Scarlet & Fiery)	11		7	24	32	12	37	15	34	36	14
3. Common Nun Babbler	15	13		34	51	17	50	52	43	59	16
4. Large Racquet-tailed Drongo	4	4	3		10	4	18	10	9	10	8
5. Black-headed Oriole	3	3	2	10		4	10	5	10	10	7
6. Arctic Leaf Warbler	10	8	6	24	28		34	29	19	38	12
7. Paradise Flycatcher	3	3	2	5	10	3		14	6	11	5
8. Fairy Bluebird	5	6	2	10	19	3	7		7	17	21
9. Bar-winged Flycatcher-shrike	4	3	2	11	10	5	17	14		8	6
10. Chestnut-breasted Malcoha	3	3	2	10	10	2	9	6	13		8
11. Green Iora	5	7	6	13	13	8	21	5	16	12	

To determine relationships in this table read horizontally. Example, there were 4 drongos (Line 4, col. 1) to 25 leafbirds (Line 1, col. 4) in the mixed flocks; or 6 Fairy Bluebirds (Line 8, col. 2) to 15 minivets (Line 2, col. 8).

Other observers have felt that the species in a wave were attracted to each other by color, sound, or activity and have attempted to designate these as positive or negative relationships. Moynihan (1962) classified the species as "Passive" if they moved through the forest independently and "Active" if they followed the "Passive" species. He based his conclusions on the number of times in which one species was seen "following" another. This presupposes that the act of following species by another was voluntary.

Such detailed tallying of individuals in the Gombak flocks was not attempted. Instead the numerical relationships between 11 species commonly found in Mile 13 flocks are shown in Tables 5 and 6. These multilateral tables present a three-dimensional picture which indicates that many species do seek the presence of other species even though we have no way of knowing cause and effect at this time.

FLOCK COMPOSITION AT MILE 22

From the platform the study situation was the reverse of that at Mile 13. Here the observer was stationary and the waves passed him, the view was of the top of the wave and lower levels could not be seen, movement was slower and tallying more accurate, and there was the added factor of 1000 feet higher altitude and its effect upon the species composition and abundance (for example the Large Racquet-tailed Drongo did not occur here). Such a platform could not be built at Mile 13 because lumbering was removing the giant dipterocarps.

Table 6

The Relationships of the Species in Feeding Flocks at Mile 13 expressed as Percentages of the Total for each Species. Italicized Figures are Totals for the Species

	1	2	3	4	5	6	7	8	9	10	11
1. Yellow-headed Green Leafbird	*252*	75.0	46.0	42.8	44.0	45.6	36.1	27.6	22.6	34.5	24.2
2. Minivets (Scarlet & Fiery)	83.3	*242*	50.8	39.2	46.2	49.5	38.4	23.5	26.0	34.7	18.1
3. Common Nun Babbler	83.7	75.3	*215*	43.2	76.2	58.6	46.0	38.6	40.0	27.4	15.3
4. Large Racquet-tailed Drongo	74.1	68.9	46.5	*58*	51.7	41.3	31.0	20.6	15.5	24.1	31.0
5. Black-headed Oriole	72.9	72.9	66.6	58.3	*48*	45.8	29.1	33.3	33.3	25.0	18.7
6. Arctic Leaf Warbler	82.2	71.6	52.4	41.1	43.2	*141*	43.2	29.0	21.9	35.4	16.3
7. Paradise Flycatcher	84.8	75.7	60.6	30.3	42.4	54.5	*33*	33.3	24.2	33.3	30.3
8. Fairy Bluebird	78.2	80.4	34.7	28.2	65.2	30.4	17.3	*46*	17.3	41.3	32.6
9. Bar-winged Flycatcher-shrike	73.5	55.8	58.8	29.4	47.0	47.0	41.1	32.3	*34*	20.5	14.7
10. Chestnut-breasted Malcoha	85.1	85.1	37.0	51.8	48.1	48.1	37.0	40.7	33.3	*27*	18.5
11. Green Iora	69.0	73.8	47.6	54.7	28.5	45.2	50.0	16.6	19.0	14.2	*42*

To determine relationship in this table read horizontally: Example, 45.2 percent of the Green Ioras (Line 11, col. 6) were seen in association with 16.3 percent of the Arctic Leaf Warblers (Line 6, col. 11); or 66.6 percent of the Black-headed Orioles (Line 5, col. 3) with 76.2 percent of the Common Nun Babblers (Line 3, col. 5).

During the 33 months between September 1960 and June 1963. 123 observations were made and 80 waves were recorded. The number of species noted was 75 with a total of 2911 birds. The average number of birds per wave was 32.7, average number of species per wave 9.8, and average number of birds per species 3.3 (Table 2). Among the flocks at Mile 13 many individuals were counted without being identified. but from the platform accuracy in identification and tally was much greater. Except on rare occasions every bird that passed in view was identified and counted. The flocks showed a seasonality similar to that of flocks at Mile 13. Peak activity fell in December at Mile 22 and in January at Mile 13.

The distribution among families of the 75 species seen in the flocks is shown in Table 1. Campephagids were in 94% of the waves. and aegithinids in 96%. more clearly designating the flocks as Minivet-Leafbird Associations than the flocks at Mile 13. Muscicapids and sylviids were in 71 and 75% of the flocks respectively, and pycnonotids and timaliids 42 and 57%. Five species appeared in 50% or more of the waves, Green Iora, Scarlet Minivet, Yellow-headed Green Leafbird, Flyeater, and Bar-winged Flycatcher-shrike, in that order. An additional eleven species were in 25 to 50% of the flocks: Arctic Leaf Warbler, Spotted Fantail Flycatcher, Fiery Minivet, Common Nun Babbler, Lesser Green Leafbird, Velvet-fronted Nuthatch, Greater Green Leafbird, Fairy Bluebird, Verditer Flycatcher, Scaly-breasted Bulbul, and Grey-headed Flycatcher. The remaining 59 species were those seen in less than 25% of the flocks. Table 3 lists the common species and compares their occurrence in the waves with those of Mile 13.

At Mile 13 the length of the study route was such that birds unassociated with flocks could be counted with some assurance that they had not been counted in the flock just passed or would not be in the next flock along the way. But at the platform the Green Leafbirds, Verditer Flycatcher, Striped Tit-Babblers and others in the vicinity were probably counted and recounted during the morning as they moved about, both attendant to flocks and away from them. For this reason no attempt has been made to determine the percentage of the population of each species that was seen in flock associations.

Thirteen species habitually found in the feeding flocks are compared in Tables 7 and 8 in the same way as were species common in the Mile 13 waves. Green Ioras and Flyeaters were among the most abundant high canopy forms and occupied important positions in the guidance and cohesion of the upper levels of the waves. In 36 of the 56 flocks in which Green Ioras were present the Flyeater was also present, and in 36 of the 47 flocks with Flyeaters there were Green Ioras. The relationship between Flyeaters and Scarlet Minivets was almost the same and the three species were integral parts of the flocks. Numerically there were 13 Green Ioras to 7 Flyeaters and 12 Scarlet Minivets to 8 Flyeaters. Fairy Bluebirds filled a somewhat similar niche in the flocks at this altitude that the Racquet-tailed Drongo did lower down.

From the canopy observations there are further comparisons of the position of the Yellow-headed Green Leafbird and Common Nun Babbler in the flocks. Among the birds in 52 flocks with Yellow-headed Green Leafbirds, there were 26 with Common Nun Babblers and among 31 with the babbler there were 26 with leafbirds. Further, there were 8 babblers with each 12 leafbirds and 89.2% of the total babblers were seen in company of the leafbirds but only 58.1% of the leafbirds were with the babblers. These data from both study areas suggest that the babblers seek the company of the leafbirds.

In the upper canopy the affinity between the Green Iora, Scarlet and/or Fiery minivet, Flyeater, Barwing Flycatcher-shrike, and Spotted Fantail

TABLE 7

THE NUMERICAL RELATIONSHIPS BETWEEN SPECIES ASSOCIATED IN THE FEEDING FLOCKS AT MILE 22, GOMBAK

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Scarlet Minivet		7	9	12	20	11	22	8	10	28	18	17	33
2. Green Iora	13		13	13	19	18	33	15	17	38	20	19	38
3. Yellow-headed Green Leafbird	11	8		12	19	13	25	11	12	25	15	16	32
4. Flyeater	8	7	8		15	12	23	11	11	24	17	14	23
5. Bar-winged Flycatcher-shrike	5	5	5	7		7	14	6	8	15	11	14	20
6. Arctic Leaf Warbler	9	5	7	8	14		22	9	7	24	14	11	30
7. Spotted Fantail Flycatcher	4	3	4	4	7	5		4	5	10	7	6	10
8. Fiery Minivet	12	6	9	9	17	11	24		12	30	15	21	32
9. Common Nun Babbler	10	6	8	9	12	14	20	8		23	16	16	23
10. Velvet-fronted Nuthatch	3	3	4	4	7	4	10	3	4		8	6	11
11. Lesser Green Leafbird	5	5	6	6	8	7	14	6	6	13		10	18
12. Greater Green Leafbird	6	5	6	7	7	9	17	5	6	17	10		13
13. Fairy Bluebird	3	3	3	4	5	3	10	3	4	9	5	7	

To determine relationships in this table read horizontally: Example, 19 Green Iora (Line 2, col. 5) were found in association with 5 Bar-winged Flycatcher-shrike (Line 5, col. 2).

Flycatcher appeared to be very strong. All five of them were present in 11 (13.7%) of the waves, four of them in any combination were present in 21 (26.2%), and three of them in 28 (35%) of the flocks. Two species were present in 12 (15%) waves, six waves had but one species, and only two flocks were free of them.

Separated by only nine miles of continuous forest and 1000 feet altitude on the same watershed, the flocks of both study areas can probably be considered components of wave action that is relatively similar all along the range to about 3000 feet. Combining the data from 154 waves probably arranges the species in order of occurrence which would be generally true for the whole watershed (Table 3). Since the top and bottom of such waves could not be seen at the same time, the number of birds involved in the waves may lie somewhere near the combined total of the two areas, i.e., 70 individuals of 17 species.

OTHER FLOCKS WITHIN THE CANOPY

Winterbottom (1943, 1949), Moynihan (1962), and others noted that there were other flocks within the canopy which were unrelated to the feeding flocks of predominantly insectivorous species but which were often in-

TABLE 8

THE TOTAL BIRDS FOUND IN FEEDING FLOCKS AT MILE 22 AND PERCENTAGE OF THESE BIRDS FOUND IN ASSOCIATION WITH OTHER SPECIES

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Green Iora	*345*	79.7	62.0	65.7	59.1	64.3	57.9	50.7	37.9	40.5	62.8	36.8	43.4
2. Yellow-headed Green Leafbird	80.7	*270*	71.8	61.8	55.5	49.6	58.1	42.9	32.2	35.1	56.6	39.2	34.0
3. Scarlet Minivet	63.4	71.5	*257*	66.1	56.0	31.5	47.4	66.3	52.9	39.2	48.2	43.1	43.1
4. Flyeater	83.5	69.0	71.5	*200*	65.0	50.5	50.5	68.0	51.0	37.0	64.5	48.0	45.5
5. Arctic Leaf Warbler	69.3	69.3	77.9	63.0	*163*	61.3	46.6	66.8	55.2	39.8	64.4	50.9	41.7
6. Fiery Minivet	89.9	75.4	61.6	59.1	69.1	*159*	54.7	59.7	44.0	45.2	69.8	40.2	42.1
7. Common Nun Babbler	76.5	89.2	83.2	61.0	69.7	47.6	*149*	44.2	47.6	49.6	77.1	48.3	42.9
8. Bar-winged Flycatcher-Shrike	73.1	49.5	65.8	75.6	61.7	45.5	42.2	*123*	56.0	38.2	58.5	41.4	43.9
9. Lesser Green Leafbird	76.7	65.1	87.2	69.7	76.7	52.3	51.1	68.6	*86*	50.0	60.4	44.1	53.1
10. Greater Green Leafbird	83.7	68.6	69.7	60.4	67.4	39.5	54.6	39.5	52.3	*86*	44.1	46.5	30.2
11. Spotted Fantail Flycatcher	78.3	74.6	66.2	66.2	57.8	55.4	68.6	62.6	43.3	26.5	*83*	31.3	33.7
12. Fairy Bluebird	58.9	58.9	60.7	75.0	50.0	35.7	55.3	46.4	37.5	53.5	42.8	*56*	37.5
13. Velvet-fronted Nuthatch	73.5	67.9	73.5	69.8	52.8	41.5	52.8	67.9	67.9	28.3	50.9	43.3	*53*

To determine relationships in this table read horizontally. Example, 69 percent of all Flyeaters (line 4, col. 2) were found in association with 61.8 percent (line 2, col. 4) of all Yellow-headed Green Leafbirds.

corporated within them either by accident or by stimulus. In the Gombak watershed the Hook-billed Graybird moved in small flocks and in directions that indicated no relationship to the waves, but often when they intercepted such a wave they joined it, feeding among and in association with the other flock members. Such a flock was left behind when a wave moved on or it would travel on in a route divergent to that of the wave.

At times when Brown Barbets, which normally move in flocks, were overtaken by waves the barbets moved about within the mixed flock joining in to feed, but were left behind as the wave moved on.

Also conspicuous in the canopy were barbets and bulbuls that gathered at favored fruit trees, usually figs. These trees fruited as often as three times a year and were sought out by hundreds of birds. When such a tree was occupied by barbets and bulbuls a wave would flow through it and the insectivores would turn to the fruit as well as the insects. Such actions served to make the relationships even more complex for species as divergent in habits as minivets and barbets were now in association and at least temporarily in competition for the same food.

Although the barbet components of these frugivorous flocks, including five species, appeared to be unorganized, some of the bulbuls were in flocks. The Scaly-breasted Bulbul moved through the canopy in loose knit but organized flocks which often came in contact with the waves of insectivores, but were independent of them. They joined 22 of the 80 waves passing the platform. Their numbers exceeded those of other species of bulbuls attending the same waves. In most instances the relationship between the bulbul flock and the insectivores was only competition for the ripe fruit.

WAVES AT SUBANG

Feeding flocks did not appear to be organized as often in this swamp and lowland forest as at higher levels. Only 8 waves were intercepted, all in winter months and these included 40 species.

The White-throated Bulbul was apparently an important species in the flocks and was present in 5 of the 8. Other regularly attendant species were White-eyed Brown Bulbuls (4 of 8), Greater (3) and Lesser (3) Red-headed Tree Babblers, Raffles Malcoha (3), Chestnut-breasted Malcoha (3), Red-rumped Trogon (4), Banded Broadbill (3), Green Iora (3), Lesser Green Leafbird (3), Black-necked Tree Babbler (*Stachyris nigricollis*) (3), Paradise Flycatcher (4), and Little Spiderhunter (4).

Those species appearing twice in the flocks (25%) were: Grey-and-buff Woodpecker, Large Racquet-tailed Drongo, Crested Malay Jay (*Platylophus galericulatus*), Red-eyed Brown Bulbul, Scrub Bulbul, Plain Babbler, Red-rumped Tree Babbler, and Arctic Leaf Warbler.

Those species tallied but once in the 8 flocks were: Lesser Green-billed Malcoha, Rufous-bellied Malcoha, Blue-throated Bee-eater, Banded Red Woodpecker, Orange-backed Woodpecker, Green Broadbill (*Calyptomena viridis*), Black-crested Magpie (*Platysmurus leucopterus*), Ashy Minivet, Fiery Minivet, Crested Brown Bulbul (*Pycnonotus eutilotus*), Greater Green Leafbird, Yellow-headed Green Leafbird, Ferruginous Babbler (*Trichastoma bicolor*), Black-naped Blue Flycatcher, Crimson-breasted Flowerpecker, Scarlet-backed Flowerpecker (*Dicaeum cruentatum*), and Purple-naped Sunbird.

These lowland flocks were characterized by more bulbul and babbler participants than the mountain flocks. Both groups were active "organizers" filling the niches of the leafbirds and ioras in Gombak. Since this forest had only two stories and the trees lacked the height of those of Gombak, the canopy species were less involved or lacking. They were porportionately fewer in the whole population. This was a habitat of babblers and bulbuls and they dominated the feeding flocks as well.

In spite of differences in composition the average wave as recorded in all three study areas was remarkably uniform. About the same number of species, birds, and birds per species were involved in flocks in each location (Table 9).

FLOCK PARTICIPANT CLASSIFICATION

Moynihan (1962) revised earlier concepts and set up categories to indicate degrees of importance or effect in the flocks. Those species that the flocks appeared to be built around and which through voice, color, and action seemed to mold or hold the flock he designated as *nuclear*. Others were *attendant*. Species usually present were *regular*, less often seen *occasional*. Leaders which did not approach or follow other species so often were *passive* and species that followed others were *active*. This classification applies to the abundant or common forms in waves and does not attempt to include those species that are excited by a wave's passage and join it for a short distance or those that are incorporated only as the wave flows over. These could be designated as *temporary attendants* and *accidental attendants*.

The twenty ranking Gombak species based upon the numbers of waves in which they were known to occur were as follows:

Rank	*Species*	*Moynihan's Classification*
1	Yellow-headed Green Leafbird	Regular-passive-nuclear
2	Green Iora	" " "
3	Scarlet Minivet	" " "
4	Arctic Leaf Warbler	" active "
5	Fiery Minivet	" passive "
6	Common Nun Babbler	" " "
7	Barwinged Flycatcher-shrike	" active attendant
8	Flyeater	" " nuclear
9	Spotted Fantail Flycatcher	" " attendant
10	Fairy Bluebird	Occasional-active-attendant
11	Lesser Green Leafbird	" " nuclear
12	Velvet-fronted Nuthatch	" " attendant
13	Paradise Flycatcher	" " "
14	Large Racquet-tailed Drongo	Regular-passive-attendant
15	Greater Green Leafbird	Occasional-active-nuclear
16	Black-headed Oriole	Occasional-passive-attendant
17	Verditer Flycatcher	" active "
18	Scaly-breasted Bulbul	" passive "
19	White-bellied Crested Babbler	" active nuclear
20	Chestnut-breasted Malcoha	" " attendant

TABLE 9

A COMPARISON OF THE AVERAGE FEEDING FLOCK RECORDS FROM THE THREE STUDY AREAS NEAR KUALA LUMPUR

Altitude	Subang 150 ft	Gombak Mile 13 500–1,000 ft	Gombak Mile 22 2,000 ft
Number of flocks	8	74	80
Total species	40	88	75
Average number of species per flock	11.0	7.6	9.8
Total birds	227	2,983	3,045
Average number of birds per flock	28.3	34.2	37.0
Average number of birds per species per flock	2.6	2.7	3.3

GENERAL OBSERVATIONS

The flocks appeared to arise spontaneously. The abundant, gregarious Common Nun Babbler was usually involved in the Gombak waves and its insistent five-to-seven-noted flock call of descending inflection was usually evidence that a wave was approaching. From the platform this call could be heard before any birds approached, but there was no evident movement of birds toward the sound to indicate that the calls were an assembly note. Along the Mile 13 route these babblers were often at the head of a wave.

From the platform the calls were often heard at dawn, but it would be an hour or so before wave leaders would appear. This early morning period may have been taken up in preening and indiscriminate feeding. What set a wave in motion was never evident.

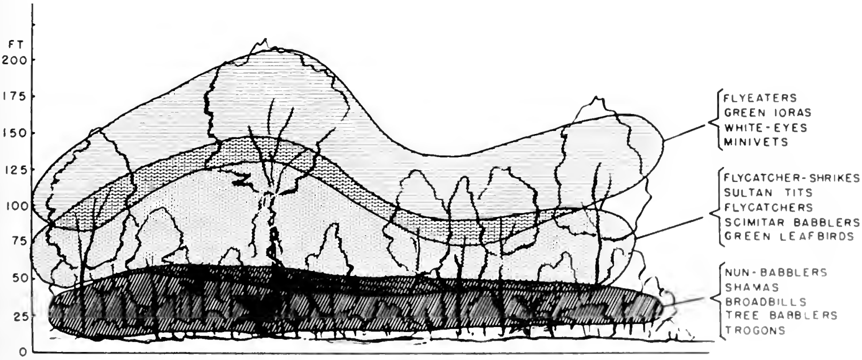


FIG. 4. The usual realms of bird groups within a wave.

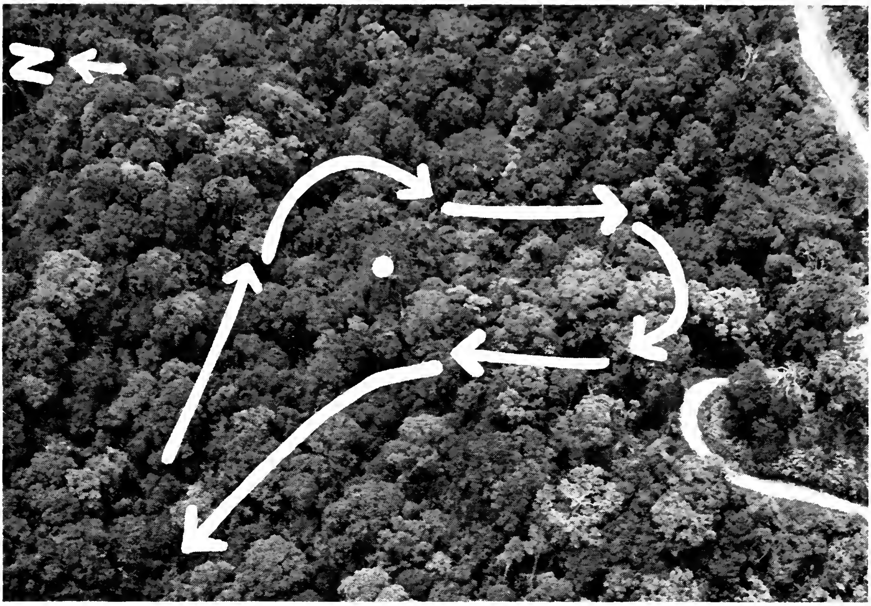


FIG. 5. Usual route of the mixed flock that fed in the vicinity of the platform at Mile 22.

When moving through the forest a wave had length, breadth and depth. At times the babblers would lead or they might be overrun by the flycatchers, cuckoo-shrikes and minivets above them, and at other times pseudopodia of species would stream ahead at different levels.

The wave filled the forest and its depth was controlled by the height of the trees. It was usually not much wider than high but had considerable length, up to a thousand feet attenuating to the malcohas and trogons at the tail.

There was some vertical movement of species within the wave, but in general species or groups of species tended to stay at relatively uniform heights (Fig. 4). An individual such as a Paradise Flycatcher might spiral down after a falling insect but would usually return to the same general level at which the group was feeding.

The speed at which a wave moved forward was often great enough that counting and identification of individuals became difficult. It usually took several minutes for all to move on and the last malcoha to arrive. At the height of the platform the motion was slower so that the lower levels of birds were usually ahead of the ioras or minivets which would work slowly through a crown and then catch up by dashing to the next crown.

It was noticed that along the Mile 13 route certain areas of the forest were

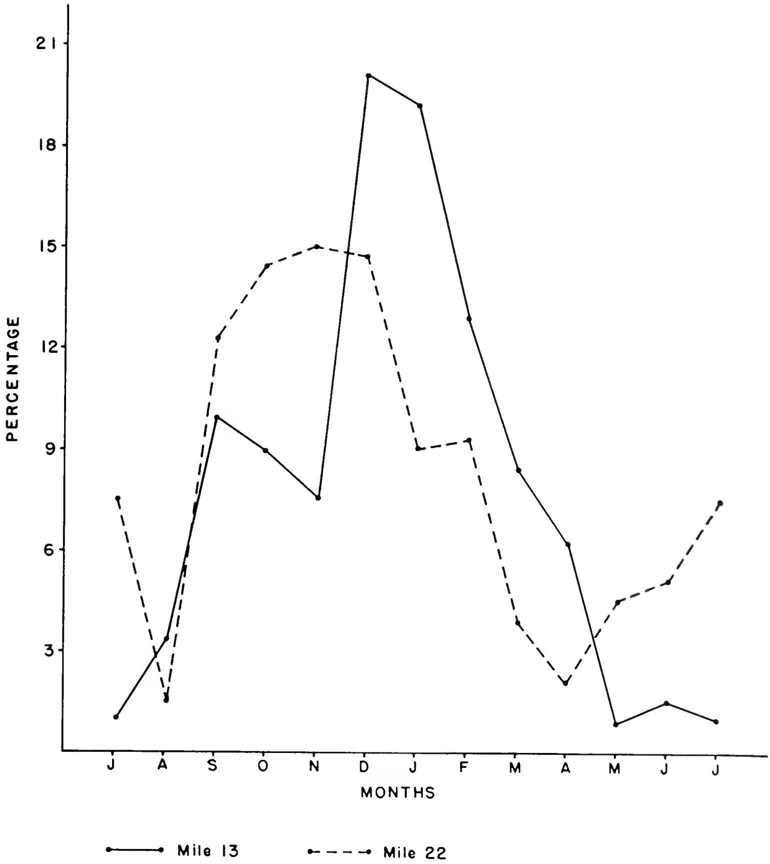


Fig. 6. The seasonality of flock formation, based upon the percentage of field observations when waves were intercepted at Mile 13 and Mile 22 of the Gombak watershed.

usual flight paths of the waves. At the platform the restricted areas used by waves became more evident. Here the usual route was that shown in Fig. 5. Occasionally a wave would come from the south above the tree and return to the valley. On these occasions it was assumed that the wave had passed up the hillside at a distance too great from the tree to be seen and was returning through the tree. The pattern shown in Fig. 5 was so persistent that it was obviously the territory and route of one flock. When a male Chestnut-backed Scimitar Babbler moved into the area and attended the flock regularly, it served to support this assumption since it was an identifiable individual.

The routes followed by certain species were characteristic. The trogon

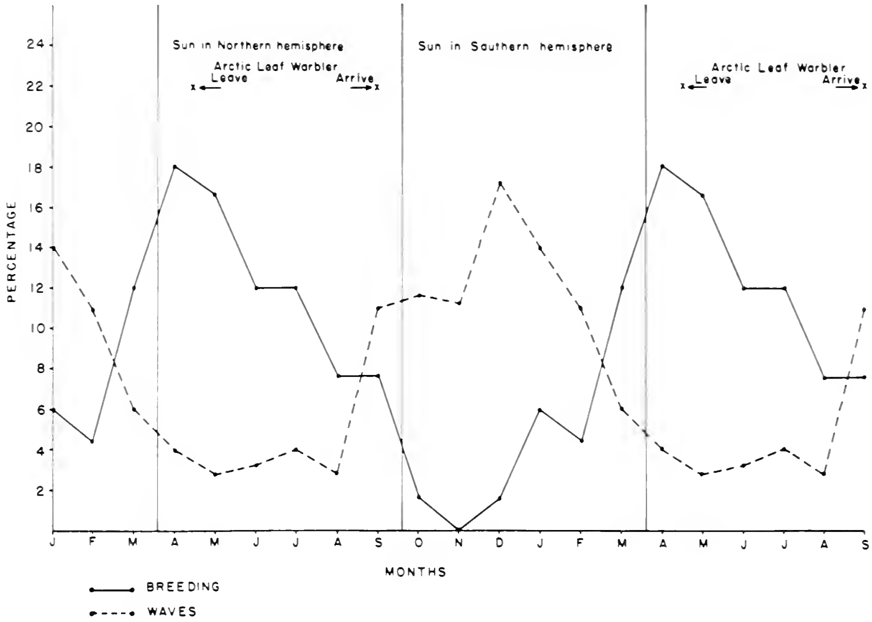


FIG. 7. The relationship between the number of feeding flocks seen each month and the amount of breeding in the population as indicated by the percentage of the total flocks seen and the percentage of the annual breeding activities noted.

tends to sit quietly on a low branch while the flock passes by and then to fly on just before the malcoha arrives. Nuthatches searched the trees as nuthatches do everywhere. Among steep hillsides and valleys the patterns were often somewhat different. The bulk of the wave followed contours while certain species made shortcuts across valleys between large trees. Although tree swifts were never an integral part of such waves they occasionally worked above them as if gleaning insects that became airborne to escape the feeding flock.

From the platform it was noted that birds took similar routes often enough to suggest that one individual was involved.

Following or during their morning flight. flocks were observed to bed down and rest or preen. Many species drifted away (malcohas or woodpeckers) but the flycatchers. babblers. flycatcher-shrikes. leafbirds, and others of the middle canopy descended into a dense tree or clump. The minivets often rested on some high limb, but not necessarily near or above the lower canopy forms. The wave poured into its roost with the same speed at which it moved while feeding. How long the flock remained quiet was probably dependent upon many things, but if startled the whole troupe streamed from its roost and moved away.

A flock usually had about 10 species that included most of the birds, but as has been discussed, other species were incorporated as the wave passed. Mammals, especially squirrels, were also stimulated by the presence of a wave. Three species—*Callosciurus tenuis*, *C. nigrovittatus*, and *C. vittatus*—were often seen in association with the birds. These came out of hiding and scurried through the trees in which the birds were feeding. They also fed upon bark, fruit, and buds and then returned to their hiding places after the flock had passed.

Where, how, when, and if the flock disbands in the evening for sleep was not determined.

Although seasonality in the temperate zone sense with its overt and massive phenological events is unknown in the tropical rain forest at 3° north of the equator, there were regular phenological determinants which could trigger physiological responses in local residents. These included arrival and departure of migrants from the north, the change in the position of the sun from north to south of zenith and return, and the regular January–February dry period brought on by the change in monsoon winds and the resulting defoliation and fruiting of some forest tree species during this period. The formation of the feeding flocks was seasonal. An occasional flock may be assembled during any month of the year, but they were regularly seen from August into April, with peak numbers from October into February. Figure 6 illustrates by month the percentage of the field observations when waves were identified. This period of intensive flocking coincides with the presence of such migrants as the Arctic Leaf Warbler which were attendant to many of the flocks. Not only were there more waves during the winter months, but also the number of birds per flock was greatest (Table 2).

Evidence of breeding (feeding fledglings, building nests, carrying food to nestlings) was recorded for 36 species and peak activity came between March and June in this watershed and at this altitude. In coastal lowland habitats it was two months earlier. Figure 7 compares the amount of breeding based on the percentages of the annual observations of breeding activities seen each month with the amount of flocking. In this watershed the grouping into feeding flocks coincided with a reduction of breeding activities of local birds, with the presence of northern migrants, and with the presence of the sun in the southern hemisphere.

APPENDIX

List of species of birds associated with feeding flocks in the Gombak watershed. Those found in more than 50 per cent of the flocks indicated by 1; 25 to 49 per cent by 2; 12 to 24 per cent by 3; and 1 to 11 per cent by 4.

Columbidae: Lesser Thick-billed Green Pigeon (*Treron curvirostra*), 4.

Psittacidae: Blue-crowned Hanging Parakeet (*Loriculus galgulus*), 4.

Cuculidae: Chestnut-breasted Malcoha (*Phaenicophaeus curvirostris*), 3; Raffles Malcoha (*P. chlorophaeus*), 4; Red-billed Malcoha (*P. javanicus*), 4; Lesser Green-billed Malcoha (*P. diardi*), 4; Rufous-bellied Malcoha (*P. sumatranus*), 4; Drongo-Cuckoo (*Surniculus lugubris*), 4; Violet Cuckoo (*Chalcites xanthorhynchus*), 4; Emerald Cuckoo (*C. maculatus*), 4.

Trogonidae: Red-rumped Trogon (*Harpactes duvauceli*), 4.

Meropidae: Blue-throated Bee-eater (*Merops viridis*), 4; Red-bearded Bee-eater (*Nyctiornis amictus*), 4.

Capitonidae: Little Barbet (*Megalaima australis*), 3; Gold-whiskered Barbet (*M. chrysopogon*), 4; Yellow-crowned Barbet (*M. henrici*), 4; Gaudy Barbet (*M. mystacophanes*), 4; Brown Barbet (*Calorhamphus fuliginosus*), 3.

Picidae: Fulvous-rumped Woodpecker (*Meiglyptes tristis*), 3; Crimson-winged Woodpecker (*Picus puniceus*), 4; Banded Red Woodpecker (*P. miniaceus*), 4; Checker-throated Woodpecker (*P. mentalis*), 4; Grey-and-buff Woodpecker (*Hemicircus concretus*), 4; Maroon Woodpecker (*Blythipicus rubiginosus*), 4; Great Slaty Woodpecker (*Mulleripicus pulverulentus*), 4; Orange-backed Woodpecker (*Chrysocolaptes validus*), 4.

Eurylaimidae: Black-and-red Broadbill (*Eurylaimus ochromalus*), 4; Banded Broadbill (*E. javanicus*), 4.

Laniidae: Brown Shrike (*Lanius cristatus*), 4.

Oriolidae: Malaysian Black-headed Oriole (*Oriolus xanthonotus*), 2.

Dicruridae: Large Racquet-tailed Drongo (*Dicrurus paradiseus*), 2; Crow-billed Drongo (*D. annectans*), 3.

Campephagidae: Scarlet Minivet (*Pericrocotus flammeus*), 1; Fiery Minivet (*P. igneus*), 2; Ashy Minivet (*P. divaricatus*), 4; Bar-winged Flycatcher-shrike (*Hemipus picatus*), 1; Black-winged Flycatcher-shrike (*H. hirundinaceus*), 3; Lesser Graybird (*Coracina fimbriata*), 3; Hook-billed Graybird (*Tephrodornis gularis*), 4.

Pycnonotidae: Scaly-breasted Bulbul (*Pycnonotus squamatus*), 2; Red-eyed Brown Bulbul (*P. brunneus*), 3; Grey-bellied Bulbul (*P. cyaniventris*), 4; Stripe-throated Bulbul (*P. finlaysoni*), 4; White-eyed Brown Bulbul (*P. simplex*), 4; Black-headed Bulbul (*P. atriceps*), 4; Black-crested Yellow Bulbul (*P. dispar*), 4; Black-and-white Bulbul (*P. melanoleucos*), 4; Lesser Brown Bulbul (*P. erythropthalmos*), 4; Ashy Bulbul (*Hypsipetes flavalus*), 3; Streaked Bulbul (*H. viridescens*), 3; Hairy-backed Bulbul (*H. criniger*), 4; Crested Olive Bulbul (*H. charlottae*), 4; White-throated Bulbul (*Criniger phaeocephalus*), 4; Scrub Bulbul (*C. bres*), 4; Finsch's Bulbul (*C. finschi*), 4.

Aegithinidae: Yellow-headed Green Leafbird (*Chloropsis cochinchinensis*), 1; Lesser Green Leafbird (*C. cyanopogon*), 2; Greater Green Leafbird (*C. sonnerati*), 2; Green Iora (*Aegithina viridissima*), 1; Great Iora (*A. lafresnayei*), 4; Fairy Bluebird (*Irena puella*), 2.

Timaliidae: Common Nun Babbler (*Alcippe poiocephala*), 2; Striped Tit Babbler (*Macronus gularis*), 3; Chestnut-backed Scimitar Babbler (*Pomatorhinus montanus*), 3; White-bellied Crested Babbler (*Yuhina zantholeuca*), 3; Lesser Red-headed Tree Babbler (*Malacopteron cinereum*), 4; Greater Red-headed Tree Babbler (*M. magnum*), 4; Plain Babbler (*M. affine*), 4; Red-rumped Tree Babbler (*Stachyris maculata*), 4.

Muscicapidae: Spotted Fantail Flycatcher (*Rhipidura perlata*), 2; Verditer Flycatcher (*Muscicapa thalassina*), 2; Grey-headed Flycatcher (*Culicicapa ceylonensis*), 2; Paradise Flycatcher (*Terpsiphone paradisi*), 2; Black-naped Blue Flycatcher (*Hy-*

pothymis azurea), 3; Tickell's Blue Flycatcher (*Muscicapa tickelliae*), 4; Brown Flycatcher (*M. latirostris*), 4; Siberian Flycatcher (*M. sibirica*), 4; Chestnut-winged Flycatcher (*Philentoma pyrrhoptera*), 4.

Sylviidae: Flyeater (*Gerygone fusca*), 1; Arctic Leaf Warbler (*Phylloscopus borealis*), 2; Lesser Brown Wren-Warbler (*Prinia rufescens*), 4; Black-necked Tailorbird (*Orthotomus atrogularis*), 4.

Turdidae: Common Shama (*Copsychus malabaricus*), 4.

Paridae: Sultan Tit (*Melanochlora sultanea*), 4.

Sittidae: Velvet-fronted Nuthatch (*Sitta frontalis*), 2.

Zosteropidae: Oriental White-eye (*Zosterops palpebrosa*), 4.

Dicaeidae: Orange-bellied Flowerpecker (*Dicaeum trigonostigmum*), 4; Crimson-breasted Flowerpecker (*Prionochilus percussus*), 4; Yellow-throated Flowerpecker (*P. maculatus*), 4; Thick-billed Flowerpecker (*D. agile*), 4; Plain Flowerpecker (*D. concolor*), 4.

Nectariniidae: Little Spiderhunter (*Arachnothera longirostris*), 3; Lesser Yellow-eared Spiderhunter (*A. chrysogenys*), 4; Long-billed Spiderhunter (*A. robusta*), 4; Grey-breasted Spiderhunter (*A. affinis*), 4; Scarlet Sunbird (*Aethopyga mystacalis*), 4; Yellow-backed Sunbird (*A. siparaja*), 4; Ruby-cheeked Sunbird (*Anthreptes singalensis*), 4; Rufous-throated Sunbird (*A. rhodolaema*), 4; Purple-naped Sunbird (*Nectarinia hypogrammica*), 4.

Ploceidae: Sharp-tailed Munia (*Lonchura striata*), 4.

SUMMARY

Between January 1959 and June 1963 feeding flocks (bird waves) of mixed species of insectivores were under observation in Central West Malaya, 8 in a secondary forest at 150 feet altitude, 74 in lowland forest at 1,000 feet, and 80 in sub-montane forest at 2,000 feet. One hundred nine species were in association in these flocks, of which 20 were the most often encountered as nuclear or regularly attendant species. Five species of aegithinids, *Aegithina viridissima, Chloropsis cochinchinensis, C. sonnerati, C. cyanopogon, Irena puella*, and two campephagids *Pericrocotus igneus* and *P. flammeus* dominated the flocks. The timaliid *Alcippe poiocephalus* and sylviid *Gerygone fusca* were important wave "organizers" having conspicuous flock calls.

The segments of waves recorded usually included about 10 species and 35 individuals, but much greater numbers were encountered. The average number of individuals per species varied with the species and season. Greatest number of waves, species and individuals were encountered between November and March. Waves flowed through the forest in definite patterns and had length, depth, and width. The species in the flocks tended to remain at certain levels within the canopy and position within the wave.

LITERATURE CITED

Davis, D. E.

1946 A seasonal analysis of mixed flocks of birds in Brazil. *Ecology*, 27:168–181.

McClure, H. E.

1963 English vernacular names of the birds of the Malaysian Subregion. *Malayan Nature Jour.*, 17:75–121.

1964 Avian bionomics in Malaya: 1. The avifauna above 5000 feet altitude at Mount Brinchang, Pahang. *Bird-Banding*, 35:141–183.

McClure, H. E. and H. bin Othman
1965 Avian bionomics of Malaya: 2. The effect of forest destruction upon a local population. *Bird-Banding*, 36:242–269.
Moynihan, M.
1962 The organization and probable evolution of some mixed species flocks of neotropical birds. *Smithsonian Misc. Collections*, 143:1–140.
Short, L. L., Jr.
1961 Interspecies flocking of birds of montane forest in Oaxaca, Mexico. *Wilson Bull.*, 73:341–347.
Stanford, J. K.
1947 Bird parties in forests in Burma. *Ibis*, 89:507–509.
Winterbottom, J. M.
1943. On woodland bird parties in Northern Rhodesia. *Ibis*, 85:437–442.
1949 Mixed bird parties in the tropics with special reference to Northern Rhodesia. *Auk*, 66:258–263.

MIGRATORY ANIMAL PATHOLOGICAL SURVEY, APO, SAN FRANCISCO, CALIFORNIA 96346, 22 MARCH 1965.

NEW LIFE MEMBER

A new Life member of The Wilson Ornithological Society is Arthur J. Wiseman, a registered pharmacist of Cincinnati, Ohio. Mr. Wiseman, a graduate of the University of Cincinnati, is an amateur ornithologist with a deep and serious interest in birds. His contributions to ornithology include reports to *Audubon Field Notes*, and he is currently engaged in cataloging the bird-skin collection of The University of Cincinnati. He is a member of the AOU, National Audubon Society, Inland Bird Banding Association, Northeastern Bird Banding Association, and the Cincinnati Bird Club. Mrs. Wiseman is also both a pharmacist and a dedicated amateur ornithologist.

ADDITIONAL NOTEWORTHY RECORDS OF BIRDS FROM ARCHAEOLOGICAL SITES

Paul W. Parmalee

Indians of eastern United States utilized many of the native animals for basic subsistence: the flesh was eaten, hides served as clothing and robes. and bones were altered to make tools and ornaments. Occasionally certain body parts (skulls, claws, teeth, feathers) figured significantly in ceremonial rites and regalia and they were included with the dead as grave offerings. Remains of these animals often provide an index to their early distribution and possible abundance. Differences between past and present numbers, range and/or status of certain species are of special zoological interest.

In addition to the ornithological interest in these elements, the fact that the birds were taken and used by the Indian often compounds the significance of such records; discussion of this material should be treated as an intricate part of both fields of archaeology and zoology. Since the publication of an article dealing with archaeological remains of rare or extinct birds and those now extirpated from Illinois (Parmalee, 1958), additional faunal samples from eleven Indian midden deposits and cemeteries have supplemented the presently known early range of such species. Basic data pertaining to the archaeological sites from which these avian remains were recovered are listed in Table 1. All of the elements discussed here are in the archaeozoological collections of the Illinois State Museum.

Swallow-tailed Kite (*Elanoides forficatus*).—Ridgway (1889) wrote that "In former years common throughout the State, and in some portions even at times abundant, . . . is becoming scarcer every year." Smith and Parmalee (1955) report the species as accidental in Illinois and list only four sight records since 1900. The first archaeozoological evidence of this kite in Illinois was reported by Parmalee (1958): a complete femur and tibiotarsus were recovered from a refuse pit at the Cahokia Site.

Although never numerous in proportion to remains of Turkey and waterfowl. bones of the Bald Eagle, hawks (*Buteo, Falco, Accipiter*), and owls (*Strix, Bubo*) are encountered not uncommonly in midden deposits. An incomplete right tarsometatarsus (proximal end missing) found at the Jasper Newman Site represents the second and most recent prehistoric record of the Swallow-tailed Kite in Illinois.

Whooping Crane (*Grus americana*).—Baker (1941) recorded this species as having been identified from remains recovered from Late Woodland–Early Mississippian sites in Peoria and Jackson counties, Illinois. Only one other bone of *G. americana* has since been found at an Indian site in Illinois. This element, a 7-inch section of a right humerus taken from a refuse pit at

TABLE 1

ARCHAEOLOGICAL SITES FROM WHICH THE BIRD BONES WERE RECOVERED

Site name and location	Cultural affiliation and time of occupancy	Investigator and year excavated or (published reference)
Cahokia: 3 mi. W. of Collinsville, Madison/St. Clair counties, Illinois.	Middle Mississippi 900–1500 A.D. (Village and Mounds)	Parmalee (1958)
Crawford Farm: 1½ mi. E. of Milan, Rock Island County, Illinois.	Historic Sauk-Fox 1790–1810 A.D. (Village and Cemetery)	Parmalee (1964)
Emmons: 1 mi S. of Marbletown, Fulton County, Illinois.	Middle Mississippi 900–1500 A.D. (Cemetery)	Merrill Emmons 1958
Etowah: 3 mi. S.W. of Cartersville, Bartow County, Georgia.	Etowah Period I to IV (1100–1500 A.D.) to Early Cherokee (1600–1700 A.D.) (Village and Mounds)	Kelly and Larson (1957) van der Schalie and Parmalee (1960)
Fairchance: Moundsville. Marshall County, West Virginia.	Early Woodland–Hopewell 0–200 A.D. (Village and Mound)	West Va. Archaeo. Society 1964
Flynn Cemetery: Northern Allamakee County, Iowa.	Historic 1650–1700 A.D. (Cemetery)	Bray (1961)
Irving: 1 mi. N. of Chambersburg, Pike County, Illinois.	Late Woodland 525–1025 A.D. (Village)	McGregor (1958)
Jasper Newman: 10 mi. S.W. of Sullivan, Moultrie County, Illinois.	Middle Mississippi 900–1500 A.D. (Village)	Wm. M. Gardner 1964
Modoc Rock Shelter: 2 mi. S.E. of Prairie du Rocher, Randolph County, Illinois.	Archaic 8000 B.C.–1500 A.D. (Camp)	Parmalee (1959*b*)
Pool: 1½ mi. N. of Chambersburg, Pike County, Illinois.	Late Hopewell 100–300 A.D. (Village)	McGregor (1958)
Schild: 4 mi. S. of Eldred, Green County, Illinois.	Late Woodland–Early Mississippi 800–1200 A.D. (Cemetery)	Gregory Perino 1962
Snyders: 4 mi. N. of Batchtown, Calhoun County, Illinois.	Hopewell 100 B.C.–200 A.D. (Village)	Stuart Struever 1960

the Pool Site, had several deep, transverse butchering (?) cuts at the center of the shaft; both ends had been broken off.

Ridgway (1895) states "Once an abundant migrant, and in some localities a common summer resident, . . . Mr. Nelson remarks of it: 'Along the Illinois River and more thinly settled portions of the State it is still common during the migrations, and a few pairs breed upon the large marshes in central Illinois.' " However, the paucity of remains of the whooping crane from archaeological sites suggests that the Indian seldom took—or encountered—this bird. On the other hand, numerous bones of the Sandhill Crane (*Grus canadensis*) found at Cahokia (Parmalee, 1957) and at other sites indicate that this species was far more common in prehistoric times than the Whooping Crane.

In September, 1958, an Indian burial site was discovered during road construction along Bear Creek in northern Allamakee County, Iowa. This site, referred to as the Flynn Cemetery, contained approximately 17 burials. Two bird skulls, placed with separate burials as intentional offerings, were of special interest. The bill and anterior part of the skull of a Raven (*Corvus corax*) was found just above the right shoulder of Burial No. 1. In addition to two swan (?) wing bone whistles recovered with Burial No. 4, Bray (1961) reported that "Lying on top of the left femur at its proximal end was the beak and part of the skull of a bird tentatively identified as a heron." This specimen was, in fact, a Whooping Crane; a complete quadrate, upper bill, a portion of the cranium, and sections of the lower bill had been salvaged. The bird was probably taken locally as *G. americana* was known to have nested in Iowa (A.O.U., 1957) and since the skull (head) had been included as a grave offering, this crane was apparently of special significance.

Large quantities of bone and shell were recovered during summer (1954, 1955, 1956) excavations of Mounds B and C at the Etowah Site, Georgia. The species of vertebrates and number of remains were similar for both of these mounds and their adjoining village areas; animal remains from Mound C have been reported by van der Schalie and Parmalee (1960). With regard to bird remains, bones of the Turkey were the most numerous, followed by those of the Passenger Pigeon. One interesting find from Mound B that was not encountered in Mound C included three bones of the Whooping Crane: a complete right 1st phalanx; a 7¼-inch shaft section of a left ulna and the proximal end section of a left tarsometatarsus. According to the 5th A.O.U. Check-list (1957), *G. americana* formerly wintered along the southeast coast of Georgia (St. Simons Island). Bones of the Whooping Crane from the Etowah Site were from a bird—or birds—taken probably during migration through the northwestern section of Georgia (Bartow County) or possibly from wintering birds killed by Indians on forays to the coast.

Long-billed Curlew (*Numenius americanus*).—Presently this bird is considered of accidental occurrence in Illinois although Ridgway (1895) referred to early accounts which listed it as "more or less" common or even abundant locally during migration and as a summer resident. Remains of shorebirds are rarely encountered in archaeological sites and apparently the Indian made little use of these birds. The most recent archaeozoological record of this curlew from Illinois consisted of a complete left carpometacarpus and section of a left ulna from the Crawford Farm Site (Parmalee, 1964). Since publication of that article, a complete left radius of *N. americanus* was identified from a small sample of bone saved by Mr. Dale F. Holmgrain, East Moline, during final salvage operations at this site in 1963.

Carolina Parakeet (*Conuropsis carolinensis*).—With reference to the parakeet's status in Illinois, Ridgway (1889) wrote that it ". . . is probably now everywhere extinct within our borders, though fifty years ago it was of more or less common occurrence throughout the State." Remains of this extinct bird in Indian midden and refuse deposits are rare and prior to the following, bones of *C. carolinensis* have been reported from only the Cahokia Site in Illinois (Parmalee, 1958).

A complete left coracoid of this parakeet was found at the Irving Site. Considering the former abundance and distribution of the Carolina Parakeet in Illinois and the few remains thus far encountered at archaeological sites, the Indian rarely made use of this beautiful bird. However, in addition to the two ulnae and a tarsometatarsus recovered at the Cahokia Site (Parmalee, op. cit.), nine upper bills were found together in a refuse pit at this site which suggests that, at least in one instance, the Indian had used the parakeet as some form of decoration.

Snowy Owl (*Nyctea scandiaca*).—Smith and Parmalee (1955) list the Snowy Owl as an irregular and rare winter visitant in northern Illinois and a very rare winter visitant in the central and southern parts of the state. Bones of this attractive owl might be expected in midden deposits since feathers and occasionally body parts of raptorial and certain other species or groups of birds were used for ornaments and decoration. However, the normal rarity of the Snowy Owl in Illinois would limit the number of birds available to the Indian. The following records, the first evidence of the prehistoric Indian in Illinois using this owl, are noteworthy because of the rarity of *N. scandiaca* in central Illinois and the purpose for which the birds were used.

The late Mr. Merrill Emmons, Astoria, Illinois, had an extensive Middle Mississippian cemetery on his property. The burials had been placed at the top and along the slope of a section of bluff bordering the Illinois River on the west. On 16 August 1958, Mr. Emmons uncovered a child burial (est.

age, 5 years); beside each upper arm (humerus) of this child was a complete right carpometacarpus of the Snowy Owl. Of special interest was the fact that both of these elements were from a right wing, thus representing two owls. These owl wings had been used probably as fans or for some type of decoration and were placed beside the arms of the child when the body was interred. The practice of placing bird wing artifacts with burials by peoples of the Mississippian culture has been reported from sites in Arkansas (Parmalee, 1959*a*) and from sites in other eastern states.

The second archaeozoological record of this owl in Illinois consisted of wing and leg elements recovered with two burials at the Schild Site. Mr. Gregory Perino, Thomas Gilcrease Foundation, Tulsa, Oklahoma, removed approximately 300 Late Woodland–Early Mississippian burials from this cemetery. Found with Burial No. 70 were the paired carpometacarpals (process of metacarpal I and extensor attachment of the right had been cut away) and left wing digits of *N. scandiaca.* Burial No. 265 was a bundle reburial and with it was found the left carpometacarpus of a Great Horned Owl (*Bubo virginianus*) and the left tarsometatarsus of a Snowy Owl. In addition to the leg element, 10 phalanx elements (including 6 claws) were also recovered which suggest that probably both legs of the owl had been placed with the burial at the time of original interment. A similar grave offering from a Hopewell burial mound in Michigan was illustrated and described by Flanders and Cleland (1964).

The most recent discovery of Snowy Owl remains found in association with archaeological materials occurred on 16 October 1966. While removing 11 Indian burials on the farm of Victor Krueger, located on the Mississippi River bluff three miles southwest of Columbia, Monroe County, Illinois, Mr. Perino recovered the right tarsometatarsus, and a first and ungual phalanges that were lying near the skull of an adult male. This lower leg of the Snowy Owl, plus the carpometacarpus of a Turkey and the lower jaw of a mink found together with another burial, were the only grave offerings encountered. Teeth in two of the human skulls had been filed or edge-notched (Perino, pers. com., letter of 16 October 1966); this condition (of Mexican origin) plus the trait of including bird wing or leg parts when interring the body, suggests that these burials were of the Mississippian cultural period.

Ivory-billed Woodpecker (*Campephilus principalis*).—Remains of this woodpecker have been found in few archaeological sites located in states (Ohio: Wetmore, 1943; Illinois: Parmalee, 1958, 1964) north of its known former range in eastern North America. The bones of *C. principalis* from Scioto County, Ohio (Wetmore, op. cit.) and Madison County, Illinois (Parmalee, 1958) were both tarsometatarsals and were recovered in midden deposits rather than with burials; therefore, they probably represent the remains of birds that died or were killed locally and not an imported or bartered trade item. However, the one upper and two lower bill sections (2 individuals) recovered from the historic Sauk-Fox cemetery in Rock Island County, Illinois (Parmalee, 1964) may have been part of a headdress or pipe decoration and represent decorative items obtained from another (southern?) source or locality. The use of bills and "scalps" of this woodpecker by certain historic Indian groups for pipe stem decoration is well documented.

During the summer of 1964, members of the Wheeling area chapter of the West Virginia Archeological Society excavated the Fairchance Mound and some of the associated fill and village midden. John E. Guilday, Carnegie Museum, Pittsburgh, submitted a small series of bird bones from this site to the author for identification and among these elements were two lower bill sections (same bird?) of the Ivory-billed Woodpecker that had been recovered in the midden debris. It is impossible to ascertain whether these bones were from a bird taken locally or represent a trade artifact; the early range of this species probably included sections of West Virginia although there are apparently no existing specimens or other authenticated records from this region.

Common Raven (*Corvus corax*).—Whether or not the Indian utilized ravens and crows for food is a matter of speculation, but the fact that he was well aware of these birds is evidenced by occasional bones recovered in midden debris, bones (originally, body parts) placed with burials (Bray, 1961; Wittry, 1962) and depictions in the form of effigy pipes (Fowler, 1957). Miller (1961) has stated that "My surmise is that at least certain clans or brotherhoods of the tribe used the corvids in sacrifice or captured them for their plumage. . . ." The raven is presently of accidental occurrence in Illinois although it probably was never a common bird in the prairie regions.

Parmalee (1958) summarized archaeozoological records of this bird in Illinois to that date; since then, paired wing elements (carpometacarpal) recovered in 1960 at the Crawford Farm Site were reported (Parmalee, 1964). In addition to these two wing bones from this Sauk-Fox village, a complete right 1st phalanx of *C. corvax* was later determined from a small sample of bone that had been inadvertently mixed with artifact material. In May, 1958, the late Merrill Emmons found an eagle claw and two upper bill sections (two individuals), a complete right carpometacarpus and right tarsometatarsus of the raven with a Middle Mississippian burial on his property. These elements were placed with the body (an adult male) when it was interred as contents of a medicine bag or possibly as trophies or ornaments sewn to the clothing.

Fish Crow (*Corvus ossifragus*).—With reference to the Midwest, the 5th A.O.U. Check-list (1957) records the inland distribution of the Fish Crow as ". . . along major river systems to southwestern Tennessee (Memphis), ..." Although this bird has not been reported from Illinois, recent records along the Mississippi River in southeastern Missouri (Easterla, 1965) indicate the Fish Crow to be at least a summer resident in that region. Easterla (op. cit.) mentions that several members of the St. Louis Audubon Society have reported summer sight records of this species along the river south of St. Louis; it is reasonable to assume the bird probably occurs on both sides of the river. The following two specimens are of special interest since they represent the first archaeozoological records and constitute evidence for the prehistoric occurrence of the Fish Crow in Illinois, a bird previously unrecorded from the state.

The first element, a nearly complete right carpometacarpus, was found at the Modoc Rock Shelter Site. Bone and shell were extremely abundant in this deposit (nearly 8,000 identifiable vertebrate remains: Parmalee, 1959*b*): a minimum of 56 species of birds were identified. The second Illinois specimen is a complete right tarsometatarsus found by Stuart Struever at the Snyders Site. Both elements occurred in midden deposits and although there is no evidence to suggest special use of the Fish Crow by the Indians, these bones provide the basis for assuming that this bird did occur in prehistoric times along the Mississippi River bordering central and southern Illinois.

SUMMARY

Remains of seven species of birds found in archaeological sites in Iowa, Illinois, West Virginia, and Georgia which are now either extinct, rare, or extirpated in these states are discussed. Supplements to the known range of these species and their use by the Indian are presented; two bones of the Fish Crow from Indian sites in southwestern Illinois constitute the first record of this bird for that state.

ACKNOWLEDGMENTS

I would like to express my gratitude to Mrs. Rosalie Emmons, Stuart Struever, John C. McGregor, Robert T. Bray, John E. Guilday, Gregory Perino, Dale F. Holmgrain, William M. Gardner, and Lewis H. Larson, Jr. for donating the specimens described and for permission to use the data. Special appreciation is extended to Alexander Wetmore, Research Associate, United States National Museum, Washington, for verification of preliminary identifications made on several of the bird bones described here.

LITERATURE CITED

AMERICAN ORNITHOLOGISTS' UNION
1957 The A.O.U. check-list of North American birds: 5th edition.

BAKER, F. C.
1941 A study in ethnozoology of the prehistoric Indians of Illinois. Pt. 2, *Trans. Amer. Philosoph. Soc.*, 32:51–77.

Bray, R. T.

1961 The Flynn cemetery: an orr focus Oneota burial site in Allamakee County. *J. Iowa Archaeological Soc.*, 10:15–25.

Easterla, D. A.

1965 Range extension of the Fish Crow in Missouri. *Wilson Bull.*, 77:297–298.

Flanders, R. E., and C. E. Cleland

1964 The use of animal remains in Hopewell burial mounds, Kent County, Michigan. *Jack-pine Warbler*, 42:302–309.

Fowler, M. L.

1957 Rutherford Mound, Hardin County, Illinois. *Illinois State Mus. Sci. Papers*, 7.

Kelly, A. R., and L. H. Larson

1957 Explorations at Etowah, Georgia 1954–1956. *Archaeology*, 10:39–48.

McGregor, J. C.

1958 The Pool and Irving villages. Univ. of Illinois Press, Urbana.

Miller, L.

1961 Bird remains from Indian middens in the Dakota area. *Bull. So. California Acad. Sci.*, 60 (Pt. 3):122–126.

Parmalee, P. W.

1957 Vertebrate remains from the Cahokia site, Illinois. *Trans. Illinois State Acad. Sci.*, 50:235–242.

1958 Remains of rare and extinct birds from Illinois Indian sites. *Auk*, 75:169–176.

1959*a* Animal remains from the Banks site, Crittenden County, Arkansas. *Tennessee Archaeological Soc. Misc. Paper* No. 5.

1959*b* Animal remains from the Modoc Rock Shelter Site, Randolph County, Illinois. Appendix II, pp. 61–65 in Summary Report of Modoc Rock Shelter 1952, 1953, 1955, 1956 by M. L. Fowler. Illinois State Museum Report Invest. No. 8.

1964 Vertebrate remains from an historic archaeological site in Rock Island County, Illinois. *Trans. Illinois State Acad. Sci.*, 57:167–174.

Ridgway, R.

1889 The ornithology of Illinois. State Lab. Nat. Hist., Pt. I, Vol. I. Springfield.

1895 The ornithology of Illinois. State Lab. Nat. Hist., Pt. I, Vol. II. Springfield.

Smith, H. R., and P. W. Parmalee

1955 A distributional check list of the birds of Illinois. Illinois State Mus., Pop. Sci. Ser. IV.

van der Schalie, H., and P. W. Parmalee

1960 Animal remains from the Etowah site, Mound C, Bartow County, Georgia. *Florida Anthropol.*, 13:37–54.

Wetmore, A.

1943 Evidence of the former occurrence of the Ivory-billed Woodpecker in Ohio. *Wilson Bull.*, 55:55.

Wittry, W. L.

1962 A raven headdress from Sauk County, Wisconsin. *Wisconsin Archaeology* 43:87–94.

ILLINOIS STATE MUSEUM, SPRINGFIELD, ILLINOIS. 16 MARCH 1966.

BIRDS OF THE SIERRA DE TUXTLA IN VERACRUZ, MEXICO

Robert F. Andrle

The Sierra de Tuxtla is a small mountain range which forms an isolated topographic uplift from the nearly level Gulf coastal plain of southern Veracruz about 90 km southeast of Veracruz city (Fig. 1). Within the Sierra is one of the most extensive humid tropical forest areas in Mexico. The region's varied habitats not only provide suitable ecological conditions for many bird migrants (Andrle, 1966) but support an abundance of resident species. This paper deals with the Sierra's nontransient bird species and attempts to analyze briefly their composition and affinities, distribution and abundance, and some aspects of their ecology. Since Sclater's (1857 *a,b*) reports appeared on birds collected near San Andrés Tuxtla and Sontecomapan, and Nelson and Goldman secured specimens in the region in 1894, apparently the only published ornithological studies have been those by Wetmore (1943) on part of the western section, by Davis (1952) on a small area south of Lake Catemaco, and by Edwards and Tashian (1959) on the section about Coyame. My investigations were carried out in short periods in 1951, 1952, and 1960, and during about eleven months residence in 1962.

DESCRIPTION OF THE SIERRA DE TUXTLA

The Sierra is a volcanic range about 4,200 square km in area whose four largest volcanoes culminate an uplift that in most directions slopes gradually to the coastal plain. Exceptions to this are where long ridges form headlands at the Gulf and where Cerros Tuxtla and Blanco, two outlying volcanoes, interrupt the descent to the lowlands (Fig. 2). The northwestern massif, centered on Volcán San Martín Tuxtla, has a surface characterized by medium to small-sized, cratered cones and rounded hills interspersed among ridges, valleys, and undulating terrain. The line of cones extending from Volcán San Martín southeast across the north side of the Lake Catemaco basin merges into the southeastern massif dominated by Volcán Santa Marta. There deep gorges and dissected lava ridges radiate toward the coast, while broad ridges and narrow valleys lead southward from the peaks. The Sierra is a well-watered region with Lake Catemaco lying in a large basin partially bordered by volcanic cones and hills, Bahía Sontecomapan on the Gulf, about ten scattered crater lakes, and many permanent streams.

For study purposes I set the inland border of the Sierra at about the 100 m contour. The more abrupt descent to the Gulf and the general proximity of the range to the coastline make sea level there a practical delimitation for avifaunal analysis.

CLIMATE, VEGETATION, AND LIFE ZONES

The Sierra's climate is influenced by northeast trade and continental winds, northers, occasional easterly waves, and by the moderating effects of the Gulf. Its large volcanoes and their subsidiary cones and ridges form a front about 50 km long that is an orographic barrier to air masses from the Gulf and inland. The resulting orographic precipitation and that from convection give the range a generally humid character, although drier conditions exist in the rain shadow on the inland slopes and along the Gulf. Mean annual precipitation ranges from about 1,700 to over 4,000 mm, the complex topography affecting local amounts and intensity. During the rainy season from May to November and at times in the dry season the mountains above 700 m are often cloud covered. Although the warm Gulf water, persistent cloud cover, and extensive forests contribute toward temperature moderation (mean annual recorded 24.2 C), minimum temperatures, especially during northers, can be fairly low (6–10 C) and freezing does occur infrequently at upper altitudes.

High rainfall and warm temperatures support the development of luxuriant vegetation, much of it comparatively homogeneous humid forest. Yet volcanism and weathering have formed a varied topography that interacts with changes in soil type, depth, and moisture to cause considerable local structural complexity in plant formations. Such variability is increased in much of the Sierra by expanding human modification of vegetation creating seral stages that provide diverse habitats for birds (Fig. 3). Figure 4 shows the general distribution of vegetation types except for restricted areas of tropical semideciduous forest on the inland slopes and lowland valley and swamp forest occupying small sections in stream valleys on the Gulf side.

Rain forest (Fig. 5) occupies a large part of the Sierra and varies in stratification and height with change in altitude and the factors mentioned previously. Although here I designate it as rain forest, in many places its structure is more like Beard's (1944:138) "Evergreen Seasonal Forest" than his optimum rain forest formation. At higher altitudes the humid forest resembles his "Lower Montane Rain Forest," "Montane Rain Forest," and "Elfin Woodland" formations. Some of the canopy tree genera in the Sierra's tall rain forest are *Bernoullia, Brosimum, Dussia, Ficus, Ilex, Phoebe, Pithecollobium, Talauma,* and *Virola.* Vines, air plants, climbers, and tree buttressing are conspicuous. Above about 1200 m the transition occurs to a lower forest that becomes elfin and more moss-covered on crater walls and peak ridges (Fig. 6). Miranda and Hernandez (1963), however, classify the tall, humid forest in the Sierra as "selva alta perennifolia," which they equate with Beard's optimum rain forest. The montane types, including cloud forest and the elfin woodland, they designate as "selva mediana o baja perennifolia."

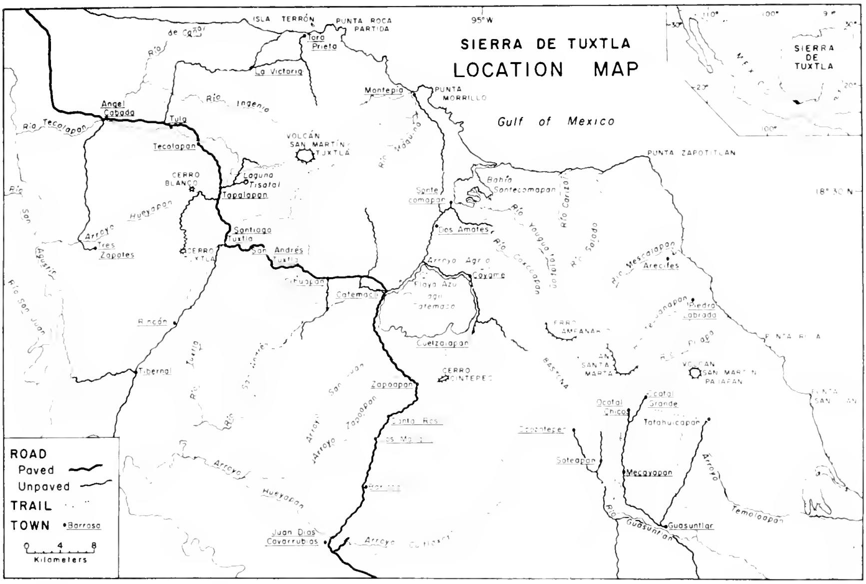


FIG. 1. Drainage system and principal peaks of the Sierra de Tuxtla in relation to roads, trails, and urban centers.

Although there is not sufficient precipitation data available for the Sierra to make a complete analysis of vegetation under the Holdridge (1947) system, probably none of the range's humid forest can be placed in his "Rainforest" formations. Most of this forest should be classified in his "Tropical Moist Forest" category with that at higher altitudes being placed in the "Subtropical Wet" or "Subtropical Moist" formations.

An open, pine and oak woodland with pines (*Pinus oocarpa*) chiefly on the ridges and oaks more on the ravine and valley sides occurs on the southern slopes of the Volcán Santa Marta massif (Fig. 7). Remnants of tropical semideciduous forest ("Selva alta o mediana subcaducifolia" of Miranda and Hernandez) and extensive oak woodlands interspersed with tree savanna lie at lower elevations to the south. Sweet gum (*Liquidambar styraciflua*) occurs sporadically in the humid forests of both massifs and north of the Lake Catemaco basin, but large stands ("bosque caducifolia" of Miranda and Hernandez) exist only on the upper southern slopes of the Volcán Santa Marta section where they merge at their upper edge into montane rain forest. Deforestation has resulted in a great expansion of open country with grasslands and weedy fields broken by tree rows, forest remnants, and occasionally palms or patches of palm forest.

The Sierra de Tuxtla lies entirely within the Tropical Life Zone. The

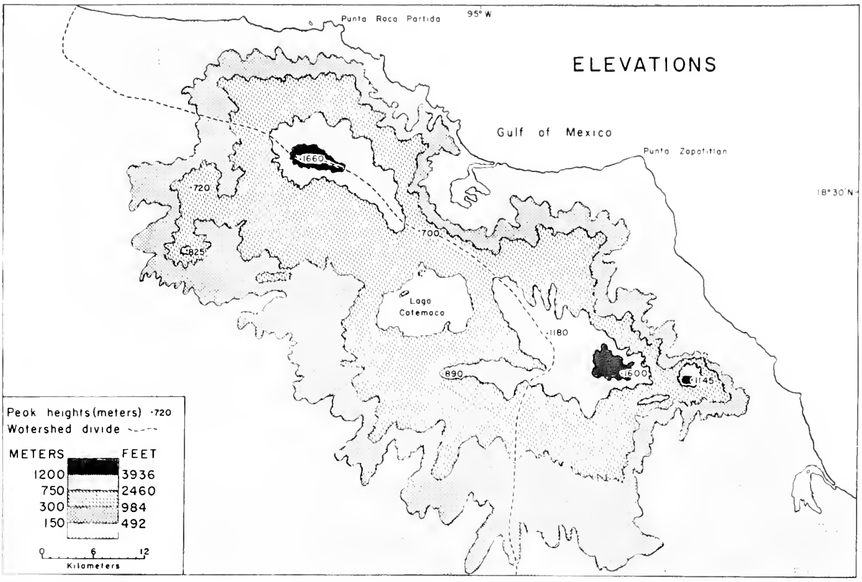


FIG. 2. General elevation pattern of the Sierra de Tuxtla showing key heights.

Humid Upper (Subtropical) and Lower Tropical Zones encompass mostly the rain and cloud forests and some of the nonforested terrain. The Arid Division of the Lower Tropical Zone extends into the Sierra from the inland side, including principally the semi-open palm-forest-grass areas, oak and tropical semideciduous forests, the savannas and some of the pine-oak section. My investigations show that in regard to the avifauna there are no distinct life zone boundaries in the Sierra, and the demarcation between Humid Upper and Lower Tropical Zones is definitely transitional as evidenced by altitudinal mixing of avian forms. The arid part of the Lower Tropical Zone is not strongly indicated by the avifauna, comparatively few species occurring that can be considered typical of this division. From an altitudinal viewpoint the role of temperature in life zone definition here is apparently minimized by the small relief and relatively low latitude of the range.

NONTRANSIENT BIRDS

Historical background, composition, and affinities.—The Sierra de Tuxtla has been available for permanent avian colonization since its final emergence from the sea and uplift during the Pliocene. At this time probably some modern bird genera became well established, and the range's avifauna very likely contained a pronounced tropical element. However, the avifauna's

FIG. 3. Sierra landscape near Cerro Blanco, one which supports many species of habitat B. In the background are forested Volcán San Martín Tuxtla and subsidiary mountains.

composition during the late Tertiary and Pleistocene is necessarily speculative because, like other parts of Mexico and Central America, the Sierra was affected by the faunal mixing of northern and southern elements that possibly increased after closing of the water gaps between North and South America and cooling of the climate in North America in the Pleistocene. Even during lowered temperatures of Pleistocene glacial stages, however, it seems unlikely that the Sierra's climate ever became cooler than warm temperate. From the Eocene to the Pleistocene and in the latter's interglacial stages it was probably tropical (Dorf, 1959:185). Therefore, though tropical vegetation elements may have been less abundant during the Pleistocene, and the Upper Tropical Life Zone probably descended in elevation (see Griscom, 1950:358), it seems certain that the Sierra's avifauna at this time was not completely displaced. When the climate ameliorated after the final glacial stage and humid tropical vegetation was able to attain its present northward extent and abundance, bird species of the Upper Tropical Zone in the Sierra were then restricted to higher altitudes and more suitable conditions were afforded for northward dispersal into the range of Lower Tropical Zone birds from the Central American lowlands. It is probable that the avifauna, for most of the range's history since its volcanic formation, has consisted

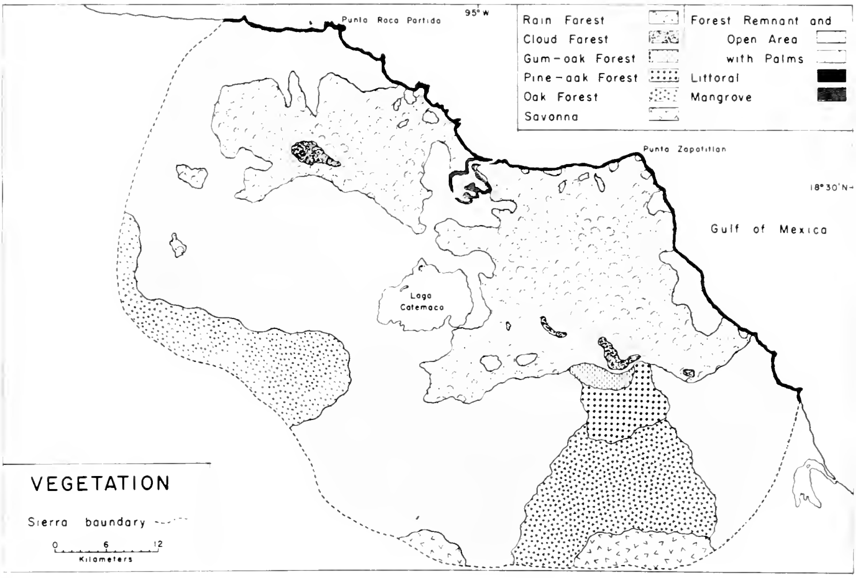


Fig. 4. Principal vegetation types of the Sierra de Tuxtla.

mainly of forest-adapted species. Only in the comparatively short time since it has been occupied by humans has a major transformation occurred to the preponderance of nonforest types evidenced by the present avifaunal composition.

Nontransient species (including those that are known to breed or may possibly do so) recorded in the Sierra de Tuxtla number 251, representing 58 families. Since there are suitable nesting habitats for those not known to breed and their ranges in Mexico either encompass the Sierra or are not far distant, it is probable that some breed at present. The family represented in the Sierra by the largest number of species (26) is the Tyrannidae. The six other families among the highest in number of species are: Accipitridae (13), Columbidae (13), Trochilidae (14), Icteridae (14), Thraupidae (14) and Fringillidae (14). Almost one-third of all the families are represented by only one species each.

On the basis of Mayr's (1946) analysis of the history of the North American bird fauna, the Sierra's nontransient avifauna can be divided into six elements. Species of probable North American and Old World origin total about 67 in contrast to the essentially southern origin of the Panamerican and South American elements, represented by a total of about 111 species. Almost half of the species comprising these last two elements are characteristic of the humid tropical forest which formed a medium for their dispersal

FIG. 5. Interior of montane rain forest along old road at 650 m elevation southeast of La Victoria. Upper Tropical Zone birds, such as *Geotrygon lawrencii*, *Turdus assimilis*, and *Chlorospingus opthalmicus*, are fairly numerous here.

FIG. 6. Crater of Volcán San Martín Tuxtla covered by cloud forest. Relatively few birds inhabit the elfin type predominant here. View is from 1600 m elevation toward northwest where clouds from the Gulf are beginning to move over the range.

northward. The avifauna is also composed of a large number of species (70) in the Widely Distributed and Pantropical elements of unknown or uncertain origin (27 per cent of the nontransients). Apart from these last two elements, however, species of probable Neotropical origin predominate (44 per cent) in the Sierra in comparison to those with northern affinities (26 per cent), reflecting the principally tropical character of this portion of the nontransient avifauna.

Systematic lists by habitat.—The difficulty in relating species to particular habitats is increased by the fact that many are not restricted to one type and that humid and drier areas are not well defined. As an example of this, the Streak-headed Woodcreeper (*Lepidocolaptes souleyetii*) occurs regularly in rain forest but also frequently in tropical semideciduous and oak forest. Some other species regularly found in at least two habitats are the Wedge-tailed Sabrewing (*Campylopterus curvipennis*), Golden-olive Woodpecker (*Piculus rubiginosus*), Pale-billed Woodpecker (*Phloeoceastes guatemalensis*), and Bright-rumped Attila (*Attila spadiceus*). In the following lists I have assigned each species to the major habitat in the Sierra with which it is primarily associated. The House Sparrow (*Passer domesticus*), which in small numbers frequents primarily the large towns, is excluded. The six

FIG. 7. Pine forest on southeast ridges of Volcán Santa Marta at 800 m altitude. Birds are more numerous in adjacent ravines where gum-oak and rain forest occur. In the background is cloud-covered Volcán San Martín Pajapan.

habitats are based on distinctive vegetation formations and associations and upon the existence of water bodies.

Included after each species is an abbreviation indicating its relative observable abundance in the Sierra as a whole based on sight and/or sound record or collecting in its preferred habitat during several hours of field work. Admittedly, attempts to be quantitative in this regard are difficult. However, the following categories (modified from Loetscher, 1941) are based only on the numbers of birds that might be recorded by a competent observer and do not purport to show actual abundance of each species. But I believe that in most cases the category to which a species is assigned fairly closely corresponds with its real abundance.

Abundant (A): over 150 recorded every day
Very common (VC): 75–150 recorded every day
Common (C): 15–75 recorded every day
Fairly common (FC): 5–15 recorded every day
Rather uncommon (RU): 3–8 recorded but not every day
Uncommon (U): 1–5 recorded, but frequently not observed for one or a few days at a time
Very uncommon (VU): 1–5 recorded in one to three months and usually not observed for one to three weeks at a time

Rare (R): less than 10 recorded per year and not recorded at all for varying, sometimes prolonged periods

Very rare (VR): recorded from one to three or four times in the region and likely to occur again.

Altitudinal ranges after each species are in meters above sea level. A hyphen before or after a single elevation or the limits of a species' range indicates that it possibly occurs beyond the altitude(s) given. A dagger following a species name indicates that it occasionally frequents a more humid or drier habitat as the case may be. First records for the Sierra, as here delimited, that have not, to my knowledge, been previously published (55) are marked by an asterisk. Eisenmann (1955) has been followed here and elsewhere in the paper for most species' common and technical names.

Habitat _A_—Tropical rain forest (montane and coastal lowland) and cloud forest—82 species.

Tinamus major U 0–850
Crypturellus soui U 0–800
Crypturellus boucardi FC –250–900
*_Chondrohierax uncinatus_ VR 300
Accipiter bicolor VR 400
Leucopternis albicollis† RU 0–900
*_Spizaetus tyrannus_† VR 0–850
*_Micrastur semitorquatus_ U 0–1300
*_Micrastur ruficollis_ RU 500–1500–
Crax rubra RU 0–900
Penelope purpurascens FC 0–1400–
Odontophorus guttatus FC 300–1300
Columba speciosa RU –350–800
Columba nigrirostris FC 0–750
Leptotila verreauxi† C 0–1100
Leptotila plumbeiceps FC 0–750
Geotrygon lawrencii FC 350–1400–
Geotrygon montana RU 0–900–
*_Bolborhynchus lineola_ VR 800–
Pionopsitta haematotis† R 400–550
Otus guatemalae † U 0–1100
Pulsatrix perspicillata VR 0–
Ciccaba virgata† FC 0–1660
Phaethornis superciliosus FC 0–850
Phaethornis longuemareus RU 0–550
Campylopterus hemileucurus RU 0–1500–
*_Colibri thalassinus_ U 650–800
*_Lampornis amethystinus_ VR –1280–
Trogon massena U 0–500
Trogon collaris FC 0–1660
Trogon violaceus† FC 0–1200
Hylomanes momotula R –750
Momotus momota† FC 0–1200
Aulacorhynchus prasinus RU 400–1660
Celeus castaneus VU 0–600
Phloeoceastes guatemalensis† U 0–950
Dendrocincla anabatina VU 0–800
Sittasomus griseicapillus FC –900
Dendrocolaptes certhia U –850
Xiphorhynchus flavigaster† FC 0–1300
Lepidocolaptes souleyetii† RU –800–
Lepidocolaptes affinis U 900–1660
Anabacerthia variegaticeps U 700–1200–
Automolus ochrolaemus FC 0–1400
Xenops minutus U 0–850
Formicarius analis FC 0–950
Grallaria guatimalensis R 0–800–
Pipra mentalis VU 0–850
Empidonax flavescens RU 900–1660
Myiobius sulphureipygius VU 0–600
*_Onychorhynchus mexicanus_ R 0–650
Platyrinchus mystaceus RU 0–850
Tolmomyias sulphurescens† U 0–750
Rhynchocyclus brevirostris RU 500–1200
Oncostoma cinereigulare VU 0–850
*_Ornithion semiflavum_ R 0–800–
*_Leptopogon amaurocephalus_ VR 300
Pipromorpha oleaginea RU –950
Cyanocorax yncas† FC 250–1300
Henicorhina leucostica C 0–1500–
Turdus assimilis C 300–1300–
*_Turdus infuscatus_ R 1300–1660
Myadestes unicolor FC 400–1660
Catharus mexicanus FC 450–1400–
*_Smaragdolanius pulchellus_ R 0–800
Hylophilus ochraceiceps RU 0–900

Hylophilus decurtatus FC 0–850
Cyanerpes cyaneus† C 0–950
Parula pitiayumi† FC –150–950
Myioborus miniatus FC 600–1250–
Basileuterus culicivorus C 0–1000
Basileuterus belli U 750–1660
Chlorophonia occipitalis VR 300–750–
*_Euphonia gouldi_ VU –700–
Piranga leucoptera U 450–1000–
Habia rubica† RU 0–1100
Lanio aurantius VU 0–650
Eucometis penicillata U –650
Chlorospingus opthalmicus FC 500–1660
Caryothraustes poliogaster C 0–850
Cyanocompsa cyanoides RU 0–850
Atlapetes brunneinucha FC 400–1660

Habitat _B_—Humid forest edge, thickets, bush and tree rows and fields in humid areas—93 species.

*_Harpagus bidentatus_ VR 300
Buteo magnirostris† FC 0–850
Buteo nitidus† RU 0–950
Herpetotheres cachinnans† VU 0–650
Falco albigularis †VU 0–800–
Ortalis vetula† VU 0–1000
Columba flavirostris† C 0–1660
Columbigallina minuta VR –400–
Columbigallina talpacoti C 0–800
Claravis pretiosa U 0–950
Aratinga astec† C 0–750
Amazona autumnalis† C 0–700
*_Coccyzus minor_ VR 625
Piaya cayana† RU 0–750
Crotophaga sulcirostris† C 0–650
Tapera naevia† VU 0–350
Glaucidium brasilianum† RU 0–750
Nyctibeus griseus† R 0–800
Nyctidromus albicollis† C 0–950
Campylopterus curvipennis FC 0–1200
Anthracothorax prevostii† U 0–650
*_Paphosia helenae_† VU 600–
Chlorostilbon canivetii† RU 0–800
Amazilia candida FC 0–1100
Amazilia tzacatl† FC 0–800
*_Galbula ruficauda_ U 0–50–
Pteroglossus torquatus† RU 0–600
Ramphastos sulfuratus† FC 0–1250
Piculus rubiginosus RU –1660
Centurus aurifrons† C 0–1000–
Centurus pucherani VU 0–800
Veniliornis fumigatus VU 0–800
Synallaxis erythrothorax† FC 0–750
Taraba major VR 0–300
Thamnophilus doliatus† FC 0–850
*_Cotinga amabilis_ VR 300
Attila spadiceus† RU 0–950
Pachyramphus major† R 0–1250
Platypsaris aglaiae† RU 0–750
Tityra semifasciata† FC 0–1250
*_Tityra inquisitor_† VU 0–700–
Tyrannus melancholicus† C 0–950
Legatus leucophaius RU 0–900
Myiodynastes luteiventris† FC 0–950
Myiodynastes maculatus RU 0–750
Megarhynchus pitangua† FC 0–850
Myiozetetes similis† C 0–850
Pitangus sulphuratus† C 0–850
Myiarchus tyrannulus† FC 0–750
Myiarchus tuberculifer† FC 0–1300
Contopus cinereus† U –150–700
Elainea flavogaster† U 0–850
Myiopagis viridicata† VU 0–600
Psilorhinus morio† C 0–800
Campylorhynchus zonatus† FC 0–650
Thryothorus maculipectus† FC 0–1250
Troglodytes musculus U –100–850
Turdus grayi† C 0–950
Ramphocaenus rufiventris† VU 0–850
Cyclarhis gujanensis† U 0–600–
Vireo olivaceus† C 0–1250
Coereba flaveola RU 0–1100
Chamaethlypis poliocephala† FC 0–750
Basileuterus rufifrons FC 0–950–
Zarhynchus wagleri VR –300–
Gymnostinops montezuma FC 0–650
Amblycercus holosericeus† FC 0–600
Psomocolax oryzivorus VU 0–600
Tangavius aeneus† FC 0–700
Cassidix mexicanus† VC 0–800
Dives dives† C 0–700
Icterus prosthemelas† RU 0–750
Icterus wagleri VR 500
*_Icterus cucullatus_ R 0–
Icterus mesomelas U 0–650
*_Euphonia musica_ VR 500–850
Euphonia affinis† RU –850
Euphonia lauta† FC 0–850

Thraupis virens† FC 0–750
Thraupis abbas† C 0–850
Phlogothraupis sanguinolenta RU 0–650
Habia gutturalis† FC 0–850
Saltator atriceps† C 0–900
Saltator maximus VU 0–650
Saltator coerulescens† FC 0–750
Richmondena cardinalis† RU 0–850
Cyanocompsa parellina† VU 0–650
Tiaris olivacea† FC 0–750
Sporophila torqueola† C 0–750
Volatinia jacarina† C 0–650–
**Spinus psaltria*† U –200–900
Arremenops rufivirgatus† FC 0–850
Aimophila rufescens† FC 0–950

Habitat *C*—Semideciduous forest and edge, thickets, bush and tree rows and fields in drier areas—20 species.

Crypturellus cinnamomeus† RU 0–800
**Colinus virginianus*† FC 0–800
Zenaida asiatica† R 0–600
Scardafella inca† R 0–450
Columbigallina passerina† VR 350
**Coccyzus americanus* U –100–200
**Rhinoptynx clamator*† VR –150–300
Amazilia yucatanensis† U 0–400
**Heliomaster longirostris*† U 0–800
Trogon citreolus† FC 0–700
Dryocopus lineatus† U 0–700
Dendrocopos scalaris† U 0–700
Pyrocephalus rubinus† VU 0–400
Muscivora tyrannus† VU 0–700
**Camptostoma imberbe*† U 0–400
Uropsila leucogastra† RU 0–600
**Mimus polyglottos* VR 400
**Polioptila caerulea* RU 0–200
Icterus gularis† U 0–700
**Sturnella magna*† VR –250

Habitat *D*—Pine-oak forest (also in other forest types and edge)—4 species.

**Amazilia cyanocephala* FC –500–850–
**Melanerpes formicivorus* C 0–850–
**Parus atricristatus* VU –150–
Icterus chrysater U 0–750–

Habitat *E*—Humid and drier open areas (widely ranging or not assignable to a particular habitat)—14 species.

Sarcoramphus papa VU 0–900
Coragyps atratus VC 0–1660
Cathartes aura RU 0–1660
Elanus leucurus VU 0–750
**Buteo albonotatus* VR –400
**Buteo brachyurus* VR 0–800
Polyborus cheriway RU 0–750
Falco femoralis VU 0–600
**Tyto alba* VU –150–600
**Chordeiles acutipennis* R 0–500
Streptoprocne zonaris FC 0–1000
Chaetura vauxi C 0–1100
Progne chalybea U 0–800
Stelgidopteryx ruficollis FC 0–800

Habitat *F*—Water bodies (associated primarily with lakes, ponds, streams, swamps and marshes)—37 species.

**Podiceps dominicus* C 0–400
Podilymbus podiceps FC 0–400
Pelecanus occidentalis U 0–350
Phalacrocorax olivaceus A 0–400
**Anhinga anhinga* R 0–400
Fregata magnificens FC 0–400
Butorides virescens FC 0–650
**Florida caerulea* U 0–650
**Casmerodius albus* R 0–350
Leucophoyx thula A 0–450
**Bubulcus ibis* U 0–450
**Hydranassa tricolor* VU 0–350
Nycticorax nycticorax FC 0–600
**Nyctanassa violacea* VU 0–350
**Ixobrychus exilis* VR 350
Cochlearius cochlearius VR 350
**Mycteria americana* VR 350
Eudocimus albus VR 0–
**Dendrocygna autumnalis* R 350
Rostrhamus sociabilis RU 0–350
Buteogallus anthracinus RU 0–1100
**Hypomorphnus urubitinga* U 0–800
**Aramus guarauna* VR 0–
**Amaurolimnus concolor* VR 0–
Aramides cajanea R 0–
**Laterallus ruber* VR 350

**Porphyrula martinica* VR 350
**Heliornis fulica* RU 0–
Jacana spinosa FC 0–350
**Charadrius collaris* RU 0
**Charadrius wilsonia* U 0
Ceryle torquata FC 0–350
Chloroceryle amazona U 0–350
Chloroceryle americana RU 0–350
Chloroceryle aenea VU 0–450
Sayornis nigricans U 200–500–
Iridoprocne albilinea FC 0–400

Areal distribution and relative observable abundance.—Of the 82 species listed in habitat A, 16 (19.5 per cent) were found to frequent drier habitats: in contrast, 66 (70.9 per cent) of the 93 species associated with habitat B range at times into drier areas. The low percentage of species inhabiting rain and cloud forest that enter drier habitats indicates the restricted ecological requirements of this portion of the avifauna. A comparison of the species' observable abundance in habitats A and B, the two encompassing most of the Sierra, shows that about 48 per cent of the species in the latter habitat are fairly common to abundant, but only 35 per cent of those in the former type are classed similarly. This contrast is apparent through the range, and, though the actual difference may be offset somewhat by greater difficulty of observation in forest, corresponds with my observations of the relationship in other tropical areas. Often some species of habitat B enter the rain forest or frequent natural or man-made openings, which are numerous in the Sierra. Many species of this habitat are very irregularly distributed. Some, such as the Bronzed Cowbird (*Tangavius aeneus*) and White-collared Seedeater (*Sporophila torqueola*), gather in flocks and may be entirely absent from many suitable sections. In habitat B, as well as in other types where seral communities exist, cutting, burning, and livestock grazing are important factors influencing bird movement and distribution.

Species primarily associated with habitat C seem to be even less abundant than those of habitats A and B, only two of the 20 being classed as fairly common. The Red-billed Azurecrown (*Amazilia cyanocephala*) and Acorn Woodpecker (*Melanerpes formicivorus*) of the pine-oak habitat also range upward to more open ridges near the gum forest and to lower elevations in tropical semideciduous and oak forests. Most of the widely ranging species are not common, but the White-collared Swift (*Streptoprocne zonaris*) and Vaux's Swift (*Chaetura vauxi*) often congregate in flocks (about 10–200 birds) as does the Black Vulture (*Coragyps atratus*) when feeding or sighting food. The largest flock of these vultures I have seen in the Sierra was 220 near Santiago Tuxtla. Many species primarily associated with water bodies also range into forest edge and open country some distance from water. The hawks *Buteogallus anthracinus* and *Hypomorphnus urubitinga* particularly do this. A few small marshes on Lake Catemaco and Bahía Sontecomapan are frequented by members of the Ardeidae and Rallidae. The Brown Pelican (*Pelecanus occidentalis*) and Magnificent Frigatebird (*Fregata magnificens*)

FIG. 8. Air view of Volcán Santa Marta massif from the Gulf side showing large extent of montane forest. Deforestation is progressing upwards in some valleys. This wilderness area and a similar one on the northwestern massif would make excellent parks or natural reserves.

occur inland over the Sierra, especially during northers, and apparently breed at its base in a small colony on Isla Terrón in the Gulf off Punta Roca Partida.

Continuing deforestation and prevention of forest regeneration in many places by new settlements are resulting in considerable expansion in areal range and increase in overall abundance of nonforest species at the expense of forest birds. Yet this trend has apparently not occurred as rapidly as it has in other parts of Veracruz because difficulty of access to parts of the Sierra has permitted much forest habitat to remain essentially undisturbed by man. In this regard the excellent potential of the Sierra as a region where a large national park or rain forest preserve could well be established has been brought out by Shelford (1941), Leopold (1959), and the author in a previous report to the Mexican authorities (Fig. 8).

Altitudinal distribution.—Since the Sierra's relief is small compared to that of most other Mexican mountain ranges, and consequently its vertical temperature gradient (normal lapse rate) not great, it seems that temperature is not an important factor affecting the normal altitudinal ranges of birds. A few species' adaptability permits their vertical ranges to extend over the maximum relief of the Sierra. Most forms, however, usually occur within smaller elevation limits and are to a considerable degree controlled by the distribution of forest formations and the secondary vegetation modified chiefly by man.

The elevation ranges of species inhabiting rain and cloud forest indicate that almost two-thirds do not normally ascend above about 1,000 m. Species observed regularly above this altitude are those which occur through either the entire altitudinal extent of the Sierra or mainly in the Upper Tropical Zone. The occurrence of some Upper Tropical Zone species, such as the Purplish-backed Quail-Dove (*Geotrygon lawrencii*), Slate-colored Solitaire (*Myadestes unicolor*), and Slate-throated Redstart (*Myioborus miniatus*), commonly below 1,000 m, frequently below 600, and occasionally below 450 in the months of the northern winter and summer indicates their ecological adaptability and reflects the ill-defined nature of the Upper Tropical Zone lower limit in the Sierra. Also, as Wetmore (1943:223–224) pointed out, such species tend to descend lower here than in the mountains of Central America probably because of being affected in the winter and early spring months by lower temperatures brought about by northers usually accompanied by heavy rain.

Since the majority of nontransients normally are found in the Lower Tropical Zone usually well below 1,000 m, the comparative number of birds at higher elevations is greatly restricted. The variety of resident species above this altitude is also curtailed by the presence of only one habitat type, unbroken forest and the fact that only about 10 per cent of the Sierra's land area lies above 750 m. On the inland side of the range deforestation allows species associated with both humid and drier nonforest habitats to ascend to much higher altitudes than is possible on the Gulf slopes. The upper altitudinal limits of some of these species would be even higher if they were not blocked by the forest. The altitude ranges for species in the habitat lists are based on my observations and those of other investigators. They are approximate altitudes within which each species was normally recorded and do not mean that the species does not exceed these limits occasionally. Actually, the normal upper limits of some species, such as the Scaled Antpitta (*Grallaria guatimalensis*), are probably higher than is indicated.

Notes on ecology and breeding.—The observations of Edwards and Tashian (1959:328–330) on the ecology and abundance of birds in rain forest and forest edge around Coyame in the months of June and July are generally similar to my own made in the same habitat types in the Sierra. As expected, however, I found that abundance and habitat preferences of some species vary with the seasons and other factors such as meteorological phenomena and food availability. The presence of flowering plants in forest openings and in forest edge or open areas markedly influenced the local abundance and distribution of hummingbirds. I found that they were often as abundant in number and variety of species in forest edge and open sections as they were in the forest interior. At no time did I discover any great concentrations at flowers as did Lowery and Dalquest (1951) in the Veracruz lowlands. Although Edwards and Tashian (1959) listed the White-bellied Emerald (*Amazilia candida*), and Yellow-billed Cacique (*Amblycercus holosericeus*) as interior rain forest species. I observed them more frequently in edge, openings, and low, secondary growth. Red-legged Honeycreepers (*Cyanerpes cyaneus*), though often feeding in the tops of trees within the rain forest, frequently forage in forest edge and in open places with scattered large trees. Particularly attractive to them are the orange-red flowers of *Bernoullia flammea*, a large rain forest tree that is sometimes left standing in the open when forest is destroyed. I have counted as many as 70 honeycreepers in the top of one of these trees when it was in bloom in early April.

Fruiting of trees in forest and open areas is a great attraction throughout the year for many species, influencing their local distribution and constituting an important element in the avian ecology of the Sierra. Lowery and Dalquest (1951:635) report the collection of two specimens of the Blue-crowned Chlorophonia (*Chlorophonia occipitalis*) from such a tree (probably *Ficus* species) near San Andrés Tuxtla in January 1948. Several other tanager species, particularly the Yellow-winged Tanager (*Thraupis abbas*), were also feeding there. I have observed Yellow-throated Euphonias (*Euphonia lauta*), Scrub Euphonias (*Euphonia affinis*), Olive-throated Parakeets (*Aratinga astec*), Clay-colored Robins (*Turdus grayi*), White-throated Robins (*Turdus assimilis*), and Montezuma Oropendolas (*Gymnostinops montezuma*) in fairly high numbers in such fruiting trees. Among the many tree species utilized in this regard by the birds are *Ficus costaricana*, *Ficus glabrara*, and *Mirandaceltis monoica*, three in which I have noted especially large concentrations. Such trees not only attract birds from considerable distances and from different habitats but also draw species inhabiting forest understory and low thickets to upper levels where they normally do not occur. Members of the Columbidae especially are attracted when ripe fruits fall to the ground.

Flocks of forest birds occur throughout the year in the Sierra, but there is a marked decrease in this activity in late February and March as more species start to breed. In March many species commence nest building, and in April and early May the breeding cycle reaches a high level in numbers of individuals involved. From mid-May through June young birds out of the nest are very conspicuous. Breeding activity continues through July and August involving lesser numbers of birds, but thereafter a marked decline takes place and more flocking occurs through the months of the northern fall and winter. I have not observed nesting activity from November through January in the Sierra. but some species may breed then because specimens collected during this period have apparently been in breeding condition. A pronounced breeding season as well as an earlier and more prolonged one than in more northern areas would be expected at the Sierra's latitude (18°30′N). The incubation phase of the cycle seems to be at a maximum in April at a time when rainfall is very low, severe northers have ceased, and average daily temperatures are high.

An increase in vocalization by most species also takes place in March and April; this is especially noteworthy among the Columbidae after mid-April. This vocal period continues into the summer and early fall with lessening intensity until by early November most species have ceased singing and do not call so frequently.

Endemism.—Possibly interchange of Upper Tropical Zone birds between the Sierra and inland mountains took place during the lowered elevation of this Zone in the Pleistocene, since there is no geological evidence that the Sierra was ever connected to other ranges by a highland. The physical isolation of the Sierra by lowlands has apparently been of sufficient duration to permit subspecific differentiation in a few Upper Tropical Zone forms. The five endemic birds that Wetmore (1943:225) recorded from Cerro Tuxtla and Volcán San Martín Tuxtla are *Geotrygon lawrencii carrikeri*, *Campylopterus curvipennis excellens*, *Empidonax flavescens imperturbatus*, *Myioborus miniatus molochinus*, and *Atlapetes brunneinucha apertus* (see Friedmann et al., 1950; Miller et al., 1957). Lowery and Newman (1949:8) later described another, *Chlorospingus opthalmicus wetmorei*, from specimens collected by Wetmore and Carriker. All these forms except *Empidonax flavescens* are well distributed in humid forest through the range. The normal minimum altitudinal limits of four vary from about 300 to 600 m above sea level. The minimum limit of the fifth (*E. flavescens*) is about 900 m. and the sixth (*C. curvipennis*) ranges to sea level.

Despite the relatively low altitudes reached regularly by most of these birds, the ecological isolation and the subspecific differentiation of all except the last mentioned seems to have been assured by their adaptation to high humidity conditions, somewhat cooler temperatures than exist in lowlands. and a montane rain forest environment. Humid and drier forest types in the lowlands on the inland sides of the Sierra differ in structure and plant composition from this montane forest and apparently do not provide suitable habitats for the endemics. Such vegetation conditions have probably existed for a long time and thus have served as an effective isolating barrier.

C. curvipennis excellens has been recorded in lowlands outside the Sierra near Jesús Carranza (Lowery and Dalquest. 1951:583). This is not unexpected since it occurs to sea level at the base of the Sierra and moves readily outside forest habitat. It is possible that this hummingbird, after undergoing differentiation in suitable isolating conditions at high altitudes in the Sierra. gradually adapted to nonforest habitats thereby enabling it to extend its range to the lowlands, particularly where more humid conditions exist as in the Coatzacoalcos basin.

Wetmore remarked on the survival of Upper Tropical Zone endemic birds on Volcán San Martín Tuxtla in spite of the recent volcanic activity there. The only disturbances of record in the Sierra are the eruptions on this volcano in the early 16th century, in 1664 and 1793. Apparently these caused only local changes in the vegetation. From my observations and from the nature of similar volcanic action it does not seem likely that disturbances since the development of the range's montane forest have been extensive enough to destroy simultaneously all habitat required by the endemics. The forested ridge north of Lake Catemaco provides a route for passage between the massifs and may have been a factor in the endemics' survival during periods of volcanic activity.

The existence of a pine area in the Sierra. isolated by almost 250 km from any similar habitat. suggests the possibility of endemism in its characteristic birds. However, none has been discovered so far, and the probable fairly recent development of this vegetation plus the fact that species typical of it are known to range into other habitat types and down to sea level would seem to minimize the chance of this occurring.

NOTES ON SELECTED SPECIES

Least Grebe (*Podiceps dominicus*).—This grebe occurs usually in small numbers on Lake Catemaco, Bahía Sontecomapan, and occasionally on small crater lakes. Since few are seen in summer, most individuals probably go elsewhere to breed where nesting habitat is better. On 27 March 1960, I counted 40 birds on the west side of Lake Catemaco. The maximum I recorded was about 300 on Laguna Tisatal on 31 March 1962, their abundance at this time suggesting a general movement through the region.

Pied-billed Grebe (*Podilymbus podiceps*).—This species is generally less numerous than *P. dominicus*, except at times in the summer months. It frequents the same water bodies. I found no evidence of nesting, but during late May and June there was considerable calling and vigorous pursuit among the group near Playa Azul on Lake Catemaco.

Olivaceous Cormorant (*Phalacrocorax olivaceus*).—Several searches about Lake Catemaco revealed no sign of these cormorants breeding. Local people said they do not breed there, and I suspect that the large numbers often present are attracted only by the abundance of small fish in the lake. The maximum number I observed on Lake Catemaco was about 350 on 10 June 1962, but since this count covered only part of the lake, I judge there were many more present.

Green Heron (*Butorides virescens*).—At least a dozen birds frequented the west shore of Lake Catemaco, and I noted others at various shore points and near Catemaco on the Río San Andrés where a dam forms a pond near the lake outlet. On 24 March 1960, a pair were building a nest high in a large tree on the Lake Catemaco shore at Playa Azul, and they appeared to be incubating in April. I discovered several dead young and some broken eggs in this area in early April 1962, at which time the herons were also nesting on the Río San Andrés. Nearly full grown young were at Playa Azul on 14 April and in early May.

Snowy Egret *(Leucophoyx thula)*.—Many inhabit the shores and islands of Lake Catemaco through the year, and small flocks sometimes forage in fields nearby. Some breed on Isla Tenaspi on the northwest side of the lake where I saw about 350 birds, several nests, and about a dozen almost full grown young on 10 June 1962.

Cattle Egret *(Bubulcus ibis)*.—Flocks occur in the winter and spring months in fields near Lake Catemaco and Bahía Sontecomapan and occasionally elsewhere. Normally they are composed of less than 50 birds; however, on 17 February 1962, there were about 150 near Cerro Mono Blanco. In the past several years they have increased in frequency of occurrence and numbers in and near the Sierra.

Least Bittern *(Ixobrychus exilis)*.—I observed three in the marsh at the Arroyo Agrio on the north side of Lake Catemaco on 10 June 1962. Dickerman saw one to four birds there in July and August 1963, and collected two on 9 August. They probably breed in this place.

Hook-billed Kite *(Chondrohierax uncinatus)*.—I found this species only in the lowlands near Tres Zapotes, but A. Ramírez, collecting for Phillips, secured a male near Dos Amates on 5 December 1961.

Double-toothed Kite *(Harpagus bidentatus)*.—The only record is a bird closely observed by Axtell and the author at 350 m altitude in the edge of rain forest above Dos Amates on 17 March 1960.

Bicolored Hawk *(Accipiter bicolor)*.—The only records of this apparently rare hawk are by Edwards and Tashian (1959:328) near Coyame in the summer of 1954, and by Ramírez near Dos Amates (imm. collected) in late 1962.

Zone-tailed Hawk *(Buteo albonotatus)*.—I observed one as it perched in a small tree on Cerro Blanco at 400 m elevation on 20 September 1962. Three hawks soaring over the forest west of Coxcoapan on 28 March 1962, were very probably this species.

Short-tailed Hawk *(Buteo brachyurus)*.—Phillips and I saw a dark phase individual over the northwest shore of Lake Catemaco on 11 October 1962, and I noted a light phase bird above Ocotal Chico on 25 October 1962. Dickerman reported a dark and possibly a light phase bird on 12 and 16 August 1963 north-northeast of Sontecomapan. There seems to be an autumn movement of this species over the Sierra and adjacent lowlands.

White Hawk *(Leucopternis albicollis)*.—On 12 April 1960, one was seen carrying a small snake over the forest near Dos Amates. It repeatedly gave a hoarse scream somewhat like that of a Red-tailed Hawk but less sharp and not as loud. A female I collected at 520 m on Cerro Cintepec on 24 September 1962, had an ovary measuring 13 mm. This hawk also frequents semideciduous forest on the inland slope of the Sierra.

Black Hawk-Eagle *(Spizaetus tyrannus)*.—One was reported by Dickerman on 18 August 1962, in the primary forest below the Cumbres de Bastonal at about 800 m elevation. Another, also in heavy forest, was seen by Phillips, Dickerman, and the author on Cerro Cintepec on 18 October 1962, at about 600 m. One bird I observed at the inland base of the Sierra in November repeatedly emitted a loud, harsh scream.

Barred Forest-Falcon *(Micrastur ruficollis)*.—This falcon was almost always encountered in heavy humid forest and could sometimes be decoyed by squeaking or call imitation. An immature female secured on 21 April 1962, about 5 km southwest of Sontecomapan, was in breeding condition with one egg well developed and brood patch conspicuous. A male taken in the same locality at 500 m on 4 May had the remains of a small passerine in its stomach. A female with an 11 mm ovary was secured in the same place on 3 December 1962. I also found *M. semitorquatus* in widespread places in the Sierra and it also could be decoyed. A male with testes 15 and 13 mm was collected on 15 August 1962, near sea level at the Río Carizal. The call of the larger species is a loud, somewhat prolonged *aarr* slurred downward with a woodwind instrument quality. That of *M. ruficollis* is a loud *ark*, also slurred downward but shorter, with less volume and a higher pitch than the call of the other species.

Uniform Crake (*Amaurolimnus concolor*).—The only record of this rare rail is an adult male with testes enlarged collected in Bahía Sontecomapan on 15 February 1963, by Ramírez.

Red Rail (*Laterallus ruber*).—This rail was reported by Dickerman to have been heard calling at Arroyo Agrio marsh between 22 July and 9 August, and again on 3 September 1963.

Purple Gallinule (*Porphyrula martinica*).—Two were feeding in a field at the edge of the Arroyo Agrio marsh on 11 June 1962. Dickerman reported one at this place on 9 August and 3 September 1963.

Scaled Pigeon (*Columba speciosa*).—I collected a male with testes 15 and 14 mm on 25 April 1962, in the rain forest north of Volcán San Martín Tuxtla at 670 m. The crop contained fruits of the tree *Pseudolmedia oxyphyllaria.* This pigeon's call is a fairly loud *hoo-óo-hoo* with a slight but characteristic resonant or bugle-like quality. I found this species in scattered places through rain forest but never more than one or two birds at a time. Davis (1952:315) reported 30 to 40 daily from 11 to 17 June in a coffee plantation south of Lake Catemaco.

Common Ground-Dove (*Columbigallina passerina*).—The only Sierra record is that reported by Sclater (1857*a*:205) from San Andrés Tuxtla.

Purplish-backed Quail-Dove (*Geotrygon lawrencii*).—This endemic dove is fairly common in rain forest through the Sierra, inhabiting principally the ground and understory. Its call is distinctive—a fairly soft, low-pitched *who whó-oo*, the first part of the second note more emphatic and the last syllable slurred downward. Dickerman found a nest on 11 October 1962, about 5 km southwest of Sontecomapan at 500 m altitude. It was on a hillside in secondary forest about 2.7 m above a trail. The nest was a loose but intertwined platform on vines and twigs supported by several crossed and slanted, long bamboo shoots. Its one egg was a plain, pale pinkish color. I usually found these doves singly or in pairs and they often could be decoyed by call imitations. At such times they would come walking rapidly on the ground and sometimes fly up to a low branch. I secured a male in breeding condition on 19 April 1960, about 4 km southwest of Sontecomapan at 500 m. On 1 October 1962, an immature female with ovary 12 mm was taken in the same area.

Barred Parakeet (*Bolborhynchus lineola*).—The only records are five birds reported by Phillips above Ocotal Chico on 7 December 1962, and one on 11 December in the same area.

Brown-hooded Parrot (*Pionopsitta haematotis*).—This species apparently is rare and has been reported only by Davis (1952:315) south of Lake Catemaco and Edwards and Tashian (1959:328) near Coyame. Parrots appear to be generally uncommon in the Sierra. The largest numbers (*Amazona autumnalis*) occur on the north side of the Catemaco basin and about Sontecomapan. Phillips reported seeing at least three parrots south of Soteapan that probably were *Amazona ochrocephala.*

Yellow-billed Cuckoo (*Coccyzus americanus*).—I observed several birds in the oak and tropical semideciduous forest on the southern side of the range on 16 and 17 June and 3 July 1962. A female collected on 17 June near Barrosa had the ovary slightly enlarged. Possibly the species nests in this part of the Sierra.

Mangrove Cuckoo (*Coccyzus minor*).—The only record is a bird I observed on 6 June 1962, at 625 m in thickets among cornfields about 8 km north of San Andrés Tuxtla.

Spectacled Owl (*Pulsatrix perspicillata*).—The only record is from Sontecomapan reported by Sclater (1857*b*:227).

Striped Owl (*Rhinoptynx clamator*).—I collected a female in open, semideciduous forest at Barrosa on 16 June 1962. Its stomach contained remains of a small rodent and a large grasshopper as well as small pieces of coarse grass. A female and two young were reported by Phillips to have been collected by Ramírez near Dos Amates in early 1963.

Green Violetear (*Colibri thalassinus*).—I found this species only in the montane rain forest on the south slope of Volcán San Martín Tuxtla between 650 and 800 m and collected a pair on 4 and 6 June 1962.

Black-crested Coquette (*Paphosia helenae*).—These hummingbirds were seen only in pine forest and adjacent humid montane forest in the Ocotal area where I collected two males on 16 May and 23 October 1962, and Phillips collected three females in December 1962.

Red-billed Azurecrown (*Amazilia cyanocephala*).—Although I found this species only in the Volcán Santa Marta massif above about 500 m mostly in pines, the fact that it occurs in other habitats may account for the five specimens taken by Lamb presumably on the northwest side of Lake Catemaco from 29 July to 2 August 1953.

Amethyst-throated Hummingbird (*Lampornis amethystinus*).—The only record is a female with ovary 3 mm that I secured in the rain forest on Volcán San Martín Tuxtla at 1,280 m elevation on 26 August 1962.

Rufous-tailed Jacamar (*Galbula ruficauda*).—I observed this species only near the Río Carizal not far from the coast, but I expect that it also occurs in low numbers at other places on the lower Gulf slopes.

Great Antshrike (*Taraba major*).—The only records are those by Sclater (1857*a*:203) from Sontecomapan and Ramírez, who collected a pair near Dos Amates in late December 1962.

Lovely Cotinga (*Cotinga amabilis*).—Phillips reported that Ramírez collected an adult and an immature on 7 and 8 January 1961, near Dos Amates, the only records I know of for the Sierra.

Brown-crested Flycatcher (*Myiarchus tyrannulus*).—On 13 April 1962, a pair were investigating a hollow about 3.5 m above ground in the end of a broken limb of a large tree on the lake shore at Playa Azul. They were apparently incubating in early May and on 13 May were carrying food to young in the nest. Four young were being fed out of the nest on 27 May.

Sepia-capped Flycatcher (*Leptopogon amaurocephalus*).—The only record of this rare flycatcher is a female secured by Ramírez at Dos Amates on 4 December 1961.

Southern House Wren (*Troglodytes musculus*).—Although the Mexican Check-List does not record this wren for Veracruz, it is to be expected in the southern part of the state. Edwards and Tashian observed it about one-third of the time in their 1954 field work. I found it uncommon in semi-open areas in widespread parts of the Sierra where it often frequents slash-burned sections in which stumps and fallen trees provide cover.

Common Mockingbird (*Mimus polyglottos*).—The only mockingbird I observed in the Sierra was one at Playa Azul on 2 April 1960, during a norther. It was a typical individual of this species.

White-throated Robin (*Turdus assimilis*).—On 5 June 1962, I discovered a nest in the understory of montane rain forest on Volcán San Martín Tuxtla at 750 m elevation. It was constructed of green moss, supported by a vine and small branches, and situated about 3.5 m above ground against the trunk of a tree 30 cm DBH. I could not determine its contents. At the time robins were feeding two-thirds grown young in the rain forest as were Ivory-billed Woodcreepers (*Xiphorhynchus flavigaster*), Red-legged Honeycreepers (*Cyanerpes cyaneus*), and Chestnut-capped Brush-Finches (*Atlapetes brunneinucha*). In July *T. assimilis* was the most common species I noted in this rain forest on the volcano. It is of interest that Skutch (1960:85) could find no published record of the nesting of this species in Central America, and the seven nests that he observed were apparently not in forest habitat.

Black Robin (*Turdus infuscatus*).—I collected a male with testes each 3.5 mm in elfin forest at 1600 m on Volcán San Martín Tuxtla on 26 August 1962. Another bird, possibly the female, was calling and exhibiting alarm in the same place. Two others were seen at slightly lower elevations. The small areas of cloud forest in the Sierra limit the available habitat for this species.

Tropical Parula Warbler (*Parula pitiayumi*).—This warbler is a widespread resident in humid and drier forests. I collected a singing male in breeding condition near Barrosa on 16 June 1962. These warblers habitually sing late into the morning and often in the afternoon on hot days when most species are quiet. The Mexican Check-list (Miller et al., 1957:243–244) records the species as only casual in northeast Oaxaca and central and southern Veracruz.

Golden-crowned Warbler (*Basileuterus culicivorus*).—I found a nest at 730 m in the forest on Valcán San Martín Tuxtla on 5 June 1962. It was on the ground in an open section of the forest among leaves and low herbaceous plants. Construction was of leaves, grasses, and rootlets in a dome shape with the interior 7.5 cm in diameter and lined with fine rootlets. The three eggs were pinkish-white with reddish-brown flecks over the entire surface but concentrated in a ring near the large end. One measured 18 by 13 mm.

Chestnut-headed Oropendola (*Zarhynchus wagleri*).—Sclater (1857*b*:228) reported this species from San Andrés Tuxtla, and Ramírez collected a female and male at Dos Amates on 14 and 23 November 1961. Apparently the species is very rare and local in the Sierra.

Wagler's Oriole (*Icterus wagleri*).—Davis (1952:315) reported this species south of Lake Catemaco in 1952, the only record. Although the Mexican Check-List does not list this oriole for Veracruz, it seems likely that it would occur there in highlands in view of its known overall distribution.

Hooded Oriole (*Icterus cucullatus*).—Dickerman reported four birds north of Sontecomapan on 7 August 1962, the only record for the Sierra.

Blue-hooded Euphonia (*Euphonia musica*).—On 22 March 1960, I observed a pair above Dos Amates, saw a male on 20 March 1962, above Colonia Huatusco, and another individual on 30 October 1962, above Ocotal Chico. Phillips reported about eight and collected a male above Ocotal Chico on 8 December 1962. Another was taken by Ramírez near Dos Amates on 6 November 1963. Since the Mexican Check-List (Miller et al., 1957:298) lists the species only from La Joya in Veracruz, apparently these are the first records outside the west-central mountains of the state.

Yellow-throated Euphonia (*Euphonia lauta*).—On 2 May 1962, I discovered a nest along the Lake Catemaco shore at Playa Azul, 2 m above ground on the underside of a large, horizontal tree limb. It was supported by a large, pendent herb and was oval in shape, 17.7 cm in maximum outside diameter with a 5 cm diameter entrance on the side. The nest was thin and loosely woven of rootlets, fine twigs, and a few grasses and contained four young two or three days old. Two of these were being fed out of the nest on 22 May. This nest was considerably larger than the only one for which Skutch (1954:248) gives measurements. He remarks on the variety of nest sites chosen by this tanager, mentioning fence post tops, palm frond, and holes in earth banks.

Red-crowned Ant-Tanager (*Habia rubica*).—I found a semi-pensile nest in heavy forest above Dos Amates at about 500 m altitude on 5 May 1962. It was 2 m above ground in the fork of a sapling in open understory and was constructed of grasses, rootlets, and small twigs with exterior dimensions of 10.2 by 12.7 cm. The four eggs were white with faint brown flecks more concentrated and pronounced at the large end where they formed a wreath. One measured 25 by 18 mm. It is of interest that neither Skutch (1954) nor Willis (1961) reported more than three eggs in the 20 nests of this species they observed. The female was still incubating in this nest on 8 May and four young about four or five days old were in it on 20 May.

SUMMARY

The Sierra de Tuxtla is a small, comparatively low mountain range in southern Veracruz whose rich avifauna heretofore has been investigated only in restricted areas. This paper deals with the status of nontransient birds in the entire range, covering about 4,200 square km, and lists 251 species known to have been recorded, including 55 not previously reported.

The Sierra's topography of volcanic cones, ridges, gorges, and valleys provides a varied physical base to interact with climatic elements, chief of which are trade and continental winds and northers. An important aspect of the climate is the orographic rainfall resulting from the barrier formed by the four major volcanoes and subsidiary peaks. Precipitation ranges from about 1,700 to over 4,000 mm annually, being greatest on the Gulf slopes. Although temperatures occasionally reach the freezing point at high elevations, the climate is moderated by warm Gulf water, frequent clouds on the mountains, and extensive forests.

A diverse plant cover exists owing partly to vegetation destruction and modification by man over more than half the range. Fertile volcanic soils contribute toward a more homogeneous vegetation typified by rain forest; this comprises one of the two most extensive habitats and supports much of the avifauna. Also supporting important numbers of species are large nonforested sections and water bodies, chiefly Lake Catemaco and Bahía Sontecomapan.

The Sierra lies entirely in the Tropical Life Zone with Humid Upper Tropical and Arid divisions present, the former restricted to higher parts of the mountains and the latter to inland slopes. Boundaries of these zones are ill-defined with respect to avifaunal distribution.

Faunal mixing probably occurred in the Sierra during its history so that avian forms of both northern and southern affinities were represented. Since its climate was probably never cooler than warm temperate, even during the Pleistocene, it is unlikely that bird life in the range was ever completely displaced. Shifting of tropical and northern vegetation elements caused by climatic changes also affected the avifauna. This is now composed of a large number of species in Widely Distributed and Pantropical elements

of unknown or uncertain origin, but apart from this, species of probable southern origin predominate in comparison to those with northern affinities. The Tyrannidae, with 26 members, and six other families with 13 or 14 members each, comprise almost half of the avifauna.

Six major avian habitats are outlined. Lists are given of the species primarily associated with each including estimates of their relative observable abundance and aproximate elevation ranges. Continuing deforestation is resulting in areal expansion and increase in total numbers of nonforest species at the expense of forest birds. The distribution and nature of plant formations largely governs altitudinal ranges of many species, and the majority normally occur below 1,000 m. Among factors influencing abundance and distribution of birds are human alterations of plant cover and flowering and fruiting of plants. The long breeding season, though having a peak period of activity, is expectedly less well defined and more prolonged than those in more northern latitudes.

Differentiation of the few endemic bird species was assured in the Sierra by physical and ecological isolation. Their survival despite volcanic action was possibly aided by dispersal in both massifs and probably permitted by the restricted nature of volcanic disturbances.

ACKNOWLEDGMENTS

I extend my thanks to the many persons who aided me, especially Drs. Robert C. West and George H. Lowery, Jr., of Louisiana State University, and Fred T. Hall, Director of the Buffalo Museum of Science. I am indebted to many persons in Mexico, particularly the late Ing. Luis M. Arellano, Profs. Enrique Beltrán, Othon Arroniz, Carlos F. Ramírez, Raphael G. de la Cruz, and Ing. Roberto G. Gil. Dr. Velva E. Rudd, of the U.S. National Museum, and her colleagues identified my plant collections, and I also thank Drs. Harold H. Axtell, Robert W. Dickerman, Ernest P. Edwards, John W. Hardy, Byron E. Harrell, A. Starker Leopold, Walter P. Nickell, Allan R. Phillips, and Richard E. Tashian. I am grateful to L. Irby Davis, Mr. and Mrs. John Lind, Gary N. Ross, A. J. Wright, and Mr. and Mrs. Frederic K. Wykes for their interest and assistance. My 1960 work was supported by the Buffalo Society of Natural Sciences and the study in 1962 by the National Research Council of the National Academy of Sciences (Subcontract 54).

LITERATURE CITED

ANDRLE, R. F.
1966 North American migrants in the Sierra de Tuxtla of southern Veracruz, Mexico. *Condor*, 68:177–184.

BEARD, J. S.
1944 Climax vegetation in tropical America. *Ecology*, 25:127–158.

DAVIS, L. I.
1952 Tropical woods. Sixteenth Breeding-Bird Census, *Audubon Field Notes*, 6:314–315.

DORF, E.
1959 Climatic changes of the past and present. *Contrib. Mus. Paleontol. Univ. Michigan*, 13:181–210.

EDWARDS, E. P., AND R. E. TASHIAN
1959 Avifauna of the Catemaco basin of southern Veracruz, Mexico. *Condor*, 61:325–337.

EISENMANN, E.
1955 The species of Middle American birds. *Trans. Linnaean. Soc. New York*, 7.
FRIEDMANN, H., L. GRISCOM, AND R. T. MOORE
1950 Distributional check-list of the birds of Mexico. *Pacific Coast Avifauna*, No. 29.
GRISCOM, L.
1950 Distribution and origin of the birds of Mexico. *Bull. Mus. Comp. Zool.*, 103:341–382.
HOLDRIDGE, L. R.
1947 Determination of world plant formations from simple climatic data. *Science*, 105:367–368.
LEOPOLD, A. S.
1959 Wildlife of Mexico; the game birds and mammals. Univ. of California Press, Berkeley, California.
LOETSCHER, F. H., JR.
1941 Ornithology of the Mexican state of Veracruz with an annotated list of the birds. Unpublished thesis. Cornell Univ., Ithaca, N. Y.
LOWERY, G. H., JR., AND W. W. DALQUEST
1951 Birds from the state of Veracruz, Mexico. *Univ. of Kansas Publ. Mus. Nat. Hist.*, 3:531–649.
LOWERY, G. H., JR., AND R. J. NEWMAN
1949 New birds from the state of San Luis Potosi and the Tuxtla Mountains of Veracruz, Mexico. *Occ. Papers Mus. Zool. Louisiana State Univ.*, 22:1–10.
MAYR, E.
1946 History of the North American bird fauna. *Wilson Bull.*, 58:3–41.
MILLER, A. H., H. FRIEDMANN, L. GRISCOM, AND R. T. MOORE
1957 Distributional check-list of the birds of Mexico. *Pacific Coast Avifauna*, No. 33.
MIRANDA, F., AND E. HERNANDEZ X.
1963 Los tipos de vegetación de México y su clasificación. *Bol. Soc. Bot. Mexico*. 28:29–179.
SCLATER, P. L.
1857*a* List of additional species of Mexican birds, obtained by M. Auguste Sallé from the environs of Jalapa and San Andres Tuxtla. *Proc. Zool. Soc. London*, Part 25:201–207.
1857*b* On a collection of birds received by M. Sallé from southern Mexico. *Proc. Zool. Soc. London*, Part 25:226–230.
SHELFORD, V. E.
1941 List of reserves that may serve as nature sanctuaries of national and international importance, in Canada, the United States, and Mexico. *Ecology*, 22:100–110.
SKUTCH, A. F.
1954 Life histories of Central American birds. *Pacific Coast Avifauna*. No. 31.
1960 Life histories of Central American birds II. *Pacific Coast Avifauna*, No. 34.
WETMORE, A.
1943 The birds of southern Veracruz, Mexico. *Proc. U.S. Natl. Mus.*, 93:215–310.
WILLIS, E.
1961 A study of nesting ant-tanagers in British Honduras. *Condor*, 63:479–503.

BUFFALO MUSEUM OF SCIENCE, BUFFALO, NEW YORK, 10 MARCH 1966.

AGE-SPECIFIC DIFFERENCES IN THE BREEDING BEHAVIOR AND ECOLOGY OF THE AMERICAN REDSTART

Millicent S. Ficken and Robert W. Ficken

Maturation rates in birds are controlled by natural selection (Lack. 1954: Orians. 1961: Amadon. 1964: Selander. 1965). Slow maturation rates evolved in species where there is strong intraspecific competition for food (Amadon. 1964). species with high population densities (Orians. 1961: Wynne-Edwards. 1962) and in some icterid species as an outcome of a polygamous mating system (Selander. 1965). The American Redstart (*Setophaga ruticilla*) has a slower maturation rate than other parulids. many males not breeding until their second spring. The purposes of this paper are (1) to investigate the relationship between age of males (first-year vs. older) and type of habitat utilized. and (2) to suggest the proximate and ultimate factors responsible for the complex relationships of plumage. behavior, and ecology in this species and some other passerines.

The American Redstart has an extensive breeding range and in many areas is one of the most abundant breeding birds. It is found in a variety of habitats including willow and alder thickets. deciduous. mixed deciduous and coniferous. and even primarily coniferous forests (Bent. 1953). The biology of the redstart is of special interest in relation to the evolution of adaptations leading to success as measured by broad geographic range, utilization of a variety of habitats and high population density.

METHODS

This study was conducted in two different areas. Reproductive behavior was studied from the arrival of males until the fledging of young in a deciduous swamp forest in Ithaca. New York. This stand was dominated by a nearly closed canopy of mature deciduous trees and an understory of saplings which reached 20 feet in height. Dense stands of saplings occurred in areas where the canopy was interrupted. Redstarts occurred in both types of habitats. Information was obtained on the relative number of first-year males. their behavior. and mating success.

Censuses of redstarts in a variety of habitats in Maine were conducted between 10 June and 19 June 1965. near Damariscotta (Lincoln Co.) and in the primarily coniferous forests on Mt. Desert Island (Hancock Co.). Since first-year males arrived later than older males. we selected the initial date of the census late enough to insure that all breeding males had arrived. All of the males censused behaved like territorial birds. singing loudly in a restricted area. Although we saw the mates of some birds, both first-year and older. it was not possible to determine the proportion of mated birds.

After hearing a male sing, its immediate habitat was described; then the bird was approached and its age determined on the basis of plumage.

Habitats in Maine were classified in the following manner: (1) deciduous forests—some trees taller than 30 feet, an understory of saplings to 20 feet and sometimes up to 10 per cent conifers (white pine, spruce); (2) immature deciduous forests—tallest trees smaller than above, understory not as well developed and often more open; (3) alder thickets—dense shrub growth usually to 15 feet in height, often with some willow and other deciduous growth; (4) mixed forest—more than 10 to 60 per cent conifers (white pine, and/or spruce), with rest deciduous; (5) coniferous forest—more than 60 per cent coniferous, including some virtually pure spruce forest.

All the New York birds occurred in habitat categories 1 and 2; no effort was made to distinguish between them.

OBSERVATIONS

Molt and plumage.—A hand-raised male and female were observed from eight days of age until 10 months. The male obtained a few black spots on the face and breast during the first pre-alternate molt in early spring but otherwise retained a female-like plumage. This observation supports the assertion in the literature that first-year males retain a female-like plumage but generally with additional black feathers on the breast and chin, lores, cheeks, or crown (Chapman, 1907). Unfortunately we were unable to follow this male through the pre-basic molt in the fall, but according to Chapman (1907) the adult male plumage is attained at this time. The possibility remains that some first-year males molt into adult plumage at their first pre-basic molt or that some males are delayed beyond the end of their first breeding season in attaining adult male plumage. Ossification of the skull progresses more slowly in the redstart than in most other parulids (S. Eaton, pers. com.). David Bridge (pers. com.) reports that there are rare cases of males in immature plumage during the fall migration which had completely ossified skulls, indicating that at least some males do not attain adult male plumage until their third pre-basic molt. However, for the purpose of this study, we term males with a female-like plumage "first-year." They are easily distinguished from females in the field by the presence of a few black spots.

First-year females in the spring often show less yellow in the wing than older females (Chapman, 1907) and our captive bird also had less yellow on the sides of the breast. Birds with these characters which were observed in the field were considered to be first-year females. However, it is not known if all first-year females have this plumage or if older females also sometimes do.

Time of arrival on territory.—The usual order of arrival, although there was some overlap, was older males, older females and first-year males. The arrival time of first-year females was less certain but some arrived after the first-year males. The delay between the mean arrival date of the older males and first-year males was about two weeks in both New York and Maine.

Territorial behavior.—Redstarts are very aggressive and maintain rather rigid territories, tolerating no intrusion by conspecific males (Ficken, 1962*a*). Displays and fighting are common. The redstart is more aggressive than several other parulids which we studied (*Dendroica petechia, D. pensylvanica, D. virens, Vermivora pinus,* and *V. chrysoptera*) (Ficken and Ficken, 1965). In New York, older males first settled on territories in tracts of mature forest. Later, when first year males arrived, only peripheral areas, usually where the forest was open and low in stature, were available. The young males were usually restricted to these peripheral habitats by the aggressiveness of the older males. Older males appeared to be more aggressive than the young; they always won encounters with younger males.

Territory size.—Little is known about the territory size of first-year males as compared to older males. However, in the New York study area we found that the territory size of the two age classes was not markedly different, except that the smallest territory observed belonged to a first-year male. Hickey (1940) also noted that the territory size of the two age classes was similar.

Redstart territories are quite small when compared to those of other warblers (Mayfield, 1960) even those coniferous forest species during spruce budworm outbreaks (Kendeigh, 1947). In our New York study area they averaged about 0.75 acres, and Hickey (1940) reports territories were one acre or less on a "heavily wooded slope" in Westchester County, New York. Sturm (1945) found very small territories; one group in a second growth deciduous forest averaged 0.24 acre and another 0.16 acre. Thus deciduous woodlands with much second growth appear to be optimal for the species as such habitats support the maximum population densities. However, most territories in mixed and coniferous forests in Maine were over an acre in size and even in the deciduous habitats many males were isolated or had only one neighboring male in an area of several acres.

Mating success.—All older males (52) in our New York study area obtained mates while only three out of 7 (43 per cent) first-year males did so (Ficken, 1962*a*). Similarly, Sturm (1945) noted that only three out of 5 (60 per cent) first-year males were mated in an Ohio woodland. However, the four first-year males studied by Hickey (1940) obtained mates. In our New York study area, first-year males that did not obtain mates remained only about two weeks on territory, then left.

Floaters.—In other species of warblers it has been shown that there is a population of non-breeding males which will occupy territories when space is available (Stewart and Aldrich, 1951; Hensley and Cope, 1951). First-year male redstarts are sometimes "floaters," at least in deciduous woodlands. We have on several occasions seen unmated males in sub-optimal habitats in June. Each was there for a few days and usually silent or singing only muted song fragments. Hickey (1940) reports a first-year male that was singing softly and was "furiously driven off by males and females whenever it passed through their territories." Some of these floaters may not have found suitable areas for the establishment of territories because of the aggressiveness of older males. Others may have abandoned territories when they did not obtain mates. There is also the possibility that some first-year males do not even attempt to set up territories but are floaters from the start.

Nesting success.—We did not obtain quantitative data on nesting success in the two age classes but have a few observations which show that pairs of first-year birds are less successful. One such pair constructed and subsequently abandoned seven nests, at least twice after the female had begun incubation. Finally, this pair left the area in late July and presumably made no further breeding attempts that year. The cause for the nest abandonments was not known, but this behavior was not noted in older pairs. The nest of another first-year female was blown away by winds that destroyed no other nests in that area. This was probably due to its insecure anchorage, since the female had selected a two-pronged rather than a typical three-pronged crotch (Ficken, 1964).

Foraging behavior.—It is generally agreed that redstarts prefer deciduous woodland with a good undergrowth of bushes and young trees (Chapman, 1907; Bent, 1953; Griscom and Sprunt, 1957). Redstarts forage at medium elevations, usually between 10 and 30 feet, but occasionally near the ground or on low herbaceous plants (Ficken, 1962*b*). Insects are obtained by gleaning, hovering, and flycatching. Flycatching makes up over 80 per cent of the foraging patterns before the leaves are out in May, but the other patterns are more prevalent as the season progresses.

Relation of age and habitat.—The relative number of first-year territorial males in deciduous woodlands in New York and Ohio is surprisingly small, averaging 12 per cent in the three studies with large samples of birds (Table 1). Table 2 shows the incidence of first year males in a variety of Maine habitats. Deciduous forests in Maine contain a higher percentage of first-year males than do deciduous forests in New York and Ohio but are comparable to the findings for Michigan. There are differences in the frequency of first-year males in different habitats in Maine. First-year males are least common in alder thickets and relatively mature deciduous forests and more common than older males in immature deciduous, mixed, and coniferous forests. The difference between the number of first-year males in deciduous and mixed forests is statistically significant ($P < 0.05$) while that between alder and deciduous is not ($P > 0.05$). Numbers were insufficient for a statistical analysis of mixed vs. coniferous and deciduous vs. immature deciduous forests.

The distribution of the two age classes of redstarts in Maine habitats appears to be related to the amount of deciduous foliage. Habitats which have a high deciduous foliage density in the vertical foraging range of the redstart are alder and mature deciduous. Immature deciduous (often more open) and mixed woodlands are intermediate. Of course, forests consisting of more than 60 per cent conifers have the lowest deciduous foliage density. The frequency of first-year males parallels this foliage density, being higher where the deciduous foliage density is lower. MacArthur et al. (1962) suggested that species abundance in birds is related to the foliage density of vegetation in deciduous forests and this example shows that age classes within a species may also be so related.

DISCUSSION

Our hypothesis is that originally, before the evolution of a special plumage, first-year males had lower reproductive success than older males. Such a situation exists in many birds and is probably widespread (e.g., Nice, 1937; Snow, 1958; Coulson and White, 1958; Wynne-Edwards, 1962). For example, in Song Sparrows (*Melospiza melodia*) first-year males often arrive later than older males, are less aggressive, and in many cases their females lay fewer eggs than older ones (Nice, 1937).

With intense intraspecific competition, those individuals which were the least efficient would produce too few young to balance the "expense" of breeding. Selection would favor a system for lowered reproduction in young birds if this led to enhanced reproductive success in subsequent years. The first evolutionary step is probably the establishment of a hormonal mechanism. Some support for this is found in studies of Red-winged Blackbirds (*Agelaius phoeniceus*). Testes of first-year males, which usually do not breed, attain their maximum development three weeks after older males. Also their maximum size is only two-thirds that of older males, although they do undergo spermatogenesis (Wright, 1944). A lowered hormone level and a delay in testes development might have many effects in first-year birds including lowered aggressiveness, later arrival on the breeding grounds and retention of a female-like plumage.

In many species molt into breeding plumage is at least partly controlled by androgens (Witschi, 1961). Miller (1933) suggested that the great variability in melanin deposition in first-year male Phainopeplas (*Phainopepla

TABLE 1

PERCENTAGE OF TERRITORIAL FIRST-YEAR MALES IN DECIDUOUS HABITATS

Per cent territorial first-year males	Total number of males	Habitat	Reference
12	59	deciduous—N. Y.	Ficken, 1962*a*
0	10	mixed—N. Y.	Kendeigh, 1945
8	48	deciduous—N. Y.	Hickey, 1940
29	7	deciduous—Mich.	Baker, 1944
15	34	deciduous—Ohio	Sturm, 1945

nitens) was due to a variable amount of testicular hormone at the time of the molt. The possession of a female-like plumage in first-year males which do not breed probably has not been selected for directly but is the outcome of selection for slower maturation (Orians, 1961). The plumage of the first-year male redstart seems to confer no direct advantage in the competitive situation with older males since first-year males are reacted to just as aggressively as older males. Male redstarts also react very aggressively toward females initially (Ficken, 1963) and this again illustrates that a female-like plumage is reacted to aggressively. Since first-year males sing, this probably enhances their aggressive releasers as compared to females. In Orchard Orioles (*Icterus spurius*) which also have a female-like plumage their first year (but it is not known what proportion of first-year males breed) fights between first-year and older males are intense, although the species is in general non-territorial (Dennis, 1948). Thus, first-year male plumage in this species as well apparently does not reduce aggression by other males. It might be expected that it would be advantageous for floaters not to be reacted to aggresively by other males, but as Hickey (1940) observed, redstart floaters are attacked despite their plumage. However, a female-like plumage is much more cryptic than the red and black of the adult male, at least to the human observer, and this crypticity might be of value in reducing predation on first-year males.

Later arrival may lead either to failure to procure a mate or to mating with first-year females. Since first-year males arrive later than most females, mating may be partly a matter of availability of females at the time of arrival of males. However, other factors are probably involved. Females may not be as sexually responsive to males in a female-like plumage. Also the lowered aggressiveness of first-year males may reduce chances of pairing since an initial strong aggressive response of the male toward the female may be necessary for pair formation to occur in this species (Ficken, 1963).

Late arrival may contribute to the inability of first-year males to compete successfully with older males in several ways. One is that often all suitable

TABLE 2
FREQUENCY OF TERRITORIAL FIRST-YEAR MALE REDSTARTS IN A VARIETY OF HABITATS IN MAINE

Habitat	Total no. of males	No. of first-year males	Percentage of first-year males
Alder	14	1	7
Deciduous	14	3	21
Immature deciduous	7	5	71
Mixed coniferous-deciduous	15	9	60
Coniferous	11	9	82

territories are occupied. Another is that all older males are recently mated and territorial aggressiveness seems to reach its peak at just that time (Ficken, 1962*a*) so they are likely to be more aggressive to first-year males than they were to each other initially.

The reduced aggressiveness of the first-year males probably also affects their ability to obtain suitable territories. Experience plays a part in success in aggressive encounters of many animals (Scott, 1958), and lack of experience probably reduces success in encounters between first-year and older male redstarts. The inability to compete successfully with older males probably leads to some wandering and males either become floaters or sub-optimal habitats are found and territories are established there where competition with other males is reduced or absent. First-year male redstarts are more often found in late spring outside their normal breeding range in California than are older males (Root, 1962), indicating that the young males are probably the pioneers in range and habitat extensions. The utilization of sub-optimal habitats probably reduces breeding success further. One way may be through reduction of the amount of food available since the deciduous foliage density is lower. In some species choice of a mate by the female is at least partially determined by the quality of the habitat of potential mates (Verner, 1963; Tompa, 1962). If this is true in the redstart, mating success will be further reduced by the possession of territories in sub-optimal habitats.

Thus the ultimate cause of the interrelated effects of female-like plumage, low reproductive success, less aggressive behavior and utilization of sub-optimal habitats is selection against breeding of what were originally slightly less successful birds. The question naturally arises as to why first-year males attempt to breed at all. However, if they breed where they are not competing with older males, and even some small fraction is successful, this would be advantageous. Also, there may be much learning necessary for reproductive success. By attempting to breed or just getting through some of the stages of breeding, first-year males may have a better chance for breeding in subsequent years as a result of this experience (Selander, 1965).

Many aspects of the redstart system are not unique. Wynne-Edwards (1962) has pointed out that slow maturation rates are often found in species with high population densities. However, he postulates a system based on group selection while it probably can best be explained by natural selection at the individual level (Amadon, 1964; Selander, 1965), as a result of the system older and more experienced breeders having reduced competition for territories. Orians (1961) studied the population structure of blackbirds (*Agelaius phoeniceus* and *A. tricolor*) and extended his conclusions to other species as well. He suggested that slow maturation of first-year males is "characteristic of species in which breeding sites are limited. Probably these are all species which are ineffectively controlled between breeding seasons so that surpluses of breeding birds are regularly present." Selander (1965), from his studies of polygamous *Cassidix* species suggests that "because the probability of a young male obtaining mates in competition with older experienced males is very low, males which postpone breeding may ultimately have greater reproduction; and through selection first-year males have become adaptively 'handicapped' physiologically and morphologically in competition with adult males for mates."

Delayed maturation occurs in some icterids (Orians, 1961; Selander, 1965) and although in some cases it seems to be associated with a high population density the situation is further complicated by the type of mating system, delayed maturation being more common in non-monogamous species, although this is probably a consequence rather than a cause of delayed maturation (Selander, 1965). For example, delayed maturation occurs in the grackles *Cassidix major* and *C. mexicanus* which have a plumage intermediate between the juvenile-female and the adult male, and the males do not breed until their second year (Selander, 1965). The Red-winged Blackbird (*Agelaius phoeniceus*), the Tricolored Blackbird (*A. tricolor*), and the Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*) have delayed maturation, are colonial with high breeding densities and breeding sites are at a premium in some localities. Male Red-winged Blackbirds do not normally breed until two years of age, although first-year males may occur at the periphery of the colony. Some obtain territories and a few breed. In the Tricolored Blackbird yearling males regularly establish territories, but as in the redstart they are crowded into the less desirable sites and are less successful in obtaining mates (Orians, 1961).

Orians' hypothesis of a relationship between high breeding population densities and delayed maturation seems to be applicable to cases where there is little information available on breeding behavior. For example, a delay in attaining adult male plumage occurs in the Orchard Oriole (*Icterus spurius*) but not in the Baltimore Oriole (*I. galbula*), and the Orchard Oriole seems to have intense intraspecific competition in some areas. For example, Dennis (1948) reports that males of this species are not territorial and one population which he studied attained a density of 114 males in 7 acres, with as many as 20 nests in one tree. The female-like plumage of first-year male crossbills *Loxia curvirostra* and *L. leucoptera* may also be related to locally high population densities in these semicolonial breeders. First-year male Purple Martins (*Progne subis*) differ in plumage from older males. This species nests in colonies, and there is probably also a shortage of nest sites.

The species with delayed maturation which we have discussed are those in which there is a color difference between the age classes and non-breeding first-year males are more noticeable. However, there are cases such as that noted by Selander (1964) where some species of the wren genus *Campylorhynchus* breed the first year while others do not. Whether this is related to breeding population densities and intraspecific competition is not known.

The evolution of delayed maturation rates in birds might be expected more commonly in species with a long life span as is the case with certain sea birds, many of which do not breed until they are several years old (e.g., Wynne-Edwards, 1962). These species also often have high population densities. In such species the enhancement of breeding success in older birds by reduced competition with younger ones would occur over several breeding seasons, although there are undoubtedly many other variables influencing their reproductive success. However, it is probably not surprising that relatively few of the small passerines, with their relatively short life span, have evolved such a system.

Our findings also have implications for studies of habitat "preference." The habitat difference between first-year and older males is obviously not innate. However, in the species as a whole there is probably an innate basis, although with learning also involved, for responding only to certain types of habitats. Even first-year males are selective, and are not found breeding in just any habitat. It is misleading to refer to a "preference" or "selection" in the case of first-year redstarts. They often seem to initially occupy habitats where older males are also breeding but through competition must go elsewhere. It would seem advantageous for a species to be somewhat flexible and to be able to respond to a variety of habitats (Svärdson, 1949).

Thus the redstart has evolved a system of interrelated physiological, behavioral, and ecological adaptations which are related to intraspecific competition and to its extensive and diverse geographic range and which contribute to making it one of the most successful North American passerines.

Other species with intense intraspecific competition may have similar systems, although differing in some respects from that proposed for the redstart.

SUMMARY

First-year male American Redstarts are relatively uncommon as compared to older males as breeders in deciduous forests in the eastern and central United States. However in Maine they occur more frequently than older males in sub-optimal habitats. In New York first-year males arrive later than older males, are less aggressive and consequently at a disadvantage in competing with older males for territories in optimal habitats. They are also less successful in obtaining mates, at least partly due to their later arrival. A system is proposed to explain the interrelated effects of a female-like plumage, late arrival, lowered aggression, and use of sub-optimal habitats. It is suggested that delayed maturation, probably involving a lowered androgen level, evolved as a result of intense intraspecific competition in this species, and that selection acts against first-year males breeding in optimal habitats. Other passerines in which first-year males differ in plumage from older males also have high population densities and were probably subjected to similar selective pressures.

ACKNOWLEDGMENTS

This study was aided financially by a Sigma Xi Grant-in-Aid and by National Science Foundation Grant GB-3226. We wish to thank Douglass H. Morse and Richard Root for their criticisms of the manuscript and Stephen Eaton and David Bridge for their unpublished data.

LITERATURE CITED

Amadon, D.
1964 The evolution of low reproductive rates in birds. *Evolution*, 18:105–110.
Baker, B. W.
1944 Nesting of the American Redstart. *Wilson Bull.*, 56:83–90.
Bent, A. C.
1953 Life histories of North American wood warblers. *U.S. Natl. Mus. Bull.*, 203.
Chapman, F. M.
1907 The warblers of North America. Appleton and Co., New York.
Coulson, J. C., and E. White
1958 The effect of age on the breeding biology of the Kittiwake *Rissa tridactyla*. *Ibis*, 100:40–51.
Dennis, J. V.
1948 Observations on the Orchard Oriole in lower Mississippi delta. *Bird-Banding*. 19:12–21.
Ficken, M. S.
1962*a* Agonistic behavior and territory in the American Redstart. *Auk*, 79:607–632.
1962*b* Maintenance activities of the American Redstart. *Wilson Bull.*, 74:153–165.
1963 Courtship of the American Redstart. *Auk*, 80:307–317.
1964 Nest-site selection in the American Redstart. *Wilson Bull.*, 76:189.
Ficken, M. S., and R. W. Ficken
1965 Comparative ethology of the Yellow Warbler, Chestnut-sided Warbler and American Redstart. *Wilson Bull.*, 77:363–375.

GRISCOM, L., AND A. SPRUNT
1957 The warblers of America. Devin-Adair Co., New York.
HENSLEY, M. M., AND J. B. COPE
1951 Further data on removal and repopulation of the breeding birds in a spruce-fir forest community. *Auk*, 68:483–493.
HICKEY, J. J.
1940 Territorial aspects of the American Redstart. *Auk*, 57:255–256.
KENDEIGH, S. C.
1945 Nesting behavior of wood warblers. *Wilson Bull.*, 57:145–164.
1947 Bird population studies in the coniferous forest biome during a spruce budworm outbreak. Biol. Bull. No. 1. Dept. of Lands and Forests, Ontario, Canada.
LACK, D.
1954 The natural regulation of animal numbers. Oxford Univ. Press, Oxford.
MACARTHUR, R. H., J. W. MACARTHUR, AND J. PREER
1962 On bird species diversity. II. Prediction of bird census from habitat measurements. *Amer. Nat.*, 96:167–174.
MAYFIELD, H.
1960 The Kirtland's Warbler. Cranbrook Inst. Science. Bloomfield Hills, Michigan.
MILLER, A. H.
1933 Postjuvenal molt and the appearance of sexual characters of plumage in *Phainopepla nitens*. *Univ. California Publ. Zool.*, 38:425–446.
NICE, M. M.
1937 Studies in the life history of the Song Sparrow. I. *Trans. Linnaean Soc. New York*.
ORIANS, G. H.
1961 The ecology of blackbird (*Agelaius*) social systems. *Ecol. Monogr.*, 31: 285–312.
ROOT, R. B.
1962 Comments on the status of some western specimens of the American Redstart. *Condor*, 64:76–77.
SCOTT, J. P.
1958 Aggression. Univ. Chicago Press, Chicago.
SELANDER, R. K.
1964 Speciation in wrens of the genus *Campylorhynchus*. *Univ. California Publ. Zool.*, 74:1–289.
1965 On mating systems and sexual selection. *Amer. Nat.*, 99:129–141.
SNOW, D. W.
1958 The breeding of the Blackbird *Turdus merula* at Oxford. *Ibis*, 100:1–30.
STEWART, R. E., AND J. W. ALDRICH
1951 Removal and repopulation of breeding birds in a spruce-fir forest community. *Auk*, 68:471–482.
STURM, L.
1945 A study of the nesting activities of the American Redstart. *Auk*, 62:189–206.
SVÄRDSON, G.
1949 Competition and habitat selection in birds. *Oikos*, 1:157–174.
TOMPA, F. S.
1962 Territorial behavior: the main controlling factor of a local Song Sparrow population. *Auk*, 79:687-697.

VERNER, J.

1963 Song rates and polygamy in the Long-billed Marsh Wren. *Proc. 13th Internatl. Ornith. Congr.*, 299–307.

WITSCHI, E.

1961 Sex and secondary sexual characters, p. 115–168. *In*: Marshall, A. J. (ed.), Biology and comparative physiology of birds. Academic Press, New York.

WRIGHT, P. L., AND M. H. WRIGHT

1944 The reproductive cycle of the male Red-winged Blackbird. *Condor*, 46:46–59.

WYNNE-EDWARDS, V. C.

1962 Animal dispersion in relation to social behaviour. Oliver and Boyd, Edinburgh.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF MARYLAND, COLLEGE PARK, MARYLAND. 5 FEBRUARY 1966.

JOSSELYN VAN TYNE MEMORIAL LIBRARY

The following gifts have been recently received. From:

Oliver L. Austin, Jr.—1 journal
Andrew J. Berger—3 reprints
C. T. Black—40 journals, 5 reprints
R. K. Brooke—3 reprints
George A. Clark, Jr.—2 reprints
C. T. Collins—3 reprints
Earle R. Greene—1 book
Alfred O. Gross—25 reprints
George A. Hall—1 journal
Doris C. Hauser—6 reprints
F. Haverschmidt—1 journal
J. J. Hickey—1 book
George Hunt—2 pamphlets
D. J. T. Hussell—6 journals, 10 reprints
David W. Johnston—2 reprints
Alice H. Kelley—1 pamphlet
Leon Kelso—4 books, 1 journal, 22 translations
S. C. Kendeigh—2 reprints
R. C. Lasiewski—1 reprint
Amelia R. Laskey—3 reprints
James P. Ludwig—3 reprints
Daniel McKinley—8 reprints
Harold Mayfield—15 reprints
R. E. Morrill—7 books
B. G. Murray, Jr.—1 reprint
Margaret M. Nice—5 journals, 60 reprints
Ralph S. Palmer—1 translation, 1 reprint
C. Chandler Ross—16 books, 11 reprints
R. M. Schramm—12 journals
Charles G. Sibley—1 reprint
A. M. Simonetta—3 reprints
W. E. Southern—1 reprint
Robert W. Storer—1 book
Mrs. Josselyn Van Tyne—3,300 reprints
L. R. Wolfe—1 book, 32 journals, 4 pamphlets, 62 reprints
John L. Zimmerman—2 reprints

AN ECOLOGICAL STUDY OF WINTER FLOCKS OF BLACK-CAPPED AND CHESTNUT-BACKED CHICKADEES

SUSAN M. SMITH

Most living species have developed special adaptations which enable them to fit into a particular mode of life, or niche. Two closely related species are very likely to have similar structural features, behavioral responses, and so on, which lead to correspondingly similar ecological requirements. The more closely related two symatric species are, the more need there will be for differences to evolve which will keep their modes of life separate and prevent overlap of requirements.

Ecological isolation is important to closely related avian species for two reasons. By avoiding niche overlap, interspecific competition is practically eliminated. Secondly, ecological isolation reduces the possibility of hybridization. As hybrids tend to have reduced viability and will be poorly adapted to either parental niche, hybridization, as shown by many writers, is selected against.

Several differences have evolved among closely related sympatric passerines which aid in preventing ecological overlap. Differences in anatomy such as the leg muscles of the Goldcrest (*Regulus regulus*) and the Willow Tit (*Parus montanus*) (Palmgren, 1932), or the beak shape of Eurasian tits (Snow, 1954*b*) prevent overlap of feeding niche. Differences in color, voice, and behavior (especially reproductive behavior) also serve to separate closely related species.

Peterson, Mountfort, and Hollom (1954) list nine species of the genus *Parus* in Europe, six of which occur in Great Britain. Many of these are sympatric over much of their range. European studies on the comparative ecology of these titmice have shown that each of them has evolved its separate niche enabling it to live in close contact with other tit species, yet at the same time avoid serious interspecific competition (Gibb, 1954; Haftorn, 1956; Hartley, 1953; Snow, 1954*a*, 1954*b*; and others).

Nearctic titmice have not developed nearly this degree of sympatry. However, along the Pacific coast of North America the ranges of the Black-capped Chickadee (*Parus atricapillus*) and the Chestnut-backed Chickadee (*Parus rufescens*) overlap. In describing the habitat of the Black-capped Chickadee in California, Grinnell and Miller (1944) write "Chiefly deciduous timber, especially willows and alders, along large or small water courses." Gabrielson and Jewett (1940) write of it in Oregon: ". . . The Oregon Chickadee replaces the Chestnut-backed Chickadee in the cottonwood bottoms." Jewett, Taylor, Shaw and Aldrich (1953) write of it in Washington: "Tree alders and deciduous woods are favorite foraging grounds . . ."

The habitat of the Chestnut-backed Chickadee seems to be somewhat different. Grinnell and Miller (1944) describe its habitat in California as "Coniferous forest and adjacent woodland." Jewett et al. (1953) write of it in Washington: "While preferring the dense shade of the coniferous forests of the Pacific coastal belt to any other habitat, the chestnut-backed chickadee is found rather broadly through the timbered sections . . . ordinarily it remains high in the trees . . ." While these descriptions indicate a general difference in the habitat of these two species, no more specific analysis of this seems to have been made.

In Vancouver, British Columbia, it is possible to find both of these species living side by side. They even forage in mixed flocks during the winter. This study has been conducted on winter flocks of these species in an attempt to find factors producing ecological isolation between them.

Field work was carried out on an area of mixed second growth forest adjacent to the University of British Columbia campus, and covering approximately 0.75 square miles. The vegetation of the area can be classified as the wet subzone of the Coastal Douglas Fir Zone, with transitional characteristics of the Coastal Western Hemlock Zone (Krajina, pers. comm.). Based on a strip survey made on a portion of the study area, the vegetation is 55.4 per cent deciduous and 44.6 per cent coniferous. The main conifers are Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), red cedar (*Thuja plicata*), and grand fir (*Abies grandis*). Broad-leafed maple (*Acer macrophyllum*) and red alder (*Alnus rubra*) make up virtually all the deciduous trees on the area, and the main shrubs are redberry elder (*Sambucus pubens*), thimbleberry and salmonberry (*Rubus* spp.).

Observations were made at least once weekly, for two to four hours each time, from 21 September 1962 to 15 March 1963. When a flock of chickadees was found, its size and composition were noted. A separate record was made for each feeding chickadee including the following information: species, height above ground, height and species of feeding site, and position within the feeding site.

RESULTS

Although feeding in the same area, individuals of the two species showed definite differences in selection of feeding sites. One of the main differences was in the type of tree chosen (Table 1). There are slightly more than 3.5 times as many records of Black-capped Chickadees in deciduous as in coniferous trees, while there are more than five times as many records of Chestnut-backed Chickadees in coniferous as in deciduous trees.

The second major difference in the feeding behavior of the two species was found to be in the choice of height of the feeding site. Figure 1 shows

TABLE 1

FREQUENCY OF RECORDS IN THE THREE MAIN FEEDING SITES

	Black-capped Chickadee	Chestnut-backed Chickadee
Coniferous trees	21.0 per cent	84.1 per cent
Deciduous trees	76.4 per cent	15.9 per cent
Ground	2.6 per cent	—
Number of records:	598	327

the percentages of each species' records at various distances above the ground. This shows a definite separation of the two species. The peak of the Black-capped Chickadee records occurs at the 0–5 foot class, and no Black-capped Chickadee was recorded above 70 feet; while the peak of the Chestnut-backed Chickadee records occurs at the 45–50 foot class, and 12.0 per cent of the records are for above 70 feet. Application of the Student's t-test has shown these peaks to be significantly different at the 0.01 level.

Figure 2 shows the percentage of records of each species at various distances from the top of the feeding site. In this figure no records of birds in *Rubus* spp. were included, since these shrubs are seldom over five feet high, so that virtually all records for these sites would fall in the class of five feet or less from the top of the site. As seen from the figure, there is very little difference between the two species in this respect, although a slightly larger percentage of Chestnut-backed (28.9 per cent) than of Black-capped (22.0 per cent) Chickadees was found five feet or less from the top of the feeding site. During the study, flocks of chickadees were frequently observed travelling at a fairly uniform height above ground, often seemingly regardless of the height of tree through which they were passing. Thus in this study area this factor is possibly of less value in maintaining ecological isolation between the two species than is the height above ground.

Table 2 shows the percentage of records of each species with regard to their position within the tree. Both species spent the majority of their time in the thin outer twigs of trees. However, Chestnut-backed Chickadees were seen foraging on "thick" (i.e. two inches or more in diameter) branches less often than were Black-capped Chickadees, while 4.1 per cent of the records of Black-capped Chickadees are for gleaning on the main trunk, but there are no records of Chestnut-backed Chickadees gleaning on this position. Both species were seen feeding on conifer seeds directly from the cones in western hemlocks and Douglas-firs; these records were considered as "thin branches" in Table 2.

"Mixed flocks" (those containing both species of chickadees moving together) were commonly seen during the study, being observed on all but

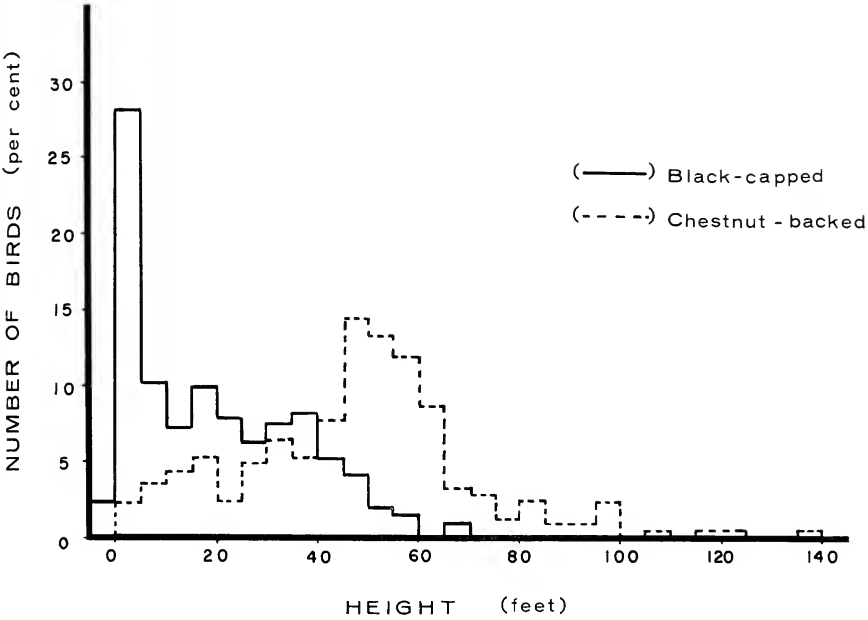


FIG. 1. Comparison of feeding heights of Black-capped and Chestnut-backed chickadees.

five days. The average mixed flock consisted of 11.8 Black-capped and 7.7 Chestnut-backed chickadees. The average number of chickadees in a pure flock of Black-capped Chickadees was 8.7, and the average number in a pure flock of Chestnut-backed Chickadees was 8.4. Thus it seems likely that mixed flocks are relatively unstable units made up of two chickadee flocks.

Neither species seemed to be influenced by the presence or absence of members of the other species, in either their choice of type or of height of feeding site. No significant difference between pure and mixed flocks was found in either consideration.

Very little aggression of any kind was observed during this study. Intraspecific aggression was observed three times among Black-capped Chickadees, and only once among Chestnut-backed Chickadees. However, at no time during the study period was any aggression observed between the two chickadee species.

During the study period no extremes in weather occurred. There was no correlation between the date of the records and the average height of the records, or of choice of type of feeding site.

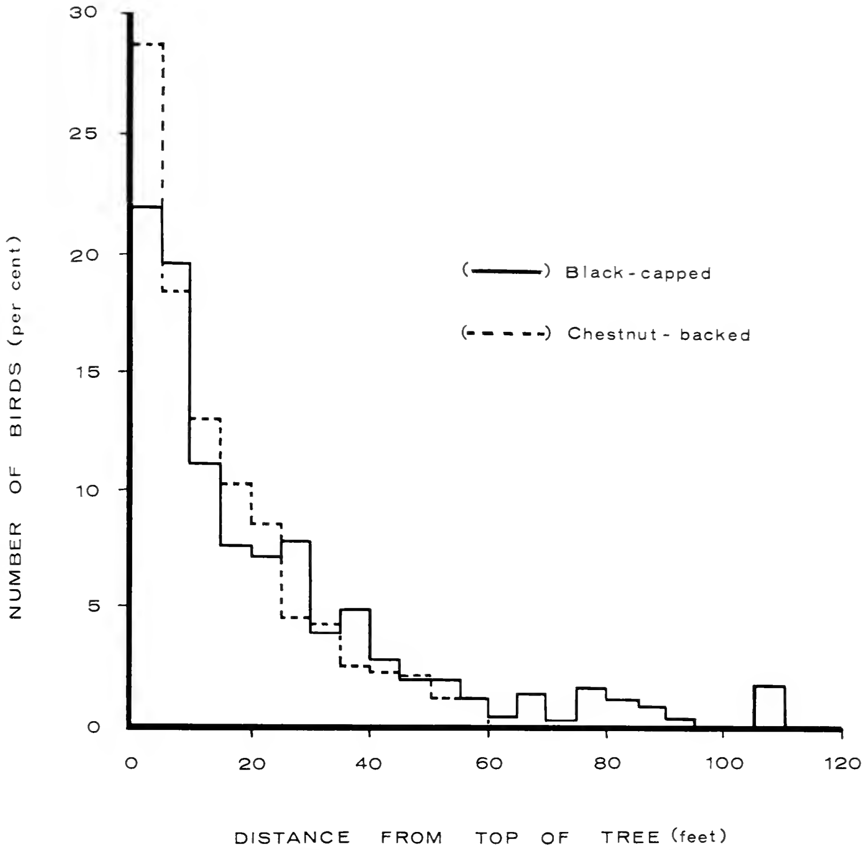


FIG. 2. Comparison of distance from top of feeding site of Black-capped and Chestnut-backed chickadees.

DISCUSSION

There are seven species of chickadees, i.e. members of the subgenus *Poecile* of the genus *Parus* (Dixon, 1961) in North America. Unlike the palearctic parids, most of these are allopatric, the most notable exception being the sympatry of the Black-capped and Boreal (*P. hudsonicus*) chickadees. These two species are the only North American chickadees with continent-wide range, and there is a broad overlap in their occurrence.

Lack (1944), Dixon (1954, 1961), and others have stressed the importance of adjustments in behavior, especially feeding behavior, if two similar forms are to coexist in the same area. Dixon (1961) writes that the Boreal Chickadee is reported to forage higher in the trees than the Black-capped Chickadees

TABLE 2
FREQUENCY OF RECORDS AT VARIOUS POSITIONS WITHIN THE TREE

	Trunk	Thick branches	Thin branches
Black-capped Chickadee	4.1 per cent	2.8 per cent	93.1 per cent
Chestnut-backed Chickadee	—	1.2 per cent	98.8 per cent

do. He also shows that there are marked differences in the habitat preferences of these two species, and he suggests that this is their principal means of ecological isolation. Most writers agree that the preferred habitat of the Black-capped Chickadee is open deciduous or mixed forest. On the other hand, the Boreal Chickadee, like the Chestnut-backed Chickadee, is most numerous in moist shaded coniferous forest (Dixon, 1961). This similarity of habitat choice between the Chestnut-backed and Boreal chickadees was a major factor in Grinnell's (1904) postulating that they both arose from a common ancestor which he named *Parus prehudsonicus.*

Apart from the Black-capped and the Boreal chickadees, the pair with the greatest range overlap seems to be the Black-capped and the Chestnut-backed chickadees, for the former occurs over much of the latter's range. In this study it was found that in winter flocks of these two species there are marked differences in feeding behavior, which are very similar to those observed between the Black-capped and Boreal chickadees. Dixon (1961) writes that the Black-capped and Boreal chickadees seem to have achieved the closest approach to "ecologic compatibility" of any pair of North American chickadees. The data of this study suggest that a similar ecologic compatibility exists between the Black-capped and the Chestnut-backed chickadees, which is achieved by essentially the same differences, i.e. tree species selection and height selection of the feeding sites. This separation is naturally augmented by differences in color and in voice. It is interesting to note that the tone of the Boreal Chickadee is reported to be very similar in quality to that of the Chestnut-backed Chickadee.

It cannot be said from these data that there is competitive exclusion or habitat adjustment as a result of overlap in range of these species. These differences in feeding habits probably do apply equally well to areas where only one of these two species occurs. Studies on Chestnut-backed Chickadees on Pacific coastal islands such as Vancouver Island (where no Black-capped Chickadees occur) may throw some light on this matter. More work is also necessary to find out whether these differences occur during other seasons of the year. Nevertheless, these differences may well be the major factors which allow stable range overlap of these two species.

SUMMARY

Winter flocks of Black-capped and Chestnut-backed chickadees were studied in an attempt to find factors producing ecological isolation between the two species.

Two major differences were observed between these chickadees. Although the study area woods were approximately 50 per cent deciduous and 50 per cent coniferous, 76 per cent of the feeding records of Black-capped Chickadees were in deciduous trees, while 83 per cent of the Chestnut-backed Chickadee records were in coniferous trees. Secondly, the peak of records of Black-capped Chickadees was between 0 and 5 feet above the ground: that of Chestnut-backed Chickadees was between 45 and 50 feet above the ground.

Black-capped Chickadees were recorded foraging on thick branches and main trunks slightly more often than were Chestnut-backed Chickadees. Black-capped Chickadees were also recorded feeding on the ground in 2.5 per cent of the records: there were no records of Chestnut-backed Chickadees feeding on the ground.

Being in mixed flocks had no significant effect on either species, for any measured variable. No interspecific aggression was observed.

It is suggested that the differences between the two species' choice of kind and height of feeding site are major factors in maintaining ecological isolation between these species in areas of sympatry.

ACKNOWLEDGMENTS

I am grateful to Dr. M. D. F. Udvardy, for his suggestions on the problem as well as his criticism of the manuscript. Thanks are also due to Dr. V. Krajina and Dr. L. Orloci for information on the vegetation of the study area, and advice on the methods of its survey. In addition I would like to thank Dr. D. H. Chitty for ideas derived from personal communications.

LITERATURE CITED

DIXON, K. L.

1954 Some ecological relations of chickadees and titmice in central California. *Condor*, 56:113–124.

1961 Habitat distribution and niche relationships in North American species of *Parus*. *In*: Vertebrate Speciation, a University of Texas Symposium. W. F. Blair, Ed. University of Texas Press, Austin.

GABRIELSON, I. N., AND S. G. JEWETT

1940 Birds of Oregon. Oregon State College Press, Corvallis.

GIBB, J.

1954 Feeding ecology of tits, with notes on Treecreeper and Goldcrest. *Ibis*, 96:513–543.

GRINNELL, J.

1904 The origin and distribution of the Chestnut-backed Chickadee. *Auk*, 21:364–382.

GRINNELL, J., AND A. H. MILLER

1944 The distribution of the birds of California. *Pacific Coast Avifauna*, 27:1–608.

HAFTORN, S.

1956 Contribution to the food biology of tits especially about storing of surplus food. Part IV. A comparative analysis of *Parus atricapillus* L., *P. cristatus* L. and *P. ater* L. *Norsk. Vidensk. Selsk. Skr.*, 4:1–54.

Hartley, P. H. T.
1953 An ecological study of the feeding habits of the English titmice. *J. Anim. Ecol.*, 22:261–288.
Jewett, S. G., W. P. Taylor, W. T. Shaw, and J. W. Aldrich
1953 Birds of Washington State. University of Washington Press, Seattle.
Krajina, V. J.
1959 Bioclimatic zones in British Columbia. University of British Columbia Botanical Series, No. 1.
Lack, D.
1944 Ecological aspects of species-formation in passerine birds. *Ibis*, 86:260–286.
Palmgren, P.
1932 Zur Biologie von *Regulus regulus regulus* Linnaeus und *Parus atricapillus* Selys. Eine verglichend-okologische Untersuchung. *Acta Zoologica Fennica*, 14:1–113.
Peterson, R. T., G. Mountfort, and P. A. D. Hollom
1954 A field guide to the birds of Britain and Europe. Collins, London.
Snow, D. W.
1954*a* Trends in geographical variation in palearctic members of the genus *Parus*. *Evolution*, 8:19–28.
1954*b* The habitats of Eurasian tits (*Parus* spp.). *Ibis*, 96:565–585.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER 8, BRITISH COLUMBIA, CANADA. (PRESENT ADDRESS: DEPARTMENT OF ZOOLOGY, UNIVERSITY OF WASHINGTON, SEATTLE, WASHINGTON 98105), 31 JANUARY 1966.

BREEDING BIOLOGY AND ECOLOGY OF THE HORNED LARK IN ALPINE TUNDRA

Nicolaas A. M. Verbeek

Aspects of the breeding biology of the Horned Lark (*Eremophila alpestris*) are reported by Kelso (1931), Dubois (1935, 1936) and Bent (1942). DuBois' and Kelso's studies dealt with prairie-nesting populations. The study here reported was conducted in alpine tundra during the summers of 1963 and 1964. Data were collected incidental to a study of the Water Pipit (*Anthus spinoletta*) (Verbeek, MS). In the summer of 1963 little time was spent on the larks and only four nests were located. In 1964, larks were much more abundant and 12 nests were located, 11 of which were on the study area proper and one outside.

STUDY AREA

The study area (Fig. 1) consisted of about 116 hectares of alpine meadow about one km NE of Beartooth Pass on the Beartooth Plateau, Park County, Wyoming. A detailed description of the vegetation and geology of the Plateau is given by Johnson and Billings (1962). The average altitude was about 3,200 m. The Beartooth Highway bounded the study area on the south and the edge of the plateau above Rock Creek Canyon formed the western boundary. On the east, Pipit Hill, so named by us, formed part of the study area up to about 3,262 m. The face of Pipit Hill was a dry meadow, although in places, below pockets of snow, there were isolated areas of moist meadow. Scattered along the face of the hill were rock outcrops, rock polygons and solifluction terraces. On the north, the boundary ran about 100 m north of the main channel which drained the whole area. This main channel had a maze of narrow branches, many of which were dry toward the end of the season. Frost hummocks were characteristic of this wet area. The vegetation consisted of plants such as *Salix planifolia*, *Sedum rhodanthum*, and *Caltha leptosepala*. Besides the low wet area in the north and Pipit Hill, there was the Central Ridge running through the center of the area and West Hill in the southwest. The Central Ridge and West Hill both had areas with fellfield characteristics such as cushion plants and much exposed rock and gravel on the western exposure. Extensive snow accumulation areas between Pipit Hill and the Central Ridge and between the latter and West Hill were bare except for some sparse vegetation in late summer when the snow had melted from part of these areas.

TERRITORY AND HABITAT

The larks occupied the whole study area and their nests were located in all cover types except exposed snow accumulation, frost hummocks and wet meadow. The distribution of the nests is shown in Figure 1. For each of 11 nests in 1964, I noted the plants growing within a 30 cm radius of the nests (Table 1). The nests are placed in one of four categories: (a) Fellfield nests, characterized by cushion plants and exposed rock: (b) Dry Meadow nests, characterized by a general absence of cushion plants: (c) Moist

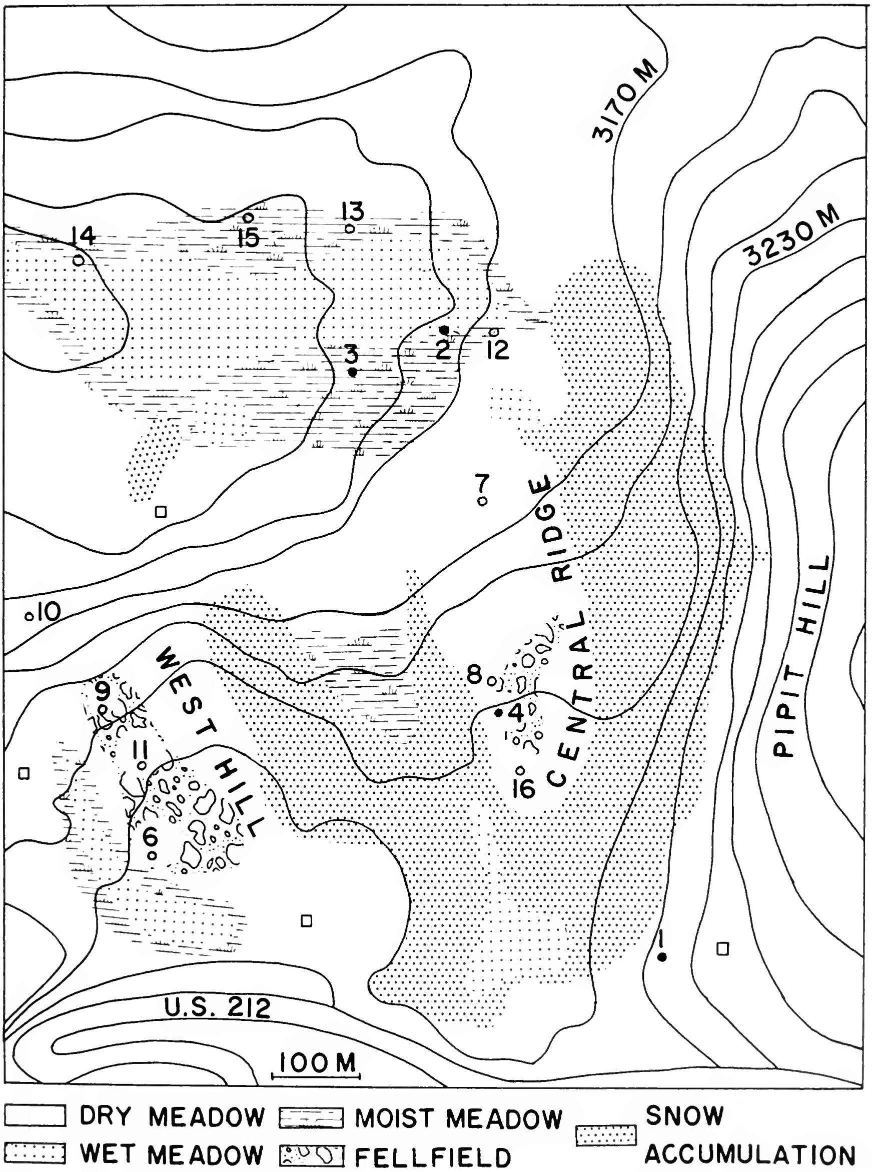


Fig. 1. Distribution of nests of the Horned Lark found in 1963 (dots) and in 1964 (open circles). The squares are suspected locations of nests in 1964. Contour lines are 12.2 m apart.

Meadow nests, characterized by moisture loving plants such as *Carex scopulorum*; and (d) an intermediate type between Dry and Moist Meadow.

Of all the nests, including those of 1963, nine were located in a dry habitat, five in a moist habitat and one in an intermediate type. The presence of five nests in a moist habitat is unusual since heretofore lark nests have been associated only with dry and gravelly sites. Two nest territories and the areas occupied by 22 pairs reported by Drury (1961) were all located in the most exposed places "where most of the surface was tan angular rock." Pickwell (1931) writes: "The Prairie Horned Lark selects the bleakest barrens available" and he feels that bare ground is the most essential condition required. The fact that nests were found in moist habitat in both years eliminates the possibility of increased population pressure in 1964 forcing the birds to occupy less favorable habitat. It seems that in an alpine population of this species, a wider range of habitat is utilized.

Horned Larks have very large territories. Besides the 11 nests found in 1964 there were at least four more known territories the nests of which were not located. Because large areas on the study plot were not suitable lark habitat, it is not possible to calculate the average size of each territory by simple division. The average distance between two nests in the same continuous habitat type, for instance between N16 (Nest 16) and N8, and between N8 and N7, etc., was about 142 m. If we take the nest as the center of the territory, then each territory occupied about 1.5 hectares.

Larks defend their territory with great persistence throughout the breeding cycle from the moment the territory is established till the time the young leave the nest. Males chase each other with great speed, often close to the ground. Sometimes several birds participate in these chases. On 5 July 1964, two males fought by standing close together and beating one another by suddenly extending one wing. After each blow they would walk away from each other for about 30 cm and then walk back again to repeat the performance. Two males can often be seen to start a fight on the ground and then continue it in the air, climbing higher and higher up to about 20 m at times. This behavior was noted also by DuBois (1935).

SONG

In the alpine zone larks are the first birds to sing in the morning and the last to cease in the evening. The flight song is given from the ground as well as from the air. On the ground, males sing while perched on some projection, usually a rock. In the air, the bird sings while his wings and tail are spread wide open and in between bursts of song he hovers to maintain altitude. The duration of the only flight song timed was 11 minutes, twice as long as that given by Pickwell for *E. a. praticola* and my impression is

TABLE 1

SPECIES OF PLANTS RECORDED WITHIN 30 CM RADIUS OF 11 NESTS OF THE HORNED LARK

Species	Fellfield nests				Dry meadow nests			Moist meadow nests			Intermediate meadow nest
	5	6	9	11	7	8	10	13	14	15	16
Rock	1	1	1	1							
Geum rossii	1	1		1	1	1	1		1	1	1
Smelowskia calycina	1	1	1		1		1				
Potentilla diversifolia	1	1		1	1	1	1				
Antennaria sp.	1										
Mertensia alpina	1		1		1		1		1		
Silene acaulis	1	1					1				
Polygonum bistortoides		1	1		1	1		1		1	1
Douglasia montana		1									
Eritrichium alpinum		1									
Castilleja sp.		1		1	1					1	
Carex sp.		1	1		1	1					1
Myosotis alpestris					1		1				
Pedicularis oederi					1		1				
Lloydia serotina			1		1		1				
Phlox caespitosa			1	1	1	1					
Erigeron caespitosa					1						
Stellaria crassifolia					1						
Claytonia lanceolata						1	1	1		1	
Senecio fuscatus			1			1					
Draba sp.						1		1			
Lupinus monticola			1				1				
Cerastium sp.			1								
Aster alpigenus				1							
Carex scopulorum								1		1	
Caltha leptosepala								1	1	1	
Artemisia scopulorum								1	1	1	1
Gentian algida									1	1	
Dodecatheon pauciflorum									1		
Sedum stenopetalum											1
Trifolium parryi											1

that all of the flight songs were longer than the five minutes reported as a maximum by Pickwell.

NESTS

Before the actual nest is built, a nest cavity is scratched out in the ground. The depth of this cavity varies with the substrate. In some cases a rock prevented any deeper excavation. The average depth of seven nest cavities was 5.0 cm (4.3 to 6.2). The nest is made of dead forbs and grasses. No hair or feathers are used to line the inside. One nest was lined with an unidentified felt-like plant material. Drury (1961) reports the use of feathers in *E. a. alpestris.*

All nests found were constructed so that there was some protective feature such as a projecting rock or a tuft of grass on the windward side. The nest entrance of 12 nests in 1964 all faced between NNW and E; one faced NNW, three N, one NNE, four NE, two ENE, and one E. The predominant winds were from the S and SW. A similar orientation with respect to the wind was reported by DuBois (1935), who found nests facing between NE and SSE under prevailing W winds. I did not notice any evidence of a "pavement" of stones or mud as reported by DuBois (1935) and Pickwell (1931).

Eleven finished nests had an average width of 7.0 cm (6.5 to 7.6) and ten nests had an average depth of 3.8 cm (3.2 to 4.7). The average thickness of seven nests of which both the depth of the scooped-out nest cavity and the completed nest were known was 1.0 cm (0.3 to 1.7). These measurements were taken after the young had left the nest.

EGGS AND INCUBATION

Eggs were laid early in the morning, some time before 0730 hours. The clutch size varied from two to four eggs (one with two eggs, ten with three eggs and three with four eggs).

Only two of the 16 nests were found before the clutch was completed. In N5, the third and last egg was laid in the morning of 29 June. All three eggs had hatched before 0530 hours on 10 July. In N8, the last of three eggs was laid in the morning of 2 July and the first egg hatched 13 July before 0930 hours. The other two eggs in this nest never hatched. The incubation period is taken to be about 11 days. DuBois (1935) gives an incubation period of 10 to 11 days and MacDonald (1916) states 11 days.

Silloway (1903) states that both male and female incubate the eggs. My own observations make me believe that only the female incubates. There is only one clutch per season in contrast to the two clutches reported by DuBois (1935) at lower altitudes. In 1964, all eggs were laid between 25 June and 10 July.

NESTLINGS

The nestling period varied from 9 to 12 days with an average of 10.2 days. This is a very short period but it agrees well with the results obtained by DuBois (1935). The young leave the nest when they have hardly any tail and when the primaries and secondaries are only one-third to one-half grown. The young are incapable of flight at first but walk readily. I caught

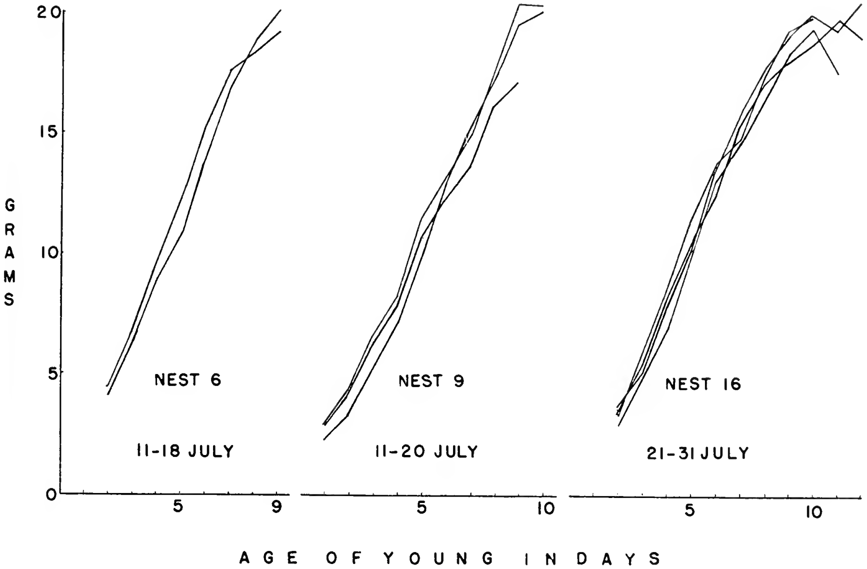


FIG. 2. Growth curves of two, three and four young in three nests of the Horned Lark.

one color-marked young five days after it had left the nest. It could only fly a few meters at the time and was soon exhausted.

Nestling development is very rapid. The average gain in weight of nine young was 1.9 g per day (0.52 to 3.45). When the young reach a weight of about 20 g, they seem to have developed sufficiently to leave the nest. Growth curves for the young of three nests are shown in Figure 2. Earlier departures (Fig. 2) are due to disturbance caused by handling the young. One young of N9, which left when it weighed 17.6 g was recaptured 5 days later when it weighed 20.2 g. The average weight of 15 adult males in the University of Montana Zoological Museum, taken on the study area in June, July, and August, was 32.3 g and the average weight of 7 adult females of the same period was 30.6 g. The young then leave the nest when they are about two-thirds the adult weight. Sexual difference in weight in adult larks has been shown by Behle (1943) and Montagna (1943).

The eyes open when the young are 3.6 days old (average of 10 nests). The primaries and secondaries break the sheaths when the young are 6 days old (average of 2 nests).

During 128 minutes of observation from a blind when the young were one day old, the female brooded them for 78 minutes or about 61 per cent of the time. The average length of the brooding period was 11 minutes (6 to 17). When the female was not brooding she was off gathering food for the young and presumably for herself. If the male came to the nest while the female brooded, she would step off the nest till the male was finished feeding the young, after which she would resume brooding. When the young were four days old, no brooding occurred during one hour of observation, but the female provided shade by standing over the young in the nest. No shading or brooding occurred when the young were 8 days old. Both parents fed the young and both removed feces.

When approaching the nest to feed the young both male and female land at some distance, about 3 to 5 m, from the nest and then walk toward it. The female approaches without any vocalization, while the male makes a soft *tjreeh* call which seems to be a call used around the nest. After feeding is finished the female tends to walk away from the nest but sometimes she flies away from within about 30 cm of the nest. The male flies from the nest more often than he walks.

The food of six nestlings in July consisted of 100 per cent insects, while 12 adults taken between 14 June and 1 September had stomach contents of 78 per cent insects and 22 per cent seeds. The 12 adults had an average of 0.15 (0.03 to 0.26) grams of grit in their stomachs and the nestlings had an average of 0.10 (0.01 to 0.17) grams of grit.

Newly hatched larks are richly covered with a creamy-white natal down. The distribution of natal down of a young just hatched is shown in Table 2. Wetherbee (1957, 1958) has summarized the information regarding natal pterylosis of the Horned Lark. To his list of tracts present can be added: crural, rectrices, and upper tail coverts. My specimen did not have the ocular tract reported by Wetherbee (1958).

The young made begging sounds on my approach to the nest, at about 4.5 days. They directed their beaks to human sounds when 3 days old and before their eyes had opened. When about 5 days old, they followed the movement of my hand over the nest without the accompaniment of human sound. After about 6.5 days, the young no longer react to human sound and movement. After this time, when one approached they remained silent and immobile or tended to crouch deeper in the nest.

Sutton and Parmelee (1955) report finding one instance of nestling larks out of the nest and they suggest that the unprotected and poorly lined nature of this particular nest could have been the cause of this. Observations from my blind, however, showed that the two 8-day old young of N13 left the nest whenever a parent came to the nest with food. They went as far as 30 to 40 cm from the nest and then crawled back again. At this age they do not leave the nest until the parent is about 100 cm from the nest. In N2, one of the four young appeared to be smaller and weaker. This bird died on 20 July when two large nestlings were outside of the nest while a third weak

TABLE 2
TRACT DISTRIBUTION OF NATAL DOWN FEATHERS OF A HORNED LARK NESTLING (JUST HATCHED)

Tract	Left	Right
Coronal	14	13
Occipital	12	11
Dorsal	22	22
Spinal	7	
Rectrices	6	6
Upper tail covert	2	3
Humeral	12	14
Greater secondary covert	9	10
Middle secondary covert	8	6
Carpal remex covert	1	1
Femoral	15	13
Crural	2	2
Abdominal	2	2

nestling was in the nest. The latter nestling died the next day. In N14, on 12 July, three of the four young were out of the nest, the smallest one farthest away, about 30 cm. The next day this one had died, while the other three were back in the nest. It seems that nestling larks leave the nest in competition for food.

When the young were about 4 days old, they panted when the sun shone in the nest. Panting could have started at an earlier age but was not observed.

FLEDGLINGS

Newly fledged young are more often heard than seen after they leave the nest. They call their parents with a single loud *peep* which sounds as if it comes from far away, although the young in actuality may only be a few meters away. The young are very well concealed and crouch when approached. One young of N6 left the nest when it was 9 days old and I saw it fly about 75 m when it was 15 days old. Young larks fly in an undulating manner, more so than the adults do. When they alight they face the intruder and they have a habit of bowing their heads. as if looking at their feet. This bowing is repeated about once every four seconds.

BREEDING SUCCESS

There was a great difference in breeding success between 1963 and 1964. In 1963, of 13 eggs laid in 4 nests, 10 young hatched, only four of which fledged, a success of 31 per cent. In 1964, out of 34 eggs in 11 nests, 31

TABLE 3

SUMMARY OF BREEDING DATA OF THE HORNED LARK

	1963		1964	
	Number	Percent	Number	Percent
Nests	4		11	
Eggs laid	13	100.00	34	100.00
Eggs per nest	3.25		3.09	
Eggs hatched	10	76.92	31	91.18
Eggs hatched per nest	2.50		2.82	
Eggs not hatched	0	0.00	2	5.88
Eggs lost before hatching	3	23.08	1	2.94
Young fledged of eggs hatched	4	40.00	21	67.74
Young fledged per nest	1.00		1.82	
Young lost before fledging	6	60.00	10	32.26
Young fledged of eggs laid	4	30.77	21	61.76

hatched, 21 of which fledged for a breeding success of 62 per cent. Details are shown in Table 3.

Causes of mortality were twofold. In 1963, 3 eggs and 6 of the 10 young that hatched were eaten by mammalian predators, probably the deer mouse (*Peromyscus maniculatus*), which was abundant that summer (Pattie, MS). No nestlings were lost to mammalian predators in 1964.

The loss of 8 nestlings in 1964 was due to blowfly larvae. The average age at death in infested nests was 8.6 days. In each of two nests one young survived. These young showed evidence of having suffered from the larvae. Their development was slowed down and the nestling period extended to 11 and 12 days. In one nest the larvae did not seem to have harmed the nestlings at all, although there were 29 larvae in the nest. Early fledging could be advantageous in escaping blowfly predation. Dead young are removed by the adults.

POST-NESTING PERIOD

Toward the middle of August when the young are independent of the adults, flocks begin to form. These flocks are very loose in nature with 10 to 20 birds scattered out in ones and twos over about 30 to 40 sq m. Whereas earlier in the season larks are found in many habitats, toward the end of the summer they are found almost exclusively in Fellfield and Dry Meadow, in this order.

SUMMARY

An account is given of the breeding biology of the Horned Lark in alpine meadows at an altitude of 3,200 m on the Beartooth Plateau, Park County, Wyoming. Of a total

of 15 nests, 9 were located in a dry habitat, 5 in a moist habitat and one in an intermediate type. Lark territories were large and in 1964 each occupied about 1.5 hectares. All nests faced between NNW and E, away from the predominant S and SW winds. Each nest had some protective feature in the form of a rock or vegetation on the windward side. The average clutch size was 3.1. The incubation period was about 11 days in two nests. Only the female incubates and there is only one clutch per season. The average nestling period was 10.2 days. Young develop rapidly and gain on the average 1.9 g per day. Young leave the nest when they weigh about 20 g. The eyes open on the average when the young are 3.6 days old and the primaries and secondaries break their sheaths when the young are 6 days old. Nestling mortality in 1963 was believed due to the deer mouse, while in 1964, nestlings were lost due to predation by blowfly larvae. Young leave the nest before they are able to fly and they become independent of the adults by the middle of August at which time flocks begin to form.

ACKNOWLEDGMENTS

This study was made possible by a grant from the Frank M. Chapman Memorial Fund of the American Museum of Natural History and a Louis Agassiz Fuertes Research Grant of the Wilson Ornithological Society. I also wish to acknowledge funds from National Science Foundation Grant No B14098 directed by Drs. R. D. Taber and R. S. Hoffmann.

Special thanks are due to Mr. D. L. Pattie and Mr. C. I. Fudge for their companionship in the field and the latter for some lark data for the 1963 season. Drs. R. S. Hoffmann and F. A. Pitelka read and criticized the manuscript for which I extend my sincere thanks.

LITERATURE CITED

Behle, W. H.
1943 Weights of some western subspecies of Horned Larks. *Auk*, 60:216–221.

Bent, A. C.
1942 Life histories of North American flycatchers, larks, swallows, and allies. *U.S. Natl. Mus. Bull.*, 179.

Drury, W. H.
1961 Studies of the breeding biology of Horned Lark, Water Pipit, Lapland Longspur, and Snow Bunting on Bylot Island, Northwest Territories, Canada. *Bird-Banding*, 32:1–46.

DuBois, A. D.
1935 Nests of Horned Larks and longspurs on a Montana Prairie. *Condor*, 37: 56–72.
1936 Habits and nest life of the Desert Horned Lark. *Condor*, 38:49–56.

Johnson, P. L., and W. D. Billings
1962 The alpine vegetation of the Beartooth Plateau in relation to cryopedogenic processes and patterns. *Ecol. Monog.*, 32:105–135.

Kelso, L. H.
1931 Some notes on young Desert Horned Larks. *Condor* 33:60–65.

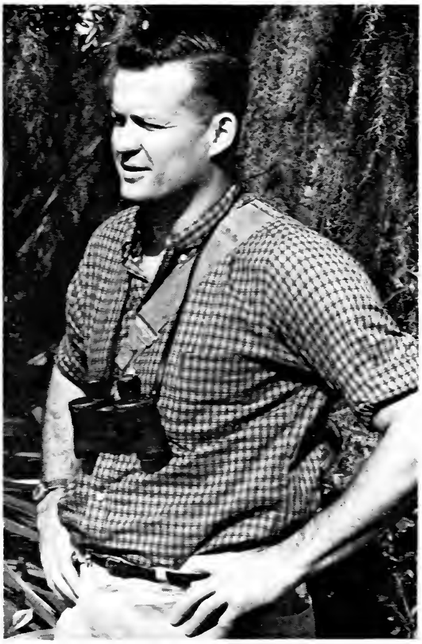
MacDonald, H.
1916 Incubation period of the Horned Lark. *Auk*, 33:435.

Montagna, W.
1943 Weights and plumages of the Horned Larks of Central New York. *Auk*, 60:210–215.

Pickwell, G. B.
1931 The Prairie Horned Lark Trans. *Acad. Sci. St. Louis*, 27:1–160.
Silloway, P. M.
1903 Birds of Fergus County, Montana. Press of the Argus, Lewiston, Montana. Fergus Co. Free High School Bull., 1:1–77.
Sutton, G. M., and D. F. Parmelee
1955 Nesting of the Horned Lark on Baffin Island. *Bird-Banding*, 26:1–18.
Wetherbee, D. K.
1957 Natal plumages and downy pterylosis of passerine birds of North America. *Am. Mus. Nat. Hist. Bull.*, 113:343–436.
1958 New descriptions of natal pterylosis of various bird species. *Bird-Banding*, 29:232–236.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF MONTANA, MISSOULA, MONTANA (PRESENT ADDRESS: MUSEUM OF VERTEBRATE ZOOLOGY, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA) 19 MARCH 1966

NEW LIFE MEMBER



Dr. Glen E. Woolfenden has recently become a Life Member of The Wilson Ornithological Society. Dr. Woolfenden is Associate Professor of Zoology at The University of South Florida, Tampa, and holds degrees from Cornell University, University of Kansas, and University of Florida. His ornithological interests include anatomy, ecology, systematics, and paleontology, and he has published 25 papers in these fields. He is a member of the Cooper Society, Bird Banding Association, BOU, Sigma Xi, Florida Academy of Sciences, and an Elective member of the AOU. Dr. Woolfenden is married and has three children.

OBSERVATIONS ON A LOCALIZED DUCK SICKNESS IN THE DELTA MARSH; SUMMER, 1964

David A. Manuwal

The 33,000-acre Delta Marsh, in south-central Manitoba, lies at the southern end of Lake Manitoba and is an important part of the waterfowl breeding area of Manitoba. Between the lake and the marsh, some nineteen miles of narrow, sandy, wooded ridge offers protection from strong winds and wave action from the lake.

The marsh is a series of shallow bays and sloughs connected by small waterways with only two outlets to the lake- a channel at Delta in the west and Clandeboye Dam in the east. The water level of the marsh is greatly affected by strong winds. Covering most of the marsh is a vast stand of phragmites (*Phragmites communis*). This plant is rarely found in water exceeding one-half meter in depth during the summer. Close to the phragmites, and often growing on islands are bulrushes (*Scirpus*) and, occasionally, cattails (*Typha*). In the deeper waters, sago pondweed, water milfoil, coontail, and other aquatic plants form beds that sometimes make it difficult to canoe.

In past years, serious outbreaks of duck sickness at Delta were, in most cases, attributed to avian botulism. H. Albert Hochbaum, Director of the Delta Waterfowl Research Station, notes that no major outbreaks occurred there before 1957. However, in 1957 there was a serious outbreak in which losses in the Lake Manitoba basin numbered about 500,000 ducks. Dying birds were found everywhere there was exposed shoreline that was reflooded by wind and rain. Since then, only small outbreaks have occurred.

On 3 August, 1964, an outbreak was reported at 22 Bay, a small body of water above five miles east of Delta. It was evident from the decomposed bird carcasses that the initial outbreak had occurred on about 20 July. The lack of laboratory facilities made it impossible to determine that *Clostridium botulinum* (Type C) was indeed the lethal agent in the 1964 outbreak.

22 Bay is located about one-half mile south of Lake Manitoba, and is approximately five-eighths of a mile across at its widest point. The vegetation is typical of the Delta Marsh, having a phragmites border, bulrush islands, and floating aquatics in open water. The bay is fed by one ditch and has outlets to a larger body of water (Blackfox Lake) to the south and a small bay to the east. The entire perimeter at the time of the study was surrounded by exposed mudflats of varying size.

The bay was divided into five study units (I–V, Table 2), each of which was composed of approximately 150 to 175 yards of exposed mudflats, shoreline, and islands. The units were checked in regular sequence as often as

TABLE 1
SEX, AGE, AND CONDITION OF DUCKS FOUND AT 22 BAY, 1964

Species	Ad. ♂	Ad. ♀	Juv. ♂	Juv. ♀	Downy*	Und.**	Flightless	Sick	Total
Pintail	89	33	15	11	2A, 2A	15	32	18	165
Blue-winged Teal	89	38	10	20		10	7	13	167
Mallard	67	12	6	2		15	9	14	102
Gadwall	28	3	1		1A, 1A, 2A	3	19	3	38
Green-winged Teal	25	16	1			2	5	5	44
Shoveler	4	1	1	3		2	2	1	11
Am. Widgeon	18					4	14		22
Redhead	8	1			1A, 1A	1	4	1	12
Canvasback	1	1			1A, 1A	1	2		5
Black Duck	3		1					3	4
Ruddy Duck	2								2
Ring-necked Duck	1								2
Lesser Scaup						1			1
Unidentified									92
Totals	337	105	37	38	9	54	94	58	666

* Refers to brood class. (Gollop & Marshall, 1954. 1A, downy young, no feathers visible; 2A, partly feathered as view from side.)

** Unidentified as to sex and age.

possible, usually every day. Dead and sick birds were sexed, aged, and taken back to the station for dissection and examination. The upper digestive tract was immediately removed and preserved in 10 per cent formalin so that animal matter present would not be further digested. The report of this analysis is not yet available.

The mechanism involved in the production and release of the bacterium *Clostridium botulinum* (Type C) appears to be closely associated with fluctuating water levels and the presence of large numbers of marsh flies (Chironomidae). Both of these conditions prevailed at 22 Bay. Strong winds caused water level fluctuations up to eight feet throughout most of August.

The weather during August was quite variable. Most of the month was rather cool. Early morning temperatures were usually in the high 40's, and day readings ranged in the 60's and 70's. The bay was checked from 4 to 25 August; on 12 of these days sick or dead birds were found. Occasionally, it was impossible to check every day, so some of the dead birds reported on certain dates may have been alive the day before. Tables 1 and 2 show the findings.

Botulism deaths result from two main causes: (1) a massive dose of toxin ingested while eating insect larval cases and (2) the ingestion of repeated sublethal doses of toxin plus food in water containing large amounts of dissolved salts (Cooch, 1964). *Clostridium botulinum* (Type C) blocks the parasympathetic nervous system and thereby affects gland function. Ob-

TABLE 2
BIRDS OTHER THAN DUCKS FOUND AT 22 BAY AND BLACKFOX LAKE, 1964

Species	Total number	Sick	Study units I	II	III	IV	V	Blackfox L.
Lesser Yellowlegs	54	10	18	3	6	5	5	17
Greater Yellowlegs	1	0	1					
American Avocet	1	0	1					
Dowitcher	8	4	2	1	1	2		2
Killdeer	1	1	1					
Semipalmated Plover	3	3	1				1	1
Pectoral Sandpiper	43	6	2	5	4	17	1	14
Least Sandpiper	15	8	3		1	1	3	7
Semipal. Sandpiper	24	16	10	1	2	2	4	5
Stilt Sandpiper	8	6	1		3	1	1	2
Spotted Sandpiper	3	2	2					1
Wilson's Phalarope	1	0						1
Ring-billed Gull	14	8	3	5		5		1
Franklin's Gull	6	0		1		2	3	
Bonaparte's Gull	4	0		4				
Black Tern	7	1	1	1				5
Forster's Tern	1	0	1					
Bl-crowned Night Heron	1	0			1			
Am. Coot	18	2	4		5	1	1	8
Pied-billed Grebe	2	0			1	1		
Eared Grebe	2	0	1		1			
Red-necked Grebe	1	0					1	
Marsh Hawk	1	1						1
Totals	219	58	52	21	25	37	20	65

served symptoms of sick birds at 22 Bay were the following: loss of ability to fly; paralysis in legs: diarrhea: non-functioning nictitating membrane: and complete collapse.

During the time of the outbreak, waterfowl usage of 22 Bay was quite intensive. Pintails (*Anas acuta*), Blue-winged Teal (*Anas discors*). Mallards (*Anas platyrhynchos*), American Widgeons (*Mareca americana*). Gadwalls (*Anas strepera*), and American Coots (*Fulica americana*) made up the bulk of the waterfowl. Lesser Yellowlegs (*Totanus flavipes*), Dowitchers (*Limnodromus* sp.), Semipalmated Sandpipers (*Ereunetes pusillus*), and Pectoral Sandpipers (*Erolia melanotis*) were the most common shorebirds. The peak population on 22 Bay occurred around the first week in August when about 1000 to 1500 birds were present. A few duck broods were still utilizing the open water during the first 10 to 14 days of August. Most of these were Redheads (*Aythya americana*). An increase in the number of shorebirds (more specifically, the "peeps"), gulls, and terns was noted. By the third week of August, about 1100 White Pelicans (*Pelecanus erythrorhynchus*) were using the bay and Blackfox Lake as well as other parts of the marsh. Also at this time, the number of ducks, especially Pintails, decreased. There was a slight increase in Shovelers (*Spatula clypeata*) toward the end of the third week. Herons, rails, and Marsh Hawks (*Circus cyaneus*) also used the area. Evidence of muskrats, skunks, and raccoons was found along the mudflats. Skunks and raccoons appeared to have eaten many of the dead birds and it is likely that several sick birds were taken. On several occasions, Marsh Hawks were observed eating both dead and freshly killed birds.

The numbers of birds affected by the sickness were directly proportional to the numbers utilizing the area. The sickness was non-selective as to sex and age. With the exception of rails, all the species in 22 Bay were affected by the sickness. However, it is quite likely that some rails were killed. Blue-winged Teals and Pintails were the birds most commonly seen feeding along the edge of the bay and; as the data show, these two species accounted for more than half the dead ducks (332 of 574). The Mallard was the third most common species at the bay edges and also ranked third among the birds affected by the sickness.

SUMMARY

An isolated outbreak of duck sickness was studied in the Delta Marsh, Manitoba. Evidence suggests that the bacterium *Clostridium botulinum* (Type C) was responsible for the deaths of 885 birds found at 22 Bay. The deaths were closely associated with fluctuating water levels. The ducks found most numerous in the kill were the Pintail, Blue-winged Teal, Mallard. Among the ducks represented, a large proportion (76:24) were drakes; however, for juvenile birds, a nearly perfect 50 : 50 ratio existed. Other species, including shorebirds, gulls, terns, herons, grebes, Coots, and Marsh Hawks were found sick.

ACKNOWLEDGMENTS

I wish to thank the staff of the Delta Waterfowl Research Station for their assistance and especially Dr. H. A. Hochbaum for his advice. I am also indebted to Drs. D. L. Allen, C. M. Kirkpatrick, and R. E. Mumford, Department of Forestry and Conservation, Purdue University for reviewing the manuscript.

LITERATURE CITED

Cooch, F. G.
1964 A preliminary study of the survival value of a functional salt gland in prairie Anatidae. *Auk*, 81:380–393.
Gollup, J. B., and W. H. Marshall
1954 A guide to aging duck broods in the field. Mississippi Flyway Council Tech. Sect. Rept. (Mimeo).
Hochbaum, H. A.
1944 The Canvasback on a prairie marsh. Stackpole Co., Harrisburg, Pa.

DELTA WATERFOWL RESEARCH STATION, DELTA, MANITOBA (PRESENT ADDRESS: DEPARTMENT OF FORESTRY, UNIVERSITY OF MONTANA, MISSOULA, MONTANA)
ORIGINALLY RECEIVED 15 DECEMBER 1965.

MIGRATION IN THE LITTLE BLUE HERON

JULIAN L. DUSI

MIGRATION in the Little Blue Heron (*Florida caerulea*) is a composite of three distinct phases: 1) dispersal of the young and adults from the colonial nesting sites; 2) the autumnal southward movement of adults and of the young after their dispersal; and 3) the return to the breeding areas in the north the following spring.

The writer started banding Little Blue Herons in 1953, at a colony south of Tuskegee, Alabama, in an attempt to obtain the data necessary to describe these migrations. Since then he has been banding them at a number of colonies distributed over the state. Data other than the bandings done by the writer were needed to explain North American migration outside of Alabama. Reports in the literature, especially those of Ben B. Coffey, Jr. (1943, 1948), have been very helpful. A listing of bandings and recoveries for the years 1926 to 1962, provided by Allen J. Duvall, from the Fish and Wildlife Service Bird Banding Laboratory, have been an additional important source of information.

PROCEDURES

Practically all of the banding of Little Blue Herons has taken place at their colonial nesting sites and practically all of the birds banded have been nestlings. Adults have been difficult to capture, whereas the nestlings have been much more easily obtained in sufficient numbers to make banding them attractive.

The banding of the nestlings has presented several problems mostly concerned with the inaccessibility of the breeding colonies and nests. The majority of the colonies has been located in small brushy ponds or swamps. The others have been in upland situations, usually with ponds, swamps, or rivers nearby. In the colonies located over water and in low bushes, the nests have been easy to reach and the young easily captured by hand or by the use of bamboo poles with wire hooks on the ends. In the colonies with higher trees, nests were frequently 20–25 feet above the water. Longer poles with hooks and baskets, or light weight extension ladders were needed in these colonies. Our use of an extension ladder from a small boat has worked well in one swamp. In upland colonies, trees were much taller and nests were frequently 35–50 feet high. This made the use of poles with hooks, from the ground, must less satisfactory or impossible. If the young fall into water, little damage is done, but if they fall onto the land, before they can use their wings to break their fall, they are usually fatally injured. Therefore, in upland colonies, the use of extension ladders was necessary when the nests were more than 15 feet from the ground. In our work, the use of a 36-foot magnesium ladder has been very successful. The trees were usually tall and spindly and would not support much weight. If the ladder was placed tightly against the tree and tied to the tree every 10 feet, as it was ascended, it supported the tree

TABLE 1
DISPERSAL OF YOUNG

Banding Locality	Banding Date	Recovery Locality	Recovery Date
Tuskegee, Ala.	6-12-53	Rising Fawn, Ga.	8-_-53
" "	5-27-55	Harperville, Miss.	7- 7-55
" "	"	Etowah, Tenn.	7- 2-55
" "	"	Meridian, Miss.	8-12-55
" "	5-14-56	Eastman, Ga.	6-19-56
" "	"	Columbus, Ga.	8-25-56
Marvyn, Ala.	5-22-59	Thomaston, Ga.	7-_-59
Mt. Creek, Ala.	6-14-60	Oneonta, Ala.	8- 1-60
Opp, Ala.	5-22-61	Andalusia, Ala.	7-10-61
" "	"	" "	7- 3-61
" "	5-30-62	" "	9-18-62
Pansey, Ala.	5-13-64	Willacoochee, Ga.	8-_-64
Florala, Ala.	6- 1-64	Thomasville, Ga.	-_-64
St. Marks, Fla.	6- 6-26	Jacksonville, Fla.	9-_-26
" "	6- 3-61	Ashburn, Ga.	8-21-61
Glen Allan, Miss.	5-25-36	Dalton, Ga.	8-28-36
" "	"	Jena, La.	7- 6-36
" "	5-24-36	Baton Rouge, La.	7-_-36
" "	"	Corning, Ark.	7-_-36
" "	"	Helena, Ark.	7- 6-36
" "	"	Watson, Ark.	7- 4-36
" "	"	Star City, Ark.	11-_-36
" "	"	Delaplaine, Ark.	7-_-36
" "	"	Wellston, Ohio	8-_-36
Harperville, Miss.	"	Desha Co., Ark.	7-_-36
" "	5-31-36	Jennie, Ark.	7-12-36
" "	"	Merigold, Miss.	7- 3-36
" "	"	Louisville, Miss.	7-27-36
" "	"	Denmark, Miss.	7- 3-36
" "	"	Drew, Miss.	7- 6-36
" "	"	Isola, Miss.	8-20-36
Glen Allan, Miss.	6- 7-36	Mayersville, Miss.	7-_-36
" "	"	Booneville, Miss.	8-_-36
" "	"	Tallula, Miss.	7-_-36
" "	"	Indianola, Miss.	8-_-36
" "	5-23-37	Rosedale, Miss.	8-_-37
" "	"	Holland, Mo.	7-22-37
" "	"	Vicksburg, Miss.	8- 3-37
" "	"	New Albany, Miss.	8-_-37
" "	"	Pollard, Ark.	8-_-37
" "	"	Doniphan, Mo.	7-_-37
" "	"	Indian Bay, Ark.	7-12-37
" "	"	Marked Tree, Ark.	7- 8-37
" "	"	Leland, Miss.	7-_-37

TABLE 1 (*cont.*)

Banding Locality	Banding Date	Recovery Locality	Recovery Date
" "	"	Alligator, Miss.	7-_-37
" "	"	Acworth, Ga.	8-_-37
" "	"	Crockett's Bluff, Ark.	7-_-37
" "	6- 6-37	Batesville, Miss.	8-_-37
" "	"	Burr Ferry, La.	9- 7-37
" "	"	Crockett's Bluff, Ark.	9-_-37
" "	"	Ruleville, Miss.	7-_-37
" "	"	Sikeston, Mo.	_-_-37
" "	"	Harrisburg, Ark.	7-20-37
" "	"	Lake Village, Ark.	7-_-37
" "	"	Carroll Parish, La.	9-_-37
" "	"	Drew, Miss.	7-_-37
Moon Lake, Miss.	6- 3-40	Elaine, Ark.	7-21-40
" "	"	Gunnison, Miss.	7-_-40
" "	"	Crowville, La.	8- 9-40
" "	"	Abbeville, La.	8-_-40
" "	6- 1-41	Lucy, Tenn.	6-30-41
" "	"	Hogansville, Ga.	7-25-41
" "	"	Calhoun, Ala.	9-10-41
" "	6- 7-42	Uniontown, Ky.	9-19-42
Glen Allan, Miss.	5-25-47	New Iberia, La.	8-_-47
" "	"	Marked Tree, Ark.	7-_-47
Moon Lake, Miss.	6- 1-47	Kennett, Mo.	8-23-47
Glen Allan, Miss.	6-15-47	Marked Tree, Ark.	7-18-47
" "	"	Beaumont, Texas	10-_-47
" "	"	Moon Lake, Miss.	9-_-47
" "	6-13-48	Bastrop, La.	9-25-48
" "	"	Memphis, Tenn.	8-14-48
Norwood, Pa.	6- 2-41	Williamstown, N.J.	6- 7-41
Elizabethtown, N.C.	6- 1-43	Goldsboro, N.C.	7- 8-43
" "	"	Dillion, N.C.	7-15-43
" "	6- 3-43	Sanford, N.C.	8-_-43
" "	"	Salisbury, N.C.	7-_-43
" "	"	Spartansburg, S.C.	7-26-43
" "	5-28-53	Danville, Va.	7- 4-53
Muskogee, Okla.	5-25-58	Warsaw, Mo.	9-_-58
" "	5-31-58	Vinita, Okla.	8-16-58
Arkoma, Okla.	5-23-59	Forest City, Ark.	7-_-59
Okla. City, Okla.	6- 7-59	Lebanon, Mo.	8-18-59
Webber Falls, Okla.	6-13-59	Waco, Texas	9-_-59
" "	"	Claremore, Okla.	8-_-59
Arkoma, Okla.	"	Heavener, Okla.	8-21-59
Webber Falls, Okla.	6-14-59	Waco, Texas	9-_-59
Muskogee, Okla.	6-12-60	Grove, Okla.	8-_-60
Charleston, S.C.	6- 9-31	Yorktown, Va.	8-20-31

TABLE 1 (*cont.*)

Banding Locality	Banding Date	Recovery Locality	Recovery Date
" "	8- 9-35	Moncks Corner, S.C.	10-14-35
Memphis, Tenn.	6- 7-42	Covington, Tenn.	7-12-42
" "	"	Monette, Ark.	7- 6-42
Dyersburg, Tenn.	6- 2-51	Madisonville, Ky.	7-22-51
Anahuac, Texas	5- 2-26	Fort Worth, Texas	9-11-26
" "	5-25-26	Baytown, Texas	7-17-26
" "	6- 3-26	Shelbyville, Ind.	8- 7-26
" "	7-29-27	Alvin, Texas	9-19-27
" "	6- 3-30	Nacogdoches, Texas	7-_-30
" "	"	Tyler, Texas	7-15-30
Columbus, Texas	6- 4-38	Jennings, La.	7-29-38

Note: Banding and recovery localities are approximations determined from coordinates, except for Alabama banding localities which are the writer's.

from bending and was much more safe. If the climber tied himself to the tree, at the top of his ascent, then caught the birds with his hands or a short pole with a wire hook, and then lowered them in a plastic bucket to a helper on the ground who did the banding and recorded the data, he could work much more efficiently.

The construction of the poles with hooks and baskets was simple. James E. Keeler, Alabama Department of Conservation, introduced the writer to the use of the hooks in a cooperative effort in banding White Ibises (Keeler, 1956). A bamboo pole of suitable length was obtained. A piece of eight or nine gauge iron wire, about four feet long, was attached to the upper two feet of the pole using several wrappings of adhesive tape. The end of the wire was then bent so that about six or eight inches of the wire was parallel to the rest of the wire and about one inch from it. The very end was bent out slightly so that it was easier to guide the hook around the neck of a bird. The basket was made with a similar pole and piece of wire. The wire was bent to form a loop six to eight inches wide and about 18 inches long. A piece of one-inch mesh chicken wire about 8 inches by 16 inches was slipped over the frame and the ends of the frame were attached to the pole with adhesive tape. Keeler found that if the

TABLE 2

DISPERSAL OF ADULTS

Banding Locality	Banding Date	Recovery Locality	Recovery Date
Tuskegee, Ala.	5-14-56	Wadesboro, N.C.	10-15-60
Glen Allan, Miss.	5-23-37	Oakland Mills, Iowa	10-27-41
" "	6- 6-37	New Orleans, La.	7-19-39
Moon Lake, Miss.	6- 3-40	" "	8- 5-40
" "	6- 7-42	" "	8-_-44
Muskogee, Okla.	6- 6-59	Dyersburg, Tenn.	8-_-61
Bay Town, Texas	5- 2-26	Baton Rouge, La.	7-31-27

TABLE 3
SOUTHWARD MIGRATION

Banding Locality	Banding Date	Recovery Locality	Recovery Date
Tuskegee, Ala.	5-27-55	British Guiana	3- 1-61
" "	"	Puerto Rico	10-31-55
" "	"	Venezuela	12-16-55
" "	"	British W. Indies	10-23-55
" "	"	Honduras	1-29-56
" "	"	Cuba	1-15-60
" "	"	"	2-13-58
" "	"	Bahamas	3-__-56
" "	5-14-56	British Guiana	2- 3-60
" "	6-16-57	Venezuela	10-__-63
Marvyn, Ala.	6- 6-58	British W. Indies	10-15-61
" "	"	British Guiana	6- 9-59
" "	5-22-59	British W. Indies	9-27-59
" "	"	British Guiana	2-15-60
Faunsdale, Ala.	6- 1-59	Cuba	8-__-60
Opp, Ala.	6-22-60	Venezuela	10-12-60
" "	6-12-61	Cuba	9-24-61
" "	5-10-62	Lake City, Fla.	6-17-64
Delaware	9-14-51	Haiti	1-__-52
St. Marks, Fla.	5-22-39	Panama	11- 1-39
" "	6-24-61	Jamaica	1-__-62
New Iberia, La.	7-17-37	Mexico	10- 2-37
Harpersville, Miss.	6-16-35	"	10-__-37
" "	6-16-35	British Honduras	7-20-36
Glen Allan, Miss.	5-25-36	Cuba	10-13-38
" "	"	Colombia	__-__-43
" "	5-24-36	Mexico	9-28-36
" "	"	French W. Indies	9-__-36
Harpersville, Miss.	5-31-36	Mexico	1-23-38
Glen Allan, Miss.	5-23-37	Colombia	4-19-50
" "	"	Cuba	7-16-41
" "	"	Honduras	9-__-37
" "	"	Mexico	9-30-37
" "	6- 6-37	Honduras	10- 8-37
" "	"	Panama	10-17-37
Moon Lake, Miss.	6- 3-40	British Honduras	12- 6-40
" "	"	Mexico	12-13-40
" "	6- 1-41	"	2-__-54
" "	6-7-42	"	4- 2-46
Glen Allan, Miss.	5-25-47	Nicaragua	11-20-49
" "	"	Haiti	3-15-48
Moon Lake, Miss.	6- 1-47	Mexico	10- 4-47
" "	"	Cuba	2-22-48
Glen Allan, Miss.	6-15-47	Panama	3-10-51

TABLE 3. (*cont.*)

Banding Locality	Banding Date	Recovery Locality	Recovery Date
" "	"	Puerto Rico	4- 1-49
" "	"	Mexico	2-_-49
Wildwood, N.J.	6- 8-41	British W. Indies	11- 6-41
" "	5-29-49	" " "	12- 3-49
Clarkton, N.C.	6- 1-43	" " "	1-_-44
" "	5-25-54	Cuba	5- 6-55
" "	6-15-54	Bahamas	12- 7-54
Muskogee, Okla.	5-25-58	Mexico	11-_-58
" "	"	"	11-_-58
" "	5-23-59	Colombia	1-16-60
" "	5-24-59	Costa Rica	8-22-60
Greenwood, Okla.	5-23-59	Mexico	3-10-60
Okla. City, Okla.	6- 7-59	British Honduras	3- 7-60
" "	"	Nicaragua	12-_-59
Okmulgee, Okla.	6-13-59	Mexico	10-13-60
" "	"	Costa Rica	11-26-59
" "	"	Panama	11-26-59
Arkoma, Okla.	"	Nicaragua	3-_-60
Muskogee, Okla.	"	Costa Rica	5-_-60
" "	6-14-59	Mexico	9-15-59
" "	"	"	2- 2-60
" "	"	"	8-15-60
Arkoma, Okla.	6- 4-60	"	12-_-60
" "	"	Panama	9-24-60
" "	"	Costa Rica	9-30-60
" "	6-18-60	Colombia	10-_-60
Muskogee, Okla.	6-12-60	Panama	10-_-60
Charleston, S.C.	6-15-31	Louisiana	6-19-36
" "	6-11-32	Jamaica	10-30-34
" "	6-24-32	British Honduras	9-25-32
" "	"	Cuba	11-18-38
" "	6-12-33	Bahamas	10- 1-35
" "	"	Colombia	4-_-38
" "	"	British W. Indies	1-16-34
" "	6- 6-34	Venezuela	10-21-34
" "	5-29-37	Haiti	2-_-43
" "	6- 5-38	Cuba	10-26-38
Dyersburg, Tenn.	6- 5-51	Colombia	3-21-53
" "	"	Mexico	12-_-51
Galveston, Texas	5-12-26	"	10- 1-26
" "	6-25-26	British Honduras	11-20-26
" "	6-14-26	Mexico	10-18-26
" "	6- 3-30	"	8-28-30

Note: Banding and recovery localities are approximations determined from coordinates, except for the Alabama banding localities.

Table 4
Northward Migration

Banding Locality	Banding Date	Recovery Locality	Recovery Date
Tuskegee, Ala	5-11-55	Wetumpka, Ala.	5-16-60
" "	"	Opp, Ala.	3-_-59
" "	5-20-55	Summit, Miss.	3-24-57
" "	5-27-55	Selma, Ala.	6-30-57
" "	5-14-56	Tuskegee, Ala.	8- 2-59*
Opp, Ala.	5-30-62	Dothan, Ala.	4-20-63
Glen Allan, Miss.	5-25-36	Coushatta, La.	3-28-38
" "	5-24-36	Winnsboro, La.	5- 2-40
" "	"	Indianola, Miss.	4- 8-38
Harperville, Miss.	5-31-36	Oxford, Miss.	7-26-38
" "	"	Natchez, Miss.	6- 1-40
Glen Allan, Miss.	5-23-37	Gonzales, Texas	3-26-39
" "	"	Indianola, Miss.	2-_-38
" "	6- 6-37	Bernie, Mo.	3-_-44
Moon Lake, Miss.	6- 3-40	Prichard, Miss.	2-_-46
" "	"	Batesville, Miss.	3-_-43
" "	"	Eudora, Miss.	3-14-41
" "	"	Swan Lake, Miss.	6-_-43
" "	6- 1-41	Clarksdale, Miss.	4-_-42
" "	6- 7-42	Crockett's Bluff, Ark.	4- 8-47
Glen Allan, Miss.	6- 1-47	Memphis, Tenn.	1-_-54
Clarkton, N.C.	5-30-42	Boardman, N.C.	4-_-44
" "	6- 3-43	Clarkton, N.C.	4-26-50
Charleston, S.C.	5-29-37	Morehead City, N.C.	2-_-38

* A date this late does not necessarily indicate the destination of spring migration but may reflect post-breeding dispersal before autumnal migration.

Note: Banding and recovery localities are approximations determined from coordinates, except for Alabama banding localities.

birds were caught by the neck, they would release their toe-holds; if caught by the leg, they usually held on and the leg would be broken. Little Blue Herons are quite agile climbers and can frequently be returned to the nest by perching them on the pole, below the hook, and raising them to their nests. Little Blue Heron nestlings that cannot climb well and some of the other herons and ibises, are best returned to the nests in the baskets.

The size of the nestlings banded varied greatly. The optimum size was that attained at about two weeks of age, at which time the birds were able to climb a little but not enough to evade the bander easily. At one week of age, the birds are at the minimum size at which the proper size band will stay on the tarsus. At about four weeks of age, the young are able to climb so well that it is difficult to capture them. It was our practice to start banding when the first group was about two weeks old and to return at periods of

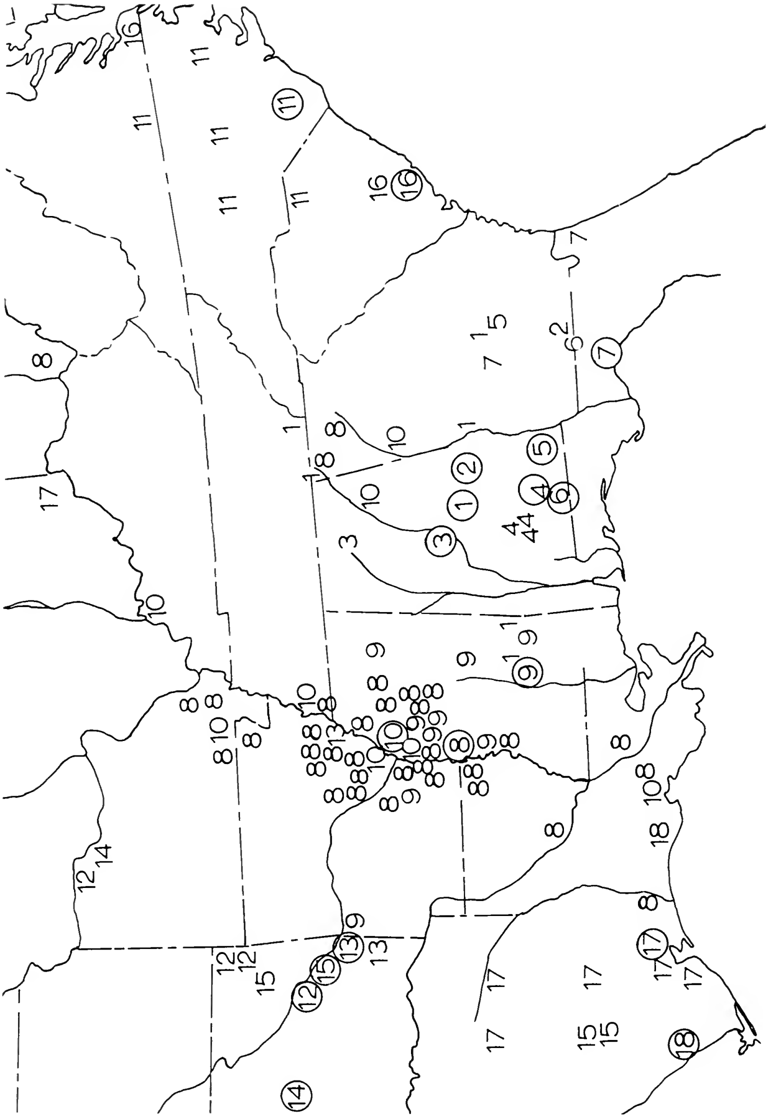


FIG. 1. Dispersal of Young From Nesting Colonies. Each number represents a colony (circled) and the band recoveries from that colony (uncircled).

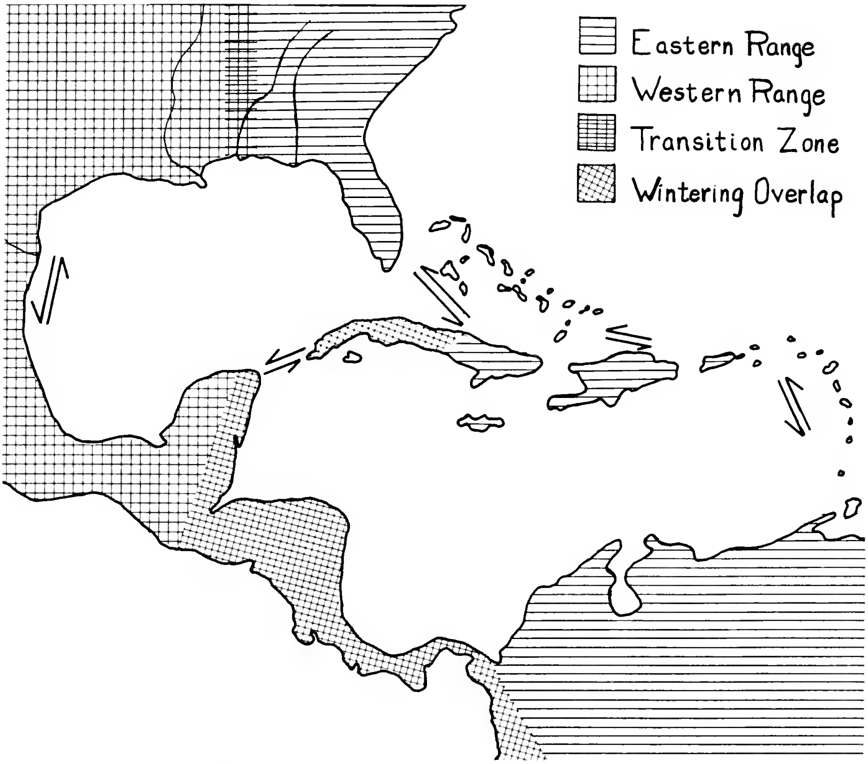


FIG. 2. Southward Migration Routes in Relation to Nesting and Wintering Areas.

two to three weeks to band later developing young, until finally diminishing returns made banding unprofitable.

In addition to the Fish and Wildlife service bands, some color bands have been used since 1963. These were the plastic Bandettes, size 4–906, obtained from the National Band and Tag Company, Newport, Kentucky. A different color combination was used for each colony, providing visual identification as to site of origin.

The recovery data as supplied by the Bird Banding Laboratory were placed in several categories: 1) recoveries dated the same summer as the banding and from localities north of, or at the same latitude as the nesting colony, were clearly dispersal records; 2) recoveries dated the same summer as the banding and from localities south of the nesting colony but still in the United States, could be either dispersal or early southward migration records and were thus of questionable value to this study; 3) recoveries from areas located south of the United States were considered southward migration

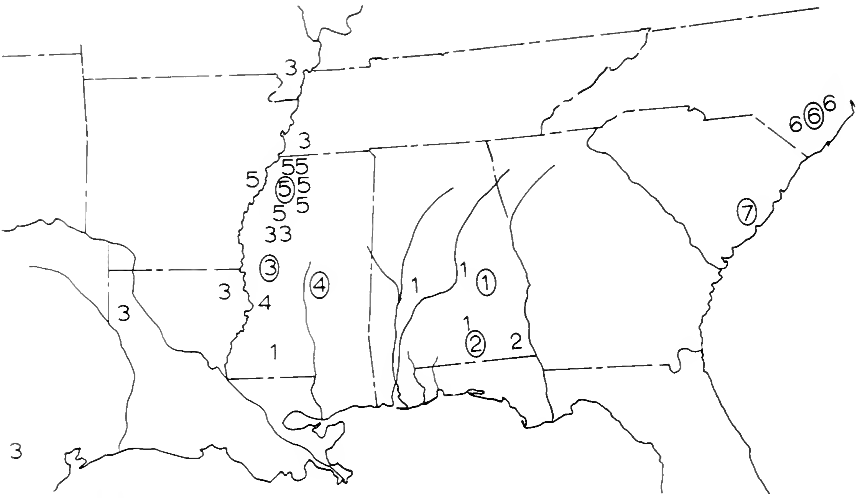


FIG. 3. Migration Northward to the Nesting Colonies. Each number represents a colony (circled) and the band recoveries from that colony (uncircled).

records; and 4) the late winter and spring records of birds in the United States were considered over-wintering records or spring migrational records of birds returning from wintering areas south of the United States.

RESULTS AND DISCUSSION

The dispersal recoveries for the young are listed in Table 1 and those for adults in Table 2. Those recoveries related to southward migration are given in Table 3. In Table 4 are listed the northward or return migration recoveries. Figure 1 contains the dispersal of young data plotted on a map. The southward migration routes are shown in Figure 2. Figure 3 contains the recovery data relating to the northward migration.

After leaving the nesting colonies. Little Blue Heron nestlings of the year apparently wandered in all directions and especially to the north, east, and west. The recovery data of Coffey (1943) and Dusi (1958) especially show this (Table 1 and Fig. 1). Apparently the birds tended to disperse along major waterways. The movements from the Tuskegee, Alabama colony (Dusi, 1958) showed no highly obvious pattern of dispersal. No prominent physiographic features such as mountain ranges or large rivers were very near the colony. Large rivers such as the Chattahoochee or Alabama were almost 40 miles away. Coffey's data, however, show a definite tendency of the herons to follow the Mississippi River or its tributaries. In a few instances the birds dispersed with no apparent reference to the Mississippi.

Recorded dispersal distances varied from a few miles to more than 600 miles. The longest dispersal recorded, started at Glen Allan, Mississippi, probably followed the Mississippi River northward to Cairo, then eastward along the Ohio River to Portsmouth and across to Wellston, Ohio. By this route the flight would have been over 600 miles. Most of the dispersal distances recorded were much shorter, averaging less than 100 miles.

Dispersal of the adults (Table 2) was similar to that of the young.

The autumnal southward migration of adults and young, for the Mississippi River area of Mississippi, has been adequately described by Coffey (1943, 1948). He concluded that they followed the mainland westwardly and southwestwardly through Louisiana, Texas, Mexico, and Central America. He interpreted the recoveries from western Cuba as probably having arrived there by the route of the mainland to the Yucatan Peninsula and then across the intervening water to Cuba. Coffey's single recoveries each, from the French West Indies, Haiti, and Puerto Rico, could be explained by migration from Yucatan to Cuba and thence to the destination. They could also and more likely have dispersed eastward from Mississippi, southward through Florida, and thence to their island destinations.

Data from the writer's banding in Alabama, showed a much different picture. These herons apparently migrated south and eastward through Florida to Cuba, or along the Bahamas to Puerto Rico, then along the Lesser Antilles to Trinidad, Venezuela, and British Guiana. The aberrant bird, banded at Tuskegee, Alabama, on 27 May 1955 was recovered from British Honduras, the January after it was banded. Its appearance far west of the usual wintering range of herons banded in Alabama might be explained by several possibilities: 1) it might have dispersed far enough west in Mississippi, that it joined a group of immatures born in that area and had migrated southward with them over their usual route; 2) it might have migrated through Florida to Cuba, to the Yucatan Peninsula and then to British Honduras; or 3) it might have migrated through Florida and the islands to Venezuela and then to British Honduras. All three are possible explanations, although the first two seem most probable.

From the data at hand, it appears that herons reared in the Mississippi River vicinity and westward migrate by the western route described by Coffey while those from central Alabama and eastward migrate by the eastern route. There are almost no data to describe the migrations of Little Blue Herons which nest between the two areas studied by Coffey and Dusi. In all probability it is an area of migrational transition, with the random dispersal of the young making it possible for them to join the young of colonies using either of the main migration routes.

The spring northward migration is the least known and is at present a subject of intensive study by the writer. Conventional banding of nestlings with the subsequent recoveries of dead birds has provided most of the small amount of presently available information. These recoveries are listed in Table 4, and Figure 3 shows the banding and recovery locations. These data are an indication that the Little Blue Herons tended to return to the general region of their birth. The records are misleading because they show a recovery site which is not necessarily the destination of the migration or the breeding colony destination. During the 1963 and 1964 nesting seasons, plastic color bands were used to mark the nestlings so that their place of birth could be determined visually. In 1963, 222 nestlings were color-banded at three colonies in Alabama: one located near Decatur, Limestone County; one near Opp, Covington County; and one at Pansey, Houston County. Observations of returned birds of the Opp and Pansey colonies in mid-March, 1964 and 1965, showed only birds in adult plumage were present. The Opp colony was not successful and the population decreased to only about 12 pairs by 21 May 1964. Therefore, no further observational data were collected relating to site-faithfulness at this area. The Pansey area contained three birds in mottled plumage on 13 May 1964, one of which bore color bands for that colony. Because only 32 nestlings were banded there in 1963 and because the first-year mortality is so great (Dusi, 1963), it was felt that this single returning individual was a preliminary indication of a rather high degree of site-faithfulness to the nesting colony of origin. However, in 1964, 464 nestlings were color-banded and none was seen in the colony in 1965. Unfortunately, an unusually small nesting population in 1965 may have altered the value of these data. Insufficient observations were made at Decatur colony to provide reliable data. None of the color-banded birds was seen at any of the other colonies studied by the writer.

The one returning bird at the Pansey colony provided some data of additional interest. The literature (Bent, 1926 and Palmer, 1962) contains many references to the mottled plumage and nesting the summer after birth but no concrete evidence is presented to establish precisely the age of the birds. The color-marked returnee to the Pansey area had a few blue feathers in the white plumage and was incubating eggs in its nest when it was first disturbed and observed. Therefore, validity is given to the idea that Little Blue Herons will nest the season after birth, that they start to acquire mottled plumage at that age and will breed in mottled plumage.

SUMMARY

Migration in the Little Blue Heron is composed of a dispersal from the nesting colony area, a southward autumnal movement, and a return northward to breeding colony areas in the spring.

Data from banded nestlings show that they dispersed in all directions from the breed-

ing areas and apparently tended to follow major waterways, traveling as far as 600 miles but usually less than 100 miles.

The southward migration of young and adults followed two major pathways. Those from the Mississippi River area and most of its drainage, migrated westward and south along the Gulf of Mexico to Mexico, Central and South America. Those from Central Alabama and to the east, migrated to the east and south through Florida and to the island chains, Trinidad and South America. A few went to Cuba. It was suggested that herons from the area between Central Alabama and the Mississippi River probably migrated either way, probably depending upon the direction of their dispersal prior to the southward migration. A migration between Cuba and Yucatan is a suggested solution to the appearance of a few aberrant individuals whose bands were recovered from wintering areas opposite to the expected distribution.

The northward or spring migration is incompletely known. Data indicated a tendency to return to the general region of birth of the nestling. The return of one color-banded nestling to the site of its birth to breed provided concrete evidence that Little Blue Herons breed in their first year, that they start to acquire their mottled plumage at that age, and that they will breed in white or mottled plumage.

ACKNOWLEDGMENTS

Support of the research has been the Department of Zoology-Entomology, Auburn University, and several research grants-in-aid from Auburn University. Individuals too numerous to list, but especially my wife Rosemary, have helped in the labors of banding and gathering the data.

LITERATURE CITED

Bent, A. C.
1926 Life histories of North American marsh birds. *U.S. Natl. Mus. Bull.*, 135: 180–181.
Coffey, B. B., Jr.
1943 Post-juvenile migrations of herons. *Bird-Banding*, 14:34–39.
1948 Southward migration of herons. *Bird-Banding*, 19:1–5.
Dusi, J. L.
1958 Dispersion of Little Blue Herons from a pond in Macon Co., Alabama. *Alabama Birdlife*, 6:9–11.
1963 Mortality of the Little Blue Heron. *Alabama Birdlife*, 11:39–42.
Keeler, J. E.
1956 White Ibis—a new breeding bird in Alabama. *Alabama Birdlife*, 4:16–19.
Palmer, R. S.
1962 Handbook of North American birds, Vol. I. Yale Univ. Press, New Haven, Conn., pp. 428–429.

THE DEPARTMENT OF ZOOLOGY-ENTOMOLOGY, AUBURN UNIVERSITY, AUBURN, ALABAMA, 20 JANUARY 1966.

GENERAL NOTES

Notes on some Chiapas birds.—During a trip to the state of Chiapas, México, in March and April 1965, information was obtained on several species of birds which supplements the "Check-list of the Birds of México" (1950, 1957. *Pacific Coast Avifauna* 29, 33) and the "Lista de las Aves de Chiapas" (Alvárez del Toro, 1964. Instituto de Ciensias y Artes de Chiapas). Specimens cited are now at the University of Michigan Museum of Zoology, mainly in the form of skeletons. I am grateful to Robert W. Storer and Guy G. Musser for their contribution to this study. I also appreciate financial support from the National Science Foundation and permission to collect specimens from the Departamento de Conservación de la Fauna Silvestre.

Several species of birds were found on Cerro Mozotal (10,000 feet in the extreme southeastern Sierra Madre de Chiapas which had previously been reported in this state only from the central highlands. These include the Green Violetear (*Colibri thalassina*) (female, 5.5 grams) and the Black-capped Siskin (*Spinus atriceps*) (male, 12.5 grams; female, 14.5 grams), which were collected on 17 April. In addition, the Ocellated Quail (*Cyrtonyx ocellatus*) the flicker (*Colaptes cafer mexicanoides*) and the Olive Warbler (*Peucedramus taeniatus*) were seen but not collected in the period 15–17 April. The siskin and quail were rare or uncommon in the pine-oak forest, while the other species were fairly common.

Three species reported only from the Atlantic lowlands were found on the Pacific slope. On 20 March a Blue-crowned Motmot, (*Momotus momota*) was collected (male, 100 grams) in cut-over tropical evergreen forest near Mapastepec, and the following day a Flint-billed Woodpecker (*Phloeoceastes guatemalensis*) was seen and heard in the same area. The White-winged Tanager (*Piranga leucoptera*) was collected (2 males, one 18 grams) between Unión Juárez and Cacahoatán in coffee plantations on the lower slopes of Volcán Tacaná. Both specimens of the tanager showed enlargement of the testes (3 × 4 mm) and appeared to be paired. They sang thin, reedy songs consisting of alternating short phrases and pauses, quite different from the full-throated utterances of some of the larger, more northern members of the genus.

Also of interest was an apparent migratory movement of Scissor-tailed Flycatchers (*Muscivora forficata*) on 30 March near the Pacific Ocean near Pijijiápan. Hundreds if not thousands of these birds streamed past in small flocks or individually flying in a northwesterly direction at heights of 100 feet or less above the savanna. The flight lasted from dawn to mid-morning and terminated with the gradual disappearance of the birds from the area.—JOHN P. HUBBARD, *Division of Birds, U.S. National Museum, Smithsonian Institution, Washington, D.C. 20560, 26 May 1966.*

Egrets serving as "beaters" for Belted Kingfishers.—Many birds associate with another organism in order to secure prey disturbed by the activities of their associate, the "beater." A classic example is that of the Cattle Egret (*Bubulcus ibis*) and its many foraging associates, especially hoofed mammals (Meyerriecks, 1960. *Nat. Hist.*, 69:46–57). Rand (1954. *Chicago Nat. Hist. Mus. Fieldiana: Zoology*, 36 (1)) and Meinertzhagen (1959. Pirates and Predators. Oliver & Boyd, Edinburgh) provide numerous examples of this phenomenon. We had several opportunities to observe such a relationship between Belted Kingfishers (*Megaceryle alcyon*) and two species of egrets, the Common Egret (*Casmerodius albus*) and the Snowy Egret (*Egretta thula*).

At 0830 on 22 December 1964, along the Hillsborough River, Hillsborough County, Florida, Nellis saw a kingfisher hovering over a foraging Snowy Egret. The egret was using the "wade slowly" technique of foraging (Meyerriecks, 1960. "Comparative Breeding Behavior of Four Species of North American Herons." Publ. Nattall Ornith. Club, Cambridge, Mass., No. 2). While the egret was foraging in an area of sparse submerged vegetation, mainly *Elodea*, the kingfisher flew back and forth, hovering over the egret several times. The kingfisher dived into the water near the egret 3 times, and it made several false dives as well. None of the kingfisher's dives were successful. The egret noticed the kingfisher but did not appear to be disturbed by it. When Nellis's boat came too close, both birds flew away. Similar behavior was noted by Nellis at the same place late in January, 1965.

On 22 August 1965, at 1030, Meyerriecks watched the foraging behavior of one Common Egret and two Snowy Egrets in a small pond in Tampa, Florida and saw a perched kingfisher fly over the pond and dive unsuccessfully three times. Next, the kingfisher flew directly towards the Common Egret, which was using the "stand and wait" foraging method. The kingfisher hovered over the egret for about 5–10 seconds, then flew off, only to return again. This behavior was continued for about 2–3 minutes. Both birds failed to make a strike. The foraging Snowy Egrets were at the other end of the pond, about two hundred yards from the Common Egret. Then the kingfisher flew directly towards a Snowy Egret that was using the stand and wait technique. It hovered over this egret for about one minute then flew back to its former perch.

The second Snowy Egret then began to use the "disturb and chase" method of foraging (Meinertzhagen, 1949. *Ibis*, 91:465–482), and at once the kingfisher flew directly to it, hovering over the actively foraging egret. The kingfisher dove three times and made two kills. The "beater" egret also caught several tiny fish during this period. When the egret flew away the kingfisher followed it for a few moments then returned to its perch. Meyerriecks watched kingfishers and egrets at this pond on a number of occasions during the fall of 1965, but did not see this relationship again.

It is of interest that the kingfisher and the egret were successful when the egret used an active foraging technique, presumably having disturbed more prey with this method. One might speculate that the kingfisher flew directly to the egret using the more active foraging method because of some previous success with an associate foraging in an active manner.—Andrew J. Meyerriecks, *Department of Zoology, University of South Florida, Tampa,* and David W. Nellis, *Box 96, Brandon, Florida. 25 May 1966.*

Wood Duck ducklings captured by bullfrogs.—On 4 June 1956, I visited a Wood Duck (*Aix sponsa*) nest at the Olentangy Wildlife Experiment Station, Delaware County, Ohio, planning to mark the ducklings by toe-clipping. The ducklings were emerging from the nesting box on my arrival, but I was able to capture five before they made their exit. After toe-clipping, the five were released onto a pond. They promptly entered a small clump of cattails (*Typha latifolia*) as they swam toward their brood mates. When they emerged from the cattails moments later, only four of the five were present. To find what happened to the missing duckling, I immediately captured the remaining four. On one leg of each of two a band was placed, the band being attached in turn to a large fish hook, a line and a bamboo fishing pole. The two were returned to the site where their brood mate had disappeared less than an hour earlier. Within 10 minutes both ducklings were attacked by large bullfrogs (*Rana catesbeiana*).

The ducklings were hidden from view among cattails so I could not see the manner of attack. One frog released the duckling after being towed a short distance on the water. The other frog was swallowing the duckling headfirst and was towed to shore with its meal. Only about one-third of the duckling's posterior end protruded from the frog's mouth, the duckling already being well down the frog's throat. Nevertheless, the duckling was pulled alive from the frog's throat and soon became active. The duckling's legs were not injured in the towing process.

The method used to capture these ducklings was different than the method earlier described as being used by a bullfrog for capturing a bird. W. E. Howard (1950. *Copeia*, 1950:152) reported seeing the capture of a Brown Towhee (*Pipilo fuscus carolae*), which was caught by one foot or leg and submerged before swallowing was started. The frog spent about an hour swallowing the bird.

A. H. Wright (1920. "Frogs: their natural history and utilization," 42) reported ducklings unusual in the bullfrog's diet. W. L. McAtee (1921. *Copeia*, 1921:40) reported shooting of a bullfrog "swallowing a three-weeks old duckling" of an unnamed species. O. H. Hewitt (1950. *J. Wildl. Mgmt.*, 14:244) reported finding two Black Ducks (*Anas rubripes*), two or three days old, in the stomach of a bullfrog.

The promptness with which the duckling disappeared as the five free ducklings moved through the cattails, together with the quick capture of the two tethered birds, suggests that bullfrog predation on young Wood Ducks may be substantial in some situations. Capture of tethered birds, of course, is only partly indicative of what would happen in a natural situation.

The observations reported in this note were made when I was conducting research on the Wood Duck under support of the Ohio Cooperative Wildlife Research Unit. Dr. E. H. Dustman guided the research project, and the U.S. Fish and Wildlife Service reviewed and typed the manuscript.—PAUL A. STEWART, *U.S. Department of Agriculture, Agricultural Research Service, Entomology Research Division, Oxford, North Carolina, 30 April 1966.*

Flight speed of the Wood Duck.—Man has always been interested in the flight speed of birds, particularly the speed and distances flown by the larger ones such as the hawks, eagles, and waterfowl. To accurately determine Wood Duck (*Aix sponsa*) flight speeds, my wife and I timed the flight speeds of seventeen flocks over a measured course.

Cooke (1937, "Flight Speed of Birds," U.S. Dept. of Agri. Circ. No. 428) tabulated early records of bird flight speeds for mores than 100 species. Flight speeds of ducks

TABLE 1

FLIGHT SPEEDS OF NINE WOOD DUCK FLOCKS RECORDED 8 AUGUST 1964

Flock No.	No. in flock	Sec. to fly 970 feet	Miles per hour
1	3	14	47
2	5	17	39
3	4	14	47
4	3	17	39
5	2	15	44
6	1	14	47
7	1	12	55
8	5	13	51
9	3	14	47
Average	3.0	14.4	45.9

TABLE 2
FLIGHT SPEEDS OF EIGHT WOOD DUCK FLOCKS RECORDED 9 AUGUST 1964

Flock No.	No. in flock	Sec. to fly 970 feet	Miles per hour
1	4	12	55
2	1	14	47
3	3	14	47
4	1	14.5	46
5	2	12	55
6	5	14.5	46
7	14	17	39
8	12	12	55
Average	5.3	13.7	48.3

varied from a low of 26 miles per hour for a Black Duck (*Anas rubripes*) to a high of 72 miles per hour for a Canvasback (*Aythya valisineria*). Cottam, Williams, and Sooter (1942. *Wilson Bull.*, 52:121–131) measured the flight speeds of 57 species. They recorded cruising speeds between 29 and 33 miles per hour for four duck species. The flight speed of four ducks which were being chased varied between 40 and 55 miles per hour. Meinertzhagen (1955. *Ibis*, 97:81–117) lists the flight speed of the Mallard (*Anas platyrhynchos*) at 46–70 miles per hour, the Pintail (*Anas acuta*) at 37–65, and the Shoveler (*Spatula clypeata*) at 47–53.

During our observations, Wood Duck flocks were clocked with a stop watch over a measured course during two evenings in August, 1964. The course was a 970-foot stretch of the Wisconsin River between two prominent points. Just before dark, wood ducks fly along this stretch of river in a relatively straight line enroute to their traditional roosting site, this particular one located upriver from the power dam in Merrill, Wisconsin. During these observations, the ducks were not alarmed. The only motivating factor was to reach the roosting area before complete darkness.

The stop watch was started as the first duck of the flock crossed an imaginery line perpendicular to the observer on the downstream point. The watch was stopped when the upstream observer signaled that the first duck of the flock had crossed the imaginary line perpendicular to him. The signal was transmitted by a flashlight blink. Spier (1945. *Auk*, 62:135–136) clocked Oldsquaws (*Clangula hyemalis*) in a similar manner but was troubled by an erratic wind. Wind was negligible during these two evening periods.

Recorded Wood Duck speeds on the two evenings varied between 39 and 55 miles per hour but averaged 47.1 miles per hour (Table 1 and 2). The range of speeds recorded during the second evening (Table 2) were similar to those recorded on the first evening (Table 1) but did average 2.4 miles per hour faster.—JOHN T. LOKEMOEN, *Northern Prairie Wildlife Research Center, P.O. Box 1672, Jamestown, North Dakota, 9 May 1966.*

Erythrism in the wild Turkey.—As far as I can determine erythrism has not been reported in the wild Turkey (*Meleagris gallopavo*).

The plumage of a hen (specimen No. 45 in my collection) obtained in 1965 from Sarasota County, Florida approaches brownish red (color terminology after Palmer, ed., 1962. "Handbook of North American Birds." Vol. 1, Yale Univ. Press, New Haven and London) making the term *erythristic* appropriate.

Body color.—The contour feathers of the breast are chestnut-brownish red, barred and speckled with brownish black, tipped with light tawny. The feathers on normal specimens of similar age are usually blackish brown, barred subterminally with black, and terminally with light shades from tawny to buffy brown.

Wings.—Little reddish color occurs in the primaries except on the distal webs. The secondaries are not barred and are more reddish than the primaries. The greater upper secondary coverts are light reddish chestnut barred subtly with blackish brown on the distal web.

Other plumage.—All feathers are more reddish than normal, but some, particularly the retrices and feathers of the neck region, closely approach normal coloration. The erythristic specimen has a black beard which by its length (160 mm) suggests advanced age (Mosby and Handley, 1943. "The Wild Turkey in Virginia." Virginia Comm. Game and Inland Fisheries. Richmond).

Unfeathered parts.—In life the feet and tarsometatarsi were reddish as in normal specimens and the eyes and skin of the head and unfeathered portion of the upper neck were colored typically.

Other examples of erythrism.—I have several retrices and remiges from a reddish female specimen taken by a hunter near Baldwin in Nassau County, Florida in 1963. They are similar to the corresponding feathers of specimen No. 45 and include a number 10 juvenal primary by which the individual is known to have been less than one year old (Petrides, 1945. *Auk*, 62:223–227). The same hunter reported that he had seen other reddish turkeys in the area.

In 1963 I saw a reddish adult male near Baldwin and have been told by wildlife wardens in the area that reddish turkeys had been seen there before.

There is evidence of erythrism in wild Turkeys also from Arkansas and Mississippi. Mr. Mark Block sent color transparencies and a humeral feather from a brownish-red adult male taken about two years ago in Arkansas County, Arkansas by Mr. C. Elmer Bohnert. The specimen was preserved in a life-like mount. Mr. Russell Davis of Jackson, Mississippi sent a brownish-red feather and a color photograph of a juvenile male from Clark County, Mississippi taken in 1952. These turkeys were living wild and are believed to be "wild" Turkeys in the genetic sense. There is little evidence, one way or the other, concerning their ancestry but there is no reason to consider them to be products of domestic-wild cross-mating.

In view of the varied plumage coloration in domestic turkey strains, it is natural to wonder whether genetic exchanges between wild and domestic strains are responsible for off-color "wild" Turkeys. Specimen No. 45 has no characteristics of domestic turkeys. The tarsometatarsus length is 135 mm (measured as suggested by Baldwin, Oberholser, and Worley, 1931. "Measurements of Birds," Scientific Publications of the Cleveland Museum of Natural History, Vol. II, Cleveland, Ohio) and the diameter of the middle of the tarsometatarsus is 15 mm. This ratio of tarsometatarsal length to mid-tarsometatarsal diameter (135:15) compares closely to the same measurements of normal wild specimens. (Domestic turkeys have shorter and very much wider tarsometatarsi.) The specimen's body conformation, size, and wattling on the head and neck are typical of adult wild hens in Florida.

I would like to thank Mr. A. D. Dawson of Arcadia, Florida for securing the erythristic hen specimen. This paper is a contribution of Federal Aid to Wildlife Restoration Program, Florida Pittman-Robertson Project W-41-R.—Lovett E. Williams, Jr., *Game and Fresh Water Fish Commission, Wildlife Research Projects Office, Suite 21, 412 N.E. 16th Avenue, Gainesville, Florida. 24 May 1966.*

FIG. 1

A Sage Thrasher in Massachusetts.—On 26 October 1965 W. R. DeGarmo, W. R. Forward, and the writer discovered a Sage Thrasher (*Oreoscoptes montanus*) on the Parker River National Wildlife Refuge, Newburyport, Essex County, Massachusetts. The bird was observed feeding in the high tide wrack on the landward side of the barrier beach at a distance varying from 50 to 300 feet for a period of 90 minutes, when I left to obtain a telephoto lens for my camera. Although the light was failing fast upon my return, I managed to obtain a number of Kodachrome slides of the bird (Fig. 1). The pictures were taken using a 500-mm telephoto lens, gunstock mount, with a Honeywell Pentax 35-mm camera.

This apparently is the first record of the Sage Thrasher for Massachusetts (Bailey, 1955. "Birds in Massachusetts," Massachusetts Audubon Society; Griscom & Snyder, 1955. "The Birds of Massachusetts," Peabody Museum; Hill, 1965. "The Birds of Cape Cod," Morrow & Company; *Records of New England Birds*, Vol. I through XXI), although Sage Thrashers have been recorded several times along the Atlantic Coast in the past 10 years. Duplicate Kodachromes and 8 × 10 inch color prints of the Sage Thrasher have been deposited with the Massachusets Audubon Society and the Peabody Museum in Salem.—WILLIAM L. FRENCH, *Parker River National Wildlife Refuge, Newburyport, Massachusetts, 9 May 1966.*

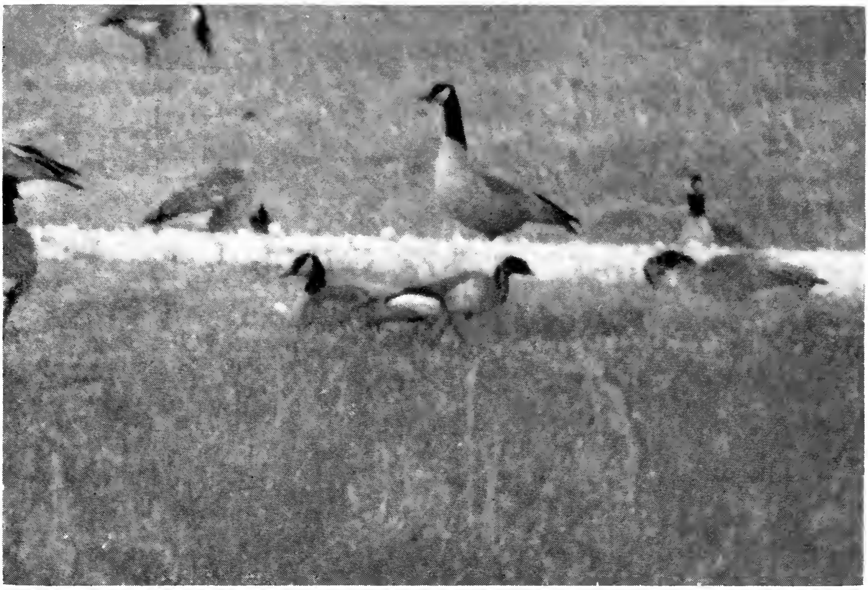


FIG. 1

Observation of Brant in southern Illinois.—There have been numerous reports from hunters of shooting Brant (*Branta bernicla*) along both the Mississippi and Ohio Rivers in extreme southern Illinois, but no specimens or confirmed identifications have been obtained. Smith and Parmalee (1955. "Distributional Check-list of the Birds of Illinois," p. 14) note only one observation of the Brant, an immature captured at Lacon, Marshall County, 9 November 1921. Three Brant were observed at McGinnis Slough, Cook County by K. Bartel (1932. *Oologist*, 50:6). Two Brant were observed at Chicago in October 1947 (1948. *Audubon Field Notes*, 2:15) and a male, now in the Principia College collection, was shot by a hunter in Jersey County in 1964 (1965. *Audubon Field Notes*, 19:45). All of these reports are from the northern or central part of the state.

On 19 December 1963, I observed a single Brant feeding with several thousand Canada Geese (*Branta canadensis*) in a pasture on the Crab Orchard National Wildlife Refuge, Williamson County. The Brant was observed for about 15 minutes at a distance of about 30 yards. On 31 December the bird was seen by Mr. James R. Rice, wildlife aid at the refuge, in the morning and during the afternoon I photographed the bird using a 300 mm lens (Fig. 1). The bird was not seen thereafter.—ROBERT A. MONTGOMERY, *Box 95, Vienna, Illinois, 27 May 1966.*

Sedatives interfere with walking more than flying.—Birds apparently find that flying takes less finesse than walking. Under the influence of chloral hydrate, a principal component of the barman's "Mickey Finn" or knockout drops, Western Gulls (*Larus occidentalis*) and White-crowned Sparrows (*Zonotrichia leucophrys nuttalli*) immediatly lose much or all of their ability to walk and stand, yet can be urged into flying very effectively for short distances. Ethyl alcohol has a similar effect on the sparrow.

Several years ago I was working on a study on the breathing of birds in flight and needed a large bird. I felt that a gull could be easily captured by putting a sedative in a sardine, rather than erecting complex and heavy nets. About a half teaspoon of chloral hydrate was put in a sardine and thrown to a gull. The bird swallowed it very quickly, regurgitated it, and took a drink of sea water. The drug took effect very quickly: the gull rocked back on its tail feathers and flopped over on its side. When approached, the gull, which immediately took off in company with a number of other gulls, flew several hundred yards as well as any of the other birds! Upon landing, it immediately collapsed and flopped around on the ground.

Two problems were then considered: 1) is this sensitivity restricted to the Western Gull, and 2) is the sensitivity limited to the effect of chloral hydrate; or is it the general effect of sedatives on birds?

White-crowned Sparrows were trapped on the campus of San Francisco State College and hand-fed with very small crystals of chloral hydrate. The sparrow would tend to squat on its legs, rather than flop over, and refused to hop. After some urging it could fly handily, however.

To test the specificity of the sedatives, ethyl alcohol was also tried. The sparrows were strongly sedated with 0.2 ml of ethyl alcohol, and again they could fly but would not hop. During the recovery from light anesthetization with ether or chloroform similar results were observed.

In both species, recovery was complete.

In addition to the sedatives mentioned, additional drugs with sedative action were tried: potassium bromide and meprobamate ("Miltown"). Crystals were hand-fed to the sparrows. In both of these cases the birds appeared uniformly affected. They refused to hop or to fly.

Lorenz (1956. *In* "l'Instinct dans le comportement des animaux et de l'Homme," page 260, Masson & Co., Paris), mentions the work of von Holst who found that decerebrated pigeons or those with labyrinth disturbances could fly and not walk.

This work was initiated under grant RG-8623 of the National Institutes of Health, U.S. Public Health Service.—JACK T. TOMLINSON, *Biology Department, San Francisco State College, San Francisco, California, 11 March 1966.*

Breeding behavior of an uniquely marked Starling.—The escape of an adult male Starling *(Sturnus vulgaris)*, instrumented for telemetering physiological parameters, provided an opportunity to observe the breeding behavior of an uniquely marked bird. This bird had been equipped in October 1964 at the Wildlife Research Center, Denver, Colorado with two electroencephalogram sensors, two electrocardiogram sensors, a respiration transducer, and a temperature transducer (Thompson, 1964. *Proc. 2nd Natl. Biomed. Sci. Instrum. Symp.* 2:123–130). The bird was marked by white masking tape on its back, which served to protect a cannon plug and the exterior wires from the internal sensors and transducers, and also by an elevated white "cap" of dental cement on its head, protecting the two electroencephalogram sensors (Fig. 1).

The Starling escaped 15 March 1965 and was first sighted 2 April feeding on a lawn one-quarter mile away. Identification was made by the "cap" on its head and tape on its back. The bird was observed courting a female in the same area 16 April, and was observed regularly until 6 May to determine any effects of surgery, color marking, and laboratory confinement. Motion pictures were taken of the feeding and nesting activities of the two birds. During this period the male copulated with his mate and, on one

FIG. 1. Adult male starling with the white "cap" on the skull and white tape on the back.

occasion, with a visiting female while his mate was present. The mated pair carried food to their nest constructed in the attic of a wooden building.

On 7 May an unsucessful attempt was made to capture the male with a mist net. The female was captured, however, and subsequently released, but this resulted in abandonment of the nesting site by the pair. Sounds of nestlings were heard at this time. Two days later entrance to the attic was gained and four dead nestlings, about 5 days old, and one egg were in the nest.

On 30 June 1965 the male Starling, too weak to fly, was captured 4 miles from the escape point by Kevin Krabacher of Lakewood, Colorado. The bird was returned to confinement but died the following day. Gross examination showed the "cap" and sensors missing and the respiration transducer torn loose from the body musculature. At death the bird weighed 57 grams, a loss of approximately 20 grams. Death was attributed to weight loss, and infection caused by loss of the sensors and the transducer.

In the wild the bird showed no abnormal deviation in its territorial breeding behavior. The stress of surgery and the implantation of sensors and transducers apparently did not affect reproductive physiology; for example, plumage changes and the ability to fertilize ova. Nor did the resultant color marking with the "cap" and tape interfere with mate selection and acceptance. The absence of disruptive effects on the breeding of this color-marked starling agrees with observations on breeding color-marked Canada Geese (*Branta canadensis*) (Helm, 1955. *J. Wildl. Mgmt.*, 19:316–317; Ballou and Martin, 1964. *J. Wildl. Mgmt.*, 28:846–847), and Mourning Doves (*Zenaidura macroura*) (Goforth and Baskett, 1965. *J. Wildl. Mgmt.*, 29:543–553).—C. VAL GRANT, *Bureau of Sport Fisheries and Wildlife, Wildlife Research Center, Denver, Colorado, 6 May 1966.*

Cattle Egret nesting in northeastern Oklahoma.—The observations reported here were made and recorded by Anne Reynolds and Bruce Reynolds of Tulsa, Oklahoma who have kept an almost daily watch at a heronry where the Cattle Egrets (*Bubulcus ibis*) have resided during the summer months of 1962, 1963, and 1964. Several other observers including the author saw the birds during the observation periods described.

The heronry is on the Romac Farm 3.5 miles southeast of the city limits of Tulsa, Tulsa County, Oklahoma. It has been inhabited regularly from 1957 through 1964. An estimate of the breeding bird population found there during the summer of 1964 is: 150 pairs of Little Blue Herons (*Florida caerulea*), 30 pairs of Snowy Egrets (*Leucophoyx thula*), 3 pairs of Common Egrets (*Casmerodius albus*), 1 pair of Green Herons (*Butorides virescens*), and 2 pairs of Cattle Egrets. The nests are located in a grove of large privet bushes (*Ligustrum* sp.) near the center of a 160-acre pasture. A stream flows from west to east across the pasture south of the privet grove. Two small ponds are impounded on this stream, one west and the other southeast of the nesting area. Large cottonwood, elm, and pecan trees grow along the stream banks.

The first Cattle Egret found in this area was an adult, seen by Anne Reynolds in the heronry on 13 May 1962. Throughout the summer to 11 August, one and sometimes two adults were seen in the same locality. Three adults were seen on 27 May 1962. No young or evidence of nesting were seen during 1962 (Baumgartner, 1962, *Audubon Field Notes*, 16:488).

One, two, and three adult Cattle Egrets were seen regularly in the same area from 20 April to 29 August 1963. Three young birds being fed by one and two adults were seen several times from 18 July to 26 July. Another brood of 2 young birds was observed being fed by one and two adults from 3 August to 21 August (Baumgartner, 1963, *Audubon Field Notes*, 17:468) (Reynolds, 1964, *Proc. Oklahoma Acad. of Sci.*, 44:64–65).

From 19 April to 4 August 1964 one to five adults were seen feeding among grazing cattle near the heronry and flying into the heronry. From 30 June to 25 July 1964 adults were seen feeding young in the branches of the privet grove.

Two specimens in juvenal plumage were obtained. One was found dead under one of the nesting trees 6 July 1964 and another apparently somewhat younger bird, out of the nest and climbing in the upper branches of a nest tree, was captured alive 11 July 1964. Both were taken to Dr. George M. Sutton at the University of Oklahoma where they were identified as *Bubulcus ibis*. They are now numbers 5487 and 5488 in the University of Oklahoma Museum of Zoology collection. The first specimen measured: length of exposed culmen, 57.5 mm; length of middle toe without claw, 58 mm; length of exposed portion of tibia, 43 mm. The latter specimen measured: length of exposed culmen, 48 mm; length of middle toe without claw, 51 mm; length of exposed portion to tibia, 34 mm. These are, I believe, the first nesting records of *Bubulcus ibis* for Oklahoma and the first specimens to be taken in this state.—John S. Tomer, *5911 East 46th Street, Tulsa, Oklahoma 74135, 11 January 1966.*

A Robin nests in winter.—On 12 December 1965 office workers at a Columbus, Ohio insurance firm noticed that a Robin (*Turdus migratorius*) was building a nest outside a window of their downtown office building. A similar late nesting of this species has been reported from Pennsylvania in January 1965 (Berger, 1966. *Auk*, 83:668).

The Columbus nest was completed in two weeks, and by 26 December the Robin was incubating three eggs. During the days of nest-building and incubation the daily high temperatures recorded averaged 43 F and the low temperatures averaged 28.5 F. The highest temperature recorded during this period was 63 F; the lowest was 12 F. After a 12-day incubation period, two of the eggs hatched on the morning of 6 January 1966 and the third hatched the following day. On 6 and 7 January the adult fed worms to the young birds, but in the early morning of 8 January the temperature dropped to a low of 12 F and by daylight the ground was frozen and unyielding. That morning the adult shuttled on and off the nest, alternately brooding the young and searching for food.

The low temperatures and lack of food were evidently too much for the young birds and on January 9, the nest was completely deserted.

At no time during these events was more than one adult observed at the nest, and nest-building, incubation, brooding, and feeding were carried out by a single bird, presumably the female.

The initiation of nesting activity coincided with the construction of a huge Christmas display across the street from this office building. The thousands of bright, colored lights adorning this display may have been a factor in triggering nesting activity in this bird. Bissonette and Csech (1936. *Bird-banding*, 7:108–111) induced Connecticut pheasants to lay fertile eggs in January by "night-lighting," and Welty (1962. "The Life of Birds," p. 152) states that "'night-lighting' has stimulated other species of birds to lay eggs out of season; rats, mice, and sheep to breed precociously; and brook trout to spawn in December instead of March." Benoit (1950. Grasse, "Traité de Zoologie," Tome XV, Oiseau. Masson et cie, Paris) points out that red light rays penetrate the tissues of the head more effectively than the shorter wave length blue light, thus providing greater stimulation of the gonads via the anterior pituitary. This may have been a factor here for over half of the lights in the display were red.—STEPHEN W. KRESS, *680 Vernon Road, Bexley, Ohio, 27 January 1966.*

Wing and tail flashing of Painted Redstart.—On 21 April 1961, near Payson, Arizona, I watched a Painted Redstart (*Setophaga picta*) as it moved around the exposed roots of an old sycamore tree (*Platanus occidentalis*) near the top of the steep river bank. While foraging the bird opened and closed its tail feathers as one would open and close a small fan and flashed its wings in a manner similar to that of the Mockingbird (*Mimus polyglottos*). In the half-light among the roots, the white wing bars and tail feathers were made very conspicuous by these movements.—MARY WIBLE, *Gaines, Pennsylvania, 28 January 1966.*

THE PRESIDENT'S PAGE

In anticipation of our June 1967 meeting in northern New England, I have been reading various comments on the results of Man's confrontation with Nature in this part of the continent. Some reactions reflect economic considerations exclusively. Take this one, for example, regarding the State of Maine:

> "Its uninterrupted forests were once full of wild animals with furs of highest value. It had various timbers, particularly white pine, with rivers to take it to market. For long spells of the year, the large streams flowing into the ocean were in former times thronged with countless shoals of salmon, shad and herring. Now the animals with valuable furs have been exterminated or driven back, and fish in large streams are of little account compared with their former value. Lumbering still flourishes in the northern and eastern parts of the State, lucrative if rightly managed, but bringing impoverishment and insolvency to crowds of people who rush in without capital or experience."

The foregoing is no recent complaint from some economic report of today. It was written a century and a quarter ago—in *1841.* It appears among remarks delivered at a meeting of a county agricultural society. A quite different reaction to the confrontation of Man and Nature found expression in 1856, in Thoreau's journal:

> "But when I consider that the nobler animals have been exterminated here . . . I cannot but feel as if I lived in a tamed, and, as it were, emasculated country . . . Is it not a maimed and imperfect nature that I am conversant with? . . . I take infinite pains to know all the phenomena of the spring, for instance, thinking that I have here the entire poem, and then, to my chagrin, I hear that it is but an imperfect copy that I possess and have read, that my ancestors have torn out many of the first leaves and grandest passages, and mutilated it in many places."

One of the field trips planned for our June 1967 meeting will take people to the Errol-Umbagog area of New Hampshire. Sixty years ago, in 1907, William Brewster included in his "Birds of Lake Umbagog" a passage which may seem amusingly quaint today—until we realize that today's implications for our wilderness areas are neither amusing nor quaint:

> "But almost no part of northern New England, however rugged and remote, is now beyond reach of the swift touring-cars. Of late they have traversed the Errol road with increasing frequency, powdering its wayside flowers with dust, disturbing the quiet of its wooded reaches with the muffled roar of their throbbing machinery, and leaving everywhere the reek of their fetid breath . . . To many of us who have long known the region and loved it especially because of its remoteness and seclusion, this invasion of its highways is scarcely less deplorable than is the ever-increasing havoc wrought in its forests by the lumbermen."

Aaron M. Bagg

ORNITHOLOGICAL NEWS

The colored frontispiece of this issue was painted especially to illustrate Dr. McClure's article by Dr. Boonsong Lekakul, of Thailand. A physician, naturalist, artist, and author Dr. Boonsong has devoted much of his time during the last 20 years to awakening the Thai public and officials to the need for conservation of the wildlife and natural resources of that country.

The Secretary of the International Commission on Zoological Nomenclature announces the possible use of plenary powers by the Commission in connection with the following names, listed by Case Number (see *Bull. zool. Nomencl.*, 24: pt. 1, 6 March 1967): 1692. Suppression of *Strix capensis* Daudin, 1800; and 1784. Validation of *Sterna tschegrava* Lepechin and *Motacilla pleschenka* Lepechin, "1770." Comments should be sent in duplicate, citing Case Number, to the Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, S.W. 7, England.

The Cornell Laboratory of Ornithology has established an award in honor of the late Arthur A. Allen, distinguished ornithologist and teacher at Cornell University for nearly fifty years. The award will be in the form of a medal.

The enormous following which ornithology enjoys today is due in a large measure to the influence of Dr. Allen. Besides his scientific studies his popular writings, photography, and public lectures, and his use of graphic art and sound recording, drew attention to birds so widely and effectively that countless people have found ornithology an avocation both challenging and rewarding.

It is in recognition of Dr. Allen's service in widening popular interest in ornithology that the Laboratory of Ornithology will make the award. The contributions of the awardee must therefore reflect his emphasis on interpreting ornithology to the public through such media as magazine articles, books, lectures, still photographs and motion-picture films, drawings and paintings, and sound recordings. Other stipulations:

1. The eligibility of an individual under consideration shall be broad and the selection not limited to a professional ornithologist.
2. The award shall be limited to the field of ornithology and not be concerned specifically with the broad areas of conservation and wildlife management.
3. There shall be no geographical or national limitations as to where the work is done or by whom.
4. A committee appointed by the Administrative Board of the Laboratory shall select the recipient of the medal.
5. The committee shall consider the award annually, but it will be the committee's prerogative to decide whether or not an award should be made in any given year.

To select the first awardee, the Administrative Board has appointed the following committee: Alexander Wetmore (Chairman), George Miksch Sutton, Wesley E. Lanyon, Roland C. Clement, and Phillips B. Street. The award will be made in the fall of 1967, the exact time and place to be announced. The recipient of the award will not be revealed until the award is actually presented.

The Raptor Research Foundation, Inc., Centerville, South Dakota 57014, announces the publication of a quarterly newsletter, *Raptor Research News.* Annual subscriptions are $1.00, sent to the above address. Interested persons may also become Associate Members of the Foundation by making a financial contribution. Byron E. Harrell is President of the Foundation.

ORNITHOLOGICAL LITERATURE

Birds of the Northern Forest. Paintings by James Fenwick Lansdowne; text by John A. Livingston. Houghton Mifflin Company, Boston, and Riverside Press, Cambridge, 1966: 9½ × 13 in., 247 pp., 55 col. pl., each with half-tone of pencil (or pencil and wash) exploratory esquisse. $15.00.

For many years I have studied with keen interest the published and unpublished work of persons often referred to as "bird artists." The term is faintly derogatory. Directors of art galleries use it by way of making clear that they consider specialists in bird portraiture not artists but naturalists or bird-lovers instead. Being called a "bird artist" does not bother me as it once did. The important thing is not to be categorized properly, but to do what one is impelled to do, and to do it well.

Human beings seem never to tire of pictures of that which they love. Abstractions are the vogue, to be sure, but Andrew Wyeth, for all his flagrant representationalism, has a tremendous following. Good bird drawings, drawings intended to look like birds rather than to explore subconscious feelings about feathers, or to illustrate fright at the sound of beating wings, will, I predict, continue to find a place in human affairs as long as our race survives. I probably have drawn our dooryard friend, the Cardinal, a hundred times. Lord knows I have not figured out a hundred different "poses," although a hundred different arrangements of adult males, adult females, young birds, and accessory material might be easy enough to devise. Never have I drawn a Cardinal tail-on. Invariably my central figure has been at least partly in profile. Two points I wish to make here. First: although I have drawn the Cardinal many times, each drawing has been different from the others, and each has had its own appeal. A reason for this is that I, the creator, though constantly changing myself, have continued to love my subject matter. I have been a different person, a different complex of ideas, opinions, and experience, each time I have drawn. I have had only to finish a painting to find myself a new man; but the new man has loved the Cardinal even as the "old" one did; the love has continued. Point two: no matter how many color plates of birds are published, they will continue to delight us so long as they represent their subject matter faithfully.

What I have just said applies to representations of living birds, not to still-lifes done from mounted specimens, and not to pictures of pictures. There is a vast difference between a drawing aimed at recording an instant in the life of an alert (or, for that matter, a sleepy) organism and one aimed at showing how light falls on a stuffed specimen standing on a table near a window. A Bruno Liljefors would fully understand what I have just tried to say; so would a Jan Vermeer.

The field of bird illustration is cluttered with the work of those who have studied not the birds themselves but rather the more or less acceptable reproductions of the works of others. The public nowadays will not accept the funny double croquet-wicket that used to stand for a flying gull in the distance, or a pupil-stabbing highlight for the eye—like that employed by Elliott Coues in the pen-and-inks he made for his "Key to North American Birds." Present-day devices are of a subtler sort. But devices they are, and guilty am I, along with others, of depending on them. A long tail, a long bill, a wide-spread wing—any of these, when pointed straight at the viewer, is extremely hard to draw. How do we solve the problem? What device do we use? We put our birds in some simpler, some time-honored, some traditionally acceptable, position.

This laziness, this subterfuge, is to some extent pardonable. Difficult indeed would it be to draw warblers without using "poses" Louis Fuertes used over and over. Allan

Brooks avoided obvious repetition by fluffing body plumage and by slightly upcurving tail feathers, but neither Brooks nor anyone else can get much out of line with warblers simply because the birds themselves are the victims of such forces as center of gravity, pterylosis, and the grasping power of toes. As for such tricky variables as the opened bill, Fuertes has had no peer; a little out-and-out copying of this detail might well be recommended to all aspiring young bird artists. The British master, Archibald Thorburn, whose work I greatly admire, never did manage to draw quite accurately the wide-open bill of a gull or hawk.

James Fenwick Lansdowne is a talented young man whose bird portraiture, as recorded in "Birds of the Northern Forest," is charming and authentic. What is of far greater moment, it reveals tremendous promise. Not one of the fifty-five color plates is in any sense of the word or phrase a copy, an imitation, or a picture of a picture. Each is a Lansdowne, an autobiographical record of intimate experience with a bird in its habitat. And each reveals Lansdowne as a careful observer, a skillful delineator, and a determined person. I include this last because, having myself just finished a watercolor of a Yellow-billed Loon in breeding feather, I know how much work, how much real work, went into the correct positioning of white dots and squares in that Lansdowne *tour de force*, the Common Loon (Pl. 1).

Each picture of the fifty-five is well conceived. Each has balance. Not one is overcrowded or cluttered. The feeling for feather texture is notable. Streaking, barring, and tarsal scutellation are well handled. Not all the birds are fluffy, and this is as it should be. Not all are perfectly smooth, perfectly symmetrical. Especially enjoyable in this respect is the hungry-looking, slightly lop-sided young Whiskey Jack, the upper figure in Plate 26. Two pictures, those of the Solitary Sandpiper (Pl. 15) and Lesser Yellowlegs (Pl. 16) are highly original in that they illustrate breeding behavior comparatively few ornithologists have witnessed. The accessory material in many of the plates is beautifully drawn, especially the flowers in Plate 11, the top of the tamarack in Plate 15, the charred wood in Plate 23, and the leaves in Plates 38, 45, 46, and 47.

In certain respects we may confidently expect Lansdowne's work to improve. In time he will perceive that for a rear-view drawing of a Spruce Grouse in display to be wholly convincing (Pl. 13), a considerable amount of air or space must *seem* to exist between the spread rectrices and the upper back and scapulars. It is the artist's duty to create this illusion. Both feet of a perched Common Raven (Pl. 27) must *seem* to be connected with the bird, whatever their position on the branch. The claws of a woodpecker must cling to the bark, but the toes themselves must *seem* to be between the bark and the bird—there must be space between them and the surface to which they cling. An artist who sets himself to the task of recording facts in minute detail must show all the toes of a Pine Grosbeak when the bird is grasping a small twig (bottom figure in Pl. 52) and he must count correctly the tail feathers in a dead flicker (Pl. 9).

Color errors in reproductions may or may not be the fault of the artist. The legs of Solitary Sandpipers that I have seen, handled in the flesh, and drawn, have been far more olive-colored than those of the individual figured by Lansdowne, and in such Olive-sided Flycatchers as I have prepared as specimens the mouth-lining has had a much yellower cast than that shown in Plate 25. From the standpoint of color the Winter Wren (Pl. 30) and Tennessee Warbler (Pl. 39) are the least successful of the collection. In each of these there is too much emphasis on pattern; the Winter Wren looks almost white-faced, the Tennessee Warbler vaguely streaked on the chest.

After this digression in a minor key, let me swing back to a final, triumphant major. Parts of each of these drawings are exceptionally well done; on the whole they are pleasing indeed; I predict that for years to come I shall point to Lansdowne's Common Loon and Red-breasted Mergansers (Pl. 8) as examples of surpassingly beautiful bird portraiture.

John A. Livingston's text, which could have been mere obbligato, is far more than that. The species write-ups, restricted as they are to one page each, cover a wide variety of subject matter, including the over-all distribution of the families to which the several birds belong; interesting and puzzling facts about food, nesting habits, molts, and habitat preference; and sound ideas concerning what is usually called conservation. Of special interest to me is the brief discussion of the regular southward movement of the Black-backed Three-toed Woodpecker (*Picoides arcticus*), a phenomenon which is, in Livingston's opinion, "apparently the result of the widespread ravages of the imported Dutch Elm disease" (opp. Pl. 22). For me a peak is reached in Livingston's prose when he says: "If we are not precisely sure what 'conservation' means any more, we do know, however, what 'preservation' means, and we do not blush to say that we are preservationists. We believe that the preservation of birds—*all* birds—is a legitimate aim that does not need justification on economic or any other grounds. Birds should be preserved because they are there—because they happened. That, to us, is reason enough" (p. 11). To this I am impelled to add: if birds are to be preserved their habitat must be preserved. Birds cannot exist without habitat. And glorious indeed is the habitat provided by Canada's woodlands.

Birds of the Northern Forest helps to make clear why people need birds, need them desperately. Lansdowne's paintings and Livingston's writing eloquently plead the cause both of wildlife preservation and of balance, joy, and satisfaction in human living.

—George Miksch Sutton

Birds of North America: A Guide to Field Identification. By Chandler S. Robbins, Bertel Bruun, and Herbert S. Zim. Illustrated by Arthur Singer. Golden Press, New York, 1966: 4¾ × 7¾ in., 340 pp., 2,000 illus. in col. Cloth, $4.95; paper, $2.95.

When I first heard that a new field guide to North American birds was about to be published, I must confess that I formed an instant bias against it, for two reasons. First, the authors of the two best known extant field guides were personal friends of mine, and I felt rather protective toward them; and second, friendship aside, I felt the current guides did an excellent job, and I did not see how they could be greatly improved upon. No sooner, however, had I started thumbing through "Birds of North America," than this prejudice instantly disappeared, for it is a book of great charm. Whether it improves upon the current guides, I will discuss later; what I would like to write about first is the attractiveness of the book.

Those who have seen Arthur Singer's illustrations in Austin's "Birds of the World" will not be surprised to learn that he has done a beautiful job of illustrating Birds of North America. I was constantly impressed and delighted not only by the wealth of illustrations of birds in all sorts of plumages but also by the gratuitous little vignettes of birds engaged in various activities besides posing for their portraits: Oystercatchers displaying and probing; coots taking off from the water; herons feeding in different attitudes. I particularly liked the herons and egrets on page 95. This is a book that I would be prepared to buy myself just to have the sheer pleasure of looking at the pictures. The color reproduction in the printing is first class, with one or two small exceptions mentioned later.

The primary purpose of the book, however, as is evident from its title, is not to delight but to inform, and it must be judged on the basis of whether it accomplishes what it sets out to do. As far as the illustrations are concerned, I think the book manifestly achieves its purpose. One of the most commendable features of the book is their abundance. Immature birds are given a great deal of coverage, a feature not sufficiently stressed by other guides. There are flight pictures not only for the usual groups such as hawks, ducks, and shorebirds, but also for many others, such as owls and alcids, not usually shown in flight. Little details I particularly appreciate are the flight comparison between immature Black-crowned and Yellow-crowned night herons, and the comparative flight shapes of Common and Snowy egrets. Whole pages are given over to illustrating difficult groups—for example, hawks in flight and fall warblers—*in addition* to the regular pictures of the species. Thus, for the sake of easier comparison with similar species, some birds may be pictured several times. It is this continuous largesse showered on the reader that I find so very attractive. This is not a stingy book; it is illustrated with a large hand.

The publishers are to be commended for not having balked at the idea that every species should be illustrated in color. Many publishers like to cut corners by having black and white plumaged birds pictured only in black and white, the idea being that this is quite sufficient for identification. This is not wholly true, nor does it make the book more attractive. Very few birds are purely black and white, and if a dark brown bird or a black bird with gloss or sheen on its plumage is pictured as plain black, this can be misleading. I am annoyed when I find black and white illustrations in books that are largely in color, and it is to be hoped that future writers of field guides around the world will use this book to throw at publishers who complain about color being too expensive.

Before passing to the text, I want to discuss the scope and arrangement of the book which has departed from the tradition of two complementary field guides, one for eastern and one for western North America. All of North America north of Mexico is included, but not Hawaii. The criterion for inclusion of a bird is that it shall have occurred in North America at least five times in the present century. A good many casual species are thus included, and the total number of species treated is 695.

Opinions vary as to the desirability of including so large a number of species in one volume. Some people contend that such a wealth of material is confusing, especially for the beginner, and they prefer the regional guides where the choice of species is limited to those which the beginner is most likely to see. Everyone must choose a field guide which suits him, but personally I find this a rather spoiled viewpoint. Having for some years had to use Mackworth-Praed and Grant's guide to the birds of eastern Africa, which treats 1,478 species, I am perfectly delighted to use a guide which covers *only* 695 species.

The book is so arranged that the text describing a bird is on one page, and the picture of the bird is on the opposite page. This scheme is followed throughout the book and is one of its unique features. The time saved by not having to hold the book open at the illustration of a bird while thumbing through to find its description in the text is enormous. This tremendously convenient device, however, has an unfortunate corollary; due to the space limitations imposed by such a system, the text has had to be very brief with much less room for word comparisons between species than there is in other field guides. The onus is thus thrown upon the illustrations as the primary means for identification in many cases.

Given the problem of greatly reduced space, the authors are to be complimented for having produced a tight, compact text which is pared down to the bare essentials. The text ranges roughly from three to ten lines per bird, averaging around six. Brief field notes are given, and one or two lines on abundance and habitat, with sometimes notes on special behavior that may help to identify the bird. In addition, each family is given an introductory paragraph describing its general characters, and the same is done for a number of well-marked generic groups, such as "Spotted-breasted Thrushes" (*Hylocichla* spp.) and "*Oporornis* warblers." These introductions often include useful information on habitat and behavior of the group, and this eliminates the necessity for repetitive descriptions in the text about each species. Such tight writing and avoidance of repetition are characteristic of the book throughout.

Beside the text of each species is a map giving its range. While not a new idea, it is a very good one. A lot of information is packed into each map: summer and winter ranges; areas traversed by the bird during spring and fall migration, these being distinguished by different hatching; isochronal lines for the spring months showing average arrival dates for spring migrants. The only drawback to the maps is their small size, and this again is due to space limitations. The maps would be ideal if they were all as large as the large-scale example on page 16; as it is, so much information is compressed into the tiny maps that they are sometimes difficult to read. This is especially true where a bird has a narrow coastal range; it is hard to see where the winter range (blue) ends and the resident range (purple) begins.

Birds with very restricted ranges are not given maps, their range being briefly noted in the text. They are, however, squeezed onto the same page with birds having maps. This makes for confusion, as it is not always immediately clear which map belongs to which bird. In some cases this has been circumvented by noting on the map the name of the bird to which it belongs, but not always. On page 152, for instance, the map opposite the Least Auklet obviously belongs to the Marbled Murrelet, the bird below. This is something that should certainly be corrected in future editions of the book.

Another unique feature of the book is the use of sonagrams for depicting songs and calls. To my mind this is the least successful feature. While sonagrams have value in scientific studies of bird calls, their usefulness as an aid to field identification is very limited. To begin with, considerable practice is needed in order to be able to read sonagrams; but even when some proficiency is acquired, I doubt if anyone can really imagine or "hear" a new song simply by reading its sonagram. I challenge anyone who has never heard the call of a Red-bellied or a Gila woodpecker to "hear" the difference between their calls by reading the sonagrams on page 182. Admittedly it is interesting to see what a call *which you already know* looks like as a sonagram, but this is not the point. A field guide should teach you to have an idea of a song *before* you hear it. I maintain that you cannot learn bird songs from sonagrams. Bird songs are best learned from records, of which there is a wide variety now available covering just about every North American species. In a book, they are best depicted by the time-honored method of verbal description, and the authors have been wise to include many such descriptions in the text. There is no sonagram for Coues' Flycatcher; there is no need for one. The authors' description of its call as "a sad, whistled 'ho-say mari-a' " is more effective. We all know that the Olive-sided Flycatcher says "Quick, three beers," (all, that is, except the authors, who maintain it says "*whip*, three beers," thereby turning a memorable phrase into a more accurate but meaningless one). There is no need to add a sonagram of its song, as has been done; the verbal description is perfect.

There are a number of smaller points on which there is room for improvement in the book. In a number of places the color is not true, and this may in part have occurred in the printing. The Baird's Sandpiper on page 128, for instance, shows a lot of yellow in the plumage, and looks quite different from the same bird pictured on page 125. In a number of illustrations, particularly those of flying terns and gulls, the painter has apparently attempted to indicate shadow by painting part of the underparts of these birds gray or brownish where they should be white. This is extremely confusing, particularly in a case like the Roseate Tern on page 143. The whole point about a Roseate Tern in summer dress is that it is whiter below (even pinkish sometimes) than the similar Arctic and Common terns, and yet here a Roseate labelled "summer" is pictured as gray below. This is a case where artistic effect should definitely be passed up in favor of formal color accuracy.

Something has gone wrong with the flight pictures of Least, Semipalmated, and Western sandpipers on page 125; they are all far too dark. The flying Black Guillemot on page 149 presents an anatomical puzzle as regards the position of the wings. The head pictures of Ruff and Reeve on page 123 are useless for field identification, especially as no two males are ever quite alike in spring dress. If there is no room for a full-length or a flight picture, the birds are best left out. On the same page, I cannot understand why the Sharp-tailed Sandpiper is shown in summer dress, when by the authors' own admission the bird is a fall visitor only, and the fall plumage is quite different. On page 94, we are left to assume that the unlabelled bird standing next to the Great Blue Heron is an immature bird of that species. Or is it a female? Or in winter plumage? The beginner needs to know.

It is a pity that only the head of Cory's Shearwater is illustrated, on the grounds that, as stated in the text, it has "plumage the same as the Pink-footed's." Not only is this an unscientific remark, as the birds belong to quite different species, but it obscures a piece of information vital for field identification, which is not mentioned anywhere in the text. The upper tail coverts of Cory's Shearwater can be very pale, almost whitish at times, giving the effect of a narrow pale band above the dark tail tip, causing confusion with the Greater Shearwater. The Pink-footed Shearwater as illustrated, on the other hand, has the upper tail coverts even darker than the rest of the upperparts. The text needs to be tightened up in this case, too, and it should be pointed out that the best field mark for telling Cory's and Greater shearwaters apart is not the pale band on the tail but the contrast between dark cap and light cheeks in the Greater.

With regard to price, I think that $2.95 for the paper cover edition of this book represents unparalleled value for money. It is incredible that a book with over 150 pages of colored illustrations should sell for under three dollars. Furthermore, the size of the book is another selling point. Most field guides today are small, but still are too large to fit into the pockets of many jackets without some squeezing. In this book, the use of a soft cover reduces its dimensions all round, and its thickness is less than three quarters of an inch. It thus fits comfortably into any but the smallest pockets.

In conclusion, in spite of some drawbacks, this is a really excellent book, and I heartily commend it. It will not replace the older field guides, because they contain additional features. Rather, it should be used to complement them, because it, likewise, contains features which they lack. It is so cheap that everyone can afford to buy it in addition to their other books. As to that inevitable, awkward question, "If you only had room for one guide, which one would you take?," I will sidestep it by saying that I usually take more than one guide with me in any case. I suggest that every field birdman makes sure that he has a spare pocket large enough for Birds of North America.

—STUART KEITH

THE BIRDS OF SHAKESPEARE. By James Edmund Harting. Including OF MEN AND BIRDS: PROLEGOMENA TO THE BIRDS OF SHAKESPEARE. By Grundy Steiner. Argonaut Inc., Chicago, 1965: 6½ × 9½ in., xxxviii + 321 pp., 33 illus., 1 table. $7.50.

The re-issue of "The Birds of Shakespeare" by J. E. Harting is an important event for all students of the poet. This book, first published in 1871 and long out of print, not only was the first complete survey of the subject but also remains the best. In making Harting's study again accessible, the Argonaut Press has rendered a valuable service.

Emphasis in the book is placed upon the poet's knowledge of falconry. This is suggested in the frontispiece, where the fine figure of a Peregrine Falcon drawn by Wolf, the famous German artist, has been superimposed upon the Chandos portrait. A wealth of further engravings throughout the book illustrates the subject at hand.

Nine chapters deal with birds in a natural grouping. Following passages containing allusion to the eagle and other large birds, the author proceeds to what is perhaps his most valuable chapter, "Hawks and Hawking." Quotations accompany explanation of the falconer's jargon—*tower*, *point*, *pitch*, *seel*, *watch*, *tire*, and others, terms which came naturally to the poet. Later, in Chapter 7, the author passes to the complementary theme, "Game-birds and 'Quarry' flown at by Falconers." Not least interesting here are quotations from royal household accounts showing an astonishing variety of table birds with the price paid for each.

In his prefatory essay, "Of Men and Birds," Professor Steiner of Northwestern University reviews the role of birds among Greeks and Romans to emphasize the force of tradition in Shakespeare's time. He remarks the extent to which the poet leans toward contemporary taste rather than to ornithological fact. He believes rightly that the plays reflect "a preponderance of tradition over observation." Mr. Harting is kinder to Shakespeare than to his own contemporary, Alfred Tennyson. Allusions to birds by the laureate, he writes elsewhere, tend to prove that he had "neither a good eye for colour nor a good ear for bird music," that in short, Tennyson was "inferior to many English poets who have preceded him" (*The Zoologist*, 1883, p. 145). But whatever its faults, all of them minor, Harting on Shakespeare's birds is admirable throughout. Here is a reprint that every lover of birds and poetry should own.—THOMAS P. HARRISON

BIRDS OF EUROPE. Illustrations by John Gould. Text by A. Rutgers. Barnes & Noble, New York (first published by Methuen & Company, London), 1966: 7½ × 9⅞ in., 320 pp., 160 col. pls. $15.00.

This is not really a book in the usual sense but a well-reproduced selection of lithographs that first appeared in Gould's "The Birds of Europe" (1837) and "The Birds of Great Britain" (1862–73). Opposite each plate is a page of brief text, written for this volume, sometimes describing the species shown and giving a little information on habitat, behavior, nesting habits, and vocalizations. Strangely lacking is a preface or any introductory material other than a table of contents. Nowhere is there one word about the author of the text, the sources of his information and the objectives of his presentation; and worse still, not one word about John Gould (1804–1881). Except for one dated quotation (p. 1) from The Birds of Europe, the reader has no way of knowing how long ago the lithographs were first published. The only information about Gould—and most inadequate—is on the front flyleaf of the jacket. Here the publishers give a few laudatory generalities about Gould's work and mention the volumes from which the present lithographs were taken, but give no dates and state that successive volumes will cover Gould's work on Asia, Australia, New Guinea, and South America. Hopefully they will be more than "non-books" such as this one. Much as the plates from Gould's works, all of them rare, are welcome, they should be given historical perspective.—OLIN SEWALL PETTINGILL, JR.

BUGS OR PEOPLE? By Wheeler McMillen. Appleton-Century, New York, 1965: 5⅝ × 8¼ in., xi + 288 pp. $4.95.

The jacket of this book includes the subtitle "A Reasoned Answer to Opponents of Pesticides"; this should be enough to forewarn the reader that a polemic is forthcoming. The author is an experienced agricultural writer who has had a long and distinguished career of service. He begins with an intimate but somewhat clumsy description of the antics of Timmy, the titmouse, on the author's breakfast terrace. This gambit is apparently designed to assure us of the author's deep and abiding concern for wildlife. The effect on me was somewhat uncertain and my unallayed suspicions were confirmed in the third chapter when the real target of the book is brought to focus: it is, of course, Rachel Carson and "Silent Spring." It is odd that an excellent and more recent review (Rudd's "Pesticides and the Living Landscape") should be overlooked by the author. This is perhaps a good measure of the continuing effectiveness of Miss Carson's role as the protagonist to the pesticide industry.

In attempting to construct a rebuttal to Silent Spring, Mr. McMillen's principal stratagem is to balance the continued need for pesticides to sustain production of food, fiber, and timber against the risks of damage to fish and wildlife. This position is undeniably one of great inherent strength; however, the author misjudges his material. To begin with, he fails to understand that threats to the robust success story of American agriculture are not likely to catch our imagination with half the force of the continued threats to an already depleted and beleaguered wildlife resource. Furthermore, the success story is poorly told. The author attempts to pull in an impressive assortment of specifics to set up his arguments. He is not deft in doing so and misses many excellent opportunities (as on p. 46) in describing biological control of the Klamath weed. He refers (p. 46) to the weed as "spread over several hundred thousand acres of once-good native pastures in Oregon, Idaho, Montana, Washington, and Nevada . . .". By failing to check his sources carefully, the author has missed his mark by a fifteen-fold underestimate; actually, more than 5 million acres were affected by the Klamath weed! There are many other examples where the author's lack of precision destroys the impact of his argument (as on p. 43): "The predatory insects, which make their living by *destroying other species* . . .".

Secondly, the author shows a startling lack of ecological perspective in his failure to understand that the principal threat of pesticides to fish and wildlife is an indirect one, namely, through the action of bio-accumulation. For example, in discussing the Mississippi River fish kill (p. 159) he asks "Could pollutions from higher up in the Mississippi and Missouri Valleys have acquired deadly effect only after they had reached so near to the big river's mouth?".

Lastly, the author fails to understand that, if the national challenge of the past century was to attain an adequate standard of living for all, the challenge of the coming century will be to preserve the quality of the environment. The author's view of man's relationship to his environment is summed up in a concluding chapter on "What Needs to Be Done." His response is "We should proceed to master our environment." One cannot help but wonder what room would be left for "bugs" and other forms of wildlife in a "mastered" environment.—DANIEL Q. THOMPSON

This issue of *The Wilson Bulletin* was published on 5 June 1967

The Wilson Bulletin

PUBLISHED BY THE WILSON ORNITHOLOGICAL SOCIETY
WEST VIRGINIA U. · MORGANTOWN, W. VA.

VOL. 79, No. 3, SEPTEMBER 1967 PAGES 257–368

THE WILSON ORNITHOLOGICAL SOCIETY

FOUNDED DECEMBER 3, 1888

Named after ALEXANDER WILSON, the first American Ornithologist.

Membership dues per calendar year are: Sustaining, $10.00; Active, $5.00. THE WILSON BULLETIN is sent to all members not in arrears for dues.

THE JOSSELYN VAN TYNE MEMORIAL LIBRARY

The Josselyn Van Tyne Memorial Library of the Wilson Ornithological Society, 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, reprints, and ornithological magazines from members and friends of the 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 contribution, 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. William A. Lunk, University Museums, University of Michigan, is Chairman of the Committee. The Library currently receives 104 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 Josselyn Van Tyne Memorial Library, University of Michigan Museum of Zoology, Ann Arbor, Michigan." Contributions to the New Book Fund should be sent to the Treasurer (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 newly acquired books are listed periodically.

THE WILSON BULLETIN

The official organ of the Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Morgantown, West Virginia. The subscription price, both in the United States and elsewhere, is $5.00 per year. Single copies, $1.25. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at $1.25 each) and may be orderd from the Treasurer. Special prices will be quoted for quantity orders.

All articles and communications for publications, books and publications for reviews should be addressed to the Editor. Exchanges should be addressed to The Josselyn Van Tyne Memorial Library, Museum of Zoology, Ann Arbor, Michigan.

Second class postage at Lawrence, Kansas, U.S.A.

PRINTED IN U.S.A. Allen Press, Inc., Lawrence, Kansas

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by The Wilson Ornithological Society

Vol. 79, No. 3 SEPTEMBER 1967 Pages 257–368

CONTENTS

GENERAL NOTES

ECOLOGY OF THE NESTING BIRDS OF THE McCURTAIN GAME PRESERVE, OKLAHOMA[1]

WILLIAM A. CARTER

This paper reports an ecological investigation of the nesting birds of a virgin woodland area. Field studies during the summer of 1961 and 1962 were conducted in the McCurtain Game Preserve near Bethel, in southeastern Oklahoma. The purpose of this paper is to describe the breeding bird populations of the major communities and to point to certain ecological relationships between these populations and their communities. Attention is directed to: (1) estimates of the breeding bird populations, (2) the type of habitats which these populations occupy for breeding and foraging territories, (3) and the community structure at the western fringe of the oak-pine forest.

This region is of particular interest since it represents a virgin forested area and is near the western limits of this formation. It is to be regretted that more detailed work has not been done in other biological fields within the river-bottom forests of the Preserve, as this association will soon be inundated by waters of the Broken Bow Reservoir. Construction of big dams, lumbering practices, and over-utilization by cattle and hogs in the river bottom areas of eastern Oklahoma are rapidly reducing the area of this biotic association and leaving the remainder unsuitable for many types of wildlife.

THE MCCURTAIN GAME PRESERVE

History of the Preserve.—The McCurtain Game Preserve includes 15,220 acres of mountainous land in north-central McCurtain County, Oklahoma. It is the only Oklahoma state-owned area of virgin oak-pine forest. According to P. R. Wheeler, director of the Southern Forest Experiment Station, New Orleans, Louisiana (in litt.) there is ". . . no comparable area of virgin timber in the Southeastern (Forest Service) Region." This, then, is a unique area for scientific research and one of high aesthetic value.

The Preserve was placed under the administration of the Oklahoma Game and Fish Department (now the Department of Wildlife Conservation) in 1927. Except for the boundary fence and maintenance roads, no cultural or management techniques were undertaken on the Preserve until 1950. During that year, a block of 40 acres was fenced in the central area of the Preserve to provide a holding pen for a turky restocking program. The Preserve has been protected from all forms of hunting and from fire, except for small burns, since 1926. Cattle penetrate the area from the surrounding open range when flooding or vandalism damages the fences, however, their numbers are small and they are promptly removed. No attempt is made to remove swine unless they become too numerous.

---

[1] Contribution No. 425 from the Department of Zoology, Oklahoma State University.

Predator control, which has been maintained in the Preserve on a limited basis, has been limited to trapping of bobcats, gray foxes, coyotes, and wolves (?). Dogs that may stray into the Preserve are caught and returned to their owners.

The U.S. Army Corps of Engineers began survey work in the virgin river-bottom areas of the Preserve for the Broken Bow Reservoir during the summer of 1963. The opening of the Broken Bow Reservoir for public recreation will have a marked effect on the remote Preserve. Inundation will destroy the most unique areas of the Preserve, the virgin river-bottom hardwood forest. Enforcement of trespassing and hunting regulations and wilderness protection for the remainder of the Preserve will be made difficult as improvement of roads leading to the lake area increase the number of visitors.

Description of the Preserve.—The Preserve lies in the southern portion of the Ouachita Uplift. The terrain varies from moderately rugged or rather steeply rolling, to precipitous. Characteristically it is composed of rough ridges. Elevations vary from 561 feet above sea level along the Mountain Fork of the Little River to 1,363 feet on Pine Mountain in the east central part of the Preserve. Drainage of the Preserve is part of the Mountain Fork River system.

The soil materials in the valleys consist of shales and fill material; the ridges are composed of sandstones, shales, and slate. Streams of high gradient are actively cutting the narrow flood plains. Bottomland soils are leached, poorly drained, and relatively infertile. There are small prairie openings and areas that support savannah on soils with a higher clay content. Much of the mountain area is rough, stony land, with some of the formations dipping 60 degrees or more from the horizontal. The exposed edges of the rocks enable tree roots to grow between the layers. This, together with the high precipitation, results in superior forest sites. By contrast, in areas where shallow soils are on horizontally bedded rocks, very poor forest sites result. Ridges of the White Oak and Little White Oak mountains fall into this classification. Shale bands across the mountain slopes produce open or savannah areas with increased grass ground-cover.

The Ouachita Mountains of Oklahoma were first studied geologically by Honess (1923) with more recent detailed work in Beavers Bend State Park (Pitt and Spradling, 1963) a few miles south of the Preserve. Surface or near surface rocks which influence the soil and vegetative associations within the Preserve include formations from the Ordovician period to the Recent geologic epoch. These include: (1) Alluvium Formation of the Recent characterized by recent stream deposits of sand, silt and clay; (2) Trinity Formation of the Cretaceous; (3) Stanley Shale Formation of the Mississipian; (4) Arkansas Novaculite Formation, of which the Upper Division is of the Mississippian period, the Middle Division between the Mississippian and Devonian periods, the Lower Division of the Devonian; (5) Missouri Mountain Shale Formation of the Silurian; (6) Blaylock Sandstone Formation of the Silurian; (7) Polk Creek Shale Formation of the Ordovician; and (8) Bigfork Chert Formation of the Ordovician. The Stanley Shale Formation is the most extensive formation in the Preserve.

The Preserve is located in the area of Oklahoma which receives the highest annual rainfall. Approximately 75 per cent of the rainfall occurs during the growing season. Records for a 10-year (1954–1963) average monthly rainfall are shown in Table 1. Extremes for the 10-year period show a high of 12.42 inches in October 1954 and a low of 0.31 inches in October 1963. Rivers and streams in the area may rise rapidly in response to heavy rainfall during short periods of time, but the run-off is rapid. The 10-year temperature records showed the highest monthly average maximum of 93 F in July and the lowest monthly average minimum of 28 F in January, as shown in Table 1. A 24-year record showed an average annual frost-free period of about 233 days with

TABLE 1
TEN-YEAR AVERAGE (1954–1963) OF CLIMATOLOGICAL DATA

	Precipitation totals	Average Monthly Temperature (°F)	
		Maximum	Minimum
January	2.80	51.48	27.78
February	2.99	57.31	33.19
March	3.96	63.55	38.03
April	4.36	74.02	49.26
May	5.35	81.60	57.75
June	3.08	87.46	64.06
July	4.88	92.66	68.59
August	4.33	92.45	67.17
September	4.29	86.28	60.78
October	4.38	76.13	51.07
November	3.48	63.43	38.10
December	3.36	54.66	32.56

the last killing frost usually occurring the third week in March, and the first killing frost in the fall occurring about the second week in November. Published records of the U.S. Department of Commerce (1954–63) were consulted for all climatic data.

The Austroriparian Biotic Province (Dice, 1943), characterized by subclimax pine forests within the eastern deciduous forests, is found within this major climatic area. The Preserve is located in the western limits of this Province. The vegetative units within the Preserve may be delimited according to the topographic and soil characteristics of the site. Lindzey, studying the deer in the Preserve (1950), recognized six game (habitat) types within the Preserve. The steep north slopes and the protected ravines are characterized by white oak (*Quercus alba*), red oak (*Quercus rubra*), and flowering dogwood (*Cornus florida*). The ridges are characterized by mature stands principally of short-leaf pine (*Pinus echinata*), but include post oak (*Quercus stellata*), white oak (*Quercus alba*), and blackjack oak (*Quercus marilandica*). The south slopes have essentially the same composition as the ridges. A large portion of the Preserve manifests an intermediate condition, with variable sites which show a composite of other upland areas. The virgin river bottom hardwood forests are dominated by holly (*Ilex opaca*), white oak (*Quercus alba*), sweetgum (*Liquidambar styraciflua*), hickory (*Carya* sp.), ash (*Fraxinus* sp.), and baldcypress (*Taxodium distichum*), with cane (*Arundinaria gigantea*), spicebush (*Lindera benzoin*), and some panic grasses (*Panicum* spp.), for ground cover. The stream bottom woodlands typically have a composition similar to that of the north slopes. It is of major importantce to recall that the avian habitats are essentially of the same life-form in all areas of the Ouachita Uplift. Outside of the Preserve, however, mature virgin stands are found in very limited areas.

METHODS

The present study is an attempt to obtain the absolute abundance or the actual avian breeding populations of sample areas and to project these figures for an estimate of the total breeding bird populations for the Preserve. As

TABLE 2
DOMINANTS AND CODOMINANTS OF THE RIVER BOTTOM FOREST*

Species	Frequency of occurrence (per cent)	Basal area (sq. ft.)	Basal area (per cent)
American holly (*Ilex opaca*)	34	12.4	19.7
White oak (*Quercus alba*)	19	11.7	18.5
Sweetgum (*Liquidambar styraciflua*)	9	13.2	20.9
Mockernut Hickory (*Carya tomentosa*)	8	3.7	5.9
Sourgum (*Nyssa sylvatica*)	5	6.1	9.6
Ash (*Fraxinus* sp.)	5	0.9	1.4
Baldcypress (*Taxodium distichum*)	4	6.8	10.8
Hornbeam (*Ostrya virginiana*)	3	–	–
Ironwood (*Carpinus caroliniana*)	3	0.6	0.9
Total		63.1	

* Plant nomenclature taken from Petrides, 1958.

this study was primarily concerned with obtaining the most dependable results possible, a combination of various census techniques was employed.

On the basis of field reconnaissance and a review of aerial photos and topographic maps, three areas were selected for intensive study. This selection was based on the following points: areas were (1) representative of the three major plant communities in the Preserve: (2) not disturbed by roads. fence lines, or other maintenance improvements of the Preserve: (3) of uniform life-form and were surrounded by identical community type in order to eliminate edge effect: and (4) of adequate size for uniform plots. The boundaries of these areas were marked. The size of each plot was determined by use of steel tape, compass, and aerial photographs. A sketch map of each plot was used each time an area was censused. These maps included any distinctive landmark which helped pinpoint the exact locality. Field data were noted on the maps to show approximate locations of singing males, active nest sites, young out of the nest, adults carrying food, family groups, or any other behavioral activities or signs that would indicate nesting. The areas were censused from 5 AM to about 8 AM. I found that the activity of singing males for most species had decreased by 7:30 AM to 8:30 AM to the point that counts were invalid. However, observations on other activities associated with breeding could be made after that time.

The belt transect sampling method (Weaver and Clements, 1929; Lutz, 1930) was used to determine species composition of trees and shrubs in the sample plots. The width of the transect lines was 20 meters for trees and two meters for shrubs. In the upland samples with a large area of uniform community type, the length of the transect line was increased until the percentage composition was not varied when the last segment was added. The river

TABLE 3
UNDERSTORY PLANTS OF THE RIVER BOTTOM FOREST*

Species	Frequency of occurrence (per cent)
Ironwood (*Carpinus caroliniana*)	16
Ward willow (*Salix caroliniana*)	14
Mockernut hickory (*Carya tomentosa*)	9
Hornbeam (*Ostrya virginiana*)	9
Buttonbush (*Cephalanthus occidentalis*)	6
Grape (*Vitis* sp.)	5
Flowering dogwood (*Cornus florida*)	3
Sweetgum (*Liquidambar styraciflua*)	2
Red oak (*Quercus rubra*)	2
Baldcypress (*Taxodium distichum*)	2

* d.b.h. less than 4″; 1 m high.

bottom and stream bottom plots were sampled by three transect lines running at right angles to the plots.

BIRD POPULATIONS AND THE PLANT COMMUNITIES

The avian habitats of the Preserve reflect the basic structure of the dominant vegetation, rather than the species composition of individual plant associations—a point well demonstrated by Pitelka (1941) for the North American bird fauna. Considering the distribution of local bird species, the predominant habitats, preferred for breeding activities, are upland forests, river bottom forests, and stream bottom woodland.

The river bottom community.—The study area of this habitat type included that portion of the river bottom east of the Mountain Fork River from the low-water bridge north to the Preserve fence. The 35-acre study area was located in Section 4, R25E, T3S. Elevation was 560 feet above sea level. One-half mile of edge occurs along the river. The closure of the forest crown cover of this community varies from 50 to 100 per cent. The frequency of occurrence and basal area of the dominant and codominant trees is given in Table 2. The frequency of occurrence of the common understory plants is given in Table 3. The ground cover is sparse, composed chiefly of: *Panicum* sp., *Smilax* spp., spicebush (*Lindera benzoin*), and cane (*Arundinaria gigantea*). A high percentage of the river bottom forest floor is open, bare ground, or covered with river drift materials.

The river bottom community is the most important one of the Preserve for the study of bird ecology as it supports the greatest total biomass. The floral and faunal composition make this a unique feature of the Preserve.

TABLE 4
NESTING BIRDS OF THE RIVER BOTTOM FORESTS

Species	Pairs/100 acres 1961	Pairs/100 acres 1962	Average	Projected estimate (200 acres)
Turkey Vulture	+	+		+
Wood Duck		1	1	1.0
Red-shouldered Hawk	1	1	1	2.0
Bobwhite	+			+
Turkey	+	+		+
Yellow-billed Cuckoo	5.7	5.7	5.7	11.4
Barred Owl	8.6	2.9	5.7	11.4
Chuck-will's-widow	8.6	2.9	5.7	11.4
Chimney Swift	+	+		+
Ruby-throated Hummingbird	2.9		2.9	5.8
Belted Kingfisher	+	+		+
Pileated Woodpecker	2.9	2.9	2.9	5.8
Red-bellied Woodpecker	5.7	5.7	5.7	11.4
Hairy Woodpecker	5.7	2.9	4.3	8.6
Downy Woodpecker	2.9	2.9	2.9	5.8
Great Crested Flycatcher	8.6	2.9	5.8	11.6
Acadian Flycatcher	14.3	11.4	12.9	25.8
Eastern Wood Pewee	5.7	5.7	5.7	11.4
Blue Jay	+	+		+
Common Crow	1	1	1	2.0
Carolina Chickadee	11.4	11.4	11.4	22.8
Tufted Titmouse	5.7	8.6	7.2	14.4
White-breasted Nuthatch	8.6	2.9	5.7	11.4
Carolina Wren	8.6	8.6	8.6	17.2
Wood Thrush	2.9	2.9	2.9	5.8
Blue-gray Gnatcatcher	11.4	2.9	7.2	14.4
White-eyed Vireo	25.7	17.1	21.4	42.8
Red-eyed Vireo	28.5	25.7	27.1	54.2
Black-and-white Warbler	8.6	8.6	8.6	17.2
Prothonotary Warbler	1	1	1	2.0
Swainson's Warbler	1	1	1	2.0
Worm-eating Warbler	3	2	2.5	5.0
Parula Warbler	8.6	11.4	10.0	20.0
Cerulean Warbler	2.9	2.9	2.9	5.8
Ovenbird	5.7	2.9	4.3	8.6
Louisiana Waterthrush	8.6	8.6	8.6	17.2
Kentucky Warbler	11.4	8.6	10.0	20.0
Yellow-breasted Chat	2	2	2	4.0
Hooded Warbler	14.3	17.1	15.7	31.4
American Redstart	20.0	14.3	17.2	34.4
Cardinal	8.6	5.7	7.2	14.4
Indigo Bunting	2.9	2.9	2.9	4.8
Totals (36 species, +6)	279	219	248	502

TABLE 5
DOMINANTS AND CODOMINANTS OF THE STREAM BOTTOM FOREST

Species	Frequency of occurrence (per cent)	Basal area (sq. ft.)	Basal area (per cent)
White oak (*Quercus alba*)	17	11.0	14.1
Shortleaf pine (*Pinus echinata*)	17	23.1	29.6
Mockernut hickory (*Carya tomentosa*)	16	11.4	14.6
Sweetgum (*Liquidambar styraciflua*)	14	13.0	16.7
Ironwood (*Carpinus caroliniana*)	7	2.7	3.4
Sourgum (*Nyssa sylvatica*)	6	4.9	6.3
Red oak (*Quercus rubra*)	4	2.8	3.6
Red maple (*Acer rubrum*)	4	1.2	1.6
Hornbeam (*Ostrya virginiana*)	4	0.7	0.9
Swamp oak (*Quercus bicolor*)	2	0.7	0.9
Pignut hickory (*Carya glabra*)	2	1.0	1.3
Winged elm (*Ulmus alata*)	2	1.5	1.9
Sycamore (*Platanus occidentalis*)	2	2.9	3.7
Red mulberry (*Morus rubra*)	2	1.0	1.3
Ash (*Fraxinus* sp.)	2	0.6	0.7
Red cedar (*Juniperus virginiana*)	1	0.5	0.6
Total		78.0	

Studies in various areas of this community other than the study area show remarkable uniformity in proportions of species. There is very little disparity between the counts made during the two summers. The estimates of species in the study area and the projected estimates for the 200 acres of this community are given in Table 4. A plus sign (+) is used to indicate species which nested outside the study area in this habitat and species frequently observed but not definitely known to breed in the habitat. The figures for the average number of pairs are derived from the populations in the study areas and augmented by data from observations in the same habitat but outside the study area.

The stream bottom community.—The stream bottom community study area consisted of a 32-acre plot along Panther Branch in Sections 4 and 5. R25E, T3S. The area averaged 130 yards wide with the stream bed in the center and the outer boundaries more or less paralleling the stream bed. Sufficient width was allowed between these outer boundaries and the slopes to avoid edge effect.

The closure of the forest cover ranged from 50 to 75 per cent and was generally uniform. The frequency of occurrence and basal area of the dominant and codominant trees is given in Table 5. The frequency of occurrence of the common understory plants is given in Table 6. This community

TABLE 6
UNDERSTORY PLANTS OF THE STREAM BOTTOM FOREST*

Species	Frequency of occurrence (per cent)
Ironwood (*Carpinus caroliniana*)	31
Red cedar (*Juniperus virginiana*)	16
Sweetgum (*Liquidambar styraciflua*)	11
Witch-hazel (*Hamamelis virginiana*)	10
Flowering dogwood (*Cornus florida*)	9
Hornbeam (*Ostrya virginiana*)	7
Red oak (*Quercus rubra*)	3
White oak (*Quercus alba*)	3
Shortleaf pine (*Pinus echinata*)	2
Sourgum (*Nyssa sylvatica*)	1
Mockernut hickory (*Carya tomentosa*)	1
Common spicebush (*Lindera benzoin*)	1
Winged elm (*Ulmus alata*)	1

* d.b.h. less than 4″; 1 m high.

had the best ground cover of the three major habitats of the Preserve. *Andropogon* spp. formed about 75 per cent of the non-woody ground cover. *Panicum* spp. and seedlings of the various woody species formed most of the remaining living ground cover. Heavy litter covered most of the space between plants so that very little bare ground was exposed.

The nesting bird populations showed a species composition intermediate between those of the moist river bottom and the drier uplands. No birds were restricted to this habitat. The estimate of species in the study area and the projected estimate for the 1,100 acres of this community in the Preserve are given in Table 7.

The upland community.—The upland Oak-Pine community study area was located in Sections 2 and 11, R25E, T3S. The 30-acre area was along the section line on the east side of the given sections. Crown closure of this area was from 70 to 100 per cent. The area is typical of the intermediate areas of the Preserve, that is, those with moderate slopes. Lindzey (1950) recognized four game types in the upland community. However, field observations showed no significant variations in the avian species distribution in these four types. Significant divergence of species composition did occur on White Oak and Little White Oak mountains, but the remoteness of these areas made it impossible to adequately sample the bird populations there. The frequency of occurrence and basal area of the dominant and codominant trees are given in Table 8. The frequency of occurrence of the common understory plants is given in Table 9. The ground cover varied

TABLE 7
NESTING BIRDS OF THE STREAM BOTTOM FORESTS

Species	Pairs/100 acres 1961	Pairs/100 acres 1962	Average	Projected estimate (1,100 acres)
Turkey Vulture	+	+		+
Broad-winged Hawk	3.1	+	1	11
Sparrow Hawk	+	3.1	1	11
Bobwhite	3.1	+	3.1	34
Yellow-billed Cuckoo	3.1	3.1	3.1	34
Screech Owl	3.1	+	1	11
Chuck-will's-widow	+	+		+
Chimney Swift	+	+		+
Ruby-throated Hummingbird	1		1	11
Pileated Woodpecker	1	1	1	11
Red-bellied Woodpecker		+		+
Hairy Woodpecker	3.1	3.1	3.1	34
Downy Woodpecker	3.1	3.1	3.1	34
Great Crested Flycatcher	3.1	3.1	3.1	34
Acadian Flycatcher	9.4	6.3	7.9	87
Eastern Wood Pewee	9.4	9.4	9.4	103
Blue Jay	6.3	3.1	4.7	52
Common Crow	+	+		+
Carolina Chickadee	12.5	9.4	10.5	116
Tufted Titmouse	3.1	6.3	4.7	52
White-breasted Nuthatch	6.3	6.3	6.3	69
Carolina Wren	9.4	9.4	9.4	103
Wood Thrush		+		+
Blue-gray Gnatcatcher	6.3	3.1	4.7	52
White-eyed Vireo	3.1	3.1	3.1	34
Red-eyed Vireo	18.8	18.8	18.8	207
Black-and-white Warbler	3.1	3.1	3.1	34
Parula Warbler	9.4	12.5	10.5	116
Pine Warbler	9.4	6.3	7.9	87
Ovenbird	3.1	3.1	3.1	34
Louisiana Waterthrush	3.1	6.3	4.7	52
Kentucky Warbler	3.1	+	3.1	34
Indigo Bunting	+	3.1	3.1	34
Totals (27 species, +6)	140	126	136	1,491

from sparse *Andropogon* in the more open areas to exclusively pine needle and leaf litter in areas with dense crown cover.

The virgin stands of mature short-leaf pine are the habitat of the Preserve's two most unique permanent avian residents, the Red-cockaded Woodpecker and the Brown-headed Nuthatch. Nice (1931) reported Red-cockaded Woodpeckers in 1925. This species was not recorded from the state again until

TABLE 8
DOMINANTS AND CODOMINANTS OF THE UPLAND FORESTS

Species	Frequency of occurrence (per cent)	Basal area (sq. ft.)	Basal area (per cent)
Shortleaf pine (*Pinus echinata*)	81	69.6	87.0
White oak (*Quercus alba*)	10	2.9	3.6
Post oak (*Quercus stellata*)	7	6.6	8.4
Blackjack oak (*Quercus marilandica*)	2	0.2	0.25
Total		79.3	

1954 (Baumgartner, 1954). The Red-cockaded Woodpeckers were limited in distribution in the Preserve to areas with stands of large mature pine—d.b.h. 15 inches or more. Nest trees which I was able to locate averaged 17 inches d.b.h. Their habit of scaling the bark from the living pine for two feet above and below the entrance of the nest cavity and of puncturing a series of small holes to allow the pine pitch to ooze to the surface allows the nests to be located easily. The only nesting record for Oklahoma outside of the Preserve was reported in Robber's Cave State Park near Wilburton in 1961 (Baumgartner, 1961). The Brown-headed Nuthatch was observed in Pushmataha County in 1920 (Nice, 1921) and was not recorded in Oklahoma again until 1953 (Baumgartner, 1954). Tom Jessee, then the Preserve manager, reported this species nesting in a fence post on the Preserve on 11 March 1954 with young noted in late April. Other species found in the upland habitat are considered typical for the region. The estimates of species in the study area and the projected estimate for the 12,000 acres of this community type are given in Table 10.

DISCUSSION

Eleven species were nesting only in the river bottom habitat within the Preserve. No species were found using the stream bottom habitat exclusively for nesting. However, seven species were limited to the stream bottom and the river bottom—the more moist habitats within the Preserve. A total of eighteen species were limited to the two riparian woodland formations within the Preserve—the river bottom and the stream bottom communities. Of these eighteen species, seven are approaching their western limits of distribution (AOU, 1957). The Wood Duck, Prothonotary Warbler, Louisiana Waterthrush, Swainson's Warbler, and Cerulean Warbler are typical nesting species of the riparian habitats over their entire breeding ranges. The Ovenbird and the Worm-eating Warbler are typical woodland nesting forms over most of their range and are restricted to the riparian woodlands only in the

TABLE 9
UNDERSTORY PLANTS OF THE UPLAND FORESTS*

Species	Frequency of occurrence (per cent)
Mockernut hickory (*Carya tomentosa*)	29
Post oak (*Quercus stellata*)	20
Blackjack oak (*Quercus marilandica*)	14
Flowering dogwood (*Cornus florida*)	14
White oak (*Quercus alba*)	6
Shortleaf pine (*Pinus echinata*)	3
Common spicebush (*Lindera benzoin*)	2
Red oak (*Quercus rubra*)	2

* d.b.h. less than 4″; 1 m high.

southwestern limits of their nesting distribution (AOU, 1957). Four species were limited to the stream bottom and upland forests for their nesting activities within the Preserve. The intermediate character of the stream bottom communities was therefore emphasized by the nesting distribution pattern which showed an overlap of species from both the river bottom and the upland forests, as well as a mixed floral composition. The upland habitat was utilized by seven species exclusively for their nesting activities. Twenty-three species utilized all three of the major habitats in the Preserve for nesting activities. This pointed out the fact that a woodland habitat—regardless of its composition—was the only requirement for certain species with less specialized nesting niches. It was also noted that some of these species reached greater densities in one habitat than in the other.

Nine species were considered to be rare within the Preserve. The following reasons are suggested to explain the limited occurrence of these nine species: The Wood Duck and Prothonotary Warbler populations were limited due to the lack of proper nesting cavities in trees along the river; the minimal numbers of Red-shouldered Hawks are attributed to their large territorial requirements and the limited area of suitable river bottom habitat; the Roadrunner, having recently invaded this region (Lowery, 1955), is reaching its eastern limits of distribution (AOU, 1957); the Red-cockaded Woodpecker, being intimately associated with mature stands of pines, is limited by their distribution; the Brown-headed Nuthatch, Prothonotary Warbler. Swainson's Warbler, Worm-eating Warbler, and Cerulean Warbler are approaching the western limits of their nesting range (Griscom and Sprunt. 1957); and the Turkey populations, once extirpated from this area, have been reintroduced.

TABLE 10
NESTING BIRDS OF THE UPLAND FORESTS

Species	Pairs/100 acres 1961	Pairs/100 acres 1962	Average	Projected estimate (12,000 acres)
Turkey Vulture	+	+		+
Sparrow Hawk	1	1	1	20
Bobwhite		+		+
Turkey	+	+		+
Yellow-billed Cuckoo	6.6	6.6	6.6	792
Roadrunner	+	+		4
Screech Owl	+	+		+
Chuck-will's-widow		+		+
Chimney Swift	+	+		+
Yellow-shafted Flicker		+		+
Red-bellied Woodpecker	3.3	3.3	3.3	396
Red-headed Woodpecker	6.6	6.6	6.6	792
Hairy Woodpecker	3.3	+	3.3	396
Downy Woodpecker	+	3.3	3.3	396
Red-cockaded Woodpecker	+	+		7–10
Great Crested Flycatcher	6.6	6.6	6.6	792
Eastern Wood Pewee	9.9	9.9	9.9	1,188
Blue Jay	3.3	6.6	5.0	600
Common Crow	+	+		+
Carolina Chickadee	6.6	6.6	6.6	792
Tufted Titmouse	6.6	6.6	6.6	792
White-breasted Nuthatch	9.9	6.6	8.3	996
Brown-headed Nuthatch	+	+		+
Carolina Wren	3.3	6.6	5.0	600
Wood Thrush	+	6.6	6.6	792
Blue-gray Gnatcatcher	3.3	6.6	5.0	600
Red-eyed Vireo	9.9	19.9	14.5	1,740
Black-and-white Warbler	3.3	+	3.3	396
Parula Warbler	+	+		+
Yellow-throated Warbler	+	+		+
Pine Warbler	9.9	13.2	11.5	1,380
Prairie Warbler	+			+
Ovenbird	3.3	3.3	3.3	396
Scarlet Tanager	3.3	3.3	3.3	396
Summer Tanager	3.3	6.6	5.0	600
Indigo Bunting	3.3	+	3.3	396
Chipping Sparrow	+	+		+
Total (35 species, +2)	107	130	128	15,262

The densities of a few species within the Preserve were lower than those outside of the Preserve. Among these, personal observations indicated that the Chipping Sparrow, Bobwhite, Cardinal, Blue Jay, and Common Crow were more tolerant of the open areas created by the activities of man. Although common outside, the Mourning Dove, House Sparrow, Orchard Oriole, Brown-headed Cowbird, Eastern Bluebird, and Starling were found only in limited numbers in the small disturbed areas around the manager's home and barns. These species were never recorded in any other part of the Preserve. The population of ground nesting species was suppressed by the destruction of the ground cover, nests, and young by the activities of swine.

SUMMARY

Field studies of the nesting birds of the McCurtain Game Preserve, McCurtain County, Oklahoma, were conducted during the summers of 1961 and 1962 in the months of June, July, and early August. Intensive studies were made in three areas representative of the major habitats of the Preserve. Data derived from these study areas were augmented by less intensive surveys within each of the habitats at various locations over the Preserve.

The river bottom community supported the highest population of nesting birds (248 pairs per 100 acres) and the greatest number of species (36, plus six others possible). Eleven species utilized the river bottom habitat exclusively for nesting activities. The stream bottom community supported 136 pairs per 100 acres with 27 species (plus six others possible). The upland community supported 128 pairs per 100 acres with 35 species (plus two others possible). The total projected breeding bird population for the 13,300 acre virgin woodlands of the Preserve was 17,255 pairs composed of 56 species. Two of these species, the Red-cockaded Woodpecker and the Brown-headed Nuthatch are limited to the mature virgin pine areas of the Preserve in Oklahoma. The activities of swine suppress the population of ground nesting birds in the Preserve. The unique attributes of the virgin hardwood forest of the river bottom will be destroyed by waters of the Broken Bow Reservior now under construction. Steps should be taken to assure adequate protection for the remaining virgin woodland areas of the Preserve.

ACKNOWLEDGMENTS

Appreciation is expressed to my major adviser, Dr. F. M. Baumgartner, who has freely given his time and counsel during the course of this research project. The results reported here represent part of a dissertation submitted in partial fulfillment of the requirements for the Ph.D. at Oklahoma State University. I wish to thank the administration of the Oklahoma Department of Wildlife Conservation for permission to carry out the field study and use the facilities in the Preserve. Special thanks are due Mr. Eugene Woods, Preserve manager, and Mr. Glen Scott, former assistant, and their families for cooperation and courtesies extended during my stay in the Preserve. I am indebted to Drs. G. A. Moore and H. W. Reno for reading early drafts of the manuscript.

LITERATURE CITED

American Ornithologist's Union
1957 Check-list of North American birds. 5th Ed. Baltimore, Maryland.

BAUMGARTNER, F. M.
1954 Southern Great Plains Region. *Audubon Field Notes*, 8:260.
1961 Southern Great Plains Region. *Audubon Field Notes*, 15:478.
DICE, L. R.
1943 The biotic provinces of North America. Univ. of Michigan Press, Ann Arbor.
GRISCOM, L., AND A. SPRUNT, JR.
1957 The warblers of America. Devin-Adair Co., New York.
HONESS, C. W.
1923 Geology of the Southern Ouachita Mountains of Oklahoma. Okla. Geological Survey, Bull. 32, Parts I and II.
LINDZEY, J. S.
1950 The white-tailed deer in Oklahoma. Okla. Game and Fish Dept., Oklahoma City.
LOWERY, G. H., JR.
1955 Louisiana birds. Louisiana State University Press, Baton Rouge, Louisiana.
LUTZ, H. J.
1930 The vegetation of Heart's Content, a virgin forest in northwestern Pennsylvania. *Ecology*, 11:1–29.
NICE, M. M.
1921 The Brown-headed Nuthatch in Oklahoma. *Condor*, 23:131.
1931 The birds of Oklahoma. Rev. ed. Univ. of Oklahoma Biol. Survey 3:1–224.
PETRIDES, G. A.
1958 A field guide to trees and shrubs. Houghton Mifflin Co., Boston.
PITELKA, F. A.
1941 Distribution of birds in relation to major biotic communities. *Amer. Midland Nat.*, 25:113–137.
PITT, W. D., AND C. B. SPRADLING
1963 Geology of Beavers Bend State Park. *In* Beavers Bend State Park. Okla. Geological Survey Guide Book XI.
U.S. DEPT. OF COMMERCE
1954–1963 Climatological Data. Oklahoma Sections. U.S. Gov't. Printing Office, Washington, D.C.
WEAVER, J. E., AND F. E. CLEMENTS
1929 Plant ecology. McGraw-Hill, New York.

DEPARTMENT OF BIOLOGY, EAST CENTRAL STATE COLLEGE, ADA, OKLAHOMA, 7 FEBRUARY 1966.

OBSERVATIONS ON BIRD DISTRIBUTION AND FEEDING ASSEMBLAGES ALONG THE RIO CALLARIA, DEPARTMENT OF LORETO, PERU

JARED M. DIAMOND AND JOHN W. TERBORGH

THIS paper presents a summary of bird observations made in late July and early August, 1963, along the Rio Callaria, a small tributary of the Ucayali in the Department of Loreto, Peru. The Rio Callaria flows westward from the Brazilian border region to its confluence with the Ucayali at approximately 8°8′S and 74°38′W. From this point we travelled by dugout canoe some 20–30 miles upstream and returned. Observations of birds were made from the river and its banks and on excursions into the flanking forests. The relative abundance of 88 species in each of three distinct vegetational zones is given along with incidental notes and a description of two mixed assemblages of birds observed in feeding trees.

ECOLOGICAL ZONATION OF BIRDLIFE

So far as we were able to ascertain, the terrain in the vicinity of the Callaria had suffered relatively little from the effects of human incursion. Three small Indian villages with their adjacent plantations of bananas and yucca occupied high sections of the bank, thus creating small enclaves of secondary habitat. In addition we were informed by a missionary, who had lived a number of years in one of these villages, that some selective logging for "cedar" had taken place in the forests upstream during periods of high water. As "cedar" trees occur uncommonly and singly, the effects of this logging were not apparent. Thus the observations reported here, to a close approximation, should reflect the status of birdlife in an undisturbed primary region.

The distinctive feature of the Callaria is that natural habitats replace one another in a succession as one passes upstream. Thus, within a relatively short distance we had the opportunity to relate changes in bird distribution to an evident ecological zonation along the river.

In the course of its lower 20 miles, the Callaria flows through three distinct vegetational zones. The first of these is a low-lying flood-plain or matorral formation (MacBride, 1936) which extends upstream from the mouth for about 3 miles. The river runs nearly straight here and at the time of our visit was confined to a shallow channel about 100 feet in width. There was no forest within sight of the river in this stretch, the vegetation along its banks consisting of a dense growth of rangy bushes and tall grass.

The second, middle zone, a transitional region, extends for 5–8 miles above the flood-plain. Along this section the river becomes gradually narrower.

turns more frequently, and flows between progressively steeper banks as one proceeds upstream. Concommitantly, the character of the vegetation changes from that of the lower reaches to the high overhanging canopied forest typical of the upper river. In most of this transitional section the forest does not impinge on the banks but lies back somewhat. A bordering strip, up to 50 yards in width, of tall grass and/or dense shrubbery and bushes fills the intervening area.

In the third zone, further upstream, the forest closes in on the banks of the river, the channel becomes reduced to a width of 40–70 feet, and the stream flows rapidly. The overhanging trees are sufficiently tall to shade the water for much of the day. Numerous fallen trunks lying in the channel provide perches for hawks, kingfishers, swallows, and flycatchers.

By early August the dry season in eastern Peru is well advanced. Consequently, during our visit the river's flow was near the minimum for the year. Extensive sandy banks were exposed along most of its course, and in the lower section particularly there were many bars and shoals in mid-stream. During the rainy season, which extends from November to May, the Ucayali and its tributaries fill with water, the annual fluctuation in river level approaching forty feet in many places. Although we were told that there had been no rain for more than two months, the vegetation, except for a few species of deciduous trees, showed few signs of desiccation either close to the river or on higher ground. The high humidity, heavy dew each night, and low evaporation from the shaded forest floor are probably all important in maintaining the verdant aspects of this region throughout the dry season.

Table 1 summarizes our observations on the distribution of birds in the three vegetational zones. The relative abundance in each zone is given for 88 species of birds. Nomenclature follows that of de Schauensee (1966). Species that were regularly seen in pairs are denoted by a "p" in parentheses after the name. The only positive evidence of breeding activity that we obtained was a nest burrow containing a single white egg attributed to *Monasa nigrifrons* by our Indian guides.

A summary of the zonal distribution of the 88 species is presented in Table 2. The species in each zone have been classified according to whether they occurred in all three zones, in two, or only in the zone in question. Those found in all three must occupy niches that all three zones share in common, for example, the air space over the river.

The data in Table 2 suggest the following statements regarding the environmental factors controlling bird distribution on the Rio Callaria.

(1) The avifauna of the lower zone is by far the poorest in species but nevertheless is distinct to a high degree. Apart from the 11 wide-ranging forms (two storks, one vulture, one kingfisher, one puffbird, two flycatchers,

Table 1

List of Bird Species Observed along the Rio Callaria.

(The relative abundance of each species in the three vegetational zones is indicated as follows: +, 1–3 observations; ++, 4–10 observations; +++, more than 10 observations)

	Zone		
	Lower	Middle	Upper
Ardeidae			
Pilherodius pileatus		+	
Butorides striatus	++		
Casmerodius albus		+	
Tigrisoma sp. (p)			+
Ciconiidae			
Mycteria americana	+	+	+
Jabiru mycteria	+	++	++
Threskiornithidae			
Mesembrinibis cayennensis			+
Anhimidae			
Anhima cornuta (p)		+++	++
Cathartidae			
Sarcorhamphus papa			+
Coragyps atratus	+++	+++	+++
Cathartes aura		++	++
Cathartes melambrotus			+
Accipitridae			
Elanoides forficatus			+
Buteo magnirostris (p)		+++	+++
Buteogallus urubitinga	+		
Busarellus nigricollis	++	++	
Falconidae			
Daptrius ater (p)		++	++
Daptrius americanus (p)			+
Milvago chimachima		++	
Falco rufigularis (p)			+
Cracidae			
Ortalis guttata		++	++
Rallidae			
Aramides cajanea		+	
Eurypygidae			
Eurypyga helias (p)		+	+
Jacanidae			
Jacana jacana	++	+	
Charadriidae			
Charadrius collaris	+		
Scolopacidae			
Tringa flavipes	++		

TABLE 1 (*cont.*)

	Zone		
	Lower	Middle	Upper
Tringa solitaria			+
Actitis macularia			+
Laridae			
Phaetusa simplex	++		
Sterna superciliaris	+		
Columbidae			
Columbigallina talpacoti	+		
Psittacidae			
Ara ararauna (p)			+
Brotogeris versicolorus		+++	+++
Amazona sp.		+++	+++
Cuculidae			
Piaya cayana		++	++
Crotophaga major (p)	++	++	
Crotophaga ani	+++	+++	
Strigidae			
Otus choliba		+	
Caprimulgidae			
Nyctidromus albicollis		+++	+
Trogonidae			
Trogon viridis			+
Trogon collaris		++	++
Alcedinidae			
Ceryle torquata	+++	+++	
Chloroceryle amazona	++	+++	++
Chloroceryle americana (p)		+	++
Momotidae			
Momotus momota		+	
Galbulidae			
Galbalcyrhynchus leucotis		++	+
Galbula cyanescens		++	++
Bucconidae			
Monasa nigrifrons		++	+
Chelidoptera tenebrosa (p)	+	+++	+++
Capitonidae			
Eubucco richardsoni			+
Ramphastidae			
Ramphastos tucanus		++	+++
Pteroglossus castanotis		++	+++
Pteroglossus inscriptus			+
Picidae			
Melanerpes cruentatus		++	
Phloeoceastes melanoleucos			+

TABLE 1 (*cont.*)

	Zone		
	Lower	Middle	Upper
Dendrocolaptidae			
Xiphorhynchus sp.		+	++
Furnariidae			
Furnarius leucopus		++	+++
Formicariidae			
Pygiptila stellaris		+	
Cotingidae			
Cotinga sp.			+
Tityra sp.		+	
Tyrannidae			
Colonia colonus			+
Arundinicola leucocephala	++		
Pyrocephalus rubinus	++	+++	+++
Ochthornis littoralis		++	+++
Tyrannus melanocholicus (p)	+++	++	
Pitangus sulphuratus (p)	++	+++	+++
Hirundinidae			
Tachycineta albiventer	+++	+++	+++
Atticora fasciata	++	++	++
Stelgidopteryx ruficollis	+++	++	+
Corvidae			
Cyanocorax violaceus			++
Troglodytidae			
Thryothorus coraya		+++	++
Mimidae			
Donacobius atricapillus (p)		+++	++
Coerebidae			
Coereba flaveola		+	
Dacnis cayana			+
Dacnis lineata			+
Thraupidae			
Chlorophonia cyanea		+	+
Tanagra laniirostris			+
Tangara chilensis			++
Ramphocelus carbo	++	++	+
Cissopis leveriana			+
Icteridae			
Psarocolius sp.		++	++
Cacicus cela		++	
Icterus icterus		+	
Agelaius icterocephalus	++		
Fringillidae			
Saltator coerulescens		+	
Paroaria gularis (p)		+++	+++

TABLE 1 (*cont.*)

	Zone Lower	 Middle	 Upper
Sporophila castaneiventris		++	
Myospiza aurifrons		+	
Total	26	57	58
Combined Total		88	

three swallows, and one tanager) whose distribution was largely independent of the character of the vegetation, the lower zone was found to share relative few species with the middle zone and none at all with the upper zone.

It was apparent moreover that the waters of the lower Callaria are ecologically distinct from those of the nearby Ucayali. The most striking evidence for this distinction was provided by the distribution of the river cormorant, *Phalacrocorax olivaceus*, which occurred on the Ucayali in flocks of thousands but was altogether absent from the Callaria. Three other common species of the Ucayali, *Casmerodius alba*, *Phaetusa simplex*, and *Sterna superciliaris*, appeared on the Callaria only in the immediate vicinity of its mouth, and there in sparing numbers.

(2) As could be expected, the middle zone is faunistically the least distinct of the three. It showed the lowest proportion of characteristic species (26 per cent). Thus our impression that the middle zone is a region of vegetational transition between the flood plain scrub habitat and the upstream forests is confirmed by the distribution of bird species in the three regions.

It will be noted in Table 1 that the middle zone was the only one in which all three species of kingfishers were found. *Ceryle torquata, Chloroceryle amazona*, and *C. americana* form a graduated series from large to small, respectively. The distribution of the three species was closely correlated with the width and swiftness of flow of the Callaria. *Ceryle torquata* was the most abundant form along the lower section, while *Chloroceryle amazona* was more common in the middle zone where the river is narrower and faster. The smallest kingfisher, *Chloroceryle americana*, was infrequent in the middle zone but was found with *C. amazona* in equal numbers on the sheltered and rapidly flowing water of the upper zone.

(3) The upper zone, though sharing 43 per cent of its avifauna with the middle zone, nevertheless had the highest proportion (38 per cent) of characteristic species. Thus, as a natural habitat the forest can be shown to offer more opportunities for ecological specialization than the habitats in the two downstream zones. In fact, apart from the wide-ranging species found over the river the fauna of the upper zone appears to be entirely distinct from that of the lower zone.

TABLE 2
ZONAL DISTRIBUTION OF BIRD SPECIES ON THE RIO CALLARIA.

Zonal distribution of species	Lower zone		Middle zone		Upper zone	
	No. of species	Per cent of total	No. of species	Per cent of total	No. of species	Per cent of total
Observed in all zones	11	42	11	19	11	19
Only in upper and middle	—	—	25	44	25	43
Only in middle and lower	6	23	6	11	—	—
Only in upper and lower	0	0	—	—	0	0
Only in one zone	9	35	15	26	22	38
Total	26	100	57	100	58	100

(4) It is evident that overall species diversity is promoted to a much greater extent by the more complex multi-storied vegetational structure of the upper and transitional zones than by the flood-plain scrub of the lower zone.

(5) The fact that the three zones shared in common only 11 species of birds suggests that ecological specialization may have played a major role in the development of the strikingly rich neotropical avifauna.

Our list of 88 bird species undoubtedly represents no more than 30 per cent of the total number that occur in the vicinity of the Rio Callaria. However, our observation time was fairly evenly divided among the three zones, and there are no outstanding reasons for supposing that any of the faunal samples we obtained are not representative. Thus it seems safe to assume that a more thorough-going study would only strengthen our conclusions, though at the quantitative level alteration of the results would be expected.

FEEDING ASSEMBLAGES

While on the Callaria we located two fruiting trees in which large and heterogeneous groups of birds had assembled for the purpose of feeding. The birds using each of these trees were observed for several periods of 1–2 hours. The first tree (see Table 3 for list of bird species observed in it) was located about 100 yards from the Rio Callaria in second growth near an Indian village and bore many brown plum-sized fruits. The second tree (see Table 4 for species list) overhung the Rio Callaria from the edge of tall upper-zone forest, and was heavily laden with orange cherry-sized fruits. A striking fact evident from the tables is that these two feeding trees contained no species in common. The first tree (Table 3) had a broad crown about 40 feet high and stood in dense second growth in the transitional zone near an Indian village. A much taller primary forest was less than 100 yards away. however. The second tree (Table 4) was located on the river bank in the primary forest upstream and was more than twice as tall as the first.

TABLE 3
LIST OF BIRDS OBSERVED IN FIRST FRUITING TREE.

Brotogeris versicolorus
Piaya cayana
Galbalcyrhynchus leucotis
Melanerpes cruentatus
Dendrocolaptidae sp.
Tityra sp.
Coereba flaveola
Psarocolius sp.
Cacicus cela
Icterus icterus
Sporophila castaneiventris

A second fact apparent from the tables is the large number of families represented in both feeding assemblages. The 11 species found in the first tree represent nine families, while the 17 from the second tree include 10 families. Similarly, Land (1963) recorded members of 11 families of birds taking fruit from a tree in Guatemala. The association of diverse species possessing a wide variety of sizes and bill shapes in feeding trees suggests extensive niche overlap among carpophagous birds in the neotropical forests. It is evident that birds so conspicuously different from one another as chachalacas, parrots, toucans, and honeycreepers at least occasionally utilize the same food sources. Though tropical species are usually assumed to be more specialized and less versatile than their counterparts in higher latitudes (Klopfer, 1962; Margalef, 1963), the congregation of large numbers of disparate species at ephemeral food sources suggests that many of them may have rather flexible feeding habits.

In observing the second tree (Table 4), we noticed that the individuals of certain species were distributed in a non-random fashion. Trogons (*Trogon collaris* and *T. viridis*) kept to the lower branches, while the toucan, *Ramphastos tucanus*, the honeycreeper, *Dacnis cayana*, and the tanager, *Tangara chilensis*, were seen only in the upper branches. Other species, e.g., the chachalaca, *Ortalis guttata*, and the *Pteroglossus* toucans, appeared to feed indiscriminately in the lower, middle, and upper branches of the crown. As MacArthur (1958) has so carefully shown for 5 species of *Dendroica* warblers in a Maine spruce forest, interspecific competition for food is greatly reduced in species having pronounced preferences for different locations in the canopy.

In general, birds arrived at and left both fruiting trees as individuals or else as groups of several individuals belonging to one species. The majority of species was seen to come and go in this manner. Although the species composition of these assemblages changed gradually with time, the total number of birds in a given tree did not vary by more than a factor of two during the observation periods. The largest movements were the arrivals and departures of small groups of parrots or toucans. Thus the congregation

TABLE 4
LIST OF BIRDS OBSERVED IN SECOND FRUITING TREE.

Ortalis guttata
Amazona sp.
Trogon collaris
Trogon viridis
Capito sp.
Ramphastos tucanus
Pteroglossus castanotis
Pteroglossus inscriptus
Phloeoceastes melanoleucos
Cotinga maynana
Cotinga cayana
Cyanocorax violaceus
Dacnis lineata
Dacnis cayana
Tangara chilensis
Ramphocelus carbo
Cissopis leveriana

of birds that are attracted to fruit trees for feeding cannot be regarded as flocks in that they do not appear to have any social or temporal integrity. Rather, they may be considered as transient and more or less chance assemblages of small flocks of several species plus scattered individuals of others. Socially organized itinerant feeding flocks of the kind extensively described by Davis (1946), Short (1961), and Moynihan (1962) are of widespread and common occurrence in neotropical forests. Such true flocks differ from feeding assemblages in the following respects. (1) They are characterized by interspecific social interactions rather than by the lack of them. (2) They retain their integrity as social units while progressing through the forest. Feeding assemblages of necessity are stationary. (3) Members of a feeding flock pursue a variety of food sources, both plant and animal, while in a feeding assemblage all individuals are consuming the same food.

It can be expected that members of feeding flocks may temporarily join feeding assemblages and that birds initially in feeding assemblages in turn may leave to join feeding flocks. Such exchanges could have taken place in the second feeding tree during our observations, as birds of the genera *Dacnis* and *Tangara* are known (Moynihan, 1962) to join feeding flocks.

SUMMARY

1. The distribution of birdlife along a 20–30 mile section of the Rio Callaria (Department of Loreto, Peru) has been tabulated with reference to three conspicuously distinct ecological zones, through which one passes in succession when travelling upstream from the mouth. They are characterized by differences in the width and rate of flow of the stream and by the principal features of the vegetation on the banks. The ecological character of the zones has been analyzed by considering the proportions of the fauna of each which occurred in only that zone and in the two other zones. The degree of faunal distinctness and the pattern of faunal overlap with other zones was different for each zone. As expected, greater species diversity was found in the zones of greater vegetational complexity.

2. Two fruiting trees which were being used for feeding by representatives of nine and ten bird families, respectively, have been described. The significance of the high diversity of bird species using these feeding trees has been discussed. Accompanying behavioral observations have been considered in relation to the problem of interspecific competition. Assemblages of birds using such feeding trees have been operationally distinguished, on the basis of three behavioral criteria, from the itinerant feeding flocks, so prevalent in neotropical forests, that recently have received much attention from other authors.

ACKNOWLEDGMENT

We are greatly indebted to Dr. Maria Koepcke of the Museo de Historia Natural in Lima for aid in identifying from our field notes many of the species listed in this report and to Dr. R. A. Paynter, Jr. for comments on the manuscript. The identifications of all species cited here have been checked against specimens in the Museo de Historia Natural in Lima, the Museum of Comparative Zoology of Harvard University, and the American Museum of Natural History.

LITERATURE CITED

Davis, D. E.
1946 A seasonal analysis of mixed flocks of birds in Brazil. *Ecology*, 27:168–181.
de Schauensee, R. M.
1966 The species of birds of South America and their distribution. Acad. Nat. Sci., Philadelphia, Pennsylvania.
Klopfer, P. H.
1962 Behavioral aspects of ecology. Prentice-Hall, Inc., Englewood Cliffs, N. J.
Land, H. C.
1963 A tropical feeding tree. *Wilson Bull.*, 75:199–200.
MacArthur, R. H.
1958 Population ecology of some warblers of northeastern coniferous forests. *Ecology*, 39:599–619.
MacBride, J. F.
1936 Flora of Peru. *Publ. Field Mus. Nat. Hist., Bot. Ser.*, 13, Part I, No. 1.
Margalef, R.
1963 On certain unifying principles in ecology. *Amer. Nat.*, 97:357–374.
Moynihan, M.
1962 The organization and probable evolution of some mixed species flocks of neotropical birds. *Smithsonian Misc. Publ.*, 143:1–140.
Short, L. L., Jr.
1961 Interspecies flocking of birds of montane forest in Oaxaca, Mexico. *Wilson Bull.*, 73:341–347.

DEPARTMENT OF PHYSIOLOGY, UNIVERSITY OF CALIFORNIA MEDICAL CENTER, LOS ANGELES, CALIFORNIA (J.M.D.), AND DEPARTMENT OF BOTANY, UNIVERSITY OF MARYLAND, COLLEGE PARK, MARYLAND (J.W.T.), 13 JUNE 1966.

REPRODUCTIVE SUCCESS OF RED-WINGED BLACKBIRDS IN NORTH CENTRAL OKLAHOMA

Stephen V. Goddard and Veryl V. Board

The general upward trend in the number of Red-winged Blackbirds (*Agelaius phoeniceus*) nesting in Oklahoma can probably be attributed to the large number of farm ponds, flood detention, and flood control dams which have beeen constructed in the last 23 years. During this period an estimated 161,000 farm ponds, flood detention, and flood control dams have been built in Oklahoma, and an additional 1,500 are being constructed every year (Anon, 1963). Presently, there are more than 4,500 farm ponds and flood control structures in the two north-central counties (Payne and Noble) selected for this study. Many of these do not have good redwing nesting habitat. However, ponds with good growths of cattails (*Typha* sp.) have high densities of nesting birds.

The major objectives of this study were to examine the phenology of redwing nesting and to determine their reproductive success in these new habitat situations. The effect on reproductive success of early versus late nesting, type of nesting cover, height of the nest above the surface of the ground or water, and water depth below the nest were considered.

METHODS AND GENERAL DESCRIPTION OF AREAS

Observations were conducted throughout the breeding season on ten study areas selected on eight ponds and two lakes. Only the larger nesting colonies were studied on the two lakes (Boomer and Yost).

Nests were numbered using a "Sanford's Marker Compact." The number was written on two or three stems or limbs supporting the nest. Blue was found to be the best color and remained readily visible for two or three weeks, at which time the nest could be re-marked, if necessary.

Initially, the following data were recorded: date, area, general weather conditions, time, number of redwings and nests in the area, and type of nesting vegetation. The height of the nest above the surface and the water depth were measured. The number of eggs and/or young were noted when present, and the ages of the nestlings were recorded. The nestlings were aged by the criteria used by Allen (1914). The subsequent history of each nest was recorded during a series of visits.

The number of active nests, those which contained at least one egg and which subsequent observations indicated were not abandoned, was used to determine the number of females using an area. This was necessary because usually fewer females than active nests were observed around a pond. Occasionally, more females were observed than there were active nests and in these cases, the actual number of females observed was used as a measure of the female population size.

The study areas varied in size from 0.25 to 7.3 acres (Table 1). The cattails growing around the borders of the ponds varied in stand density and area of coverage. All of

TABLE 1
SIZE, CATTAIL NESTING COVER, AND TERRITORIAL MALES

Area	Area (acres)	Cattails (acres)	Average number territorial males
Pond 9	0.60	0.03	3
Pond 30	0.60	0.08	2
Pond 51	0.25	0.12	2
Pond 52	1.00	0.90	7
Pond 53	0.40	0.10	5
Pond 63	0.50	0.08	4
Pond 64	0.30	0.15	5
Pond 66	0.25	0.25	3
Boomer Lake	4.50	1.00	9
Yost Lake	7.30	1.65	10
Total	15.70	4.36	50

the ponds, except Pond 53, had tall perches available on or adjacent to the pond. Male redwings used the tallest cattails and nearby fence posts for song perches in this area.

RESULTS

The average amount of cattails available per male varied from 0.01 acres (435 square feet) on Pond 9, which had the smallest amount of nesting cover, to 0.165 acres per male (7,187 square feet) on Yost Lake, which had the largest block of nesting cover (Table 1).

A few males already had established territories when the observations were first initiated on 8 April. Their number reached a peak during early May and then slowly declined. One male was still on territory on 29 July. However, it was not in the area on 31 July when observations were terminated.

The nesting cycle sequence continues with the arrival of the resident females and pairing behavior. Nero (1956) reported that the first female arrived at a nesting colony on a marsh in Wisconsin on 8 April. He also indicated that pair formation begins or actually occurs when a female enters a male's territory. Meanley and Webb (1963) stated "females usually move into territories and begin pairing after April 1 in Maryland." By the middle of April in New York, most of the females were paired (Case and Hewitt, 1963). Small flocks of female redwings were observed at various times on the study areas throughout April, which indicated that all females were not paired. There were four known pairs on the study areas by 17 April.

The tendency of male redwings to pair with more than one female has been reported by many authors: Wright (1907), Allen (1914), Linsdale (1938), Nero (1956), Case and Hewitt (1963), and Meanley and Webb (1963). Similarly, redwings were found to be polygynous in this study.

TABLE 2
NUMBER OF NESTS, ACTIVE NESTS, EGGS LAID, CLUTCH SIZE, EGGS HATCHED, YOUNG FLEDGED, AND PER CENT SUCCESSFUL NESTS FOR THE TEN STUDY AREAS

Area	Number of nests	Active nests	Eggs laid	Clutch size	Eggs hatched	Young fledged	Per cent successful nests
Pond 9	9	9	28	3.1	8	5	22.2
Pond 30	8	7	23	3.3	1	0	0.0
Pond 51	13	7	25	3.6	10	6	28.6
Pond 52	79	61	207	3.4	71	29	14.8
Pond 53	47	44	153	3.5	68	50	38.6
Pond 63	29	26	92	3.6	42	22	26.9
Pond 64	30	29	105	3.6	69	50	58.6
Pond 66	6	5	19	3.8	14	7	60.0
Boomer Lake	23	15	45	3.0	4	4	6.7
Yost Lake	62	40	124	3.1	42	23	17.5
Total	306	243	821	3.4	329	196	26.7

There were only 0.68 females per male early in the nesting season. This ratio increased to 1.95 by the peak period of nesting, which was in the third week of May. The sex ratio declined homewhat during the next three weeks and then increased to 2.19 during early July, when several females were renesting or attempting to raise a second brood. The average sex ratio for the period from 16 April to the end of July was 1.57 females per male.

The first nest, which contained two eggs, was located on 22 April. This coincides with the findings of Allen (1914) and Meanley and Webb (1963). Beer and Tibbits (1950) recorded their earliest nests on 25 April and 1 May in their two-year study in Wisconsin.

Some females built several nests before starting a clutch. This is illustrated by the fact that although 306 nests were fully completed and lined, only 243 of them were known to have been actively used by the female (Table 2). Early in the breeding season, female redwings appeared to be intolerant of disturbance and readily abandoned their nests. The rate of desertion was low (1.2 per cent) once the female had initiated a clutch or if nestlings were present.

Redwings were persistent renesters. Some females on ponds with high predator populations initiated nest after nest only to have them broken up. Generally, females will build a new nest when renesting or attempting a second brood. However, there were five instances where a female laid eggs in a nest in which the original clutch had been destroyed. This was observed early in the nesting season and only occurred once on any pond. No nest was used more than twice. Only one of the five nests mentioned above was successful.

TABLE 3
COMPARISON OF NUMBER, CLUTCH SIZE, YOUNG FLEDGED, AND NESTING SUCCESS BETWEEN EARLY AND LATE NESTS

Time of nesting	Active nests	Clutch size	Young fledged	Successful nests	Per cent successful nests
Before June 1	155	3.6	135	45	29.0
After June 1	88	3.2	61	20	22.7

There were 821 eggs laid in the active nests for an average clutch size of 3.4. The range was from one to five eggs with four being the most common number.

Allen (1914) reported that incubation began after the third egg and usually 11 days were required for the eggs to hatch. Using this information, incubation time determined during the present study varied from 10–13 days.

Three hundred and twenty-nine of the 821 eggs hatched, giving a hatching success of 38.9 per cent. One hundred and ninety-six young were fledged or 23.9 per cent of the total eggs resulted in fledged young. The results of many studies, Perkins (1928), Wood (1928), Wood (1938), Smith (1943), Beer and Tibbits (1950), and Williams (1960) have indicated that young were fledged from 48 per cent or more of the eggs.

Nesting success is another measure of reproductive success. A successful nest was one that fledged one or more young. Young fledged from 65 of the 243 active nests, which gave a nesting success of 26.7 per cent. This success was considerably lower than the 42 per cent reported by Wood

TABLE 4
NESTING SUCCESS IN RELATION TO KIND OF COVER

Nesting cover	Active nests Number	Active nests Per cent	Nesting success
Old Cattails (*Typha*)	52	21.4	38.5
Old and new Cattails	83	34.2	19.3
New Cattails	89	36.6	29.2
Willows (*Salix*)	10	4.1	10.0
Dogwood (*Cornus*)	2	0.8	0.0
Buckbrush (*Symphoricarpus*)	2	0.8	50.0
Bulrush (*Scirpus*)	2	0.8	50.0
Lead Plant (*Amorpha*)	2	0.8	0.0
Buttonbush (*Cephalanthus*)	1	0.4	0.0
Total	243	99.9	26.7

TABLE 5
NESTING SUCCESS IN RELATION TO NEST HEIGHT ABOVE SURFACE OF GROUND OR WATER

Nest height (inches)	Active nests		Nesting success
	Number	Per cent	
0–12	34	14.0	38.2
13–24	125	51.4	27.2
25–36	53	21.8	22.6
Over 36	31	12.8	19.4
Total	243	100.0	26.7

(1938) and the 57 per cent obtained by Meanley and Webb (1963). However, Young (1963), in a two-year study in Wisconsin, obtained a nesting success of 35 and 24 per cent for 1959 and 1960 respectively.

The major losses of eggs and nestlings were due to egg and young removal. probably as a result of nest predation in most cases. and to nests tipping over and the eggs or young falling out. Of 243 active nests. eggs were removed from 105, young from 25; 36 nests containing eggs and eight nests containing young were destroyed when the vegetation or wind tipped the nest. Three nests were abandoned and one was lost to flooding.

Similarly, Smith (1943) and Beer and Tibbitts (1950) obtained results indicating that there was a greater loss of eggs than of nestlings. However. Peterson and Young (1950) for Common Grackles (*Quiscalus quiscula*), and Young (1963) for Red-winged and Yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) found that losses of nestlings exceeded those of eggs.

In Oklahoma, early nests tended to be more successful than nests started after 1 June (late nests). This date was used as a separation criterion because it fell at the end of the first nesting period and before the initiation of most renesting. On nine of the ten ponds, early nests were more successful. The one exception, Pond 64, had a nesting success of 50 per cent for early nests compared to 85.7 per cent for late nests. Overall nesting success for early nests was 29.0 per cent compared to 22.7 per cent for late nests (Table

TABLE 6
NESTING SUCCESS IN RELATION TO WATER DEPTH

Water depth (inches)	Active nests		Nesting success
	Number	Per cent	
0–10	155	63.8	23.2
11–20	65	26.7	29.2
Over 20	23	9.5	43.5
Total	243	100.0	26.7

3). Nesting success among the study areas varied from zero to 62.5 per cent for early nests and from zero to 85.7 per cent for late nests. For the entire nesting season, nesting success varied among areas from zero to 60 per cent.

The average clutch size was larger for early nests (3.6 eggs) than for late nests (3.2 eggs). There were 0.87 young fledged per early nest compared to 0.69 young per nest for the later nests, another indication that early nests tended to be more productive.

The number of nests found in each type of nesting cover is presented in Table 4. The percentage of the total nests and active nests was independent of the type of supporting vegetation. For vegetation types containing at least 10 nests, nesting success was highest (38.5 per cent) in old cattails. This higher nesting success may have been due to old cattails being virtually the only nesting cover available early in the nesting season when nesting efforts were more successful.

A summary of the nest height above the surface of each pond is presented in Table 5. The highest nesting success (38.2 per cent) occurred among nests in lower situations. Nesting success decreased as the height of the nest increased. This decrease may be attributed to a majority of the nests' being constructed in cattails: the higher the nest the greater became the possibility of its tipping over and losing the contents.

The number of nests constructed above each of the three water depth categories is presented in Table 6. Nesting success increased directly with the depth of the water.

SUMMARY

During the 1965 breeding season the reproductive success of Red-winged Blackbirds was studied on eight ponds and two small lakes located in two north-central Oklahoma counties.

A few males were already on territory when observations were initiated on 8 April. Density of males on the study areas generally varied inversely with the size of the cattail nesting cover.

Four females were known to be paired by 17 April. The nesting peak occurred during the third week of May. Cattails furnished sites for over 90 per cent of the nests.

Generally, redwings built a new nest when they attempted to renest. However, on five occasions, a nest was used for two nesting attempts. This occurred early in the nesting season and only once on any pond.

Eight hundred and twenty-one eggs were laid in 243 active nests for an average clutch size of 3.4. Hatching success was 38.9 and young were fledged from 24 per cent of the eggs. Sixty-five nests fledged one or more young, giving a nesting success of 26.7 per cent.

Egg or young removal and nests tipping over were the major reasons for nest failure. Egg loss exceeded mortality of the young. The high nest densities in a limited area would make it possible for a single factor to destroy a large number of nests.

Nesting success was higher for nests initiated prior to 1 June. Average clutch size

was greater in early nests. Nests in old cattails were more successful. Over 50 per cent of the nests were constructed less than two feet above the ground or water. Nesting success was higher for nests in lower situations and decreased as nest height increased.

Approximately two-thirds of the nests were constructed above ground or above water that was less than 10 inches deep. Nesting success was greater as the depth of the water below the nest increased.

LITERATURE CITED

Allen, A. A.

1914 The Red-winged Blackbird: A study in the ecology of a cat-tail marsh. *Proc. Linnean Soc. New York*, 24–25:43–128.

Anonymous

1963 This is Oklahoma. *Daily Oklahoman*, p. 1–24. 20 October.

Beer, J. R., and D. Tibbitts

1950 Nesting behavior of the Red-winged Blackbird. *Flicker*, 22:61–77.

Case, N. A., and O. H. Hewitt

1963 Nesting and productivity of the Red-winged Blackbird in relation to habitat. *Living Bird*, 2:7–20.

Linsdale, J. M.

1938 Environmental responses of vertebrates in the Great Basin. *Amer. Midland Nat.*, 19:1–206.

Meanley, B., and J. S. Webb

1963 Nesting ecology and reproductive rate of the Red-winged Blackbird in tidal marshes of the upper Chesapeake Bay region. *Chesapeake Sci.*, 4:90–100.

Nero, R. W.

1956 A behavior study of the Red-winged Blackbird. I. Mating and nesting activities. *Wilson Bull.*, 68:4–37.

Perkins, S. E., III

1928 City park nests of Red-winged Blackbirds. *Bird Lore*, 30:393–394.

Peterson, A., and H. Young

1950 A nesting study of the Bronzed Grackle. *Auk*, 67:466–476.

Smith, H. M.

1943 Size of breeding populations in relation to egglaying and reproductive success in the eastern red-wing. (*Agelaius phoeniceus*). *Ecology*, 24:183–207.

Williams, J. F.

1940 The sex ratio in nestling eastern red-wings. *Wilson Bull.*, 52:267–277.

Wood, H. B.

1938 Nesting of Red-winged Blackbirds. *Wilson Bull.*, 50:143–144.

Wood, M.

1928 Mortality of young Red-winged Blackbirds. *Bird Lore*, 30:262.

Wright, M. O.

1907 The Red-winged Blackbird. *Bird Lore*, 9:93–96.

Young, H.

1963 Age-specific mortality in the eggs and nestlings of blackbirds. *Auk*, 80: 145–155.

DEPARTMENT OF ZOOLOGY, OKLAHOMA STATE UNIVERSITY, STILLWATER, OKLAHOMA. (PRESENT ADDRESSES: DEPARTMENT OF BIOLOGY, WISCONSIN STATE UNIVERSITY, RIVER FALLS, WIS., AND DEPARTMENT OF BIOLOGY, ARKANSAS COLLEGE, BATESVILLE, ARK.), 7 MARCH 1966.

BEHAVIORAL STEREOTYPY IN BIRDS

PETER H. KLOPFER

It has previously been argued that the climatic stability provided by the tropics allows animals to specialize to an extent not possible where climatic conditions and the sources of food and other necessities change seasonally, if not daily (see Klopfer, 1962 for bibliography). This permits the coexistence of more species than would be true in a population of "jacks-of-all-trades," and partially explains the greater faunal diversity of the tropics as compared with temperate zones.

I have sought to put this notion to an experimental test by comparing the degree of behavioral stereotypy (which is, in effect, a measure of niche size: the larger the niche the less stereotyped the animal) in selected representatives from the temperate and tropical avifaunas. The demonstration of stereotypy, of course, does not necessarily prove that constancy of available sources of energy explains species diversity. Greater stereotypy in tropical forms would provide collateral evidence for the constancy-diversity relationship, however.

Specifically, I have sought to measure degrees of stereotypy in foliage preference and motor pattern of individuals of several species of birds. (The ultimate aim, it should be added, is to include several dozen species, representing many families, in this survey, and to include measures other than foliage preferences and movement patterns.)

Regarding the relevance of measures of foliage preference, consider the work of MacArthur, MacArthur, and Preer (1963) who studied early seral stages in North America. They predicted the bird species diversity as well as the actual species which would be present in a given area from measurements of diversity in foliage height density. They showed that each bird species occurred in habitats with a characteristic proportion of foliage in each of three arbitrarily designated layers. These preferences can reasonably be assumed to be based upon either leaf number, leaf size, or leaf shape, or some correlate of these variables, since they alone determine foliage density. Thus, the work of MacArthur, et al. justifies the use of leaf shape and size as the principal discriminanda in studying perceptual preferences. Of course, there are bird species for whom some other and very particular element of the environment such as an unique nest site or particular food will be more important than the characteristics of the foliage density. In most instances these exceptions can be noted. Nor does the importance of foliage characteristics mean that other components of the environment are irrelevant. However, we can at least assert that foliage characters are an important factor in habitat selection.

Other factors than constancy of energy source may influence the degree of stereotypy. Most conspicuous among these is the role of competition, e.g., the number of potentially competing species. On islands or other geographically or topographically isolated areas the species diversity may be well below that of comparable areas of large continental land-masses (see MacArthur, 1965). In the absence of competitors, the ecology of many species is known to change (Crowell, in press, and see van Valen, 1965) generally in the direction of increased plasticity (van Valen, 1965). This increased plasticity may have two different manifestations: each individual of the species concerned may become more plastic, i.e., do more different things, or, the individuals may remain as stereotyped as ever, but with different individuals specializing for different ways of life, or a combination. This would represent decreased specific (as opposed to individual) stereotypy, and might well be regarded as a first stage in the formation of subspecies.

It is as interesting to assess the interaction between degree of isolation (or competition) and climatic stability as to study the latter alone. Thus, our design calls for comparisons between insular and continental birds of the tropics and temperate regions, as diagrammed below:

	Islands	vs	Continents
temperate	Bermuda		Eastern U.S.
vs			
tropical	West Indies		Panama

DEFINITIONS AND METHODS

"Behavioral stereotypy" refers both to perceptual and motor stereotypy. On the perceptual side, the stereotypy involves a sensitivity to, or an awareness of, or preference for, a limited range of a larger complex of stimuli. An animal that responds only to a narrow band of wavelengths, for instance, would be considered perceptually more stereotyped than one responding to a wider band. On the motor side, stereotypy refers to the availability of only a small variety of movements by means of which an animal can accomplish a given act. It reflects an inability to adjust movements in accordance with changes in the form of the substrate. In either instance, the constraints may be peripheral (in terms of muscle attachments or shapes, or sensory filters), or due to central nervous mechanisms. While it is of interest to study the nature of the constraints and to determine whether they differ systematically, this is not considered here.

To measure stereotypy in preferences for particular types of foliage the birds were tested in rooms divided by netting into two chambers, alike except for the foliage with which they were decorated. This foliage was made of a green plastic and consisted of one of 4 kinds of "leaves" that differed

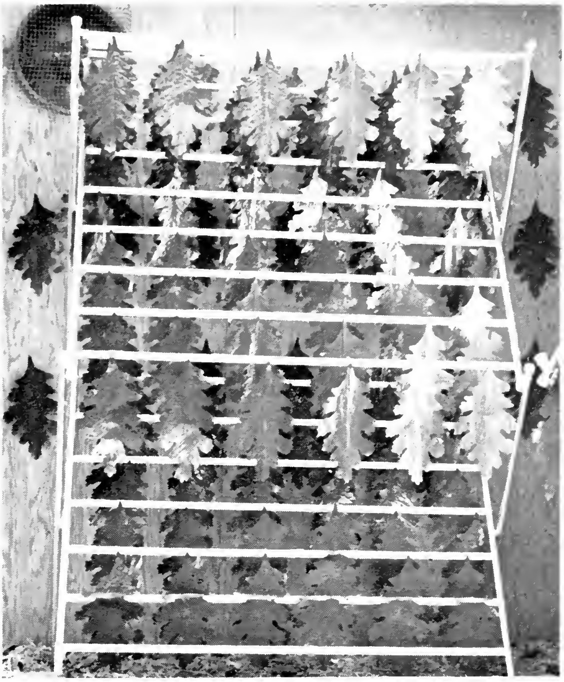


FIG. 1. Photograph of artificial leaves.

in size or shape or density (a large and small "Oak" and "Elm" type) (Fig. 1). Movement of the bird from one chamber to the other, and thus the time spent in each chamber, was monitored by a series of photo-cells in the sole connecting passage between the two chambers, which also served as a feeding place. The three test rooms averaged 3 by 3 by 4 meters. Details of the procedure and controls for position preferences have previously been published (Klopfer, 1965).

The four foliage types employed were offered in all possible pairs, though because of escapes or mortality, every bird was not tested with every pair. For each pair of foliage types, the portion of time spent amidst one or the other was calculated and converted to a discrimination index, $\overline{H}$. The rationale for the use of the index has been summarized as follows (Klopfer, 1965): the more stereotyped the preferences of an organism, the more marked will be its preferences among an array of discriminanda. If the discriminanda are paired, a non-stereotyped or plastic individual should select each member of each pair, 50 per cent of that time. A highly stereotyped individual will tend to select one member of many pairs to the exclusion of the other. The greater the stereotypy the higher the proportion of pairs

TABLE 1

Species	Rearing conditions	H of individual birds (H values are means for tests with 4 pairs of foliage; $\bar{H}$ are the means of the individual H values)	
Panamanian tanagers	Hand-reared:		
(*Thraupis cana*,	without sight of foliage	0.06, 0.08, 0.09, 0.14, 0.28	($\bar{H} = 0.13$)
and *Ramphocelus*	Hand-reared:		
dimidiatus)	with pine needles	0.08, 0.12, 0.28, 0.31	($\bar{H} = 0.20$)
	Wild-trapped:	0.16, 0.17, 0.19, 0.19, 0.20	
		0.20, 0.21, 0.25, 0.25, 0.28	($\bar{H} = 0.24$)
		0.30, 0.32, 0.36	
Dominican Bananaquits			
(*Coereba flaveola*)	Wild-trapped:	0.12, 0.12, 0.18, 0.21, 0.27, 0.31	($\bar{H} = 0.20$)

for which the choice should deviate from 50 per cent. The stereotypy index, H, represents the proportion of choices that deviates from 50 per cent. Of course, if a bird selects its habitat using one clue only, for instance light intensity, it would in fact be stereotyped but not so labelled on the basis of tests with irrelevant discriminanda. Thus far, the extremes of $\bar{H}$ values recorded have been 0 and 0.8 (see below).

Motor stereotypy was assessed in two different ways. First, by slow motion analysis of movie film of foraging movements of birds in their natural habitat, taken at varying times throughout the day. Secondly, by observation of the movements of captive birds on artificial "trees." These "trees," ca. 2 m high and varying from ca. ⅔ m to 2 m in diameter from top to bottom, were constructed of 0.5 cm steel reinforcement rods so as to allow the bird to fly in either a radial, vertical, or horizontal direction without hindrance. (By radial flight is meant flight along a branch, by vertical movement, across branches and in the vertical plane, and similarly, across the horizontal plane for horizontal or oblique flight.) Thus, the environmental constraints upon certain kinds of flight that are posed, for instance, by the thick horizontal strata of foliage or an absence of horizontal branches on some large cacti, were eliminated. The degree of motor plasticity of the subjects could be assessed (even though arbitrarily) under conditions where all three components of the normal flight directions of birds were equally possible. A stereotyped individual, then, would be one which failed to adapt its pattern of flight to this relative absence of physical constraints. Scoring was achieved by simply calculating the proportion of time spent flying in one or other of these planes.

The laboratory and some of the field data were obtained from three tropical species, Blue and Crimson-backed tanagers (*Thraupis cana* and *Rampho-*

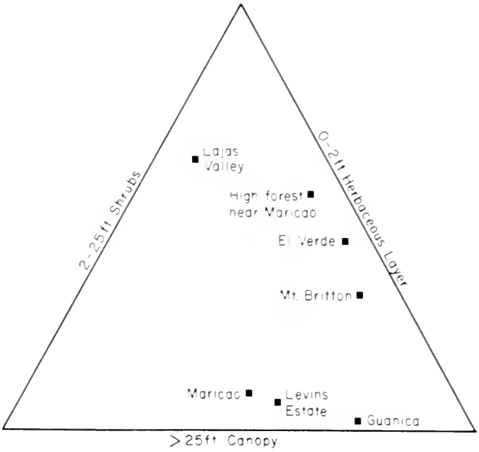


FIG. 2. Habitats in Puerto Rico in which Bananaquits are among the three most common species (after MacArthur).

celus dimidiatus), and the Bananaquit (*Coereba flaveola*). Some of these birds were wild-trapped as adults, others were hand-reared, either without sight of foliage or with a particular kind of foliage. (Comparable data have been previously published for groups of hand-reared and wild-trapped Chipping Sparrows (*Spizella passerina*) and others, Klopfer, 1962, 1965.) The Bermuda field data are taken from the work of Crowell (1962) on the feeding and behavior of Cardinals (*Richmondena cardinalis*) and Catbirds (*Dumetella carolinensis*) and vireos (*Vireo griseus*).

The inadequacy of the sampling and our frequent inability to apply statistical measures of significance, will be apparent. It is the result of the excessive amount of time required for hand-rearing birds from an early age to maturity. The justification for presenting such incomplete data lies (1) in the importance of the general problem and (2) in the desire that this approach may become known to and explored by others.

DATA AND CONCLUSIONS

Perceptual preferences of tropical mainland (Panama) species.—The data of Table 1 suggest that these tropical birds are not innately stereotyped. If reared for the first 8 weeks of life in a particular type of foliage they become more stereotyped. Wild-trapped adults are yet more stereotyped. Of the hand-reared birds, only three out of nine of the tanagers showed scores overlapping with those of any of the 13 wild-trapped tanagers. Most of the hand-reared birds had scores very much below those of the wild birds (i.e., they were less discriminating in their foliage choices).

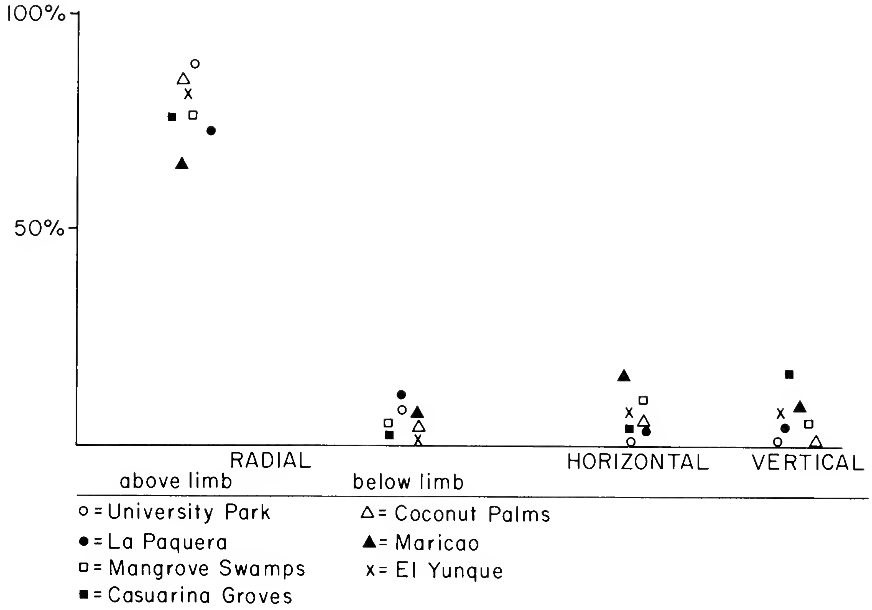


FIG. 3. Movement stereotypy of Puerto Rican Bananaquits.

Perceptual preferences of tropical island (West Indies) species.—Figure 2 indicates the character of the habitats of Puerto Rico in which Bananaquits are among the three commonest birds (the data for this figure were generously provided by R. H. MacArthur). From the variety of habitats in which they occur, it will be apparent that, if Bananaquits can in any way be considered "stereotyped," this is not manifested by their restricting themselves to any particular plant formation. Is it possible that they are responding to some feature common to all of the habitats in which they are found, and lacking in those habitats where Bananaquits do not occur? Table 1, which provides the data from foliage preference experiments with Dominican, wild-trapped Bananaquits (on Dominica, Bananaquits are also found at all altitudes and in most habitats, as on Puerto Rico) shows a rather low discrimination index (ranging from 0.12 to 0.31). Particular leaf shapes or sizes are apparently no more rigidly preferred than is the case with the relatively "plastic" hand-reared isolates of the other species tested, whether from tropical or temperate zones. In an experiment where the choice was between two different *densities* of the same foliage (artificial bamboo), a similarly low index obtained (0, 0.03, 0.14, 0.30, and 0.38), indicating that leaf density, per se, was not by itself important for three out of the five birds. Another experiment in which the Bananaquits could choose

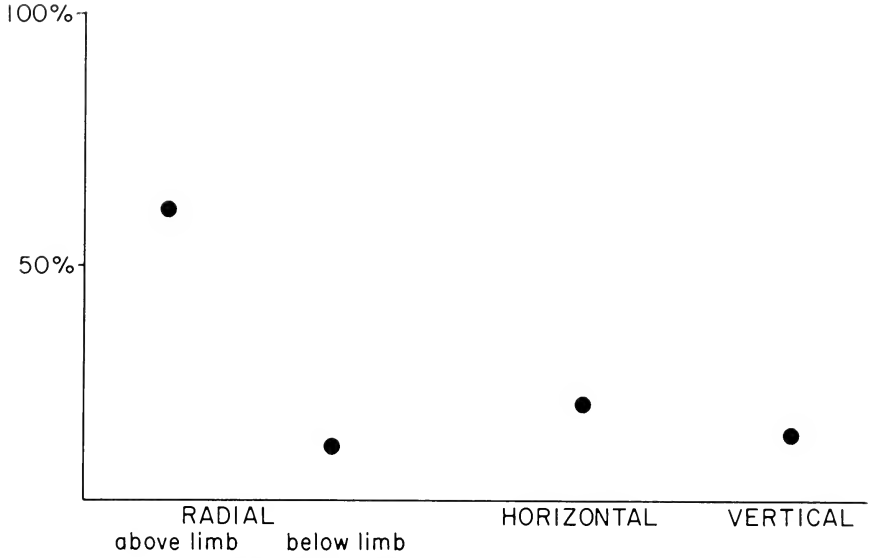


FIG. 4. Movement stereotypy of Panamanian Bananaquits.

between articial bamboo and squares of cardboard. arranged so as to afford a similar range of light intensities and "hiding places" yielded scores of 0.06. 0.08. 0.16. 0.71. 0.71. and 0.80. Thus. for half of the individuals. the presence of leaves was clearly important (scores of 0.71. 0.71. and 0.80) though strong preferences for any given configuration were. as indicated earlier. not evident. Comparable data for Bananaquits from the mainland are not available. though we should note our impression that. in Panama. Bananaquits are far less ubiquitous than they are in the West Indies. In Panama they appear to be restricted to the forest edge and home gardens. MacArthur (1965) has also suggested this in pointing to the increased "between-habitat" differences on the mainland as compared with nearby islands.

Motor patterns of tropical mainland and island species.—Figures 3 and 4 indicate variations in motor patterns of the Puerto Rican and Panamanian Bananaquits. Despite the variety of habitats in which the former is found. the similarity in its patterning of movements within all these habitats is striking. The timing of movements. however. is less stereotyped. as is seen in Figures 5 and 6. in which are graphed the duration of feeding bouts in different habitats. (By "feeding bout" is meant the period from one flight to the next. during which period feeding occurs more or less continuously.)

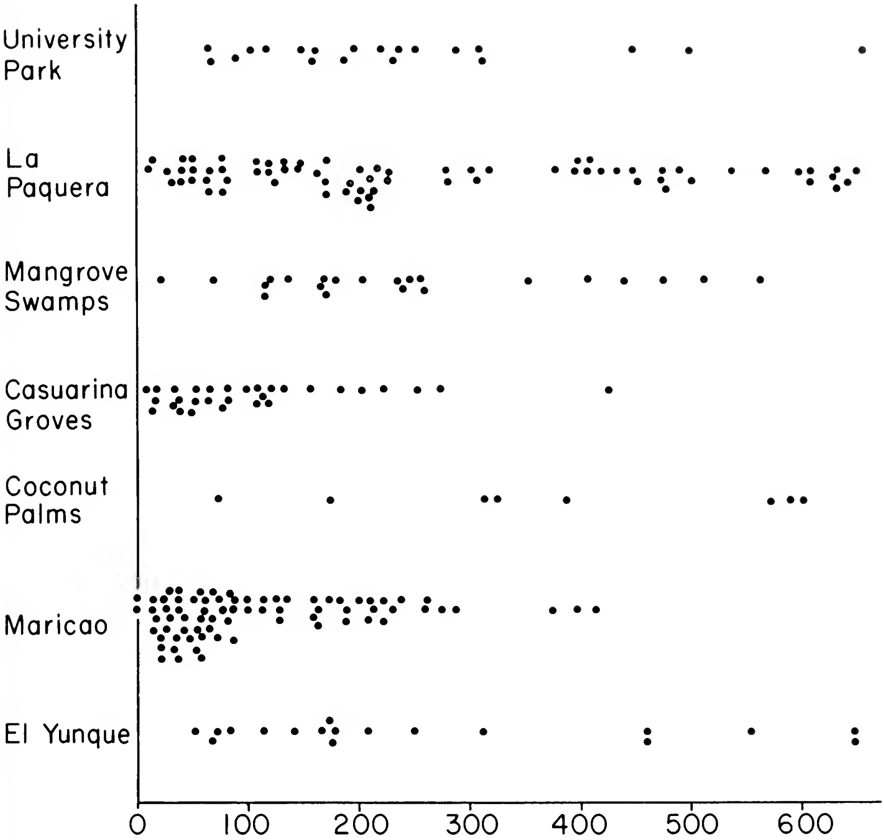


FIG. 5. Duration of feeding bouts of Puerto Rican Bananaquits.

There are some significant inter-habitat variations in this measure (specifically, Maricao vs. La Paguera, Median test, Tate and Clelland, 1957), presumably reflecting differences in the kind and amount of food available. Thus, these birds do make certain adjustments to the nature of their habitat. The data for the mainland Bananaquit show a basically similarity to Bananaquits at Maricao, P. R., both with regard to movements and duration of feeding bouts. The Maricao habitat appears, at least superficially, the most similar of any of those on Puerto Rico to the Bananaquit habitat in Panama.

On the artificial trees, neither wild-trapped Bananaquits (Dominica) or Blue Tanagers (Panama) adhered to the pattern of movements characteristic in nature. Radial movements were virtually nonexistent: Bananaquits' movements were principally in the horizontal plane (68 per cent); those of the tanagers almost evenly divided between horizontal and vertical (54–46 per

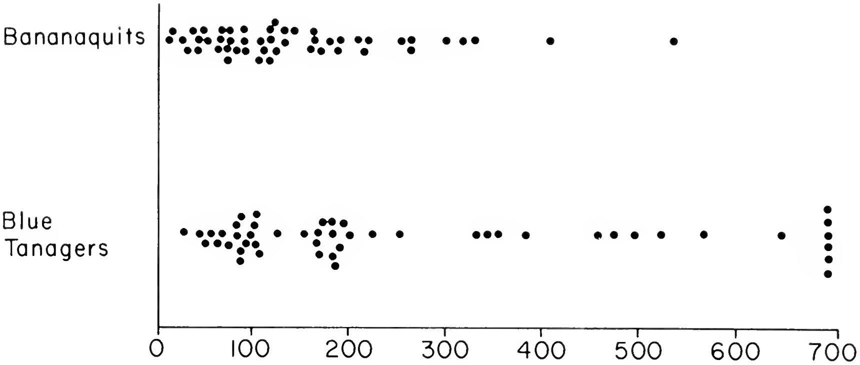


FIG. 6. Duration of feeding bouts of Panamanian birds.

cent). This does not support the notion that these birds are incapable of modifying the pattern of their movements.

Motor patterns of temperate mainland and island species.—Figure 7, taken from Crowell, illustrates in a somewhat different manner, the feeding methods of three species of passerines common both to the eastern U.S. and the island of Bermuda. The differences between island and mainland populations were significant (Chi square, $P < 0.001$). Mainland Cardinals and Catbirds showed a greater diversity of feeding methods than did their island counterparts; the reverse was true for the vireo. It is not yet known whether the increased feeding diversity reflects changes in the behavior of single individuals or different degrees of polymorphism (more strictly, polyethism) in the population as a whole. Since Crowell's mainland observations were not limited to a small area, this is a point that must be examined.

DISCUSSION

It is premature to interpret these results as either favoring or invalidating our hypothesis concerning the causes of tropical diversity. Samples including far more individuals and species will first be needed to fill gaps in the experimental design. However, a number of interesting, if tentative, conclusions can be drawn from these data.

To begin with, given a situation in which the number of potentially competing species is reduced, as occurs on islands with an impoverished fauna, at least one tropical species (specifically, the Bananaquit) apparently has no difficulty expanding into habitats in which, on adjacent mainland, it does not occur. By "habitat" we mean morphologically defined (generally in terms of foliage-height diversity) plant assemblages. On continental land masses such assemblages have particular bird species associated with them

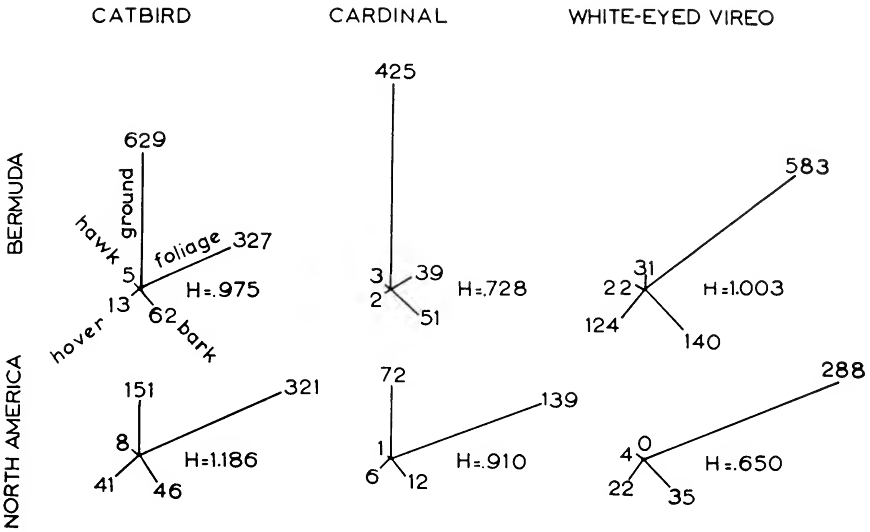


FIG. 7. Crowell's (1962) comparison of the feeding methods (pecking off ground, foliage-gleaning, bark-gleaning, feeding while hovering, hawking) of Catbirds, Cardinals, and White-eyed Vireos in North America and on Bermuda. The numbers show the frequency of the feeding method as observed at 10-second intervals; H is the measure of diversity in feeding methods.

(MacArthur, pers. comm. and 1965). Either these island birds show less selectivity in their choice of habitat or else the features of different habitats relevant to them are not associated with foliage-height diversity, as on the mainland. The data here presented (and those of Crowell, 1962 and MacArthur, 1965) suggest the former to be more likely. Thus, while as a consequence of early learning experiences, tropical birds may in fact prove more "stereotyped" in their actual behavior than temperate zone species (Klopfer, 1965), the responses of these same tropical birds on islands indicates they have a tremendous capacity for "plasticity." That this is a true ontogenetic plasticity is evident from the catholicity shown by the hand-reared birds. Thus, it would appear that while tropical species on tropical mainlands are in fact "stereotyped," this is more likely an effect rather than a cause of their greater diversity.

SUMMARY

The foliage preferences of hand-reared tropical birds are relatively broad. Exposure to a particular type of foliage narrows these preferences. Previous experiments (Klopfer, 1965) had shown that certain temperate zone birds had narrower preferences whether wild-trapped or hand-reared.

The motor patterns of tropical species were shown capable of considerable modification.

ACKNOWLEDGMENTS

This work was supported in part by an NIH career Development Award and NIH Grant #04453. Travel support was also provided by the Chapman Fund of the American Museum. I am indebted to J. Potter and J. Reiss for their assistance, and to J. J. Hatch for critical comments. Able assistance in the field was rendered by Barrie Gilbert and Dr. Wolfgang Schleidt.

LITERATURE CITED

Crowell, K.

1962 Reduced interspecific competition among the birds of Bermuda. *Ecology*, 43:75–87.

In press Changes in the ecology of Bermuda birds.

Klopfer, P. H.

1962 Behavioral Aspects of Ecology. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

1965 Behavioral aspects of habitat selection: a preliminary report on stereotypy in foliage preferences of birds. *Wilson Bull.*, 77:376–381.

MacArthur, R. H.

1965 Patterns of species diversity. *Biol. Rev.*, 40:510–533.

MacArthur, R. H., J. MacArthur, and J. Preer

1963 On bird species diversity: prediction of bird census from habitat measurements. *Amer. Nat.*, 96:167–174.

Tate, M. W., and R. C. Clelland

1957 Nonparametric and shortcut statistics. Interstate Pub., Inc., Danville, Ill.

van Valen, L.

1965 Morphological variation and width of ecologic niche. *Amer. Nat.*, 99:377–390.

DEPARTMENT OF ZOOLOGY, DUKE UNIVERSITY, DURHAM, NORTH CAROLINA, 31 MAY 1966.

SOME COURTSHIP DISPLAYS OF THE GOLDEN-WINGED WARBLER

JAMES BAIRD

Despite the fact that the Golden-winged Warbler (*Vermivora chrysoptera*) has been of exceptional ornithological interest for more than 75 years because of its interbreeding with the Blue-winged Warbler (*V. pinus*), remarkably few ethological observations have been published (see Ficken and Ficken, 1962). In view of this general lack of behavioral information, it seems worthwhile to publish the following observations on Golden-winged Warbler displays. The terminology, where applicable, follows that of Ficken (1963).

DISPLAYS

Gliding.—On 15 May 1962 a male Golden-wing was observed Gliding at the Cambridge Reservoir, Lexington, Middlesex County, Massachusetts. The context of the Glide was not determined, but briefly what was observed was that the male, which had been singing steadily for a half hour, flew to the top of a tall dead tree, took off, set his wings and Glided to a nearby tree from which he immediately Glided again (Fig. 1). No other bird was visible. Unlike the Redstart (Ficken, 1962), the male did not spread his tail during the Glide.

Courtship feeding.—In the late afternoon of 14 May 1964 in Lincoln, Middlesex County, Massachusetts, a female Golden-wing was found feeding halfway up a white pine (*Pinus strobus*). In order to obtain a closer look, I started "squeaking" and immediately a male Golden-wing appeared in a maple adjacent to the pine, chipped a few times, and flew down to sit about 6 inches away on the same branch as the female. At once the female raised her bill and fanned her tail so that the white flashed conspicuously (Fig. 2a). She then thrust her head towards the male and gaped (Fig. 2b). The male,

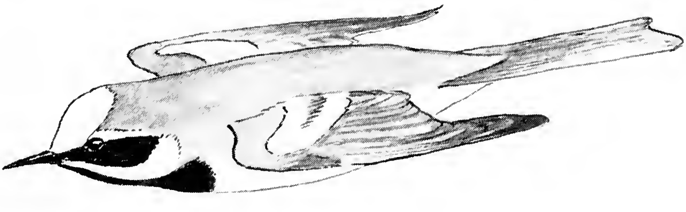


FIG. 1. Male Golden-winged Warbler Gliding.

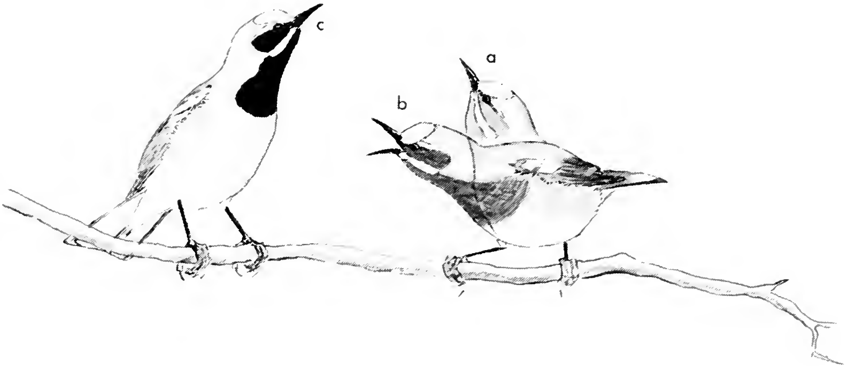


FIG. 2. Agonistic displays of Golden-winged Warblers.

either simultaneously or shortly thereafter, sleeked his plumage and raised his head and pointed his bill upwards at a 45 degree angle (Fig. 2c). As far as could be seen, he did not fan his tail. The female flew and the male followed at once; they then separated, the female foraging low and the male feeding high in an oak.

A few minutes later the male flew down to the female, which was perched on a low dead shrub, and fed her a caterpillar. In feeding the female, the male perched beside her with his body and head held high and his bill pointing down. As the male alighted, the female crouched, turned her head towards him and raised her bill and accepted the caterpillar (Fig. 3). It was not noted whether she wing-quivered.

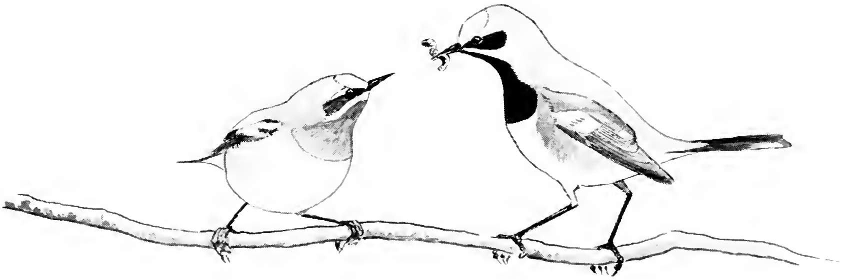


FIG. 3. Courtship Feeding by male Golden-winged Warbler.

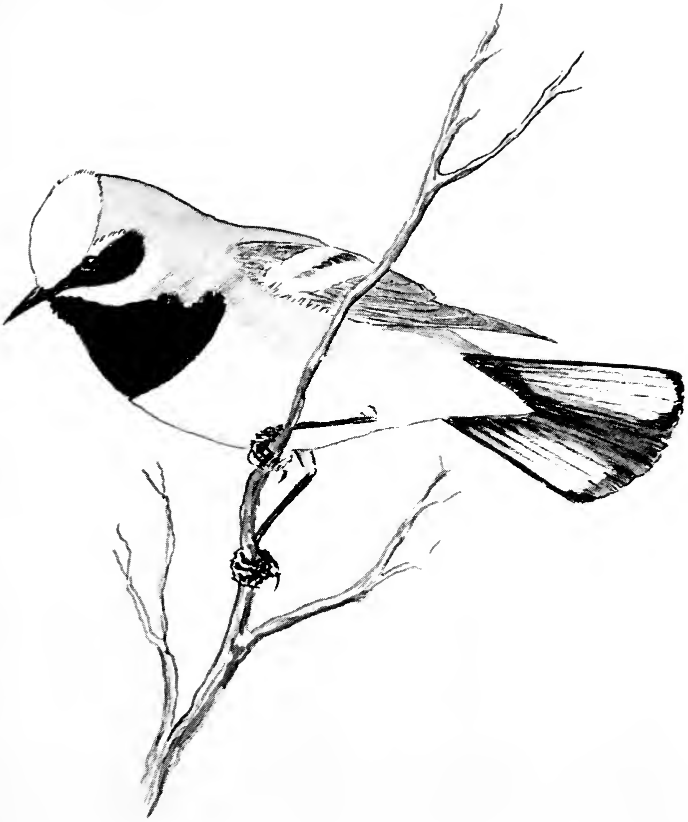


FIG. 4. Courtship Display of male Golden-winged Warbler: fluffed display given while following the female.

Although a male had been heard singing in this locale earlier in the day, this male did not sing during any of these displays. The female did quite a bit of chipping (largely in response to my "squeaking"); her most frequent note was a very short *tchip* and occasionally a dry *rattle*.

During this half-hour observation period, the male Golden-wing was seen to chase a male Prairie Warbler (*Dendroica discolor*), a male Magnolia Warbler (*Dendroica magnolia*), a Parula Warbler (*Parula americana*) and a Nashville Warbler (*Vermivora ruficapilla*).

Courtship display.—On the afternoon of 17 May 1965 in Lincoln, Middlesex County, Massachusetts, I observed a female Golden-wing foraging along the edge of an alder thicket that bordered the road. A male Golden-wing was persistently following her and continually orienting his head towards her

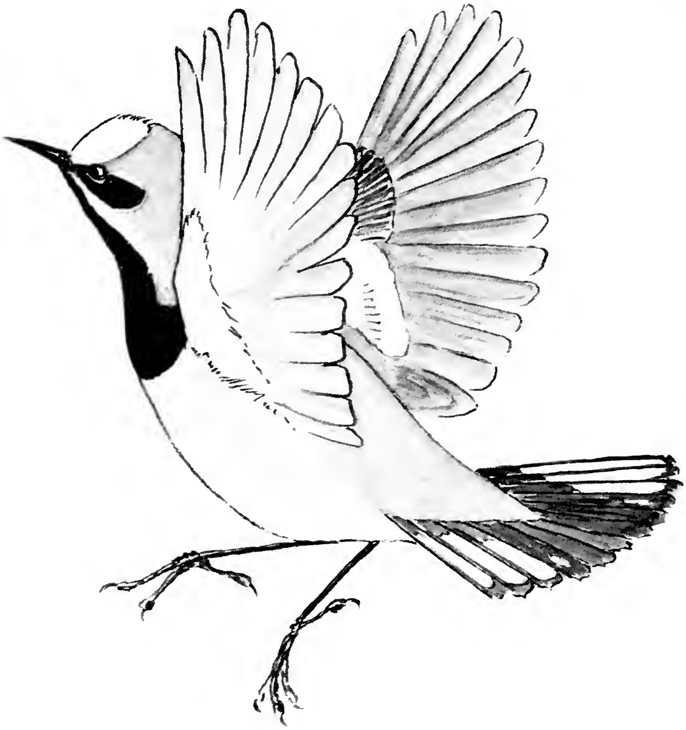


FIG. 5. Courtship Display of male Golden-winged Warbler: hovering flight display.

(when beneath her, he looked up; when above her, he looked down, when to one side, he looked towards her). During this following, his crown feathers were raised and his cheek and throat feathers were fluffed. His tail was continually being fanned (opened and shut), thus showing the white markings, and occasionally waved from side to side (Fig. 4). The male followed the female in this fashion for a full five minutes. Then he suddenly crouched, raised and spread his tail, raised his wings and started to vibrate them very rapidly, while lifting his head high, and raising his crown feathers (Fig. 5). He then assumed a more normal posture, hopped towards, and resumed following the female. Again he raised his tail, spread it, raised his wings, vibrated them, and this time actually flew to within eight inches of the female, where he hovered briefly, and then, with his wings still upraised and vibrating, made a rapid, sideways flight around the female in an arc of about two feet. He attempted to land either on or near the female but she pecked at him and he flew away in a normal flight. This was repeated again. Although my attention was focussed on the male, I am reasonably certain that the female maintained a "normal" posture during these displays.

Because of the fragmentary nature of the above observations, detailed discussion of their ethological significance is not possible, however, since apparently none of these displays have been reported in the literature, some comment seems justified.

DISCUSSION

Although Gliding in warblers has been shown to be an expression of both agonistic and sexual behavior (Ficken and Ficken, op. cit.), it seems likely that the Gliding I observed was a sexual display (despite the fact that a second bird was not seen), since M. S. Ficken informs me (pers. comm.) that she has seen ". . . . Gliding several times in both Golden-wings and Blue-wings," and that it "definitely seem part of the courtship ceremony (rather than agonistic)."

The observation on Courtship Feeding was preceded by displays by both sexes, which were apparently initiated by the male violating the female's individual distance. The female reacted to the male's intrusion by Bill Raising, Tail Fanning, and then giving a Head Forward display (including Gaping); the male responded by Bill Raising and sleeking his plumage. The most unusual aspect of these essentially agonistic displays was the Bill Raising by both the male and the female. Ficken and Ficken (op. cit.) considered that Bill Raising is "apparently lacking in warblers (except the Ovenbird (*Seiurus aurocapillus*))."

Equally interesting was the Courtship Feeding which was observed within minutes after the previous displays. Courtship Feeding has not been reported for the Golden-wing and is apparently rare among warblers; Nolan (1958) found evidence of Courtship Feeding in only "three or four" of 21 parulids reviewed. However, incubation feeding has been reported for many warbler species (Nolan, op. cit.), and a male Brewster's Warbler has been seen to feed his mate, an incubating female Golden-wing, on the nest (Carter, 1944).

The actions and the feather postures adopted by the male during the Courtship display were similar to those reported for other warblers (Ficken and Ficken, op. cit.—see especially Table IV, p. 115). Particularly noteworthy were the persistent following movements by the male during which the head with its striking markings was directed towards the female, and the display flight, which emphasized the golden wing bars, and the white in the tail. As Ficken and Ficken (op. cit.) point out such displays as fluffing the plumage and moving the wings tend to accentuate the species-typical markings.

SUMMARY

Three sexual displays previously unreported for the Golden-winged Warbler are described: Gliding, Courtship Feeding, and a Courtship display. The behavior of the male during the Courtship display was similar to that of other parulids, involving such display components as plumage fluffing, crown raising, wing movements, etc.

ACKNOWLEDGMENTS

I would like to thank Dr. Millicent S. and Dr. Robert W. Ficken for reading the manuscript and making several helpful suggestions.

LITERATURE CITED

Carter, T. D.
1944 Six years with a Brewster's Warbler. *Auk*, 61:48–61.
Ficken, M. S.
1962 Agonistic behavior and territory in the American Redstart. *Auk*, 79:607–632.
1963 Courtship of the American Redstart. *Auk*, 80:307–317.
Ficken, M. S., and R. W. Ficken
1962 The comparative ethology of the wood warblers (Parulidae): a review. *Living Bird*, 1:103–122.
Nolan, V., Jr.
1958 Anticipatory food-bringing in the Prairie Warbler. *Auk*, 75:263–278.

MASSACHUSETTS AUDUBON SOCIETY, LINCOLN, MASSACHUSETTS, 22 APRIL 1966.

NEW LIFE MEMBER

Mr. Clive Goodwin, of Weston, Ontario, has recently become a Life Member of The Wilson Ornithological Society. A graduate of the University of Toronto, Mr. Goodwin is Executive Director of the Conservation Council of Ontario. He is a member of the AOU, BOU, and British Trust for Ornithology, as well as The Federation of Ontario Naturalists, for which he served as editor of *Ontario Naturalist* and *Young Naturalist.* He has also served as Regional Editor for *Audubon Field Notes.* He has published numerous papers in local journals on his principal ornithological interests, bird populations and migrations. Mr. Goodwin's other interests include photography, biophilately, and music.

FOOD AND FEEDING HABITS OF AUTUMN MIGRANT SHOREBIRDS AT A SMALL MIDWESTERN POND

William S. Brooks

Most shorebirds in migration traverse so great a distance and so many ecologically different areas that it is improbable that they are able to maintain a very specific diet. Whereas they might feed, for example, mainly on certain dipteran larvae on the breeding grounds, they may not find these available during migration. Thus they must turn to other types of food and broaden their feeding niches. This may cause greater dietary overlap and competition between species.

Although some overlap is to be expected, there are differences in the basic feeding patterns and size differences which preclude total overlap between species. It is the purpose of this study, besides adding to the sparse knowledge of foods of migrating birds, to demonstrate that while there is considerable overlap in the diets of several species of shorebirds during autumn migration, there are differences which indicate at least partial segregation into different feeding niches.

The data were gathered in conjunction with a migration study done in 1960 and 1961. Observations were made and sampling was done at a shallow mud-bottom pond approximately ¼ mile north of Champaign, Illinois. This was apparently the only suitable feeding place for shorebirds in the area, and it is probable that the birds collected had consumed their food there.

METHODS

Varying numbers of nine of the 20 species under observation were collected with a shotgun for stomach analysis during the autumn migration: Common Snipe (*Capella gallinago*), 5 in October, 1961; Greater Yellowlegs (*Totanus melanoleucus*), 2 in October, 1960, one in November, 1961; Lesser Yellowlegs (*Totanus flavipes*), 4 in September and 2 in October, 1960, 3 in October, 1961; Pectoral Sandpiper (*Erolia melanotos*), 2 in October, 1960, and 1 in October, 1961, 4 in July, 1961; Least Sandpiper (*Erolia minutilla*), 1 in October, 1960, 3 in July, 1961; Dunlin (*Erolia alpina*), 2 in October, 1961; Stilt Sandpiper (*Micropalama himantopus*), 2 in October, 1960; Semipalmated Sandpiper (*Ereunetes pusillus*), 2 in August, 1961; Wilson's Phalarope (*Steganopus tricolor*), 1 in July, 1961.

The digestive tract was removed no later than one hour after death and preserved in 70 per cent ethanol. The contents of esophagus, proventriculus, and ventriculus were later emptied into a shallow dish and the parts of each type of food organism separated into groups using a binocular dissecting microscope. The number of organisms making up each group and the percentage that these made up of the total number of organisms in the stomach was then determined. In the cases where it was considered that plant material was purposefully ingested the percentage by bulk of this material was estimated, and the percentage of other organisms calculated on the remainder, as above.

The pond bottom was sampled throughout the year to determine the kinds and numbers of benthic organisms available to the birds by pushing a brass cylinder of 0.0077 m^2 area into the substrate to a depth of 10–15 cm, washing the contents through a 1.5 mm mesh sieve, and counting the organisms. Sampling locations were randomly selected in water 15 cm or less deep in the general areas where the birds fed. Varying numbers of samples were taken 2 to 4 times a month during migrations, and once a month at other times of the year.

Mats of filamentous algae formed over much of the pond's surface in late summer and autumn, creating a new feeding substrate for the smaller shorebirds in particular. Free-swimming, algal-mat, and shoreline food organisms were not sampled quantitatively but relative numbers were established by observation on the days when bottom samples were taken.

RESULTS AND DISCUSSION

In addition to the benthic organisms (Table 1), northern fathead minnows (*Pimephales promelas*: Cyprinidae) and numerous free-swimming adult aquatic beetles were present. Relative numbers of the fish could not be determined but, of the insects, Dytiscidae made up approximately 50 per cent, Haliplidae (crawling water beetles), 30 per cent, and Hydrophilidae, 20 per cent. Their relative numbers did not appear to change significantly during the migration period. Other aquatic insects were present but in very small numbers. Non-aquatic insects made up about 60 per cent of the available shoreline and algal-mat organisms during the entire migration period, stratiomyid (soldier fly) larvae, 30 per cent, and haliplid larvae, 10 per cent. Terrestrial insects of various species were commonly found trapped on the water surface, and wind-blown concentrations were often found against and on the algal mats.

Specificity of diet concerns the number of different food items consumed by a species. By these terms the Lesser Yellowlegs would be least, and the Stilt Sandpiper most specific (Tables 2 and 3), but the small and unequal sample sizes do not permit any conclusion here. It is probable that the larger species are less specific than the smaller ones, since they are not as restricted to the shoreline or to relatively smaller organisms.

TABLE 1
DENSITIES[1] OF BENTHIC ORGANISMS

Organism	Jan. (3)[2]	Feb. (2)	Mar. (4)	Apr. (7)	May (4)	June (3)	July (7)	Aug. (11)	Sept. (15)	Oct. (8)	Nov. (4)	Dec. (2)
Physidae (snails)	130	65	130	334	1,203	650	1,021	1,076	966	748	390	130
Chironomidae (midge flies) larvae, pupae	173	–	195	111	293	130	111	166	337	211	98	65
Diptera (flies) larvae, pupae	87	–	228	74	163	216	74	142	57	33	131	65
Corixidae (water boatmen)	–	–	163	56	98	43	37	154	61	98	98	–
Baetidae (may-flies) naiads	–	–	–	–	33	43	56	59	132	65	–	–
Hydrophilidae (water scavenger beetles) larvae	–	–	–	–	65	43	56	24	20	16	–	–
Anisoptera (dragonflies) naiads	–	–	–	19	65	43	–	12	1	16	–	–
Coenagrionidae (damselflies) naiads	–	–	–	–	33	43	–	12	–	–	–	–
Dystiscidae (predaceous diving beetles) larvae	–	–	–	–	–	43	–	24	–	16	–	–

[1] Individuals per m^2.
[2] Number of samples.

Selectivity of diet concerns the relation between the quantity of a certain food item available and the quantity consumed. The forage ratio of Hess and Swartz (1941), calculated by dividing the per cent of a food item in the stomach by the per cent of that item in the fauna, gives a measure of the selectivity of an animal for the components of its diet. A value of less than unity denotes that the item is not selected in relation to its abundance; unity, that it is selected in direct relation to its abundance; greater than unity, that it is selected out of proportion to its abundance or that it is a preferred item. The forage ratios (Tables 2 and 3) show that most of the species were apparently selective for several items in their diets but had at least one item of high preference peculiar to each.

Lack (1945) concluded that closely related species differ in one or more of the following: habitat, region, or diet. Two closely related phalacrocoracids, very similar in appearance, habitat, and region "differ markedly in both nesting sites and food." Dietary selectivity is the major differing factor in the niches of these species which can account for their coexistence without contradicting Gause's rule. He found (1944) that in many closely related sympatric passerines dietary differences were important in their ability to coexist. This is now a rather well-known ecological fact, but his and others' observations have concerned only breeding or permanent resident birds. Lack stated (1944:276) that "closely related species are potential food competitors in winter, and so have evolved geographical isolation at this season . . . ," and suggested that off the breeding grounds (during migration and on the wintering grounds) their food may become more similar. The results of the present study, however, indicate that the identities of separate feeding niches may be maintained through migration, or, in light of Holmes' (1964) finding, that the feeding niches of congeneric species of sandpipers almost completely overlapped during the breeding season, the niches may even become more divergent.

Competition should be greater for preferred food items than for others. In cases where two or more species shared a high preference, they usually did not compete, because their feeding areas were different. However, during the peak of migration, in early September both years, competition should have been and apparently was keenest between species which had common preferred food items and common feeding areas. Lesser Yellowlegs and Pectoral Sandpipers (the first and second ranked species at the pond with respective 4-month averages of 14 and 12 birds seen per trip to the area and peak numbers of 125 and 50) both selected hydrophilid larvae, and aggressive encounters between these two species were the only ones seen, being most noticeable in early September. Close study was not made of this behavior, and although Hamilton's (1959) "crouch" and "supplanting" displays by Pectoral Sandpipers were the only ones noticed, there were no doubt other aggressive displays that I did not recognize. This behavior was shown usually between Pectoral Sandpiper individuals, less often between these and Lesser Yellowlegs, with the former being the apparent aggressor. The Least Sandpiper also selected hydrophilid larvae but no aggressive displays were noted involving this species, although less obvious displays, sufficient to cause the smaller species to move away without apparent conflict, could have been employed by the larger sandpipers.

No encounters between Stilt Sandpipers and Lesser Yellowlegs were observed, although they both selected chironomid larvae and corixids. Either the supply was sufficient or the fact that the former habitually fed in deeper water may have eliminated competition. There was no competition for chironomids between Lesser Yellowlegs and Least Sandpipers, since the

Table 2
Food Habits of the Shoreline-frequenting Shorebirds

	Common Snipe			Pectoral Sandpiper						Least Sandpiper			Dunlin			Semipalmated Sandpiper		
	October (5)[1]			July (4)			October (2)			July (3)			October (2)			August (2)		
Food item	F[2]	D[3]	FR[4]	F	D	FR	F	D	FR	F	D	FR	F	D	FR	F	D	FR
Benthic																		
Physidae	20	2	<0.1	100	52	0.7							100	3	0.1	50	3	<0.1
Chironomidae				25	+	<0.1	50	1	<0.1	66	11	**1.4**						
Diptera	20	+	<0.1							33	1	1.0						
Corixidae										33	1	0.2						
Hydrophilidae	20	+	<0.1	25	3	0.8	50	25	**25.0**	100	7	**1.8**				50	4	**4.0**
Dytiscidae										33	1	1.0						
Free-swimming																		
Dytiscidae	80	21	0.4	75	9	0.2	50	25	0.5	100	14	0.3	100	8	0.2	50	3	0.1
Hydrophilidae				75	6	0.3				66	10	0.5	100	58	**2.9**	50	4	0.2
Shore, Algal Mat																		
Insects, misc.							50	7	0.1	66	2	<0.1	100	16	0.3			
Stratiomyidae	20	20	0.7				50	42	**1.4**	66	43	**1.4**	100	14	0.5			
Haliplidae	20	2	0.2	25	17	**1.7**				33	10	1.0						
Plant Material																		
Algae	60	43	–													100	86	–
Seeds	100	12	–	75	13	–	50	1	–				100	3	–			

[1] Sample size.
[2] Frequency, per cent of stomachs containing item.
[3] Per cent of item in diet.
[4] Forage ratio, values > 1 in boldface.

TABLE 3
FOOD HABITS OF THE SHOREBIRDS FEEDING AWAY FROM SHORE

	Greater Yellowlegs						Lesser Yellowlegs						Stilt Sandpiper October (2)		
	October (2)[1]			November (1)			September (4)			October (5)					
Food item	F[2]	D[3]	FR[4]	F	D	FR	F	D	FR	F	D	FR	F	D	FR
Benthic															
Physidae				100	25	0.5	50	4	0.1						
Chironomidae							100	35	**1.7**				100	46	**2.6**
Diptera							25	+	<0.1	20	+	<0.1			
Corixidae				100	2	0.2	75	20	**5.0**	100	59	**7.4**	100	54	**6.8**
Baetidae							25	10	**1.3**	20	8	**1.6**			
Hydrophilidae							75	6	**5.5**	40	3	**3.0**			
Anisoptera	100	88	**2.8**	100	5	0.2				60	10	0.3			
Coenagrionidae										20	1	1.0			
Free-swimming															
Dytiscidae				100	50	1.0	50	23	0.7	60	17	0.3			
Hydrophilidae							25	1	0.1						
Cyprinidae	50	12	–	100	5	–									
Shore, Algal Mat															
Insects, misc.							25	+	<0.1	60	2	0.1			
Stratiomyidae				100	10	0.3				20	+	<0.1			
Plant Material															
Seeds				100	3	–	25	+	–						

---

[1] Sample size.
[2] Frequency, per cent of stomachs containing item.
[3] Per cent of item in diet.
[4] Forage ratio, values > 1 in boldface.

former generally probed the bottom and the latter took only pupae which had come to the surface and were washed ashore or against the algal mats.

It is possible that the aggressive behavior described above was not due to active competition for a food item but to the preservation by the birds of their "individual distances." Hamilton (1959) reports that when this distance is reached, threatening usually occurs among Pectoral Sandpipers. However, he did not mention that this occurred interspecifically in the general feeding area, and for this reason active competition cannot be excluded as being responsible for the aggressive behavior shown between species in the present study.

Several species examined had eaten considerable plant material. Forage ratios could not be calculated for this type of food but the high frequencies and percentages of seeds taken by the Common Snipe and Pectoral Sandpiper, and of algae by the snipe and Semipalmated Sandpiper indicate that they were selecting this over animal food in some instances. Plant material was present in almost all stomachs examined but was usually in very small amounts and was considered to have been taken incidentally with animal food by all except the species mentioned above.

Of interest is that while adult haliplid beetles composed about 30 per cent of the free-swimming fauna, not one was found in the stomachs. The reason for their apparent unpalatability may be that they have an extremely thick and hard external covering and are very resistent to crushing. If they cannot be crushed they obviously have little food value.

Little correlation can be made between temporal changes in densities of food organisms, number of birds present, and dietary changes of the birds, due to the relatively small number of stomachs examined. Forage ratios should reflect a change of any sort (or no change) when comparing a species of shorebird at different times. The Lesser Yellowlegs, for which the most samples are available, is taken as an example. Of those food items for which the ratio was greater than unity in either September or October (see Table 3) the density of hydrophilid larvae decreased about 20 per cent, mayfly naiads, 50 per cent, and chironomid larvae and pupae, 33 per cent, while corixids increased about 33 per cent. The respective forage ratios decreased about 50 per cent, increased 20 per cent, decreased 100 per cent, and increased about 33 per cent. Although the data do not permit a conclusion, it is attractive to speculate that as the density of one preferred organism decreases, the birds feed more intensively on another preferred organism for which the density has increased. This, of course, follows the established ecological principle that as a population decreases or increases, external pressures such as predation tend to decrease or increase with it.

The size of the bird, or more accurately, the leg-length, appeared to influence the food of the different species. The smaller or short-legged species usually did not feed in deeper water, taking organisms available on the shore, the algal mats, or in very shallow water. Greater numbers of free-swimming and terrestrial forms were consumed by them, in contrast to the larger species, which took more benthic organisms (see Tables 2 and 3 respectively). It should be mentioned here that the Least Sandpiper collected in October and the Wilson's Phalarope in July, omitted in the tables, had eaten only non-aquatic insects.

On the basis of the food habits, general size of the birds, main feeding sites, and tendency to feed together, the 20 species present at the pond during the study can be placed into three feeding groups:

Group I. Larger species which fed exclusively on the shore:
  Killdeer (*Charadrius vociferus*), American Golden Plover (*Pluvialis dominica*), Black-bellied Plover (*Squatarola squatarola*), Buff-breasted Sandpiper (*Tryngites subruficollis*).

Group II. Smaller or short-legged species which fed on or near the shore or on the algal mats:
  Semipalmated Plover (*Charadrius semipalmatus*). Common Snipe, Spotted Sandpiper (*Actitis macularia*), Pectoral Sandpiper, Baird's Sandpiper (*Erolia bairdii*), Least Sandpiper, Dunlin, Semipalmated Sandpiper, Western Sandpiper (*Ereunetes mauri*), Sanderling (*Crocethia alba*).

Group III. Larger species which fed most commonly in water up to belly-deep:
  Solitary Sandpiper (*Tringa solitaria*), Greater Yellowlegs, Lesser Yellowlegs, Short-billed Dowitcher (*Limnodromus griseus*), Stilt Sandpiper. Wilson's Phalarope.

There were individual exceptions, but as a rule these groups were distinguishable in the field. A zonation was evident, with Group I at the periphery, Group II near the water's edge, and Group III located out in the water. The Lesser Yellowlegs was ubiquitous but more often fed in deeper water away from shore. It has been somewhat arbitrarily placed in Group III rather than in Group II.

The Wilson's Phalarope possibly should be grouped by itself. Although it fed with the others of Group III, the specimen collected had consumed 100 per cent non-aquatic insects, as mentioned above. Apparently it took floating insects from the surface of the water and from algal mats, unlike the others.

SUMMARY

The general feeding habits of 20 species of shorebirds at a small pond near Champaign, Illinois, were observed and stomach analyses of nine of these species were made

during the autumn migrations of 1960 and 1961. The numbers and kinds of available food organisms at the pond were established by quantitative sampling of benthic invertebrates and estimation of relative numbers of free-swimming and shoreline organisms.

Although most species did not show dietary specificity, consuming a rather wide array of organisms, all showed dietary selectivity, in that one or a few of the food items were sought out over the others and out of proportion to their abundance. Competition was probably reduced by this selectivity, and where two species shared high preference for the same item, competition was alleviated by the fact that they usually fed at different sites.

Aggressive behavior was observed intraspecifically with the Pectoral Sandpiper, and at the peak of migration, interspecifically between these and Lesser Yellowlegs. They may have been actively competing for a preferred food item common to both.

The Common Snipe, Pectoral Sandpiper, and Semipalmated Sandpiper appeared to consume considerable amounts of plant material intentionally. The other species probably took it incidentally with animal food.

The size or leg-length of the bird partially determined its diet. Small species were apparently unable to forage in deeper water or ingest large organisms.

The 20 species were placed into three groups on the basis of their food, general size, main feeding sites, and tendency to feed together. These groups, when feeding, were distinguishable in the field because of their evident zonation.

ACKNOWLEDGMENTS

I greatly appreciate the help and advice given me by S. Charles Kendeigh during the study. Thanks are due John E. Williams for his aid in obtaining specimens for stomach analysis. For identifications of various food organisms I am indebted to Mrs. Leonora K. Gloyd, John M. Kingsolver, Milton W. Sanderson, and Philip W. Smith of the Illinois Natural History Survey. This report is based on a portion of a master's thesis in the Department of Zoology, University of Illinois.

LITERATURE CITED

Hamilton, W. J.
1959 Aggressive behavior in migrant Pectoral Sandpipers. *Condor*, 61:161–179.
Hess, A. D., and A. Swartz
1941 The forage ratio and its use in determining the food grade of streams. *Trans. Fifth North Amer. Wildl. Conf.*, 1940:162–164.
Holmes, R. T.
1964 Food overlap in breeding sandpipers in northern Alaska (Abstract). *Proc. 14th Alaskan Sci. Conf.*, Anchorage, 1963:66.
Lack, D.
1944 Ecological aspects of species-formation in passerine birds. *Ibis*, 86:260–285.
1945 The ecology of closely related species with special reference to Cormorant (*Phalacrocorax carbo*) and Shag (*P. aristotelis*). *J. Animal Ecol.*, 14:12–16.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS (PRESENT ADDRESS: DEPARTMENT OF BIOLOGY, RIPON COLLEGE, RIPON, WISCONSIN 54971), 21 MARCH 1966.

CICONIA MALTHA AND *GRUS AMERICANA* FROM THE UPPER PLIOCENE OF IDAHO

J. Alan Feduccia

Recent paleontological collecting by Claude W. Hibbard and his field assistants has yielded a large array of avian fossils from Idaho. The specimens reported herein were collected from the Glenns Ferry Formation. Twin Falls County, Idaho, and constitute part of the Hagerman Local Fauna, which has been assigned to the Upper Pliocene (Hibbard et al., 1965). The best estimate of the age of this fauna on the basis of potassium-argon dating is considered to be 3.48 ± 0.27 million years (Evernden et al., 1964, p. 191).

Ciconia maltha has been reported previously from the Upper Pliocene of Idaho (Miller, 1944), but the locality from which the specimens were taken, the Bruneau Formation, has more recently been assigned to the Middle Pleistocene (see Malde and Powers, 1962). This species has also been reported from numerous Upper Pleistocene localities (see Brodkorb, 1963). *Grus americana* has been reported from the Glenns Ferry Formation (13 miles NW of Grandview, Idaho) on the basis of a tibial fragment (Miller, op. cit.), and from several Pleistocene localities (see Wetmore, 1956).

In the course of this study I examined Recent specimens of *Jabiru mycteria*, *Euxenura maguari*, *Ciconia ciconia*, *Grus americana*, and *Grus canadensis* in the skeletal collection of the University of Michigan Museum of Zoology. A scapula of *Ciconia maltha* from the type locality of Rancho La Brea, and skeletal elements of Recent *Grus americana* were kindly loaned by Theodore Downs of the Los Angeles County Museum of Natural History and Clayton M. White of the University of Kansas Museum of Natural History, respectively. All of the specimen numbers refer to the University of Michigan Museum of Paleontology unless otherwise indicated.

DESCRIPTION OF MATERIAL

Ciconia maltha.

Specimen: Proximal 69 mm of right scapula (UMMP 52540), from the Hagerman quadrangle, SE ¼ sec. 29, T7S, R13E, 1,850 feet W and 1,100 feet N of SE corner of sec. 29, elevation 3,125 feet. Measurement: maximum breadth of head, 26.1 mm.

There has been considerable uncertainty in the past regarding the number of species of fossil storks (excluding the Mycteriinae) recorded from North America. Howard (1942) examined all of the then known specimens and concluded that all represented one highly variable species, *C. maltha*. I have examined scapulae from four specimens of *Jabiru mycteria*, a form that closely approximates *C. maltha* in size and in osteological characters, and have found not only variation in size, but also in osteological characters of the scapulae. It is therefore not surprising to find individual bones that do not conform in all details to the presently known specimens of *C. maltha*. The fossil reported herein differs from the scapula of *C. maltha* (Los Angeles County Museum of

Natural History B8120) that I examined and from the description of scapulae of *C. maltha* (Howard, 1942, p. 196) in the following characters: concavity between acromion and glenoid facet slightly deeper, and the depression at the base of the dorsal surface of the coracoid articulation somewhat more depressed. However, both of these characters vary somewhat in the specimens of *Jabiru* that I examined. The Hagerman fossil agrees with the scapula of *C. maltha* in general form, the region of the base of the scapula mesial to the coracoid articulation being straight (in *Jabiru* the same region is well rounded) and coming to an abrupt end at the furcula articulation. This region of the base in the Hagerman fossil and in *C. maltha* is perforated by pneumatic foramina. Scapulae of *Ciconia ciconia* and *Euxenura maguari* are similar to those of the Hagerman fossil and the specimen *C. maltha* in general contour of the basal region, but the depression under the coracoid articulation is absent in *Euxenura* and only slightly depressed in *C. ciconia.* In size, the Hagerman scapula and that of *C. maltha* overlap with *Jabiru mycteria* and are larger than either *Euxenura maguari* or *C. ciconia.* The differences in osteological characters between this fossil and *C. maltha* are not, in my opinion, sufficient to warrant recognition of a new species.

Grus americana.

Specimens: (1) Fragment of proximal 53 mm of left coracoid (UMMP 48927), from the Hagerman quadrangle, SW ¼ NW ¼ sec. 16, T7S, R13E, elevation 3,025 to 3,100 feet. Measurements: least width of shaft, 13.8 mm; least depth of shaft, 9.4 mm.

(2) Left quadrate minus orbital process (UMMP 52249), from the Hagerman quadrangle, SE ¼ SW ¼ sec. 5, T8S, R13E, 1,400 feet E and 250 feet N of SW corner of sec. 5. Measurement: greatest distance from squamosal articulation to mandibular articulation, 18.2 mm.

(3) Distal 93 mm of left tibiotarsus (UMMP 52541), from the Hagerman quadrangle, NE ¼ NE ¼ sec. 32, T7S, R13E, 850 feet S and 1,100 feet W of NE corner of sec. 32, elevation 3,050 feet. Measurements: depth through condyles, 23.2 mm; width of condyles, 23.0 mm.

(4) Fragment of distal end of right tibiotarsus (UMMP 52288), from the Hagerman quadrangle, NW ¼ NE ¼ sec. 16, T7S, R13E, 800 feet S and 2,600 feet W of NE corner of sec. 16, elevation 3,010 feet. This bone appears to be that of a large crane but is so fragmentary that specific designation seems inadvisable.

(5) Fragment (155 mm) of proximal end of right tarsometatarsus (UMMP 52242), from the Hagerman quadrangle, SE ¼ NE ¼ sec. 17, T7S, R13E, elevation about 3,225 feet. No useful measurements could be taken from this fragment.

(6) Distal 51 mm of right tarsometatarsus minus trochleae for digits III and IV (UMMP 52243), from the same locality as UMMP 52242. Measurement: greatest anteroposterior distance through trochlea for digit II, 12.7 mm.

I have examined the following bones of the Recent form: four coracoids, quadrates from one skull, five tarsometatarsi from four specimens, seven tibiotarsi from four specimens, plus six complete skeletons of *Grus canadensis*. *Grus americana*, like *Ciconia maltha*, varies both in size and in osteological characters of bones. All of the specimens reported herein are intermediate in size between the largest and smallest of the Recent *G. americana* that I examined, and are well accommodated into the range of variability of osteological characters. Although the possibility exists that the fossils reported herein do not actually represent the same biological species as Recent *G. americana*, the bones appear to be inseparable from those of the Recent form.

ACKNOWLEDGMENTS

I am indebted to Dr. Claude W. Hibbard for permission to study the fossils and for supervision throughout this study, and to Dr. Robert W. Storer for criticizing the manuscript. Mr. B. G. Murray, Jr., did considerable work in sorting the Hagerman fossils.

LITERATURE CITED

BRODKORB, P.
1963 Catalogue of fossil birds. Part 1 (Archaeopterygiformes through Ardeiformes). *Bull. Florida State Mus.*, 7:180–293.

EVERNDEN, J. F., D. E. SAVAGE, G. H. CURTIS, AND G. T. JAMES
1964 Potassium-argon dates and the Cenozoic mammalian chronology of North America. *Amer. J. Sci.*, 262:145–198.

HIBBARD, C. W.
1965 Quaternary mammals of North America *In* The Quaternary of the United States (H. E. Wright, Jr., and D. G. Frey, Eds.), Princeton Univ. Press, Princeton, N.J., pp. 509–525.

HOWARD, H.
1942 A review of the American fossil storks. Carnegie Inst. Wash., Publ. 530: 187–203.

MALDE, H. E., AND H. A. POWERS
1962 Upper Cenozoic stratigraphy of Western Snake River Plain, Idaho. *Geol. Soc. Amer. Bull.*, 73:1197–1220.

MILLER, L.
1944 Some Pliocene birds from Oregon and Idaho. *Condor*, 46:25–32.

WETMORE, A.
1956 A check-list of the fossil and prehistoric birds of North America and the West Indies. *Smithsonian Misc. Coll.*, 131:1–105.

MUSEUM OF ZOOLOGY, THE UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN, 11 MAY 1966.

SEED-SIZE PREFERENCE IN CHICKADEES AND TITMICE IN RELATION TO AMBIENT TEMPERATURE

Becky A. Myton and Robert W. Ficken

Competition for food between two closely related, sympatric species can be assayed in four ways—differences in feeding habits, feeding locations, nature of food, and size of food (Hinde, 1959).

The original object of this study was to test the seed-size preference of two sympatric species, the Carolina Chickadee (*Parus carolinensis*) and the Tufted Titmouse (*P. bicolor*). A direct correlation has often been observed between the size of food taken and the size of the bill of the bird (Lack, 1947; Snow, 1954; Betts, 1955; Morris, 1955); hence, we hypothesized that chickadees would prefer smaller seeds while the larger-billed titmice would prefer larger ones. Further, we predicted that both species would be most efficient at husking and eating the size they preferred. It became apparent soon after observations began that the chickadees took more of the larger seeds on colder days. The objective was therefore expanded to test for correlation between temperature and seed-size preference.

MATERIALS AND METHODS

Feeders were attached four feet up on large trees at four well-separated locations in deciduous woods near College Park, Maryland. The feeders were flat plastic trays measuring 12 × 30 inches with a 1 inch rim. Observations were begun on 17 November 1964, and continued through 22 February 1965.

Two size groups of sunflower seeds, dyed black with India Ink, were placed on one or the other side of each feeder; the large-seed group was 0.12–0.17 g and the small-seed group was 0.03–0.07 g. The two size groups were shifted randomly in order to minimize the effect of position. To test for randomness of choice on each side of the feeder, observations were obtained on mixtures of both sizes.

Data taken included seed size (large or small) chosen. the amount of time spent husking and eating, and ambient temperature.

RESULTS

Control for position effect.—Virtually the same number of seeds of mixed size was chosen from the right side of the feeder (78) as from the left (75) by a flock including several birds of both species, thus indicating no preference for a particular side.

Time spent husking and eating.—The relative efficiency of the two species in dealing with each seed size is presented in Table 1. Chickadees ate the

TABLE 1
MEAN TIMES FOR CHICKADEES AND TITMICE TO HUSK AND EAT LARGE AND SMALL SUNFLOWER SEEDS (IN SECONDS)

Species	Seed size	Husk	Eat	Husk plus Eat
Chickadees	large	14.6	69.0	76.4
Chickadees	small	10.1	29.6	39.7
Titmice	large	5.3	28.5	33.8
Titmice	small	3.3	23.3	26.9

smaller seeds faster than the larger ($P < 0.05$, Student's "t" test) and titmice husked the smaller seeds faster than the larger ($P < 0.05$, Student's "t" test). A comparison of husking, eating, and husking plus eating in both species shows that titmice were significantly faster with both seed types, except in eating the small seeds.

Effect of temperature on size preference.—The observations on size choice were divided into two periods based on temperature (32 F and below, "cold," and above 32 F, "warm").

Chickadees showed a very strong preference for small seeds on warm days and a marked shift in preference toward large seeds on cold days ($P < 0.0001$, Chi Square for contingency). The titmice always preferred large seeds and chose a slightly greater proportion of them on the warm days than on the cold days ($P < 0.05$, Chi Square for contingency) (Table 2).

DISCUSSION

In general, the titmice preferred larger seeds than the chickadees. This supports the original hypothesis; namely, that the larger-billed titmice would prefer larger seeds and the smaller-billed chickadees would prefer smaller seeds. The titmice were more efficient than the chickadees as judged by the time spent husking plus eating both seed sizes, indicating an absolute advantage to a larger bill in utilizing sunflower seeds.

TABLE 2
THE NUMBER OF LARGE AND SMALL SUNFLOWER SEEDS TAKEN BY CHICKADEES AND TITMICE ON WARM AND COLD DAYS

	Chickadees		Titmice	
Temperature	Large	Small	Large	Small
Above 32 F	98	346	301	83
32 F and below	333	352	785	331
Total	431	698	1,086	414

The change in size preference by the chickadees on cold days might be explained by the increased amount of food obtained per unit effort when large seeds were taken. Although there was slightly more than twice as much endoplasm in a large sunflower seed as in a small one, it also took the chickadee approximately twice as long to husk and eat a large seed as a small one (Table 1). However, the chickadee had to make two trips to the feeder to obtain the same amount of food when it chose small seeds, and it would be more efficient for the chickadees to take the large seeds. Because of the stress of cold placed on the chickadees in the cold weather (Brewer, 1963) and the need for greater energy on cold days, it follows that chickadees would benefit by being more efficient on cold days. Thus, it seems that there are two mechanisms in operation. First the chickadee shows a natural preference for smaller seeds; and, second, this preference is modified under conditions of cold stress when efficiency is of overriding importance.

SUMMARY

Field experiments on seed-size choice revealed that Tufted Titmice preferred larger sunflower seeds and Carolina Chickadees preferred smaller sunflower seeds as predicted from their difference in bill size. However, the chickadees showed a marked shift toward large seeds when the temperature was 32 F or below. Two mechanisms seemed to operate in this species: 1) a natural preference for small seeds, and 2) the modification of this preference toward one of increased efficiency under cold stress.

ACKNOWLEDGMENTS

We are grateful to Edward C. Keller for his help with the statistical analyses, and to him and Millicent S. Ficken for their critical reading of the manuscript. This research was supported by the National Science Foundation (GB-891 and GB-3226).

LITERATURE CITED

Betts, M. M.

1955 The food of titmice in an oak woodland. *J. Animal Ecol.*, 24:282–323.

Brewer, R.

1963 Ecological and reproductive relationships of Black-capped and Carolina Chickadees. *Auk*, 80:9–47.

Hinde, R. A.

1959 Behaviour and speciation in birds and lower vertebrates. *Biol. Rev.*, 34:85–128.

Lack, D.

1947 Darwin's finches. Cambridge Univ. Press, Cambridge.

Morris, D.

1955 The seed preferences of certain finches under controlled conditions. *Avicultural Mag.*, 61:271–287.

Snow, D. W.

1954 The habitats of Eurasian tits (Parus spp.). *Ibis*, 96:565–585.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF MARYLAND, COLLEGE PARK, MARYLAND (PRESENT ADDRESS (R.W.F.), UNIVERSITY OF WISCONSIN-MILWAUKEE, MILWAUKEE, WISCONSIN). 3 MARCH 1966.

ADDITIONAL OBSERVATIONS ON THE STRUCTURE OF UNUSUAL FEATHER TIPS

Alan H. Brush

In spite of their obvious importance in almost all phases of avian biology there are still some aspects of feathers which are poorly known structurally. Accordingly, interest in feather morphology persists among ornithologists (Portmann, 1963). One such area is the internal morphology of tipped elements which occur on feathers of widely diverse taxonomic groups of birds. Recently, for example, the relationship between pigment and feather tip structure has been described in the Cedar Waxwing (*Bombycilla cedrorum*) (Brush and Allen, 1963), and in the Scaled Cuckoo (*Lepidogrammus cumingi*) (Brush, 1965). These investigations have indicated the existence of at least two different structural arrangements involved in the formation of such tips. The first, as found in the waxwing, involves the expansion and flattening of the terminal portion of the rachis. In these structures, the structured medulla lies between unequal thicknesses of the surrounding amorphous cortex. The carotenoid pigment is deposited in the cortex. This uneven cover produces the shiny ventral and duller dorsal aspect characteristic of these tips. The second mechanism, as found in the cuckoo, involves the fusion of the rachis with a number of barbs and minor structural elements. This produces a flattened structure with an internally segmented appearance. Individual segments are compressed laterally and may fuse. There is a heavy pigment (melanin) concentration in the center of the tip. There are no external differences in the appearance of the surfaces in such tips.

The latter mechanism is more common than the former. Indeed, Chandler (1916) suggested that the structure in the waxwing may be unique among birds. It should also be noted that there is a weak correlation of one mechanism with melanin pigments and of the other with carotenoids. In no case described thus far is the functional aspect of these structures completely clear.

It was the objective of the study reported here to investigate further the structural and chemical nature of various unique feather tips not reported previously. Included in this investigation were feathers from the Curl-crested Araçari (*Pteroglossus beauharnaesii*) (family Ramphastidae), and several species of the genus *Rallus*.

METHODS AND RESULTS

Pigmentation.—The coloration of the tips in all feathers described in this study was due to melanin pigments. The techniques of bleaching with hydro-

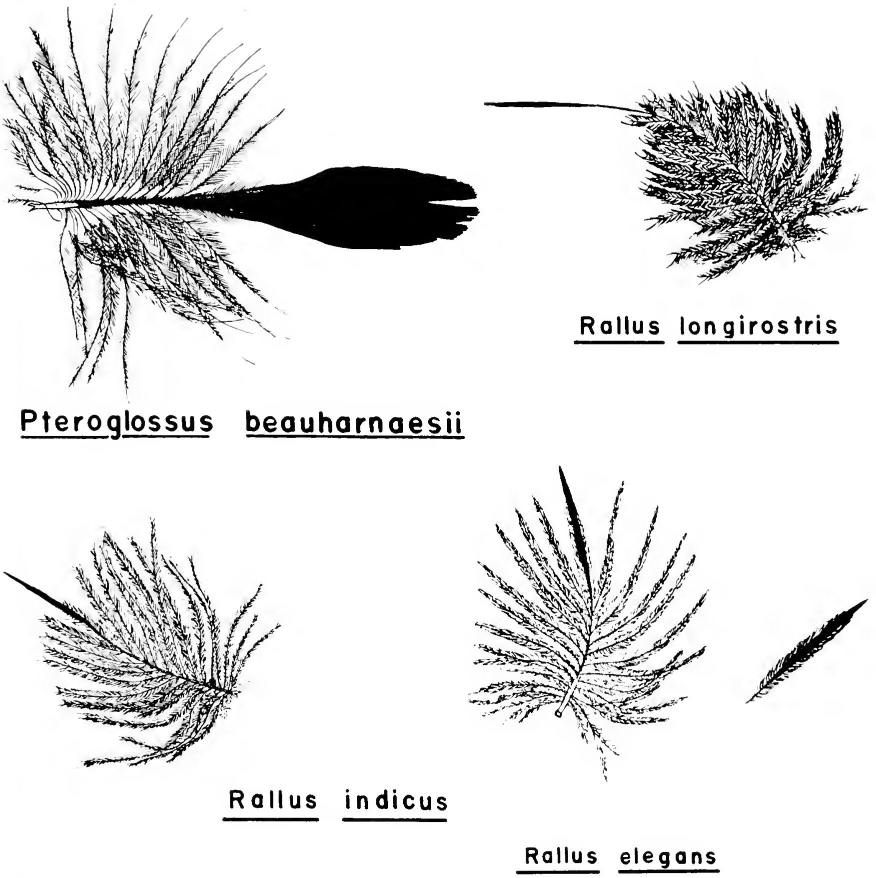


FIG. 1. Tipped feather from the crest of the Curl-crested Araçari (*Pteroglossus beauharnaesii*). Actual length, 20 mm.

Tipped feathers from several Rails. Lengths range from 7.2 mm (*R. elegans*) to 1.1 mm (*R. longirostris*).

gen peroxide or peracetic acid and reduction of ammonical silver nitrate were used for melanin analysis (Brush, 1965).

Structure.—Whole mounts of feathers were made with Canada balsam (Fig. 1).

Cross-sections were made by mounting tissues in methacrylate and sectioning with a glass knife. Several other techniques which included embedding and sectioning in high melting point paraffin (Dr. P. Stettenheim, pers. comm.), diethylene glycol distearate, or gelatin were tried, but met with less success.

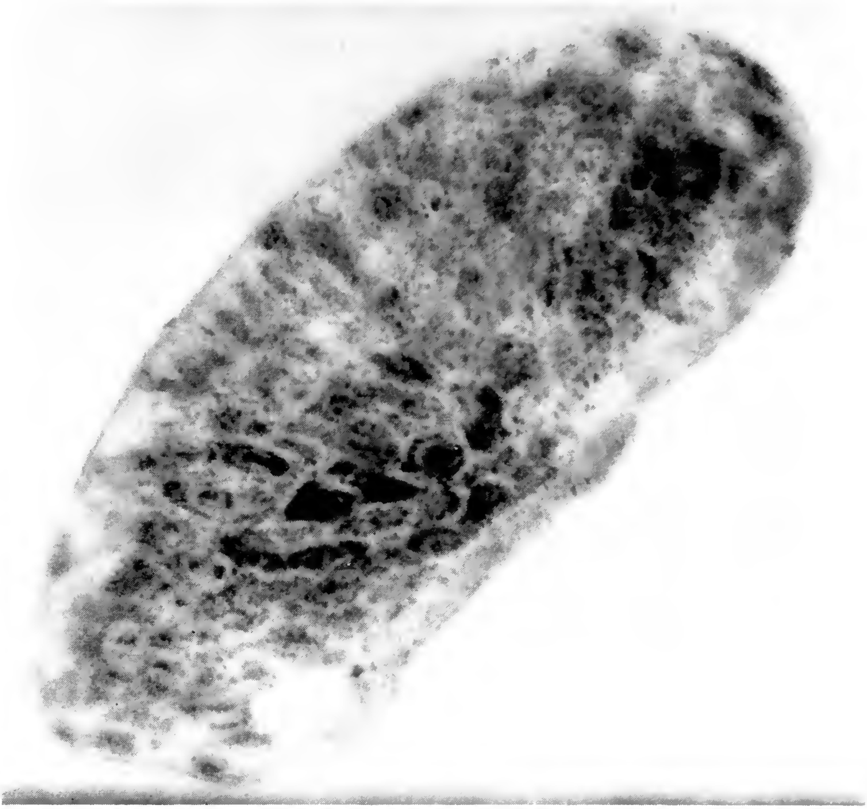


FIG. 2. Cross-section of feather tip from *R. indicus*. Note relatively unstructured cortical layer.

In cross-section the tips of the feathers from the crest of the Curl-crested Araçari appeared similar in morphology to that of the Scaled Cuckoo, in that the tip consisted of an internal medullary area which was heavily pigmented and which was surrounded by a relatively clear cortex. The highly keratinaceous cortex when seen in serial section supports the notion that it has developed from the fusion of several barbs or barb-like structures.

Cross-sections of the feather tips from members of the genus *Rallus* (*R. aquaticus*, *R. elegans*, and *R. longirostris*) presented a pattern quite different from that described above. Tips generally tended to be oval rather than flattened and the internal structure (Fig. 2) suggested that only the rachis was involved in the formation of the tip. The tips of the rail feathers lacked the regular, repetitive structural units characteristic of the *Pteroglossus* tip. The cuticle appeared unsegmented and the inner pulp contained pigment

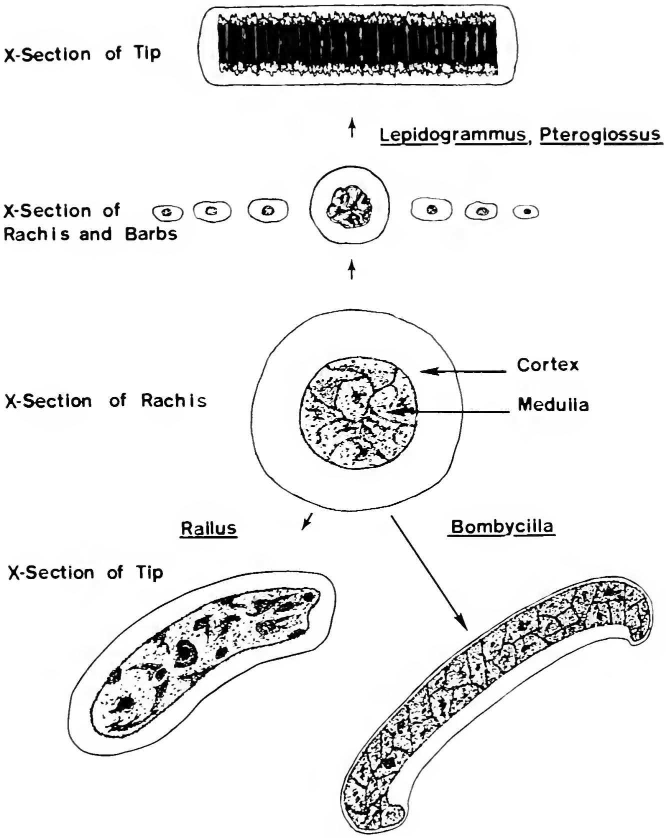


FIG. 3. Suggested relationships among various tipped feathers. The generalized structure of the rachis can be modified to produce tip structures of divergent morphology.

granules and various structural elements characteristic of the rachis. Generally, the tips of *Rallus* were considerably smaller than any of those investigated previously. Feathers similar to those in *Rallus* were also observed on the forehead of the Pied-billed Grebe (*Podilymbus podiceps*).

DISCUSSION

As was suggested earlier, at least two mechanisms may exist for the production of feather tips. Both types are found in widely divergent taxonomic groups and are therefore the result of convergent evolution within these group.

Bonhote (1912) observed that the external structure of the feather tip of the rails resembled those of the waxwing. There are, however, differences. The waxwing tip contains carotenoid rather than melanin pigments and it is considerably more flattened than is the rail tip. Carotenoid pigments are deposited in the relatively clear, unstructured cortex while the melanin pigment of the rails is deposited in the medullular areas. In spite of these differences in the location and type of pigments it appears the basic internal structure is similar in both forms. Therefore the waxwing tip can no longer be considered an entirely unique structure.

The function of the feather tips described here is still somewhat obscure. Bonhote suggested that the tipped feathers on the head of the rails may serve a protective function in preventing the abrasion of the feathers as the bird moved through the underbrush. The small size and the fact that relatively few feathers actually have tips cast some doubt on this interpretation. However, the similarity of the size, structure, and location of the tipped feathers in the rails and the grebe may be a convergent response to similar selective pressures. The larger tips of the araçari and cuckoo may serve a signal function. However, they are dark and their visibility, and thus potential usefulness, in the animal's habitat is unknown. The absence of a satisfactory functional analysis of the tips in the waxwings has been discussed (Brush and Allen, 1962).

Regardless of differences in their internal structure and function, the feather tips presumably share a common origin (Fig. 3). The structural elements of the tips are derived ultimately from modifications of structural elements already present in feathers. The formation of feathers may be one of the most complex developmental processes in vertebrate skin as it involves the alignment of rows of cells which form the shaft, barbs, and barbules (Spearman, 1966). Additional studies on the control of development of these structures promise to be of interest.

ACKNOWLEDGMENTS

I thank Avis Sylvia for technical assistance and Dr. Allen Wachtel for the generous loan of equipment. This investigation was supported in part by a grant from the University of Connecticut Research Foundation.

LITERATURE CITED

Bonhote, J. L.
1912 On a peculiar type of feather in the Water-rail. *Brit. Birds*, 5:42–44.

Brush, A. H.
1965 The structure and pigmentation of the feather tips of the Scaled Cuckoo (*Lepidogrammus cumingi*). *Auk*, 82:155–160.

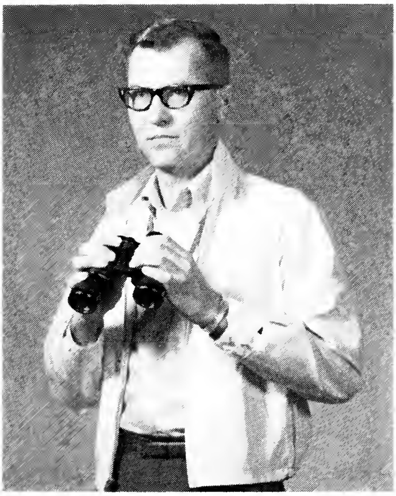
Brush, A. H., and K. Allen
1963 Astaxanthin in the Cedar Waxwing. *Science*, 142:47–48.

Chandler, A. C.
1916 A study of the structure of feathers, with reference to their taxonomic significance. *Univ. California Publ. Zool.*, 13:243–446.

Portmann, A.
1963 Die Vogelfeder als morphologisches Problem. *Verhandl. Naturf. Ges. Basel*, 74:106–132.
Spearman, R. I. C.
1966 The keratinization of epidermal scales, feathers and hair. *Biol. Rev.*, 41:59–96.

DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY, UNIVERSITY OF CONNECTICUT, STORRS, CONNECTICUT, 25 APRIL 1966.

NEW LIFE MEMBER



Dr. William A. Carter, Associate Professor of Biology at East Central State College, Ada, Oklahoma, is a new Life Member of The Wilson Ornithological Society. Dr. Carter holds a bachelor's degree from East Central State, and a Ph.D. from Oklahoma State University. His doctoral research involved an ecological study of the nesting birds of the McCurtain Game Preserve. Some of the results of this project appear in the paper on page 259 of this issue of *The Bulletin.* He is a member of the AOU, Cooper Society, National Audubon Society, Oklahoma Ornithological Society, American Society of Ichthyologists and Herpetologists, as well as other scientific societies. His principal ornithological interests are in the fields of ecology and niche positions, and bird populations, and he has published several papers in this field, as well as in the field of herpetology.

THE INFLUENCE OF VOCAL BEHAVIOR ON THE PERFORMER'S TESTICULAR ACTIVITY IN BUDGERIGARS (*MELOPSITTACUS UNDULATUS*)

Barbara F. Brockway

A striking feature of an aviary containing the Budgerigar is the seemingly constant "chatter" or "singing" which results from many individuals simultaneously performing Loud and Soft Warble. Both of these "songs" (sensu Borror, 1961) contain several components performed in varying sequences and are the most elaborate of all Budgerigar vocal patterns (for description of all vocalizations, see Brockway, 1964*a* and 1964*b*).

It is common avicultural knowledge that Budgerigars (commonly called parakeets in the U.S.A.) typically do not breed unless pairs can hear each other. This has been experimentally substantiated by Ficken et al. (1960) and Brockway (1964*c*). When males are able to hear others, individuals commonly spend up to one-quarter of their waking hours performing Loud Warble as a result of inductive mimesis (Brockway, 1964*b* and unpublished data). If permitted to interact with a homo- or heterosexual partner, such males will also perform three precopulatory vocalizations, namely Soft Warble, Tuks, and Whedelees. These three vocal patterns function in part to stimulate ovarian activity (Brockway, 1965). Even without a sexual partner, males that are able to hear others maintain their year-long typically high levels of testicular activity and can be milked for motile, unstainable spermatozoa (see Table 1). Males, which are prevented from hearing each other, perform such vocalizations as alarm and location calls in quantities similar to those of males able to hear others. Such isolated males, however, perform significantly little or no Loud Warble or precopulatory sounds, cannot be milked for seminal fluid containing spermatozoa, and possess markedly regressed testes and vasa deferentia after 3 to 5 weeks of isolation (Brockway, 1964*c* and Ficken et al., 1960).

To investigate whether it is the *hearing* of Loud Warble with or without precopulatory vocalizations performed by other males and/or some factor arising from the *performance* of these by an individual which stimulates a male's testicular activity, the gonadal conditions of both "devocalized" and sham-operated males able to hear others was studied.

MATERIALS AND METHODS

Seven males were rendered incapable of performing recognizable budgerigar sounds by surgically severing their right and left sternotrachialis muscles and removing a half-inch segment from both the right and left hypoglossal nerves adjacent to these muscles. Such "devocalized" birds utter only hoarse mono- and polysyllabic "burp" or "keek" sounds. Sham operation on seven control birds involved procedures identical to those used in "devocalization" except the sternotrachialis muscle and hypoglossal nerves were only gently touched with forceps. For further control, "devocalization" surgery was performed on only the left side of two additional males.

At the time of surgery (day 0) and at 21 and 36 days later, all of the sexually mature 9 month old virgin males used for this study were milked for spermatozoa and laparotomized so that their reproductive organs could be measured. Following the initial surgery, all males were returned to the aviary environment in which they had previously lived and where they could hear all budgerigar sounds including the almost continual daily Loud Warble performed by some 60 males in stock cages and 14 males of pairs in breeding cages.

Control and experimental males were placed in adjacent cages so that both groups could hear the abnormal utterances of "devocalized" males. The sounds produced by each "devocalized" or control male were qualitatively and quantitatively recorded during 45 minute observation periods three to six times a week for 35 days. Maintenance (e.g.; preening, eating, etc.) and sexual behavior were noted during these observations and also at other times during the study.

French's Parakeet Seed, French's Conditioning Food, cuttlebone, quartz gravel, and water were provided ad libitum.

RESULTS AND DISCUSSION

After three days, all control birds resumed their typical performance of budgerigar sounds including large quantities of Loud Warble. The seven "devocalized" males continued to perform only low-pitched "burp" or higher-pitched "keek" sounds throughout the study. The results, presented in Table 2, show that high levels of testicular activity are maintained only by males performing typical budgerigar sounds. Hearing the vocalizations of other males is not sufficient. No finer correlation was found between the recorded amounts of any vocalization performed by an individual and the size of his reproductive organs within either the control or experimental groups. That surgical trauma did not produce the decreased testicular activity of the "devocalized" males can be seen from data on controls, especially those "half-devocalized" birds which showed no significant changes in testicular activity and performed Loud Warble and all typical adult non-sexual vocalizations.

"Devocalized" birds experience two phenomena which control birds do not. They suddenly (1) are unable to perform normal species-typical vocal

TABLE 1

EFFECT OF INTRASPECIFIC VOCAL STIMULI FOR 35 DAYS UPON TESTICULAR ACTIVITY OF ADULT MALE BUDGERIGARS.*

		Mean testis length (mm)			Mean testis width (mm)			Mean vasa deferentia diameter (mm)			No. of males showing spermatozoan upon milking			Mean stage of spermatogenesis****
Males	No.	Day-1**	Day-35	P***	Day-1	Day-35	P	Day-1	Day-35	P	Day-1	Day-35	P	Day-35
Can hear others	24	7.35	8.68	<0.005	4.75	5.10	>0.20	1.00	1.00	>0.20	24	24	–	7.00
Isolated	12	7.46	4.39	<0.005	4.79	2.42	<0.005	1.00	0.37	<0.005	12	22	–	3.08
P***		>0.20	<0.005		>0.20	<0.005		>0.20	<0.005		–	<0.005		<0.005

---

* All males, 1 to 2 years old, were caged with a mate and performed similar amounts of all budgerigar vocalizations except Loud Warble or precopulatory vocalizations. Each isolated male could hear no other male and performed virtually no Loud Warble or precopulatory vocalizations.

** Prior to experimentation; when all males, caged under typical aviary conditions, could hear others.

*** Data were evaluated by analysis of variance tests (Li, 1964).

**** Scored on histological preparations by the system used by van Tienhoven et al. (1956).

TABLE 2
STIMULATION OF TESTICULAR ACTIVITY BY FACTORS INVOLVED IN PERFORMING VOCAL BEHAVIOR.*

	Mean values for															
	Testis length (mm) on day				Testis width (mm) on day				Vasa deferentia width (mm) on day				Number of males showing spermatozoan upon milking, on day			
Treatment of males	0**	21	36	*P*(0/36)***	0	21	36	*P*(0/36)	0	21	36	*P*(0/36)	0	21	36	*P*(0/36)
Devocalized	6.71	3.21	3.79	<0.005	3.93	1.79	2.29	<0.005	1.04	0.41	0.43	<0.005	7	0	0	<0.005
Sham-operated	7.50	6.82	7.36	>0.20	4.46	4.04	4.36	>0.20	1.04	0.98	1.09	>0.20	5	6	6	>0.20
Half-devocalized****	(7.75	7.75	8.00)		(5.00	5.50	5.37)		(1.16	1.16	1.16)		(2	2	2)	
P	>0.20	<0.005	<0.005		>0.10	<0.005	<0.005		>0.20	<0.005	<0.005		>0.10	<0.005	<0.005	

	Changes in testis lengths per individual between days		Changes in testis widths per individual between days		Changes in vasa deferentia widths per individual between days	
	0–21	0–36	0–21	0–36	0–21	0–36
Devocalized	–3.21	–2.64	–2.14	–1.64	–0.62	–0.61
Sham-operated	–1.07	–0.18	–1.07	–0.64	–0.11	–0.06
P	<0.005	<0.005	<0.05	<0.05	<0.005	<0.005

---

* All males heard all vocalizations including extensive Loud Warble from 60 non-paired and 14 heterosexually paired males both before and during study. Only sham-operated and "half-devocalized" males performed any Loud Warble or precopulatory vocal patterns. Data were evaluated by Chi-square and analysis of variance tests.

** The day of surgery, 1 day before the start of this study.

*** Comparisons between values for day 0 and 36.

**** These values are not included in the statistical comparisons between devocalized and control sham-operated males.

behavior and (2) produce sounds dissimilar to any they had previously made. These experiences cannot, as yet, be separated from each other. Furthermore either, in itself, might be a stress sufficient to prompt the decreased testicular activity observed for "devocalized" males. This possibility might be minimized by "devocalizing" young birds well before they ordinarily would perform the elaborate Loud Warble and precopulatory vocalizations and studying their subsequent gonadal development. High blood levels of adrenal hormones (e.g., corticosteroids) are commonly associated with stress, resulting in gonadal regression. Unfortunately, methods do not yet exist for measuring these levels in the limited blood volumes of small birds. Accordingly, birds were examined for other, grosser indications of stress. The following data suggest that the "devocalized" males were *not* undergoing reactions to stress as a result of their inability to perform anything but abnormal vocalizations: (1) the amounts of food and water they consumed did not differ from the amounts consumed by the control group; (2) their body weights were insignificantly different from those of the controls; (3) they showed no abnormal persistently ruffled or sleeked body feather postures; (4) they performed no aberrant visible behavior patterns; (5) some males performed visible precopulatory displays oriented to other males (a typical event among unisexually caged Budgerigars); and (6) 70 days after devocalization, their reproductive organs were in the same conditions as noted 35 days after "devocalization."

Of all the vocalizations in the repertoire of *Melopsittacus*, only Loud Warble, Soft Warble, Tuks, and Whedelees appear to be associated with gonadal activity (Brockway, 1964*c*). Not all control birds were heard to perform the three precopulatory vocalizations and yet all non-performers showed spermatozoa when milked and there was no distinguishable difference in their testes and vasa deferentia measurements and those of control males which did perform these vocalizations. Furthermore, the circumstances during which these three vocalizations are predominantly performed, i.e., precopulatory interactions, are not necessary for the full gonadal development or function of either sex (Brockway, 1962 and 1965). These observations strongly suggest that the performance of Loud Warble promotes the maintenance of high levels of testicular activity.

Whilst hearing the vocalizations of other males appears insufficient, in itself, to maintain full testicular activity, a male's performance of Loud Warble stimulates and in turn is stimulated by the Loud Warble of others. By so stimulating individual vocal performances, social vocal activity would play an important role in promoting the testicular activity of the flock. This would also help to explain why a male which is isolated from the sounds of others typically shows low levels of androgen secretion and spermatogenesis and why pairs of Budgerigars isolated from the sounds of others typically fail to breed.

Other known instances in which the performance of specific behavior patterns stimulates or is required for anterior pituitary gonadotrophin or gonadal hormone secretions *in the performer* seems mainly restricted to parental behaviors (for review, see Lehrman, 1961). Other known examples of a behavior's stimulation of anterior pituitary or gonadal activity involve sexual or courtship interactions between 2 individuals. In these, the behavior of one influences the endocrine activity of the other (e.g., Brockway, 1965: Burger, 1942 and 1953; Polikarpova, 1940; Matthews, 1939: Shoemaker. 1939; Lehrman et al., 1961, and Warren and Hinde, 1961). Thus, this study on Budgerigars may be the first experiment indicating a self-stimulation of an individual's gonadotrophin secretion or gonadal activity by the performance of a non-parental behavior. It would be interesting to know if any "songs" of other avian species might have, in part, a similar function.

Another point of interest stems from the ethological designation of all vocal behaviors as displays. Displays are commonly regarded as those species-typical behavior patterns primarily functioning to provide signals which alter the activity of the nervous or endocrine systems of other individuals (Tinbergen, 1964; and Hinde and Tinbergen, 1958). Budgerigars may possess at least one display which functions not only to stimulate other males to perform it but also stimulates the endocrine activity of the performer.

SUMMARY

Data on surgically "devocalized" and sham-operated controls indicates that the gonadal activity of male Budgerigars may be stimulated as a result of their performance of vocal display(s) rather than as a result of hearing such behavior by others. This may be the first demonstration of the self-stimulation of an individual's endocrine activity by his performance of a species-typical behavior which involves gonadotrophins and non-parental behavior. Since vocalizations are ethologically regarded as displays, the current thinking about the functions of displays may need expansion.

ACKNOWLEDGMENTS

This study was supported by Research Grant GB-3191 from the National Science Foundation and the generous provision of seed by the R. T. French Company of Rochester, N.Y. The author also wishes to thank Dr. Alan P. Brockway and Mrs. Marilyn Goodrich for their invaluable help during this study.

LITERATURE CITED

Borror, D. J.
1961 Songs of finches (Fringillidae) of eastern North America. *Ohio Jour. Sci.*, 61:161–174.
Brockway, B. F.
1962 The effects of nest-entrance positions and male vocalizations on reproduction in Budgerigars. *Living Bird*, 1:93–101.

1964*a* Ethological studies of the Budgerigar (*Melopsittacus undulatus*): nonreproductive behavior. *Behaviour*, 22:193–222.

1964*b* Ethological studies of the Budgerigar (*Melopsittacus undulatus*): reproductive behavior. *Behaviour*, 23:294–324.

1964*c* Social influences on reproductive physiology and ethology of Budgerigars (*Melopsittacus undulatus*). *Animal Behaviour*, 12:493–501.

1965 Stimulation of ovarian development and egg laying by male courtship vocalition in Budgerigars (*Melopsittacus undulatus*). *Animal Behaviour*, 13: 575–578.

Burger, J. W.

1942 The influence of some external factors on the ovarian cycle of the female starling. *Anat. Rec.*, 84:518.

1953 The effect of photic and psychic stimuli on the reproductive cycle of the male starling, *Sturnus vulgaris*. *J. Exp. Zool.*, 124:227–239.

Ficken, R. W., A. van Tienhoven, M. S. Ficken, and F. C. Sibley

1960 Effect of visual and vocal stimuli on breeding in the Budgerigar (*Melopsitacus undulatus*). *Animal Behaviour*, 8:104–106.

Hinde, R. A., and N. Tinbergen

1958 The comparative study of species-specific behavior. *In* Behavior and Evolution (A. Roe and G. G. Simpson, ed.), Yale Univ. Press, New Haven:251–268.

Lehrman, D. S.

1961 Gonadal hormones and parental behavior in infrahuman vertebrates. *In* Sex and Internal Secretion; Vol. II (W. C. Young, ed.), Williams and Wilkins Co., Baltimore: 1268–1382.

Lehrman, D. S., P. N. Brody, and R. P. Wortis

1961 The presence of the mate and of nesting material as stimuli for the development of incubation behavior and for gonadotropin secretion in the Ring Dove (*Streptopelia risoria*). *Endocrinology*, 68:507–516.

Li, J. C. R.

1964 Statistical Inference: Vol. I. Edwards Bros., Ann Arbor, Michigan.

Matthews, L.

1939 Visual stimulation and ovulation in pigeons. *Proc. Royal Soc.*, 126B:557–560.

Polikarpova, E.

1940 Influence of external factors upon the development of the sexual gland of the sparrow. *C. R. Acad. Sci. U.R.S.S.*, 26:91–95.

Shoemaker, H. H.

1939 Effect of testosterone propionate on behavior of the female canary. *Proc. Soc. Exp. Biol. N.Y.*, 41:299–302.

Tinbergen, N.

1964 The evolution of signaling devices. *In* Social Behavior and Organization Among Vertebrates (W. Etkin, ed.), Univ. Chicago Press, Chicago:206–230.

van Tienhoven, A., H. C. Thomas, and L. J. Dreesen

1956 The effect of sulfamethazine feeding on the thyroids, combs, and testes of single combed white leghorn cockerels. *Poultry Sci.*, 35:179–191.

Warren, R. P., and R. A. Hinde

1961 Does the male stimulate oestrogen secretion in female canaries? *Science*, 133:1354–1355.

DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY, THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO, 30 JUNE 1966.

AN IMPROVED CAGE DESIGN FOR EXPERIMENTATION WITH PASSERIFORM BIRDS

Elden W. Martin

One of the essential laboratory items needed for experimental studies of the bioenergetics of birds in captivity is a properly designed cage. Cages used at the University of Illinois were first constructed entirely of hardware cloth (Kendeigh, 1949), but many improvements were made in later years. In the author's nutritional studies with the Tree Sparrow (*Spizella arborea*), begun in 1962, several new modifications were incorporated in the cages in the interest of decreasing food loss, lessening the chance for birds to escape, and increasing the efficiency of separation of feed from accumulated feces. Since there are frequent inquiries concerning these cages, it seemed desirable to publish a set of directions for their construction.

DETAILS OF CONSTRUCTION AND DISCUSSION

The cage proper measures 31 × 16 × 31 cm, and is built with galvanized sheet-metal walls which extend above the level of the perch (Fig. 1). The upper two inches of the walls and the top of the cage are of one-half inch mesh welded hardware cloth which permits adequate light entry and air circulation. The vertically sliding door reduces chances of escape whenever the birds are handled. The cage, as illustrated, is equipped for recording of bird activity. The switch assembly (S in Fig. 1) on top of the cage, similar to that used on the older-type cages, consists of an adjustable spring-assisted microswitch that supports a hooked center rod to which the perch and moveable cage bottom are attached. The switch closes whenever the bird jumps onto or off of the perch or cage bottom. The moveable cage bottom is suspended approximately one inch above the excrement-pan floor.

The cage is easily modified to a non-activity type. For that purpose, a one-inch mesh screen bottom (less center rod) is supported by four one-eighth inch bolts arranged two on a side about one inch above the floor pan. A centrally positioned one-half inch wooden dowel perch, with ends tooled to fit one-quarter inch holes in the cage sides replaces the rod perch. A handle formed from number nine galvanized wire and attached to the top of the cage aids in the cleaning operations. The simple conversion feature of this type of cage reduces the number of cages necessary for the conduct of studies alternately considering or ignoring activity. Detailed construction plans for the cage and its attachments are shown in Figure 2. The floor pan (Fig. 1) consists of a simple one-half inch deep pan with rolled edges except at the open end which extends about two inches in front of the cage to collect any accidentally spilled feed.

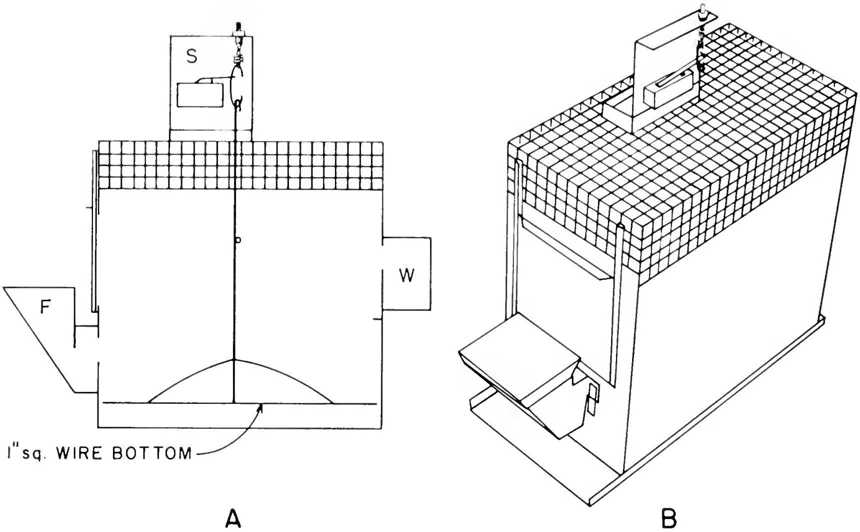


Fig. 1. A: Cut-away view from the right side of experimental cage showing relative positions of feeder (F) and water cup (W), and perch-bottom unit hooked to activity switch assembly (S). B: General view of cage as placed on the excrement pan, showing feeder attachment and vertically sliding door.

The placement of the food source outside the cage prevents, to a large extent, scattering of feed inside the cage. The birds quickly learn to reach through the one-inch diameter hole to feed, being encouraged to do so by purposeful displacement of some feed through the hole onto the cage floor when they are first introduced. Part F_3 (Fig. 2 and Fig. 1A), in addition to forming the front of the feeder, includes an apron portion which serves partially to separate the feeding area and storage area, thus preventing gross scattering of feed. This also serves to encourage the birds to eat most of the feed in the feeding area before fresh unpicked feed falls from the storage area. When food is offered in the form of finely ground mash, it is advisable to release any compressed mash by passing a spatula or similar tool down through the storage area at least once a day so that the feeding area constantly contains food. The portion of the food hopper immediately outside the feeder hole is covered by a fitted lucite strip so that the feeding area is well lighted.

In actual use, the cage is usually cleaned at three-day intervals. After cleaning, a labeled, pre-weighed sheet of aluminum foil (both Reynolds Wrap and Kaiser Foil in 12-inch widths have been used at one time or another) is placed under the cage proper so that the floor pan is lined. At the end of the three-day interval, the accumulated excreta is separated from any feed

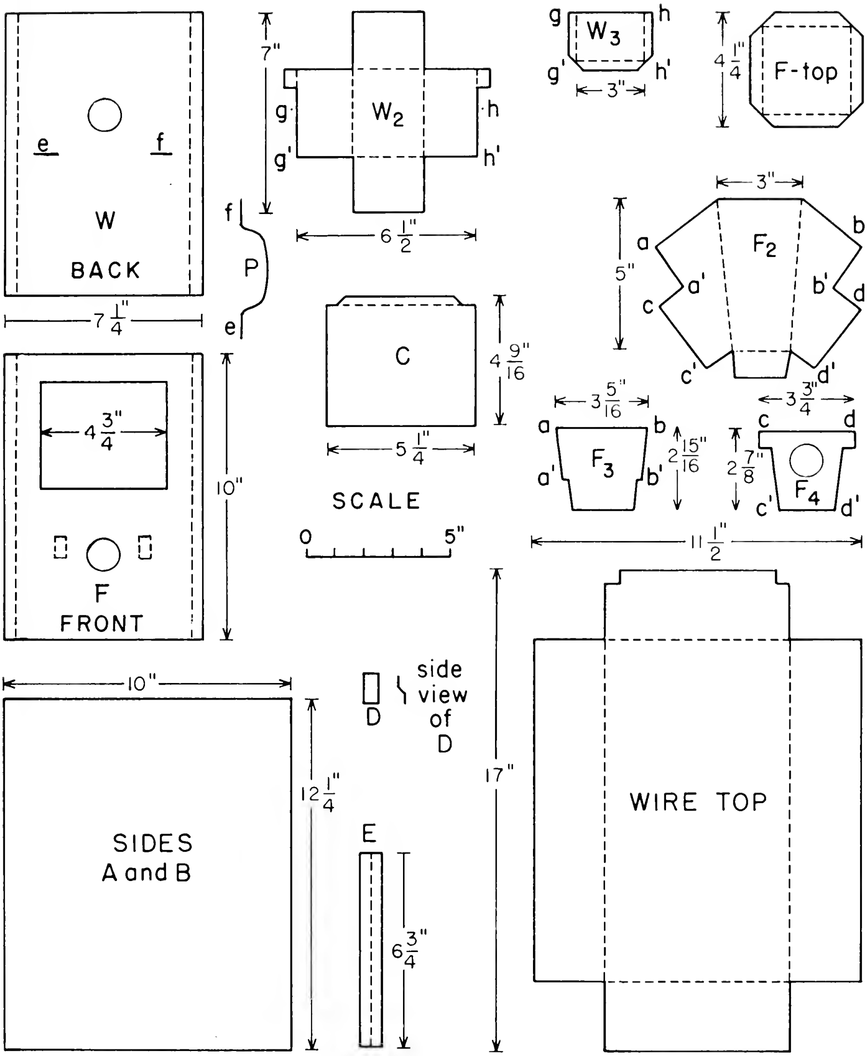


FIG. 2. Scale drawing of composite parts of experimental cage. W—Back side of cage with watering hole over which waterer (W_2) fastens on clips D. Points e and f are soldered points of attachment for perch (P). W_3 is cage side of waterer. F—Front side of cage with feeding hole and door opening. Feeder (F_2) has a top front (F_3) which attaches at common letter points (a to a, b to b, etc.) and a bottom front (F_4) which provides extensions (c and d) to hold feeder to the cage by hooking on clips D. Sliding door (C) runs in channels formed by bending strip E double. A & B—identical side pieces for cage. Wire Top—piece cut from ½ inch mesh hardware cloth; to be soldered to main cage frame formed by soldering W, F, A, and B. Dotted lines represent break-points for 90-degree bends except for piece E which requires a bend of about 170 degrees.

(finely ground) which may have been spilled, with the aid of a draftsman's brush and a one-sixteenth inch wire screen sieve. The excreta is gathered into the bottom foil, which is then folded loosely (to prevent loss) and oven-dried.

Other investigators that have used the cage have not employed the foil liner, simply allowing excreta to accumulate on the bottom pan. However, the use of foil eliminates the necessity of scraping, and thus fragmenting the excrement. When foil is used, granules of feed readily tap free from the polished surface at the time of cage-cleaning whereas scraping from the excrement pan requires drying of spilled (and uneaten) feed and excrement together, followed by screening and mechanical agitation to dislodge food particles. The latter process would seem to encourage further fragmentation of the excrement with a resultant loss of part of the excrement quantity through the sieve. Where metabolism or bioenergetics studies are in progress, this loss of raw material may result in underestimation of excrement quantity produced, and overestimation of feed not eaten.

SUMMARY

Several new ideas were incorporated in the design of an experimental cage for passeriform birds. Detailed construction plans are included and some of the design features are discussed. Suggestions for routine application procedures of the cage are offered including the use of aluminum foil as a disposable medium to aid in quantitative excrement collection and handling.

ACKNOWLEDGMENTS

I wish to thank August Kosowski for his timely design suggestions and for his skill and care employed in the actual construction of the cages. I am indebted to Dr. S. Charles Kendeigh for his encouragement in this endeavor and for his criticism of the manuscript. The project was supported in part by National Science Foundation grants awarded to Dr. Kendeigh. The paper was based on part of a doctoral thesis in the Department of Zoology, University of Illinois, Urbana, Illinois.

LITERATURE CITED

Kendeigh, S. Charles
1949 Effect of temperature and season on energy resources of the English Sparrow. *Auk*, 66:113–127.

DEPARTMENT OF BIOLOGY, BOWLING GREEN STATE UNIVERSITY, BOWLING GREEN, OHIO, 43402, 25 JANUARY 1966.

GENERAL NOTES

Flightless Green-winged Teal in southeast Missouri.—On 25 September 1963, four adult female Green-winged Teal (*Anas carolinensis*) were caught in a night drive-trapping operation on the Duck Creek Wildlife Management Area near Puxico, in southeast Missouri. All had recently molted their wing feathers and were flightless. New flight feathers were at various stages of development: in three birds the longest primaries (the ninth primary in each case) were 70–75 mm long; in one bird the longest primary was 48 mm long. The flight feathers all had soft, blood-filled shafts. In contrast, the full-grown ninth primary is about 120 mm long in adult females, and feather shafts are hard and translucent. This information is reported here because there appear to be no previous observations of flightless Green-winged Teal in Missouri or in other areas so far south of the breeding grounds. No further drive-trapping has been done at Duck Creek so it is not known if such molting occurs regularly here.—John P. Rogers, *University of Missouri, Gaylord Memorial Laboratory, Puxico, Missouri, 2 August 1966.*

Disgorging of food by Wood Ducks.—Malone (1966. *Wilson Bull.*, 78:227–228) reported regurgitation of *Chara* by Mallards (*Anas platyrhynchos*) about 45 minutes after ingestion. The *Chara* was disgorged in loosely compacted balls, each ball being about one inch in diameter. Malone postulated that disgorging resulted from overeating. No comparison was made of the moisture content of the food when eaten and when disgorged. It is the purpose of this note to report somewhat similar behavior by the Wood Duck (*Aix sponsa*).

In Ohio during 1955–57, I trapped and banded some 600 Wood Ducks. Traps were placed at the water's edge, with the corn on dry soil at the rear of the traps and the funnel entrance of the traps in shallow water. The birds could thus drink water as they fed on the dry corn. An abundance of corn was kept in the traps, and Wood Ducks regularly entered the traps and ate to the limit of their capacities. Crops and gullets were often crammed so full they literally could not hold another kernel. Feeding was completed in a few minutes.

These corn-filled ducks were sometimes kept overnight in burlap bags before work with them could be completed, and corn was often found loose in the bags. In one bag holding 12 ducks, 264 kernels were found, for an average of 22 kernels per bird. The corn was necessarily disgorged by the ducks. Even after such a night in confinement, the ducks often had well-filled crops and gullets. The corn presumably did not move through the alimentary tracts sufficiently rapidly to keep pace with the increase in volume resulting from imbibition.

In the morning, a total of 190 kernels of corn was removed from the digestive tract of one of these corn-filled ducks, 136 kernels coming from the crop and gullet. In a supplementary test, 158 (136 plus 22) kernels of corn were soaked in water overnight; the increase in volume was such that 46 kernels were displaced. With 22 kernels disgorged per bird and the crops and gullets being about equally well-filled in the morning as the preceding evening, approximately 24 kernels moved from the crop farther into the digestive tracts.

This ability to disgorge food in excess of capacity may operate to avert rupture of the crop wall. If the crop is filled to capacity, increase in volume of crop contents presumably would be hazardous to the crop wall.

Malone (op. cit.) commented on the possibility of regurgitation of food by ducks operating in the dissemination of plant propagules. In this case with the Wood Ducks, the disgorging of food can be seen as an effective means for transporting viable propagules from the birds' feeding places to their roosting places.

The observations reported in this note were made when I was a Research Fellow of the Ohio Cooperative Wildlife Research Unit.—PAUL A. STEWART, *Entomology Research Division, Agricultural Research Service, USDA, Oxford, North Carolina, 13 July 1966.*

Buff-breasted Sandpiper in northwestern Ohio.—On 11 June 1966 I was participating in a state-wide breeding bird census. I, accompanied by five of my students, ran a 25-mile transect stopping to make a 3-minute observation every half mile. Approximately half of my transect was in Hardin County and the remainder in Wyandot County. At 10:00 AM we were standing outside the car beside a plowed field on Wyandot County Road 294, five miles west of Harpster, Ohio. While I was listening for bird songs from a nearby woodlot my attention was drawn to a sandpiper moving among the clods in the adjacent field. It was a Buff-breasted Sandpiper (*Tryngites subruficollis*). Within a few minutes we located six other individuals. They were exceedingly tame and fed over the plowed field independently. On several occasions they approached within 30 feet and we observed them for 20 minutes. At the end of that time the birds got up as one and flew off to the east. The only previous spring record of this species in Ohio is given as 6 May 1923 by Borror (1950. *Ohio Jour. Sci.*, 50:1–32). Although the spring record of the Buff-breasted Sandpiper in Ohio is unusual, the date is not. Oring (1966. *Wilson Bull.*, 78:173) had this species in Oklahoma on 3 June.—RICHARD S. PHILLIPS, *834 Liberty Street, Findlay, Ohio, 23 July 1966.*

Egg teeth and hatching methods of the Long-billed Curlew.—Recent discussions on egg teeth (Wetherbee, 1959. *Bird-Banding*, 30:119–121; Clark, 1961. *Wilson Bull.*, 73:268–278; Parkes and Clark, 1964. *Wilson Bull.*, 76:147–154) stress the paucity of information on Scolopacidae, so some recent observations on three hand-reared Long-billed Curlews (*Numenius americanus*) seem pertinent. The set of four eggs was obtained from a nest west of Brigham City, Box Elder Co., Utah on 24 May 1966. Upon pipping, all four chicks had cream colored egg teeth on both upper and lower bills. The upper tooth was a raised projection 1 mm from the distal tip of the culmen. The lower tooth, on the distal tip of the lower mandible, was smaller, rounded, and barely raised from the surface of the bill. Both teeth were ephemeral and deciduous. In each of the three birds that survived, the lower mandibular teeth were lost on the first day after hatching, and the upper tooth persisted until the second day. The same situation has been described for the American Woodcock (*Philohela minor*) by Wetherbee and Bartlett (1962. *Auk*, 79:117), and for the Willet (*Catoptrophorus semipalmatus*) by Tomkins (1965. *Wilson Bull.*, 77:151–167). Conflicting data have been reported for other members of the genus *Numenius*. Willink (cited in Clark, op. cit.) found only a lower egg tooth in *Numenius* sp.; while Parkes and Clark (op. cit.) found only an upper bill tooth in *N. tahitiensis*.

Observations on the hatching method of *N. americanus* showed that the pip hole was started approximately one third the distance from the large end of the egg. It was progressively enlarged until a circle about 1.5 cm in diameter was formed. The chick then pushed out the large end and emerged by splitting the remaining shell into three approximately triangular pieces. This method is similar to that utilized by the

Willet (Tomkins, op. cit.) but different from that of the woodcock (Wetherbee and Bartlett, op. cit.).

I wish to thank K. L. Shirley for cooperation in gathering data and Dr. K. L. Dixon for criticisms of this note. This study was supported by an NDEA Predoctoral Fellowship.—Dennis M. Forsythe, *Department of Zoology, Utah State University, Logan, Utah, 18 July 1966.*

Foreign Eggs in Nests of California Gulls.—During a study on the interactions between California (*Larus californicus*) and Ring-billed gulls (*Larus delawarensis*) at Miquelon Lake, located at 53°15′N and 112°55′W in Alberta, in 1964 and 1965, three coot, two grebe and two Lesser Scaup (*Aythya affinis*) eggs were found intact in California Gull nests and were being incubated. Neither coots nor grebes nested on the island or had been seen visiting gull nests. It appears, therefore, that they were ingested whole by the gulls and regurgitated in the nest. On several occasions grebe and duck eggs were observed which were pecked open just outside and over the nest rims. As a rule, when the gulls bring whole eggs back from different localities and regurgitate them outside the nest, they are pecked open and devoured. However, when the eggs are regurgitated within the nest, the drive to incubate these eggs may be stronger than the urge to eat them.

Twomey (1948. *Condor*, 50:97–100) observed California Gulls bringing other birds' eggs to their nests in Idaho. Sometimes they were carried in the bill, but more often they were swallowed and regurgitated at the nest. The eggs brought were those of Cinnamon Teal (*Anas cyanoptera*), Ring-necked Pheasant (*Phasianus colchicus*), American Coot (*Fulica americana*), Black-necked Stilt (*Himantopus mexicanus*), and Eared Grebe (*Podiceps caspicus*). Sugden (1947. *Condor*, 49:93–96) found Ring-necked Pheasant, Shoveler (*Spatula clypeata*) and Cinnamon Teal eggs in the California Gull nests in Utah. These data all confirm the suggestion that California gulls swallow eggs whole and regurgitate them later in the nest.—Kees Vermeer, *10177-104 Street, Edmonton, Alberta, 2 August 1966.*

Bonaparte's Gull feeding on walnut meat.—The food of Bonaparte's Gulls (*Larus philadelphia*) wintering along the seacoast usually consists of live marine life, mostly taken from the surface of the water (Bent, 1921. *U.S. Natl. Mus., Bull.*, 113:178).

During many years of observation of gull concentrations in New Jersey, I have never seen a Bonaparte's Gull at garbage dumps, pig farms, or the other scavenging areas where the larger gulls congregate. Therefore, I was surprised to find the crop of a Bonaparte's Gull crammed full of walnut meat. This food was also in the gizzard, whereas no other food was present. The walnut meat was in the form which is commonly used by housewives.

The bird, a female in immature plumage, was collected on 22 April 1963 at South Amboy, Monmouth County, New Jersey from a flock of about 200 Bonaparte's Gulls. This species is common at this time of year at this location. Large numbers are often noted feeding in the tidal rifts in Raritan Bay.

I have no idea where this individual could have obtained its unusual meal. The specimen is no. 210605 in the University of Michigan Museum of Zoology.—Robert C. Frohling, *Howell, Michigan, 6 April 1966.*

Predation by the Chuck-will's-widow upon migrating warblers.—That the Chuck-will's widow (*Caprimulgus carolinensis*) captures birds was known to Audubon (1859. *Birds of America*, 1:154) who suggested that the species might be "carnivorous." Subsequent reports of bird-capture have shown his supposition to be, to an extent, valid (see e.g., Bent, 1940. *U.S. Natl. Mus. Bull.* 176:506.) and have, as Terres (1956. *Auk*, 73:290) expressed it, indicated that the Chuck-will's-widow may be "a seasonal if not regular eater of small birds." Additional evidence of the seasonal aspect of its predatory habits is herewith presented.

A Chuck-will's-widow, found dead during the morning of 18 October 1961 in Miami Shores, Dade County, Florida, was brought to Mrs. Arthur Gasche of that municipality who presented the specimen to me. Wedged tightly into the throat of the caprimulgid, its head well down into the esophagus, was a male Yellowthroat (*Geothlypis trichas*). Death of both birds would seem to have been by suffocation. During preparation of the two as study skins for the University of Miami Research Collections (UMRC), further pertinent information was obtained.

The Yellowthroat, weighing 12.9 grams, contained much subdermal fat. In its stomach were small insects. The Chuck-will's-widow, a female, weighed—apart from the Yellowthroat—121.4 grams. It likewise contained considerable fat. In the stomach of the Chuck-will's-widow was a nearly intact male Cape Warbler (*Dendroica striata*). Only the warbler's skull, from which the feathers and skin loosened when the bird was removed from the stomach, gave evidence that digestion of it had begun. Remains of this warbler weighed approximately 8.0 grams. (The combined weights of the two warblers, incidentally, are equal to about 17 per cent of the weight of the Chuck-will's-widow minus its warbler content.) In addition, there were in the stomach two large glassy-winged locusts (*Stenacris vitreipennis*), these showing but little evidence of digestion.

In mid-October, migration down the Florida peninsula is at a peak. That the Chuck-will's-widow and the Yellowthroat were migrating seems probable from their considerable content of fat. The Cape May Warbler is present in Florida only as a migrant. It seems logical to assume that, under ordinary circumstances, only during the seasons of migration would small birds such as warblers be available to nocturnal predators seeking flying prey. Here then, within the range of the Chuck-will's-widow, is one more hazard which small night-migrants face. In this instance, however, circumstances allow a certain degree of speculation as to the time of capture of the warblers. Judging from the condition of the three birds, it seems unlikely that they were captured before dusk on 17 October or, for that matter, early that night. Considering the stage of digestion of the insects in the stomach of the Yellowthroat and of that of the diurnal locusts in the stomach of the Chuck-will's-widow, it seems far more likely that these insects were taken in daylight on 18 October. Thayer (1899. *Auk*, 16:273–276) presented a fascinating account of Chuck-will's-widows capturing migrating warblers over the open ocean during daylight. Similarly, this Chuck-will's-widow at Miami Shores may be suspected of gathering its warblers at dawn or during early morning hours, both prey and predator, possibly, being engaged in building up or replenishing fat reserves prior to migration beyond the shores of Florida.

The fact that the Chuck-will's-widow can capture small birds in daylight requires emphasis, for as Thayer's (op. cit.) observations showed, this migrant stands in the unique position of being able to feed while enroute over the ocean, a potential which exclusively terrestrial birds quite generally lack.—Oscar T. Owre, *Department of Biology, University of Miami, Coral Gables, Florida 25 August 1966.*

Josselyn Van Tyne's Common Nighthawk nesting return.—Among the notes and files turned over to me for "Fundamentals of Ornithology," I found three paragraphs of a first draft of a paper which Josselyn Van Tyne obviously intended to finish as a general note on the return of a Common Nighthawk (*Chordeiles minor*) to its breeding ground. Van Tyne had prepared some bibliography cards on the subject through 1952. The three paragraphs are hand-written on the back of a page of *Conservation News*, dated 15 May 1955, so we can only assume that this is the approximate time that he jotted down his first ideas. It is almost certain that he did no further work on the project because, despite his remarkable command of current world literature on birds, he did not include a reference to Dexter's second paper on Common Nighthawk returns (1956. *Bird-Banding*, 27:9–16).

Why Van Tyne did not complete the short note is purely conjectural at this time. He spent the period of 10 to 26 June 1955, in field studies: 12–13 and 24–26 June in his Kirtland's Warbler study area in Crawford County, and the intervening period in Michigan's Upper Peninsula with Dr. L. H. Walkinshaw and Dr. and Mrs. W. Powell Cottrille. He was also devoting a considerable amount of time to the AOU Check-List during this general period.

Van Tyne's hand-written notes read as follows:

"While studying Kirtland's Warblers with us in June, 1942, ten miles southeast of Mio, Oscoda County, Michigan, Frances Hamerstrom found a Nighthawk nest with 2 eggs in a little open area on a hillside among the jack pines that sheltered the Kirtland's Warblers.

"On 20 June 1942, I set a carefully concealed bow-net at the nest and caught and banded the incubating female (No. 41-222357).

"We studied the same area in 1943 but found no Nighthawk nest. However, on 24 June 1944, I found a nest in a similar habitat 450 feet south of the 1942 nest. Capturing the female with a bow-net, I found that I again had No. 41-222357."

The area "ten miles southeast of Mio, Oscoda County" was in Section 19, T25N, R4E.

Parks (1946. *Bird-Banding*, 17:168) reported on a Common Nighthawk which returned to lay its eggs on the roof of the same high school in two successive years, in Hartford, Connecticut, and Dexter (1952. *Bird-Banding*, 23:109–114; 1956. *Bird-Banding*, 27:9–16) told of the return of a banded bird to the roofs of several buildings of Kent State University in Ohio. Van Tyne, however, appears to have been the first person to make observations on a banded Common Nighthawk returning to the same general nesting area on the ground, the original primitive nesting site for this species. It may be recalled that Van Tyne also was the first ornithologist to show by banding that passerine birds return to the same wintering ground in the tropics (1932. *Bird-Banding*, 3:110).—Andrew J. Berger, *Department of Zoology, University of Hawaii, Honolulu, Hawaii, 14 July 1966.*

Retarded or arrested cranial development in *Myiornis ecaudatus*.—A pair of Short-tailed Pigmy-tyrants, (*Myiornis ecaudatus*) were obtained, 19 August 1966, from rain forest, near Los Guaraunos, Estado Sucre, Venezuela. They were feeding two nestlings that were nearly ready to leave the nest.

While preparing the specimens, we observed that both had partially pneumatized or incompletely ossified skulls. The frontals and parietals were almost completely unpneumatized (single-layered), thin, transparent and flexible structures. Only the anterior parts of the frontals and posterior parts of the parietals were pneumatized (double-layered). In passerines, this condition is usually found only in the sexually immature birds whereas, actually breeding adults have a completely pneumatized skull.

This condition of unpneumatized skull has been reported in individuals of several passerine species which were sexually mature or actually reproducing. Noteworthy are the following: *Loxia curvirostra* (McCabe and McCabe, 1933, *Condor*, 35:136–147); *Quelea quelea* (Disney and Marshall, 1956. *Proc. Zool. Soc. London*, 127:379–387); *Lepidocolaptes lachrymiger, Euscarthmornis granadensis, Elaenia obscura, Mionectes striaticollis, Myadestes ralloides, Molothrus bonariensis, Tanagra xanthogaster* (Miller, 1963. *Univ. California Publ. Zool.*, 66:1–78), *Synallaxis albescens* (Miller, 1955. *Acta XI Congr. Intern. Ornith. Basel*, p. 495–503). Grant (1966. *Amer. Midland Nat.*, 75:142–149) also observed the same phenomenon in *Myiopagis viridicata* and gave a good review of the genera and families in which retarded or arrested skull ossification has been reported.

According to Dwight (1900. *Ann. New York Acad. Sci.*, 13:73–360) and Nero (1951. *Wilson Bull.*, 63:84–88), the skulls of passerine species appear to pneumatize completely at about eight months of age. On the other hand, Miller (1963. op. cit.), indicated that in some of the tody-flycatchers there are single-layered regions in the skull that may prove to be permanent. Concerning the genus *Mionectes*, Miller (1963) said, "the skull either is slow in attaining adult double-layered condition throughout or never attains this state in some individuals." He also reported (Miller, 1946. *Bird-Banding*, 27:33–35) that complete pneumatization (doubling) may never be complete in some non-oscine families such as the Furnariidae. Since *Myiornis ecaudatus* is not biologically well known, we can not specify whether or not the incomplete pneumatization is the result of an arrested or a retarded process. Neither can we say that this phenomenon is of usual occurrence in this species. It also seems possible that individuals of this species are sexually mature or actually reproducing while still being very young as indicated by the presence of unpneumatized skulls.

We thank Mr. James Dale Smith for helping in the preparation of the manuscript, and the Shell Foundation of Venezuela who provided a vehicle for field work. This study is a byproduct of ecological research while the senior author was a Ph.D. student of the Department of Zoology of the University of Montreal. Financial support was given by the University of Oriente in Venezuela and the National Research Council of Canada.—RAYMOND MCNEIL AND AIDA MARTINEZ, *Departamento de Biologia, Universidad de Oriente, Cumana, Sucre, Venezuela, (Present Address (McNeil), Department of Zoology, University of Montreal, Montreal, Canada.) 12 September 1966.*

The gaping response of nestling Bank Swallows.—Because of the hole-nesting habit of Bank Swallows (*Riparia riparia*) the behavior of the young on the nest is difficult to observe. Beyer (1938. *Wilson Bull.*, 50:122–137) observed Bank Swallows on their nest by digging an observation hole behind their burrow. He reported that the parents gave a high pitched call when entering the nest. If this did not release gaping, the adults would nudge the young. In the summer of 1964 I undertook to study the gaping response of young Bank Swallows from an observation hole similar to that described by Beyer (op. cit.).

On 7 July 1964 near the W. K. Kellogg Biological Station of Michigan State University, Barry County, Michigan, I found a large Bank Swallow colony and began construction of an observation hole. The nest contained three young estimated from Beyer's fledging dates to be eight days old. Before completion of the hole I observed that the young birds gaped vigorously and gave begging calls when I darkened the nest chamber by placing my hand over the burrow entrance, as they did when I brightened the nest chamber with a flashlight.

The young birds were 10 days old when I was first able to observe them inside the nest. The young gaped when the adults entered the burrow, even if the adults did not walk back to the nest chamber. Although I could hear the begging calls of the young, in none of the observation periods did I hear the adults give any call upon entering the nest. The nestlings lifted up their heads when a shadow from another bird passed across the burrow entrance, but they did not gape. The next day I noted the same behavior.

On the 12th day of the birds' life it was cloudy and rainy all day. The young were fed at intervals of 15 to 30 minutes. Perhaps due to the infrequent feeding, the young gaped at shadows that passed over the burrow; and once when I shined a flashlight through the glass plate between my observation hole and the nest chamber, they all turned and gaped widely toward it.

In all previous observations the nestlings did not move off the nest; on the 13th, 14th, and 15th days, however, two of the nestlings were continually off the nest and about one-third of the way down the burrow. A third nestling remained on the nest.

On the 16th and 17th days all three young were fed at the entrance of the burrow. They gaped whenever another bird hovered about them. On the 18th day the nestlings had fledged, and for the next three days I found them on the nest only at night.

Nestling Bank Swallows apparently do not gape in response to a call from the parents, but rather either to a change in lighting or to the approach of another swallow.—George W. Fulk, *Department of Zoology, Michigan State University, East Lansing, Michigan, (Present address: Department of Zoology, University of Rhode Island, Kingston, Rhode Island).*

Seasonal variation in bill length of House Sparrows.—In the course of an investigation of geographic variation of House Sparrows (*Passer domesticus*), data were obtained which further demonstrate seasonal variation in bill length of this species. Specimens were collected at Kit Carson, Cheyenne Co., Colorado, in mid-October, 1964, and in late August, 1965. Measurements of the bill were taken from the anterior margin of the nostril to the tip of the mandible, and were recorded to the nearest 0.1 mm. Only adult birds (as determined by cranial ossification) were used in the present study so as to ensure that the samples are comparable. Statistical treatment was by analysis of variance (Steel & Torrie, 1960. "Principles and Procedures of Statistics." McGraw-Hill, New York).

A statistically significant variation in bill length among groups was indicated (see Table 1). However, no portion of this variation could be attributed either to differences between sexes ($P > 0.10$) or to an interaction component ($P > 0.10$). All of the variation in bill length could be assigned to effects of season of capture ($0.025 > P > 0.010$), birds obtained in August having longer bills than birds captured in October.

The results are in essential agreement with reports by Clancey (1948. *Brit. Birds*, 41: 115–116) and Davis (1954. *Condor*, 56:142–149) which indicate that bills of House Sparrows are longer in summer than in autumn and winter. Presumably this variation has as its basis seasonal changes in food habits of sparrows (Davis, op. cit.; Selander and Johnston, 1967, *Condor*, 69:217–258); wear to the bill is thought to be greater during late autumn and winter when the primary foods are seeds than it is in summer when a substantial part of the diet is soft-bodied insects.

TABLE 1
BILL LENGTH OF HOUSE SPARROWS
(MEAN PLUS STANDARD ERROR)

Sex	August	October
Female	9.42 ± 0.122 (6)*	9.27 ± 0.100 (12)
Male	9.44 ± 0.053 (7)	9.04 ± 0.104 (9)

* Sample size.

Furthermore, absence of differences in bill length that are related to sex supports earlier contentions that North American House Sparrows have not undergone evolutionary change effecting a partitioning of the food niche (Packard, 1967. *Syst. Zool.*, 16:73–89; Selander and Johnston, op. cit.). Presumably, failure of House Sparrows to experience evolutionary change of this sort is related to their exploitation of an abundant and diverse food source, thereby obviating specialization of bill structure for restricted food sources (Selander, 1966, *Condor*, 68:113–151).—GARY C. PACKARD, *Department of Zoology and Entomology, Clemson University, Clemson, S.C., 9 September 1966.*

Unusual activities of a House Sparrow and a Blue Jay at a Tufted Titmouse nest.—A Tufted Titmouse (*Parus bicolor*) pair nested in a Bluebird (*Sialia sialis*) nest box in my yard at Pennington, N.J. On the morning of 4 July 1965 the titmouse young were fed by a female House Sparrow (*Passer domesticus*) on three occasions within a 40-minute period. She was also making frequent feeding flights to her nestlings in a bird house 17 ft. away. The titmouse pair protested noisily by scolding and diving and once successfully drove her away.

The following morning (5 July) as I watched closely to see if the sparrow would return, a Blue Jay (*Cyanocitta cristata*) flew to the titmouse nest box just as an adult titmouse left, perched on the lower rim of the nest hole, pushed its head and neck well into the nest box and pecked eight times at the nest contents. Then it perched a few moments on an adjacent branch, 10 inches away, before returning to peer in the nest box and poke at the nestlings. Once again it perched on the branch, returned, and poked into the nest box. The jay did not taken anything from the nest. Although the titmouse pair protested noisily by scolding and diving at the jay as it perched on and near the nest box, they did not deter the jay. The entire incident took nine minutes.

Twenty-nine minutes later a jay (same?) flew to the nest box, thrust its head and neck into the box as before, poking three times at the contents before leaving slowly up through the nest tree, branch by branch.

The design of the box was such that it was 8½ inches deep in front but only 8 inches at the back with the almost-square interior 5 inches wide. The nest rim was approximately 3½ inches below the box entrance hole and it seems possible that the jay could have reached the nestlings.

There were ample auditory and visual cues to the nest's location for a potential predator. The titmouse nestlings were very noisy when fed by the adults and at times the nestlings continued calling after the feedings. Moreover, the adults generally flew directly to the nest box hole with food.

The four titmouse nestlings fledged on 5 July. I was unable to determine if the nestlings were injured by the jay's thrusts. Inspection of the nest and box disclosed no signs of blood.—KENNETH W. PRESCOTT, *New Jersey State Museum, Trenton, New Jersey, 24 May 1966.*

Extralimital breeding of Painted Buntings in Florida.—On 8 July, 1966, two singing male Painted Buntings (*Passerina ciris*) were found on the northeastern outskirts of Apalachicola, Franklin County, Florida. The buntings were adjacent to the Apalachicola River, about one-half mile from the Gulf coast, in an open growth of willow (*Salix* sp.), chinaberry (*Melia azedarach*), and wax-myrtle (*Myrica cerifera*), with a thick understory, predominately of blackberry (*Rubus* sp.) and sesbania (*Sesbania* sp.). On a second trip to the area on 29 July, 1966, two males were again singing, and a third male, also in song, was located nearby in similar habitat. Breeding was suspected when two juveniles were located near the third male. They were actively fed by a dull, female-like bunting, showing faint reddish on its underparts.

This small colony at Apalachicola is located near the center of a hiatus in the Painted Bunting's breeding range; a 400 mile break between southern Alabama (Mobile County: Imhof, 1962. "Alabama Birds") and coastal portions of eastern Georgia and northeastern Florida (Burleigh, 1958. "Georgia Birds"; Sprunt, 1954. "Florida Bird Life"). The absence of breeding buntings in Florida portions of this hiatus has been corroborated at Pensacola by Weston (1965. A Survey of the Birdlife of Northwestern Florida, Bull. Tall Timbers Research Station, No. 5. Tallahassee.), and throughout the interior and Gulf coastal regions of North Florida by H. M. Stevenson and his workers during recent state-wide field investigations of breeding birds. No Painted Buntings were found at Apalachicola during previous summers (Stevenson, personal communication), however, two summer records near Tallahassee, in 1962 and 1966 (Robertson, 1962. *Audubon Field Notes*, 16:47; Stevenson, 1966. *Audubon Field Notes*, 20:564), of single, singing males, are the first known summer occurrences for that area, and suggest that the appearance of the Painted Buntings at Apalachicola may be part of a trend towards occupation of the hiatus.

The factors which brought about this wide gap in breeding range are not understood. Suitable breeding habitat appears to exist throughout the range-gap, and migrant Painted Buntings are regularly found in small numbers along the northeast Gulf coast in spring, adjacent to the unoccupied area. The presence of these migrant buntings along the coast may be due to displacement of trans-gulf migrants by weather associated with northwesterly cold fronts crossing the Gulf of Mexico. The possibility that such displacement resulted in the establishment of the colony in Franklin County, Florida, seems good. Several cold fronts did cross the Gulf during April and May, 1966, resulting in eastward displacement of trans-gulf and western migrants (Cunningham, 1966. *Audubon Field Notes*, 20:497). An area-wide field count on 22 April, 1966, in Franklin and adjacent Wakulla Counties, produced 13 Painted Buntings, second highest number in the history of spring counts in these counties, and buntings at Alligator Point, Franklin County, on 7 May, and at Pensacola on 11 May, were the latest or equaled previous late spring records for those two areas respectively (Cunningham, (loc. cit.); Imhof, 1966. *Audubon Field Notes*, 20:518).—JOHN C. OGDEN AND FRANK L. CHAPMAN, *Department of Biological Science, Florida State University, Tallahassee, Florida, 1 September 1966.*

Goldfinch accept young after long and short incubation.—In the summer of 1965, in Toledo, Ohio an experiment was carried out in which eggs of the American Goldfinch (*Spinus tristis*) from clutches just laid were exchanged for eggs that were in advanced incubation.

On 31 July I exchanged eggs between nests of 11 day incubation and those where the fifth egg had just been laid. The eggs that had been laid for only the short time were taken by a predator on the following day. The other female Goldfinch continued to incubate for an additional 12 days until the entire clutch had hatched. She had been incubating for a total of 23 days. I was not able to examine this nest until 10 days later. At that time the nest looked "used" but since there was no defecated material on the nest it would appear that the young had not been in the nest for long.

On 5 August, I exchanged eggs that were in day four of incubation with a clutch that had two eggs piped. The eggs hatched in both nests and the young were all fledged. The one female had incubated for about five days and the other had incubated for 19 days.

The mean incubation period for this species has been reported as about 11–12 days, (Walkinshaw, 1938. *Jack-Pine Warbler*, 16:3–11 and 14–15). From the preceding experiments it is obvious that at least in some instances, the female will accept young after one-half the length of or twice the length of the mean incubation time.—LARRY C. HOLCOMB, *Department of Biology, Creighton University, Omaha, Nebraska, 11 July 1966.*

New status for the Rufous-crowned Sparrow in Utah.—The first record of the Rufous-crowned Sparrow (*Aimophila ruficeps*) for Utah (Wauer, 1965. *Condor*, 67:447) was based on a specimen taken at Oak Creek Canyon, Zion National Park, Washington County, Utah, 5 November 1963. The writer reported the species as wintering in Zion Park. He concluded that, "early fall records, in August, in Zion Park indicate a fall wandering tendency for the species, but the presence of Rufous-crowned Sparrows throughout the winter months appears to suggest a northerly movement in fall and, perhaps, a return to southerly breeding grounds in spring."

However, an immature Rufous-crowned Sparrow (deposited at Museum of Vertebrate Zoology, University of Utah), taken by the author at Oak Creek Canyon, Zion National Park on 10 August 1965, suggested that the species may be more than a wintering resident there. It, like a specimen collected on 5 November 1963, was of the race *scottii*, according to Lester L. Short. The possibility was suggested that the species resides permanently in the vicinity, nesting on the upper slopes of the canyons and moving into the lower canyons after nesting and to winter. In Arizona, the species is a spring to late summer nester; its period of breeding closely tied with summer rainy season. Brandt (1951. "Arizona and Its Bird Life" p. 702) reports a completed nest as early as 24 May, nests as late as 15 August, and that the height of the season for fresh eggs is during the latter half of June. Assuming that the species did reside within the Zion Canyon area, the author searched appropriate habits during May and June, 1966; on 29 June on the west slope of Steven's Wash, Parunuweap Canyon of Zion National Park, a lone singing adult was found. I watched it for several minutes through 9× binoculars. It moved to several perches within an approximate 100 foot circle singing all the while. Suddenly a second Rufous-crowned Sparrow, its bill full of grass, flew to a perch about two feet from the singing bird. Both remained there for five to ten seconds before they departed, flying up the slope and around a number of large rocks out of sight. I was unable to locate them again.

Although I was not able to return to the scene before being transferred from Zion Park, this observation of one singing adult and another carrying nesting material offer good evidence of nesting. The habitat, too, is typical of Rufous-crowned Sparrow nesting grounds. The elevation is about 4,200 feet. Huge sandstone boulders dominate the seven degree slope where *Pinus monophylla*, *Juniperus osteosperma*, and *Quercus gambellii* are common. The heavy patches of grasses that occurred there were under study as a choice "relict grassland" by LaMar Mason and James Carley of the Soil Conservation Service. Mason's identifications of the major grasses on the site include needle-and-thread (*Stipa comata*) as the dominant grass, while Indian rice grass (*Oryzopsis hymenoides*), black grama (*Bouteloua eriopeda*), and mutton grass (*Poa fendleri*) were abundant.

A portion of the above data was obtained during field research supported by National Science Foundation Grant No. GB-4035.—Roland H. Wauer, *Big Bend National Park, Texas, 12 September 1966.*

ANNOUNCEMENT

The XV International Ornithological Congress

The International Ornithological Committee decided, at the close of the XIV International Congress, that the next Congress would be held in the Netherlands in 1970 and appointed Professor N. Tinbergen as President. The Netherlands members of the International Ornithological Committee elected Professor K. H. Voous as Secretary-General and formed a Netherlands Executive Congress Committee.

The International Committee accepted the Dutch proposal that the date of the Congress would fall within the first week of September, as it was feared that appropriate accommodation would not be obtainable earlier in the summer months. No major ornithological excursions will be organized, but in the middle of the congress week a variety of one-day excursions will be held. After full consideration the Netherlands Executive Congress Committee decided that the XV International Congress would be held at 's-Gravenhage (The Hague), with the provisional date: 30 August–5 September 1970.

Applications for membership in the Congress will be accepted until 4 months before the opening date of the Congress, viz. till 1 May 1970. Applications for presenting papers and for arranging "Specialists Meetings" should reach the Secretary-General not late than 1 April 1969.

Further information regarding the Congress can be obtained from The Secretary-General, XV International Congress, c/o Burgemeester de Monchyplein 14, The Hague, Netherlands.

THE PRESIDENT'S PAGE

The Proceedings of our excellent 1967 meeting, held during 15–18 June at the Crawford House, New Hampshire, appear elsewhere in this issue, as recorded by Pershing B. Hofslund, who has completed his fifth and final year as the dedicated Secretary of this Society. As I express to him the grateful appreciation of all of us for the fine work which he has done, I would welcome, with similar gratitude, his successor, Jeff Swinebroad, who was elected Secretary at the June meeting.

This specific example of one good man taking over from another illustrates a general point which one of our esteemed Past Presidents, Maurice Brooks, has made. Writing to me, shortly after the meeting, Dr. Brooks commented: "The setting was great, the crowd excellent, and the spirit encouraging as always." He then said: "I never cease to marvel at the viability of this organization; year after year it comes up with devoted people who get the jobs done."

The continuing devotion of Past Presidents, as exemplified by Maurice Brooks, is a large part of the viability of the Wilson Society. This continuity of devotion also can be seen in the fact that the symposium on nocturnal migration and orientation, which was an outstanding feature of the papers sessions at the meeting, was proposed by a Past President, Sewall Pettingill, and was organized and chaired by one of our Vice Presidents, William Gunn. Two Past Presidents, moreover, participated in the Saturday evening program, after the Annual Dinner: Dr. Pettingill as Toastmaster, and Dr. George Sutton as the speaker of the evening.

Next year's meeting, to be held at Southern Illinois University, Carbondale, Illinois, 2–5 May, 1968, will provide still another example of a Past President's contribution to the viability of the Wilson Society. Roger Peterson will be the Chairman of a symposium on the preparation of state and regional bird books. In writing to say how pleasant the 1967 meeting was, Dr. Peterson said that he will enjoy planning and chairing the 1968 Symposium. The latter will be concerned with a subject of timely relevance. No one who is interested in North American birds can afford to miss it. But the point is that, busy man though he is, Past President Peterson is sufficiently devoted to the Wilson Society to take the time to organize this important symposium for next May's meeting.

Aaron M. Bagg

(As we go to press, we learn that an unexpected commitment will make it impossible for Dr. Peterson to attend the Carbondale meeting, but we expect to continue with the symposium which he had planned.—Ed.)

CORRECTION

The following correction should be made in the article, "A new subspecies of the Boat-tailed Grackle from Mexico," *Wilson Bull.*, 78:129–131 (1966). In Table 1 the weight data for females of the subspecies *prosopidicola* should read: (6) 117–137.6
(125.2)

ORNITHOLOGICAL NEWS

FROM THE AOU

At its annual meeting in Toronto, Ontario on 21 August 1966 the AOU elected the following officers:

Harold F. Mayfield, President	L. Richard Mewaldt, Secretary
John W. Aldrich, First Vice-President	Burt L. Monroe, Sr., Treasurer
Eugene Eisenmann, Second Vice-President	Oliver L. Austin, Jr., Editor

The Brewster Medal was awarded to W. E. Clyde Todd for his book, "Birds of the Labrador Peninsula." Mr. Todd, the senior member of the AOU, is the first person to win the Brewster Medal for the second time.

The Smithsonian Institution and the United States Department of the Interior have designated part of their page allotment under the National Science Foundation translation program for the six volumes of Dement'ev and Gladkov: "The Birds of the Soviet Union." The series is being translated in Jerusalem by the Israel Program for Scientific Translations which holds the copyright. Drs. A. Birron and Z. S. Cole are the translators and Dr. Cole is editor. Volume 1 has already appeared and is available for $3.00, paperbound, from the U.S. Department of Commerce, Clearing House for Federal Scientific and Technical Information, Springfield, Virginia 22151. The translation for Volume 4 has been completed and page proof has been read. It should appear in late 1967, barring unforeseen problems in the Middle East. Unfortunately, Dr. Cole died this year and translation has been interrupted. Before he died, however, Volume 6 was almost completed, volumes 2 and 3 were each about one third translated but Volume 5 was not yet started. The schedule for issuing the remaining four volumes will be announced after a new translator and editor have been found.

Royal Terns from coastal Virginia have recently been color banded as part of a study by P. A. and F. G. Buckley on variation in chick color. A total of ten different colors have been used (including light blue, purple and dark blue); three at a time plus one Fish and Wildlife band, have been placed on each bird, in unique combinations. Anyone observing such a banded bird is asked to send a postcard to Dr. Buckley, Department of Biology, Old Dominion College, Norfolk, Virginia 23508, with the following information on it: date, location, and observer's name, plus the band colors and their positions (upper/lower, right or left leg). Assistance in this project will be greatly appreciated.

Joanna Burger and Richard Brownstein of Buffalo, New York, are working on the distribution and migratory behavior of the Bonaparte's Gull. The gulls are dyed a bright color and banded. The color used denotes the date of the marking session. All birds are color marked in Buffalo. If you see any unusually colored Bonaparte's Gull, please send the following information to Joanna Burger, Department of Biology, State University College, 1300 Elmwood Avenue, Buffalo, New York 14222: Date, Location, Color, Number of marked individuals, and the Number of unmarked Bonaparte's Gulls with the color marked gulls. Any other data from personal records on the distribution and movement of these gulls would also be appreciated.

ORNITHOLOGICAL LITERATURE

The Birds of Colorado. Two volumes. By Alfred M. Bailey and Robert J. Niedrach. Denver Museum of Natural History, 1965: 9 × 12⅜ in., vol. 1, xxii + 454 pp., vol. 2, x + 455 pp., 124 col. pls., over 400 bl. and wh. photos, back endpaper map in each volume. Set of two volumes, $35.00.

News that another "state list" is about to appear always provokes certain expectations. It will be a monumental piece of book-making, sumptuous, an armload, and too big for the usual bookcase. It will be as much of a personal document as it is a magnum opus of its author, reflecting his style and special interests as well as his longtime dedication to the subject. Although written in popular style, it will bow to the scholarly approach in its coverage of literature. It will be handsomely illustrated with the latest and best efforts of photographers and artists. Even though underwritten by one or more benefactors, it will be too costly for the average book-buyer. Nevertheless, it will sell like hotcakes and become a boon to the rare-book market in no time at all.

Statism, like nationalism, is a fact of life these days. However ornithologists may scoff at such senselessness when carried to the point of confining treatises on birds to political boundaries, there is not an ornithologist I know who would not relish owning every work of the sort produced. I thoroughly enjoy acquiring, perusing, and reading parts of each state bird book that comes along. None have I enjoyed more than "The Birds of Colorado."

The two volumes tip the scales at twelve and one-half pounds and measure three and three-quarters inches in total thickness. On the book shelf they stand 12 and three-eighths inches tall, exceeding by an eighth of an inch Harold H. Bailey's "The Birds of Florida"—heretofore the loftiest state list. They are sturdily bound in coarsely pebbled red buckram and colorfully jacketed. Within they are in every way elegant—the paper of the finest quality, the print large and crisp, the page margins and sectional spacing generous, and the illustrations superlative.

The first 70 pages cover introductory matter, the next 676 pages contain the accounts of 439 species, and the remaining pages consist of a gazetteer, bibliography, and index to birds.

The introductory matter adheres closely to the traditional pattern for a state list, with a definition of the scope, an explanation of terms, a survey of previous ornithological work, presentations of the state's topography and climate, and outlines with summations of bird distribution and migration in the state. Where the introduction breaks with tradition is in the special discourses on the migration, orientation, and life histories of birds in general, and the effects of pesticides on birds. Also, a unique and commendable feature that I have not seen in any other state list is a classification of the typical plant associations in Colorado together with an 11-page list of common state plants and the elevations at which they may be found.

Each species account consists of the two traditional parts: (1) In small print, the summations on recognition marks, over-all range, distribution and abundance in the state, and—in the case of breeding species—the nesting data. A concerted effort has been made to include all published Colorado records with full literature citations. (2) In large print, the general discussion. From a paragraph to several pages of text depending on the commonness of the species, this contains personal observations and reflections by the senior author and others not heretofore published, material drawn from the literature, and so on. Although the accounts center on the species as they occur in Colorado, they incorporate considerable information about the species from outside the boundaries, thereby making the two-volume work useful as a reference to birds of the western Great Plains and the Rocky Mountains from Montana into New Mexico.

The senior author came to Colorado as Director of the Denver Museum of Natural History in 1936 and the junior author has been on the staff of the museum since 1913. For both, The Birds of Colorado is their magnum opus, representing many years of ornithological work in the state. However, it is the senior author who has prepared the text and it is the character and special interests of the senior author which come through on the pages. Like the man himself, his writing is informal and unpretentious. Time and again in numerous anecdotes and digressions, it reflects his worldwide travels and his experiences with birds in distant places.

But far more than in the writing, Alfred M. Bailey comes through in the illustrative content, the truly superlative feature of The Birds of Colorado. An admirer of artistry with the brush or camera, and a master photographer himself, he was determined that all the birds should be illustrated by the best paintings and photographs that talent could provide. The result: 23 of the world's leading bird artists painted 124 plates of 420 species (700 individual birds) in full color; 36 photographers provided over 400 black-and-white photographs.

Dr. Bailey was just as determined that the reproduction of the paintings and photographs should be the best that money could provide. How well he succeeded with the paintings I cannot tell without seeing the originals, but the plates look flawless to me. They are "ganged" in small groups convenient to the applicable text. For anyone wishing to study and compare the respective techniques of our most eminent bird artists, the plates certainly provide an unparalleled opportunity. All are the same size, reproduced by the same engraver on the same kind of paper (glossy surfaced). In other words, all have been given identical treatment. As to the photographs, I cannot praise them highly enough. Indeed, the photographs are equal to the paintings in eye-appeal—and this is saying a lot when the world's best talent has gone into the paintings and no cost has been spared to reproduce them properly. Other works have been generously illustrated with both photographs and paintings, but the trick here is the excellent selection and handling of the photographs. Not one is fuzzy; not one is without pleasing contrast. Many are blown up to nearly page size. (I strongly suspect that the decision to make the volumes as big as they are was influenced by the desire for large photographs.) The scenic shots in the introduction to the work rival those of the birds in beauty, and why not. The scenery in Colorado is that way.

The authors and all the other persons associated with the Denver Museum of Natural History, which published The Birds of Colorado, have every reason to be proud of this achievement. It has lived up to the fullest expectations.—OLIN SEWALL PETTINGILL, JR.

THE SNOW BUNTING. By Desmond Nethersole-Thompson. Oliver & Boyd, Edinburgh, 1966: 5¾ × 9 in., xii + 316 pp., 14 pls. (1. col.), 11 figs. and maps. $6.30.

The Snow Bunting is a wonderful bird; it nests the farthest north of any passerine in the world, in the bleakest of environments of snow, ice, and bitter winds; it hides its nest safely in rocky crevices; the plumage of the male is striking, and his song is rich, varied, and different in each individual. In Scotland it nests sporadically in the highest hills. Here in 1934 the author and his wife camped for 66 days and nights on the Cairngorm tops; they found five nests and watched two broods of *Plectrophenax nivalis*.

That first summer Desmond and Carrie Nethersole-Thompson lived under great hardships. "In rough weather it was almost impossible to leave the tent and go to the hill, for when we tried to do so, we were soaked within a few minutes and had no means of drying our clothes until the sun shone strongly or a wind came without mist on its wings. For sixty-six days and nights our tent stood above the 3000-foot line." Throughout their stay Carrie never had a hot meal, but her husband occasionally was fed by friends when ten miles down in the valley to replenish provisions.

The Nethersole-Thompsons never banded any of the snow birds; they distinguished the three pairs and the one unmated cock by differences in their plumage, territories, and voices. "Baldy," which never won a mate, was a strikingly handsome and vigorous bird. "He ranged over miles of scree, singing and making exquisite shuttlecock flights between display rocks in glens and corries as far as one and a quarter miles apart."

The next year no Snow Buntings were seen in the Cairngorms and none were present from 1937 through 1939; in 1941 there were a few but none the following year. From 1948 through 1952 the Nethersole-Thompsons were again watching snow birds in Scotland, and from 1957 through 1964 their son Brock took over this responsibility. In Appendix 4 there are listed 38 nests found in Scotland in 14 seasons from 1934–64 by the "N-T family"; and 29 other nests discovered in 24 seasons by 24 men from 1861–1964. Northern Scotland is on the fringe of Snow Bunting habitat; the population of this species is always sparse in this region and sometimes absent altogether.

Two chapters vividly describe the experiences of "The First Summer" and "Our Snow Birds" of 1934. The next seven deal with the life history of the species, comparing the findings in Scotland with the reports of other observers. For instance, territorial behavior in the few Scottish birds is distinctly flexible in contrast to the rigid territorialism found in the large populations in Greenland by Tinbergen (1939). By the way, the eight little sketches of displays by cock Snow Buntings reproduced from Tinbergen's notable study were drawn by Joost ter Pelkwyk, who met his death in the East Indies in May 1942.

In the chapter on "Snowflake Country" the author describes the habitat of this intrepid bird throughout the northern regions of the world. The next chapter, contributed by D. A. Ratcliffe of the Nature Conservancy, describes "The Habitat of the Snow Bunting in Scotland." He concludes as follows: "Today the snow bunting stands as a survivor of a group of plants and animals which flourish in a habitat once widespread in lowland Britain but are now banished to the highest tops and even there sadly depleted in kind and number."

The fluctuating status of the Snow Bunting in Scotland is compared with the fluctuating weather reports; during years with warmer temperatures, these birds are absent. The possible favorable role of snowfields in Snow Bunting ecology is discussed. A long chapter, "Distribution, Numbers, and Movements," is devoted to this species throughout the Northern Hemisphere; here two world maps show its Holarctic summer range and its wide winter range throughout central United States and central Europe and Asia. It has not been determined to which of the five races of this species the Scottish breeders belong.

The 15 photographs, one in color, are excellent. The bibliography, 12 pages long, shows the wide coverage of the subject by the author. Although many technical subjects are discussed, the writing for the most part is full of action, life, and eloquence. A fine book that calls attention to many subjects still needing to be explored.—Margaret M. Nice.

Enjoying Birds around New York City; An Aid to Recognizing, Watching, Finding and Attracting Birds in New York City, Long Island, the Upstate Counties of Westchester, Putnam, Dutchess, Rockland, and Orange, and Nearby Points in New Jersey and Connecticut. By Robert S. Arbib, Jr., Olin Sewall Pettingill, Jr., and Sally Hoyt Spofford for the Laboratory of Ornithology, Cornell University. Houghton Mifflin Company, Boston, 1966: 6 × 9½ in., 125 drawings, 17 maps plus endpaper map. Cloth, $4.50; paper, $2.45.

Birders in the New York metropolitan area, whether veteran or beginner, will be delighted with this book. It is a specific local "Pettingill," with detailed descriptions of more areas than are included in his and Mrs. Spofford's predecessor volume, "Enjoying Birds in Upstate New York."

A symptom of observing birds in our area, the parking problem, is acknowledged and welcome directions are given. The book benefits by the inclusion of 17 excellent maps prepared by the Linnaean Society of New York. Certain of these are credited to Richard Edes Harrison, the cartographer, but he had a hand in others and supervised them as chairman of the Society's map committee.

Bronx Park might have received more emphasis and a map. It has long been favored as a spot to catch landbird waves. The southern Nassau Christmas Count is mentioned, but not its venerable rival, Bronx-Westchester. Such, perhaps, is loyalty to one's area, though the senior author, formerly of Nassau County, now resides in the area of the Bronx-Westchester Count. The latter area was also the locality of an important published list. The very popular Riis Park perhaps deserved a map, though small and easily covered in one trip. There is a diverse bibliography of books and periodicals, and local bird clubs are listed with information on meetings; however nothing is said about their publications which include a number of comprehensive local lists. The book includes an attractively illustrated section on feeders and birdhouses.

A "Checklist and Calendar Graph" indicates habitat preferences and times of year the species may be expected. Makers of large lists will be much interested in the selection of the 300 species therein. A number of the least likely on the list, such as Whistling Swan, Blue Goose, King Rail, Acadian Flycatcher, and Boreal Chickadee might just as well be replaced by such species as Eared Grebe, European Teal, Golden Eagle, and Little Gull. It is my experience over many years of this very interesting pursuit that a considerable number of one's rarities for the forthcoming year will be even more unusual than the expectable ones. I question indication of Baird's and Buff-breasted sandpipers in spring. There is a "Calendar for a Big List of Birds" suggesting specific trips throughout the year. It would be interesting to know how a big year-list obtained in this way would differ from one achieved by following up reported rarities.

There seem to be remarkably few typos and slips. On page 115, line 4, Wassic should be Wassaic. Mianus River Gorge has been placed, unusually, in a subsection and is not in the index. Croton Point Park's specialties are to be sought in winter; this is implied but not specified. The listing of Sharp-tailed Sparrow as a breeder in Hatfield Swamp is evidently a *lapsus calami* for Swamp Sparrow; this suggests that distinction might be made in the "Key to Habitats" (p. 130) between fresh and salt water marshes. There is a 46-page section with descriptions and black-and-white illustrations of 80 familiar species. Probably no two birders would agree on the selection of these 80. With the ample availability of field guides, this section seems superfluous.

A section of acknowledgments is adequate and placed rather unusually at the end of the volume. The format and type of this book are attractive, and it is most welcome.—Geoffrey Carleton.

Island Life: A Natural History of the Islands of the World. By Sherwin Carlquist. The Natural History Press, New York, 1965: 7 × 10¼ in., 451 pp., 7 col. illus., 242 bl. and wh. illus. $9.95.

Islands with their much simplified ecosystems have long fascinated biologists because of the unique and oftimes bizarre forms of life which are found on them. The classical writings of Charles Darwin and Alfred Wallace were inspired by their first-hand experience with insular life in the Pacific.

This new volume is one of several semi-popular books to be published here and abroad in recent years that treats of insular phenomena of the world's oceanic islands. From a scholarly viewpoint, Carlquist's "Island Life" is undoubtedly the best of the lot. The author, who is a botanist at the Rancho Santa Ana Botanic Garden of Claremont College, California, is perhaps best known for his important studies on plant morphology. Clearly, Dr. Carlquist's botanical interests are reflected in the examples which he has chosen, and in this respect Island Life is a most refreshing departure from other books on this subject in that it brings the reader a good balance between plant and animal considerations.

To judge from the extensive chapter bibliographies, the author has ferreted out the most significant contributions to island biology, thoroughly digested these, translated their contents into a clear, coherent, yet spirited, story that is as fascinating to the tyro as it is useful to the professional scientist.

Those persons beginning the study of island natural history will welcome this introductory presentation. In 16 chapters Carlquist presents a wealth of information by word and picture. Starting with a brief description of the island environment, the text moves quickly to problems of transoceanic transport of plants and animals, to disharmonic biotas, filters, and related phenomena, to adaptive radiation, with a lengthy consideration of Australian marsupials, to insular gigantism and dwarfism, to the origin of the island tree habit, to the loss of typical mainland mechanisms of plant and animal dispersal, to unique niche exploitation, to sexual selection, relictual species and the perils of insular specialization. The two concluding chapters present a general description of two insular areas of distinction, the Galápagos and Madagascar.

The important contribution of ornithology to the understanding of insular evolution is evidenced by the fact that words about birds fill over 50 pages, in addition to 9 color plates and 38 black and white illustrations. The original color illustrations are not skillfully executed and, because of the lack of fidelity in the glaring colors, give the impression of a newspaper Sunday supplement. The black-and-white illustrations have been well selected for their clarity and interest.

Especially interesting to students of birds are the popular sections dealing with flightless rails, adaptive radiation in the finches of Galápagos and the vanga-shrikes of Madagascar, sexual dimorphism in the forging habits of the extinct Huia of New Zealand, and the courtship displays of lyrebirds, birds-of-paradise, and bowerbirds. These accounts are based on the well-known writings of ornithologists, including Greenway, Rivolier, Amadon, Gilliard, Iredale, Marshall, Mayr, Lack, Bowman, Milne-Edwards, Rand among others.

Attractive in layout, literary in style, authoritative in content, and reasonable in price, Sherwin Carlquist's Island Life is a thoroughly meritorious book that will be appreciated by a wide audience of laymen and specialists for many years to come.—Robert I. Bowman.

RESTORING THE QUALITY OF OUR ENVIRONMENT. By Environmental Pollution Panel, President's Science Advisory Committee. The White House, 1965: 5⅞ × 9⅛ in., xii + 317 pp.

This monumental report is the work of 40-odd scientists who gave generously of their time and energies in serving on various aspects of the Environmental Pollution Panel. The prefacing letter by President Johnson recognizes that pollution is one of the most pervasive problems facing the nation; he closes by asking that each governmental agency report to him on ways in which corrective measures can best be taken.

The panel's view of man's role in the environment is set forth on page 5 as "Man is but one species living in a world with numerous others; he depends on many of these others not only for his comfort and enjoyment but for his life." The report is organized around the role of each of the eleven subpanels which carried out the study. The book begins with chapters on the effects of pollution, the sources of pollution, and recommendations. These chapters are areas of mutual agreement among the sub-panels.

The area of common ground covered by all of the sub-panels concludes with a statement of principles, a long list of recommended actions and a survey of research needs. Those of us concerned with wildlife conservation will be gratified to find the following statements among the general recommendations:

> "All concerned should recognize the quality of human life and the presence and growth of other living things as the major values currently damaged by pollution."
>
> "The filling-in of shallow waters essential in life cycles of fishes and shellfish be regarded as an important kind of pollution."
>
> "The control of pest populations should increasingly depend on an integrated combination of pesticide use with wide variety of bio-environmental techniques."
>
> "Unnecessary use of pesticides should be avoided whenever possible."

The remaining space in the volume is devoted to the details of each sub-panel's report. Some of the most interesting reading in the volume is to be found among the specifics reported by the various panels. For example, the sub-panel on climatic effect of pollution estimates that, by the year 2000, our consumption of fossil fuels will have increased atmospheric CO_2 to about 25 per cent—enough to modify the heat balance of the atmosphere and possibly bring on marked changes in climate.

While the technical quality of this publication is excellent, the work suffers from a somewhat fragmented organization which might discourage the casual reader. The use of appendix numbers in place of chapter titles at the top of each page also tends to confuse the reader who wishes to skim through the report before settling down to a perusal of selected subjects. These faults would be difficult to avoid in a report involving so many contributors; nevertheless, a more integrated format would have done much to pull the diverse materials together.

This is certainly not popular reading but for anyone concerned with the quality of his existence (who is not?), this work will serve as an invaluable reference. Perhaps one of the most important aspects of the work is recognized in the title. Ours is not a problem of preserving the quality of a relatively unspoiled environment; rather, we are faced with the task of *restoring* the quality of a seriously polluted environment.—DANIEL Q. THOMPSON

PROCEEDINGS OF THE FORTY-EIGHTH ANNUAL MEETING

Pershing B. Hofslund, Secretary

The Forty-Eighth Annual Meeting of the Wilson Ornithological Society was held Thursday, 15 June to Sunday, 18 June 1967, at Crawford House, Crawford Notch, New Hampshire. Sponsoring organization was the Audubon Society of New Hampshire and the local committee was under the chairmanship of Robert W. Smart. The meeting was attended by 279 registered members and guests.

The meeting opened on Thursday night with an informal reception at the Crawford House followed by a film showing and a field trip to hear the thrush chorus. The Council was in executive session the same evening. On Friday morning the Society was formally welcomed by Tudor Richards, President of the Audubon Society of New Hampshire. Following the response by President Aaron Bagg and the first business session, an introductory paper by Tudor Richards ushered in the first of four papers sessions. The Saturday's papers sessions were highlighted by a symposium on "Nocturnal Migration and Orientation," chaired by Dr. William W. H. Gunn.

On Friday night there was the showing of the film "Sights and Sounds of the African Wild." This was narrated by the photographer, G. Stuart Keith.

The annual dinner held Saturday evening was featured by the presidential address given by Aaron Bagg and a program "A Summer On Jenny Lind Island," presented by George M. Sutton. David F. Parmelee presented a series of recordings of sounds from the Arctic, and there was an exhibition of some of Dr. Sutton's paintings, done on Jenny Lind, following the main address. Dr. O. S. Pettingill, Jr. acted as master of ceremonies during the evening.

Field trips were held on Friday and Saturday mornings to local areas and on Sunday there were choices offered from three areas: the Connecticut Lakes region, the Errol-Umbagog area, and Mount Washington.

First Business Session

The meeting was presided over by President Aaron M. Bagg. The Secretary, Pershing B. Hofslund, summarized the principal actions of the Executive Council Meeting from the previous evening as follows:

1. The Council reaffirmed the decision of the 1966 Council to hold the 1968 meeting at Southern Illinois University in Carbondale. Dr. William George, representative from S.I.U., was asked to arrange meeting dates from 2–5 May, if possible.
2. Tentative acceptances were given to invitations for the 1969 meeting at Williamsburg, Virginia, for April and for the 1970 meeting in Bozeman, Montana. Special notice for these two meetings should be given as the 1969 meeting will represent the fiftieth stated meeting of the Wilson Society, and the 1970 meeting possibly is to be a joint meeting with the Cooper Ornithological Society.
3. George A. Hall was re-appointed editor of the *Wilson Bulletin*.
4. The president announced the appointment of Willaim Elder as W.O.S. representative to the inauguration of the president of the University of Missouri.
5. The Council concurred in the decision of the Editorial Board to have an issue of the 1968 *Wilson Bulletin* dedicated in honor of his seventieth birthday to Dr. George M. Sutton whose devotion to the Society has been such a guiding force. The issue will be devoted largely to Arctic ornithology.
6. Dr. Roger Tory Peterson was asked to organize and chair a symposium devoted

to the preparation of state and regional ornithological publications for the 1968 meeting.

7. The Council voted to submit a charter amendment to change the reading of Article II, Section 3, from "Any member may become a Patron, exempt from further dues, by making a payment into *the* endowment fund of the Society of five hundred dollars ($500.00) or more." to "Any member may become a Patron, exempt from further dues, by making a payment into *an* endowment fund of the Society of five hundred dollars ($500.00) or more."
8. The Council accepted the report of the Research Committee. Due to the generosity of a Wilson Society member, the Council was able to make two awards this year. The recipients are named in the Research Committee Report.
9. The Council noted again the lack of funds to recognize really outstanding requests. Considerable discussion was given to the possibility of setting up a grant for members wishing to do research and who were not connected to a college or university. As there is a possibility that through the generosity of a Wilson Society member such a fund will become available, considerable discussion was given to this type of grant.

The following committee reports were given by the Committee Chairmen, or where indicated, were read by the Secretary.

Report of the Treasurer for 1966

GENERAL FUND

Balance as shown by last report dated 31 December 1965		$7,878.26
RECEIPTS		
Dues		
Active Memberships	$ 7,190.00	
Sustaining Memberships	850.00	
Subscriptions to *The Wilson Bulletin*	2,050.00	
Sales of back issues of *The Wilson Bulletin*	1,405.26	
Interest and Dividends on savings and investments	2,032.41	
Gifts	9.00	
Royalties from microfilming back issues of *The Wilson Bulletin*	9.30	
Society's share of income from the Christian J. Goetz Estate	652.57	
Total Receipts	$14,198.54	
DISBURSEMENTS		
The Wilson Bulletin (printing and engraving)	$ 9,768.78	
The Wilson Bulletin (mailing and maintenance of list)	1,317.38	
Editor's Expense	148.92	
Secretary's Expense	46.65	
Treasurer's Expense	515.37	
Canadian Discount and Transfer Fees	20.81	
Annual Meeting Expense	330.09	
Committee Expense	24.85	
International Council for Bird Protection (1966 dues)	25.00	
Transfer to Research Fund	58.00	
Total Disbursements	$12,255.85	

Excess of Receipts over Disbursements for Year 1966	$1,942.69
GENERAL FUND CASH ACCOUNTS	
Checking Account	$3,115.95
Savings Account	6,705.00
Balance in Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1966	$9,820.95

Josselyn Van Tyne Memorial Library Book Fund

Balance as shown by last report dated 31 December 1965	$ 323.95
RECEIPTS	
Sale of duplicates and gifts	89.80
Total Balance and Receipts	$ 413.75
DISBURSEMENTS	
Purchase of books and postage	198.40
Balance in Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1966	$ 215.35

Louis Agassiz Fuertes Research Fund

Balance as shown by last report dated 31 December 1965		$ 132.00
RECEIPTS		
Contributions		31.00
Transfer from General Fund		58.00
Total		$ 221.00
DISBURSEMENTS		
Award to Douglas D. Dow	$ 100.00	
Award to Ralph W. Schreiber	100.00	
Total Disbursements		200.00
Balance in Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1966		$ 21.00

Endowment Fund

Balance in Endowment Fund Savings Account as shown by last report 31 December 1965		$ 225.51
RECEIPTS		
Life Membership payments		
Cash	$1,325.00	
Patronship payments		
Cash	1,100.00	
Stock Dividends received (included below)		
14 shares Massachusetts Investor's Trust		
Sale of 3 shares Standard Oil of California	248.12	
Legacy from Estate of Frances A. Cook	100.00	
Total Receipts		2,773.12
		$ 2,998.63
EXPENDITURES—none		—

Balance in Endowment Fund Savings Account, Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1966		$ 2,998.63
Securities Owned (listed at closing prices 31 December 1966)		
Bonds	$17,133.44	
Preferred Stocks	3,427.50	
Common Stocks	24,880.57	
Total Securities Owned		$45,441.51
Total Endowment Fund 31 December 1966		$48,440.14

Respectfully submitted,
C. CHANDLER ROSS
Treasurer

Research Grant Committee Report

Secretary Hofslund summarized Chairman Tordoff's report as follows:

"We advertised the Louis Agassiz Fuertes Research Grant for 1967 through notices in the major American ornithlogical journals. Sixteen inquiries resulted in a total of ten completed applications. Once more we are impressed with the quality of the majority of the applications, and dismayed that we have only a single grant to award.

"If funds are available for two awards, we recommend that the 1967 award be given to Dennis L. Kalma, Osborn Memorial Laboratory, Room 401, Yale University, New Haven, Conn. 00520, for his study entitled: 'A Comparison of the Reproductive Ecologies of a Temperate and an Equatorial Sparrow,' and to Spencer G. Sealy, Department of Zoology, University of British Columbia, Vancouver, B.C., for his study: 'Timing of Breeding Cycle in North Pacific Auklets.'

"The ten applications are being sent to the Secretary, who can then make them available for inspection by the Council. We suggest that all applicants be sent a letter announcing the results of the competition."

Conservation Committee Report

Roland Clement, Chairman of the Conservation Committee, summarized the report for the attending audience. A complete report will appear in the next issue of *The Bulletin.*

Membership Committee Report

Chairwoman Hazel Bradley Lory reported that, "because of the chairman's many other jobs and responsibilities, her membership work for the Wilson Ornithological Society is always done by 'fits and starts.' Starting in September, the committee was weeded out by dropping those members who had not secured any new members or who felt they could not continue to do membership work.

"Nine of the old members were retained and two new ones were added in the fall. These people were each supplied with names of ten prospective members to whom they were asked to write an invitation to join this society.

"Two later 'fits' of activity in January and February resulted in the addition of five more members to the committee, bringing the total to 16 plus the chairman. The five, too, were supplied with ten or more names of prospects whom they were to ask to join.

"The Treasurer, Chandler Ross, reported as of 15 May, we had 71 dropouts, 28 resignations, 11 deaths—110 on the debit side as compared with 127 reported last year. We have about 47 new subscriptions and 131 new members on the list to be posted. Thirty of the new members were enlisted directly by the efforts of the membership committee, seven by Secretary Hofslund, five by George Hall, and two by the President.

"Again this year, as in previous years, a goodly number of our new members are students (36.7%) or teachers (19%)."

Library Committee Report

Secretary Hofslund read the following report as submitted by Chairman William Lunk:

"The year was marked by no notable events in connection with the Josselyn Van Tyne Memorial Library, and its affairs ran smoothly. Norman Ford, of the Museum of Zoology Bird Division, continued in direct charge of all details; and we learn with regret that by the time another few months have passed he will no longer be here. The value of his services has been tremendous, during some critical times in the library's development.

"Gifts received during the year total 60, from 43 donors. In all, 34 books, 147 journals, 3,563 reprints, 24 translations, and 7 pamphlets were accepted.

"Of the reprints, 3,300 made up the current increment of Mrs. Josselyn Van Tyne's generous gift of her late husband's personal library.

"Seventy-five out-of-town loans, of 187 items, were made to 57 individuals. This showed an encouraging increase over last year's total. And, of course, constant use of the collection is made in the building by local and visiting members.

"As reported last year, 117 journals are regularly received, 91 of them by exchange for *The Wilson Bulletin.*

"Use of the library by all research-minded members is continually urged, as are the donation of books and other items, and contribution to our New Book Fund."

Endowment Committee Report

Endowment Committee did not function as such in 1966.

Temporary Committees

The following committees were appointed by President Bagg:

Auditing Committee	*Nominating Committee*	*Resolution Committee*
Edward L. Altemus	Maurice Brooks	Andrew J. Berger
Alan Crawford, Jr., Chairman	Roger Tory Peterson	Roland Clement, Chairman
John H. Foster	Phillips B. Street, Chairman	Ralph Dexter

Second Business Session

The Secretary read the report of the Auditing Committee:

"On June 2 we conducted our annual audit of the Treasurer's books and records, including an examination of receipts and expenditures in detail. The exemplary devotion to the task of Chandler Ross continues to be evident. All records are in order and the Society remains in excellent financial condition."

Report of the Resolutions Committee

Chairman Roland Clement gave the following resolutions which were passed without a dissenting vote by members in attendance at the meeting:

WHEREAS the officers and members of the Audubon Society of New Hampshire, as hosts to this 48th annual meeting of the Wilson Ornithological Society, have contributed immeasurably to the success and pleasure of all of us in attendance through their advice and assistance in attending to the thousand and one details that were quietly taken care of in order to provide the smoothly functioning organization of this meeting, both indoors and afield,

THEREFORE BE IT RESOLVED that the Wilson Ornithological Society—its council, officers, and members—do extend a formal and warm-hearted expression of appreciation to President Tudor Richards and all his colleagues in the Audubon Society of New Hampshire for untiring efforts on our behalf.

WHEREAS the selection of so happy a meeting place in a lovely natural environment; and the selection of such a stimulating program of papers and films as we have enjoyed at this meeting bespeaks creative leadership and hard work over many months by the Officers of the Society

THEREFORE BE IT RESOLVED that The Wilson Ornithological Society and more particularly we members and guests who have been the beneficiaries of these services—do, at this 48th Annual Meeting of the Society held at Crawford Notch, N.H., this 17th day of June, 1967, express our warm appreciation to all the Officers of the Society, and more particularly to its President and committee members, to Dr. W. W. H. Gunn for arranging the productive symposium on bird orientation, and to Dr. George Miksch Sutton and Mr. Stuart Keith for so graciously contributing their fine film programs.

WHEREAS the success and rewards of this 48th Annual meeting of The Wilson Ornithological Society owe an obvious debt to the forethought, hard work, and devotion and patience of the Local Committee on Arrangements; and

WHEREAS our comfort and physical well-being while in attendance at this 48th Annual meeting on the edge of the northern spruce wilderness is almost equally obviously dependent on the physical and administrative facilities so ably provided us by Crawford House and its management and staff,

THEREFORE BE IT RESOLVED that The Wilson Ornithological Society assembled in annual meeting at Crawford Notch, N.H., this 17th day of June, 1967, does extend its warm appreciation to Chairman Robert W. Smart and all the members of his Local Committee on Arrangements; and to the Management and Staff of Crawford House, for the exceptional attention they have given to our every need.

WHEREAS it is well-known to many of us that Norman I. Ford of the University of Michigan's Museum of Zoology has contributed many years of dedicated service to the maintenance of this Society's Josselyn Van Tyne Memorial Library, and

WHEREAS Mr. Ford will soon leave the University of Michigan to assume new duties elsewhere,

THEREFORE BE IT RESOLVED that The Wilson Ornithological Society, assembled in 48th Annual Meeting at Crawford Notch, N.H., on this 17th day of June, 1967, does express its deep appreciation to Norman I. Ford for his years of devoted service to the Society and does extend its heartiest good wishes in his new undertakings.

WHEREAS the Quetzal has for centuries been one of the New World's most celebrated birds, both because of its striking beauty and its symbolic significance as the national bird of Guatemala, and

WHEREAS the habitat of this exciting species is being destroyed rapidly and irrevocably for lack of adequate ecosystem conservation programs within its range, and

WHEREAS the very rarity of this bird has augmented demands for its capture as zoo, pet, or other uses, thus further threatening it with extinction.

THEREFORE BE IT RESOLVED that the Wilson Ornithological Society, assembled in its 48th annual meeting at Crawford Notch, N.H., on this 17th day of June, 1967, offer its aid and encouragement to the Pan-American section of the ICBP and the Latin

American desk of the Nature Conservancy in working for any and all habitat preservation and protective measures that may contribute to the perpetuation of this valuable and beautiful species.

WHEREAS it is known, through the field research of the large cooperating group of federal, state, university, and private investigators who have contributed to the National Audubon Society's cooperative Bald Eagle Research and Conservation Program that our national bird's decline is due in part to disturbance during the nesting cycle and to loss of habitat—particularly nesting trees—during necessary land uses such as forestry—to wanton shooting, and very probably to food-chain poisoning due to a variety of environmental pollution problems,

THEREFORE BE IT RESOLVED that the Wilson Ornithological Society assembled in annual meeting at Crawford Notch, N.H., on 17 June 1967, does extend a formal expression of appreciation and congratulations to the Northern States Power Company, with headquarters in Minneapolis, Minn., for its leadership in recognizing the conservation needs of our national bird, the Bald Eagle, and having implemented a series of special conservation measures to favor the reproductive success of this great bird along some seventy miles of the St. Croix River, north of Taylors Falls, Minn., and helped publicize the importance of such corporate participation in the conservation program on behalf of the Bald Eagle by the placing of conspicuous advertisements in the *Wall Street Journal* and elsewhere; and

BE IT FURTHER RESOLVED that copies of this resolution be communicated to the President of Northern States Power Company and included in the report of this meeting to appear in the Society's *Wilson Bulletin* in due time.

WHEREAS it is known, through the field research of the large cooperating group of federal, state, university, and private investigators who have contributed to the National Audubon Society's cooperative Bald Eagle Research and Conservation Program that our national bird's decline is due in part to disturbance during the nesting cycle and to loss of habitat—particularly nesting trees—during otherwise necessary land uses such as forestry—to wanton shooting, and very probably to food-chain poisoning due to a variety of environmental pollution problems,

THEREFORE BE IT RESOLVED that the Wilson Ornithological Society assembled in annual meeting at Crawford Notch, N.H., on 17 June 1967, does extend a formal expression of appreciation and congratulations to the Red Lake Band of Chippewa Indians, who, on 5 April 1967, under the leadership of their Tribal Council, did declare their 564,000 acre reservation in northwestern Minnesota an eagle sanctuary and adopt a nest-protection program as part of the forest management program of this large reservation in cooperation with the Bureau of Indian Affairs and the U.S. Fish and Wildlife Service, and,

BE IT FURTHER RESOLVED that a copy of this resolution be sent to the Chief of the Red Lake Band of Chippewa Indians.

WHEREAS it is known, through the field research of the large cooperating group of federal, state, university, and private investigators who have contributed to the National Audubon Society's cooperative Bald Eagle Research and Conservation Program that our national bird's decline is due in part to disturbance during the nesting cycle and to loss of habitat—particularly nesting trees—during otherwise necessary land uses such as forestry—to wanton shooting, and very probably to food-chain poisoning due to a variety of environmental pollution problems,

THEREFORE BE IT RESOLVED, that the Wilson Ornithological Society, assembled in annual meeting at Crawford Notch, N.H., on 17 June 1967, does extend a formal expression of appreciation and congratulations to the Boise-Cascade Corporation, a large timber-holding corporation with headquarters in Idaho, for its leadership in recognizing the conservation needs of our national bird, the Bald Eagle, and having implemented a series of special conservation measures to favor the reproductive success of this great bird on some 325,000 acres under its control and management in Minnesota, and

BE IT FURTHER RESOLVED that a copy of this resolution be sent to the president of the Boise-Cascade Corporation.

WHEREAS it is known, through the field research of the large cooperating group of federal, state, university, and private investigators who have contributed to the National Audubon Society's cooperative Bald Eagle Research and Conservation Program that our national bird's decline is due in part to disturbance during the nesting cycle and to loss of habitat—particularly nesting trees—during otherwise necessary land uses such as forestry—to wanton shooting, and very probably to food-chain poisoning due to a variety of environmental pollution problems,

THEREFORE BE IT RESOLVED, that the Wilson Ornithological Society, assembled in annual meeting at Crawford Notch, N.H., on 17 June 1967, does extend a formal expression of appreciation and congratulations to the National Audubon Society, the U.S. Forest Service, and the U.S. Fish and Wildlife Service for their successful collaboration in working out cooperative land-use management programs which will minimize disturbance of Bald Eagles during their nesting cycle, and otherwise protecting nesting sites in the forested areas of the Great Lakes region, involving not only federal and state lands but corporate and private land holdings as well, and

BE IT FURTHER RESOLVED that copies of this resolution be communicated to the President of the National Audubon Society, the Director of the U.S. Forest Service, and the Director of the U.S. Fish and Wildlife Service.

Election of Members and Officers

The proposed new members as posted by the Chairwoman of the Membership Committee were elected without dissenting vote.

The Nominating Committee presented the following slate for the 1968 offices: President, Aaron M. Bagg; First Vice-President, H. Lewis Batts, Jr.; Second Vice-President, William W. H. Gunn; Secretary, Jeff Swinebroad; Treasurer, C. Chandler Ross; Elective member of the Council to fill the unexpired term of Jeff Swinebroad, Pershing B. Hofslund (term expires 1968); Elective Member of the Council, Andrew J. Berger (term expires 1970).

The report of the Nominating Committee was accepted and the slate was elected without dissenting vote.

PAPERS SESSIONS

1. Tudor Richards, Hollis, New Hampshire. *The Bird Life of the White Mountain Region of New Hampshire, Past and Present.*
2. Richard C. Banks, U.S. National Museum. *Comments on Variation in the Red-breasted Nuthatch.*
3. Elden W. Martin, Bowling Green State University. *A Comparison of Bird Preserves and Prevailing Attitudes toward Naturalists in Great Britain and the United States.*
4. Ralph W. Dexter, Kent State University. *Banding and Nesting Studies of Marine Birds at Cape Ann, Massachusetts.*

5. William G. George, Southern Illinois University. *Feeding Behavior of Wintering White-winged Crossbills in Southern Illinois.*
6. Chandler S. Robbins and Willet T. Van Velzen, Migratory Bird Populations Station, Laurel, Maryland. *The Breeding Bird Survey, a Cooperative Program for Measuring Population Changes.*
7. Salvatore F. Bongiorno, Rutgers University. *The Use of Marginal Breeding Areas by Laughing Gulls (*Larus atricilla*).*
8. Ian A. McLaren, Dalhousie University. *The Current Status of the Ipswich Sparrow on Sable Island.*
9. Kenneth C. Parkes, Carnegie Museum. *Migration, Banding, and Taxonomy.*
10. Flight Lieutenant A. D. Herbert, Canadian Forces Base Rivers, Obodo, Manitoba. *Vertigo in Pilots as It Might Be Experienced in Birds.*
11. Raymond P. Coppinger, Amherst College. *Reactions to Novel Stimuli by Hand-reared and Wild Caught Birds.*
12. David Krieg, St. Bonaventure University. *Courtship Feeding in the Eastern Bluebird.*
13. Frank Bellrose, Illinois Natural History Survey. *The Physical Nature of Bird Migration.*
14. Jeff Swinebroad, Rutgers University. *Orientation of Nocturnal Migration over New Jersey.*
15. W. John Richardson, McMaster University. *Radar Studies of Bird Movements in Canada: an Interim Report.*
16. William H. Drury, Jr., Massachusetts Audubon Society. *Radar Studies of Song Bird Migration in Massachusetts.*
17. Sidney A. Gauthreaux, Louisiana State University. *Bird Migration as Simultaneously Viewed by Telescope and Radar.*
18. William W. Cochran, Illinois Natural History Survey. *Aerial Telemetric Studies of Nocturnal Migration of Passerines.*
19. Charles Walcott, Tufts University. *Airplane Tracking of Single Pigeon Homing.*
20. Lester Talkington, University of Wisconsin. *Helicopter Studies of Pigeon Homing.*
21. Richard L. Penney, Institute for Research in Animal Behavior, New York Zoological Park. *Tactics in the Study of Bird Orientation.*
22. Douglas James, University of Arkansas. *Passerine Orientation in a Planetarium.*
23. Stephen T. Emlen, Cornell University. *The Ontogeny of Migration Orientation.*
24. R. W. Dickerman and G. Gaviño T., Cornell University Medical College. *Nesting Studies of the Green Heron in Mexico.*
25. Allen Keast, Queen's University. *Bird Adaptations to Desert, with Reference to Australia.*
26. William A. Klamm, Lakewood, Ohio. *Some Observations on Competition between Lewis' Woodpeckers and Red-shafted Flickers.*
27. Devin A. Garrity, Rye, New York. *Antarctic Wildlife.*

ATTENDANCE

Members and guests who registered totaled 279 persons. Twenty-eight states, the District of Columbia, four Canadian provinces, and Bermuda were represented.

From **Arkansas**: 1—*Fayetteville*, Douglas James.

From **Connecticut**: 13—*Ansonia*, Noble Proctor; *Bristol*, J. Stanley Quickmire; *Middlebury*, Mr. and Mrs. Newell W. Mitchell; *Norwalk*, Roland C. Clement; *Old Lyme*, Dr. and Mrs. Roger T. Peterson; *Orange*, Phillip R. Sharp; *Riverside*, Bruce Adams; *Simsbury*, Mr. and Mrs. Harold S. Peters; *Storrs*, Mr. and Mrs. David N. Doubleday.

From **Delaware**: 2—*Middletown*, Mrs. Richard Herbert; *Newark*, Warren R. Faust.

From **Florida**: 1—*Winter Park*, Mrs. Marjory B. Sanger.

From **Hawaii**: 1—*Honolulu*, Andrew J. Berger.

From **Illinois**: 7—*Carbondale*, William G. George; *Momence*, Hazel Bradley Lory; *Urbana*, Mr. and Mrs. Frank Bellrose, Mr. and Mrs. William Cochran, William J. Francis.

From **Indiana**: 3—*Richmond*, Mr. and Mrs. M. S. Markel, J. Schnell.

From **Iowa**: 2—*Grinnell*, Helen Treat Stewart, Mildred Stewart.

From **Kansas**: 1—*Emporia*, David F. Parmelee.

From **Louisiana**: 4—*Baton Rouge*, Mr. and Mrs. William Buskirk, Sidney Gauthreaux, Jr., Robert J. Newman.

From **Maine**: 10—*Brunswick*, Dr. and Mrs. Alfred O. Gross, Mr. and Mrs. Charles E. Huntington, Mr. and Mrs. F. Burton Whitman, Jr.; *Orono*, Mr. and Mrs. Edward J. Danforth; *Portland*, Mr. and Mrs. Edward F. Dana.

From **Maryland**: 8—*Baltimore*, William Sladen; *Beltsville*, Orrey P. Young; *Chestertown*, Mr. and Mrs. Edward Mendinhall; *Chevy Chase*, Mr. and Mrs. Elting Arnold; *Laurel*, Chandler S. Robbins; *Towson*, Gladys Hix Cole.

From ***Massachusetts***: 35—*Amherst*, Mr. and Mrs. Lawrence Bartlett, Mr. and Mrs. Raymond Coppinger; *Andover*, Juliet Kellogg; *Arlington*, Doris Atwater; *Athol*, Steven Piragis; *Boston*, Haven H. Spencer; *Cambridge*, Kimball Elkins, John Minot; *Dover*, Mr. and Mrs. Aaron M. Bagg; *Gardner*, Henry F. Howe; *Lawrence*, Dennis Coskren, Michael Coskren; *Lincoln*, James Baird, Charles Walcott; *Lynfield*, Mr. and Mrs. Robert Rathbone; *Middleboro*, Kathleen S. Anderson; *Nahant*, Donald C. Alexander; *Newtonville*, Katherine Curtis, Eleanor B. Richmond; *North Andover*, Oscar M. Root; *Petersham*, Robert A. Clark, Mr. and Mrs. John Fiske; *Roslindale*, William P. Blakeslee; *Salem*, Dorothy E. Snyder; *Sherborn*, Richard T. Darby; *South Wellfleet*, Wallace Bailey; *West Medford*, Dr. and Mrs. O. Sewall Pettingill, Sr.; *West Newton*, Mr. and Mrs. Frank O. Howard.

From **Michigan**: 1—*Ann Arbor*, James Howell.

From **Minnesota**: 4—*Duluth*, Mr. and Mrs. Joel K. Bronoel, Dr. and Mrs. P. B. Hofslund.

From **New Hampshire**: 49—*Campton*, Gordon E. Davis; *Concord*, Mrs. Robert Dyment, Mrs. Charles Gallagher, David Mann, Betty Steele; *Dunbarton*, Mrs. Wilcox Brown, Jane Grant; *Durham*, Mrs. May Berry, Constance Casas, Lorus J. Milne, Richard Yelle; *East Andover*, L. C. Rising; *Greenland*, Ruth Gamester; *Hanover*, Evelyn Hanson, Erika Parmi, Mr. and Mrs. Edwin Sherrard; *Hill*, Dana Charles; *Hollis*, Mr. and Mrs. Tudor Richards, Jeff Smith; *Intervale*, Mr. and Mrs. Stephen Lawrent; *Jackson*, Jeannette E. Graustein, Mr. and Mrs. James R. Warren, Fern Yates; *Jaffrey Center*, Mr. and Mrs. Norman Torrey; *Laconia*, H. Cook Anderson; *Lisbon*, Harold H. Blanchard; *Littleton*, Robert Bradley, Harry McDade, Kathleen McDade, John McIlwayne; *Manchester*, Mrs. Robert Booth; *Meredith*, Alex Lincoln; *Monroe*, Mrs. Lois Cole; *New Hampton*, Vera Hebert, Pauline Merrill, Robert W. Smart; *Newport*, Mr. and Mrs. Sterling Brackett; *North Hampton*, Sue Fowler; *Plymouth*, Julia M. Stark; *Portsmouth*, Irene Garland; *Rye Beach*, Hope Wright; *Silver Lake*, Joan A. Watt; *Whitefield*, Mrs. Walter Bradley.

From **New Jersey**: 16—*Denville*, Anne Benton; *Jamesburg*, Jeff Swinebroad; *Madison*, F. H. Glenny; *Maplewood*, Otto Brief; *Morristown*, Jack Stewart; *Mountainside*, Mr. and Mrs. Albert Schnitzer; *Newfoundland*, Mr. and Mrs. Frank P. Townsend; *Orange*, Anne W. Wachenfeld; *Ramsey*, Eleanor Dater; *Roselle Park*, Dorothy

Browne; *Tenafly*, Dr. and Mrs. Dean Amadon; *Trenton*, Kenneth W. Prescott; *Wenonah*, E. R. Manners.

From **New York**: 26—*Allegany*, Dr. and Mrs. Stephen W. Eaton; *Amherst*, Richard Brownstein; *Buffalo*, Joanna Burger; *Center Moriches*, Mr. and Mrs. Theodore Chase Jr.; *Hopewell Junction*, Davis Finch; *Ithaca*, Stephen T. Emlen, Lawrence Grinnell, William T. Keaton, Douglas A. Lancaster, Dr. and Mrs. O. Sewall Pettingill, Jr., Samuel Weeks; *New York City*, Charles T. Collins, Robert Dickerman, G. Stuart Keith, Richard L. Penney, Richard L. Plunkett; *Rye*, Devin A. Garrity; *St. Bonaventure*, David Krieg; *Solvay*, Mr. and Mrs. Donald S. McChesney; *Tappan*, Lester Talkington; *Williamsville*, Mr. and Mrs. Harold D. Mitchell.

From **Ohio**: 18—*Bowling Green*, Elden W. Martin; *Burton*, Robert McCullough; *Canfield*, Mr. and Mrs. G. William Richter; *Chardon*, Marjorie Ramisch; *Cincinnati*, Rod Crafts; *East Liverpool*, Mr. and Mrs. John T. Laitsch; *Gambier*, Robert D. Bevins, E. Ray Heithaus; *Girard*, Mr. and Mrs. H. O. Heimerdinger; *Kent*, Dr. and Mrs. Ralph W. Dexter, Mr. and Mrs. Alex Warner; *Lakewood*, Mr. and Mrs. William A. Klamm.

From **Oklahoma**: 1—*Norman*, George M. Sutton.

From **Pennsylvania**: 26—*Chester Springs*, Phillips B. Street; *Dunmore*, Elizabeth A. Taft; *Fort Washington*, Mr. and Mrs. Edward L. Altemus; *Harrisburg*, Donald S. Heintzelman; *Narberth*, Paul A. Livingston; *Newton*, Mr. and Mrs. Lester S. Thomas; *Philadelphia*, C. Chandler Ross, Mr. and Mrs. Gene Stern, Mr. and Mrs. Warren E. Swank; *Pittsburgh*, Dr. and Mrs. Kenneth C. Parkes; *Selinsgrove*, Mr. and Mrs. George C. Boone; *Sheffield*, Mr. and Mrs. Charles A. Neel; *State College*, Blanche M. Bordner, Dorothy L. Bordner; *Trout Run*, Mr. and Mrs. Walter K. Bigger; *Willow Grove*, John Knichen; *Wycombe*, Mr. and Mrs. Alan Brady.

From **Rhode Island**: 2—*Jamestown*, Mrs. Allen Davenport; *Warwick*, Mrs. Kenneth Kinsey.

From **South Carolina**: 6—*Chester*, Mrs. J. H. McClure, Mrs. W. Cornwell Stone, Sr.; *Travelers Rest*, Charles Gilreath, Liz Gilreath, M. Ruth Gilreath, Winnie Gilreath.

From **Tennessee**: 3—*Gatlinburg*, Mr. and Mrs. Arthur Stupka; *Maryville*, Ralph Zaenglein.

From **Vermont**: 2—*Londonderry*, Mrs. James R. Downs; *Lyndonville*, Donald Miller.

From **Virgina**: 4—*Ashburn*, Mrs. Herbert M. Church; *Scottsville*, Caroline L. Whiteside; *Williamsburg*, Mr. and Mrs. Paul S. Baker.

From **West Virginia**: 6—*Huntington*, Ralph M. Edeburn; *Morgantown*, Mr. and Mrs. Maurice Brooks; Dr. and Mrs. George A. Hall; *St. Albans*, George F. Hurley.

From **Wisconsin**: 1—Margarette E. Morse.

From **Washington, D.C.**: 3—Richard C. Banks, Charles A. Ely, Roxie C. Laybourne.

From **Bermuda**: 1—*Hamilton*, David B. Wingate.

From **Manitoba, Canada**: 1—*Obodo*, A. D. Herbert.

From **New Brunswick, Canada**: 2—*St. John*, Mr. and Mrs. W. Austin Squires.

From **Nova Scotia, Canada**: 1—*Halifax*, Ian A. McLaren.

From **Ontario, Canada**: 4—*Burlington*, W. John Richardson; *Guelph*, M. I. Dyer; *Kingston*, J. Allen Keast; *Toronto*, William W. H. Gunn.

Addresses Unknown: 14—Mr. and Mrs. Carlyle Burland, Alexander Davis, Mr. and Mrs. Harold Flanders, Murray E. Haight, Mr. and Mrs. J. Chester Littlefield, Martin Michener, Richard Missellis, Mrs. Ernest B. Neel, Mr. and Mrs. David Ochsner, Lee Snyder.

This issue of *The Wilson Bulletin* was published on 30 September 1967

The Wilson Bulletin

PUBLISHED BY THE WILSON ORNITHOLOGICAL SOCIETY
WEST VIRGINIA U. • MORGANTOWN, W. VA.

VOL. 79, No. 4 DECEMBER 1967 PAGES 369–489

THE WILSON ORNITHOLOGICAL SOCIETY

FOUNDED DECEMBER 3, 1888

Named after ALEXANDER WILSON, the first American Ornithologist.

President—Aaron M. Bagg, Farm Street, Dover, Massachusetts.

First Vice-President—H. Lewis Batts, Jr., Dept. of Biology, Kalamazoo College, Kalamazoo, Michigan.

Second Vice-President—William W. H. Gunn, Apt. 1605, 155 Balliol Street, Toronto, Ontario.

Secretary—Jeff Swinebroad, Dept. of Biological Sciences, Douglas College, Rutgers–The State University, New Brunswick, New Jersey.

Treasurer—C. Chandler Ross, Academy of Natural Sciences, 19th and Parkway, Philadelphia, Pennsylvania.

Elected Council Members—Pershing B. Hofslund (term expires 1968); Kenneth C. Parkes (term expires 1969); Andrew J. Berger (term expires 1970).

Membership dues per calendar year are: Sustaining, $10.00; Active, $5.00.
THE WILSON BULLETIN is sent to all members not in arrears for dues.

THE JOSSELYN VAN TYNE MEMORIAL LIBRARY

The Josselyn Van Tyne Memorial Library of the Wilson Ornithological Society, 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, reprints, and ornithological magazines from members and friends of the 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 contribution, 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. William A. Lunk, University Museums, University of Michigan, is Chairman of the Committee. The Library currently receives 104 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 Josselyn Van Tyne Memorial Library, University of Michigan Museum of Zoology, Ann Arbor, Michigan." Contributions to the New Book Fund should be sent to the Treasurer (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 newly acquired books are listed periodically.

THE WILSON BULLETIN

The official organ of the Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Morgantown, West Virginia. The subscription price, both in the United States and elsewhere, is $5.00 per year. Single copies, $1.25. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at $1.25 each) and may be orderd from the Treasurer. Special prices will be quoted for quantity orders.

All articles and communications for publications, books and publications for reviews should be addressed to the Editor. Exchanges should be addressed to The Josselyn Van Tyne Memorial Library, Museum of Zoology, Ann Arbor, Michigan.

Second class postage at Lawrence, Kansas, U.S.A.

PRINTED IN U.S.A. Allen Press, Inc., Lawrence, Kansas

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by The Wilson Ornithological Society

Vol. 79, No. 4 DECEMBER 1967 Pages 369–489

CONTENTS

GENERAL NOTES

BIRD POPULATIONS OF BOGS

RICHARD BREWER

BOGS throughout the glaciated region of the northern hemisphere show considerable uniformity in structure and composition (Curtis, 1959). In the southern portion of this region, bogs form "boreal islands" with a high percentage of species of northern affinities and are regarded as relicts of former conditions associated with Pleistocene glaciation (Bailey, 1896; Transeau, 1903). These statements are fair conclusions based on numerous floristic and vegetational studies. Faunal studies are fewer and, as a consequence, such questions as the degree of uniformity of species composition and geographical affinities among bog animals are unresolved. As a contribution toward answering such questions, bird populations in two bogs in southwestern Michigan were studied and analyzed in conjunction with the existing published information on avian populations of eastern North American bogs.

STUDY AREAS

One study area (Portage Bog) consisted of a 16.5-acre tract of sphagnum-leatherleaf-tamarack bog with sides of 600 and 1200 feet. Located south of Portage in Kalamazoo County (NE ¼, Sec. 28, R 11 W, T 3 S), it is part of a much larger area of similar peatland about one-quarter-mile wide and one and one-half miles long. The study area is surrounded on all sides by similar vegetation but about 150 feet to the southwest and roughly parallel to one side runs a drainage ditch 12 feet wide. Beyond the ditch is deciduous thicket or forest on thin peat or mineral soil. The study area was located wholly on deep peat (17 feet). Six physiognomic vegetation types occurred in a fairly complex mosaic. Open wet bog made up about 0.3 acre; open dry bog (Fig. 1), 8.7; low thicket, 0.9; high thicket (Fig. 2), 4.7; parkland, 0.8; and tamarack forest, 0.9.

The second study area (Sugarloaf Bog, Fig. 3) consisted of a strip 100 × 1000 feet (2.3 acres) in 1965 and 200 × 1000 feet (4.6 acres) in 1966 running down the center of a red maple-yellow birch-white pine bog forest fringing Sugarloaf Lake southwest of Portage in Kalamazoo County (Sec. 32, R 11 W, T 3 S). The bog forest was 300–600 feet wide and lay between an upland oak-pine forest and an expanse of open bog 100–300 feet wide adjacent to the lake.

Elevation of both study areas was 850–60 feet above mean sea level. Botanical features of both areas and a vegetation map of Portage Bog are given in Brewer (1966).

METHODS

Breeding bird populations were studied by the standard spot-map method (Williams, 1947). Establishment of census plots was careful, using a Brunton pocket transit and steel tape. Because of the strip-like nature of the Sugarloaf Bog plot, virtually no territories lay wholly within it and, therefore, estimation of the fraction included was

FIG. 1. General view in Portage Bog showing expanse of open bog with a narrow zone of high tamarack thicket fringing a strip of tamarack forest (canopy height 20–40 feet). The only noticeable plants are leatherleaf and tamarack. (Sept. 1965)

one source of error. This error is also present when using plots of more standard dimensions because, except when plots are very large, most territories include some area beyond the boundaries. At Portage Bog, for example, only about one-third of the total number of Song Sparrow territories touching the plot lay wholly within the 16.5 acres.

Coverage of Portage Bog included six breeding seasons as follows: 1961 (9 trips, 1 May–21 August; total hours 17), 1962 (4, 10 April–24 July; 8.5), 1963 (7, 4 May–17 August; 15), 1964 (7, 20 May–22 July; 10.5), 1965 (9, 22 April–24 August; 17), and 1966 (12, 11 April–30 July; 37). Most censuses were in the forenoon, usually beginning after 6 and before 9 and lasting about two hours. Visits to the tract for other purposes provided corroborative observations beyond the time spent in formal censusing. Although the results for 1962 are believed to be generally correct, less confidence can be placed in them compared with other years because of the sparseness of coverage.

Less attention was paid to the area outside the breeding season, but 20 additional trips totaling 55 hours were made (September, 5; October, 2; November, 3; December, 6; January, 2; February, 1; March, 1), and the same field procedures of mapping locations of birds were followed.

Sugarloaf Bog was censused the summers of 1965 (15 trips, 7 June–23 August; total hours 29.5) and 1966 (8, 13 May–30 June; 23.5).

FIG. 2. The denseness of the extensive high thickets is indicated by this photograph taken just outside one. The pale spot to the left of center is the jacket worn by a person standing about six feet inside the thicket. (Sept. 1965)

BREEDING BIRD POPULATIONS AT PORTAGE BOG

Twenty-four species occurred regularly during at least one of the six breeding seasons; however, the average annual number of breeding species was only about 16 (Table 1). Density was about 170 pairs per hundred acres. In interpreting this and other estimates of density, the limits to the precision of the spot map method (see, e.g., Breckenridge, 1955:410), especially for species not showing Type A territories (Nice, 1941) and those with very large territories need to be borne in mind. The only species in these groups which seemed of moderately high density here was the Brown-headed Cowbird.[1] For this species the largest number of males seen together in June was assumed to represent the number frequenting the area: density was taken as one-half this number on the assumption that most of the cowbirds had some portion of their home range outside the tract. The reader may decide for himself the limits of precision of this estimate.

Song Sparrows were by far the most abundant species, having an average density of 9.4 territorial males (57 per 100 acres). The only other species

---

[1] Scientific names of birds are given in Table 3 or, for species not in Table 3, where they are first mentioned.

FIG 3. Sugarloaf Bog, looking toward the lake. Canopy height is 65–80 feet. Cinnamon fern is noticeable on the hummocky surface. The shrub at left is spice bush. (Sept. 1965)

having an average density greater than 10 per 100 acres were Yellowthroat, Field Sparrow, Rufous-sided Towhee and, perhaps, Brown-headed Cowbird.

The Yellow Warbler was present the first two years and virtually absent thereafter (although it continued to occur elsewhere in the bog). The Traill's Flycatcher (evidently *Empidonax brewsteri* Oberholser, according to Stein's diagnosis, 1963) was absent the first two years and present three of the last four. Both species were birds of the thicket areas, and it may be that between 1961 and 1963 conditions became unfavorable for the warblers and favorable for the flycatchers. The most prominent change was an increase in high thicket at the expense of low thicket. Possibly the same successional trend was responsible for the appearance in 1965 of the Nashville Warbler, a northern species not previously known to nest in southwestern Michigan (Brewer and Raim, 1966).

Neither Black-capped Chickadees nor Yellow-shafted Flickers had a nest on the study area. Tamaracks were the only dead trees of any size, and they seemed not to decay in a way that rendered them suitable for excavation by cavity-nesting birds. The scarcity of such species is evident. Both chickadees and flickers may have nested in hardwoods adjacent to the bog and used

TABLE 1

BREEDING BIRD POPULATIONS OF PORTAGE BOG (MALES)

Species	1961	1962	1963	1964	1965	1966	Mean, all years	Males/100 acres
Song Sparrow	9.5	8.0	10.1	9.8	10.2	8.5	9.4	57
Yellowthroat	3.8	5.6	3.8	5.3	3.4	4.9	4.5	27
Field Sparrow (*Spizella pusilla*)	1.1	4.0	2.4	3.0	2.4	1.2	2.4	14
Rufous-sided Towhee	2.2	2.1	1.7	4.1	1.6	3.0	2.4	14
Brown-headed Cowbird	+	+	+	+	+	+	2.4	14
Catbird	1.0	1.2	1.2	2.1	2.0	1.5	1.5	9
Am. Goldfinch	+	+	+	+	1	1	>0.3	6
Traill's Flycatcher	0	0	2.0	1.4	1.1	0	0.8	5
Yellow Warbler	2.3	0.8	0	0	0	+	>0.5	3
Black-capped Chickadee	+	+	+	+	+	0.9	>0.2	3
Mourning Dove	+	0	+	+	+	+	+	3
Cedar Waxwing	+	+	+	+	+	+	+	3
Yellow-shafted Flicker	+	+	+	+	+	+	+	2
Cardinal	0	0	0	0.8	0.9	0.9	0.4	2
Brown Thrasher	0	0.9	0	+	0.5	0.6	>0.3	2
Ruby-throated Hummingbird (*Archilochus colubris*)	0	0	0	1♀	0	0	0.2	1
Nashville Warbler	0	0	0	0	0.9	0	0.2	1
Mallard (*Anas platyrhynchos*)	1 nest	0	1 nest	+	1 nest	+	+	+
Marsh Hawk	+	+	0	0	0	+	+	+
Eastern Bluebird (*Sialia sialis*)	+	0	0	0	0	0	+	+
Tree Swallow	+	0	0	0	0	0	+	+
Robin	0	0	0	0	+	+	+	+
Whip-poor-will (*Caprimulgus vociferus*)	?	?	?	?	+	?	+	+
Veery	0	0	0	0	0	+	+	+
No. species	16	13	13	16	18	18	16	
No. males							>25.1	>166

+ indicates present on tract but density low or difficult to assess.

the tract only as a part of their feeding range. A possible indication of the rarity of suitable nest holes within the bog was the use of the same cavity in a dead pine just off the tract by bluebirds in May 1961 and Tree Swallows in June. I believe that Robins also placed their nests in deciduous areas and came into the bog only for feeding.

There were substantial differences in the utilization of different vegetation types by certain species. To place this on a quantitative basis, numbers of territories were calculated for the eastern portion of the bog (8.7 acres) which was predominantly open and for the western portion (5.1 acres) which was predominantly low and high thicket. The year 1962 was omitted because the small number of sightings for each territory made approximation of percentages in different vegetation types impossible. The average figures for five years indicate slight preferences by Field Sparrow for open bog and Song Sparrow for thicket and rather strong preferences by towhee, Yellowthroat, and Catbird, for thicket. The number of species occurring regularly during at least one year in open bog was about 13 and in thicket about 21; densities were less than 100 males per 100 acres in open bog and well over 200 males per 100 acres in thicket.

Several differences between 1964 and other years appeared related to a fire which that spring burned areas on each side of the drainage ditch along one edge of the tract, although not reaching the tract itself. The immediate result of the fire was a reduction in woody growth followed by plentiful root sprouting of aspens. Changes in density considering the whole tract between 1963 and 1964 were not particularly striking, but the distribution of territories was. Song Sparrows were virtually absent from the areas (open bog) adjacent to the burn, with the result that the number of territories in open bog dropped from 6.4 in 1963 to 3.4 in 1964. An increase from 1.2 to 4.0 in thicket compensated for the decrease in open bog. Towhees used the burnt area much more extensively than in other years, so that portions of 3 territories included open bog whereas only the edge of 1 territory did so in most years. Similar trends of increased density in open bog for 1964 were seen in Yellowthroat and Field Sparrow.

Breeding season visitors to the bog were infrequent. Probably most represent birds making an occasional trip beyond their usual limits or adults, young, or family groups that moved away from their nest area following nesting. The only species that visited the bog in numbers were the Blue Jay and the Robin. Blue Jays were frequently seen in the bog until late May; then they were almost entirely absent until early August at which time they again began to visit the bog regularly. Robins were essentially absent from the bog during winter and also during the peak of the breeding season (except in 1965 and 1966, when one pair included a part of the bog in its breeding territory). They were occasionally seen during spring, but it was only during blueberry season that they were common. With ripening of the berries, both adults and young swarmed into the area. On 11 July 1964, I plotted 18 individuals and twice that number would be a conservative estimate of the birds present during the two-hour census.

It is my impression that some of the visitors were surplus single birds seeking to set up territories or pairs searching for a suitable area for nesting, possibly following a nest failure. In the latter category might fall Eastern Meadowlarks which I three times saw in the open portion of the bog. On 25 June 1963, I saw two meadowlarks, one with what I took to be nesting

TABLE 2
BREEDING BIRD POPULATIONS OF SUGARLOAF BOG
(Males per 100 acres)

Species	1965	1966	Mean
Black-capped Chickadee	39	41	40
Ovenbird	4	72	38
Wood Pewee	24	28	26
Blue Jay	28	15	22
Cardinal	28	13	20
Scarlet Tanager	24	11	18
Downy Woodpecker	22	11	16
Red-eyed Vireo	17	15	16
Great Crested Flycatcher	13	17	15
Song Sparrow	26	0	13
Tufted Titmouse	4	13	8
Rufous-sided Towhee	17	+	>8
Wood Thrush	13	0	6
Yellow-throated Vireo (*Vireo flavifrons*)	0	11	6
Hairy Woodpecker	9	0	4
Yellow-shafted Flicker	6	2	4
White-breasted Nuthatch	+	6	>3
Black-throated Green Warbler	6	0	3
Catbird	4	0	2
Common Grackle	+	0	+
Veery	+	+	+
Ruffed Grouse	+	+	+
Yellowthroat	+	0	+
Owl (Barred?) (*Strix varia?*)	+	0	+
Wood Duck (*Aix sponsa*)	0	+	+
Brown-headed Cowbird	0	+	+
Number of species	23	18	20
Number of males	>284	>255	>270

+ indicates present on tract but density low or difficult to assess.

material in its beak, sit for more than 20 minutes on a dead tamarack. The speculation is worth entertaining that the physiognomy of open bog is close enough to that of open fields that in hunting for nest-sites the species may occasionally be misled.

It is evident that the avifauna of Portage Bog has little of a boreal nature about it. To provide an objective standard for determining geographical affinities here and in subsequent sections, I have used the analysis of Udvardy (1963) in which he erects 17 faunal groups each composed of North American passerine species "whose ranges are similar and more or less overlapping. Most of them also stand well as ecological entities." In making use of Udvardy's analysis, two additional categories were necessary: an unanalyzed element, consisting of several species of wide geographical range which Udvardy did not assign to faunal groups and non-passerine species, which also tend to have extensive geographical ranges and which Udvardy did not treat.

For Portage Bog, the unanalyzed element was by far the most important, making up 42 per cent of the species; next most important were non-passerine species (25 per cent). This agrees with the frequent observation (e.g., Odum, 1945:198) that geographically wide-ranging species are important in early seral stages. Species of the eastern deciduous forest, boreal forest, and eastern ecotone faunas were all about equally well represented (12, 12, and 8 per cent).

In terms of vegetational affinities, the avifauna is forest edge. The species list is scarcely different from that to be expected on a southwestern Michigan moist thicket area having a wholly different flora of, for example, willows, brambles, and goldenrod. This conclusion supports the view that physiognomy or structure of vegetation is important in the community distribution of birds (Odum, 1945; Kendeigh, 1948).

BREEDING BIRD POPULATIONS AT SUGARLOAF BOG

Twenty-six species occurred as breeding birds during one of the two summers. The average number of species per year was about 20, or four more than at the 16.5-acre Portage Bog, and the density was about 270 males per 100 acres. The Black-capped Chickadee was the most abundant species, with an average of 40 males per 100 acres (Table 2). Ten species occurred at densities greater than 10 males per 100 acres compared with four such species at Portage Bog. Nine species (22 per cent) were common to the two tracts.

Thirty-eight per cent of the species, including five of the 10 most common, were members of the eastern deciduous forest fauna. Unanalyzed and non-passerine species together made up 46 per cent, eastern ecotone species 12 per cent, and boreal forest species 4 per cent.

There were notable changes in abundance between the two years. Partly this was because the tract was small: a territory shifted 200 feet could make a difference of 20 males in the calculations for 100 acres. Two changes were certainly real; these were the decrease of Song Sparrows and the increase of Ovenbirds. In 1965, the territories of five Song Sparrows lay partly on the 4.6-acre strip, mainly centered toward open bog; in 1966 no territories reached the strip. In 1965 territories of four Ovenbirds just touched the strip; in 1966 three territories were centered on the strip and three others included sizable portions of it. There was an interesting difference in behavior of the Song Sparrows in Sugarloaf Bog compared with their usual habitats; they were little in evidence past late June. In such areas as Portage Bog, singing and nesting activities continue far into July and beyond. The latest nesting record for Kalamazoo County is 8 September (Batts, 1957). Most of the extension of Ovenbird territories onto the census strip occurred in the latter part of the summer after Song Sparrows had largely disappeared.

An explanation for these changes lies in two possible directions: (1) the environment may have changed so that Song Sparrows were favored in 1965 and Ovenbirds in 1966, or (2) a competitive situation may exist in which the presence of Song Sparrows prevented the occupation of the area by Ovenbirds in 1965 (the reverse, that Ovenbirds in 1966 prevented utilization by Song Sparrows, is also conceivable). In favor of the first hypothesis is the fact that the other forest edge species in Sugarloaf Bog were also scarcer in 1966 than 1965. Individually all of the declines were slight (Cardinal, 1.3 to 0.6 males on the 4.6-acre strip; towhee, 0.8 to 0; and Catbird, 0.2 to 0), but the decline of the whole group possibly has significance. There was, however, no evident change in the habitat except that the peat surface was slightly wetter in 1966. This would seem to favor Song Sparrows over Ovenbirds because Song Sparrows do not avoid hydric habitats, whereas Ovenbirds tend to be more common in mesic situations. Standing water also decreases the area available for nests of the exclusively ground-nesting Ovenbird.

Relevant to hypothesis 2 are the following points: (a) The two species are similar enough in feeding, nesting, and singing sites that they could be competitors if they occurred together; (b) Their ecological distribution is such that only in a few communities, somewhat marginal for both, are they likely to come into contact; (c) Spring territory establishment of Song Sparrows precedes that of Ovenbirds (in southwestern Michigan mid-April or earlier compared with early May). If interspecific territoriality existed, Song Sparrows would have the advantage of possession; (d) Interspecific territoriality is prominent in Song Sparrows (Nice, 1943:158–161; Tompa, 1964), although I am not aware of any instances involving Ovenbirds; (e) Bog forest is probably used by both species mainly by overflow populations from more nearly optimal vegetation. The open bog and thicket areas of Portage Bog, two miles from Sugarloaf, represent nearly optimal conditions for Song Sparrows. In 1965 numbers were the highest in six years and in 1966, the second lowest (Table 1). It is possible that population changes in optimum habitats are only a very subdued reflection of actual population changes (Brewer, 1963; Kluyver and Tinbergen, 1953); it is perfectly feasible that there were substantial surplus sparrows in 1965 and few or none in 1966.

It is hoped that observations during territorial establishment will allow a choice between the two hypotheses.

In a sense the presence of Ovenbirds and Song Sparrows in Sugarloaf Bog depends on adjacent vegetation types. This was also true of Yellowthroats, which had high populations on the bog mat and occasionally extended their activities as far as the census strip. The Acadian Flycatcher (*Empidonax virescens*) was an interesting contrast. Although quite common in upland forest, including the part immediately adjoining the bog forest, it seemed never to penetrate the bog forest more than five or ten feet, and that only rarely.

Estimation of population size was difficult for the Veery. It sang steadily on the border between bog forest and open bog (about three males), rarely on the border between bog forest and upland forest, and almost never within the bog forest. I suppose that territories may extend across the bog forest, but I have not tried to estimate density.

About one-third of the breeding species and individuals were hole-nesters. This is probably related to the large number of dead elms (of Dutch elm disease) and yellow birch suitable for excavation.

OBSERVATIONS AT PORTAGE BOG OUTSIDE THE BREEDING SEASON

The mean number of species recorded per visit during June and July was 10. For August it was slightly less, 9; but about the end of August there appears to be a rapid exodus from the bog so that the mean number for September and October is 5. The sparseness of the bird population in the bog at this time compared with the deciduous areas near it is quite noticeable. Most of the prominent birds of the bog, towhee, Song Sparrow, Yellowthroat, Catbird, are still to be found in numbers in the aspens and bog birches along the drainage ditch when they are virtually absent from the census tract. Of several possible explanations, a post-breeding emigration into different vegetation types seems most likely; why this would occur is not evident.

Winter populations were low; on two December trips of about an hour each, no birds were seen on the census plot. The average number of species seen per trip was 2 for November, less than 1 for December, and slightly more than 1 for January–March. Only Blue Jay (seen on 5 trips), Black-capped Chickadee (4), and Eastern Goldfinch (2) occurred on more than one of the 13 winter trips.

The extreme sparseness of the bird population in winter is probably related to a poor food supply, although the flatness of the peatland, resulting in lack of protection from wind, may also be involved. It is evident from an examination of the list of plant species present in Portage Bog (Brewer, 1966) that fruits and seeds are not likely to be in good supply in the winter. Tamarack, which might be thought to provide a fairly rich supply, sheds its seeds in the autumn. Duncan (1954) found that in Minnesota about 97 per cent of tamarack seeds had fallen before 31 October. I have no direct evidence that invertebrates are scarcer in bogs than elsewhere in winter, but in view of the substantial amount of energy that becomes tied up in peat and thus does not become available to other trophic levels, this seems a reasonable possibility.

BREEDING BIRD POPULATIONS OF EASTERN NORTH AMERICAN BOGS

Ecological and zoogeographic relationships of bogs were studied by means of compilations including previous studies. Both censuses and studies giving lists of characteristic species for a particular area were used. All such studies that I am aware of were included except those conducted on areas of heterogeneous vegetation or on excessively small and isolated areas.

The study areas were grouped into open bog (8 areas), thicket (8), and forest (17) using physiognomic criteria. Forests were further classified into those of pure or nearly pure tamarack, those with spruce as a dominant or co-dominant, those with cedar as a dominant or co-dominant, and those with both coniferous and broad-leaved trees important.

The specific areas used were as follows:

Open Bog—Martin (1959, 1960), wet bog and dry bog; Jackson (1914), sedge and cassandra associations; LeFebvre (1959), open sedge mat; Root (1942), bog mat association; Aldrich (1943), *Chamaedaphne calyculata* consocies; and open wet and dry areas of Portage Bog.

Thicket—Buckner and Turnock (1965), Plot II; LaFebvre (1959), bog birch; Root (1942), lowland thicket and dead tree associations; Aldrich (1943), *Nemopanthus–Alnus* association; Stewart and Aldrich (1952), scrub black spruce bog and bog shrubs; Robbins and Stewart (1951), scrub spruce bog; and high and low thickets of Portage Bog.

Tamarack Forest—Buckner and Turnock (1965), Plot I; LeFebvre (1959), tamarack; Goodwin and Jarvis (1964), Fairfield, Jarvis, and Woodford (1960), tamarack swamp; and tamarack forest of Portage Bog.

Spruce Forest—Jackson (1914), tamarack–black spruce association; Walkinshaw (1949), black spruce–tamarack bog; Martin (1959, 1960, and pers. comm.), *Picea mariana* and *P. mariana–Thuja* forests; Stewart and Robbins (1951), virgin spruce–hemlock bog forest.

Cedar Forest—Breckenridge (1955), bog forest habitat; Jackson (1914), cedar–balsam–hemlock association; Root (1942), cedar bog association; Kendeigh (1948),

TABLE 3

PERCENTAGE FREQUENCY OF OCCURRENCE (AND MAXIMUM DENSITY) IN BOG VEGETATION TYPES

Species	Open bog	Thicket	Tamarack forest	Spruce forest	Cedar forest	Mixed forest
American Bittern (*Botaurus lentiginosus*)	38	25	0	0	0	0
Marsh Hawk (*Circus cyaneus*)	38	12	25	0	0	0
Ruffed Grouse (*Bonasa umbellus*)	0	0	25	20	67	40
Virginia Rail (*Rallus limicola*)	25	0	0	0	0	0
Sora (*Porzana carolina*)	38	0	0	0	0	0
Mourning Dove (*Zenaidura macroura*)	12	25	50	20	33(11)	20
Yellow-shafted Flicker (*Colaptes auratus*)	25	62	50	80	50	80
Pileated Woodpecker (*Dryocopus pileatus*)	0	0	0	20	50	40
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	0	12	25	20	17	20
Hairy Woodpecker (*Dendrocopos villosus*)	0	38	0	20	67	60
Downy Woodpecker (*D. pubescens*)	0	38	0	0	17	60(16)
Eastern Kingbird (*Tyrannus tyrannus*)	50	25	25	0	33	0
Great Crested Flycatcher (*Myiarchus crinitus*)	0	25	25	20	50(14)	80(15)
Eastern Phoebe (*Sayornis phoebe*)	0	25	50	0	0	0
Yellow-bellied Flycatcher (*Empidonax flaviventris*)	0	25	25	60(22)	33(22)	0
Traill's Flycatcher (*E. traillii*)	12	50	50	20	0	0
Least Flycatcher (*E. minimus*)	0	25	25	0	50	20
Eastern Wood Pewee (*Contopus virens*)	0	0	25	0	33	60(26)
Olive-sided Flycatcher (*Nuttallornis borealis*)	12	25	25	40	33	0
Tree Swallow (*Iridoprocne bicolor*)	38	25	0	0	0	0
Barn Swallow (*Hirundo rustica*)	25	0	0	0	0	0
Blue Jay (*Cyanocitta cristata*)	12	25	25	60	67	80(22)
Common Crow (*Corvus brachyrhynchos*)	0	0	0	40	17	60
Black-capped Chickadee (*Parus atricapillus*)	25	75	75(13)	60	100(19)	100(40)
White-breasted Nuthatch (*Sitta carolinensis*)	0	0	0	0	33	40
Red-breasted Nuthatch (*S. canadensis*)	0	0	25	60	84	20(12)
Brown Creeper (*Certhia familiaris*)	0	0	25	40	33	20(12)
House Wren (*Troglodytes aedon*)	0	25	0	0	17	20

TABLE 3 (*Cont'd*)

Species	Open bog	Thicket	Tamarack forest	Spruce forest	Cedar forest	Mixed forest
Winter Wren (*T. troglodytes*)	0	0	25	80	50	20
Catbird (*Dumetella carolinensis*)	12	50(11)	50	20	17	60
Brown Thrasher (*Toxostoma rufum*)	0	25	25	0	17	0
Robin (*Turdus migratorius*)	0	38(11)	75	0	33	40(14)
Wood Thrush (*Hylocichla mustelina*)	0	0	0	20	33	80(13)
Hermit Thrush (*H. guttata*)	0	38(19)	25	40	17	20(21)
Swainson's Thrush (*H. ustulata*)	0	25(14)	25	60	17	20
Veery (*H. fuscescens*)	0	25	25(18)	20	84(18)	80
Golden-crowned Kinglet (*Regulus satrapa*)	0	12	25	100(32)	50(15)	40(32)
Cedar Waxwing (*Bombycilla cedrorum*)	38	62(11)	75(27)	60	67	20
Red-eyed Vireo (*Vireo olivaceus*)	12	12(42)	50(16)	0	50	60(16)
Black-and-white Warbler (*Mniotilta varia*)	12	25(11)	50	60	67(19)	60
Tennessee Warbler (*Vermivora peregrina*)	0	25(22)	25	0	17	20
Nashville Warbler (*V. ruficapilla*)	0	62(39)	100(55)	60(28)	100(28)	40
Parula Warbler (*Parula americana*)	0	0	25	0	50	40
Yellow Warbler (*Dendroica petechia*)	0	50(10)	25	20	0	0
Magnolia Warbler (*D. magnolia*)	0	38(33)	25	100(40)	50(27)	60(40)
Myrtle Warbler (*D. coronata*)	12	38	25	60	50	20
Black-throated Green Warbler (*D. virens*)	0	0	0	20	33(18)	40(26)
Blackburnian Warbler (*D. fusca*)	0	38(39)	25	60(96)	67(13)	60(96)
Chestnut-sided Warbler (*D. pensylvanica*)	12	38	0	20	33	0
Ovenbird (*Seiurus aurocapillus*)	12	0	0	0	50	60(38)
Northern Waterthrush (*S. noveboracensis*)	0	25(33)	25	60(64)	33	60(64)
Yellowthroat (*Geothlypis trichas*)	75(134)	100(55)	100(32)	60(26)	50(29)	60(13)
Canada Warbler (*Wilsonia canadensis*)	0	38(22)	50	60(44)	50(12)	60(44)
Red-winged Blackbird (*Agelaius phoeniceus*)	75(12)	12	25	0	0	0
Common Grackle (*Quiscalus quiscula*)	25	0	0	0	0	20
Brown-headed Cowbird (*Molothrus ater*)	25	25(25)	50	0	17(13)	40
Scarlet Tanager (*Piranga olivacea*)	0	12	25	40	67	80(18)
Cardinal (*Richmondena cardinalis*)	12	12	50	0	0	40(20)

TABLE 3 (*Cont'd*)

Species	Open bog	Thicket	Tamarack forest	Spruce forest	Cedar forest	Mixed forest
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	0	12	50	0	17	20
Purple Finch (*Carpodacus purpureus*)	25	50	50(15)	60	50	20
American Goldfinch (*Spinus tristis*)	25	12	50	20	17	20
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	25	50(24)	25	0	17	20
Slate-colored Junco (*Junco hyemalis*)	0	38(13)	0	80	50	20(14)
White-throated Sparrow (*Zonotrichia albicollis*)	0	38(61)	50(39)	80(62)	100(48)	40(14)
Swamp Sparrow (*Melospiza georgiana*)	75(176)	50	50	20	17	20
Song Sparrow (*M. melodia*)	75(51)	88(63)	75	20	50	40(13)

cedar–balsam forest: Martin (1959, 1960, and pers. comm.), *P. mariana–Thuja* forest: Stewart and Aldrich (1952), white cedar–tamarack–black ash bog forest.

Mixed Coniferous–Deciduous Forest—Sugarloaf Bog: Aldrich (1943, also 1939), *Larix–Acer–Betula* association: Stewart and Aldrich (1952), white cedar–tamarack–black ash bog forest; Smith (1938, 1941, 1943, 1944, and 1945), balsam–black ash bog; Stewart and Robbins (1951), virgin spruce–hemlock bog forest.

Community relationships.—The categories given above (and in Table 3) are of descriptive value but otherwise have no fundamental significance. The breeding birds of one open bog are not greatly like those of another: the avifauna of one spruce forest is rather like that of another, but it may be equally similar to that of a cedar forest or a spruce thicket.

If we attempt to determine in what vegetation types the peaks of occurrence for various species fall, they appear to be equally scattered through the whole series from open bog to mixed forest (Table 3). If we pursue the matter, however, by preparing other lists for pure deciduous forest in the same geographical areas, non-bog spruce–fir forest, etc., it becomes evident that the peaks of occurrence tend to fall into four groups corresponding to marsh, thicket or forest edge, spruce–fir forest, and deciduous forest. The species which seemingly peak at tamarack forest, between spruce and cedar bog, etc., virtually all have still higher peaks in one of these four types. If we recognize these four ecological groups (which appear to correspond to the biociations and biocies of Kendeigh, 1948) we can make the following statements:

(1) The avifauna of open wet bogs is not closely related to other bog types, being made up of wide-ranging marsh species such as rails, American bittern, Red-winged Blackbird, and Swamp Sparrow.

(2) Open dry bogs are depauperate forest-edge communities possessing those species able to exist with a minimum of taller woody growth (e.g., Song Sparrow, Yellowthroat).

(3) The avifauna of thickets is a conglomeration of species, mainly forest-edge (such as Yellow Warbler, Traill's Flycatcher, Rufous-sided Towhee) but also with species from adjacent forests (e.g., Downy and Hairy woodpeckers, Hermit Thrush, and several warblers).

(4) Bird populations of tamarack forests are likewise conglomerations of thicket and forest species. The species that within the bog sequence reach their peak of frequency in tamarack forest (e.g., Phoebe, Brown-headed Cowbird, Rose-breasted Grosbeak, American Goldfinch) are probably all still more frequent in some non-bog vegetation.

(5) Spruce bog populations are composed primarily of spruce–fir forest species such as Yellow-bellied Flycatcher, Swainson's Thrush, Golden-crowned Kinglet, Hermit Thrush, Myrtle Warbler, Winter Wren, Magnolia Warbler, Brown Creeper, Purple Finch, and Slate-colored Junco. There are few very striking differences in species composition between spruce bogs and mature spruce–fir forests on non-peat sites. The Olive-sided Flycatcher is perhaps more apt to occur in spruce bogs, and the Solitary Vireo (*Vireo solitarius*), Cape May Warbler (*Dendroica tigrina*), and Bay-breasted Warbler (*D. castanea*) are probably more frequent in spruce–fir forests.

(6) Cedar forests share species of spruce–fir forest (e.g., Winter Wren, Yellow-bellied Flycatcher, Slate-colored Junco, Purple Finch) and deciduous forest (e.g., Hairy Woodpecker, Wood Pewee, White-breasted Nuthatch, Red-eyed Vireo).

(7) Mixed forests likewise have birds both of spruce–fir and deciduous forest, with the latter more prominent than in cedar forest. Virtually all of the species in the bog sequence reaching their highest frequency in mixed forest (e.g., Wood Pewee, Ovenbird, Scarlet Tanager) have still higher peaks in pure deciduous forest. Mixed bog forests and pure deciduous, non-bog forests differ in three ways: (a) The spruce–fir species that persist at varying frequencies in mixed forest are generally absent in deciduous forest. (b) Several forest-edge species have rather high frequencies in mixed bog forest but are scarce in pure deciduous forest. I suspect that this is related to the presence of a dense shrubby and herbaceous cover through the summer in mixed bog forest (see Brewer, 1966:44). (c) Many deciduous forest species have higher frequencies in pure deciduous forest than in mixed forest.

(8) A few species have rather obvious peaks in cedar or cedar-mixed forest and do not seem still more characteristic of pure deciduous forest or pure spruce–fir forest. These include Red-breasted Nuthatch, Black-throated Green Warbler, Parula Warbler, Black-and-white Warbler, and Veery. The first three of these Martin (1960) assigns to a hemlock forest community. This may be correct; nevertheless, in comparing species lists for pure hemlock forests and hemlock–white pine–northern hardwoods forests, I see few differences other than the absence of a few species from pure hemlock. Such species as Black-and-white Warbler, Black-throated Green Warbler, Black-throated Blue Warbler, and Yellow-bellied Sapsucker appear to reach their peak frequencies in hemlock–pine–hardwood forests. This may also be the case for the Veery. The Red-breasted Nuthatch does not seem to be a member of this group; Fawver (cited in Kendeigh, 1961), in contrast to Martin (1960), found the species to be more common in spruce–fir than in hemlock. Possibly the answer is that this species is, in fact, most characteristic of neither of these, but cedar forest instead.

A second way of looking at the community relationships of bog bird populations is this: the species present in any given stand of bog vegetation depend not only on the vegetation of that stand but also upon the geographical ranges of species able to utilize the vegetation and further upon adjacent vegetation and the birds occurring there. The latter point is particularly important in bog communities because they generally occur in relatively small patches surrounded by dissimilar vegetation. Examples have already been given in the occurrence of Yellowthroats, Ovenbirds, and Song Sparrows in Sugarloaf Bog and in the effect of a fire in adjacent vegetation at Portage Bog. To illustrate the geographic effect, the southwestern Michigan bogs have no White-throated Sparrows for the simple reason that the southern limit of this species lies well to the north (however complicated the interactions of climate, physiology, etc. that set this limit).

Furthermore, when it is stated that the species present in a given stand are, in part, determined by the vegetation of that stand, it is not meant that the birds select marsh, thicket, spruce–fir forest, or deciduous forest as such. Presumably they behave in habitat selection as they do in other areas of their life and tend to establish themselves in areas possessing features that act as a series of releasers for, perhaps, investigation of an area, establishment of a territory, etc. (Svärdson, 1949). Doubtless these features are those generally associated with the presence of certain environmental factors required for the birds' existence. In some cases we may see some fairly obvious feature such as the presence of dead trees suitable for nesting cavities with which the occurrence of certain species is correlated. Given this factor, the species may occur in stands of otherwise greatly variable vegetation.

Such observable features may be the releaser or the requisite, or both, or neither but merely some additional features associated with one or the other.

The "typical" birds of a given kind of vegetation are not all of a piece. No two show exactly the same distribution when examined stand by stand. "Deciduous forest species," for example, may be such for quite dissimilar reasons. Ovenbirds, Kendeigh (1945:428) suggests, may require broad leaves for use in nest building. Scarlet Tanagers, on the other hand, appear to require "deciduousness" rather than "broad-leavedness." They tend to be present in bog forests with a deciduous element whether provided by broad-leaved trees or by the needle-leaved but deciduous tamarack. Their dependence on deciduousness may be related to illumination in the spring. Prescott (1965) has described courtship activities involving display of the red back by males perched near the ground to females in the canopy that seem to demand good light penetration.

Because the bird population of a given stand of vegetation is a product of so many factors—the geographical location of the stand, the surrounding vegetation, and a great variety of structural features of the vegetation—we cannot expect to find a given community displaying much unity. This lack of unity is both geographical, in that a given spruce bog is likely to have fewer and fewer species in common with other spruce bogs located at greater and greater distances, and vegetational, in that there is no tendency for "spruce bog" to have a well-defined group of species occurring in about the same relative numbers over the whole variety of vegetational conditions that can be contained in the term "spruce bog." Rather we find the avian composition shifts as we move from tamarack–spruce to pure spruce to spruce–cedar or from spruce forest with small trees and openings to spruce forest of large trees and a closed canopy.

The two foregoing discussions represent, I believe, the organismic and the individualistic views of communities as they can be applied to bog bird populations. Briefly, for those unfamiliar with this controversy (Curtis, 1959; Goodall, 1963; Daubenmire, 1966), the concepts differ as follows: Given a region occupied by biota, the individualistic view holds that each species occurs independently of others in those spots it is able to disperse to and survive in. Further, the conditions under which each species survives and prospers differ from those of every other species. As a consequence, the biota of a given piece of ground is simply a gathering of those species finding it within their tolerances. A usual corollary to the individualistic view is the continuum approach to describing biota: the biota is supposed to vary continuously in time and space, and each point of the continuum is equally probable. In other words, if a certain combination of species is termed oak–hickory forest and another combination, beech–maple forest, every intermediate between these two combinations is possible and, in fact, just as likely to occur as oak–hickory or beech–maple forest.

The organismic concept regards the biota as being integrated. The emphasis is upon interactions among community associates rather than upon the responses of a single individual to its environment. As a consequence, proponents of the organismic concept generally adopt a classificatory approach to the description of biota, regarding various combinations of species as being more probable than others, the "others" representing transitions. The greater probability of certain combinations is viewed as the result of activities of the community, such as production of a mature soil, development of a certain level of shading, establishment of food chains, etc.

If these are fair statements of the two positions, I believe that both are, to a degree, correct. One possible area of reconciliation in the interpretation of bog bird populations is that of paleoecological history.

The broad-leaved deciduous forests of eastern North America are the product of a long period of development, largely from the temperate portion of the Arcto-Tertiary Geoflora (Braun, 1950). The now extensive boreal forest is probably a product of the Pleistocene (Braun, 1950:511; Mengel, 1964:10); at least, there are no known Tertiary floras so heavily dominated by spruce, fir, and similar coniferous forms. The bog sere of glaciated North America is also doubtless a product of the Pleistocene, constituted of plants from a variety of pre-glacial sources.

I shall suggest that the number of species typical of a certain kind of vegetation (i.e., having their peak of occurrence there) is strongly dependent on the opportunity for species to adapt to this vegetation. Three prime considerations in this opportunity are (1) time of existence of the vegetation; (2) area occupied by the vegetation; and (3) the number of species already able to use the vegetation. The opportunity for adaptation to eastern deciduous forests has been extensive because of the long period of their existence and the rather large area occupied. The opportunity for adaptation to spruce–fir forest has also been of large magnitude (as Mengel (1964) has pointed out), representing as it did a large area of vegetation of a kind previously unavailable. The bog communities of open wet bog, open dry bog, bog thicket, tamarack forest, and cedar forest offered much less of an opportunity for several reasons: bog communities tend to occur as small patches surrounded by different kinds of vegetation. They tend also to be short-lived in any one place, disappearing through successional processes. Finally, open wet bog duplicates in many structural features the ancient marsh vegetation type, and open dry bog, thicket, and tamarack duplicate in many features forest-edge vegetation such as occurred along streams, cliff-edges, etc. throughout the history of the eastern deciduous forest. Thus, many species were probably already available to occupy these types.

It seems entirely reasonable then that we may recognize four "clumps" of species corresponding to conditions of the ancient communities of marsh, deciduous forest, and deciduous forest edge and to the new spruce–fir forest community. It seems possible that a few species might find themselves pre-adapted for success in tamarack or cedar forest or in coniferous forest edge (largely provided by bogs) and might fairly rapidly become adjusted in their habitat selection and life history to these communities. The Nashville Warbler appears to come close to such a species for coniferous forest edge-tamarack, and the Olive-sided Flycatcher may represent another coniferous edge species. Possibly the Red-breasted Nuthatch is such a cedar forest species.

I suspect that the hemlock–white pine–hardwood forests represent another community to which adaptation of several species has occurred and which has supplied species to mixed bog forests; however, the history of the former vegetation type is not clear (Braun, 1950:528).

Both the organismic and individualistic concepts, in their usual practice, have failed to take adequate account of historical and evolutionary factors in community organization. The organismic concept seems to consider all communities as equally well integrated and, by implication, equally ancient. The individualistic concept seems to ignore history, except that of the individual stand, altogether.

It is scarcely possible to deny the existence of biotic continua, in the sense that when the abundance of species is plotted against a real or hypothetical environmental gradient a series of curves with differing modes and amplitudes is produced. The existence of continua, however, seems to favor the organismic concept. Given an area of deciduous forest for existence and adaptation, there seems every reason to believe that different species, as they experienced differential success resulting from competition, would become adapted to somewhat different conditions. I see little difference between this form of organization and such forms as stratification and aspection. In all three cases, the environment is divided up in a manner suggesting that the presence of other species has been important in the evolutionary processes producing such partitioning. The view that such organization depends solely on the combination at a particular time and place of species having tolerances and life histories that happen to fit one another and the physical environment is almost perfectly correct if all we are interested in is the instantaneous description of an individual stand; but it is incomplete.

TABLE 4

ZOOGEOGRAPHIC RELATIONS OF THE BREEDING BIRDS OF VARIOUS BOG VEGETATION TYPES (PERCENT OF SPECIES IN EACH FAUNAL GROUP)

Vegetation	Unanalyzed	Non-passerine	Boreal	Eastern ecotone	Eastern deciduous forest
Open	50	30	20	0	0
Thicket	26	13	35	22	4
Tamarack Forest	36	9	22.5	22.5	9
Spruce Forest	11	7	54	21	7
Cedar Forest	14	14	31	25	16
Mixed Forest	18	15	12	27	27

Zoogeographic relationships.—All species of at least 33 per cent frequency in each vegetation type (Table 3) were assigned to faunal groups (Udvardy, 1964). (Complete species lists for each vegetation type were not used because many species of low frequency may be represented for some nearly accidental reason, such as the presence of some favorable vegetation adjacent to a single study area.) This analysis supports the conclusions drawn in preceding sections. The early successional stages of open bog, thicket, and tamarack forest show high percentages of the wide-ranging species of the unanalyzed element (Table 4). Open bog, by virtue of its marsh birds, has a high percentage of non-passerine species. Spruce bogs are heavily dominated by boreal forest species; cedar forest has fewer boreal species and mixed forest still fewer. Eastern deciduous forest species show the reverse trend, increasing from boreal through cedar to mixed forest.

To return to the question of bogs as boreal islands, we may examine the percentages of boreal species occurring on the individual study areas. Given in Figure 4, these show a strong latitudinal trend, northern bogs having high percentages and southern bogs low.[2] At the latitude of northern Michigan it is reasonable to regard bog forests as boreal islands because both the actual and the presumed potential general vegetation of the region has a substantially lower percentage of boreal birds. For example, the beech–maple–pine forest in Cheboygan County (45.5° N. lat.) reported on by Kendeigh (1948) had only 12.5 per cent boreal species compared with values from 16 to 37 per cent for bog thickets and forests in the area. Farther north, however, the concept has less validity because the region in general is rather strongly boreal. For Aroostook County, Maine, Stewart and Aldrich

---

[2] Some of Udvardy's eastern ecotone species could be considered "boreal." I have preferred to use Udvardy's groups rather than risk the possible circularity involved in constructing my own. In any case, expansion of the boreal category to include group 1 of Udvardy's eastern ecotone fauna would not change the trends described.

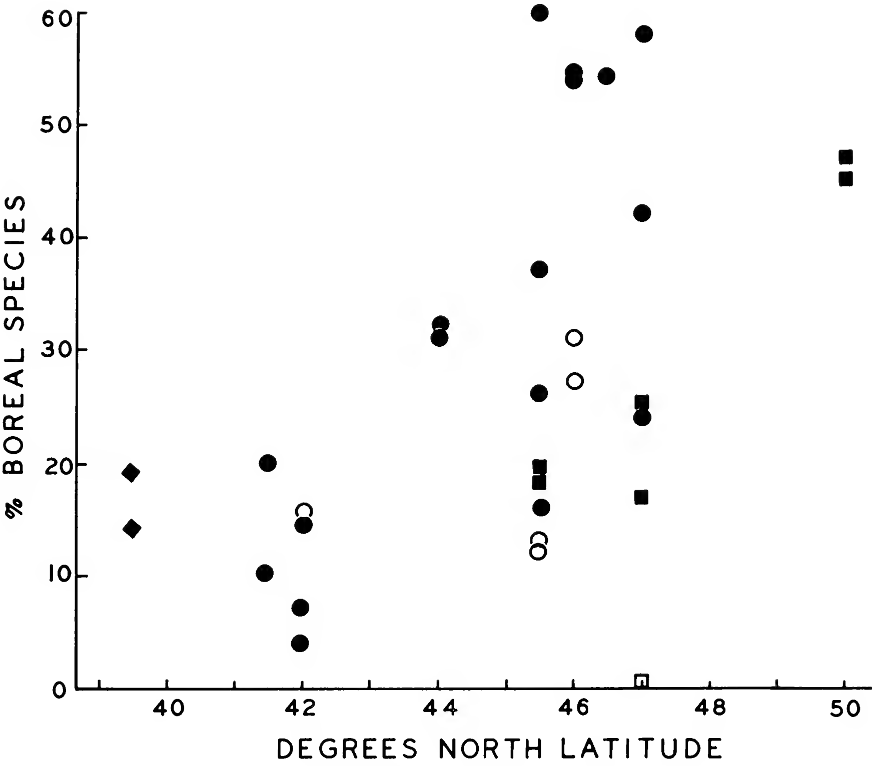


FIG 4. Relationship between percentage of boreal species in the avifauna of 31 bog areas and latitude. Open symbols represent open bog, squares represent western areas (Minnesota and Manitoba), and diamonds, Appalachian areas (Maryland).

(1952) state that a mixed hemlock–hardwood–spruce–fir forest is probably the climax vegetation. One such forest for which they give census data had 33 per cent boreal species compared with values from 24 to 58 for bog thickets and forests of the area. In Ontario, if hemlock forest is indeed climax (as Martin, 1959, states), the percentage of boreal species in the potential prevailing vegetation of the area is 50 per cent compared with 54 per cent for spruce and spruce–cedar bog forests (Martin, 1960).

As one proceeds south from northern Michigan, the percentage of northern species declines. A comparison between Portage Bog and a tamarack bog in Ontario (Goodwin and Jarvis, 1964) illustrates this. The Ontario area has a much higher percentage of tamarack forest and much less open bog, but having allowed for these differences, the dissimilarity of avian populations is still striking. The two areas have 12 species (out of 40; 30

per cent) in common. Present on the Ontario area but absent from Portage Bog are such northern species as White-throated Sparrow, Canada Warbler, Red-breasted Nuthatch, Brown Creeper, Winter Wren, and Purple Finch. No similar array of species replaces these in the south, and as a result Portage Bog has a much less diverse avifauna (mean number of species per year about 16 compared with about 20 for the Ontario area).

The entire boreal element of the two southwestern Michigan areas consists of Tree Swallow, Black-capped Chickadee, and Traill's Flycatcher. All three are widely distributed in non-bog vegetation in southwestern Michigan and farther south. More to the point as boreal, or at least northern species, are the Nashville Warbler at Portage Bog and the Black-throated Green Warbler at Sugarloaf Bog. Both are rare in southwestern Michigan, and the Nashville Warbler probably would not be present if bog vegetation were not present. Black-throated Green Warblers, however, have been reported as summer residents elsewhere in the region in non-bog forests (e.g., MacArthur, 1964). And finally, such good boreal species as the Brown Creeper (Walkinshaw, 1948) and the Winter Wren (Wallace, 1944) have spent the summer (and nested in the case of the creeper) in two Michigan localities of about the same latitude as Kalamazoo County. Neither record was from a bog. In sum, the concept of bogs as boreal islands seems to have no validity when applied to bird populations of southwestern Michigan.

A few other trends in the percentage of boreal species are also present. Open bogs are not particularly boreal in character whether located north or south. It must be remembered that open bogs have a high proportion of non-passerine and thus unclassified species; however, I do not think the conclusion would be substantially altered if the non-passerines were assigned to faunal groups. There appears also to be a trend toward increased numbers of boreal species in the Appalachians, as might be expected, and a decrease westward such that the Minnesota bogs and even those of Manitoba rate rather low in comparison with others of the same latitude.

Succession.—Table 3 lists all species occurring in at least two open bogs, two bog thickets, and four bog forests (i.e., all species having about a 25 per cent frequency or greater in one of the three types). Frequency and maximum reported density (mean number of males per 100 acres; only values over 10 included) for each species in each of the six vegetational categories are given. This compilation is of descriptive value for two reasons. First, it is often handy to categorize bog vegetation into these six types and, within the already stated limitations of geographic and local variation, the lists indicate the prevailing avifauna of these vegetational categories. Second, the sequence open bog to mixed forest is a frequent successional pathway in northern Michigan (Gates, 1942). The table may be taken as a generalized summary of bird succession in bogs if it is borne in mind that no real bog in northern Michigan or elsewhere is likely to exhibit just such a sequence of species. This is true because (a) succession of bird species in a given bog will have a strong local character because of differing geographical ranges of species, the influence of surrounding vegetation, and peculiarities of particular situations as they influence the structure of the vegetation, and (b) vegetational succession is itself highly variable both between and within regions. The sequence given is frequent in northern Michigan, but it often happens that spruce enters without an intervening tamarack stage. In southwestern Michigan spruce and cedar are essentially absent and here the succession may be from open bog to tamarack thicket to tamarack forest to mixed forest.

Within a restricted geographical area, there appears to be a decrease in number of species from open wet bog to open dry bog and then an increase from open dry bog through thicket and forest. Probably these trends are related to a loss of marsh growth forms followed by the addition of low and then high woody strata. When numbers of species for given vegetation types are examined over larger geographical areas, however, these trends largely disappear; open dry bog is consistently low in species, but otherwise numbers overlap widely. This situation appears to result from the differing distributions of species able to make use of the various vegetation types. Specifically, it seems to be related to the decrease of boreal and eastern ecotone species southward and westward and the extent to which deciduous forest and forest-edge species enter the various vegetation types.

Although densities as reported here for southwestern Michigan increased directly from open bog to thicket to mixed forest, this trend was not general. In Ontario, for example, open bogs had 50–100 more males per 100 acres than bog forests (Martin, 1960). Neither were there obvious geographical trends in population size.

SUMMARY

Bird populations were studied on two bog areas in southwestern Michigan. One, a sphagnum–leatherleaf–tamarack bog, had an average of about 16 breeding species per year and an average density of about 170 males per 100 acres. Song Sparrow was by far the most abundant species; Yellowthroat, Rufous-sided Towhee, and Field Sparrow were also numerically important. All but the last showed higher densities in thicket compared with open parts of the bog. Most of the birds were forest-edge species of wide geographical range. Populations were sparse outside the breeding season, probably because of a poor food supply.

The second area, a yellow birch–red maple–white pine bog forest, had about 20 breeding species a year. Density was about 270 males per 100 acres. Black-capped Chickadee, Ovenbird, Wood Pewee, Blue Jay, Cardinal, Scarlet Tanager, and four other species had densities greater than 10 per 100 acres. Between 1965 and 1966, the number of Ovenbirds greatly increased and Song Sparrows greatly declined.

Two ways of viewing bog bird communities are set forth. The first, classificatory or organismic, recognizes four main ecological groups of birds occurring in bogs (marsh, thicket or forest edge, spruce–fir forest, and deciduous forest), while acknowledging that any given stand may contain elements of more than one group. The second, individualistic, view emphasizes the tendency for each species to be distributed accordingly as it encounters suitable habitat within its range of geographic occurrence. The second view is essentially correct for the instantaneous description of a stand, but it seems not to give sufficient weight to historical and evolutionary factors.

The concept of bogs as boreal islands is valid for a certain range of latitudes. North of this, bogs are not much more boreal than surrounding vegetation and southward the number of boreal species rapidly diminishes until in southwestern Michigan there is practically no boreal character to the bird population.

ACKNOWLEDGMENTS

For assistance with various phases of field work, I am indebted to Frederick Courville, Willard Holley, and especially Jack W. Kammeraad and Arlo Raim. J. R. and B. Morren and C. S. Warren kindly allowed access to the study areas.

LITERATURE CITED

Aldrich, J. W.

1939 Red maple–yellow birch bog forest. *Bird-lore*, 41, Suppl.: 20–21.

1943 Biological survey of the bogs and swamps of northeastern Ohio. *American Midl. Nat.*, 30:346–402.

Bailey, V.

1896 Tamarack swamps as boreal islands. [Reported by F. A. Lucas. Biological Society of Washington, 254th meeting, January 25] *Science*, n.s., 3:249–251.

Batts, H. L., Jr.

1957 A preliminary report on seasonal distribution of birds in Kalamazoo County, Michigan. *Jack-Pine Warbler*, 35:9–13.

Braun, E. L.

1950 Deciduous forests of eastern North America. Blakiston, Philadelphia.

Breckenridge, W. J.

1955 Comparison of the breeding-bird populations of two neighboring but distinct forest habitats. *Audubon Field Notes*, 9:408–412.

Brewer, R.

1963 Stability in bird populations. Occas. Papers Adams Ctr. Ecol. Studies, No. 7:1–12.

1966 Vegetation of two bogs in southwestern Michigan. *Michigan Bot.*, 5:36–46.

Brewer, R., and A. Raim

1966 Summer observations of Nashville and Black-throated Green Warblers in Kalamazoo County, Michigan. *Jack-Pine Warbler*, 43:169.

Buckner, C. H., and W. J. Turnock

1964 Avian predation on the larch sawfly, *Pristiphora erichsonii* (Htg.), (Hymenoptera: Tenthredinidae). *Ecology*, 46:223–236.

Curtis, J. T.

1959 The vegetation of Wisconsin. University of Wisconsin Press, Madison, Wisconsin.

Daubenmire, R.

1966 Vegetation: identification of typal communities. *Science*, 151:291–298.

DUNCAN, D. P.

1954 A study of some of the factors affecting the natural regeneration of tamarack (*Larix laricina*) in Minnesota. *Ecology*, 35:498–521.

FAIRFIELD, G., J. JARVIS, AND J. WOODFORD

1960 Tamarack Swamp. *Audubon Field Notes*, 14:494.

GATES, F. C.

1942 The bogs of northern lower Michigan. *Ecol. Monogr.*, 12:213–254.

GOODALL, D. W.

1963 The continuum and the individualistic association. *Vegetatio*, 11:298–316.

GOODWIN, C. E., AND J. JARVIS

1964 Tamarack Swamp. *Audubon Field Notes*, 18:551–552.

JACKSON, H. H. T.

1914 The land vertebrates of Ridgeway Bog, Wisconsin: their ecological succession and source of ingression. *Bull. Wisconsin Nat. Hist. Soc.*, 12:4–54.

KENDEIGH, S. C.

1945 Community selection by birds on the Helderberg Plateau of New York. *Auk*, 62:418–436.

1948 Bird populations and biotic communities in northern lower Michigan. *Ecology*, 29:101–114.

1961 Animal ecology. Prentice-Hall, Englewood Cliffs, New Jersey.

KLUYVER, H. N., AND L. TINBERGEN

1953 Territory and the regulation of density in titmice. *Arch. Neerland. Zool.*, 10:265–289.

LEFEBVRE, J. H.

1959 Preliminary ornithological survey of French Creek Bog. *Flicker*, 31:106–108.

MACARTHUR, P. A.

1964 Upland beech mixed forest. *Audubon Field Notes*, 18:549.

MARTIN, N. D.

1959 An analysis of forest succession in Algonquin Park, Ontario. *Ecol. Monogr.*, 29:187–218.

1960 An analysis of bird populations in relation to forest succession in Algonquin Provincial Park, Ontario. *Ecology*, 41:126–140.

MENGEL, R. M.

1964 The probable history of species formation in some northern wood warblers (Parulidae). *Living Bird*, 3:9–43.

NICE, M. M.

1941 The role of territory in bird life. *American Midl. Nat.*, 26:441–487.

1943 Studies in the life history of the Song Sparrow. II. *Trans. Linnaean Soc. New York*, 6:1–328.

ODUM, E. P.

1945 The concept of the biome as applied to the distribution of North American birds. *Wilson Bull.*, 57:191–201.

PRESCOTT, K. W.

1965 Studies in the life history of the Scarlet Tanager, *Piranga olivacea*. New Jersey State Mus. Invest., No. 2.

ROBBINS, C. S., AND R. E. STEWART

1951 Scrub spruce bog. *Audubon Field Notes*, 5:325.

ROOT, O. M.

1942 The bog birds of Cheboygan County, Michigan. *Jack-Pine Warbler*, 20:39–44.

SMITH, W. P.
1938 Balsam-black ash bog. *Bird-lore*, 40:354.
1941 Balsam-black ash bog and border. *Audubon Mag.*, 43, Sect. II:481–482.
1943 Balsam-black ash bog and border. *Audubon Mag.*, 45, Sect. II:18.
1944 Balsam-black ash bog and border. *Audubon Mag.*, 46, Sect. II:15–16.
1945 Balsam-black ash bog and border. *Audubon Mag.*, 47, Sect. II:58–59.
STEIN, R. C.
1963 Isolating mechanisms between populations of Traill's Flycatchers. *Proc. Amer. Phil. Soc.*, 107:21–50.
STEWART, R. E., AND J. W. ALDRICH
1952 Ecological studies of breeding bird populations in northern Maine. *Ecology*, 33:226–238.
STEWART, R. E., AND C. S. ROBBINS
1951 Virgin spruce–hemlock bog forest. *Audubon Field Notes*, 5:317–318.
SVÄRDSON, G.
1949 Competition and habitat selection in birds. *Oikos*, 1:157–174.
TOMPA, F. S.
1964 Factors determining the numbers of Song Sparrows, Melospiza melodia (Wilson) on Mandarte Island, B. C., Canada. *Acta Zool. Fenn.*, 109:1–73.
TRANSEAU, E. N.
1903 On the geographical distribution and ecological relations of the bog plant societies of North America. *Bot. Gaz.*, 36:401–420.
UDVARDY, M. D. F.
1963 Bird faunas of North America. *Proc. XIIIth Internatl. Ornith. Congr.*, 1147–1167.
WALKINSHAW, L. H.
1948 Brown creeper nesting in Calhoun County, Michigan. *Jack-Pine Warbler*, 26:157–160.
1949 Birds along the Tahquamenon. *Jack-Pine Warbler*, 27:91–98.
WALLACE, G. J.
1944 Winter wren at East Lansing in summer. *Jack-Pine Warbler*, 22:97–98.
WILLIAMS, A. B.
1947 Climax beech–maple forest with some hemlock (fifteen-year summary). *Audubon Field Notes*, 1:205–210.

C. C. ADAMS CENTER FOR ECOLOGICAL STUDIES, DEPARTMENT OF BIOLOGY, WESTERN MICHIGAN UNIVERSITY, KALAMAZOO, MICHIGAN, 3 AUGUST 1966.

FALL MIGRATION OF SHARP-SHINNED HAWKS

Helmut C. Mueller and Daniel D. Berger

This paper is an analysis of data on the migration of Sharp-shinned Hawks (*Accipiter striatus*) recorded at the Cedar Grove Ornithological Station in the autumns of 1952 through 1964. Particular emphasis is placed on: (1) the time of occurrence of the migrations, (2) the temporal distribution of age classes during migration, (3) weather correlations, including a discussion of the structure of updrafts, and (4) the origins and destinations of the migrants observed at Cedar Grove.

The station is located on the western shore of Lake Michigan about 40 miles north of Milwaukee, Wisconsin. A detailed description of the area can be found in Mueller and Berger (1966). A general description and analysis of hawk migrations at Cedar Grove is given in Mueller and Berger (1961). An essentially dawn-to-dusk watch for migrating hawks was maintained on 915 days in the autumns of 1952 through 1964. Hawk traps were operated on most of these days, and on many days some of the observed migrants were trapped and banded. Observations often became sporadic on days with little or no migration; periodic watches were made with sufficient frequency to insure that few hawks passed unseen on any given observation day. Most of the hawks could be observed easily with the unaided eye, but 7 and 10 power binoculars and a 30 power spotting-scope were used when necessary, both for surveillance and as an aid in identification. In most years observations were conducted at the station on essentially every day from late August until at least late October. In 1952, 1956, and 1957 we sometimes left the station during periods of poor weather.

A total of 17,628 Sharp-shinned Hawks was observed and 2,052 were trapped, banded, and released. The species has been recorded at Cedar Grove only as a migrant. Sharp-shinned Hawks occur only rarely in summer or winter in southern Wisconsin. Our earliest "autumnal" record of a Sharp-shinned Hawk at Cedar Grove is 13 August; the latest date on which we have observed this species is 6 December. Most of the hawks were seen in the period between 10 September and 20 October (Fig. 1). There are three peaks in occurrence within the period: two in mid- to late September and one in mid-October. However, the migrations of all species of hawks are highly correlated with weather conditions, and the temporal distribution of weather conditions must be taken into account in any attempt to determine the periodicity of migration.

At Cedar Grove major fall hawk flights usually occur when the weather map has the following characteristics: (1) a low pressure area to the northeast and high pressure to the southwest of Cedar Grove; (2) the isobars lie across Wisconsin on a northwest-southeast diagonal, and (3) a cold front lies somewhere to the south and east (Class A weather of Mueller and Berger, 1961). However, Class A weather can occur without a concurrence of a major flight of Sharp-shinned Hawks (Fig. 1). Within the period 10 September through 20 October there is only one marked peak in the weather histogram; this coincides with one of the peaks in the hawk histogram. The remaining two peaks in the occurrence of Sharp-shinned Hawks, as well as the low point in occurrence in early October do not coincide with the peaks and low points in the distribution of Class A weather (Fig. 1). The occurrence of major flights, those days on which more than 100 Sharp-shinned Hawks were seen, closely resembles the distribution of the average number of hawks observed; and, similarly, seems to show two peaks which occur semi-independent of the distribution of weather (Fig. 1).

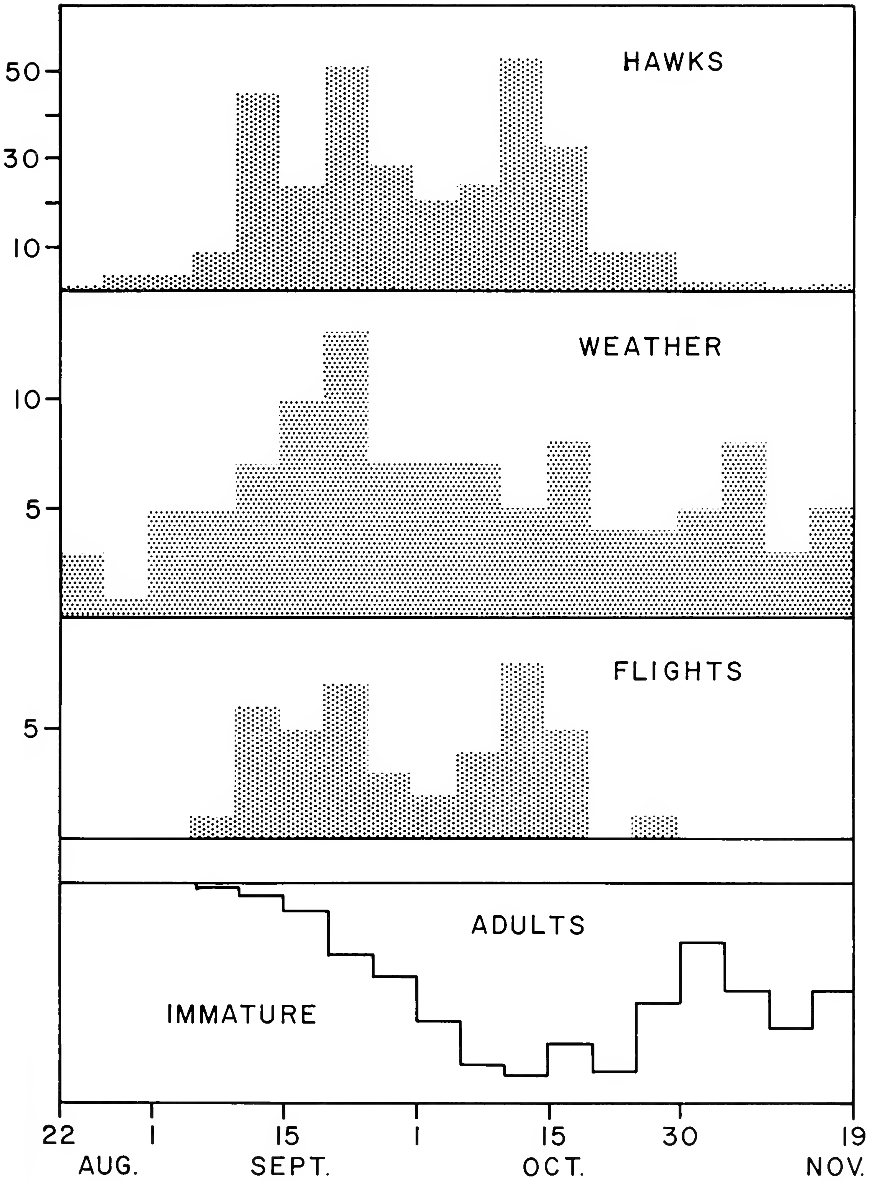
The age ratio of birds that were trapped indicates that immature birds predominate early in the season and that adults predominate late in the season. After 30 October very few Sharp-shinned Hawks are seen or trapped; many of these very late birds are immatures. Thus, there appear to be two peaks in the fall migration of Sharp-shinned Hawks at Cedar Grove: one in mid-September, composed mostly of immature birds, and one in mid-October, composed largely of adults.

WEATHER CORRELATIONS

The four most important meteorological factors associated with the fall migration of Sharp-shinned Hawks at Cedar Grove are probably (1) wind direction and velocity, (2) cold fronts, (3) the decrease in temperature concomitant with frontal passage, and (4) sunshine. The correlations of weather with migration presented in Figures 2, 3, and 4 are based on data from 29 August through 28 October of the years 1958 through 1963, inclusive, a total of 352 observation days.

→

FIG. 1. Temporal distribution of Sharp-shinned Hawks, suitable migration weather, major hawk flights, and age ratio; for the years 1952 through 1964. The abscissa indicates calendar date; the data are grouped in five-day intervals and each bar thus represents five calendar days and from 21 to 64 observation days. Hawks: the mean number of Sharp-shinned Hawks observed per day. Weather: the total number of days having Class A weather (see text). Flights: the total number of days on which more than 100 Sharp-shinned Hawks were observed. The lower histogram indicates the age ratio of the birds that were trapped.


HAWKS
50
30
10
WEATHER
10
5
FLIGHTS
5
ADULTS
IMMATURE
22
AUG.
1
15
SEPT.
1
15
OCT.
30
19
NOV.

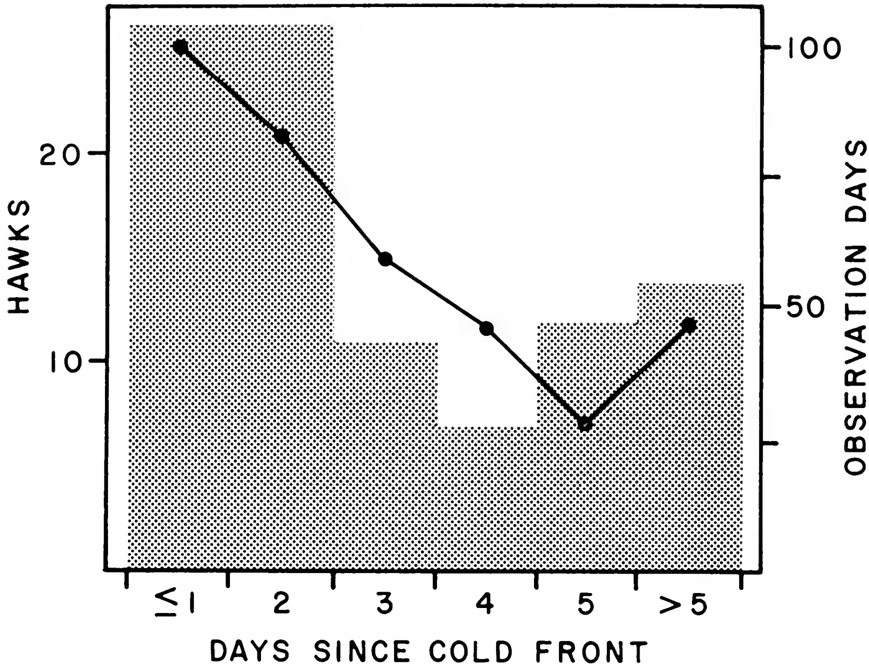


FIG. 2. Sharp-shinned Hawk migration in relation to time of passage of cold fronts. The bars indicate the mean number of Sharp-shinned Hawks seen per day, the points and line the number of observation days on which each bar is based.

Cold fronts.—The time of passage of cold fronts at Cedar Grove was estimated by examination of the U. S. Weather Bureau publications, *Daily Weather Map, Local Climatological Data,* and *Local Climatological Data Supplement* for Milwaukee, Wisconsin, and from uninstrumented observation at Cedar Grove. The mean time interval between cold fronts was 3.8 days and the maximum interval was 9 days during the six autumn study-periods. More than 39 per cent of all the Sharp-shinned Hawks observed migrated over Cedar Grove within one day after the passage of a cold front, and a total of 72 per cent passed within two days of frontal passage. The mean number of Sharp-shinned Hawks observed per day dropped sharply on the third and fourth days after the passage of a cold front and then increased slightly five or more days after the frontal passage (Fig. 2). This increase in hawks observed when the interval between cold fronts is prolonged is apparently the result of birds crossing a slowly moving or stationary front and therefore occurring before an oncoming front rather than after the preceding one. Thus, most hawks migrate in the relatively cooler air behind

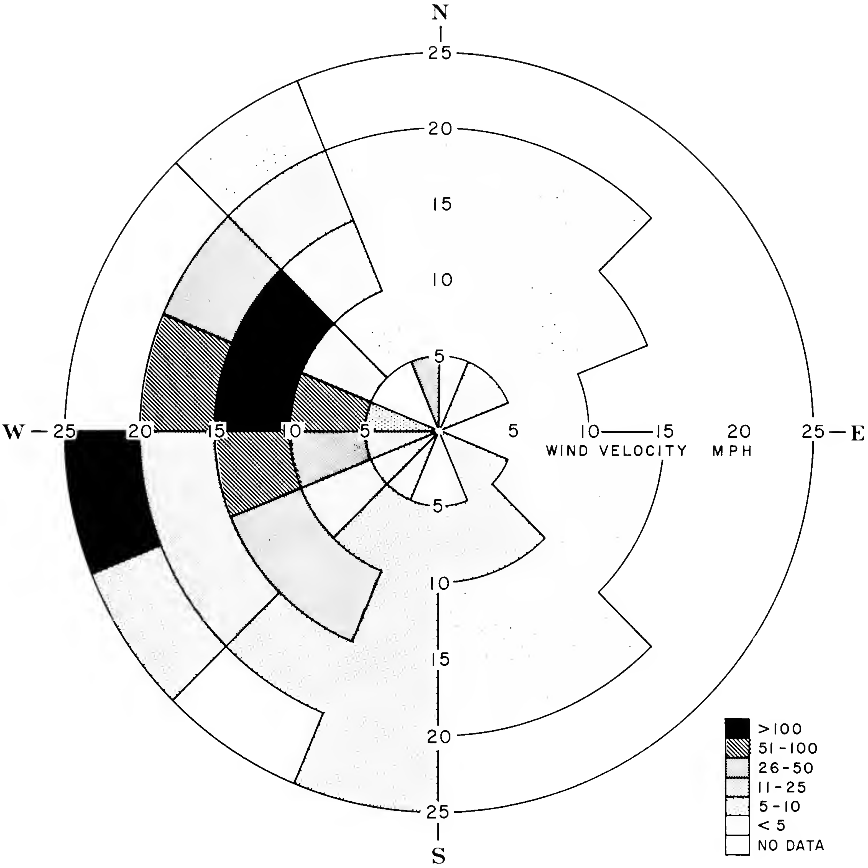


FIG. 3. Correlation of Sharp-shinned Hawk migration with wind direction and velocity. The wind data are the vector means of the 12 hourly readings taken between 0600 and 1700 hours at the U. S. Weather Bureau Station in Milwaukee, Wisconsin. The radial lines enclose 22.5° increments of mean wind vector-directions (e.g. all mean winds between W and WNW). The concentric circles enclose five mph increments of the vector-mean velocity. The intensity of shading within a given segment of the graph indicates the mean number of Sharp-shinned Hawks seen per day under the indicated conditions of wind direction and velocity. For example, a mean of more than 100 Sharp-shinned Hawks per day was observed on those days having a mean wind vector lying between W and WSW in direction and 20 to 25 mph in velocity.

a cold front, and a few cross slowly moving or stationary fronts into the relatively warmer air preceding the front.

Wind.—More than 93 per cent of the Sharp-shinned Hawks observed at Cedar Grove occurred on days when the mean diurnal wind was westerly.

The greatest mean number of hawks per day was seen when the mean diurnal wind was quite strong and had a marked westerly component (Fig. 3). Westerly winds drift southbound hawks eastward until they encounter the west shore of Lake Michigan (Mueller and Berger, 1961). Hawks are reluctant to fly out over the lake, and they tend to follow the leading line formed by the shore of the lake. A concentrated stream of migrating hawks results from the interaction of wind drift and the leading line. A detailed discussion of these phenomena can be found in Mueller and Berger (1967). Few hawks were seen on days when easterly winds prevailed. Easterly winds apparently drift birds away from the lakeshore (Mueller and Berger, 1961).

The wind usually has a northerly component after the passage of a cold front, although occasionally the winds are WSW, or more rarely SW, after frontal passage. Thus, the occurrence of some massed migrations on WSW winds is not surprising. However, the occurrence of migrating hawks on SSW, S, and even SE winds as compared with the paucity of migrating hawks on N and NNW winds is interesting (Fig. 3). The action of wind drift in NNW winds may be considerably less than in SSW winds. Northerly winds speed the southward passage of the birds allowing less time for drift while southerly winds slow the southward progress permitting wind drift to affect the bird for a longer period. Birds fly higher in a tail wind and exhibit less of a tendency to follow leading lines than in a head wind, when they fly lower (Mueller and Berger, 1967). When the wind is southerly at Cedar Grove there is a local tendency for the wind to blow in off of Lake Michigan, giving the wind in the immediate vicinity of the lake an easterly vector. In the warmer air mass usually associated with southerly winds, the air over the lake is often cooler than that over the land. When this cooler air blows in over the warmer land, displacing the warmer air, a line of updrafts paralleling the lake may be created, and, as we will show later, hawks apparently utilize updrafts. Once a hawk has found these updrafts, it might be induced to stay in the updraft zone, and thus fly along the lakeshore. In the cooler air mass usually associated with northerly winds there is little difference in temperature between the air over the lake and that over the land. Under these conditions we would expect about as many updrafts at any inland locality as we would along the lakeshore and, hence, no concentrations of hawks.

Temperature change.—In view of the correlation of the migration of Sharp-shinned Hawks and the recent passage of cold fronts, it is not surprising to find that the migrations correlate rather well with a recent drop in temperature (Fig. 4). In an earlier paper on the influence of weather on the migrations of all species of hawks (Mueller and Berger, 1961), we

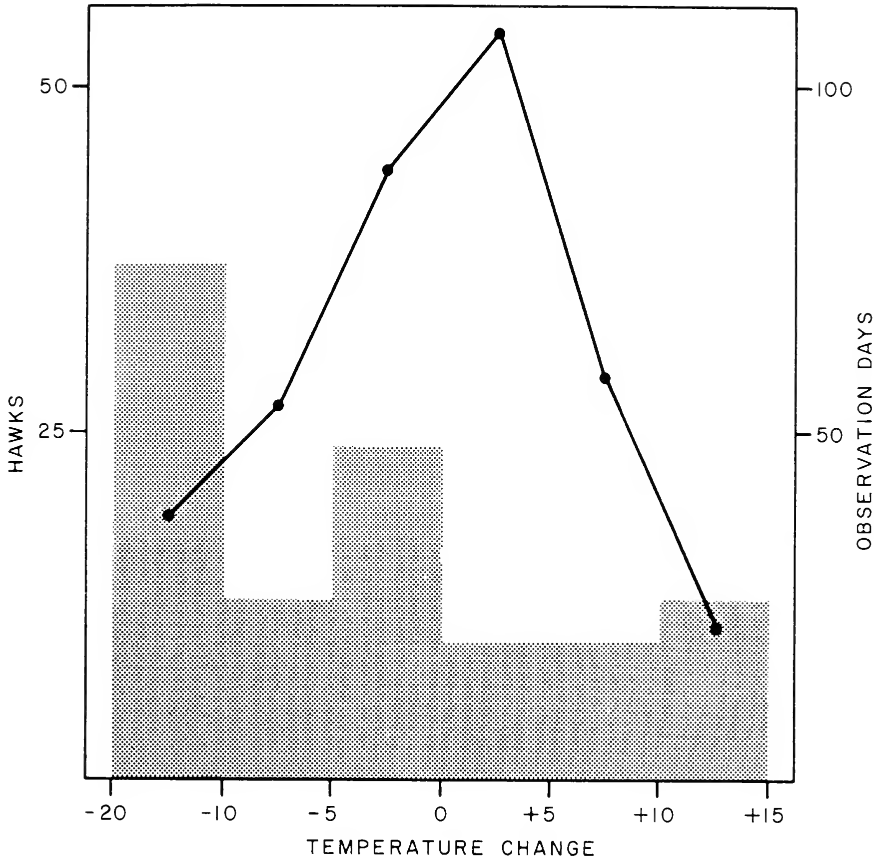


Fig. 4. Temperature change and the migration of Sharp-shinned Hawks. The bars indicate the mean number of hawks observed and the points and line the number of observation days on which each bar is based.

attempted to correlate migration with a variety of temperature measurements and changes in temperature. Of these attempts, perhaps the best correlation was obtained by use of the departure of the mean 0030 (CST) temperatures for Duluth, Minnesota, Wausau, Wisconsin, and Escanaba, Michigan, from the corresponding data of the previous day. This measurement represents an index of temperature change in the probable area of immediate origin of the migrations observed at Cedar Grove. This temperature change was used in compiling Figure 4 and is the only datum used in temperature analysis in this paper. More than 69 per cent of the Sharp-shinned Hawks observed at Cedar Grove occurred when the area temperature had dropped during

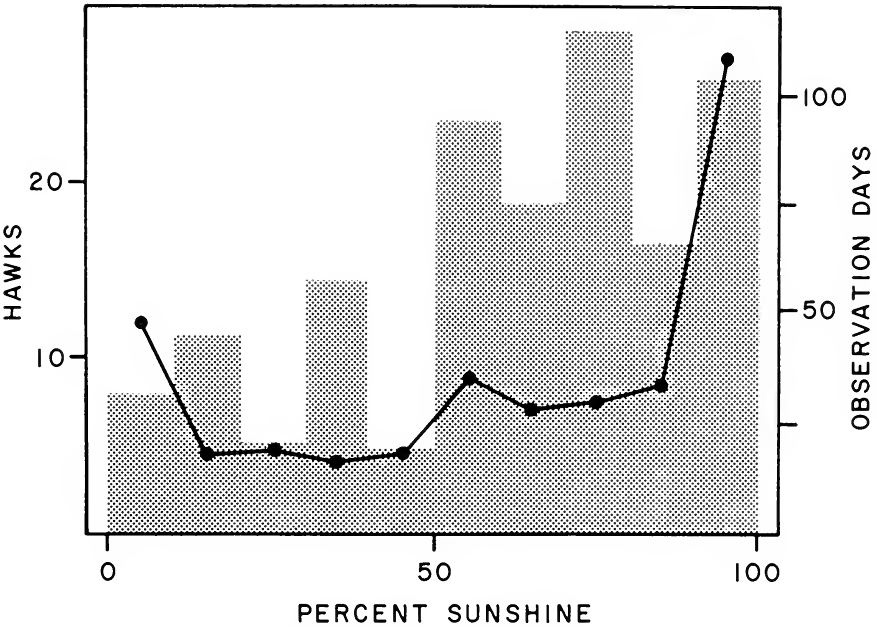


Fig. 5. The migration of Sharp-shinned Hawks in relation to sunshine. The incidence of sunshine is expressed in terms of the per cent of the possible sunshine. The bars indicate the mean number of hawks observed and the points and line indicate the number of observation days on which each bar is based.

the previous 24 hours. The greatest number of hawks per day was observed when there was a marked decrease in temperature, although many hawks were seen when the temperature dropped only slightly (Fig. 4). The slight increase in the number of birds observed when there was a marked increase in temperature may be attributed, largely, to those birds that crossed slow moving or stationary cold fronts into the warmer air mass preceding the front.

Sunshine.—More than 84 per cent of the Sharp-shinned Hawks observed at Cedar Grove occurred on days when the sun was shining at least half of the time between sunrise and sunset (Fig. 5). Insolation heats the ground, and the warmed ground heats the air immediately above. Warm air rises, creating updrafts. The cooler air and the usually partly cloudy or clear skies in the air mass following a cold front provide optimal conditions for updraft formation.

UPDRAFTS

In the lower layers of the atmosphere updrafts can largely be placed into two classes: (1) mechanical updrafts caused by the vertical deflection of the horizontal wind, as on a mountain ridge, and (2) thermal updrafts, the rising of warmer, less dense air through cooler, denser air. The structure of thermal updrafts varies with the temperature difference between the air and the underlying surface, the roughness of the surface, and the wind velocity. The temperature responses to insolation of ground surfaces and their heat capacities also vary widely. Little is known about the structure of updrafts under these varying conditions.

Earlier theories held that thermal updrafts were in a columnar form. Later theories held that convection over a terrestrial surface was in the form of discrete bubbles (Ludlam and Scorer, 1953). More recently, Cone (1962) theorized, partly on the basis of observations of soaring birds, that updrafts over a terrestrial surface take the form of discrete vortex rings. In addition to the upward movement of such a vortex ring, the air on the surface of the ring circulates in such a way that it moves upward on the inside of the ring and downward on the outside. Birds remain airborne by soaring in circles in the upcurrents on the inside of the ring. Cone (1962:190) observed that individuals of a group of soaring birds always circle at about the same altitude, and he offers this as partial evidence in proof of his vortex ring hypothesis. However, on many occasions we have observed Broad-winged Hawks (*Buteo platypterus*) soaring in circles in a column, with birds more or less uniformly distributed at all altitudes in the column. On a few occasions the height of the column of circling birds, from the lowest birds to the highest, exceeded 1,000 feet. The updrafts must have been in the form of a column, or in the form of a continuous chain of bubbles or vortex rings. Further systematic observations of circle soaring in various localities and under a variety of conditions are needed.

Our observations also suggest that still other forms of updrafts may exist. The great majority of Sharp-shinned Hawks that migrate over Cedar Grove do not soar in circles. The typical mode of flight consists of a few flaps of the wings followed by an extended glide, all in an approximately straight line. The birds appear to be utilizing updrafts since they often rise 25 to 50 feet with little or no flapping of wings. On windy days even the larger hawks and vultures, which normally soar in circles, are seen to pass over Cedar Grove in a more or less straight line. Many of these birds fly for hundreds of feet without flapping and without losing altitude. Hankin (1913) lists many similar observations of rectilinear soaring or gliding by Indian birds of prey.

Woodcock (1942) studied updraft structure over the North Atlantic Ocean by watching the soaring of gulls. Gulls soared in circles when the surface water temperature was at least 2 degrees C higher than that of the overlying air and the wind velocity was less than 15 mph. When the air–water temperature difference was at least 4 degrees C and the wind velocity was between 15 and 28 mph the gulls soared in straight lines, headed upwind. No soaring was observed at wind velocities greater than 28 mph, presumably because updraft structure was disrupted or updrafts were of insufficient lateral extent to support gulls. He hypothesized that under these conditions of moderate to high winds the thermal updrafts were in the form of longitudinal, vertical sheets, oriented up- and downwind. These updraft sheets are probably the rising portions of horizontally oriented helical vortices, convection cells in which the long axis is parallel to both the wind and the surface of the earth. Similar convection cells have been observed in a lake (Langmuir, 1938) and in the laboratory (Phillips and Walker, 1932; Graham, 1934). An ocean surface is flat and is uniform in temperature. Land surfaces are irregular, and the surface temperature often varies greatly over a distance of a few feet. Convection patterns over a land surface undoubtedly differ from those over the ocean. However, the presence of a strong horizontal wind certainly must affect the structure of updrafts over a land surface. In the absence of evidence to the contrary, we suggested in an earlier paper (Mueller and Berger, 1961) that updrafts over a land surface, under conditions of high land–air temperature contrast and winds of 15 to 30 mph, might assume a form similar to that described by Woodcock (1942). The irregularities in topography and temperature of the ground, acting individually or in combination, might produce a quasi-permanent distribution of updrafts over a land surface in the presence of moderate to high winds. Mechanical updrafts would remain in the same place as long as the wind remained constant in direction and velocity. Areas with high surface temperatures would remain largely unchanged as long as the amount of heat delivered to the surface remained unchanged. Thus, for periods up to a few hours the updraft distribution over a given area might vary only slightly.

We have often noted that most of the hawks observed at Cedar Grove in a given period of time appear to be following one or several invisible, three-dimensional paths through the air over the area. Many of the hawks change direction and altitude at the same points where previous hawks have altered course and altitude. Since the hawks do considerable gliding, this suggests that they are "following" an updraft pattern through the area. We do not know to what extent Sharp-shinned Hawks use such updrafts away from a leading line, but once they arrive at the western shore of Lake Michigan in the vicinity of Cedar Grove the hawks definitely appear to be using an updraft pattern that permits rectilinear gliding at low altitudes. Since most of the Sharp-shinned Hawks observed at Cedar Grove occur on days favorable for the formation of updrafts (Figs. 3, 4, and 5) and when moderate to strong winds are blowing (Fig. 2) it may be that most Sharp-shinned Hawks migrate when the updraft pattern is somewhat similar to that described by Woodcock (1942). However, Sharp-shinned Hawks occur at Cedar Grove on westerly winds, and increased wind velocities increase the effects of wind drift. With increased drift, increasing numbers of birds arrive at the leading line formed by the shore of Lake Michigan, and larger numbers of hawks are counted at Cedar Grove. Thus, most Sharp-shinned Hawks may migrate on days on which updrafts and strong winds occur, or the correlation of migration with strong winds at Cedar Grove may be purely the result of increased wind drift. We suspect that Sharp-shinned Hawks exhibit a greater tendency to migrate on windy days. Regardless of the structure of updrafts, our data indicate that most Sharp-shinned Hawks migrate on days when the weather conditions are conducive for the formation of updrafts. The cooler air, and the partly cloudy skies in the air mass following a cold front provide optimal conditions for the formation of updrafts.

EXTRAORDINARY MIGRATIONS AND WEATHER

In the autumns of 1952 through 1964 we have recorded 42 days on which more than 100 Sharp-shinned Hawks were observed at Cedar Grove. More than 400 Sharp-shinned Hawks were seen on only four days: 486 were observed on one day, 676 on another, and on each of two days extraordinary totals of more than 1,200 Sharp-shinned Hawks were seen. The latter two days, 15 September 1952 and 13 October 1955, were associated with a sequence of weather conditions that occurred only during the brief periods prior to and including these two days and not again during the 13 years of our study. The essential feature of the weather map at these times was a cold front extending from east to west, which penetrated into northern Wisconsin, stalled, and then retreated slowly to Lake Superior over a period of two or three days (Fig. 6). A second cold front, extending from north to south swept through the area three to five days after the first front and continued onward to the east and south (Fig. 6). The extraordinary flight in both cases occurred on the day after the second front passed Cedar Grove.

In both of these cases of extraordinary flights, we believe that it is probable that the Sharp-shinned Hawks began to migrate with the southward movement of the first cold front. When this front stalled, and subsequently retreated, a few hawks probably continued to migrate southward, but we suspect that most individuals soon ceased migrating. The weather situation thus deposited great numbers of hawks in northern Wisconsin and upper Michigan. The second cold front again initiated migration, and unusual numbers of hawks passed Cedar Grove.

TABLE 1
WIND DIRECTION AND VELOCITY AT 1200 HRS.

Date	Hawks**	U. S. Weather Bureau Station*				
		Dlh	LCr	SSM	GrB	Mke
12 Sept. 1952	31	S 10	SSW 8	E 6	SSW 11	ESE 15
13	87	ESE 12	S 12	SE 5	SSW 16	SE 13
14	285	WSW 25	NW 17	SSE 14	SW 16	SW 20
15	1219	WNW 20	WNW 20	NW 6	WNW 23	W 21
10 Oct. 1955	43	SSE 8	SSE 10	WSW 9	SW 20	SW 15
11	16	SSE 21	S 20	S 7	SW 17	SW 18
12	200	WNW 35	NW 22	ESE 12	WNW 22	WNW 23
13	1220	NW 23	NW 20	SSW 7	NW 22	WNW 21

* Duluth, LaCrosse, Sault Ste. Marie, Green Bay, and Milwaukee.
** Number of Sharp-shinned Hawks observed at Cedar Grove.

Table 1 presents the noon records of wind direction and velocity recorded by the U. S. Weather Bureau at Milwaukee and four selected points to the north and northwest during the two critical periods which ended with the extraordinary flights. On 12, 13, and 14 September 1952 the winds at noon at Sault Ste. Marie, Michigan, had an easterly component (Table 1). Birds flying over the isthmus between Lakes Superior and Huron would presumably be drifted westward and would have an increased probability of ending up on the western, rather than the eastern side of Lake Michigan. Those hawks that continued southward into Wisconsin encountered winds with a westerly component in the vicinity of Green Bay, Wisconsin, and presumably were drifted eastward to Lake Michigan. A few birds presumably continued to follow the leading line provided by the lakeshore on 12 and 13 September, even though the winds again became easterly in the vicinity of Milwaukee (Table 1). On 14 September the winds were westerly at both Green Bay and Milwaukee, and the daily count of Sharp-shinned Hawks increased accordingly. Noon wind recordings at Duluth, Minnesota, at the western end of Lake Superior, suggest that the winds in this area were not adequate to drift birds toward Cedar Grove until 14 September, when strong WSW winds may have provided for sufficient eastward drift (Table 1). At LaCrosse, approximately south of Duluth and west of Cedar Grove, winds had either a positive or neutral westerly component throughout the period (Table 1). The weather data thus suggest that hawks were trickling southward from the Sault Ste. Marie area toward Cedar Grove from 12 through 14 September 1952. The strong WSW winds at Duluth may have begun to add to this flow on 14 September. On 15 September strong westerly to

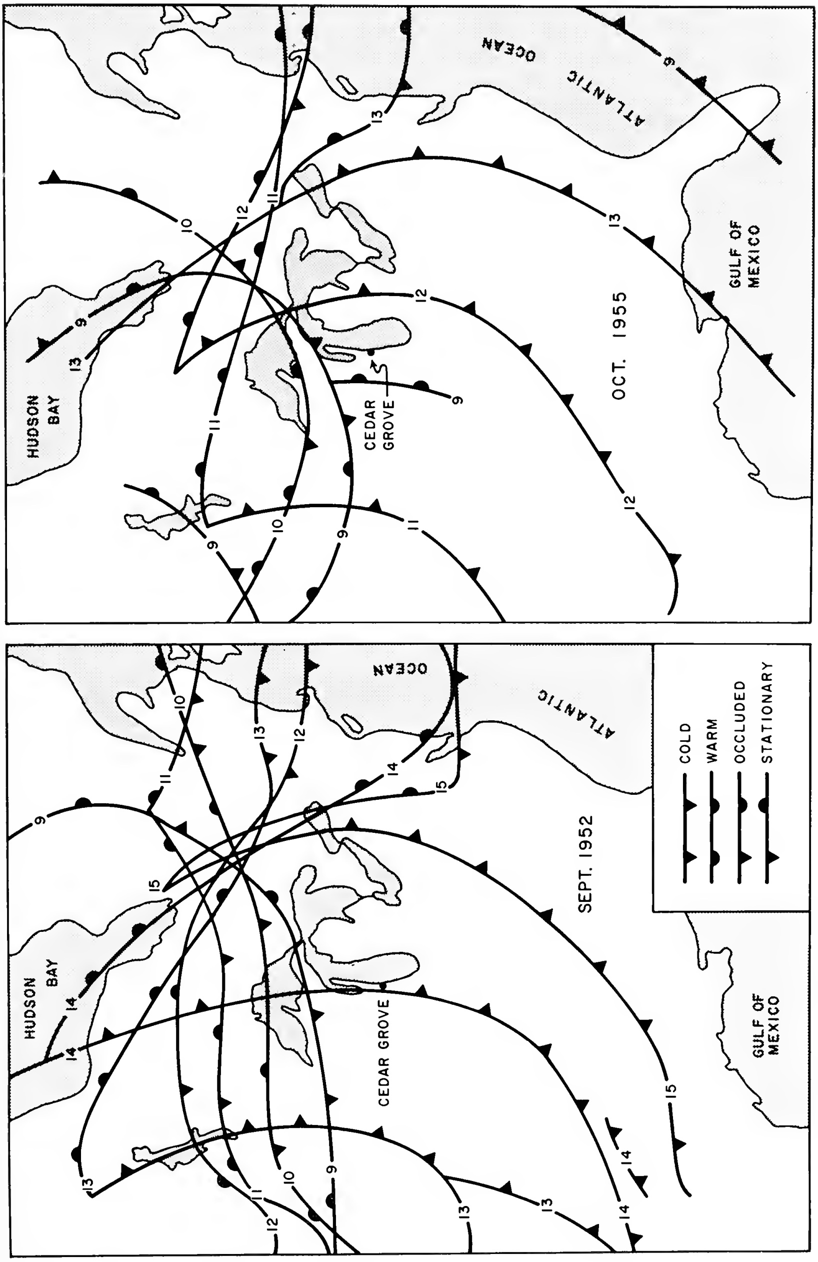


FIG. 6. Positions of fronts in the eastern United States at 1200 hours (CST) on each of several days. Left: 9 through 15 September 1952. Right: 9 through 13 October 1955.

northwesterly winds and optimal conditions for migration quickened the flow, resulting in a record count of Sharp-shinned Hawks at Cedar Grove.

The extraordinary flight of Sharp-shinned Hawks on 13 October 1955 was preceded by only slightly different wind conditions than that of September 1952. Winds with an easterly component at Sault Ste. Marie did not prevail until 12 October. As a result, hawks entering the Wisconsin area at Sault Ste. Marie may have contributed less to the flight of 13 October 1955 than that of 15 September 1952. The noon wind at Duluth on 12 October 1955 had an extremely high westerly component of more than 32 mph, and it is possible that birds entering Wisconsin in the Duluth area contributed greatly to the record flight observed at Cedar Grove on 13 October 1955. Winds were westerly at Milwaukee and Cedar Grove throughout the four-day period, providing good local conditions for the drift of birds to the shore of Lake Michigan (Table 1). On 12 and 13 October 1955 the westerly component of the wind was particularly high at Milwaukee, and other weather conditions were also optimal for migration. Thus, the spectacular flights of Sharp-shinned Hawks on 15 September 1952 and 13 October 1955 appear to be due to an unusual sequence and movement of fronts and to the temporal and spatial distribution of wind conditions in the area north of Cedar Grove.

RECOVERIES OF BANDED BIRDS

We know of 57 recoveries of Sharp-shinned Hawks banded in the vicinity of Cedar Grove (Fig. 7). Eighteen birds were recovered before 15 December of the same autumn in which they had been banded (closed circles in Fig. 7). The mean angle from Cedar Grove for this distribution of recoveries is about 10 degrees east of south. Fifteen birds were recovered during the winter (15 December through 15 March) immediately following the autumn in which they were banded (closed triangles of Fig. 7). The distribution of these recoveries has an average angle of about five degrees east of a line drawn south from Cedar Grove, an angle not significantly different from that of the autumn recoveries.

Both the autumn and winter recoveries show a marked change in mean direction with change in latitude. The 17 birds recovered north of the southern border of Tennessee and within five months of the time of banding have a geographic distribution which yields a mean angle of 18 degrees east of a line drawn south from Cedar Grove. The distribution of the 16 similar recoveries from south of the Tennessee border yields a mean angle of 7 degrees west of south, about 25 degrees farther west than the more northern recoveries. The prevailing winds during September, October, and November generally have a westerly component in the north central United

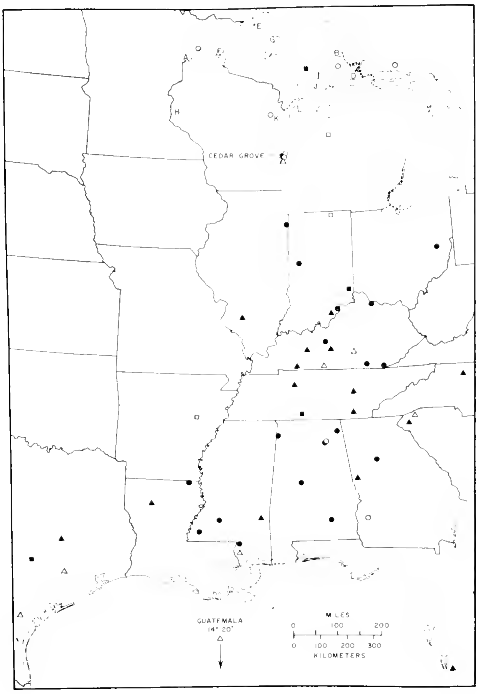


FIG. 7. Distribution of recoveries of Sharp-shinned Hawks banded at Cedar Grove during autumnal migration. Closed symbols indicate birds recovered less than one year after the time of banding; open symbols indicate birds recovered four seasons or more after the time of banding. Circles: autumn recoveries (1 September–15 December). Triangles: winter recoveries (16 December–15 March). Squares: spring recoveries (16 March–31 May). Other symbols indicate localities mentioned in the text.

States and an easterly component in the states bordering the Gulf of Mexico (U. S. Department of Commerce, 1964). The apparent tendency for hawks to move south-southeastward from Cedar Grove and then turn somewhat to the west in the southern United States may thus be nothing more than a result of wind drift. The above evidence suggests that the heading, or standard direction, of migration of the Sharp-shinned Hawks observed in autumn at Cedar Grove is approximately due south.

The eight birds that were recovered in winter a year or more subsequent to the time of banding add little to the above discussion except: (1) there is one far northern recovery, in the vicinity of Cedar Grove, and (2) there is one far southern recovery in southeastern Guatemala (open triangles of Fig. 7).

Six of the eight birds recovered in autumn one or more years after the autumn in which they had been banded are of considerable interest (open circles of Fig. 7). Four of these birds were recovered to the north of Cedar Grove, one at the western end of Lake Superior, two at the eastern end, and one just west of Green Bay. The distribution of these four recoveries suggests that Sharp-shinned Hawks observed at Cedar Grove during autumnal migration enter the Wisconsin area around both ends of Lake Superior, with possibly the majority entering through the Sault Ste. Marie region. Two birds were retrapped at the Cedar Grove Ornithological Station approximately one year after banding, indicating that individual birds occasionally occur at the same point on the migratory route in subsequent years. However, the recurrence at Cedar Grove of these two individuals can probably be attributed to a chance distribution of weather patterns which brought the birds to the same point on the migratory route in two consecutive years. We trap about 12 per cent of the Sharp-shinned Hawks we observe at Cedar Grove. If we assume a 50 per cent annual mortality for the combined sample of juveniles and adults, and that all survivors of the group of birds banded at Cedar Grove will recur there during the next autumn, we would expect to catch six birds for every 100 banded the previous autumn. We would expect to have recaptured 104 banded Sharp-shinned Hawks at Cedar Grove in the autumn subsequent to the year of banding. We would further expect additional birds to be recaptured two or more years after banding. The fact that only two birds have been recaptured suggests that individual Sharp-shinned Hawks do not follow the same migratory route year after year.

Two of the seven hawks recovered during the time of spring migration (15 March through 31 May) are of interest (squares in Fig. 7). These two individuals were recovered to the east of Lake Michigan, suggesting that migratory routes change with the season or that Sharp-shinned Hawks do not follow the same migratory route year after year. We have obtained only one summer recovery of a Sharp-shinned Hawk. This bird, banded as an adult on 17 October 1964, was found dead on 22 July 1965 at Fawcett, Alberta, about 1,500 miles northwest of Cedar Grove.

OTHER OBSERVATIONS OF HAWK MIGRATION IN THE UPPER GREAT LAKES AREA

Many of the hawks observed at Cedar Grove probably enter Wisconsin and upper Michigan by passing around the ends of Lake Superior. The spectacular flights at Duluth, at the western end of Lake Superior, are well known (Hofslund, 1954). (See point A in Figure 7. The parenthetical letters after other locations mentioned below also refer to Figure 7). Great numbers of hawks apparently also enter the United States at the eastern end of Lake Superior, but the flights are less well known because often the birds are not found in as concentrated a "flyway" as at Duluth. Some hawks cross Whitefish Bay to Whitefish Point (B) some 40 miles west of Sault Ste. Marie (C. Hawkins, pers. comm.). J. M. Speirs (pers. comm.) has observed a broad-front movement through the Sault Ste. Marie area (C). Concentrated hawk flights have also been observed on the north shore of Lake Huron (D) between Detour and the Pine River (K. Slater, pers. comm.).

Some hawks may cross Lake Superior. Concentrations of hawks occur in fall at Isle Royale (E) (Peet, 1909). Lesser concentrations occur on the Apostle Islands (F) (J. Keener, pers. comm.) and on the Keweenaw Peninsula (G) (Binford, 1965). The concentrations at the latter two points may be the result of the northbound wanderings of young hawks rather than overwater migrations. In spring hawks do depart in a northerly direction across Lake Superior from the tip of the Keweenaw Peninsula (Wood, 1933). On the south shore of Lake Superior, the Bayfield County peninsula, the Keweenaw Peninsula, and Whitefish Point all provide leading lines which tend to gather and direct hawks out over the lake. On the other hand, the leading lines of the north shore (except for the islands and peninsulas in the limited area north of Isle Royale) tend to lead birds to the ends of the lake. We suspect that the majority of the hawks involved migrate around, rather than across, Lake Superior in autumn.

We know little of what happens to the Duluth hawk flights after they pass south of Lake Superior. S. Robbins (pers. comm.) occasionally has seen hawk movements near Roberts, Wisconsin (H). The Sault Ste. Marie flights are somewhat easier to trace. Hawk movements have been observed both inland (I) and on the north shore of Lake Michigan (J) in Schoolcraft County, Michigan (K. Christofferson, pers. comm.; Beebe, 1933). C. Richter (pers. comm.) has observed hawk flights on the west shore of Green Bay (K) which in some instances correlated rather well with flights seen a day or so later at Cedar Grove. H. Wilson (pers. comm.) once saw migrating hawks at the northern tip of the Door County Peninsula (L), suggesting that some hawks may cross the mouth of Green Bay on the chain of islands stretching from Delta County, Michigan, to Door County, Wisconsin.

Some 20 miles south of Cedar Grove the volume of hawk migration appears to be reduced. Hawk flights are rarely observed in or about the city of Milwaukee, about 40 miles south of Cedar Grove. Near Racine, another 20 miles south, some hawk migration is again observed (M. Higgins, pers. comm.). Some migrating hawks are also seen near Zion, Illinois (J.

Weaver, pers. comm.), but south of this point we have no information concerning hawk flights. The number of hawks observed at the last two localities is usually not as great as at Cedar Grove.

To summarize these observations, hawk flights have been observed at both the east and west ends of Lake Superior. Some hawks may cross Lake Superior. Hawk flights have been observed at a number of points on the west shore of Lake Michigan. The volume of the flight varies as does the direction of the lakeshore, the topography, the incidence of urban and industrial areas, and the distribution of habitat types. Lack of reports from the areas between known hawk migration points does not imply that flights are lacking; too often it means that adequate observations have not been made. Many of the Sharp-shinned Hawks observed at Cedar Grove probably enter the United States at Sault Ste. Marie. Most of the rest of the hawks seen at Cedar Grove probably enter Wisconsin near Duluth.

SUMMARY

Daily counts of Sharp-shinned Hawks were conducted on 915 days in the autumns of 1952 through 1964. A total of 17,628 Sharp-shinned Hawks was observed and 2,052 were trapped, banded and released. There are two peaks in the autumnal migration, one in mid-September, composed mostly of immature birds, and one in mid-October, composed largely of adults.

Ninety-three per cent of the Sharp-shinned Hawks were observed on days with westerly winds, 72 per cent were recorded within two days of the passage of a cold front, 69 per cent were seen on days when the area temperature had dropped during the previous 24 hours, and 84 per cent were observed on days when the sun was shining for at least one-half of the time between sunrise and sunset. On the basis of these data we suggest that hawks fly when conditions are conducive for the formation of updrafts and that wind drift concentrates migrants along the leading line formed by the western shore of Lake Michigan. The flight behavior of hawks and the structure of updrafts is discussed in some detail.

An analysis of two extraordinary migration flights suggests that weather conditions hundreds of miles to the north may affect the numbers of birds seen at Cedar Grove.

The recoveries of banded birds, and observations of hawks at other points in the Upper Great Lakes region suggests that most of the hawks seen at Cedar Grove enter the area at the eastern and western ends of Lake Superior. The distribution of fall and winter recoveries suggest that the birds head approximately southward, are drifted eastward in the north and central portions of the eastern United States, and are drifted westward in the states bordering the Gulf of Mexico.

ACKNOWLEDGMENTS

Frances Hamerstrom, K. H. Kuhn, H. E. Meinel, N. S. Mueller, J. J. Oar, D. E. Seal, C. R. Sindelar, and others aided in the field work. The study was supported in part by the National Science Foundation (Grant GB-175). The Cedar Grove Ornithological Station is a cooperative project of the University of Wisconsin and the Wisconsin Conservation Department. We are indebted to J. T. Emlen for frequent aid, counsel, and encouragement.

LITERATURE CITED

BEEBE, R.
1933 Influence of the Great Lakes on the migration of birds. *Wilson Bull.*, 45: 118–121.

BINFORD, L. C.
1965 Unusual bird records from the upper peninsula of Michigan. *Jack-Pine Warbler*, 43:144–145.

CONE, C. D.
1962 Thermal soaring of birds. *Amer. Scientist*, 50:180–209.

GRAHAM, A.
1934 Shear patterns in an unstable layer of air. *Phil. Trans. Royal Soc. London*, 232A:285–296.

HANKIN, E. H.
1913 Animal flight; a record of observations. Iliffe, London.

HOFSLUND, P. B.
1954 The hawk pass at Duluth. *Flicker*, 26:97–98.

LANGMUIR, I.
1938 Surface motion of water induced by wind. *Science*, 87:119–123.

LUDLAM, F. H., AND R. S. SCORER
1953 Convection in the atmosphere. *Quart. Jour. Royal Meteorol. Soc.*, 79:317–341.

MUELLER, H. C., AND D. D. BERGER
1961 Weather and the fall migration of hawks at Cedar Grove, Wisconsin. *Wilson Bull.*, 73:171–192.
1966 Analyses of weight and fat variations in transient Swainson's Thrushes. *Bird-Banding*, 37:83–112.
1967 Wind drift, leading lines, and diurnal migration. *Wilson Bull.*, 79:50–63.

PEET, M. M.
1909 The fall migration of birds at Washington Harbor, Isle Royale, in 1905. *Michigan Geol. Surv. Ann. Rept. for 1908*: 97–119.

PHILLIPS, A. C., AND G. T. WALKER
1932 The forms of stratified clouds. *Quart. Jour. Royal Meteorol. Soc.*, 58:29–30.

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
1964 Prevailing direction, mean speed (m.p.h.), and fastest mile of wind. Sheet of the National Atlas of the United States. U. S. Government Printing Office, Washington, D. C.

WOOD, N. A.
1933 Birds of Keweenaw Point, Michigan. *Papers Michigan Acad. Sci., Arts, Letters*, 17:713–733.

WOODCOCK, A. H.
1942 Soaring over the open sea. *Sci. Mon.*, 55:226–232.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF WISCONSIN, MADISON, WISCONSIN, AND CEDAR GROVE ORNITHOLOGICAL STATION, ROUTE 1, CEDAR GROVE, WISCONSIN. (PRESENT ADDRESS: (HCM) DEPARTMENT OF ZOOLOGY, UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL, NORTH CAROLINA), 31 MAY 1966.

SELECTION FOR A DELAYED SIMULTANEOUS WING MOLT IN LOONS (GAVIIDAE)

Glen E. Woolfenden

A simultaneous molt of the remiges, with its concomitant flightless period, is a feature widespread in the class Aves. It has been recorded for members of no less than ten orders of flying birds: Gaviiformes (Palmer, 1962), Podicipediformes (Palmer, op. cit.), Procellariiformes (Murphy, 1936), Pelecaniformes (Palmer, op. cit.), Phoenicopteriformes (Palmer, op. cit.), Anseriformes (Delacour, 1954), Gruiformes (Van Tyne and Berger, 1959; Witherby et al., 1940), Charadriiformes (Storer, 1960), Coraciiformes (Van Tyne and Berger, op. cit.), and Passeriformes (Sullivan, 1965). Knowledge of the considerable expenditure of energy required for the replacement of feathers has led to the conclusion that molt is normally a prolonged process and that rapid feather replacement develops only as a result of strong environmental selection (Humphrey and Parkes, 1959). For the remiges the consensus seems to be that simultaneous molt occurs only when it is the sole means by which a species can survive. This is perhaps true for loons as is discussed below, but two reasons suggest it may not be the case for all such birds, namely seasonal fluctuations in the abundance of food, and the extra energy required for flight by birds undergoing a gradual wing molt. It is possible that some of the wide variety of species with a simultaneous wing molt occupy niches in which either method could occur, but that rapid replacement confers slight advantages and therefore has been selected.

A simultaneous loss of the remiges is probably a necessity for loons. D. B. O. Savile (1957) states, "The Common Loon (*Gavia immer*) is a flying anachronism. . . . It has an appallingly high wing loading and a very inefficient wing form. Under these handicaps it takes off only with difficulty, after a long run, and climbs shallowly." It seems likely in a species so poorly designed for flight that the loss of even one remex from each wing would be a considerable handicap.

Typically the simultaneous loss and replacement of flight feathers is a post-breeding, late summer or early fall phenomenon—a phase of the prebasic molt. Hornbills, the coraciiform example, are exceptions, for females of certain species are flightless during breeding. The habit of the male sealing the female in the nest cavity provides the ecological opportunity. The three large species of loons are also exceptions. In adults of the Common Loon, Yellow-billed Loon (*Gavia adamsii*), and Arctic Loon (*G. arctica*) remigial replacement occurs in late winter while the birds are in their winter range.

Of the more than 40 dead Common Loons I have found along the beaches in Florida from November through June, eight were flightless, and these eight were all February birds.

Features of the life history of loons suggest some of the selective forces that may have brought about the delay of the remigial portion of the prebasic molt. The Common Loon will be used to present these ideas since more is known about its biology, primarily through the work of Olson and Marshall (1952), than is known about the other three species. Common Loons reach the breeding lakes in Canada and northern United States from mid-May to the latter half of June. After arriving at least two weeks are required to establish a territory, choose a nest site, build the nest, and lay their one or two eggs. Incubation requires another four weeks. Care of the young, which normally continues until they can fly, requires an additional 10 or 11 weeks. Thus even if a pair of Common Loons were to begin breeding at the earliest possible time, mid-May, they would be caring for young until mid-September. With actual cases it is later; Olson and Marshall (op. cit.) recorded the first flying young on 9 October in Minnesota, which is near the southern limit of the species range. Throughout this more than four-month breeding period the ability to fly is essential, for there are important aerial components in the territorial and pair-bond maintenance displays of the Common Loon.

Data are not available for the time interval between loss of the remiges and the regaining of flight in loons, but assuming it is similar to that of other water birds, ducks for example (Hochbaum, 1944), it would require three or four weeks. If loons replaced their flight feathers on the nesting lakes following breeding it would be impossible for them to leave before late October. But according to Pleva (1957) the lakes in Canada freeze over between mid-September and mid-November, and Hochbaum (op. cit.) states that ice closes the bays at Delta, in southern Manitoba, in late October or early November. Thus under present climatological conditions loons molting their remiges on the breeding lakes after nesting often would be trapped by ice and eliminated from the population. Occasionally even volant loons are trapped in this manner. Boardman (1874) reported the human slaughtering of about 30 Common Loons concentrated in a small area of open water in Big Lake, Maine. From these facts one must conclude that a simultaneous remigial molt after breeding, but before migration, is impossible.

The advantages of replacing the remiges immediately prior to spring migration probably brought about further delay once the process was postponed until after departure from the breeding areas. Movement from the nesting lakes to maritime waters is a lengthy procedure for many individuals (Palmer, op. cit.), and it is not safe for loons to become flightless on any body of water that might freeze over. Trautman (1940), for example, lists the first week in December as the time of departure of Common Loons from Buckeye Lake in Ohio. An additional advantage is that late winter molt assures unworn feathers for the flight north and the ensuing aerial displays.

A temporary loss of the remiges while in their maritime wintering quarters is probably advantageous to loons. A reduced pectoral appendage benefits wing-propelled divers (Storer, op. cit.), and loons occasionally use this means of subsurface locomotion (Townsend, 1924). Furthermore, temporary loss of even a few buoyant feathers, and a slightly reduced cross-sectional area would be of some advantage to a foot-propelled diver.

Adult Red-throated Loons (*Gavia stellata*) and the immatures of all four species replace their remiges in summer or fall. The need for a delayed simultaneous wing molt is not as great in the Red-throated Loon for the reduced wing loading virtually eliminates the chance of their being trapped by ice. A number of observers even have seen the species take flight from land (*in* Palmer, op. cit.)! Furthermore, Red-throated Loons are decidedly more coastal than the other species, particularly during migration and in winter. According to Godfrey (*in* Palmer, op. cit.) the time of the simultaneous remigial molt in this species is from early August to November.

Immature loons of all four species replace their remiges simultaneously in summer (late May to early August in *G. immer*). But these non-breeding loons do not fly to the nesting lakes; instead they normally remain on salt water where need for wings is negligible. Thus these exceptions add strength to the hypothesis that factors associated with breeding and migration have caused the winter remigial molt in adults of the three large species of loons. Use of the morphogenetic law would suggest that the primitive condition was one of a summer wing molt, and that selection indeed has *delayed* the process in adults.

The seeming necessity for a post-migratory simultaneous wing molt in loons brings up the question of how other water birds, namely waterfowl and grebes, nesting in the same area are able to survive with a simultaneous wing molt that precedes fall migration. Data obtained at Delta, Manitoba, by Hochbaum (op. cit.) provide the answer for ducks. Males desert the females in mid summer, change into a less conspicuous eclipse plumage and replace their flight feathers well before they are needed for migration. Females continue to care for the young, but only until the first week in August when they desert the broods, no matter how immature, and replace their remiges before freeze-up. Geese undergo their wing molt while caring for the young (Kortright, 1943). Unfortunately little is known about molt in grebes although it seems certain that some forms, *Aechomophorus* for example, do shed their remiges simultaneously prior to fall migration (Palmer, op. cit.). The apparent absence of display flights (Storer, 1963) would allow breeding and wing molt to occur simultaneously, although this is conjecture, and it may be that other factors are involved.

SUMMARY

It is suggested that adult Common Loons, and probably adults of the two other large species of *Gavia*, cannot have a gradual wing molt for structural reasons, and cannot have a simultaneous wing molt while on the breeding lakes for behavioral and climatological reasons combined. The only remaining possibility is a simultaneous molt of the remiges following fall migration. Additional selective factors have caused further delay until finally the gaining of new flight feathers immediately precedes spring migration.

ACKNOWLEDGMENTS

I am grateful to Kenneth C. Parkes and Sievert A. Rohwer who read and improved earlier versions of the manuscript.

LITERATURE CITED

BOARDMAN, G. A.
1874 A loon-atic on ice. *Forest and Stream*, 3:291.
DELACOUR, J.
1954 The waterfowl of the world. Vol. 1. Country Life Ltd., London.
HOCHBAUM, H. A.
1944 The Canvasback on a prairie marsh. The Stackpole Co., Harrisburg, Penna.
HUMPHREY, P. S., AND K. C. PARKES
1959 An approach to the study of molts and plumages. *Auk*, 76:1–31.
KORTRIGHT, F. H.
1943 The ducks, geese and swans of North America. The Stackpole Co., Harrisburg, Penna.
MURPHY, R. C.
1936 Oceanic birds of South America. Vol. 2. The Macmillan Co., New York.
OLSON, S. T., AND W. H. MARSHALL
1952 The Common Loon in Minnesota. Occas. Paper No. 5, Minnesota Mus. Nat. Hist.
PALMER, R. S.
1962 Handbook of North American birds. Vol. 1. Yale Univ. Press, New Haven and London.
PLEVA, E. G., ed.
1957 The Canadian Oxford school atlas. Oxford Univ. Press, Toronto.
SAVILE, D. B. O.
1957 Adaptive evolution in the avian wing. *Evolution*, 11:212–224.
STORER, R. W.
1960 Evolution in the diving birds. *Proc. XIIth Internatl. Ornith. Congr.*, pp. 694–707.
1963 Courtship and mating behavior and the phylogeny of the grebes. *Proc. XIIIth Internatl. Ornith. Congr.*, pp. 562–569.
SULLIVAN, J. O.
1965 "Flightlessness" in the Dipper. *Condor*, 67:535–536.
TOWNSEND, C. W.
1924 Diving of grebes and loons. *Auk*, 41:29–41.

TRAUTMAN, M. B.
1940 The birds of Buckeye Lake, Ohio. *Misc. Publ. Mus. Zool., Univ. Michigan*, No. 44.

VAN TYNE, J., AND A. J. BERGER
1959 Fundamentals of ornithology. John Wiley and Sons, Inc., New York.

WITHERBY, H. F., F. C. R. JOURDAIN, N. F. TICEHURST, AND B. W. TUCKER
1940 The handbook of British birds. Vol. 4. H. F. and G. Witherby Ltd., London.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF SOUTH FLORIDA, TAMPA, FLORIDA, 9 SEPTEMBER 1966.

NEW LIFE MEMBER

Dr. Kenneth F. Edwards of Collins Bay, Ontario is a new Life Member of the Wilson Ornithological Society. A holder of an M. D. degree from the University of Toronto, Dr. Edwards is an anesthesiologist at Kingston General Hospital. He is a member of the AOU, the National Audubon Society, the Canadian Audubon Society, and the Federation of Ontario Naturalists. His ornithological interests have been centered on the study of migration particularly on Grand Manan Island, New Brunswick, and upon bird photography. He has been a longtime contributor to *Audubon Field Notes*. Dr. Edwards is married and has four children.

ROOSTING BEHAVIOR OF THE HERRING GULL IN CENTRAL MAINE

Ralph W. Schreiber

Communal roosting and the environmental conditions affecting roosting have long interested ornithologists. This paper investigates the environmental factors influencing the roosting of the Herring Gull (*Larus argentatus*) population in the upper tidal reaches of the Penobscot River, near Bangor, in central Maine from July through November 1965.

Cullen (1964) reviews the roosting habit in birds and concludes that roosting affords protection and is a means of maintaining the body temperature. Wynne-Edwards (1962) feels that the primary function of roosting is to bring together the members of a bird population for a continuous seasonal epidiectic ("meant for display") demonstration, similar to that which occurs during the breeding season, and that as a result of this display, adjustment and regulation of the population density occurs.

Environmental conditions affecting roosting are: time and light intensity, of primary importance in controlling roosting, with the time of roosting varying during the year as the daylight period changes; the amount of cloud cover and its effect on light intensity influences the time of roosting in some species; temperature, wind, social interactions, and other factors usually have little direct effect, but may have some indirect influence in certain situations: and, different species may vary in their response to similar environmental conditions.

METHODS

The roosts were located by observing the direction in which the gulls flew when leaving feeding areas and "clubs." "Club" is defined here as the gathering of gulls during the day when they are not actively feeding. While in the club, the gulls spent their time preening, sleeping, or otherwise loafing. The major feeding spots in this study region were the municipal refuse dumps of Bangor, Orono, and Old Town. These dumps lie in an irregular line from NNE to SSW with approximately five miles between the Old Town and Orono dumps, and three miles between the Orono and Bangor dumps. Each dump had a clubbing area close by, usually an open field within a half mile.

A banding and marking study showed that the gulls frequenting these dumps and clubs make up a relatively discrete population (Schreiber, 1965). During July and August, this population flew to a small group of rocks and an old grounded raft in the Penobscot River within the town limits of Orono (the summer roost). In September, October, and November the flight lines from the dumps and clubs led to Pushaw Lake, a small lake five miles west of Orono (the fall roost).

Sunset was used as a constant throughout the study and observations were begun daily at two and a half hours before sunset. For recording data, this period of observation was divided into five minute intervals. All birds present at the roost were counted at the beginning of the period and individual birds were counted as they arrived throughout the observation period. Light intensity was measured with a Weston Illumination Meter (Model 756 with Quartz filter) aimed directly overhead. Observations were made so that the sky overhead and to the west was not obscured by shadows and so all directions from which the gulls arrived could be observed. Cloud cover was rated as clear (no clouds), partly cloudy, or cloudy (solid cloud cover with no breaks). Temperature was recorded in degrees Centigrade. The wind for the day was rated as calm, medium, or strong.

The five minute intervals of observation were divided into half-hour groupings for analysis. Using the total number of birds arriving on a specific day, the percentage of birds arriving in each thirty minute interval of that day was calculated. The days were then grouped according to cloud cover and the average percentage of arrivals for each type of day was calculated using the inverse sine transformation. The Orono roost was observed from 10 July to 29 August, on six cloudy, seven partly cloudy, and four clear days for a total of 17 days. The Pushaw roost was observed on 31 days from 19 September to 27 November, consisting of 14 cloudy, 11 partly cloudy, and six clear days.

OBSERVATION

Number of birds utilizing the roosts.—In Figure 1 are given for the two roosts the average number of arrivals up to dark (the time when I could no longer be accurate in counting arriving birds) for two or three days of observation. A decline in the Orono roost population occurred through July and August until 25 September, after which no birds were seen at this roost. The number of birds utilizing the Pushaw roost steadily increased during September until a peak was attained during the second week of November, but on 27 November and thereafter the Pushaw roost was not used consistently. The number of birds feeding in the study area was lowest during the first two weeks of August, when the roosting population was also the lowest. As the feeding population began to increase during the last two weeks of September, the Orono roost was at a minimum while the Pushaw roost enlarged in numbers.

From June through Labor Day weekend, Pushaw Lake is highly congested with summer residents and there is much motorboat activity even after dark

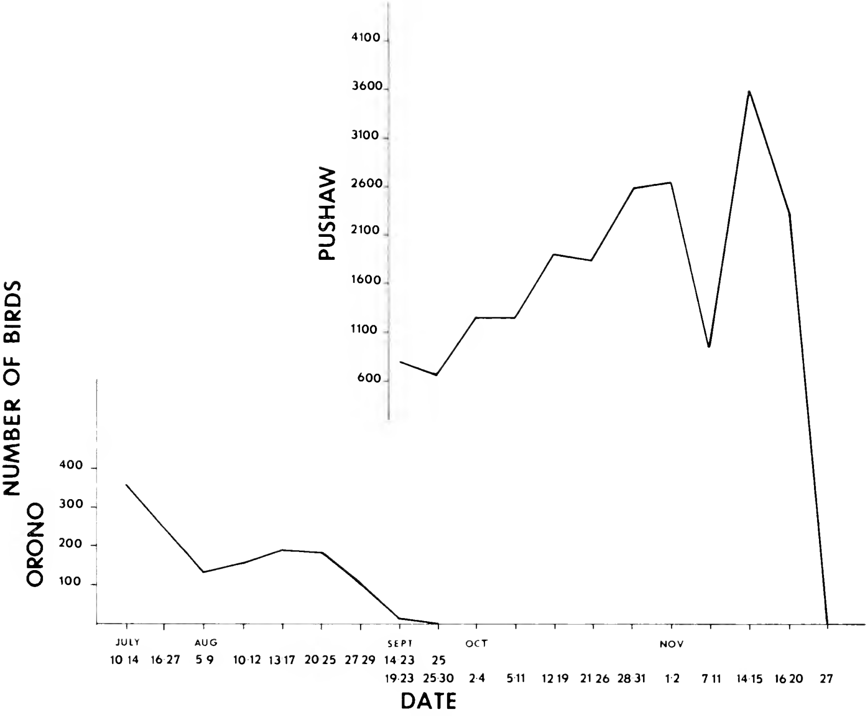


Fig. 1. Seasonal fluctuations in the numbers of gulls using two roosts near Bangor, Maine between 10 July and 27 November 1965.

making it an unsuitable roosting site. The Orono roost, on rocks in the swift flowing river, can hold only so many birds per night. During the summer the 300 to 400 gulls in the area can rest comfortably in Orono, but in the fall, when the population is building up to over 4,000 birds, they must move to a place with greater area. After Labor Day weekend, there are few boats on Pushaw Lake and the shores are relatively deserted. The gulls, a gregarious species, all go to Pushaw where the entire population can spend the night on the water in relative quiet. No birds were observed during the night on Pushaw in the summer and none came to Orono after 25 September. When the gulls left Pushaw on the morning of 27 November, after a very calm, cold night, there was a thin film of ice on the lake. That night the gulls moved down the Penobscot River to roost. During the following two weeks Pushaw was alternately open and frozen, and, depending on the condition of the water, the gulls either spent the night there or moved to the river. By 6 December the lake was completely frozen and the birds stopped going there at night.

Roosting flights.—Wind velocity and time of arrival had a pronounced effect on the mode of flight to the roost. On still days the gulls arrived at the Pushaw roost from the dumps and clubs with a direct flapping flight or with an easy flapping and gliding while overland. When over the edge of the lake, they began a long straight glide to the flock of gulls already on the water. The gulls gathered in a flock about 400 yards out from the southern edge of the lake. If the birds did not glide directly to the flock, they would fly over the flock and then spiral down to the water. At the Orono roost, the birds invariably flew over the rocks and circled back, turning their heads sideways as if picking out a suitable spot for landing. At both roosts on still days, the early flights (two hours to a half hour before sunset) were at an estimated height of 50 to 150 feet above the trees.

When the wind was blowing in the direction of the roosting flights, the birds tended to glide and soar a great deal. When the wind opposed the direction of flight, the flying appeared labored and was very erratic in its direction. The stronger the wind, the more erratic became the flight. In a strong wind, the gulls flew very close to the tree tops (5 to 35 feet). During the fall, upon reaching the edge of Pushaw Lake, the gulls would drop quickly down to about three feet above the water and then proceed to the gathering flock. Many of the gulls would fly along the lee shore of the lake until reaching the point of land nearest the flock. During windy weather the gulls flying to the roost in large flocks tended to fly less compactly than on a calm day.

During the summer the gulls tended to come to the roost, throughout the arrival period, singly, in pairs, or in small groups of between 10 and 30 birds, with a slight increase in group size near dark. During the fall, with few birds arriving early, the gulls tended to fly to the roost in massed groups, often numbering as many as 600 birds in one flock.

The summer roost flights were not as direct as in the fall and the gulls did more circling and towering on updrafts. At both seasons the gulls leaving the dumps and clubs either flew directly toward the roost at about 50 to 150 feet or would circle up to about 500 feet from whence it appeared that they glided and flapped in a straight line to the roost. This roosting flight seemed quite "purposeful" and I felt that I could tell very soon after a bird took off if it was going to the roost rather than just changing places in the dump or moving to the club.

Display flights.—During the later weeks of October and through November, as the population at Pushaw built up, there was mass circling above the roost site. At this time the early arrivals gathered together at the southern end of the lake. As darkness approached and the number of birds present

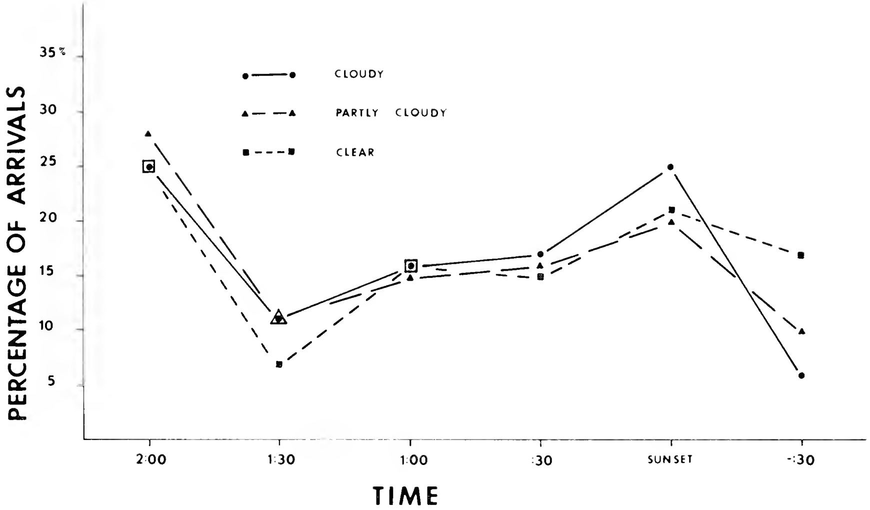


FIG. 2. Percentages of arrivals during half hour intervals with sunset as a parameter at the Orono roost by gulls between 10 July and 16 September 1965.

increased, the whole flock would rise and wheel in circles. Usually, a majority of the birds would then move north to settle farther up the lake. The remainder would settle again on the water in the original gathering site. By sunset all of the birds would have moved north and the late arrivals flew directly toward this northern congregation. At the Orono roost there was little movement within the roost once the birds had settled, and no mass display flights were observed unless the gulls were disturbed.

Pre-flight activity.—The birds leaving the club for the roost also exhibited a type of social interaction. The gulls gathered in the clubs were quite still, either sitting quietly or sleeping, during most of the afternoon. As the light failed, a number of birds would begin to preen, stretch, stand up, and walk around. It appeared as if the birds grouped closer together. The intensity of the movement increased as more birds became active and after about ten minutes of this activity a number of birds would take off and fly toward the roost. The birds which took off first were those which had been more active. Usually several birds which had not been "restless" would fly up and follow the leaders. A period of quiet would ensue and after five to ten minutes the activity would begin again and the sequence would be repeated. The number of birds leaving during each sequence increased as darkness approached until only four or five birds remained. These either left as individuals or as a group when the light intensity was near zero. Each time

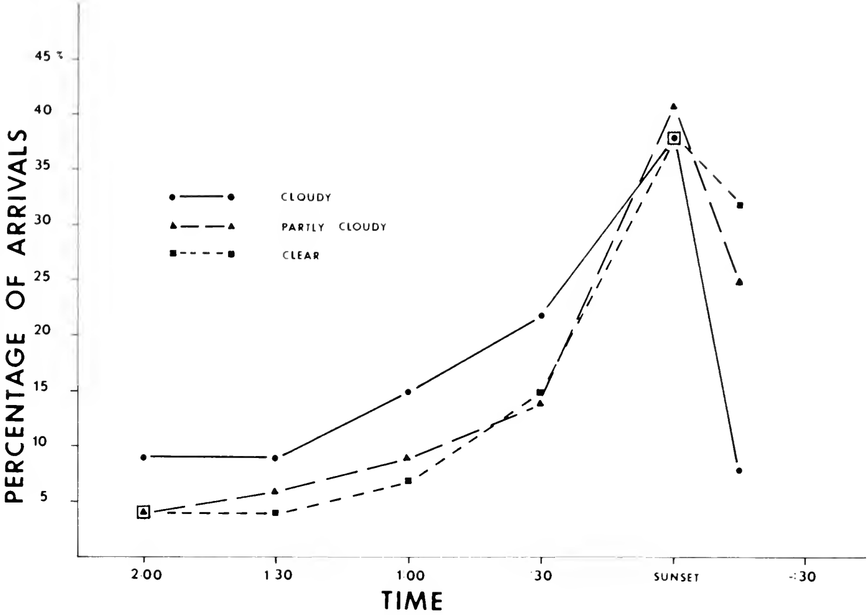


FIG. 3. Percentage of arrivals during half hour intervals with sunset as a parameter at the Pushaw roost by gulls between 17 September and 27 November 1965.

the club was observed, this type of behavior was noticed. Miskimen (1955) also found a distinct pre-roosting activity in ducks.

If the birds were disturbed (either while feeding or in the club) early in the day, the flock would take off, circle and the majority would again land and resume their activity. If the club was disturbed, all of the birds took off, circled, and landed again at a "safe" distance. Again, none moved toward the roost. This behavior was observed during the day until about an hour and a half before sunset or until a light intensity of below 900 foot candles was reached. Once this threshold was reached, and the birds were disturbed, a number could be seen heading toward the roost. As sunset approached and/or the light intensity dropped below 900 foot candles, more and more of the flock would go to the roost. It was possible on some days to disturb the birds enough so that they would all leave for the roost well before the usual time.

Roost flights and environmental conditions.—The time of roosting by the gulls in this region appears to be controlled by light intensity and the length of daylight.

Figures 2 and 3 show the percentage of the total roost population arriving

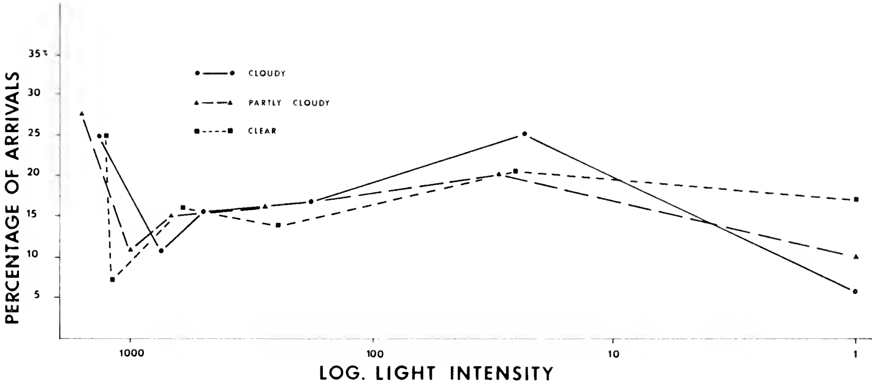


FIG. 4. Percentage of arrivals during the two and a half hours before dark plotted against the log. of light intensity measured in foot candles. At the Orono roost between 10 July and 16 September 1965.

during half-hour intervals with sunset time treated as a constant throughout the observation period. At the Orono summer roost (Fig. 2) no difference at the 95 per cent confidence level exists between the percentage of birds arriving on cloudy, partly cloudy, and clear days at the respective time intervals. At the Pushaw fall roost (Fig. 3), a significant difference exists between cloudy and clear days, $P > 0.05$. During the summer at two hours before sunset between 25 and 28 per cent of the arriving birds were already present at the roost. At the fall roost only four to nine percent of the arriving birds were present two hours before sunset. There is a significant seasonal difference between these early arrivals, $P > 0.05$.

Figures 4 and 5 show the percentage of birds arriving during half-hour intervals, plotted against the logarithm of light intensity. At the Orono summer roost (Fig. 4) a slight peak in the arrivals was reached at sunset, but a fairly constant number of birds arrived throughout the period, with a distinct drop after sunset on cloudy days. The clear day arrivals stay quite high at the lower light intensities. A different situation exists at the fall roost (Fig. 5), however. Here, between 80 and 85 per cent of the birds arrive at the roost at light intensities lower than 300 foot candles. On cloudy days the light intensity drops from 300 to zero foot candles over a period of one hour, but on partly cloudy days and clear days the same change occurs over a period of 30 minutes (Fig. 6). The arrival percentages reached a distinct peak at sunset. Again, cloudy day arrivals dropped off distinctly after sunset but the partly cloudy and clear day percentages remained high at the very low light intensities.

During July and August the time between sunrise and sunset was 14 to

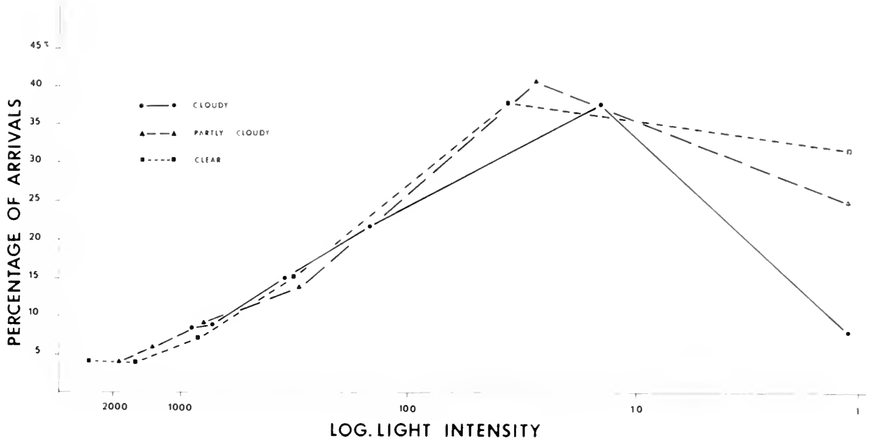


FIG. 5. Percentage of arrivals during the two and a half hours before dark plotted against the log. of light intensity measured in foot candles. At the Pushaw roost between 17 September and 27 November 1965.

15 hours. During October and November this time was 9.5 to 10.5 hours. In August, twilight lasted for 45 minutes after sunset but by the end of October it was dark within 15 minutes after sunset. As far as I was aware, all birds arrived at the roost before complete darkness and there was a distinct reduction in the number of arrivals at light intensities under two foot candles.

DISCUSSION

From the above observations we can draw some conclusions about environmental conditions and their role in affecting roosting behavior in the Herring Gull in central Maine.

Season of the year.—The season of the year has the most marked effect on the time of roosting. During the summer when the days are long and the temperature is moderate to warm, the gulls tend to move to the roost quite early relative to sunset and at times when the light intensity is high (above 2,000 foot candles). During the shorter, cool days of fall, the gulls do not move to the roost until nearly dark, when the falling light intensity causes the roosting flights to occur. There is little seasonal change in the amount of food present in the dumps in this region but with the longer foraging time available during the summer the gulls probably become satisfied more quickly than during the winter and so move to the roost when satisfied rather than remain at the feeding areas until dark. With the shortening day length and the longer, cold nights of fall, the physiological demands involved

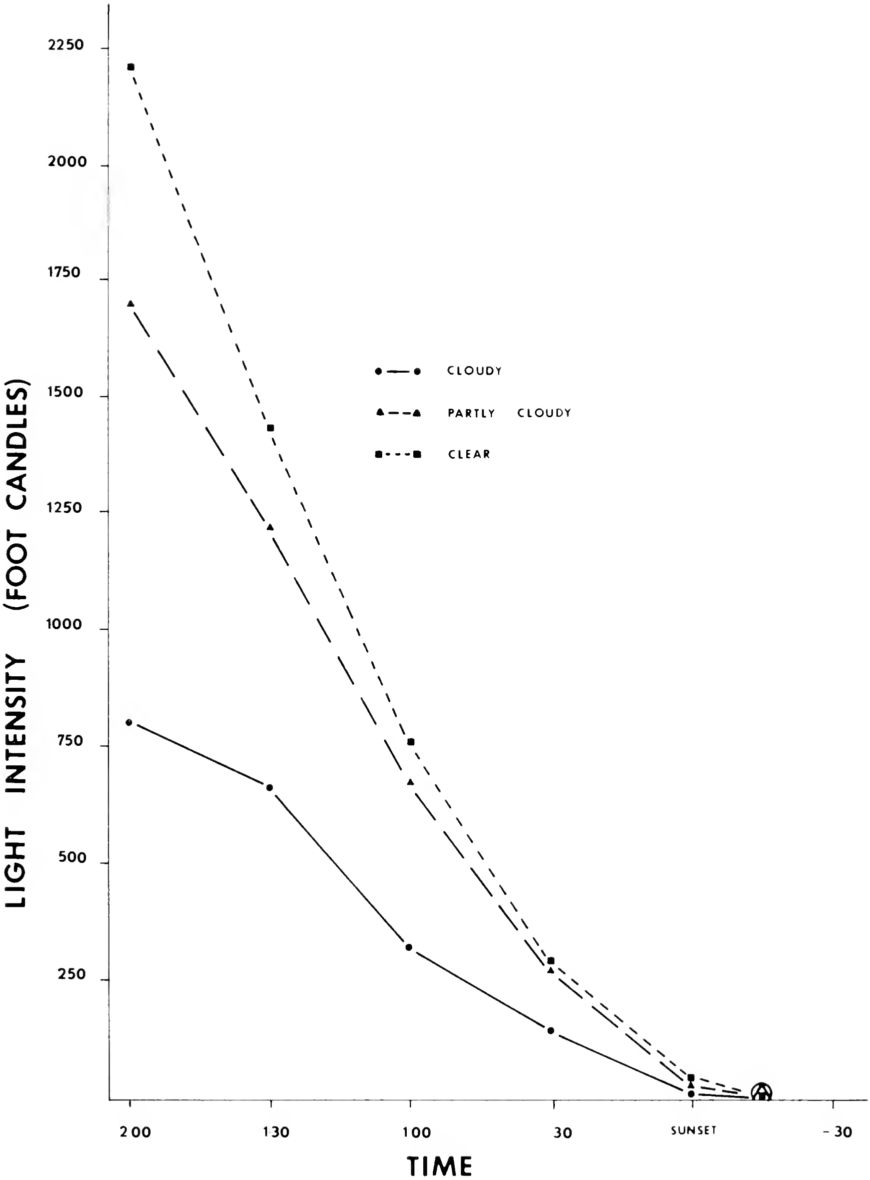


FIG. 6. Changes in light intensity measured in foot candles on cloudy, partly cloudy, and clear days during the two hours preceding sunset from 17 September to 27 November 1965.

in maintaining the body temperature are more stringent and it seems that there is an increased utilization of available light for feeding.

Light intensity.—During the fall the majority of the gulls arrive at the roost when the light intensity falls below 300 foot candles, with a peak of arrivals being reached between 115 and ten foot candles. Summer roosting does not appear to be controlled so directly by light intensity but, with approaching darkness, there is a peak in the arrivals at the roost between 50 and five foot candles. Hiller's observation (cited by Kellogg and Hutchinson, 1964) that gulls moved toward the roost during an eclipse in July but returned to feed after the light returned would confirm that light intensity may still be a factor during the summer, even though not as strong a stimulus as during the periods of shorter day length. In the summer there is no difference between clear and cloudy days in terms of rate of arrival. However, during the fall, on cloudy days significantly more birds arrive at the roost early than on clear days.

Wind, temperature, and social factors.—Wind velocity and direction appear to have little effect upon the time of roost flights. Schnell (1965) has recorded the flight speed of gulls at a breeding colony under varying wind velocities, using a Doppler type radar unit. Assuming his data will also hold for gulls away from the colony, the gulls leaving the major dump and club in this study region would take approximately 12 minutes to reach the roost on a still day, 16 minutes flying into a wind of up to 15 mph, and 8 minutes flying with such a wind. Gulls in this study area did not leave any earlier for the roost on windy days than on calm days even though it took them longer to reach the roost on such days. Temperature does not have a direct effect on roosting time but indirectly affects the time of roosting by its effects on maintenance of body temperature. Disturbances at the feeding and clubbing areas tend to cause earlier departure to roosting sites and there is an element of social interaction in the gulls leaving the clubs.

The above data suggest that there is a specific light intensity threshold for roosting in the individual gull but that this may be modified by many factors in the environment. This hypothesis cannot be verified in a field experiment but it would be interesting to test it with birds under controlled laboratory conditions.

SUMMARY

1. During the summer and fall of 1965 the roosting behavior of Herring Gulls in central Maine was studied with a view of attempting to correlate this behavior with environmental factors.

2. The summer roost was on rocks in the swift flowing Penobscot River within the town limits of Orono. The fall roost was five miles distant on Pushaw Lake.

3. During the summer the Penobscot River roost was used by up to 400 gulls but

by 25 September no birds roosted there. Beginning in September the roost at Pushaw Lake was used and by the middle of November as many as 4,000 gulls were using this roost. When the ice formed on the lake no gulls spent the night there. These changes in the location of the roost are explained in relation to the numbers of gulls in the area and the human activity on the lake.

4. A significant difference exists between the time of roosting during the summer and fall. During the summer the gulls roost earlier relative to time of sunset than during the fall. These differences are probably caused by changes in the physiological needs of the gulls and by the changes in day length.
5. During the fall the majority of the gulls arrive when the light intensities are under 300 foot candles; a peak movement is reached between 115 and ten foot candles.
6. During the summer the rate of arrival does not vary between clear and cloudy days, but during the fall significantly more birds arrive at the roost earlier on cloudy than on clear days.
7. Wind velocity and direction, and temperature do not have a direct effect on roosting time, but may have an indirect effect.
8. Social interaction and disturbances at the feeding and loafing areas of the gulls may hasten roosting flights.

ACKNOWLEDGMENTS

The results reported here are a portion of a thesis submitted while a candidate for the Master of Science degree in zoology at the University of Maine, Orono. Many people at that institution were helpful to me during this study. I would especially like to thank Dr. Wm. H. Drury, Jr., of the Massachusetts Audubon Society for his interest and many helpful suggestions. This study was partially supported by a research grant from the Massachusetts Audubon Society, a Grant-in-Aid of Research from The Society of the Sigma Xi, and a contribution from the Mae P. Smith fund of the American Museum of Natural History.

LITERATURE CITED

Cullen, J. M.
1964 Roosting. *In* A new dictionary of birds, Ed. by A. L. Thomson, T. Nelson Ltd., London.
Kellogg, P. P., and C. M. Hutchinson
1964 The solar eclipse and bird song. *Living Bird*, 3:390.
Miskimen, M.
1955 Meteorological and social factors in autumnal migration of ducks. *Condor*, 57:179–184.
Schnell, G. D.
1965 Recording the flight speed of birds by Doppler radar. *Living Bird*, 4:79–87.
Schreiber, R. W.
1965 Seasonal population fluctuations and roosting behavior of the Herring Gull in central Maine. (MS Thesis, The University of Maine, Orono.)
Wynne-Edwards, V. C.
1962 Animal dispersion in relation to social behaviour. Hafner Publishing Co., New York.

DEPARTMENT OF ZOOLOGY; UNIVERSITY OF MAINE, ORONO, MAINE (PRESENT ADDRESS: SMITHSONIAN INSTITUTION PACIFIC PROJECT, WASHINGTON, D. C., 10 MAY 1966.

VARIATION IN THE BREEDING SEASON AND CLUTCH-SIZE OF THE ROBIN IN THE NORTHEASTERN UNITED STATES AND THE MARITIME PROVINCES OF CANADA[1]

Deborah V. Howard

This paper summarizes an analysis of nest record cards of the Robin (*Turdus migratorius*) for variations in breeding season and clutch-size. Although these variations have been studied in detail for several species of European birds, very little similar work has been done in North America, partly because the available data were widely scattered and difficult to obtain. The North American Nest Record Card Program at Cornell University, organized to make a centralized source of records available to workers throughout the continent, should provide the stimulus for additional work here.

Many important variations are apparent only when the number of records is very large. There are, however, numerous sources of error in data collected by many observers. These are lucidly discussed by Myres (1955) and Snow (1955 *a, b*) in their papers on breeding season, clutch-size, and nesting success in three species of thrushes (Blackbird (*Turdus merula*), Song Thrush (*T. ericetorum*), and Mistle Thrush (*T. viscivorus*)). Burton and Mayer-Gross (1965) have recently compiled a list of papers based on records from the British Nest Records Scheme. These have been most helpful and merit careful study by anyone analyzing nest cards. Unless otherwise stated, it should be understood that Robin refers to the American Robin, and not the European Robin (*Erithacus rubecula*).

METHODS

A total of 1,605 records, collected in Massachusetts and New York states and the Maritime Provinces of Canada (New Brunswick, Nova Scotia, and Prince Edward Island) in 1963, 1964, and 1965, were used. The records from New York were loaned by the North American Nest Record Card Program at Cornell and those from the Maritime Provinces by the Maritimes Nest Record Scheme at Sackville, New Brunswick. All the records for Massachusetts (with the exception of 7 from Cornell) were collected by the Massachusetts Audubon Society as part of their Robin Nest Survey.

Figure 1 shows the distribution of records by counties. The most heavily represented areas are those nearest the record collection centers: western and southern New York around Ithaca, eastern Massachusetts around Lincoln, and

---

[1] Contribution No. 56 from the Hathaway School of Conservation Education, Massachusetts Audubon Society, Lincoln, Massachusetts 01773.

TABLE 1
SEASONAL VARIATION IN CLUTCH-SIZE

Mean clutch-size by months for Massachusetts and New York states and each of the Maritime Provinces.

	April			May			June			July		
	Mean	S.D.	No.	Mean	S.D.	No.	Mean	S.D.	No.	Mean	S.D.	No.
Massachusetts (408 clutches)	3.5 ± 0.07	0.60	83	3.5 ± 0.04	0.68	258	3.1 ± 0.13	0.89	50	3.1 ± 0.09	0.35	17
New York (351 clutches)	3.5 ± 0.07	0.61	85	3.6 ± 0.05	0.69	190	3.4 ± 0.08	0.58	60	3.2 ± 0.18	0.73	16
New Brunswick (169 clutches)	3.3		3	3.5 ± 0.06	0.65	116	3.0 ± 0.10	0.68	46	2.5		4
Nova Scotia (162 clutches)	2.9		7	3.3 ± 0.07	0.65	97	3.2 ± 0.10	0.71	53	3.0		5
Prince Edward Island (73 clutches)				3.1 ± 0.07	0.53	52	3.0 ± 0.15	0.71	21			

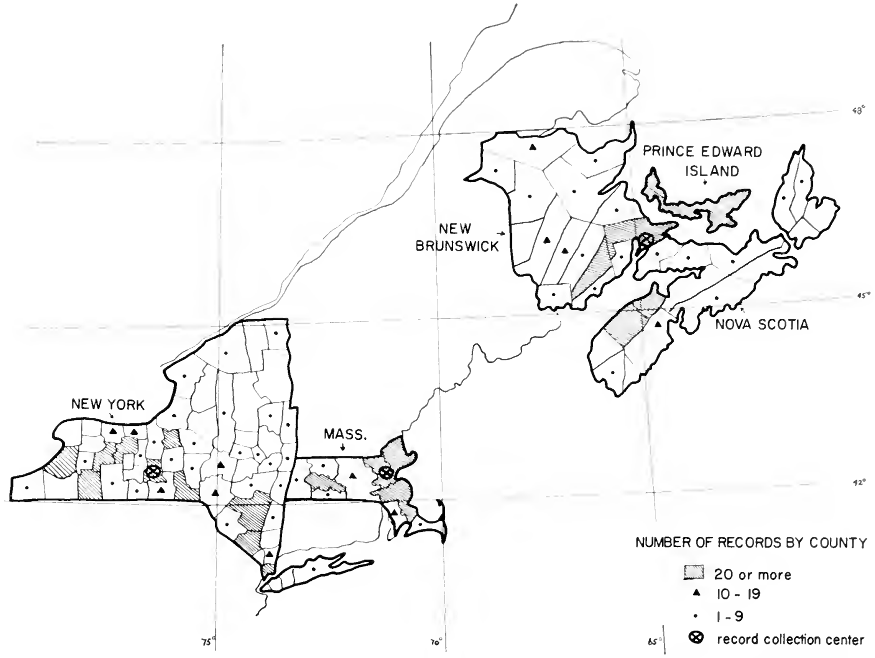


FIG. 1. Geographical distribution of nest records from Massachusetts, New York, and the Maritime Provinces.

the central Maritime region around Sackville. The less populated areas are poorly represented.

The criteria used for inclusion and dating of records were a modification of those of Myres and Snow. A total of 1,167 nests were available for analysis of clutch-size. All nests containing eggs were used except that obviously incomplete clutches and all clutches of one were excluded, as were nests containing hatched young together with infertile eggs. Those nests found during laying and closely watched until the clutch is complete give the most nearly accurate figures. These comprised one quarter of the cards. The remaining three quarters were nests found during the incubation period. About one fifth of these were visited only once. Because some incomplete clutches and some clutches which had lost eggs were doubtless included, all the figures given for clutch-size are probably low. They are therefore suited for comparative purposes, but caution should be used in drawing conclusions from the absolute values.

Nests were dated from the day the first egg was laid. For those found during laying, the initial date could be figured most accurately. If the hatching or fledging date or the age of the young was given, the initial date could be calculated less accurately using an average incubation period of 13 days and an average nestling period of 13 days (Young, 1955; pers. obs.). Nests visited more than once during the incubation or nestling period with none of the above dates given were dated using the bracketing method of Myres: the earliest and latest dates on which the hatching or fledging could have occurred were calculated from the observations. The date when the clutch was started was then estimated from the median date between them. The largest possible bracket was 12 days, with an error of plus or minus six days from the middle date. Nests visited only once, with no additional information given, were assumed to be in the middle of the incubation or nestling period (D. Lack, 1946; E. Lack, 1950). Nests could also be dated if the banding date was given, as the young birds are usually banded when they are 7 or 8 days old. Once dated, the nests were grouped into 5-day periods for description of the breeding season. Although 40 per cent of the cards were dated using brackets, most of these were smaller than the maximum of 12 days. There is nevertheless the possibility that some were placed in the wrong 5-day period.

CLUTCH-SIZE

Robins usually lay a clutch of three or four eggs. Casual description of the clutch-size as three to five is misleading, as only 2 per cent of the clutches in Massachusetts and New York and less than one per cent in the Maritimes consist of five eggs. Most clutches of one and two are probably the result of disturbance or actual predation during laying, although it is probable that clutches of two are more common in the Maritimes (see below). Nests containing more than five eggs have been reported, but are apparently the result of multiple nesting or erratic behavior on the part of a single female (Young, op. cit.; Howell, 1942). The Brown-headed Cowbird (*Molothrus ater*) lays in Robin's nests occasionally, but the Robins customarily remove the egg (Friedmann, 1929; pers. obs.). This results in a lower clutch-size, for the cowbird removes a robin's egg before it lays its own, and this egg is not replaced.

Seasonal variation.—Table 1 shows the mean clutch-size in Massachusetts, New York, and each of the Maritime Provinces by months throughout the nesting season. In all but Massachusetts, the clutch-size is higher in May than in April or June, suggesting a peak during that month. Further, the majority of clutches of five reported were begun in May. The rise between April and May is not statistically significant (using a two-sided T test, with a confidence limit of 95 per cent), nor is the drop from May to June except for Massachusetts and New Brunswick. The difference between May and July, however, is significant for all areas but Nova Scotia. The difference in all cases is small, being on the order of half an egg.

TABLE 2
PERCENTAGE DISTRIBUTION OF CLUTCH-SIZES IN MASSACHUSETTS-NEW YORK AND THE MARITIME PROVINCES

Clutch-size	Mass.-New York per cent	Maritimes per cent
5	2	1
4	50	38
3	41	45
2	7	15
Total number of clutches	762	405

Lack (1946), Monk (1954), Peakall (1960), and Snow (1955*a*) using British nest records, have found that clutch-size for the European Robin, the Yellowhammer (*Emberiza citrinella*), the Greenfinch (*Chloris chloris*), and the Blackbird and the Song Thrush rises to a peak in May or June and then declines. That of the Robin apparently also follows this pattern, although the initial rise is much less pronounced than the later decline. The Robin does not begin to lay until late April. In contrast, the Blackbird, which lays its first eggs in March in Great Britain, shows a gradual rise in clutch-size from March until mid-May, after which it declines. Lack (1954) has pointed out that the clutch-size of many double-brooded passerines reaches a peak in May or June. He suggests that this seasonal variation in clutch-size has come about through natural selection and results in the production of the most young possible. The proximate factors influencing the variation are changes in day-length and the availability of food for the young throughout the breeding season.

Geographical variation.—The percentage distribution of clutch-size in Massachusetts–New York and the Maritime Provinces is shown in Table 2. The most common clutch-size in the Maritimes is 3, while that in Massachusetts–New York is 4. Clutches of five are less than half as frequent in the Maritimes and there are twice as many clutches of two. Clutches of two are more or less evenly distributed through the season in Massachusetts–New York, supporting the theory that many of them are due to predation (Snow, 1955*a*), but there is a sharp rise in the number of clutches of two in the Maritimes late in the season. The overall mean clutch-size for the Maritime Provinces is 3.2 ± 0.04. This differs significantly at 99 per cent confidence limits from the overall mean for Massachusetts–New York, which is 3.5 ± 0.02. Moreover, the mean clutch-size declines steadily from New Brunswick (3.3 ± 0.05) to Nova Scotia (3.2 ± 0.06) to Prince Edward Island (3.0 ± 0.10). This tendency persists on the island of Newfoundland, where, out of more than 70 Robin nest records, only 4 were found to contain 4 eggs or

TABLE 3
ANNUAL VARIATION

	Variation in mean monthly clutch-size in Massachusetts-New York each year from the overall monthly mean.			
	1963	1964	1965	All years
April	3.6	3.5	3.6	3.5
May	3.6	3.6	3.4	3.5
June	3.0	3.3	3.3	3.3
July	3.0	3.1	3.2	3.2

young (Tuck, pers. comm.) while in Labrador, clutches of 4 are more common (Todd, 1963).

Howell (op. cit.) and Young (op. cit.) each calculated an overall mean clutch-size for the Robin which agrees closely with the overall mean for Massachusetts–New York: Howell at Ithaca, New York (42°N lat)—3.4, 127 nests; Young at Madison, Wisconsin (43°N lat)—3.4, 146 nests.

It has been shown for a number of species in northern Europe that clutch-size increases with increasing latitude. In the case of the Robin in New York–Massachusetts and the Maritime Provinces, any influence of the increase in latitude is apparently overridden by the more maritime climate in the Provinces. Lack (1947, 1948*a*) and others have commented on the fact that clutch-size tends to be lower in maritime or island situations than in a continental environment. Detailed records for the European Robin and Common Swift (*Apus apus*) in Europe show that this is true for these species (Lack, 1954; Lack and Lack, 1951) and Tompa (1964) has shown that this variation holds for the Song Sparrow (*Melospiza melodia*) in British Columbia. Generally accepted theory suggests that this is an adaptation to a poorer food supply in maritime as compared with continental environments.

Annual variation.—Annual variation in clutch-size has been described for several species of European birds (Lack, 1948*b*; Kluijver, 1951; Snow, 1955*a*). Table 3 shows the monthly means for Massachusetts–New York for each year and the overall monthly means for all years combined. Although there is a slight amount of variation from the overall mean on each month, in no case is the difference statistically significant.

BREEDING SEASON

Robins raise more than one brood during a season in northeastern United States and the Maritime Provinces. Howell (op. cit.) estimated that a maximum of one out of seven pairs raised a third brood at Ithaca, New York but I suspect that third broods are rare in the Maritimes, as there were only nine

TABLE 4
BREEDING SEASON

Number of clutches begun in each 5-day period in Massachusetts-New York and the Maritime Provinces in the years 1963, 1964, and 1965.

	1963		1964		1965	
	Mass.-New York	M.P.	Mass.-New York	M.P.	Mass.-New York	M.P.
12–16 April	2		3		1	
17–21	4		11		14	
22–26	14	1	41	2	40	1
27–1	24	6	59	4	74	8
2–6 May	37	8	50	14	75	19
7–11	17	19	34	27	49	15
12–16	19	18	27	30	51	36
17–21	9	23	39	22	31	36
22–26	9	16	31	15	34	23
27–31	9	15	14	12	17	30
1–5 June	4	7	12	6	27	12
6–10	4	17	17	14	15	22
11–15		5	5	13	15	20
16–20	7	3	13	5	14	10
21–25		6	7	6	2	5
26–30		4	8	8	6	4
July	2	8	21	12	23	6
Mean date of completion of first clutches*	3 May	16 May	2 May	15 May	3 May	17 May

* Calculated for Massachusetts-New York using all clutches begun through 16 May; for the Maritimes, all those begun through 31 May.

nests out of 405 reported from the three Provinces which were begun late enough to fall in this category.

While nests with eggs are commonly found in New York and Massachusetts in late April, they are rather rare this early in the Maritimes. The great majority (80 per cent) of nests reported from all areas were begun in May and June, with a few in July and one from New York in August (omitted from Table 4). Part of the seasonal decline is an artifact, however, because nests are harder to find and less sought after later in the season. Indeed, Peakall (op. cit.) was able to show that, for the Yellowhammer, this bias shifted the nesting season peak forward by about five days. It probably applies equally to all nest records examined in this study, and they can therefore be compared. The breeding season is approximately 14 days earlier in the Massachusetts–New York area than it is in the Maritimes. Although the weather was compatible with a truly earlier season in 1964, there is not enough information to show whether there is an annual variation.

SUMMARY

A total of 1,605 nest record cards from New York and Massachusetts and the Maritime Provinces of Canada were examined for variations in the breeding season and clutch-size of the Robin. In all areas but Massachusetts, clutch-size is higher in May than in April or June, suggesting a peak during that month. Clutch-size is significantly lower in the Maritimes than in New York–Massachusetts and declines steadily from New Brunswick to Nova Scotia to Prince Edward Island. The breeding season is approximately two weeks earlier in New York–Massachusetts than in the Maritime Provinces.

ACKNOWLEDGMENTS

I would like to thank both Dr. David B. Peakall of the North American Nest Record Card Program and Mr. A. J. Erskine of the Maritimes Nest Record Scheme for loaning me their original data. Dr. John Kadlec gave me helpful advice about the statistical aspects of the paper, and Mr. James Baird, Dr. William Drury, Jr., and Dr. David Snow read and criticized the original manuscript. The work for this paper was supported, in part, by a grant from Sigma Xi.

LITERATURE CITED

Burton, J. F., and H. Mayer-Gross
1965 The first 25 years of the nest record scheme. *Bird Study*, 12:100–107.
Friedmann, H.
1929 The Cowbirds. Charles C. Thomas, Springfield, Illinois.
Howell, J. C.
1942 Notes on the nesting habits of the American Robin. *Amer. Midland Nat.*, 28:529–603.
Kluijver, H. N.
1951 The population ecology of the Great Tit, *Parus m. major* L. *Ardea*, 39:1–135.
Lack, D.
1946 Clutch and brood size in the Robin. *Brit. Birds*, 39:98–109; 130–135.
1947 The significance of clutch-size. *Ibis*, 89:302–352.
1948*a* The significance of clutch-size, Part III. *Ibis*, 90:25–45.
1948*b* Natural selection and family size in the Starling. *Evolution*, 2:95–110.
1954. The natural regulation of animal numbers. Clarendon Press, Oxford.
Lack, D., and E. Lack
1951 The breeding biology of the Swift *Apus apus*. *Ibis*, 93:501–546.
Lack, E.
1950 Breeding season and clutch-size of the Wood Warbler. *Ibis*, 92:95–98.
Monk, J. F.
1954 The breeding biology of the Greenfinch. *Bird Study*, 1:2–14.
Myres, M. T.
1955 The breeding of Blackbird, Song Thrush and Mistle Thrush in Great Britain. Pt. I. Breeding seasons. *Bird Study*, 2:2–24.
Peakall, D. B.
1960 Nest records of the Yellowhammer. *Bird Study*, 7:94–102.
Snow, D. W.
1955*a* The breeding of Blackbird, Song Thrush, and Mistle Thrush in Great Britain. Pt. II. Clutch-size. *Bird Study*, 2:72–84.

1955*b* The breeding of Blackbird, Song Thrush, and Mistle Thrush in Great Britain. Pt. III. Nesting Success. *Bird Study*, 2:169–178.

Todd, W. E. C.
1963 Birds of the Labrador Peninsula. University of Toronto Press, Toronto.

Tompa, F. S.
1964 Factors determining the numbers of Song Sparrows, *Melospiza melodia* (Wilson), on Mandarte Island, B. C., Canada. *Acta Zoologica Fennica*, 109: 4–73.

Young, H.
1955 Breeding behavior and nesting of the Eastern Robin. *Amer. Midland Nat.*, 53:329–352.

MASSACHUSETTS AUDUBON SOCIETY, LINCOLN, MASS. 01773, 15 JUNE 1966

NEW LIFE MEMBER

A recent addition to the roll of Life Members of the Wilson Ornithological Society is Dr. Robert C. Stein, Professor of Biology at the State University College, Buffalo, New York. Dr. Stein has a bachelor's degree from St. Olaf College, and a doctorate from Cornell University. He has specialized in bioacoustics and the use of sound as a species isolating mechanism. He has published numerous papers in these fields and is perhaps best known for his work in studying the two different songs of the Traill's Flycatcher. Dr. Stein is a member of the AOU, the BOU, the Cooper Society, American Society of Zoologists, as well as several other ornithological and zoological organizations. He is married and has one child.

CARE, FOOD CONSUMPTION, AND BEHAVIOR OF BALD EAGLES USED IN DDT TESTS

NICHOLAS J. CHURA AND PAUL A. STEWART

WIDESPREAD concern exists over the decline in numbers of the Bald Eagle (*Haliaeetus leucocephalus*), our national emblem. In the continental United States there were approximately 3,642 Bald Eagles present in 1961, 3,807 in 1962, and 3,547 in 1963, according to January censuses (Sprunt and Ligas, 1963). A study was undertaken to help determine if pesticides may possibly be one of the factors lowering eagle populations.

Feeding experiments were conducted with 27 Bald Eagles in 1962 and 1963 to determine the approximate level of DDT in the diet that might cause death, the rates of accumulation and loss of DDT residues in various tissues, and the effects of DDT on reproductive organs. Results of this work have been reported by DeWitt and Buckley (1962), Buckley and DeWitt (1963), Locke, Chura, and Stewart (1966), and Stickel, et al. (1966).

The purpose of this paper is to present information on care, food consumption, behavior, and symptoms of DDT poisoning of eagles used in the tests.

CAPTURE AND HOUSING

Bald Eagles were captured in November and December of 1961 and 1962 along the Chilkat River near Haines, Alaska, where they congregate each year to feed on late-spawning chum salmon. Many shallow channels are bordered by extensive gravel bars littered with uprooted stumps and other drift. Eagles coming from roost trees along the shore often perch on these snags before proceeding to the water's edge for food. Number 1½ steel traps (single spring and jump type) were loosely wired on snags 1 to 4 feet above the ground and camouflaged with leaves and debris. When the birds alighted and were caught by the toes, the traps pulled free from the snags allowing the birds to fall to the ground. Trap chains stapled to the snag or a drag prevented captured birds from flying off. Captured birds were shipped by air to the Experimental Fur Station at Petersburg, Alaska.

Ten eagles were housed in a wooden shed, 120 × 12 feet, built along a chain-link fence on the west side of the station. Perches made from sections of tree trunks were supported by pipes driven into the ground and spaced 8–10 feet apart and 3–4 feet from the rear wall. The legs of the birds were jessed (Michell, 1959) and the jesses were connected by swivel to a nylon leash that had one end looped around the pipe so birds had free movement up, onto, and around the perches. Cake pans were nailed on top and to one side of each perch to hold similar pans containing food. Water was offered in metal bowls nailed to the wall behind the perches.

Because of space limitations, several 1963 birds were housed in wire cages (12 × 6 × 5 feet high) which had small logs on the floor for perches. Food and water were offered in containers placed on the wire floors.

BEHAVIOR

The eagles were visited frequently for care and observation. When first approached, one or more birds gave a cackling warning. Most birds then dropped to the ground and began pulling against their leashes trying to escape. However, one bird usually stayed on its perch even when being fed and another generally stood on the ground in a low crouched position.

Trembling and feather erection, signs of distress, varied in intensity according to the type of disturbance, temperament of the birds, and the degree of adjustment to captivity. Newly captured birds trembled the most. Even after months in captivity they trembled slightly when mildly disturbed.

Feather erection usually accompanied trembling. A fluffing out of head and chin feathers occurred when the birds were mildly disturbed. Additional distress caused the erection of wing and back feathers (to about a 45° angle) and abdominal feathers (to a 90° angle). Birds were frequently observed shaking out their feathers. Typically, the birds would stand on their perches with wings partly outstretched. The feathers were then erected and shaken vigorously for a few seconds. Actual preening was not observed, but some birds occasionally appeared to scratch their bodies with their bills.

The birds usually cleaned their bills by rubbing them vigorously on convenient surfaces such as the top edges of the perches, or food pans. But one bird dug in the ground with its bill and would mouth the soil and debris without swallowing. Another bird rubbed and whittled on the edges of wooden beams behind its perch as high as it could reach. One bird occasionally reached down during a meal to take a talon in its beak, setting the point of the talon in the curve of its upper mandible. Then it pulled on the talon with a side-to-side motion of the head. This may have served to cleanse the inside of the bill, the talons, or both.

Birds frequently exercised their wings while standing on perches or on the ground. When on the ground they pulled against their leashes in a controlled and deliberate manner. The digging action of the talons in these exercises caused deep circular grooves to form around the perches.

When handled, the eagles instinctively attempted to flip over on their backs, and strike with their talons. They were also able to reach up and strike at a hand near their head if the legs were not restrained. In addition, most birds made use of their sharp and powerful bills to defend themselves.

HANDLING

Untethered birds in cages were best caught with a net. A tethered bird could be restrained and then grabbed safely while it was on the ground by walking on the leash up to its immobilized feet. A leashed bird could also be caught by grabbing its outstretched wings, folding them against its body and stepping back away from the perch to keep the legs extended by the leash. The feet could then be tied, or fitted with a snug leather pouch that prevented use of the talons. For further handling, transporting, or force feeding, the bird could be bound in a rectangular piece of cloth which was tied at the chest and around the tail under the legs to hold the wings firmly against the body.

It was necessary to approach and work slowly around the birds because fast movements got them too excited. Their rapid heartbeats could sometimes be heard from several feet away. When handled they emitted high-pitched, ear-piercing screams and panted from their exertion of trying to escape. Only by covering their heads with heavy cloth to blind them could they be calmed and kept relatively immobile during handling.

Certain recommendations can be made for preventing injury at capture and increasing the comfort of experimental eagles in captivity: (1) Modify the steel traps by using lightweight number 4 jaws, padded, combined with a number 1½ spring to catch and hold the birds around the tarsus, thus preventing toe damage during capture. (2) When possible, use large cages with wire floors and wooden perches; insert an inner wall of nylon net, which gives upon impact, in the cages of the more nervous birds. This has been tried and found successful. (3) If birds must be leashed to perches, ample space should be allowed around each perch. (4) Place a second swivel, just after the loop connection around the perch upright, to help decrease leash twisting. (5) Shorten the leashes of the more nervous birds to prevent their gaining momentum enough to sprain a leg. (6) Keep birds isolated and relatively free of disturbance, particularly during feeding periods. (7) Handle birds as little as possible, particularly during the critical adjustment period, unless they are to be properly manned. (Our eagles were not manned because of the number of birds and time limitations.

EARLY ADJUSTMENT AND VOLUNTARY FEEDING

The interim between capture and voluntary feeding on a regular basis was a critical period for the eagles. Prior to the 1963 tests four birds died even after they began taking food voluntarily (Table 1). Important problems of confining wild animals, including those of the transition from freedom to captivity, are discussed by Hediger (1950).

TABLE 1

VOLUNTARY FOOD INTAKE BY 21 NEWLY CAPTURED BALD EAGLES HELD AT THE EXPERIMENTAL FUR STATION, PETERSBURG, ALASKA, FOR THE 1963 TESTS

Day at station first food taken	Day when ground fish taken alone	Bird number
–	–	77[a]
1	1	11A, 14A, 89[b]
6	6	14
7	7	17, 19
8	8	11, 12, 18
9	9	13
10	13, 15	20, 17A[c]
11	11, 12	22, 15
15	19	23
17	18, 23	21[d], 87[e]
18	20	16[f]
19	23 (#86 only)	81[g], 86[h]

[a] Died on 6th day without taking food; [b] Died on 5th day; [c] Successfully force fed on 4th day; [d] Successfully force fed on 16th day; [e] Died on 38th day; [f] Successfully force fed on 16th and 18th day; [g] Unsuccessfully force fed on 16th day but successfully fed on 18th day. Died on 25th day; [h] Successfully force fed on 16th and 18th day. Died on 33rd day.

Encouraging the eagles to feed on ground fish regularly was accomplished by offering whole or parts of fish and mammals simultaneously with ground fish (usually pink salmon). Food was left with the birds day and night so they could sample it at will. Once birds began eating, the daily offering of whole food was decreased until the changeover to ground fish was complete.

Five birds had to be force-fed to give them nourishment and to encourage them to feed. Strips of fish (about 6 × 1 inches) were forced down the gullet: when the bird began to swallow, its neck was gently massaged until the meal was completely taken. Because of the stress involved, force-feeding was used only as a last resort measure.

DIETS AND FOOD CONSUMPTION

Fish from local canneries was ground, packaged, and frozen for storage, then thawed for use. At various times during the 1962 (March–June) tests the diet consisted of ground salmon, herring, flounder, and supplements. In the 1963 (January–May) tests the basic food was ground pink salmon waste. With little variation the regular diet consisted of pink salmon (99 per cent), liver meal (1 per cent), multiple vitamins (1 teaspoonful per 10 pounds of food) used daily, and Terramycin (1 gram active ingredients per 10 pounds of food) used for periods of about 7 days and omitted for 3 or 4 days.

TABLE 2

FOOD CONSUMPTION OF CAPTIVE BALD EAGLES

Bird number	Age	Sex	DDT dosage level (ppm)[a]	Dosage period (days)	Daily food consumption (grams)	
					Mean ± standard error	Range
1962:						
1	Adult	♂	0	112	314 ± 14	0–700
10	Immature	?	0	112	288 ± 16	0–700
3	Immature	?	10	98[b]	401 ± 17	0–719
6	Adult	♂	10	77[c]	150 ± 19	0–680
2	Adult	♂	160	71[c]	215 ± 18	0–609
9	Adult	♂	160	112	335 ± 14	0–700
5	Adult	♂	800	62[c]	213 ± 20	0–546
7	Immature	♀	800	59[c]	238 ± 25	0–815
4	Adult	♂	4000	23[c]	198 ± 26	8–490
4A	Adult	♂	4000	15[c]	109 ± 35	0–344
8	Immature	♂	4000	18[c]	215 ± 32	0–530
1963:						
15	Adult	♀	0	120	324 ± 9	33–467
12	Adult	♀	10	120	265 ± 9	0–484
13	Adult	♂	10	120	312 ± 8	0–501
20	Adult	♀	10	120	229 ± 8	0–657
22	Adult	♂	10	120	204 ± 13	0–500
11	Adult	♂	10	60	274 ± 14	93–609
14	Adult	♂	10	60	219 ± 14	0–465
17	Adult	♀	10	60	252 ± 15	0–500
23	Immature	♀	10	60	303 ± 19	0–500
14A	Adult	♀	10	60	194 ± 11	0–449
17A	Adult	♂	10	60	254 ± 20	0–492
11A	Adult	♂	10	39[c]	252 ± 23	0–499
16	Adult	♂	10 & 0	60 & 292 60 258	275 ± 11	0–703
18	Adult	♂	10 & 0	60 & 232 60 176	204 ± 9	0–504
19	Adult	♀	10 & 0	60 & 229 60 196	213 ± 11	0–489
21	Adult	♂	10 & 0	60 & 287 60 252	269 ± 12	0–490

[a] Dietary concentration expressed on a dry weight basis, on the assumption of 70 per cent moisture content. Actual moisture content proved to be 65 per cent.

[b] Bird escaped.

[c] Bird died.

A uniform blend of all ingredients, including technical grade *p,p′* DDT dissolved in Wesson oil, was achieved by using a motor driven bread mixer. Food was weighed on a beam balance before and after feeding. Birds were fed about 4:00 PM daily and were generally offered all the food they would eat in about an hour.

In the 1962 tests 11 eagles ate an average of 274 grams per bird day with a range of 109 to 401 grams per day between birds (Table 2). The wide range between birds on 10 ppm DDT (150 to 401 grams) was caused in part by bird 6 being long off feed because of illness. Birds that died ate little or no food immediately before death.

In the 1963 tests 16 eagles ate an average of 254 grams of food per bird day with a range of 194 to 324 grams per day between birds. Average daily food consumption of birds in two 1963 tests was computed as a percentage of average body weight (based on mean of near-capture and death weights). Females on 10 ppm DDT for 120 days ate at the rate of 4.9 per cent of their body weight, whereas the males ate 6.4 per cent. Similarly, females on 10 ppm DDT for 60 days ate 5.0 per cent of their body weight, but the males ate 6.2 per cent. Fevold and Craighead (1958) reported a similar sex difference in Golden Eagles (*Aquila chrysaetos*) and suggested this might result from differences in basal metabolism.

WEIGHT CHANGES

Eagles in the 1962 tests were first weighed at time of capture. Seven adult males averaged 10.7 pounds (range 9.3–12.4), one immature male weighed 10.8 pounds and one immature female weighed 12.4 pounds. These weights are higher than the averages reported for other Alaskan eagles by Imler and Kalmbach (1955).

All 1962 birds, except a control, lost weight between capture and death or sacrifice (Table 3). Weight losses for the seven birds that died on dosage varied from 23 to 49 per cent and were probably a result of impaired health due to DDT poisoning. General health may also have been poor, however, for a control lost 14 per cent and bird 6 on 10 ppm DDT died of a lingering illness. For this reason Terramycin was added to the diet in 1963.

The 1963 test birds were weighed upon their arrival at the fur station 1 to 13 days after capture during which time they ate little and lost an unknown amount of weight. Thus, valid weight comparisons could not be made.

MORTALITY AND SYMPTOMS OF DDT POISONING

Tremors attributable to DDT poisoning (Rudd and Genelly, 1965, and others) were evident in all but bird 6 of the 1962 birds that died. The intensity of tremors varied. Tremors generally were stronger (jerking wings and general incoordination simultaneous with vigorous feather shaking) in birds receiving higher dosages, but one bird on 800 ppm DDT and one on 4000 ppm DDT had only mild tremors (slight quivering of tail, wing, or erected body feathers).

TABLE 3
WEIGHT CHANGES OF 1962 TEST EAGLES

Bird number	Age	Sex	Dosage level DDT (ppm)[a]	Dosage period (days)	Weight (grams) At capture	At death	Per cent change
1	Adult	♂	0	112	4,238	4,252	+ 0.3
10	Immature	?	0	112	4,706	3,955	− 14
3	Immature	?	10	98[b]	4,649	–	–
6	Adult	♂	10	77[c]	4,536	2,211	− 49
2	Adult	♂	160	71[c]	5,642	3,629	− 36
9	Adult	♂	160	112	5,273	4,423	− 11
5	Adult	♂	800	62[c]	4,295	3,289	− 24
7	Immature	♀	800	59[c]	5,642	4,026	− 29
4	Adult	♂	4000	23[c]	4,777	3,671	− 23
4A	Adult	♂	4000	15[c]	5,075	3,444	− 32
8	Immature	♂	4000	18[c]	4,904	3,544	− 27

[a] Dietary concentration expressed on a dry weight basis, on the assumption of 70 per cent moisture content. Actual moisture content proved to be 65 per cent.

[b] Bird escaped.

[c] Bird died.

Tremors and death occurred first for the birds on the highest dosage and progressively later in birds on lower dosages. The 4000 ppm DDT birds showed tremors 12–18 days after dosage began and died at 15–23 days on dosage. It took 34–45 days for tremors to appear on the 800 ppm DDT birds and 59–62 days on dosage for death to occur. Tremors appeared on the 160 ppm DDT birds at 55 days on dosage and one of these birds died at 71 days on dosage. The birds on 10 ppm DDT, including bird 6 that died, showed no evidence of tremors caused by DDT poisoning. The influence on tremors or survival of two days in April when no DDT was fed is not known.

The only test eagle that died in 1963 had lesions suggestive of a serious respiratory disease. None of the 1963 birds exhibited tremors attributable to DDT poisoning.

SUMMARY

Twenty-seven Bald Eagles captured in southeastern Alaska were used in feeding tests to determine the effects of DDT in the diet.

Trapping and housing of eagles are discussed. Various aspects of eagle behavior and handling techniques are also presented. Recommendations are made for preventing injuries and increasing the comfort of captive birds.

The 1962 test birds consumed an average of 274 grams per bird day with a range of 109 to 401 grams per day between birds. Average food intake was 254 grams per bird day for the 1963 test birds with a range of 194 to 324 grams per day between birds.

Weight losses varied from 23 to 49 per cent of normal body weight for the 7 birds

which died in the 1962 tests. Tremors and death occurred first for birds on the highest dosage and progressively later for birds on the lower dosages.

ACKNOWLEDGMENTS

Eagles were acquired with the assistance of J. Branson and F. Robards of the Alaska Regional Office of the Bureau of Sport Fisheries and Wildlife. Many facilities were furnished by J. R. Leekley, director of the Petersburg Experimental Fur Station, Petersburg, Alaska. L. F. Stickel, Patuxent Wildlife Research Center, Laurel, Maryland, reviewed the manuscript.

LITERATURE CITED

Buckley, J. L., and J. B. DeWitt
1963 Progress report, pesticide–Bald Eagle relationships. *In* A Florida Notebook. National Audubon Society, New York.
DeWitt, J. B., and J. L. Buckley
1962 Studies on pesticide–eagle relationships. *Audubon Field Notes*, 16:541.
Fevold, H. R., and J. J. Craighead
1958 Food requirements of the Golden Eagle. *Auk*, 75:312–317.
Hediger, H.
1950 Wild animals in captivity. Butterworths Scientific Publications, London.
Imler, R. H., and E. R. Kalmbach
1955 The Bald Eagle and its economic status. U. S. Department of the Interior, Fish and Wildlife Service, Circular 30.
Locke, L. M., N. J. Chura, and P. A. Stewart
1966 Spermatogenesis in Bald Eagles experimentally fed a diet containing DDT. *Condor*, 68:497–502.
Michell, E. B.
1959 The art and practice of hawking. Charles T. Branford Co., Boston.
Rudd, R. L., and R. E. Genelly
1956 Pesticides: their use and toxicity in relation to wildlife. *California Game Bull.* No. 7:1–209.
Sprunt, A., IV, and F. J. Ligas
1963 Continental Bald Eagle project. Progress Report No. III. *In* A Florida Notebook. National Audubon Society, New York.
Stickel, L. F., N. J. Chura, P. A. Stewart, C. M. Menzie, R. M. Prouty, and W. L. Reichel
1966 Bald Eagle pesticide relations. *Trans. N. Am. Wildl. and Nat. Res. Conf.* 31:190–200.

U. S. DEPARTMENT OF THE INTERIOR, NATIONAL PARK SERVICE, OFFICE OF NATURAL SCIENCE STUDIES, WASHINGTON, D. C. (PRESENT ADDRESS OF P. A. STEWART: U. S. DEPARTMENT OF AGRICULTURE, ENTOMOLOGY RESEARCH DIVISION, OXFORD, NORTH CAROLINA). 18 MARCH 1966.

GENERAL NOTES

Goshawk predation on Sharp-tailed Grouse in the Nebraska sandhills.—There are few observations of Goshawks (*Accipiter gentilis*) preying on prairie grouse. Moran (1966. *Auk*, 83:137) observed a Goshawk kill a Greater Prairie Chicken (*Tympanuchus cupido*) in Wisconsin; this grouse was preyed upon in an area where it had taken refuge after being flushed from a booming ground. Ammann (1959. *J. Wildl. Mgmt.*, 23: 110–111) found a Goshawk feeding on a freshly killed male Sharp-tailed Grouse (*Pedioecetes phasianellus*) on a Michigan dancing ground; and Berger, Hamerstrom, and Hamerstrom (1963. *J. Wildl. Mgmt.*, 27:778–791) observed a Goshawk feeding on the hot carcass of a Greater Prairie Chicken on a booming ground in Wisconsin.

On 7 April 1966, I witnessed Goshawk predation on a Sharp-tailed Grouse on Display Ground 11 on the Bessey District of the Nebraska National Forest, Thomas County, Nebraska. The National Forest is located in the Sandhills and is described in a previous report (Blus, 1966. *Nebraska Bird Rev.*, 34:23–30). A male juvenile sharptail, which had flown from the display ground when I arrived by automobile at 6:15 AM, was taken by an immature hawk 100 yards from the display ground. The Goshawk, flying at an altitude of approximately 4 feet, hit the grouse on the ground. The grouse dragged the hawk for short distances on several occasions in attempting to escape. The hawk began to pull feathers from the breast of its prey about 10 minutes after the strike; the dead sharptail was taken from the hawk at this point.

In five years of prairie grouse study on the 90,000-acre National Forest, observations of seven single Goshawks and one pair were recorded; Goshawks were observed in four of the five years. Only two of these birds were seen in the 25,000 acres of planted coniferous plantations. In addition to the spring kill mentioned above, three hawks (a single and a pair) were observed feeding on two sharptail carcasses in winter; one hawk was relieved of a captured sharptail in winter; two were seen harassing sharptails on display grounds during spring; one was observed in late August flying over an area from which I flushed seven sharptails a few seconds previously; and one was not associated with either harassment or kill of Sharp-tailed Grouse. Karl Menzel (pers. comm.) rescued the captured sharptail mentioned above from a Goshawk in a coniferous plantation; the grouse was not seriously injured and was eventually released. Grange (1948. "Wisconsin Grouse Problems," p. 124) included the Goshawk among the most skillful grouse predators in Wisconsin; this also seems to hold true for Nebraska where Sharp-tailed Grouse are apparently among the preferred prey of this raptor.

Appreciation is expressed to Karl Menzel, C. Phillip Agee, and Carl Wolfe for editorial criticisms. This represents a contribution from Nebraska Pittman–Robertson Project W-33-R "Studies in the ecology and management of prairie grouse."—LAWRENCE J. BLUS, *Nebraska Game, Forestation and Parks Commission, Thedford, Nebraska, 18 October 1966.*

Regurgitation by Killdeer as a possible means of dispersal for seeds and aquatic organisms.—Gleason and Cronquist (1964. "The Natural Geography of Plants." Columbia Univ. Press, New York) suggest that transport via the external surfaces of waterbirds is the principal dispersal means for seeds of aquatic angiosperms. On the contrary, however, Schlichting (1960. *Trans. Amer. Microscopical Soc.*, 79:160–166) has found that mud and debris seldom remain on ducks suspended in air for more than 30 minutes. Resistant disseminules may be carried between aquatic habitats within the intestinal tract of birds. Barriers to dispersal possibly exist, then, for aquatic organisms lacking resistance to avian digestive processes. A recent observation indicating that dispersal via the avian intestinal tract might be feasible for seeds and other aquatic organisms deficient in resistant disseminules prompted this note.

In the course of an investigation to determine and contrast the effects of avian digestion on disseminules of 23 aquatic angiosperm species, Killdeer (*Charadrius vociferus*) and Mallards (*Anas platyrhynchos*) were fed various seeds. Occasionally Killdeer were observed to regurgitate portions of their meal within one hour after ingestion. The small pellets apparently had not entered the proventriculus for they were not altered by digestive processes. Viable seeds of the plant species under investigation were discovered in each of the disgorged pellets. Regurgitation generally followed the feeding of large seeds or occurred when the birds gorged themselves. My observations of disgorgement by Mallards in the present study confirm an earlier report of this phenomenon by Malone (1966. *Wilson Bull.*, 78:227–228). Disgorgement, however, has not previously been observed among waders.

Little significance can be attached to this observation with respect to dispersal of aquatic plants since a majority of the species surveyed possess resistant seeds which survive passage through the avian intestinal tract. However, seeds (notably of upland plants) which failed to pass successfully through Killdeer remained viable after disgorgement. Seeds of *Ratibida columnifera, Samolus parviflorus, Cosmos bipinnatus,* and *Raphanus raphanistrum* each failed to pass successfully through the Killdeer intestinal tract, but were viable after regurgitation. Other aquatic organisms or their disseminules ingested by Killdeer, yet not capable of withstanding avian digestive processes, may also be dispersed by this method.

Transport via the crop of birds would be a highly advantageous means of overland transport for seeds of aquatic species, aquatic organisms, or other disseminules destroyed by avian digestion or by desiccation. Nevertheless, the occurrence and frequency of regurgitation are poorly documented. Further research is needed to elucidate this neglected mechanism of dissemination.—Victor L. de Vlaming, *Department of Biology, Texas Technological College, Lubbock, Texas. (Present address: Department of Zoology, University of California, Berkeley, California), 3 October 1966.*

Mourning Dove egg in nests of Catbird and Robin.—The Mourning Doves (*Zenaidura macroura*) occasionally utilize nests of other birds and squirrels as a platform for their own frail nest, and they often use old Mourning Dove nests again (Hanson and Kossack. 1963. Illinois Dept. of Conserv. Tech. Bull. 2).

In the spring and early summer of 1966, at Fremont, Nebraska, I observed the re-use of old nests several times. In addition, I observed one Mourning Dove egg placed in an old nest. This one egg was never incubated.

On 6 May, a Robin (*Turdus migratorius*) nest had no eggs at 0555. At 0545 on 7 May, a Mourning Dove was sitting on one Robin egg and one dove egg. The Robin laid three more eggs but the dove was never seen at this nest site again. Three of four Robin eggs hatched but the dove egg was unhatched after 17 days. It was opened and appeared to have been infertile.

On 30 May, a Mourning Dove was discovered incubating one egg in a Robin nest. She had added no nest material to the Robin nest. The egg hatched and the young bird was fledged on 16 June.

On 5 and 6 June, a single Mourning Dove egg was laid in each of two different Catbird (*Dumetella carolinensis*) nests. These nests were approximately 200 meters apart and I suspect that the same dove laid both eggs.

On 5 June, a dove had laid an egg in one of the Catbird nests just after it was completed. She had added a few twigs of her own to the nest. The dove egg remained in the nest until 8 June when there were two Catbird eggs. I suspect that the Catbird removed the dove egg.

On 6 June, a dove egg was laid in a Catbird nest that had just been completed the previous day. It remained there for two days and then disappeared. Catbird eggs were not observed in this nest.

It may be that the Mourning Doves that laid these eggs had eggs in the oviduct before they had constructed a nest and used the first convenient site they could find.

These observations were made in connection with Red-winged Blackbird research supported in part by the Chapman Memorial Fund. I would like to thank James Linder, a student at Midland College, for bringing the one nest to my attention.—LARRY C. HOLCOMB, *Department of Biology, Creighton University, Omaha, Nebraska, 27 September 1966.*

Overlapping nestings by a pair of Barn Owls.—In February, 1961, a male Barn Owl (*Tyto alba*) was captured in a church spire in New Haven, Middlesex County, Connecticut. It was banded and returned to the tower after four weeks in captivity. In April a Barn Owl was incubating seven eggs in a corner of the room over the tower belfry. Five young were reared from this clutch, fledging in mid-August, after which the family left the tower.

In 1962 five eggs were laid between 8 and 17 April. Subsequent candling revealed that only three of these were fertile and only two hatched. Between 16 May, when I first saw the two young, and 4 July I made only brief visits. Usually both adults were seen (the male banded) but no attempt was made to capture them, as they invariably flew up inside the spire to perch on a small platform near the top. Light from a small glass window near the platform made them easily seen. On 4 July the older nestling displayed aggressively when I entered the tower. Both were running and jumping about, but were not able to fly upward.

The following day I returned to the tower, accompanied by Mr. Michael Trevor and Rev. Edward L. Duncan. The young were as aggressive as on the previous day, but were easily handled for banding. The only adult present, an unbanded bird which we assumed to be the female, did not fly up the spire but allowed itself to be captured rather easily. In contrast to the struggling, hissing young, this bird was docile when handled. When released, it flew to the perch inside the spire window and remained there.

Despite my assurance that his attempts would prove futile, Trevor insisted on searching the tower for possible eggs. To my chagrin, he located a clutch of four warm eggs in a hollow of the wall, eight feet directly over the original nest site. After ascertaining that at least one egg contained an embryo, we left the tower. On 11 July we returned, finding only a banded adult present. Where the four eggs had been, there was now only the empty cavity.

While there is no proof that the same female or even the same male owl was involved in the two 1962 nestings, there is less evidence that more than two birds were involved.

If three or four owls were occupying the tower concurrently one would have expected to find more than two birds present on at least some visits. Moreover, one might have expected a greater degree of overlap between the two broods if two pairs or two females were present.

Stewart (1952. *Auk*, 69:227–245) notes that Barn Owls have been found breeding in all months of the year, even in the northern part of their range. He cites a case of a pair in New York with young in late July and again in December. In this case the female was banded and was recaptured with the second brood. Wayne (1908. *Auk*, 25:21–24) pointed out that in South Carolina the eggs are often laid in September. The only case of overlapping broods known to me is that reported by Morejohn (1955. *Auk*, 72:298) from California. The situation was similar to that in the Connecticut birds: the first brood had been reduced, by non-hatching and nestling mortality, to one bird. Of the four eggs in the second clutch, one was opened by Morejohn and found to contain an embryo, and two of the remaining three hatched.

The above data suggest that in some parts of the United States individual Barn Owls are in breeding condition in all months of the year and that a pair may retain its breeding capability for a period longer than that found in most other large raptors. These characteristics facilitate the production of second broods, despite the four months required from egg laying to fledging in each brood. If the size of the first brood and the availability of food are such that one adult can provide food for both the young and the other adult, the second clutch may occasionally be laid before the first brood is out of the nest.—Peter L. Ames, *Museum of Vertebrate Zoology, University of California, Berkeley, California, 27 July 1966.*

A possible case of egg transport by a Chuck-will's-widow.—Audubon (1821. Ornithological Biography, I.) reported observing oral egg transport in the Chuck-will's-widow (*Caprimulgus carolinensis*). Although Audubon's account for the Chuck-will's-widow remains unconfirmed, Truslow (1966. *Natl. Geographic*, 130:882–884) has observed and photographed similar behavior in a Pileated Woodpecker (*Dryocopus pileatus*). Ganier (1964. *Wilson Bull.*, 76:19–27) dismissed Audubon's account as a fabrication, or possibly a ghostwriter's attempt to inject "novelty" into his writings. Ganier concluded that the lack of substantiating evidence for Audubon's observations was sufficient to refute the story and stated that "future authors should avoid its repetition."

In the late spring of 1966, I witnessed a sequence of events suggesting that efforts to discredit egg transport in Chuck-will's-widows may be premature. Unfortunately, I attributed no special significance to the observations (until I read Truslow's paper), and consequently, I failed to record dates and other pertinent details desirable in a published account.

My home near State College, Mississippi is adjacent to an 18-acre woods—predominantly pine with a mixture of young deciduous growth in the understory. A number of cleared paths traverse the woods and I walk them almost daily. In 1965, a Chuck-will's-widow nested near one path. On several occasions the female feigned injury by performing various antics in the path. No nest was observed.

In 1966 (about mid-May), I flushed a Chuck-will's-widow from a nest near the same area. The unprepared nest was 15 to 20 feet off the path on the forest floor which was matted with pine needles and deciduous leaves. I did not touch the two eggs. The next day, the female flew off the nest as I approached, but she remained on the nest when I walked by the following day. On the third day, I took my 5-year-old son to see the nest. When the female was not visible from the path, we approached the nest and found no young, eggs, or eggshells. I suspected that the young had hatched and moved away a short distance, or that a predator had devoured or removed the eggs. As we stood at the nest, my dog flushed a female from a site about 15 feet farther off the path. This nest also contained two eggs, and was similarly located, but partially concealed from the path by a small tangle of vines.

The terrain between the nests was level, but leaves, pine needles, sticks, and debris would have made rolling the eggs a difficult task. Although it is possible that there were originally two nests, one of which was destroyed, it seems unlikely that nests would be located only 15 feet apart. Furthermore, only one female was observed and only a single male called in the 18-acre woods during the spring and summer of 1966.

I related this incident to several persons at the time and expressed an opinion that the eggs had been moved by some means. The coincidence between my observations and those of Audubon is remarkable, to the extent that his statement provides a logical explanation for my own observations. At any rate, this incident justifies keeping the subject of egg transport in Chuck-will's-widows open to investigation.—Denzel E. Ferguson, *Zoology Department, Mississippi State University, State College, Mississippi 39762, 9 January 1967.*

Nest site movements of a Poor-will.—On 2 August 1965 the nest of a Poor-will (*Phalaenoptilus nuttallii*) was found in Little Valley, Nevada at an altitude of 7,300 feet. Little Valley is 25 miles south of Reno in the Carson Range. The nest, which was in a slight depression in pine needles and which contained two eggs, was on an east-facing slope. The dominant tree of the area is Jeffrey pine (*Pinus jeffreyi*), and the most common shrub of the immediate nest area is manzanita (*Arctostaphylos patula*).

In the course of taking daily weights of the Poor-wills I found that the nest site was frequently shifted. On 7 August the parent bird flushed, exposing the young, 14 feet west of the original site. On 8 August the young were found 20 feet north of site number two. The nest site was in the same place on 9 August but on 10 August the nestlings were found 35 feet west of site number three. On 11 August they were found 17 feet south of site number four. Because of inclement weather the nest area was not checked on 12 and 13 August, but on 14 August the nest was found 7 feet west of site number five. The bad weather persisted through 15, 16, and 17 August, and on 18 August the young birds could not be found.

This study was carried out at the University of Nevada Field Station in Little Valley.—Raymond N. Evans, *Biology Department, University of Nevada, Reno, Nevada, 31 October 1966.*

The amphirhinal condition in the Passeriformes.—The occurrence of the amphirhinal condition has largely been ignored by ornithologists. Many of the early avian anatomists mentioned it briefly, usually in reference to the suboscines. For example, Forbes (1881. *Proc. Zool. Soc. London*, 1881:435–438) stated that in *Conopophaga* the external nares are divided into an anterior and posterior opening by the ossification of the alinasal cartilages, but he placed little taxonomic importance on the character because of its seemingly spasmodic occurrence in other families. Von Ihering (1915. *Auk*, 32:150) proposed that the term amphirhinal be used to apply to the "style of skull structure in which instead of one large bony nostril we have two, a posterior and anterior one . . . ." He was referring to the condition of the nostril found in the members of the Formicariidae that he had examined. Since that time very little work has been directed towards documenting the occurrence of this character or determining its functional significance.

TABLE 1
OCCURRENCE OF THE AMPHIRHINAL CONDITION IN PASSERINE FAMILIES

	No. forms examined		No. amphirhinal	
Families	Genera	Species	Genera	Species
Dendrocolaptidae	10	23	2	2
Furnariidae	29	48	1	1?
Formicariidae	26	37	24	33
Conopophagidae	2	2	1	1
Cotingidae	14	24	8	11
Tyrannidae	73	129	21	30
Phytotomidae	1	2	1	2
Corvidae	17	39	2	2
Grallinidae	2	2	1	1
Timaliidae	7	11	1	1
Pycnonotidae	6	13	3	4
Chloropseidae	3	3	1	1
Vangidae	2	2	1	1
Laniidae	8	14	5	8
Prionopidae	2	2	2	2
Ploceidae				
Bubalornithinae	2	2	2	2
Passerinae	4	8	1	1
Ploceinae	3	17	1	7
Estrildinae	8	26	1	1
Thraupidae	27	69	1	1

While studying the Dendrocolaptidae and Furnariidae I was surprised to find the amphirhinal condition present in the woodhewer *Xiphorhynchus erythropygius,* but absent in the six other members of the genus that I examined, especially in view of the fact that the genus *Xiphorhynchus* (as delimited by Peters, 1951. "Check-list of birds of the world." Vol. VII. Cambridge, Harvard Univ. Press) is a rather uniform group with respect to other details of skull structure. In an attempt to learn the taxonomic distribution of this character I surveyed the passerine birds in the skeletal collection of the University of Michigan Museum of Zoology.

In Table 1 are listed the families that I examined that contain amphirhinal members. The sequence of families follows that proposed by Wetmore (1960. *Smithsonian Misc. Coll.,* 139). The following is a list of the families that I examined which contain no amphirhinal members. The first number in parentheses represents the number of genera examined, the second, the number of species.

Rhinocryptidae (2,2), Pipridae (6,14), Alaudidae (6,9), Hirundinidae (10,21), Dicruridae (1,4), Oriolidae (1,5), Ptilonorhynchidae (1,1), Paradisaeidae (1,1), Paridae (4,17), Sittidae (2,6), Certhiidae (2,3), Chamaeidae (1,1), Campephagidae (2,4), Cinclidae (1,2), Troglodytidae (9,31), Mimidae (10,20), Turdidae (16,58), Sylviidae (18,34), Muscicapidae (15,19), Prunellidae (1,1), Motacillidae (3,14), Bombycillidae (1,3), Ptilogonatidae (3,4), Dulidae (1,1), Artamidae (1,1), Cyclarhidae (1,1), Sturnidae (6,12), Meliphagidae (6,8), Nectariniidae (2,12), Dicaeidae (1,1), Zosteropidae (2,6), Vireonidae (2,17), "Coerebidae" (6,12), Parulidae (21,69), Ploceidae: Viduinae (3,4), Icteridae (18,42), Tersinidae (1,1), Fringillidae: Richmondeninae (12,24), Fringillinae (1,2), Carduelinae (14,36), Emberizinae (47,123).

The oropendolas and caciques of the Icteridae and the Cracticidae are excluded, for in these massive-billed birds it is impossible at present to state whether or not the condition of the nostril was preceded by the amphirhinal condition. In many cases several specimens of each species were examined, in other cases only one specimen was available. I found that in some species the amphirhinal condition may be present in some specimens, but not in others. I was unable to determine if an age factor is involved, but I suspect it may be, because in certain specimens a partially formed bony plate is present in the nostril that would represent the amphirhinal condition if fully formed. In some specimens preparation of the skull may account for the apparent absence of the amphirhinal condition, especially in soft-billed species. For these reasons, it is likely that some families listed here as lacking the amphirhinal condition will be found subsequently to possess it in some species.

The apparent parallel evolution of the amphirhinal condition in diverse passerine families probably indicates a potential for producing the character in all passerines. In fact, all that is necessary is the ossification of a cartilage. Of interest in this respect is one specimen of the ovenbird *Philydor rufus* which shows the nostril bounded by a membrane that has become partially ensheathed with bone; if ossification were completed this would represent the amphirhinal condition. Both available specimens of *Philydor lichtensteini* lack the condition. One specimen of the cotinga *Gymnoderus foetidus* shows no sign of the amphirhinal condition; in another specimen one side of the nostril has a condition very similar to that described above for the specimen of *Philydor rufus.*

The apparent ease with which the amphirhinal condition has arisen in so many passerine families, plus the fact of its occurrence in some species but not in others of reasonably well-defined genera is sufficient recommendation for extreme caution with its use, if any, in passerine taxonomy. Genera in which the amphirhinal condition is present in some species but not in others include *Xiphorhynchus*, *Cyanolyca*, *Garrulax*, *Lanius*, and *Passer.*

Detailed analysis of foraging behavior and of the forces acting on the bill might give a clue as to the function of the amphirhinal condition.

I am indebted to R. W. Storer and H. B. Tordoff for criticizing the manuscript, and to N. L. Ford and J. R. Jehl, Jr. for offering many helpful suggestions.—J. ALAN FEDUCCIA, *The University of Michigan Museum of Zoology*, *Ann Arbor*, *Michigan*, *27 September 1966.*

A Common Grackle learning to soak bread.—There is only a little information available on specialized feeding techniques learned by wild birds, and still less data on how these are acquired. This has prompted me to record the following observations made on a lawn in Chesterton, Indiana, in the spring of 1966.

In April and May, 1966, when a half dozen pair of Common Grackles (*Quiscalus quiscula*) were feeding on our lawn, we put out bread and water and grackles came regularly to eat dry bread, and to drink. But, our desultory watching gave no record of "dunking."

Then on 15 May 1966, I noticed a female grackle with white marks acquired from the newly painted wall of a neighbor's garage against which its nest was placed. The following itemized observations refer to this bird:

3:50 PM White-marked female ate dry bread; flew to nest.

4:00 PM White-marked female came, ate dry bread, swallowing with difficulty, and went to water. As she bent to drink, several crumbs fell from gape into water, apparently accidentally. She drank, then picked two crumbs from water and swallowed them; then walked back to bread, picked up a piece, walked back to water, dropped it in, and ate the wet bread; flew to nest.

4:10 PM Female came, carried a piece of bread to water, dropped it in, and ate it; then flew on to nest.

4:30 PM Female came, drank, walked over to bread, carried a piece to water, dropped it in, picked off pieces; after eating about one-half of piece, female flew back to nest.

5:00 PM Female returned to food, ate part of dry bread but too hard to manage and abandoned it; got another piece, ate it dry; walked to water, drank, flew to nest.

There is no doubt what happened. The following interpretation is possible. The grackle was in the habit of feeding on dry bread and drinking. By accident it found dropping bread into the water made it easier to swallow. This association was utilized immediately, and was used in two following periods of feeding, about 10 and 20 minutes apart. At the next feeding period, 30 minutes later, the association had been lost.

Some six or eight other grackles, males and females, came to feed on the bread and to drink during this same period and some were there while the white-marked female was "dunking" bread. At 4:35 three grackles found the bread left in the water by the white-spotted female at 4:30 and ate it greedily. But, no other bird dunked its bread. Can it be that the habit of dunking bread, a fairly common, but irregularly used one of grackles is a matter of learning by each individual? The general habits of the birds would make the acquiring of such a specialized feeding technique an easy step. The sporadic use of the technique would support this view that each learns it.—A. L. RAND, *Field Museum of Natural History, Chicago, Illinois, 29 September 1966.*

Prealternate molt in the Summer Tanager.—One of the most useful qualities of the method of study of molts and plumages introduced in 1959 (Humphrey and Parkes, *Auk*, 76:1–31) has proved to be its predictive value. It has been possible to find molts, previously unreported, whose presence in a sequence was deduced from sequences of related forms. For example, we have encountered, thus far, no bird species with two definitive ("adult") plumages per cycle which does not also have two corresponding plumages in its first year. The discovery of the "missing" first alternate plumage of the Great Blue Heron (*Ardea herodias*) is described in our later paper (1963. *Auk*, 80:500). Equally, we know of no species which has a prealternate molt in its first year of life, but never thereafter. A plumage sequence of this type has been alleged to occur in some genera of Icteridae (*Cassidix*, *Molothrus*), but the limited prealternate molt of adults of these birds had simply been overlooked (A. R. Phillips and R. W. Dickerman, MS.).

The seasonal change of plumages of males of the Scarlet Tanager (*Piranga olivacea*) is highly conspicuous, with a prealternate molt involving the exchange of greenish for bright red body feathers. Males of its close relative, the Summer Tanager (*P. rubra*), however, never lose their pinkish red color once it has been attained at the first prealternate molt. Dwight (1900. *Ann. New York Acad. Sci.*, 13:223) described in detail the "partial prenuptial moult" (= first prealternate molt) whereby the greenish or yellowish "first winter" (= first basic) plumage of Summer Tanager males is replaced by red feathers of the "first nuptial" (= first alternate) plumage. Dwight, however, went on to say that the "adult nuptial plumage" is "acquired by wear which is not very perceptible even on close examination of the feathers. . . There appears to be no second prenuptial moult in this species."

This concept, of a prealternate molt confined to the first year, has been repeated without question in all of the subsequent literature of the Summer Tanager, culminating in the account by Bent (1958. *U.S. Natl. Mus. Bull.* 211:499–500), who quoted much of Dwight's description verbatim more than half a century after its original publication. It is perhaps understandable that Dwight, in 1900, had insufficient material available to permit demonstration of the prealternate molt of adult Summer Tanagers. Oddly, no subsequent author seems to have bothered to check the now abundant material of this species taken on the wintering ground (chiefly South America), where the prealternate molt does, in fact, take place.

The present note is based on a study of the eastern race, *Piranga r. rubra,* of which ample material was available to me, well distributed both geographically and seasonally. A similar study of the western *P. r. cooperi* would be more difficult, as the breeding and wintering ranges overlap, and the breeding season of the more southern populations in Mexico may be expected to be rather different from those in the southwestern United States. All specimens mentioned are in the collection of Carnegie Museum.

Dwight (loc. cit.) properly emphasized the variability of the extent of the first prealternate molt, by which the male attains his first red feathers. This molt may involve all of the feathers except the primaries, or may be confined to isolated patches on the head, breast, mantle, upper tail coverts, etc. There is, of course, a fundamental misunderstanding involved in the statement by Burleigh (1958. "Georgia Birds," Univ. of Oklahoma Press, p. 606) that "Occasionally an individual will be seen that has failed to acquire this adult plumage after the post-juvenal moult, and presents an odd appearance, the back and underparts being patched with rose-red and olive green." Birds of this aspect are commonly, not "occasionally" seen (as quickly evident by a glance at any museum tray of Summer Tanagers), and the "adult plumage" is acquired at the second prebasic ("first postnuptial") molt rather than "after the postjuvenal moult."

The patchy appearance of the first-year males seen in the United States in spring is misleading. Although (for example) the figure presented by Eaton (1914. *New York State Mus. Mem.* 12, pt. 2:pl. 87) is captioned "changing male," active molting has *ceased* by the time most migrants have reached the southern United States, in late March or early April. Examination of a series of 38 first-year spring males failed to show any evidence of active molt in the form of sheathed feathers after the end of March. The peak period of molt is probably February to early March. A 27 February and a 17 March specimen, both from Colombia, are superficially similar in appearance with respect to relative amount of red present. The earlier bird, however, has many and the later bird few incoming feathers, suggesting that the February-taken bird would ultimately have become the redder of the two.

The prealternate molt of adult males is naturally much less conspicuous than that of first-year males, simply because the incoming feathers are the same color as the surrounding old ones, which are normally relatively little faded or worn. Specimens examined suggest that the prealternate molt of adults is also highly variable in extent but probably never involves as many feathers as in the extreme cases among first-year birds. Dates of collection of eight molting adult males from Costa Rica, Colombia and Venezuela are as follows: 22 December, 12 January, 24 January, 3 February, 6 March, 11 March, 12 March, and 16 March. In none of these is there any sign of molting of flight feathers; pinfeathers are usually most easily demonstrated on the crown, but also appear on back, throat, and breast. Even the earliest of these dates is far too late for the incoming feathers to represent the last of the prebasic molt, which takes place principally in August but may begin as early as 15 July (specimen from Takoma, Maryland).

Of female Summer Tanagers, Dwight (loc. cit.) states: "The plumages and moults correspond to those of the male, but the plumage remains similar to that of the male in first winter and the first and only prenuptial moult is mostly suppressed. Adult females may be red tinged, but regularly they are even yellower than the male in first winter dress." Roberts (1932. "The Birds of Minnesota," vol. 2, Univ. of Minnesota Press, p. 697) even goes so far as to state not only that the "prenuptial" molt of males is confined to the first year, but that even this first-year molt is absent in females.

First-year female Summer Tanagers may be recognized as such by their more pointed rectrices and brownish or grayish rather than greenish tertials. Examination of specimens reveals that, just as in males, both age classes of females undergo a prealternate molt on the wintering ground. Four adult females with sheathed incoming feathers were collected as follows: 20 January (Colombia), 23 January (Venezuela), 24 February (Venezuela), and 5 March (French Guiana). Molting first-year females were collected in Colombia on 22 January, 12 February, and 23 February, and in French Guiana on 26 January. The latter specimen is not only in heavy body molt, but is replacing rectrices. It and several other very reddish females show that Dwight was incorrect in believing that only "adult" females of this species are red tinged; reddish feathers may often be attained at the first prealternate molt. Those females with the most extensive prealternate molt are frequently those with the reddest, or most "masculine" plumage, suggesting a hormonal relationship between these two variables.

In summary, in spite of long-repeated statements to the contrary, both first-year and adult birds of both sexes of the eastern subspecies of Summer Tanager (*Piranga r. rubra*) have a highly variable partial prealternate molt, taking place on the wintering ground between late December and late March.—KENNETH C. PARKES, *Carnegie Museum, Pittsburgh, Pennsylvania, 29 September 1966.*

CORRECTION

Vol. 79, page 342, line 19 should read, ". . . . Chuck-will's-widow was a nearly intact male Cape May Warbler (*Dendroica tigrina*). Only . . ."

THE PRESIDENT'S PAGE

As we reported in the September *Bulletin*, Roger Peterson found that the scheduling of a trip which he is committed to lead will make it impossible for him to attend the Carbondale, Ill., meeting to be held during 2–5 May 1968. Thus, Dr. Peterson will be unable to serve as Chairman of the symposium on the preparation of state bird books, whose organization he was so enthusiastically planning. We shall miss him.

Nevertheless, the symposium will go on as planned. And all of us will be delighted to know that an excellent man, Chandler S. Robbins, has agreed to serve as Chairman of this important feature of the Carbondale meeting. Mr. Robbins' qualifications for this assignment need no elucidation among North American bird students. I will mention one point of particular relevance: the fact that Mr. Robbins is a co-author of the highly esteemed "Birds of Maryland and the District of Columbia."

While we have referred to the proposed discussion of state bird books as a "symposium," I learned during a conversation with Mr. Robbins that it may not be such in the usual, formal sense. Rather, he may organize a panel discussion in which the participants will express their opinions on various aspects of state bird books which are of special interest both to the authors who write them and to the rest of us who read and use them.

What this means is that, to a greater degree than is usually the case, all of us can contribute to the success of the symposium, or panel discussion, by suggesting to Mr. Robbins the particular aspects of state bird books which we should like to see discussed. What do you look for, in particular, in such a book? What should be the emphases of future books of a state, provincial, regional, or national nature?

This is to urge, therefore, that, between now and next May, members send in suggested topics for discussion, about state bird books, to: Mr. Chandler S. Robbins, Migratory Bird Populations Station, Laurel, Maryland 20810.

Here is a unique opportunity for each of us to make a contribution towards the success of an annual meeting of our Society.

AARON M. BAGG

LOUIS AGASSIZ FUERTES RESEARCH GRANTS

These grants, established in 1947, are devoted to the encouragement and stimulation of young ornithologists. One particular desire is the development of research interests among amateur ornithologists. Any kind of ornithological research may be aided. Recipients of grants need not be associated with academic organizations. Each proposal is considered primarily on the basis of possible contributions to ornithological knowledge.

An anonymous donor gave $500 to found the fund; later donors have provided additional money. The Council of the Wilson Ornithological Society has added funds as necessary to provide at least one $100 grant annually. Two grants were made in 1966 and again in 1967.

Although grantees are not required to publish their studies in *The Wilson Bulletin*, it is hoped that they will submit their manuscripts to the Editor of the *Bulletin* for consideration.

Since its inception, the Fuertes Research Grant has been awarded to 24 persons, many of whom have continued their research work.

Application forms may be obtained from Harrison B. Tordoff, Museum of Zoology, The University of Michigan, Ann Arbor, Michigan 48104. Completed applications must be received by 1 March 1968.

ORNITHOLOGICAL NEWS

On 15 September Roger T. Peterson, the immediate Past President of the WOS, was awarded the first Arthur A. Allen Award by Cornell University for distinguished service to ornithology.

First Vice-President H. Lewis Batts was honored with an American Motors Company Conservation Award for his efforts in establishing the Kalamazoo Nature Center. The Kalamazoo Nature Center won one of the four merit awards given in 1967 by the Soil Conservation Society of America.

George M. Sutton was one of eight persons honored by induction into the Oklahoma Hall of Fame on the occasion of the state's 60th birthday on 16 November 1967.

The International Council for Bird Preservation has announced that the Pan-American Section of the Council will meet during the week of 18–24 March 1968 in Caracas, Venezuela. Details about the meeting can be obtained from: Comisión Organizadora, Reunión PANAM-CIPO '68. Sociedad Venezolana de Ciencias Naturales, Apartado 1521, Caracas, Venezuela.

The classic ornithological spoof, "*Eoörnis pterovelox gobiensis*" by A. C. Fotheringham is once again available for $1.10 post paid in the U.S. and Canada and $1.25 elsewhere from G. E. Watson, 2621 O Street N.W., Washington, D.C. or R. C. Banks, 3200 Curtis Drive, Washington, D.C. 20031.

The Eastern Bird Banding Association is again sponsoring a $100 award for student research (graduate or undergraduate) in ornithology that includes bird banding as a part of the research. Applications must be received prior to 29 February 1968. Details are available from F. R. Scott, 115 Kennondale Road. Richmond, Virginia.

It is a pleasure to announce the addition of Dr. Glen E. Woolfenden of the University of South Florida, Tampa, as a new member of the Editorial Board of the *Bulletin.*

The preparation of a volume of a journal such as *The Wilson Bulletin* is a cooperative effort on the part of many people and the Editor wishes to express his thanks at this time to all those who participated in the production of Volume 79. Besides the authors of the papers and reviews (approximately 100 in number), 21 ornithologists reviewed papers and offered comments or criticisms. The members of the Editorial Board, whose names appear on the back cover, in addition to reviewing papers served as never-failing sources of information for the Editor. President Aaron Bagg, and Past Secretary P. B. Hofslund contributed help in a variety of ways. Once again the tedious job of preparing the index was carried out by Miss Mildred Stewart. I would like also to add a word of thanks to the many members who took time out to send me comments about the *Bulletin.* These have been very helpful, and while it has not been possible to answer each of these personally they nevertheless have been greatly appreciated.—G. A. H.

ANNUAL REPORT OF THE CONSERVATION COMMITTEE

President Aaron M. Bagg's address at the Crawford Notch meeting stressed the responsibility of ornithologists in the defense of our common environment and was good orientation for the report of the Conservation Committee. As Mr. Bagg said, "what we do to the environment we do to man himself."

This statement is part of a new wave of awareness that the scientist must accept some responsibility for the use of his data, as so well expounded by Dr. Barry Commoner in a small but important book, "Science and Survival," published in 1967 as an outgrowth of the deliberations of the American Association for the Advancement of Science's committee on the role of science in human affairs. The Wilson Ornithological Society's role should, and can be an expanding one in informing citizens and legislators and other groups of the need for studying the interrelationships of living things and their environment and the implications of applying our technology to the out-of-doors.

One attempt to make the voice of science effective, in this case through the judicial process, is the legal action brought by Victor J. Yannacone, Jr., to bar the use of DDT by the Suffolk County (Long Island, N.Y.) Mosquito Control Commission, because the use of so long-lived an insecticide leads to poisoning ecosystems and depleting populations, particularly those at the ends of long food chains. A temporary injunction granted on 15 August 1966, has continued in force, a one week trial presented the pros and cons of the scientific evidence, and the court has withheld judgment on the constitutional issue raised although it agreed that the use of DDT should be barred because of its effects in the environment. The National Audubon Society has published the transcripts of this hearing, together with pleas, etc., and copies of this 400-page volume are available for $15.00 each from the Society's New York office.

The Torrey Canyon disaster off the southwest coast of England that loosed 118,000 tons of crude oil in the Atlantic Ocean and the English Channel in March was the most dramatic conservation challenge of the year. Sweeping across the Channel, the oil pollution killed 90 per cent of the nesting alcids of the Brittany Coast in France, and no estimate of the loss of British sea birds was possible. Of some 7,000 birds rescued and put through a cleaning process by volunteers in England, less than 500 survived. A great and continuing out-pouring of suggestions for coping with such disasters, whether by detergents or jelling substances, or otherwise, overlooked the fact that present regulations lack teeth and the imposition of fines high enough to induce adequate care to prevent a repetition of such blundering, or perhaps even halt the trend to larger and larger tankers which makes accidents increasingly difficult to cope with. Mr. James Baird of the Massachusetts Audubon Society pointed out that a challenge of perhaps similar proportions faced the United States in connection with recent requests for permits to exploit the oil-bearing strata underlying George's Bank off Cape Cod, Mass., where 70 per cent of our fish food supplies come from.

The back-up approach to Whooping Crane conservation got off to a good start this spring. U.S. and Canadian wildlife biologists found eight occupied nests in the Wood Buffalo Park area, took six eggs by a quick descent from helicopters, and flew the eggs in specially designed, heated carrying boxes to the Patuxent Wildlife Research Center, Maryland. One egg hatched en route and the chick died. Another young died shortly afterward, but five young birds now form the nucleus of a new captive flock. Of equal importance, surely, is the return of all parent birds to their nests after having been robbed of that one egg of their double clutch which they were unlikely to fledge in any rate. Disturbance thus appears to have been minimal (see editorial of The Threatened Species Program, *Audubon Mag.*, May–June, 1967).

In April the Ohio Farm Bureau succeeded in getting the agricultural establishment to call a North American Conference on Blackbird Depredation at Columbus. The drive for agricultural efficiency (measured solely in return on dollar invested) is obviously in conflict with birds that are attracted to feedlots and crops grown in the wrong place, and certain of the more aggressive farmers are impatient with the conservative approach of the U.S. Fish and Wildlife Service in providing "control" and would like to see this operation shifted to the U.S. Department of Agriculture. This demand, to suit the convenience of individual producers, is part of that federal-private combination economist Galbraith calls the technostructure and is thus subject to the serious scientific shortcomings Professor Commoner warns about. The Congress, fortunately, moderated the dispute by appropriating $800,000 for a program centering on the establishment of a field research station in Ohio. As this report went to press, however, at least one Congressman was attacking the appropriation as an unnecessary luxury in view of impending tax increases proposed to counterbalance the Vietnam War outputs. Whether or not the research station is built, ornithologists had better keep a wary eye on the control establishment.

In March the National Audubon Society spearheaded a civil suit against the U.S. Army Corps of Engineers to prevent the "pulling of the plug," in Canal 111 where this crosses U.S. Route 1 below Homestead, east of Everglades National Park. It was insisted that this section of Route 1 should not be excavated until suitable barriers have been built in the canal to prevent salt water intrusion into the Park.

In May it was learned that the Corps of Engineers had directed its Jacksonville office to provide Everglades National Park with fresh water on "a basis parallel to the requirements of municipalities, industry and agriculture." No copies of the directive were provided other agencies or conservation organizations, but if the above paraphrase is at all accurate, the Park has to all intents been assured an equal diminishing share of the water it needs to keep it viable. What must be done is to give the Park priority until its minimum needs have been met.

In southwest Florida, the National Audubon Society had to purchase nearly four sections of wetlands, at a price of $650,000, to protect its famous Corkscrew Swamp Sanctuary against drainage by land speculators: and in Texas, conservationists, led by Congressman Bob Eckhardt of Houston, opposed the granting of permits to dredge the oyster reefs of Galveston and Trinity Bays. Legislation (H.R. 25 introduced by Congressman John Dingell) to prevent wasteful dredging of estuaries was compromised in early July when the Army Corps of Engineers and the Department of the Interior entered into a Memorandum of Understanding which would give Interior the privilege of reviewing all applications for dredging permits in estuarine waters. Conservationists immediately pressed Secretary Udall's office with examples of projects needing review, and the Bureau of Sport Fisheries and Wildlife made the Galveston Bay problem its first test case.

Of growing concern to many of us is the burgeoning trade in imported wild species for the pet trade. Hummingbirds from South America bring $50 and up in a Denver pet shop, and hordes of individuals of scores if not hundreds of species seem available to anyone willing to pay the price. This is commercial exploitation that rivals the plume trade of the turn of the century. California, a principal port of entry, is reviewing its laws and regulations, and it is hoped that this review may give the nation a new perspective on a problem created by the advent of inexpensive air freight.

WOS Conservation Committee

Roland C. Clement, Chairman, Wm. H. Drury, Jr., Richard L. Plunkett

ORNITHOLOGICAL LITERATURE

The Birds of Canada. By W. Earl Godfrey. National Museum of Canada Bulletin No. 203, Biological Series No. 73, Ottawa, 1966: 8½ × 11 in., 428 pp., 69 col. pls. by John A. Crosby, many line drawings by Stewart D. MacDonald, 2 endpaper maps, 380 small distributional maps. $12.50. (Checks should be made out to the Receiver General of Canada and order mailed to the Queen's Printer, Ottawa.)

Many of the most exciting days of my life have been lived in Canada. Icebergs, seals, fulmar petrels, and shearwaters "down north" along the Labrador; treacherous "white water," with long portages to match, along the Abitibi and the Missinaibi; vast mudflats and a skyful of wavies at the south end of James Bay; Eskimos, husky dogs, walruses, and polar bears on Southampton Island; clouds of mosquitoes and brown muskeg water at Churchill; Black Oystercatchers and a dripping jungle of salal at the north end of Vancouver Island; Clark's Nutcrackers, mountain goats, and hoary marmots in high country near Red Pass, British Columbia; ocean whirlpools in Richmond Gulf and Frobisher Bay; bands of caribou at Amadjuak; cliffs towering above the ocean ice along the north coast of Victoria Island; Solitary Sandpiper eggs in a waxwing nest near Rocky Mountain House, Alberta; recently hatched Knots on Jenny Lind Island; Ross's Geese circling over their nests in the Perry River district south of Queen Maud Gulf—all these have been part of my experience during the past fifty years. Memories of them are vivid and important. Small wonder that I open so eagerly this new "Birds of Canada" with its eye-catching jacket photograph of an Arctic Tern. The picture itself rouses memories—of a newly hatched baby tern crouched on the sand, of an irate parent directly above me, and of blood enough on my forehead to convince me that I was not wanted there.

Except for the somewhat surprising omission of habitat photographs, Earl Godfrey's book is no disappointment. Most of the 518 species covered are exceptionally well illustrated in color. Three forms considered full species in the A. O. U. Check-list of North American Birds (1957)—the Blue Goose, Black Brant, and Harlan's Hawk—are believed by Godfrey to be conspecific with the Snow Goose, Brant, and Red-tailed Hawk, respectively; one form, Thayer's Gull, which the Check-list considers a race of Herring Gull, Godfrey believes to be a full species. For each of 380 species there is a good map showing breeding distribution in red. Species writeups, each with measurements and a discussion of field marks, habitat, nesting, over-all range, range in Canada, and subspecies found in Canada, cover the ground effectively. Maps prepared by the Surveys and Mapping Branch of the Department of Mines and Technical Surveys in Ottawa serve as endpapers. The map at the front gives the position of hundreds of localities—though I look in vain for Killinek and Indian Harbor on the Labrador, for Masset on the Queen Charlotte Islands, and for Taylor Island, off the eastern end of Victoria Island, place-names which are important ornithologically. The map at the back shows the distribution of forest regions, grassland, and tundra. The treeline merits careful study. The fact that forest extends northward to the mouth of the Mackenzie has long been known and documented; but the "fingers" of forest extending almost to the Arctic Ocean along the Anderson and Coppermine rivers, the "island" of forest along the Thelon River, and the straight, southwestward-pointing "finger" of forest along the Leaf River, between the head of Ungava Bay and the east coast of Hudson Bay, have received comparatively little attention in ornithological literature. Maps giving in detail the breeding distribution of such hardy woodland species as the Boreal Chickadee, Ruby-crowned Kinglet, and Pine Grosbeak probably would show some or all of these "fingers" and "islands."

The parts of the book headed "Range in Canada" must have involved a staggeringly large amount of work. I have not gone over much of this material in detail, for checking many records would be impossible without visiting the National Museum of Canada, where "the source of any particular distributional or other data" is available (p. 7); but the records for certain species in which I have long had special interest (e.g., Snow Goose, Marbled Murrelet, Yellow Rail, Le Conte's Sparrow) are thoroughly covered. The nesting habits of the Marbled Murrelet continue to be virtually unknown despite the finding of full-formed eggs in oviducts, of flightless young, and of "an adult with a broken partly-incubated egg in debris of a felled tree," and "numerous observations of adults carrying food inland" (p. 200). Another puzzling bird is the large, dark form of White-fronted Goose, *Anser albifrons gambelli*, possibly a full species rather than a race of *A. albifrons*, which has been "recorded from Mackenzie Delta, Repulse Bay, and the arctic coast east of Fort Anderson" but whose "breeding range remains to be found" (p. 52).

The small distributional maps are an invaluable feature of the book. Very few persons are familiar enough with the Canadian Arctic Archipelago to remember at all accurately where the many islands are, so limits of distribution as set by long lists of place-names (islands, trading posts, missions, weather stations, Dewline stations, etc.) might be difficult indeed to work out, even with the best of maps at hand for reference. In this connection, consider for a moment the breeding distribution of the jaegers. How easy it is, using the maps, to see that the Long-tailed species is decidedly the most northward-ranging; that the Parasitic is the most southward- and eastward-ranging; that the Pomarine, despite its being the heaviest and supposedly the "toughest" of the three, is considerably the most restricted in its summer distribution. How utterly impossible it would be, using place-names only, to convey these concepts promptly! Incidentally, my own experience with the Pomarine Jaeger leads me to suspect that from time to time, depending largely, perhaps, on the abundance of lemmings, it may nest in many areas not marked with red on the map (p. 171).

Comparison of maps pertaining to certain well-known birds may bring surprising facts into focus. Take, for example, the Least and Semipalmated sandpipers, new world forms which breed almost literally side-by-side throughout a considerable northern part of continental North America. The breeding-habitat requirements of the two must be much the same, yet a glance at the maps (pp. 155, 160) instantly reveals that the Semipalmated breeds northward well beyond the northern limits of the other. Is the Semipalmated therefore the hardier? The answer to this question might be an unequivocal *yes*—were reproductive success at high latitudinal limits-of-breeding the only possible criterion. But observe that in Oklahoma the Least Sandpiper has been recorded repeatedly between 21 December and 1 March (specimens taken 15 January 1955, 26 February 1955, 26 February 1961), whereas there are few sight records for, and not a single specimen of, the Semipalmated Sandpiper for the same dead-of-winter period. My own feeling about this discrepancy is that although the nesting-habitat requirements of the two species are much the same, the winter-habitat requirements may differ considerably.

Puzzling indeed is the fact that although there are several acceptable old world records for the two scolopacids just discussed there are few, *if any*, new world records for the Little Stint (*Erolia minuta*), only two (one of them unpublished) for the Longtoed Stint (*E. subminuta*), and only one (unpublished) for Temminck's Stint (*E. temminckii*). Here I cannot dispel suspicion that all three have been taken from time to time in America but that the specimens have been misidentified. In any event we find no mention of them in this compendious work; nor do we find a record for the Ringed Plover (*Charadrius hiaticula*) from any locality south of the much-restricted new world part of that species' breeding range (pp. 131–132). At this point I must make clear that Godfrey considers the Ringed Plover and Semipalmated Plover (*C. semipalmatus*) distinct species.

Among the many surprises afforded by the maps are the red spots indicating small discrete breeding populations far removed from the principal breeding areas. See, for example, the Northern Mockingbird map (p. 292) with its red spots scattered from southern Alberta to easternmost Newfoundland; the Clay-colored Sparrow map (p. 393) with its red spot in southwestern Quebec; the Field Sparrow map (p. 395) with its red spot in southern Manitoba; and the Brown-headed Cowbird map (p. 361) with its red spot at the mouth of the Great Whale River on the east coast of Hudson Bay. Well may one wonder whether these small populations are truly discrete. The point of my comment is not, however, that future work may show them to be not wholly discrete after all, but rather that the maps present so effectively the facts as these are known today.

So very useful are these distributional maps that I am tempted to comment—in a way which may sound like adverse criticism, though it is not intended as that at all—on what a *magnum opus* of this sort might accomplish. Scores, literally scores, of these small distributional maps chop the poor birds off at the Alaska international line in a way which is downright painful to the zoogeographer. Might it not have been possible to combine forces in such a way as to map the distribution of species throughout the whole of northern America? The part titled "range" in each species writeup covers this ground, to be sure, but words lack the direct power of maps—as I have said above. Leaving Alaska (and Greenland) out is an unfortunate by-product of nationalism which should be foreign to scientific investigation. Were this book about a single province or island, or about, say, eastern Canada or western Canada, the omission of Alaska and Greenland would seem less glaring; but as the maps stand they seem to say only part of what they really ought to say. Canadians will counter with the statement that Canada was footing the bill. Godfrey will argue, and justifiably, that including Alaska and Greenland would have tripled the work. Well, might not the money and the man-power to help have been found in the United States and in Denmark?

Zoogeographically considered, the important lines are almost never political; they are tree-lines, soil-lines, permafrost-lines, continental divides, and the like. The distribution of birdlife in the far north has interested me deeply for a long time. As I examine these excellent, these truly inspiring, maps, I cannot help feeling that rather than showing what is known about bird distribution in the governmental entity called Canada they should declare the universality of the forces which determine bird distribution throughout a vast and important northern part of the world.

Finally, some comments on the color plates and the other bird drawings. John A. Crosby, whose work is quite new to me, has obviously paid very close attention to the facial expressions and feather-patterns of living birds and to the colors of their fleshy parts. His choice of background tones and accessory material deserves special praise. The stippled paper on which he drew the sandpipers of Plate 27 is wonderfully effective as background. So exquisitely done are the eleven "peeps" shown on this plate that I find myself turning to them for refreshment and inspiration. They form a remarkably convincing *ensemble*. So satisfying are the individual birds that one does not worry about the mixup of seasons they represent, or about the laws of perspective which might *force* the figures at the top to be smaller than those at the bottom. The two species figured at the top are actually the smallest of the six shown, so the general effect is pleasing and accurate. The more I study the plate the more certain I am that the arrangement of bird-figures was no accident. Plate 27 is the work of a genius.

A quality possessed by the plates as a whole is their freshness, their freedom from any straining for effect. As one studies them one does not feel that the artist has tired of his subject matter, or become "fed-up" with the problems of artificial arrangements, pieces of branches, patches of forest, etc. The simple profiles are not monotonous because they are profiles of living birds. The way in which water, dead leaves, and bits of debris have been "whisked in" is, in my opinion, remarkable.

The engravers and printers deserve much credit for their part in producing these fine plates. I call attention particularly to the Yellow-breasted Chat on Plate 59. Here the yellow of the breast is perceptibly richer in tone than that of the yellowest parts of the other warblers shown in the same plate. The color is precisely as it should be; what is noteworthy is that artist, engraver, and printer have so successfully collaborated as to do this beautiful bird full justice.

Crosby will not resent my calling attention to certain shortcomings. Heavy birds such as the Band-tailed Pigeon in Plate 37 should not be shown at the very tip of a twig so slender that it would sag, thus forcing the bird to flutter in maintaining a foothold. Woodpecker feet should be drawn with great care, for the functional beauty of the powerful toes is something no artist should miss. In four-toed woodpeckers the hallux (first toe) is, according to my observations, invariably the shortest; the inner is somewhat the shorter of the two front toes; and the outer of the hind toes is about as long as, but never shorter than, the outer front toe. In Crosby's adult male Yellow-bellied Sapsucker (6a in Plate 42) the hallux is far too long and the outer hind toe far too short; in the Red-bellied Woodpecker on the same plate the inner front toe is much too long and the outer hind toe much too short. In the Horned Lark and Skylark (Plate 50) the hind claws should be only slightly curved. Straightness of the long hind claw is a dependable family character throughout the Alaudidae.

Stewart D. MacDonald's drawings add pleasing variety. Values in the two meadowlark heads (Fig. 67) are not consistent. We read as yellow the dark tone of the chin and throat, yet the same dark tone, as used on the top of the head, is restricted not to the yellow forepart of the superciliary, as it should be, but to brown parts of the crown and auriculars. In all adult Pomarine Jaegers that I have handled, the two middle rectrices "twist" in opposite directions in such a way as to give the tips of the feathers a "roofed" arrangement (Fig. 52). In both the Brown Creeper (Fig. 63) and Bobolink (Fig. 66) the tail has twelve rectrices rather than ten. The line drawings showing the modification of the sternum in the Whistling and Trumpeter swans (Figs. 17 and 18), the drawings of the foot of the Ruffed Grouse in winter and in summer (Fig. 43), and the drawing of the outermost primary in the Whimbrel and the Eskimo Curlew (Fig. 49) strike me as being especially well done.—GEORGE MIKSCH SUTTON.

THE BIRDS OF GUYANA (formerly British Guiana): A CHECK LIST OF 720 SPECIES, WITH BRIEF DESCRIPTIONS, VOICE AND DISTRIBUTION. By Dorothy E. Snyder. Peabody Museum, Salem, Massachusetts, 1966: 5⅛ × 7¾ in., 308 pp., endpaper map. $6.00.

The main value of this small book is that it gives a complete list of the birds of Guyana. This was long overdue as nothing of the kind has been published since Charles Chubb's monumental two-volume work, "The Birds of British Guiana" (London, 1916, 1921). The records seem to have been compiled carefully and critically and are based mostly on specimens, though this is not always quite clear. We should have liked more definite data—e.g., on the ibises of the genera *Theresticus, Cercibis,* and *Phimosus,* as there has been some confusion in their identification by some authors.

The lack of regular field observations is apparent in the case of many waders. The records certainly do not give a true picture of the actual situation.

The short descriptions will be valuable in identifying the more "easy" species, but those of certain flycatchers and antbirds, to mention only a few, will hardly help the field observer. However, we cannot blame the author for this because even the experts with specimens before them make sometimes contradictory identifications.

There is also a special section on "voice" which will be especially useful for the English-speaking readers of the book. For this reviewer who "hears in Dutch" it was once more evident that the method of rendering bird songs and calls in words or phonetics is impractical. I tried all the songs and calls of the species with which I am familiar, but I failed to recognize practically all of them as presented in the book. I fear that it will be even worse for readers who speak the Latin languages.

The bibliography at the end of the book contains a number of publications scarcely relevant to the subject. One would have wished for a complete bibliography of the ornithology of Guyana.

For such a small book without illustrations, its price is high.—F. HAVERSCHMIDT.

BIRDS IN OUR LIVES. Edited by Alfred Stefferud. U. S. Department of Interior, Bureau of Sport Fisheries and Wildlife, Washington, D. C. 1966: 8 × 11 in., xiii + 561 pp., 1 col. pl. and 80 wash drawings by Bob Hines, 372 photos. $9.00 (for sale by the Superintendent of Documents, Washington, D. C.).

This elaborate book is the second effort of the Bureau of Sport Fisheries and Wildlife to make available for the general public a semi-technical publication on North American wildlife, the first having been the 1964 publication, "Waterfowl for Tomorrow." Many readers will recognize the ancestry of the present volume in the popular "Yearbooks of Agriculture" sponsored over the years by the Department of Agriculture. The general format as well as the method of presentation of the subject matter are very similar, and it comes as no surprise to learn that Editor Stefferud had also served as editor of the Yearbooks.

Following a foreword by Secretary of the Interior, Stewart Udall, and an editor's preface, the main portion of the book consists of 54 chapters divided under nine topical headings: In Perspective, Literature and Arts, Sports and Recreation, In Nature's Scheme, Science and Husbandry, The Hand of Man, For Better or Worse, Answers to Conflicts, and For Their Survival. A total of 61 authors contributed to the work and a listing of their names reads like a Who's Who in modern ornithology, conservation, and wildlife management.

There is hardly a subject that even lightly touches on birds that is not included. The reader is treated to a wide gamut of interesting reading on such things as the use of birds on postage stamps and coins, as well as other artistic representations; the references to birds in the Bible and other literature; aspects of aviculture; falconry, waterfowl hunting, and such bird-watching sports as Christmas Counts, as well as such fundamental topics as bird biology, ecology, conservation, and management. The level of presentation is directed towards the general reader who may wish to learn something about birds. If he is not floored by the encyclopedic nature of the book this reader can learn an awful lot from this book. It would seem to have attained its general purpose very well, but one does wonder how many of those for whom the book was intended will accept the offering.

There is some unevenness about the various chapters, and while most of them deal adequately with their topics a few seem hardly worth including. To my mind the most effective chapters are the three introductory ones: "What Are Birds For?" by Roger Tory Peterson; "Masters of the Air" by Olin Sewall Pettingill, Jr.; and "Birds and Science" by Ernst Mayr. The chapters on conservation by Roland Clement and John Aldrich are also effective. As might be expected most of the chapters on management are devoted to some of the specific problems with which the sponsoring Bureau is currently concerned, some of which are only of transitory or minor importance.

I have two major criticisms of the book. Despite the many chapters on conservation I do not feel that the book gives a balanced ecological picture. While the pesticide problem (which is probably temporary) and such things as the casualties at TV towers (a minor problem despite the impressiveness of the numbers of birds killed) are fully discussed, there is no place in the book which makes any attempt to discuss the major problem facing all forms of wildlife today—uncontrolled habitat destruction. In the long run this destruction (often sponsored by the very governmental Department which published this book) will account for greater population decreases than will pesticides, TV towers, and some of the other matters that are discussed.

Secondly I feel that there is too much emphasis on the type of "economic" ornithology that was prevalent in the 19th century. We are still told that there are "good" birds and "bad" birds and the time-honored stories about the great economic value of many species are paraded out. Is it not time that even the general public be made aware of the fact that there are no "good" and no "bad" birds; that all species have their proper places in a healthy biota; and that a biota that lacks some of its basic species is not a healthy one, and in the long run is an undesirable environment for every species, including man?—GEORGE A. HALL.

THE SHELL BIRD BOOK. By James Fisher. Ebury Press and Michael Joseph, London. 1966: 5 × 8 in., 344 pp., 20 col. pls., many bl. and wh. illus., maps. $3.50.

For many years the Shell Oil Company in Britain has sponsored a series of beautifully produced nature guides and atlases, all generously illustrated in color. Aside from using the name "Shell" in the titles, and occasionally the familiar scallop-shell trademark on the jacket or cover, the company has been remarkably self-effacing in performing a great educational service. "The Shell Bird Book" is its latest and most voluminous contribution and, like some of its earlier publications, authored by England's eminent and scholarly ornithologist, James Fisher.

The book should have had a more revealing title. What I find between the covers is information in an astonishing amount and variety. Much of it will be illuminating and useful to anyone interested in British ornithology and to any bird-oriented person who will visit Britain and Ireland.

Most of the book is, in the author's apologetic words, "something of a rehash" of old themes and subjects updated and rewritten from some of his earlier and now out-of-print books such as "Watching Birds," "Birds in Britain," "Birds as Animals," and "A History of Birds"; it is also an attempt to make "new soup from old stock" that he had once published in various magazine articles. He has added new material, particularly on the fossil birds of Britain and Ireland. The total result is 12 chapters.

Chapter 1: A Bird's Eye View of Britain. Mainly a history of the avifauna from prehistoric times to be present. Chapter 2: The Naming of Birds. The identification, description, naming, recording, and study of birds from earliest historic times, and the principal persons who participated. Chapter 3: The Peculiarity of British Birds. The composition, origin, and distinctiveness of the avifauna. Chapter 4: Bird Migrants. The observatories for, and comments on the techniques in, the study of migration. Chapter 5: Bird Protection. Chapter 6: Bird Gardening. Information on how to attract and feed birds. Chapter 7: Bird Song. Chapter 8: Birds in Literature, Music and Art. Chapter 9: A List of Bird Watchers. Famous persons in British and Irish bird literature not now living. Chapter 10: The Ornithologists. Primarily an evaluation of the deceased figures in British ornithology.

Chapter 11, A Bird-Watcher's Guide to the Birds' Provinces, gives "all major accessible Bird Reserves, Wildfowl Refuges, Migration Watch Points, Bird Observatories, Zoos with birds, Museums with bird material, etc." known to the author in 1965, together with "a bibliography of the latest regional published works" and a list of "the major bird-watching societies, and natural history societies with bird interests or sections." The chapter is not really a guide in the usual sense since it fails to give directions on how to reach different places, where to go, and what to expect. Only to the extent that the places are located by vice-county numbers—referable to maps on the endpapers of the book—is the chapter helpful to anyone planning his itinerary and finding his way.

The final chapter, a "Shell List of British and Irish Birds," includes every species recorded from prehistoric times to 1964. Indeed, it is the first full British list to include fossil records and, if I am not mistaken, the first bird list ever to attempt summarizing both prehistoric and modern records for an area. The succinct and very precise annotations give, for fossil species, the prehistoric periods from which the fossils came and where they were found; and for extant species, the earliest prehistoric period, if known, and the earliest year, if available, of actual records—sightings or collected specimens. For all vagrant or extralimital species, the exact number of records (date of the first) is stated. All in all the list reflects the meticulous record-taking by so many people for so long a period. It is doubtful that such a list could come from any other country.

The writing throughout the book is strictly and recognizably James Fisher—discursive and verbose, with involved syntax, but always meaty and sparked every now and then by a pun, a cleverly turned phrase, or an outlandish personal opinion. It is never dull. I only wish that the type were larger for easier reading. But then, perhaps I am due for another appointment with my oculist.

The book is generously illustrated in black and white by many photographs, sketches, engravings, maps, etc., and in color by the work of Eric Ennion, Peter Scott, Charles Tunnicliffe, and five other artists. At the price of 25 shillings ($3.50), it is a lot of book for the money.—Olin Sewall Pettingill, Jr.

POPULATION STUDIES OF BIRDS. By David Lack. Oxford University Press, London, 1966: $6\frac{1}{2} \times 9\frac{1}{2}$ in., v + 341 pp., 1 pl., 31 figs., 50 tables, 29 drawings. $10.10.

In 1954, David Lack published "The Natural Regulation of Animal Numbers" in which he clearly set forth his concept that populations are regulated in a density-dependent manner, the ultimate factor limiting populations being the food supply. His ideas have since been repeatedly challenged; indeed, the entire concept of density-dependence of any kind has been rejected by some authors. Andrewartha and Birch ("The Distribution and Abundance of Animals") have favored density-independent population regulation with climatic factors being the effective agents in population change. In 1962, Wynne-Edwards embraced density-dependence in his controversial "Animal Dispersion in Relation to Social Behaviour," but maintained that animals regulate their own populations below the limits of the food supply by behavioral means and that these behaviors have evolved through the unorthodox mechanism of group selection. It is against this background that Dr. Lack has set the present book. In an introductory chapter and a long appendix (32 pp.) he gives a very useful summary of his 1954 book (now out of print), maintains and expands his position in the light of recent work, and discusses, and gives his comments on, some of the attacks directed at his position. These two parts of the book provide a contextual framework for the whole work and should in themselves be useful in the libraries of all persons interested in the mechanisms of population regulation.

The body of the book is concerned with the interpretation and analysis of 13 published studies of bird populations. The studies were chosen on the basis of their duration (minimum study time of four years) and their thoroughness, and embrace a wide variety of bird species—herbivores, omnivores, frugivores, predators, and sea birds. In all, 12 families, representing nine orders, are discussed in detail. The paucity of studies in the tropics permitted the inclusion of only two species from that region—the Quelea of Africa and the Black and White Manakin of Trinidad. All the other species, no less than eight of them from the British Isles, breed in temperate regions: the Great Tit, Coal Tit, Pied Flycatcher, European Blackbird, Tawny Owl, Wood Pigeon, Red Grouse, White Stork, Black-legged Kittiwake, Mutton-birds (Sooty Shearwater and Slender-billed Shearwater), and Yellow-eyed Penguin. In most chapters, additional work with closely related species is discussed if it helps to elucidate the general theme. Thus the total number of studies reviewed is actually increased by 11.

The theme underlying Dr. Lack's review of all the studies is that populations are regulated by a density-dependent mortality upon nestlings, fledglings, or adults, brought about by the amount of accessible food. The reproductive rates that have evolved are such that the largest number of surviving young will be produced by each pair. Dr. Lack stresses the fact that mortality rates are a function of birth rates. One very significant finding is that some species (Great Tit and Pied Flycatcher) lay their eggs at a date later than one which would produce nestlings when food is most abundant. Dr. Lack thinks that females lay only when they can get enough food to form their eggs, and as a consequence they may sometimes rear young under sub-optimal conditions. This throws light on another possible role of courtship feeding: aside from its behavioral function in pair formation and maintenance, it may well assure the female the extra food necessary for her to start the clutch earlier and hence to bring forth her young at a time more favorable for food procural.

Dr. Lack's discussions strongly support his basic contentions. Animal populations usually fluctuate about some definite mean value and thus must be regulated in some density-dependent manner. The evidence points to the food supply as the most important limitation, but the author's discussions often demonstrate other mechanisms that may aid in effecting population regulation. For example, with increased densities of Great Tits and Wood Pigeons, there is increased predation. Black and White Manakins, with a year-round abundance of food (fruit), lost 86 per cent of their nests to predators during the study period. In addition, most of the 11-per-cent-per-year adult mortality was assumed to have resulted from predation. In both Great Tits and Coal Tits, pairs in dense breeding populations produced smaller clutches of eggs than those in sparse ones. In at least one area (Marley Woods, England), the population size of Tawny

Owls remained almost constant in spite of violent fluctuations in the number of prey. This stability is a function of territorial behavior (although young production dropped to zero in bad years). It is interesting that the fluctuations in the nearby populations of Short-eared Owls paralleled the abundance of their prey. Heavy mortality (Great Tits) or dispersion (Wood Pigeons) occurred with severe winters. Dr. Lack points out that in all the above examples the production of surviving young depended (or in the case of the Manakins, may depend) on the availability of food, and that these other mechanisms did not appreciably affect the number of young produced. It would be hasty to conclude, however, that they are never a primary factor in the population regulation of other species.

One is always disappointed to look up a reference in the text, only to find it unlisted in the bibliography. Hopefully the following will prevent this frustration: Richdale, 1965 (cited pp. 255 and 265) refers to "Biology of the Birds of Whero Island, New Zealand," *Trans. Zool. Soc. London* 31:1–155. Richdale, 1962 (cited p. 257) should be Richdale, 1952.—CAMERON B. KEPLER.

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION OF THE WILSON BULLETIN, REQUIRED BY ACT OF 23 OCTOBER, 1962: SECTION 4369, TITLE 39, UNITED STATES CODE, FILED 25 SEPTEMBER 1967.

THE WILSON BULLETIN is published quarterly at the Department of Chemistry, West Virginia University, Morgantown, West Virginia 26506. General business offices: c/o C. Chandler Ross, Treasurer, Academy of Natural Sciences, Philadelphia, Pennsylvania 19103. Publisher: The Wilson Ornithological Society, (no address). Editor: George A. Hall, Department of Chemistry, West Virginia University, Morgantown, West Virginia 26506. Managing Editor: None. Owner: The Wilson Ornithological Society, a non-profit scientific organization.

The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: NONE.

EXTENT AND NATURE OF CIRCULATION	Average number copies each issue during preceding 12 months	Single issue nearest to filing date
Total Number Copies Printed (Net Press Run)	2325	2325
Paid Circulation		
1. Sales through Dealers and Carriers, Street Vendors and Counter Sales	None	None
2. Mail Subscriptions	2122	2122
Total Paid Circulation	2122	2122
Free Distribution by Mail, Carrier or Other Means	103	103
Total Distribution	2225	2225
Office Use, Left-Over, Unaccounted, Spoiled after Printing	100	100
Total	2325	2325

I certify that the statements made by me above are correct and complete. Signed, George A. Hall, *Editor*.

INDEX TO VOLUME 79, 1967

By Mildred Stewart and Tanya Hall

This index includes, in addition to names of genera, species, and authors, references to the following topics: anatomy, banding, behavior, distribution, ecology, flight, food habits, habitat, incubation, measurements, migration, molts and plumages, mortality, nesting parasitism, pesticides, physiology, populations, predation, taxonomy, voice, weather, and weights.

This issue of *The Wilson Bulletin* was published on 29 December 1967

Bound Dic, 1969

Date Due

~~JU [illegible] 1970~~

~~MAY 28 1990~~

~~JUL 31 1993~~