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H. LEWIS BATTS, JR.
EDITOR

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OLIN SEWALL PETTINGILL, JR.

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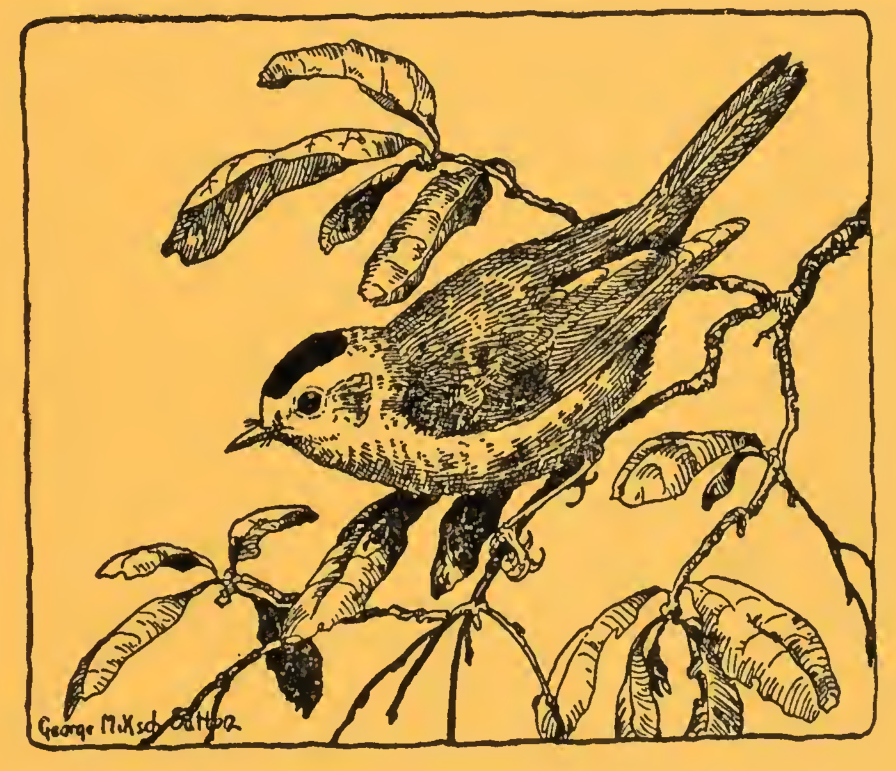

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Variation in winter plumage of *Coturnix* (upper, male; lower, female).

COMPARATIVE GROWTH AND PLUMAGE DEVELOPMENT IN *COTURNIX* AND BOBWHITE

David L. Lyon

Several releases of Japanese Quail (*Coturnix coturnix japonica*) have been made in the United States since 1956. This attempted stocking appears to have been unsuccessful, as were releases of this form and *C. c. coturnix* made more than fifty years ago (Phillips, 1928). However, recent interest in the bird has pointed up its qualities as an experimental animal. As Padgett and Ivey (1959) pointed out, *Coturnix* is easy to handle, hardy, has short breeding cycles, and great egg-laying ability.

Objectives of the present study were to provide detailed information on eggs, growth, and plumage development of *C. c. japonica*, and to find accurate criteria for determining age in this bird. Bobwhites (*Colinus virginianus*) reared under the same conditions as the Japanese Quail furnished a standard for comparison of growth rates and plumage development.

MATERIALS AND PROCEDURES

Coturnix c. japonica and Bobwhite eggs were obtained from Lowrance Quail Farm, Joplin, Missouri. Upon hatching, all chicks were taken to an electrically heated outdoor brooder, and later removed to smaller rearing pens. Chicks were fed a commercial game starter until six weeks of age and then were fed either growing mash, laying mash, or chicken scratch.

During 1957, some data were obtained from 120 Japanese Quail, but a complete history of growth was obtained for only 37 of these birds. In 1958, data were gathered from 20 *Coturnix*. Bobwhite measurements were obtained from 20 birds in 1958. Data on molting were collected from all these groups as well as three additional groups: 15 *Coturnix* in 1957, another 15 in 1958, and 20 Bobwhites in 1958. Measurements included length of culmen, tarsus, fifth primary, and body weight.

EGGS

Coloration and shape.—The *Coturnix* egg is similar in shape to the Bobwhite egg but tends to be less conical and more variable in shape. The coloration of *Coturnix* eggs is extremely variable (Taka-Tsukasa, 1935). The usual background coloration is light tan to brown with dark brown or purplish blotches, freckles, or spots scattered over the entire egg. In the present study some eggs were almost completely white and were difficult to distinguish from those of the Bobwhite; Taka-Tsukasa did not describe eggs of this type.

Egg weights.—In this study two groups of unincubated eggs were weighed; 60 *Coturnix* and 30 Bobwhite eggs layed in the first week of March, and 25 *Coturnix* and 25 Bobwhite eggs produced in the first week of August. The average weight for the early set of eggs was 10.6 grams for *Coturnix* and 9.3 grams for Bobwhite; in the later sets the average weight of *Coturnix* eggs was 10.2 grams, and for Bobwhite, 9.8 grams.

Stanford (1957) also found *Coturnix* eggs to be heavier than those of Bobwhites. He reported an average weight of 10.6 grams for *Coturnix* eggs, and 9.3 grams for Bobwhite eggs laid in the hatchery. Both Stanford's Bobwhite eggs and mine were heavier, on the average, than those weighed by Stoddard (1931). He found that 845 eggs of wild Bobwhites collected during a three-year period averaged 8.6 grams.

In the present study, only the Bobwhite eggs showed increased weights as the breeding season progressed. An increase could be expected not only within a breeding season, but also with increasing age of the females (Stoddard, op. cit.; Romanoff and Romanoff, (1949). The latter relationship was not examined in this study, and the weights reported were from *Coturnix* and Bobwhite eggs laid by females of mixed ages.

Measurements.—Although *Coturnix* eggs weigh somewhat more than those of Bobwhite, the eggs of the two species are very similar in length and width. Several published measurements of *Coturnix* and Bobwhite eggs are compared in Table 1 with those of the present study.

Eggs of both Bobwhite and *Coturnix* in the present study are larger than most in other series reported. In hatchery-reared game birds as in domestic fowl, increased egg size may result from a number of causes: selective breeding for a larger egg (Olsen and Knox, 1940), selective breeding for a larger bird and subsequent increase in egg size, and better nutrient balance through improved game feeds (Romanoff and Romanoff, 1949).

The latter authors pointed out that species under domestication for the longest periods produce the largest eggs in comparison with their wild counterparts. Taka-Tsukasa (1935) asserted that *Coturnix* has been a favored cage bird in Japan since ancient times, and that the egg has increased "from one-third to twice its size." Possibly the disparity in size between eggs of wild *Coturnix* and those obtained in the present study indicates an admixture of "domestic" blood in the Missouri birds.

GROWTH OF CHICKS

Weight.—Growth in weight of *Coturnix* chicks varied in the 1957 and 1958 groups. In 1958, growth in weight was less erratic and more rapid. At eight to ten weeks, however, average weights of the 1957 birds equaled or exceeded those of the 1958 birds (Fig. 1). In 1957, the birds were somewhat more

TABLE 1
MEASUREMENTS OF *COTURNIX* AND BOBWHITE EGGS

Form	Measurements (mm)	Source and sample size	Authority
Colinus virginianus	Avg 30.0/25.0	Wild New England birds; sample size unknown	Minot, 1877
" "	Max 33.8/25.0 Min 32.5/24.8	Unknown	Maynard, 1890
" "	Avg 30.0/24.8	Minnesota birds; sample size unknown	Roberts, 1932
" "	Avg 30.0/24.0 Max 32.5/26.0 Min 26.0/22.5	55 eggs from U. S. National Museum	Bent, 1932
" "	Avg 31.4/24.6 Max 33.7/26.0 Min 29.1/23.3	50 eggs of hatchery birds	Present study
Coturnix c. japonica	Max 32.6/22.4 Min 26.2/20.5	Wild birds in Japan; sample size unknown	Taka-Tsukasa, 1935
" "	Max 32.6/20.4 Min 26.2/21.5	Eggs of hatchery birds; sample size unknown	Stanford, 1957
" "	Avg 31.0/24.7 Max 34.3/26.1 Min 28.7/23.0	100 eggs of hatchery birds	Present study
Coturnix c. coturnix	Avg 30.4/22.8 Max 32.7/24.9 Min 27.9/21.2	Wild British birds; 26 eggs	Witherby, 1941
" "	Avg 29.6/22.9 Max 31.5/26.1 Min 26.1/23.2	Wild Danish birds; sample size unknown	Westerskov, 1947
Coturnix pectoralis	Max 32.0/23.0 Min 29.5/21.5	Wild birds in Australia; sample size unknown	Lucas and LeSouef, 1911

crowded, mortality was greater, and there was harrassment of the birds by raccoons (*Procyon lotor*). The 1958 weight curve is thought to be more typical of this hatchery strain.

In 1958, growth rate of *Coturnix* exceeded that of Bobwhite from the second to the fifth week of age. After five weeks, weight increased steadily in Bobwhite, but began to level off in *Coturnix* and a plateau was reached at approximately eight weeks.

Growth curves for *Coturnix* obtained during 1958 agreed closely with those presented by Stanford (1957), but the growth rate of Bobwhite was greater

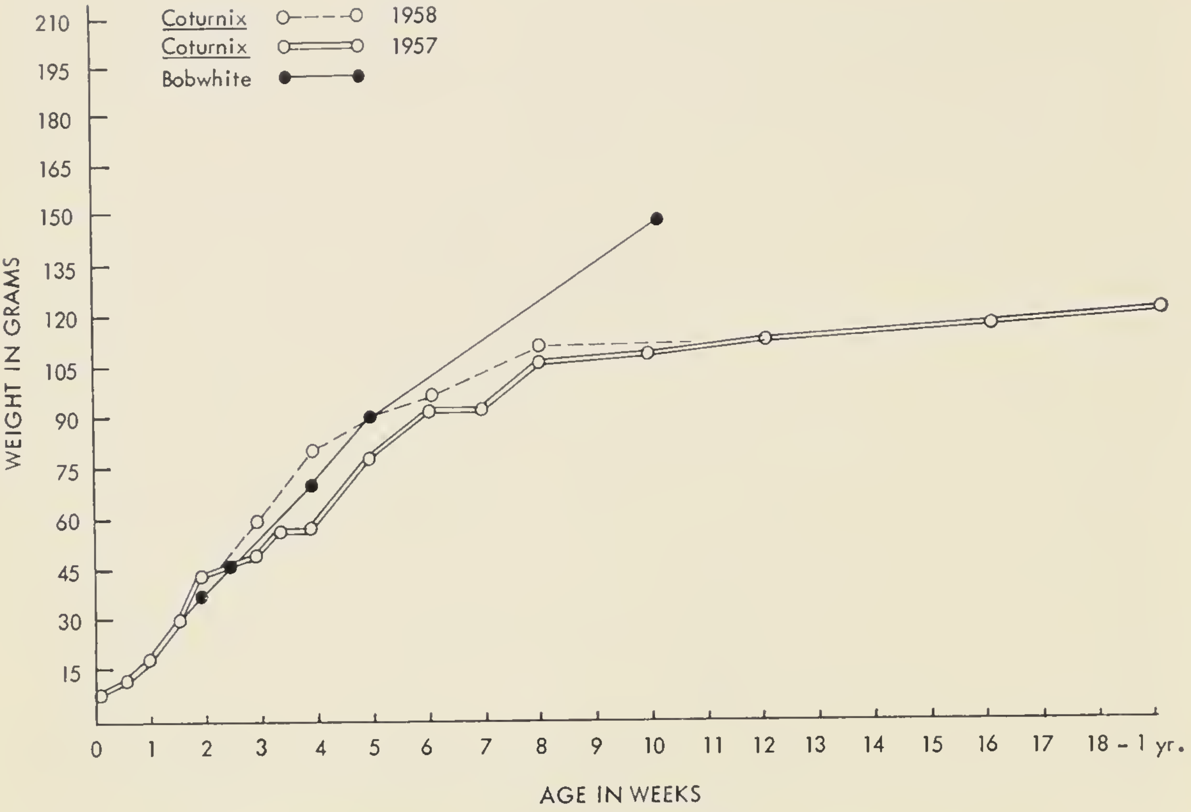

FIG. 1. Post-embryonic growth in weight of *Coturnix* and Bobwhite.

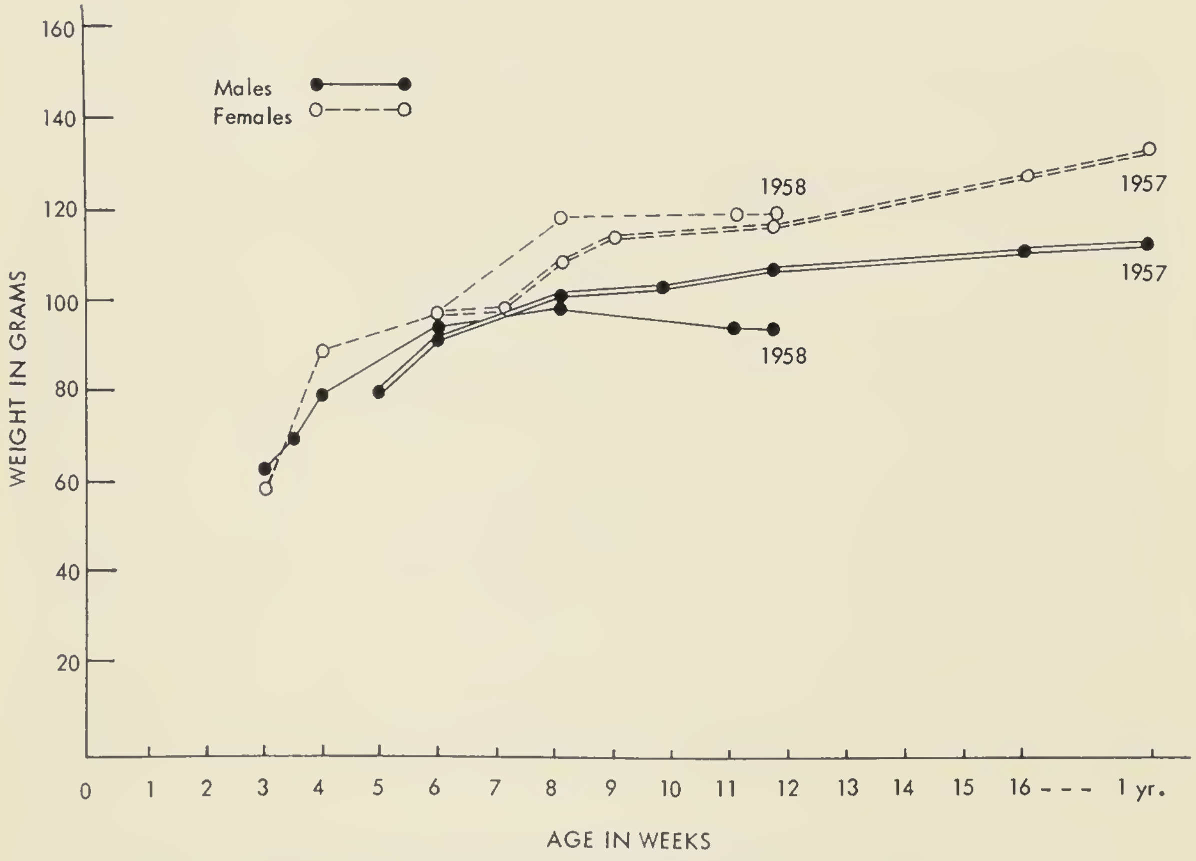

FIG. 2. Post-embryonic growth in weight of *Coturnix* according to sex.

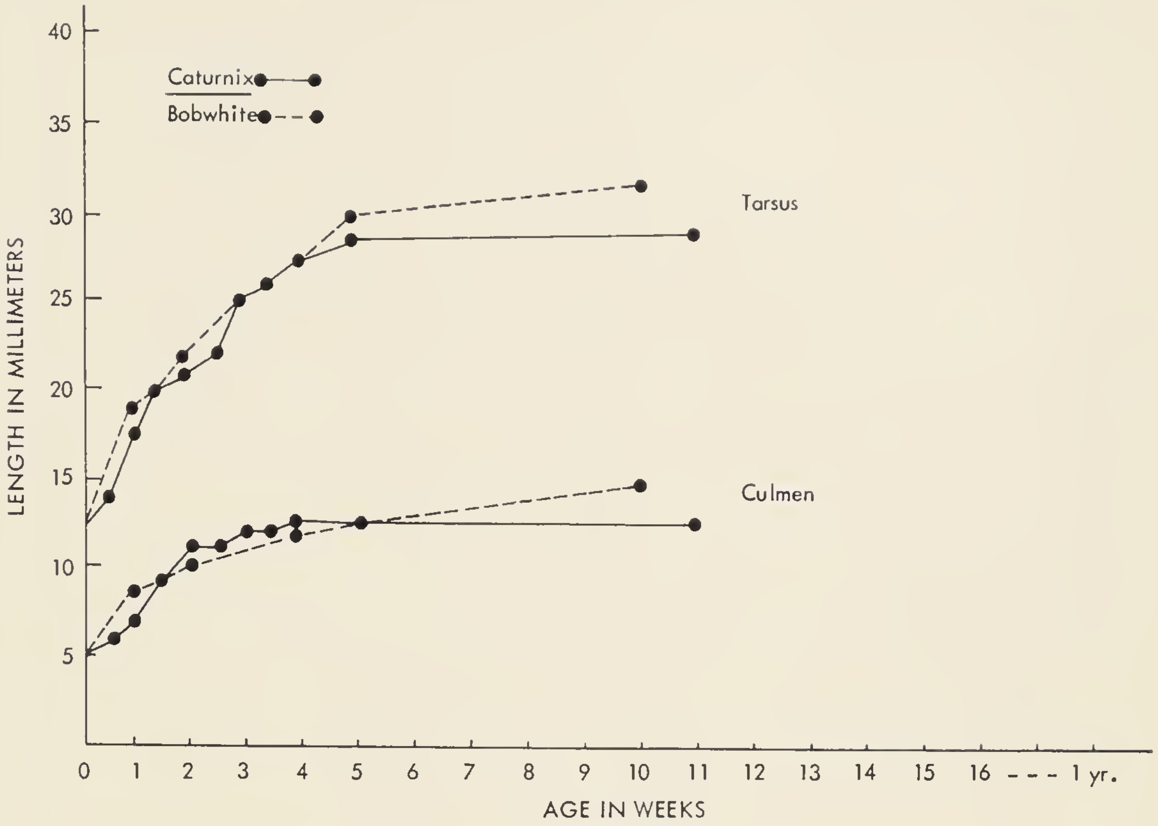

FIG. 3. Post-embryonic growth of tarsus and culmen of *Coturnix* and Bobwhite.

than those reported in most previous studies: Stoddard (1931), Reeves (1954), Hamilton (1957), and Stanford (1957).

Sexual dimorphism in size of *Coturnix*, as judged by body weight, was apparent between six and eight weeks of age (Fig. 2). A slight increase in weight of both sexes continued into the second year. Under hatchery conditions, Stanford (1957) also found a difference in weights of males and females and a slight weight increase extending into the second year. This difference between weights of males and females may result from confinement. Wyatt (1870) reported no difference in weights of males and females in the wild (*C. c. coturnix*) but found that under confinement, females consistently outweighed the males.

Culmen and tarsus.—Although weight increments of *Coturnix* differed considerably in 1957 and 1958, measurements of culmen and tarsus in the two years were so similar for both sexes of *Coturnix* that the results were combined (Fig. 3). Tarsus and culmen measurements of Bobwhite exceeded those of *Coturnix* chicks after about five weeks.

Of the three measurements taken, weight was the most variable, and for determining ages of *Coturnix* chicks, tarsus measurements are the most reliable, because of relative lack of variability in tarsus growth and the fact that

TABLE 2

SEQUENCE OF APPEARANCE OF JUVENAL PLUMAGE FEATHERS

Feather tract	Age In Days	
	Coturnix	Bobwhite
Alar	1 – 2	2 – 3
Ventral	3 – 4	4 – 5
Humeral	3 – 4	4 – 5
Femoral	3 – 4	4 – 5
Spinal	4 – 6	6 – 8
Caudal	4 – 6	6 – 8
Crural	7 – 8	8 – 9
Inferior	8 – 9	9 – 10
Capital	9 – 11	11 – 13

the tarsus requires a longer period to reach maximum size than does the culmen.

DEVELOPMENT OF PLUMAGE

Because there has been some confusion about the sequence of plumages in *Coturnix*, each plumage of *C. c. japonica* subsequent to the natal plumage is described in detail below, using Palmer and Reilly's (1956) color standard.

Natal plumage.—In both *Coturnix* and Bobwhite embryos, feathers first appear on the back as a double row of quills extending along opposite sides of the spinal column. These feathers are visible in the *Coturnix* embryo on the eighth day of incubation but are not apparent in the Bobwhite embryo until the eleventh day. The belly is the last area to develop feathering; in *Coturnix* belly feathers appear on the twelfth day of incubation, in Bobwhite on the sixteenth day.

Upon hatching, chicks of the two species are similar in general appearance, but there are differences in coloration. In *Coturnix*, black and yellow predominate (Taka-Tsukasa, 1935), while black and brown are the dominant colors in newly hatched Bobwhites (Dwight, 1900; Stoddard, 1931; and others).

First juvenal plumage of *Coturnix*: Bill light brownish olive; head, neck, and back grayish buffy brown. Feathers of the neck and back with a thin, pale cream shaft streak; throat and breast white to pale grayish cream. Breast of both sexes with blackish brown spots, but in addition, upper breast and lower throat of male tinged with light rufous; feet pale olive chestnut.

In *Coturnix* chicks, the black quills of Primaries 1–7 and Secondaries 2–11 are visible at the end of the first day and are apparent in all birds by the end

TABLE 3
PROGRESSION OF FEATHERING ON VARIOUS TRACTS IN *COTURNIX* AND BOBWHITE

Feather tracts	Origin and progression of feathering
Alar	Begins along trailing edge of wing (primaries and secondaries) and spreads anteriorly to leading edge of wing; underside of wing is last to acquire feathers.
Ventral	Begins in center of tract and spreads posteriorly to abdomen, laterally to sides, and anteriorly into throat region.
Humeral	Begins in any part of tract.
Femoral	Begins in center of tract and spreads largely posteriorly and anteriorly to cover flanks.
Spinal	Begins anywhere along mid-dorsal line as a double row of quills and develops anteriorly or posteriorly before spreading laterally to cover the back.
Caudal	Begins throughout tract with simultaneous appearance of all rectrices.
Crural	May begin anywhere in tract but usually begins on forward edge of leg before spreading to cover rest of leg.
Inferior	Begins as a double row of quills at cloacal lip and spreads anteriorly and laterally to cover abdomen.
Capital	Begins as a thin stripe on crown extending from forehead to nape. Spreads laterally to cover rest of crown, nape, auriculars, cheeks, malar region, and chin.

of the second day (Table 2). Unsheathing of these feathers does not begin until the fifth to eighth day.

At three to four days of age, feathers appear simultaneously on the ventral, humeral (scapulars), and femoral tracts and begin pushing out the natal down, but unless the young birds are examined closely these feathers are not visible. Origin and progression of feathering in various tracts are shown in Table 3.

In the four-to six-day-old *Coturnix* the quills of the spinal and tail feathers begin to emerge. All rectrices (usually 10 in number) appear together, but numbers five and six are already longer than the others one day after their appearance. Unsheathing of the first seven primaries begins.

At one week of age juvenal plumage feathers show clearly, but natal down still predominates (Fig. 4). The first seven primaries are largely unsheathed and primary and secondary coverts are growing rapidly. The fifth primary is 17 to 25 mm long (half grown). The head, legs, and abdomen, and most of the breast, back, and rump remain in natal down.

Fig. 4. *Coturnix* (left) and Bobwhite (right) at one week of age.

In the seven-to eight-day-old *Coturnix* the crural tract begins to feather, quills first appearing on the forward edge of the leg. By the eighth to ninth day of age feathers appear on the inferior tract. Two parallel rows of quills originate at the cloacal lip and extend over the abdomen. All seven primaries are unsheathed to the edge of overlapping coverts, and length of the fifth primary ranges from 23 to 36 mm.

The capital is the last tract to develop. A single row of quills appears on the head at nine to eleven days of age and extends from the forehead to the edge of the nape. At 11 to 12 days of age juvenal primaries eight and nine become visible and on the twelfth to thirteenth day the tenth primary appears.

Except for the head, the upperparts of the juvenile *Coturnix* are largely feathered at two weeks of age. The characteristic white striping of the feathers on the back and rump is now apparent. Juvenal feathers on the head form a "V" starting at the base of the bill and extending over the crown, but the rest of the head remains in natal down. The upper breast, except for a small area below the throat, is well feathered, but the underparts are mainly downy. All ten primaries are visible and growing rapidly; Primaries 1–7 are almost completely unsheathed, but Primaries 8–10 have not yet begun to unsheath. The fifth primary ranges from 43 to 54 mm in length, the eighth, 10 to 25 mm, and the tenth, 5 to 10 mm.

Feather development is most rapid between the second and third weeks. At three weeks of age the juvenile *Coturnix* is almost completely feathered, but natal down still predomiates on the head. The crown and nape are partially feathered, but down persists on the outer edges of these areas as well as on the lores, chin, and upper throat. Juvenal Primaries 1–7 are hardened and almost full grown. This is in agreement with Heinroth and Heinroth (1928) who also reported hardening of the proximal primaries at three weeks. Primaries 8–10 are beginning to unsheath. The fifth primary measures 52 to 58 mm; Primary 8 is 45 to 50 mm long, Primary 10 is 20 to 36 mm long.

By four weeks of age the first juvenal plumage is complete except for a small area immediately surrounding the eye and restricted areas on the abdomen and legs where natal down persists. Down disappears entirely on these areas at four and one-half to five weeks of age. The first seven primaries are full grown, and the fifth primary measures 61 to 62 mm. Primaries 8–10 are growing rapidly, but they will not be completely unsheathed and hardened until five to five and one-half weeks of age.

Development of the juvenal plumage in Bobwhite has been described by Dwight (1900), but the age at which feathering first appeared on the different body areas was not discussed. In the present study it was found that the development of the juvenal plumage in Bobwhite is very similar to that of *Coturnix.* Although the appearance of feathers on the different tracts occurs only slightly later in the Bobwhite (Table 3), the rate of feather development is considerably slower. In *Coturnix* the juvenal plumage is complete at four and one-half to five and one-half weeks of age, but Bobwhites do not attain full juvenal plumage until six to seven weeks of age. Stoddard (1931) and Stanford (1957) reported the juvenal plumage in Bobwhite complete at approximately seven weeks of age.

Second juvenal plumage of *Coturnix*: Bill dark brownish olive to black; forehead, nape, and crown dark buffy brown except for light cream median and superciliary lines; neck tawny and back tawny to very deep buffy brown. Feathers of both regions with a broad, cream shaft streak; wing coverts medium buffy brown to light grayish buffy brown. Primaries grayish buffy brown with tawny spots or blotches on outer web. Secondaries similar but blotches larger and broader; abdomen white and tinged with very pale tawny. Feathers on sides dark tawny with a white shaft streak near the tip of the feather; throat of male solid cinnamon to chestnut and breast pale to light tawny. Throat of female pale grayish cream with black malar line descending onto edge of throat. Breast pale grayish cream with black or blackish brown spots; feet pale olive chestnut.

The sequence of plumages in young *Coturnix* is unlike that found in the young of most gallinaceous species. Whereas most juvenile gallinaceous birds have two body molts prior to the acquisition of the first winter plumage (post-natal and post-juvenal molts), *Coturnix* has three body molts (post-natal, first post-juvenal, and second post-juvenal). Apparently Heinroth and Heinroth (1928) had observed the third molt, because they mentioned that young *Coturnix* molt differently from other gallinaceous birds, and they remarked that a body molt accompanies the shedding of the juvenal primaries. In describing molting in juvenile *Coturnix* (both *C. c. Coturnix* and *C. c. japonica*) Dementiev and Gladkov (1952) noted only a post-natal and post-juvenal molt. but the description of molts strongly suggests the existence of an extra molt.

In the present study it was found that the first and second juvenal plumages of *Coturnix* are acquired in rapid succession. Unless birds are inspected fre-

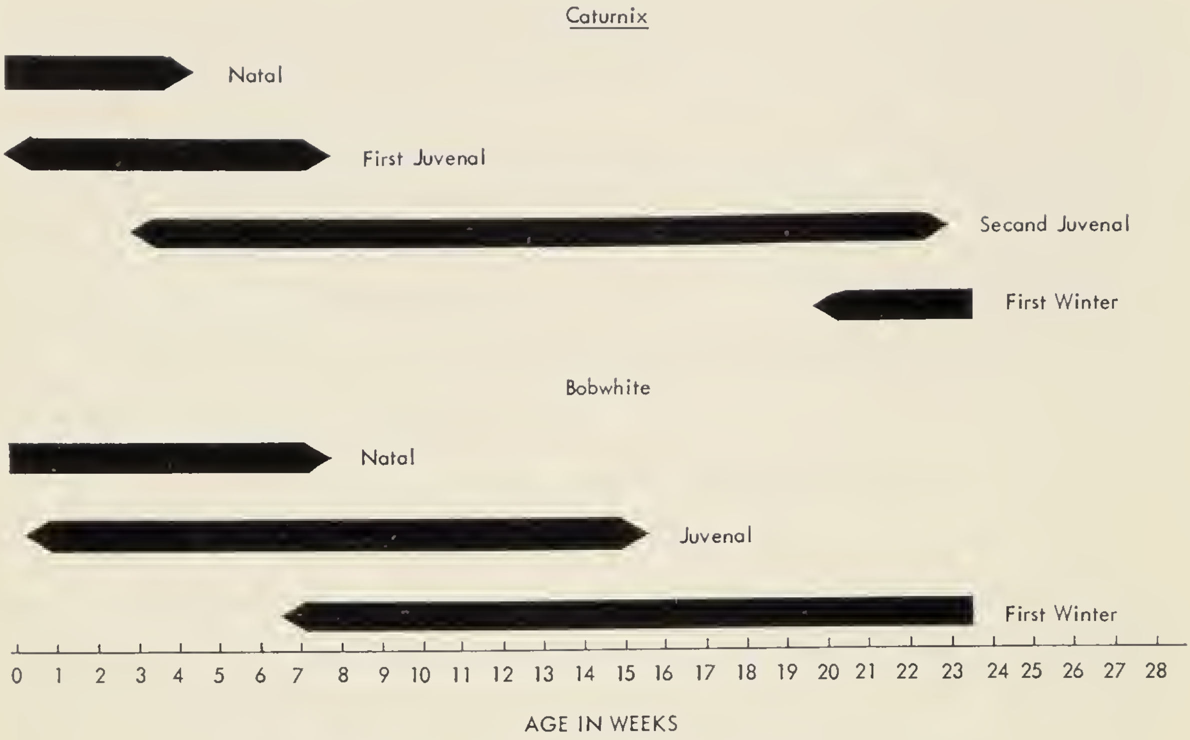

FIG. 5. Duration of plumages in *Coturnix* and Bobwhite.

quently the second juvenal plumage may be mistaken for the later stages of the first, and the two plumages may incorrectly be identified as one.

The pattern of feather development of the second juvenal plumage is similar to that of the first juvenal plumage; however, unlike the first juvenal plumage which is acquired by a complete post-natal molt, the first post-juvenal molt preceding the second juvenal plumage is only a partial molt. During this molt feathers on the ventral, humeral, femoral, spinal, caudal, and alar tracts are shed, but feathers on the crural, inferior, and capital tracts are retained until the following second post-juvenal molt.

The first feathers of the second juvenal plumage make their appearance well before the first juvenal plumage is completed. At two and one-half to three weeks, new feathers appear on the ventral, humeral, and femoral tracts, but natal down still predominates on the head and abdomen, and at approximately the same time the first juvenal primary is dropped. Shortly after, new feathers appear on the back, the juvenal rectrices are molted beginning from the outer edge and proceeding inward, and the plumage is complete at approximately seven to eigth weeks of age.

Juvenile Bobwhites, like the young of most other gallinaceous birds, have only two plumages prior to the acquisition of the first winter plumage (Dwight, 1900). Young *Coturnix* have three plumages in approximately the same period (Fig. 5).

In *Coturnix*, the post-juvenal wing molt coincides with the onset of the first post-juvenal molt. The first juvenal primary is dropped at two and one-half weeks to three weeks of age at which time the first feathers of the second juvenal plumage are noticeable on the breast. In young Bobwhites the wing molt is considered part of the post-juvenal molt and begins well in advance of the body molt (Dwight, 1900).

First winter plumage of *Coturnix*: Similar to second juvenal plumage except for coloration of throat and breast. Throat of male usually white with black anchor or streak. Breast pale to medium tawny. Throat and breast of female usually similar to second juvenal plumage, but sometimes will be identical to throat and breast coloration of the male.

In *Coturnix* the beginning of the second post-juvenal molt apparently is influenced by the time of hatching during the season as well as by the age of the bird. Birds hatched later in the season began the second post-juvenal molt at an earlier age than those hatched earlier. Stanford (1957) reported that the molt prior to the first winter plumage began on 7 October, or at approximately 20 to 22 weeks. His birds were hatched the second week in May. However, in the present study, four groups of birds hatched at different intervals during the spring and summer began the second post-juvenal molt at different ages (Fig. 6). The second post-juvenal molt is the only one thus affected. Birds of all groups began and completed the post-natal and first post-juvenal molts (or first juvenal and second juvenal plumages) at the same ages.

Apparently the duration of this molt is also affected by the hatching date. Birds hatched earlier required a longer period of time to complete the molt than did those hatched later in the season. Birds in a group hatched on 1 April began the second post-juvenal molt in the third and fourth weeks of September and completed it in seven weeks. Those of another group hatched on 18 August began the molt on 15 October and only five weeks were required for its completion.

The post-juvenal wing molt seemed also to be affected by the hatching date. However, this molt appears to be very erratic. In the present study the progress of the wing molt was recorded in the groups hatched on 1 April and 21 July. Unfortunately, most of the birds in the groups hatched 1 April were lost at 12 weeks of age, and it was possible to record only part of this molt. In birds of both groups the dropping of the first three primaries occurred at approximately the same age, but thereafter molting of subsequent primaries occurred at a greater age in the 1 April group and extended over a longer period.

Apparently, *Coturnix* is not the only gallinaceous species in which the date of hatching affects the progress of the post-juvenal primary molt. Although Buss (1946) found no difference in the wing molt of several groups of young Ring-necked Pheasants (*Phasianus colchicas*), more recent evidence

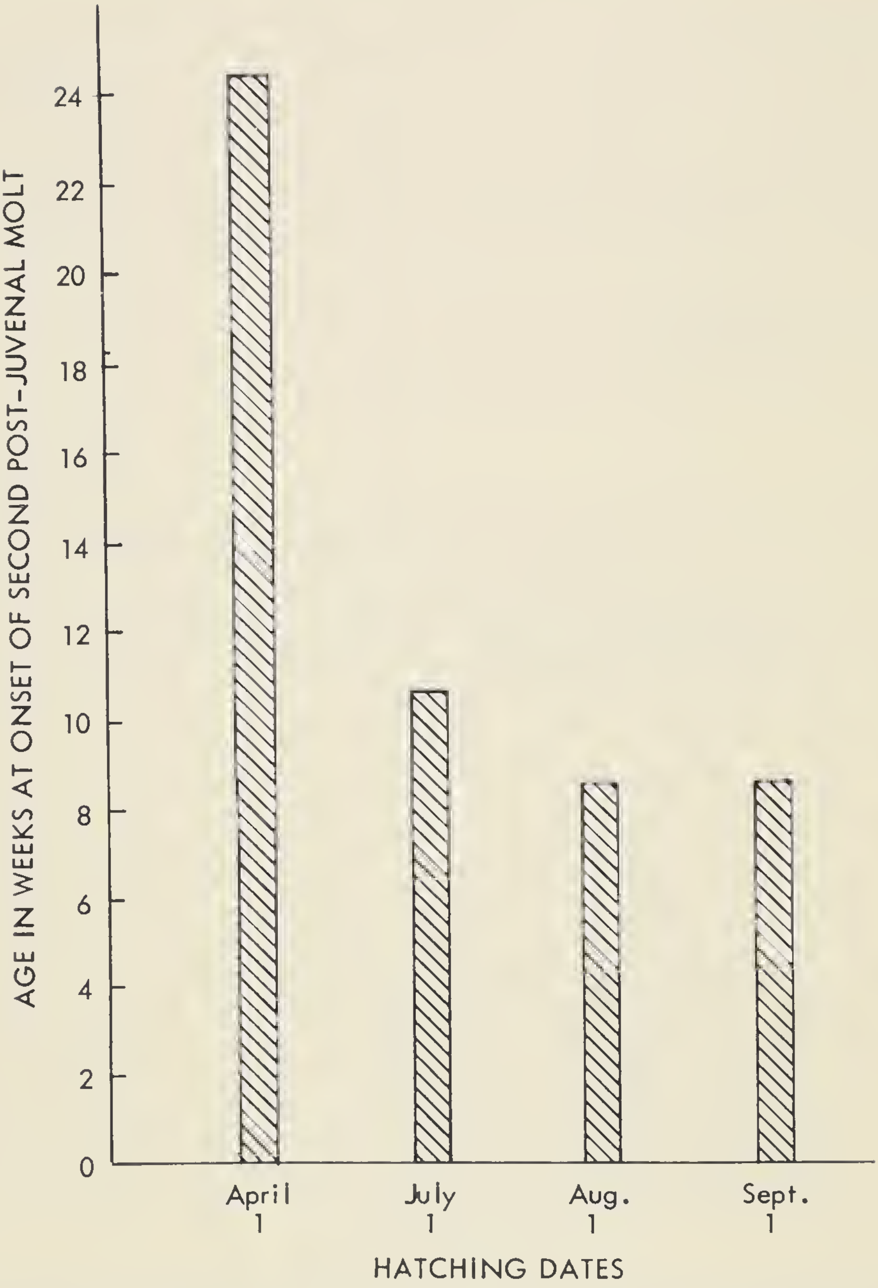

FIG. 6. Age of *Coturnix* at onset of second post-juvenal molt in relation to hatching date.

(Woehler, 1953) indicates a more rapid molt in late-hatched birds of this species. The post-juvenal wing molt in a group of young cocks hatched on 17 June was found to be five to eight days in advance of the molt in another group hatched on 20 May. All birds were chosen from the same breeding stock, were fed the same rations, and penned under identical conditions. These phenomena may be related to day length; Lesher and Kendeigh (1941) showed experimentally that short days may protract the post-nuptial molt in Bobwhites, White-throated Sparrows (*Zonotrichia albicollis*), and House Sparrows (*Passer domesticus*). In mid-winter, Host (1942) was able to in-duce the post-nuptial molt in a male Willow Ptarmigan (*Lagopus lagopus*) by artificially decreasing day length. Kobayashi (1957) showed that short days accelerated molting in Canaries (*Serinus canarius*), and he further demonstrated that short days hastened the termination of the post-nuptial molting period. Kobayashi and Okubo (1955) had shown earlier that long days may prolong the post-nuptial molt in this same species.

In Bobwhites, the hatching date apparently does not affect the age at which the post-juvenal body molt begins, nor does it seem to influence the age of inception of the post-juvenal wing molt. In the present study, birds from a group hatched on 1 May and those from a group hatched on 25 August were observed to display no differences in the timing of this molt. Birds in both groups began the body molt at seven weeks of age and the wing molt at four weeks of age.

DISTINGUISHING THE SEXES IN *COTURNIX*

Coloration of the throat and breast feathers is the best criterion of sex. Sexes may be distinguished as early as the thirteenth day. At this age birds of both sexes have spotted breasts, but in males light rufous feathers of the first juvenal plumage begin to appear along the inner edges of the ventral tract, and as the post-juvenal molt progresses the rufous coloration spreads to the throat. In females the entire breast is spotted; the rufous feathers do not appear.

In the second juvenal plumage the sexes are more easily distinguished. The throat and chin of the male are a solid cinnamon to chestnut and the breast is light to pale tawny throughout. In contrast, the throat and chin of the female are pale grayish cream and the breast is spotted with black or blackish brown.

Sex determination in the first winter plumage is quite often difficult because in both sexes the coloration of the throat and breast is variable. In males the throat is usually white and flecked or striped with light tawny, but occasionally it may be a light tawny to light cinnamon throughout. In addition, considerable variation may occur in the throat markings. Below is a list of the variations observed in male birds reared during this study.

1. “Anchor” on throat.
2. Collar encircling upper throat.
3. Single stripe running from lower mandible to mid-point of throat.
4. Stripe plus incomplete collar.
5. Incomplete collar.
6. Solidly colored triangle on throat.
7. No markings on throat.

Markings are usually black but may vary in color from blackish brown to light tawny. A thin, blackish brown to chestnut collar usually edges the lower throat but this is not present in all birds. The middle of the breast is light to dark tawny and the sides are deep tawny to chestnut. Occasionally the upper breast may be heavily streaked or flecked with chestnut.

In the female the coloration of the throat and breast is usually similar to that of the second juvenal plumage, but variation also occurs. The throat is usually a pale grayish cream without markings but gradations between this and typical male patterns are frequent. The breast is usually a very pale tawny and streaked or spotted with black, deep tawny, or chestnut, but occasional birds may present a breast coloration identical with that of the male (Front.). Taka-Tsukasa (1935) described this variation as well as several others.

Accurate determination of sex during the winter period can usually be made by a careful examination of the coloration and markings of the throat and breast. Errors in sex determination are most likely to occur in the examination of females. Although the hen occasionally resembles the male in every respect, males apparently never acquire a plumage similar to the typical winter plumage of the female.

As mentioned above, sex determination of birds in the second juvenal plumage (and subsequent nuptial plumages) is not difficult, but occasional birds are encountered in which it is difficult to distinguish the sexes. In this case another method may be used. In breeding males the cloacal region becomes enlarged and protrudes (Coil and Wetherbee, 1959), and when the bird is held tightly in the hand a frothy fluid is exuded from a gland above the dorsal lip of the cloaca. The female *Coturnix* does not show the protuberance.

AGE DETERMINATION IN *COTURNIX*

Aging of young by replacement of juvenal primaries.—Several investigators have described the molt of the juvenal primaries of *Coturnix*. Heinroth and Heinroth (1928) observed the post-juvenal primary molt in three young birds of *C. c. coturnix* and found that molting does not proceed rapidly up to the eighth primary as it does in other gallinaceous birds. At seven weeks the first five primaries in the females and the first four primaries in the male had been renewed, but Primary 6 in the females and Primary 5 in the male had not been shed. Juvenal Primaries 5-10 were full-grown so that the wing was completely feathered and ready for flight. Since young wild birds were often only two months old at the beginning of migration, Heinroth and Heinroth suggested that the interrupted wing molt was an adaptation which best suited the young birds for migration.

TABLE 4
AGE IN DAYS OF *COTURNIX* AT TIME OF SHEDDING OF JUVENAL PRIMARIES

Authority	Primary number								Sample size
	1	2	3	4	5	6	7	8	
Stanford, 1957	21	21	28	35	42	56	63	–	Unknown
Edwards (letter)	21–23	22–26	27–32	33–36	39–65	42–?	–	–	Unknown
This study (I)	18–32	21–36	28–44	32–70	35–78	42–84	49–103	57–?	120–37
This study (II)	20–27	23–29	24–32	32–?	48–?	–	–	–	25–19

The findings of Dementiev and Gladkov (1952) are similar to those of the Heinroths. In young birds (*C. c. coturnix*) at seven to eight weeks the first seven adult primaries in males and the first six primaries in females were full-grown. At this stage of wing molt the birds began migration.

Edwards (in litt.) found that in general the replacement of the juvenal primaries stopped when birds (*C. c. japonica*) were 32 to 42 days of age. In most instances this followed the replacement of the fourth primary, but one bird had shed only the first primary and several others had molted the fifth and sixth primaries. Detailed information about shedding of juvenal primaries as recorded by Edwards and by Stanford (1957) is shown in Table 4.

In the present study the progression of the post-juvenal primary molt was recorded in two groups of *C. c. japonica.* In the first group (sample size was 120 birds at the beginning of the study but only 37 remained at its completion) the time at which each specific primary was shed was variable (Table 4). The eighth primary was shed by one bird as early as 57 days, but at 147 days (mid-December) only 74 per cent of the birds had shed this feather. A few birds shed the ninth primary at 70 days. At 147 days no birds had shed the tenth primary.

In the second group (sample size was 25 birds at the beginning of the study but only 19 remained at its completion) the molting of the first three primaries was less variable than in the first group (Table 4). However, molting of the fourth and fifth primaries was more variable than in the first group.

Molting of the first three primaries in the second group was similar to that reported by Edwards (in litt.). If this is the typical molting pattern then birds may be accurately aged up to four weeks. However, other plumage characteristics and tarsus measurements may be more helpful in aging young birds (Table 5). After the six weeks no reliable criteria of age were found.

In Bobwhite the replacement of the juvenal primaries is a reliable aging method. Petrides and Nestler (1943) found that the first primary was dropped at four weeks of age, the second at five weeks, the third at six weeks,

TABLE 5

CRITERIA FOR AGING YOUNG *COTURNIX C. JAPONICA*

End of first week	Juvenal Primaries 1–7 are present and beginning to break their sheaths. Primaries 8–10 absent. Fifth primary shaft 22–23 mm; tarsus 11–18 mm.
End of second week	Juvenal Primaries 8–10 just appearing. In males, light tawny feathers are beginning to appear on breast. Fifth primary shaft 42–54 mm; tarsus 19–23 mm.
End of third week	Feathers of second juvenal plumage just beginning to appear on breast, shoulder, and flanks. Fifth primary shaft 52–56 mm; tarsus 23–27 mm.
End of fourth week	Natal down confined to small area around eye. Down disappears at four and one-half to five and one-half weeks.

the fourth at seven weeks, the fifth at eight weeks, and the eighth at fourteen and one-half weeks. Thompson and Kabat (1950) further refined this aging method; the length of the developing adult primaries was found to be a more accurate indication of age.

In the present study, the primary molt of young Bobwhites was recorded up to the fifth primary. Replacement in these pen-reared birds was very similar to that recorded by Petrides and Nestler (1943).

Means of distinguishing young-of-the-year from adults.—In Bobwhites and other North American quail, methods of distinguishing young from adults have been thoroughly investigated. Stoddard (1931) noticed that the ninth and tenth primaries of juvenal Bobwhites were pointed at the tip while those of adults were not. Van Rossem (1925) apparently was the first investigator to discover that juvenal primary coverts are retained in native quail until the second fall molt, and that they differed in color from the primary coverts of adult birds. A. S. Leopold (1943) demonstrated the greater reliability of the color of the juvenal primary coverts as compared with the shape of the outer primaries as an aging index in native quail. He found that in Bobwhites the juvenal primary coverts are tipped with buff while those of adults are solid gray.

Apparently no aging technique has been developed for *Coturnix* to distinguish young-of-the-year from adult birds. Although Witherby (1941) stated that the ninth and tenth juvenal primaries are retained until the year following hatching, Stanford (1957) found that these feathers were attenuated at the tip of both young and year-old birds and that they appeared to be of no value in determining age. Stanford's results were confirmed in the present study.

Petrides (1945) reported that unlike North American quail, all European quail shed the juvenal primary coverts during the post-juvenal molt. This was

FIG. 7. Primary coverts of *Coturnix* (young, left; adult, right).

found to be true in *Coturnix*; juvenal primary coverts were shed at approximately the same time as the juvenal primaries. Nevertheless, the second set of primary coverts in the young-of-the-year are different in some respects from those of adults. In the young the coverts are usually plain grayish to dark brown, but in adults the outer portions of the rachises of these feathers, especially the coverts of the outer four or five primaries, are usually light tawny to white. There are exceptions; the coverts of adults seldom lack the white rachis, but those of young birds occasionally have the white rachis. Of 65 adult birds and 75 young birds examined, only five adults (8 per cent) lacked coverts with white rachises, but 19 young birds (25 per cent) had primary coverts colored like those of most adults.

The shape and texture of the coverts differed in young and adult birds. In young birds the tips of the coverts are rounded or pointed but in adults the tips of these are blunt (Fig. 7). In addition, the covert tips of the young are slightly frayed while those of adults are not, a condition apparently similar to that described for juvenal Bobwhites (Haugen, 1957). This appears to be the best method for age determination. Of the 140 young and adult birds examined for the shape and texture of the primary coverts, all fitted the categories as described above. However, a group of wings from banded *Coturnix* shot during the hunting season in Nebraska were much more difficult to classify correctly. Thus, this method of age determination needs further checking under a variety of conditions.

RELATIONSHIP OF *COTURNIX* MOLTS AND PLUMAGES TO THOSE OF OTHER GALLINACEOUS BIRDS

Throughout this paper molts and plumages of *Coturnix* have been designated according to their correspondence in timing with those of Bobwhites and most other gallinaceous birds. Because *Coturnix* completed two plumages in the period in which Bobwhites completed the juvenal plumage, the two were called the first and second juvenal plumages. The last plumage to appear was termed the first winter plumage because its appearance coincided approximately with that of the first winter plumage of Bobwhites. However, the actual correspondence of plumages of young *Coturnix* and Bobwhites is not clear. The designation of avian molts and plumages proposed recently by Humphrey and Parkes (1959), is helpful in analyzing this correspondence. These authors suggest a system of nomenclature for molts and plumages which is independent of the reproductive, seasonal, and developmental phenomena upon which previous nomenclatures have been based.

In species having only one plumage per cycle as adults, this plumage is usually replaced by a complete molt. Humphrey and Parkes used the term *basic* for this plumage. The molt renewing it is called the *prebasic molt.* In birds which as adults have two plumages and two molts per cycle, one molt (the prebasic) is a complete molt. The other is usually partial, affecting only the body feathers and is followed by a plumage which is thus a composite of old basic feathers and the new incoming feathers. The authors designated this plumage as the *alternate plumage* and the molt preceding it as the *prealternate molt.* In addition, numerical prefixes may be affixed to the plumage stage if the age classes are recognizable by plumage characteristics beyond the first year class.

Two possible systems of correspondence between Bobwhite and *Coturnix* plumages are shown in Fig. 8. One, expressed in Dwight's (1900) terminology (bottom line, Fig. 8), is the one employed throughout this paper. The other (third line, Fig. 8), expressed in the Humphrey and Parkes (1959) terminology actually seems the more reasonable.

There are several lines of evidence for the latter system of correspondence. The first nuptial (first alternate) plumage in most North American gallinaceous birds is the plumage in which the birds first breed, and it is identical in coloration to all subsequent breeding plumages (Dwight, 1900). Juvenile *Coturnix* breed (in their first summer) in the second juvenal plumage, and it is identical with the breeding (alternate) plumage of adults.

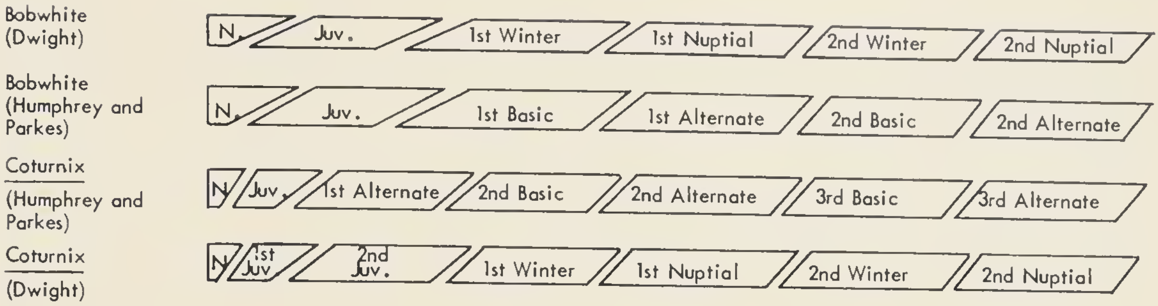

FIG. 8. Correspondence of plumages of Bobwhite and *Coturnix* according to two systems of nomenclature.

Thus the second juvenal plumage in *Coturnix* seems to be equivalent to the first nuptial (first alternate) of the Bobwhite and other North American species. Moreover, in many North American gallinaceous species the juvenal plumage of both sexes resembles that of the nuptial plumage of the female (if sexes differ). The first juvenal plumage of *Coturnix* satisfies this requirement, because in both sexes it resembles the second juvenal plumage and all other breeding plumages of the females. Apparently then, young *Coturnix* differ from the Bobwhite and, most other birds, by lacking the first basic plumage rather than having an additional juvenal plumage. In this respect the sequence of molts and plumages in young *Coturnix* may approximate that of some species of sunbirds (Nectariniidae) in which the first basic plumage appears also to be suppressed (Mackworth-Praed and Grant, 1945), and of ducks in which the first basic plumage apparently is greatly protracted (Humphrey and Parkes, 1959).

A molting sequence somewhat similar to that in young *Coturnix* has been recorded in the young of a few other gallinaceous birds. Salomonsen (1939) recorded an extensive fourth molt in the Rock Ptarmigan (*Lagopus mutus*), and A. S. Leopold (1943) found that young Turkeys (*Meleagris gallopavo*) undergo a partial first winter molt in which the body feathers, lesser and middle wing coverts, tail coverts, and the central rectrices are replaced. In ptarmigan the additional molt results in a white plumage which may be an adaptation to the arctic environment. Salomonsen (1939) regarded it as a mechanism for thermoregulation, resulting in conservation of body heat. In Turkeys the additional molt was thought by A. S. Leopold to be related to the great increase in the size of young birds during the first year. He suggested that since the first winter plumage began when the juvenal was only five to six weeks old it would be impossible for so small a bird to produce a plumage adequate to cover a full-grown bird during the first winter.

Neither of these reasons, however, seems to apply to *Coturnix*. It is believed that the exceptional pattern in the young of this species is related to the rapid maturation of young birds. Inasmuch as young *Coturnix* may be sexually mature at eight to nine weeks of age they may begin the "adult" molting pattern for the year of hatching, thus rapidly acquiring a plumage that seems to be the first alternate.

Like Bobwhites, adult *Coturnix* have two plumages and two molts per cycle; a complete molt in the late summer or fall and a partial molt of the head and throat in the spring (Stanford, 1957).

Of additional interest in *Coturnix* is the relation of the post-juvenal wing molt to the post-juvenal body molt. In North American gallinaceous birds the wing molt begins before the body molt, but both reach completion at approximately the same time (Dwight, 1900). In Bobwhites, for example, the wing molt begins at four weeks of age and is completed at fourteen and one-half weeks of age when the eighth primary is shed (Petrides and Nestler, 1943). The ninth and tenth primaries are not shed until the post-nuptial molt of the next year. The body molt begins at seven to eight weeks and is completed at approximately 15 to 16 weeks (Stoddard, 1931). However, in *Coturnix* the relation between the wing and body molt is somewhat different. Both wing and body molt begin at approximately the same time, but the body molt is complete at eight to nine weeks while the wing molt may continue until the twenty-fifth week, and in many cases may still be in progress when the second post-juvenal (second prebasic) molt begins. This suggests that in *Coturnix* at least, the post-juvenal wing molt should be regarded as a separate molt and that it may not be controlled in the same fashion as is the post-juvenal body molt.

SUMMARY

Growth and plumage development of pen-reared migratory Japanese Quail are described and compared with Bobwhites reared under the same conditions.

In young *Coturnix* an extra molt and plumage were noted and termed the first post-juvenal molt and the second juvenal plumage, respectively. The molt begins on the ventral, humeral, and femoral tracts at approximately three weeks of age and coincides with the post-juvenal wing molt. The molt is complete with the exception of the primaries, and the birds are in full second juvenal plumage at approximately eight to nine weeks of age.

The age at which the next, or *second* post-juvenal molt, begins apparently is influenced by the date of hatching. Birds hatched late in the season begin to molt at a younger age than do early hatched birds. Early hatched birds required a longer period to complete this molt.

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997 PAMMEL COURT, IOWA STATE UNIVERSITY, AMES, IOWA, 31 DECEMBER 1960

NEW LIFE MEMBER

Phyllis L. Hurlock, of Coatesville, Pennsylvania, is a new Life Member of the WOS, having joined as an active member in 1959. She is also a member of the West Chester Bird Club, the Cooper Ornithological Society, and the Wilderness Society, and is a life member of the AOU and the National Audubon Society. Miss Hurlock is a graduate student at Drexel Institute and serves as Librarian at the Downingtown Joint Junior High School. Her principal interests in ornithology include studies of bird populations, especially their composition and trends.

MOLT, AGE DETERMINATION, AND ANNUAL CYCLE IN THE CUBAN BOBWHITE

George E. Watson

As a preliminary to a study of the variation of characters within the Cuban population of the Bobwhite (*Colinus virginianus cubanensis*) it was necessary to establish the sequence of molts and plumages and the annual cycle in order to age individual specimens. Some of the findings were interesting enough of themselves to warrant publication.

Studies of the molts of U.S. populations of Bobwhite have been carried out by Dwight (1900), Stoddard (1931), Leopold (1939), Petrides and Nestler (1943), and Thompson and Kabat (1950). Dwight and Stoddard found a complete adult molt during the fall and a partial molt of the head and throat in the late spring. The others have dealt mainly with the value of the method of primary feather replacement as an indication of age of birds up to one year old. Differences in timing of both molts and the extent of the spring molt were found between the U.S. and Cuban populations during the present study.

The pterylosis of the Bobwhite has never been adequately studied. Clark (1899) gives a small plate showing the main feather tracts, but the discussion is superficial. Brewer (1961) mentions a dorsal apterium in the species. Since no clipped alcoholic specimens of Cuban Bobwhite were available, no pterylosis study of the population was attempted.

MATERIALS

One hundred thirty Cuban Bobwhite study skins were assembled from the following museums: United States National Museum, American Museum of Natural History, Chicago Museum of Natural History, Museum of Comparative Zoology, and Yale Peabody Museum. Specimens were available from every month. Of this number, one was still mostly in the juvenal plumage, 70 were birds of the year, and the rest were adults; 44 were females and the rest males (see Table 1). Breeding data were available only for 11 Peabody Museum specimens collected in 1955. In addition, specimens of Florida and Mexican Bobwhite and Black-throated Bobwhite, *Colinus nigrogularis*, were examined for comparison.

METHODS

For study of the molt, the birds were separated into the following age groups on the basis of plumage and molt characteristics; juvenal, first year, and adult. Birds in each of these age classes were then arranged by month. Each specimen was carefully examined for molt. The feathers were lifted

TABLE 1

OCCURRENCE AND NATURE OF MOLT BY MONTH IN CUBAN BOBWHITE SPECIMENS

	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Totals
First-year ♂♂		XX 0		XXX	00	---	--0 000 0	000 000 000 00	-00 000 00	-00 000	0	0	45
Adult ♂♂	X	XX	X	XXX XXX	-00	000 000	--0 000	-0	000 0	000 000 0	0	-0	41
First-year ♀♀		XXX X (juv.)		XX	X00	-00	-	--0	-00 000 0	-0	-		26
Adult ♀♀		0X	X	XX	X	XX	000	00	-00			00	18

- indicates specimen shows no molt; 0 = body molt only; X = body, wings, and tail in molt.

using a pointed probe or narrow forceps in order to disclose pinfeathers or the bases of vanes still in sheaths.

Nomenclature of molts and plumages in this study follows that of Humphrey and Parkes (1959). Each molt is named for the plumage it renews. In the Bobwhite, which has two molts a year, the sequence is as follows (Dwight's terms are included in parentheses where they differ):

Plumage	Molt
Natal	(Postnatal)
Juvenal	First Prebasic (postjuvenal)
First Basic (first winter)	First Prealternate (first prenuptial)
First Alternate (first nuptial)	Second Prebasic (first postnuptial)
Second Basic (second winter. adult)	
Second Alternate (second nuptial, adult)	

Since the material studied consisted of birds undergoing the first prebasic or later molts, natal down and juvenal plumage are mentioned only when retained on these specimens. The descriptions of molts and plumages apply to both males and females since no appreciable difference in sequence or molting pattern was found due to sex. Slight timing differences, however, are suggested by the data.

Numbering of the remiges follows the American system (e.g., Petrides and Nestler, 1943). Counts were made centrifugally from the short axial secondary as a point of reference in order to avoid missing any molting remiges. The 10 primaries are numbered distad and the nine secondaries mediad, with the five shorter innermost remiges termed tertials. Since no detailed pterylosis study was made, areas of apparent plumage are designated rather than feather tracts.

AGING

The light-colored juvenal plumage is distinct enough to be instantly recognizable (Dwight, 1900; Stoddard, 1931; Petrides and Nestler, 1943). The first basic plumage, however, is not at once separable from the perfected plumage. Since the outer two pointed juvenal primaries are retained until the second prebasic molt, birds still showing them are less than one year old (Dwight, 1900; Stoddard, 1931). The juvenal primary coverts, which, with the exception of the outer two arc white tipped, are likewise retained and have been considered far more reliable for aging quail in which primaries may be broken (Van Rossem, 1925; Leopold, 1939; Petrides and Nestler, 1943). Adult Primaries 9 and 10 are rounded; adult primary coverts lack whitish tips and are wider than the juvenal coverts. These aging characters are apparently also valid for the Cuban Bobwhite population.

A further clue is the retention of a few of the juvenal flank feathers in fall individuals which have not yet completed the first prebasic molt. The problematic specimen, however, is the year-old bird undergoing its second prebasic molt. The outer primaries are the last to be molted and regrowth is slow so that a bird may still show the juvenal first and second primaries and yet be in almost complete second basic body plumage. Birds which have just completed the first prebasic molt, however, are in full fresh plumage with the outer two primaries at approximately the same stage of wear as the other primaries. In birds more than a year old, the primaries have undergone extreme foxing and wear near the tips, especially in males which drag the wing tips on the ground during courtship strutting (Stoddard. 1931). Worn primaries appear almost buff distally rather than uniform greyish brown throughout.

FIRST PREBASIC MOLT

The juvenal plumage, with the exception of the outer two primaries and the primary coverts, is completely replaced during the late summer and fall following hatching. The first sign of this molt is the replacement of the innermost primary (1) which begins at about the same time as the initiation of growth by the outer two juvenal primaries (9 and 10). Primary replacement proceeds distad in regular order and only one or possibly two new basic primaries are in growth at any given time. The outer two juvenal primaries, which complete growth with first basic Primary 5, are not replaced in this molt but are retained until the second prebasic molt. The juvenal primary coverts are also retained.

Replacement of the secondaries begins with No. 3 and proceeds mediad and finally distad, Nos. 2 and 1 being shed last and replaced about the same time as Primary 8. The tertials are replaced before the inner secondaries; the juvenal alula is shed with Primaries 7 and 8.

Body molt begins at the sides of the upper breast while Primaries 3 and 4 are being replaced and when the bird is about half adult weight. Feather replacement spreads over the rest of the breast, upper back, and to the sides and flanks. These areas may show numerous first basic feathers while the head and nape still have remnants of the natal down. At the height of molt, active feather growth takes place in all tracts simultaneously. The belly, crown, cheeks, and throat are the last portions of the body to complete the first basic feathering.

All the rectrices are shed almost simultaneously after the completion of growth by the outer two juvenal primaries and at about the time of the completion of growth by basic Primary 6. They are quickly replaced. The fresh upper and under tail coverts are fully grown before the rectrices are shed and extend up to 25 mm beyond the tips of the growing tail stub. Apparently, the Bobwhite is the only North American galliform for which such a mode of tail replacement in the first prebasic molt has been described (Petrides and Nestler, 1943). Two adult male British Black Grouse (*Lyrurus tetrix*), examined in the Berwyn Mountains of North Wales on 29 August 1960, also had shed and were regrowing all the rectrices simultaneously (see also Witherby et al., 1940). In the adult Bobwhite, however, the tail molt is the same as that described for most of the other Galliformes with a centrifugal loss and replacement. In first prebasic molt, the Chachalaca (*Ortalis vetula*) has a centripetal first prebasic tail molt, and subsequently centrifugal (Petrides, 1942). Timing of the molt of various portions of the plumage is shown in Fig. 1.

All earlier authors imply that the system of regrowth of the juvenal and first basic primaries in U.S. quail is invariable; the outer two juvenal primaries are retained while the rest of the remiges are replaced during the first prebasic molt. Thompson and Kabat (1950), however, found that a sizable proportion (exact ratio not given but probably near 30 per cent) of first-year birds trapped in Wisconsin during the winter of 1947–1948 had an arrested primary molt which stopped at No. 7, but that only one out of 87 had an arrested molt in 1946–47. One specimen in each of the two-year samples was found to have the primary molt extended to No. 9. That these were young birds was verified by the retained juvenal primary coverts. Three adults in their two-year sample also showed arrested primary molt. The authors suggest

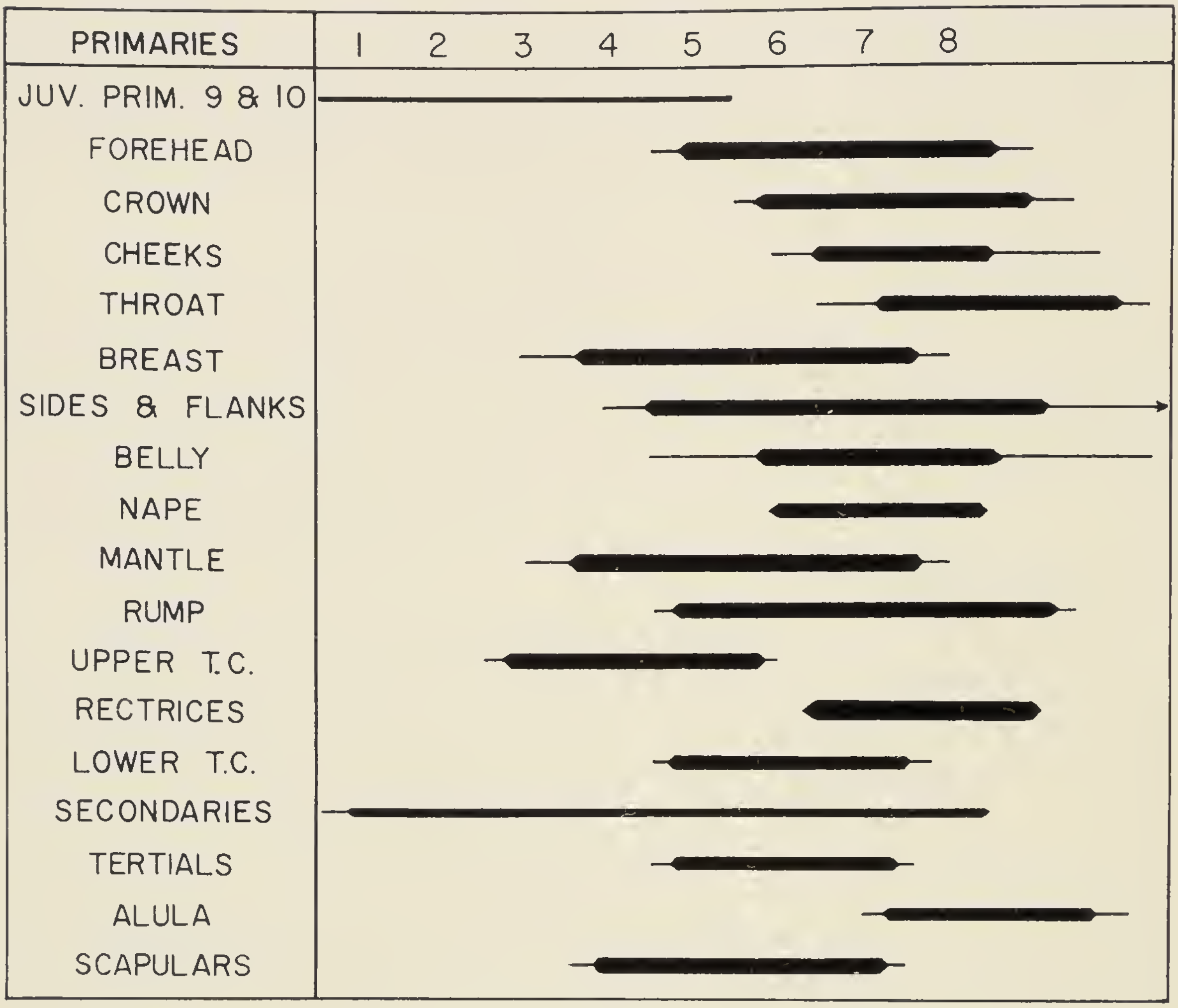

FIG. 1. The relation of first prebasic molt in various parts of the feather coat to the primary schedule in Cuban Bobwhite.

that the onset of cold weather stopped the molt in late-hatching individuals and that temperature acting on the thyroid may thereby control the initiation and extent of molt. Arrested molt in adult primaries and secondaries has also been described in the Blue Grouse (*Dendragapus obscurus*) in British Columbia (Bendell. 1955), and in the Chukar Partridge (*Alectoris chukar*) in New England (Watson, MS).

There is only one possible case of arrested second prebasic molt in a male Cuban Bobwhite and none in first-year birds. On the other hand, three male and five female Cuban specimens in the present first-year series of 45 and 26 retain only one pair of outer juvenal primaries. In two of these cases, one male and one female, only one ninth primary has been dropped (in one case the right, in the other the left). In all eight specimens, all the juvenal primary coverts are retained, indicating that the specimens are, in fact, in first basic plumage rather than undergoing second prebasic molt. In addition, most are spring birds. It seems highly improbable that bilateral loss of Primary 9 could occur fortuitously without loss of No. 10. It appears, therefore, that occasionally the wing molt of Cuban Bobwhites may be extended to include another primary. The possibility that this extension may be correlated with higher winter temperatures in Cuba suggests itself. Three of these specimens were collected in 1900, two in 1906, one in 1913, and two in 1948. The latter three of these years show higher than average November and December mean temperatures but the correlations are at best slight. Based on data supplied by the United States Weather Bureau, the mean monthly temperatures (in °F) for the 20-year period 1931–1950 at Havana, Cuba are November: 74.8 and December: 72.8. The mean temperatures during November and December of the autumn preceding the years with extended molt birds were 1889: 74.6, 71.3; 1905: 76.3, 73.1; 1912: 75.0, 74.8; and 1948: 77.9, 74.0. Both monthly means were below average in 1899, but both were above for the other three years. This evidence is hardly proof, but a few data on primary molt in wild and domestic Turkeys suggest that in that species, too, southern forms may have a more extensive primary molt. The northern race of the wild Turkey (*Meleagris gallopavo silvestris*) has the normal galliform pattern with the outer two juvenal primaries retained, but in the Florida race (*M. g. osceola*) and in the domestic Turkey, Petrides (1942) and Leopold (1943) found that only the outer juvenal primary is retained while Primary 9 is dropped during the first prebasic molt. The domestic Turkey is regarded as descended from the southernmost populations of the species (Latham, 1956). The same molt pattern is also found in the Ocellated Turkey (*Agriocharis ocellata*) in Yucatan (Petrides, 1945, and confirmed by a series in the Peabody Museum). Smith (1961) found an extended primary molt in the Chukar Partridge in Utah.

The time of start of the first prebasic molt is probably determined by date of hatching (Petrides and Nestler, 1943), and its course and duration perhaps by such additional environmental factors as temperature, humidity, and food supply. An early maturing individual collected on 22 September 1917 is in fresh first basic with no traces of juvenal plumage except Primaries 9 and 10 and the primary coverts. Other fall specimens have not yet reached this stage in November and some even in December. The first prebasic molt is complete by early January when all male first-year specimens examined show no evidence of feather replacement.

SECOND PREBASIC MOLT

Three males and one female (12 August 1955, 18 November 1911, 4 December 1913, and 26 September 1930) are definitely identifiable as undergoing the second prebasic molt. In the first male, Primary 3 is half grown, in the second, Primary 9 is three-quarters grown, and in the third, it is half grown,

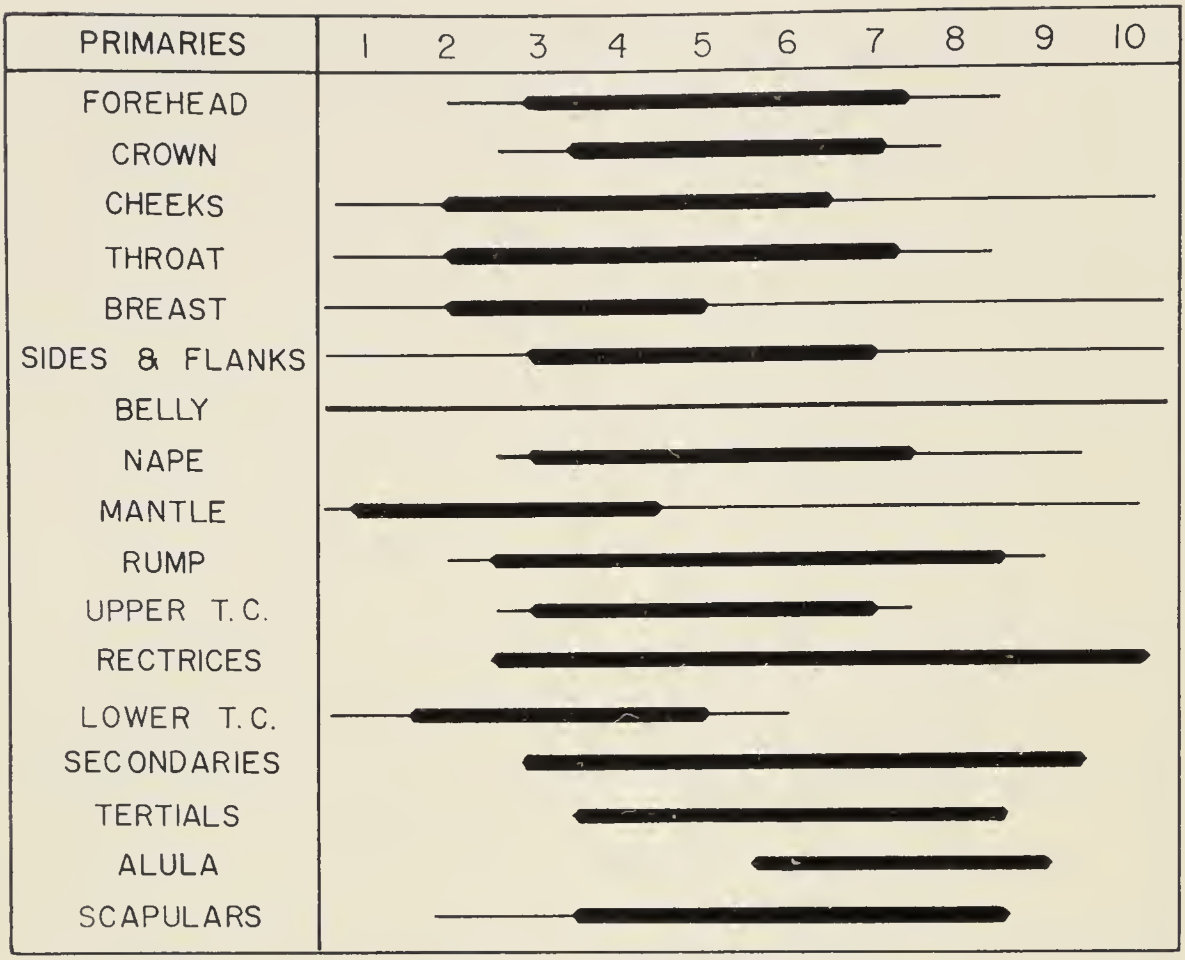

Fig. 2. The relation of adult prebasic molt in various parts of the feather coat to the primary schedule in Cuban Bobwhites.

while in both the latter the juvenal outer primary is still retained. The throat, upper breast, and back are also in molt in these two specimens. The female has just begun the molt; Primary 3 is just appearing.

ADULT PREBASIC MOLT

The first indication of the prebasic molt in the adult male is the replacement of the innermost primary. The rest of the primaries are replaced in regular succession progressing distad so that when the outer one is fully regrown, the molt is just about complete. Whereas, in the first and second prebasic molts, usually only one or two primaries grow at a time, as many as four may be simultaneously in growth in adults. Figure 2 shows the approximate correlation of the molt in the other tracts with this primary schedule. During the period of molt of Primaries 4–7 nearly all tracts show heavy regrowth of pinfeathers. Molting of the secondaries begins with No. 3 and usually progresses mediad, with Nos. 2 and 1 completing the sequence after No. 10. Miller (1941) attributes such a sequence to feather crowding in the wrist region of short-winged birds. The order of the inner secondary molt may vary both individually and from wing to wing on the same individual.

Body feather replacement begins on the breast, head, and mantle and in general progresses posteriorly from a molt center in a tract. In the adult, the head and neck are molted early, while these areas are retarded until the end of the prebasic molt in first fall birds. The under tail coverts are replaced early in the molt and the upper tail coverts soon thereafter. These coverts may possibly act as substitutes or braces for regrowing rectrices during flight. The tail is molted late, and instead of all the rectrices being dropped simultaneously as in the first prebasic molt, the central pair is shed first and molt proceeds centrifugally, the outer pair (Nos. 6–6) being complete at the time the outermost primary is dropped. This growth is not entirely regular and individuals may show asymmetric tail growth.

In some individuals, the prebasic molt may be completed in December, but molting specimens are common in January, February, and March. It is therefore difficult to define precisely the end of the prebasic molt and the start of the prealternate molt in this population. In the individual, perhaps, there is a well-defined period of cessation of molt as was apparently found by Dwight and Stoddard in U. S. quail. A good criterion for distinguishing the two molts in adults is the state of wear in the primaries and rectrices. A bird with fully grown fresh remiges and rectrices which is renewing the forehead, chin, and center of the throat is probably in the prealternate molt since these are among the early portions of the plumage to complete the prebasic molt (mostly with Primary 7). In first-year birds, since the head and throat are among the last regions to assume the first basic feathering, this method of distinguishing the two molts cannot be used.

FIRST PREALTERNATE MOLT

The first prealternate molt is probably of varying intensity throughout the population; some individuals may molt far more extensively than others. First-year males collected in January and a few collected in February are not molting, but some early February birds show molt on the chin and throat, and later examples on the upper breast and sides of the neck. In early March birds, in addition, pinfeathers are present among the ear coverts, superciliaries, nape, and mantle, while later in the month, areas in molt include the crown, forehead, back, sides of breast, flanks, and belly. No spring-collected specimens are molting any wing or tail feathers. A few specimens collected in April show little or no feather replacement and may have completed the prealternate molt, but some May, June, and July examples are still molting.

ADULT PREALTERNATE MOLT

The adult prealternate molt usually involves the chin, throat, head, breast. upper back, nape, and, in some individuals at least, feathers of the lower back, flanks, and sides of the belly. The molt may start as early as January; all April, May, June, and one July specimen in the series show evidence of molt.

Direct evidence for a prealternate molt in first-year as well as in adult birds is lacking and its occurrence must be inferred. Even using a 12-power lens, I cannot distinguish on morphological grounds alternate from basic feathers on the breast, flanks, and mantle, the three areas where such a molt has not previously been found in Bobwhites. Moreover, first basic feathers in these areas are no different from perfected feathers of later molts. Dwight (1900) and Stoddard (1931) do not mention characters for distinguishing feather generations. Individual feather color and pattern characteristics are useless in such a highly polymorphic population; such characters as buff feather tips are apparently due to individual differences.

Three possible interpretations may, therefore, be made of specimens molting during the spring: (1) They may be late individuals still undergoing the first prebasic molt. (2) An interruption in the regular sequence of the prebasic molt may have taken place so that the birds molts partly; stops in the late fall, and then resumes molting in the spring. (3) This may be a prealternate molt, more extensive than the one that Dwight and Stoddard described for U.S. populations of the species.

The available evidence on the matter is as follows:

1. A large proportion (82 per cent) of specimens from February through May are molting.
2. Some specimens (especially male birds-of-the-year) from January, February, and March are not molting.
3. There is no molt of the remiges or rectrices during the spring.
4. Portions of the body are in molt which have already undergone a fall prebasic molt in other individuals and which are fully covered with fresh feathers in January and February specimens. During the fall molt, regrowth in these same areas is correlated with regrowth of specific remiges.

This evidence, plus the fact that both Dwight and Stoddard claim on the basis of their studies of living captive birds that a prealternate molt follows a midwinter cessation of molting, suggests that the third conclusion may be true: that this is a prealternate molt, more cxtensive than that described for U.S. Bobwhites.

Dwight and Stoddard found only a limited prealternate molt about the head and throat of U. S. Bobwhites. Dwight points out, however, that spring specimens were scarce in the collections he examined due to a curtailed spring season. In Pennsylvania, for instance, spring hunting of Bobwhites has been restricted since 1838 (Latham and Studholme, 1952). Stoddard (1931:8) found birds with the appearance of "being in molt at the wrong season." This he attributed to accidental loss of loose feathers. He might possibly have been examining birds undergoing a more extensive prealternate molt than he had expected on the basis of Dwight's work. The extension of the prealternate body molt of the Cuban quail, however, may also indicate that a marked physiological adjustment, genetically determined, has taken place in the Cuban population not found in the Florida or other more northern populations. This may be an adaptation to increased wear and heavy summer rain in the southern part of the species range. The extreme wear of the unmolted remiges and rectrices of summer specimens supports this conclusion. The molt of the Mexican and other southern populations of Bobwhites should also be investigated to ascertain whether they, too, show a more extensive prealternate molt. Cursory examination of four specimens of *Colinus virginianus thayeri* collected in Chivela, Oaxaca, from 27 March to 6 April 1927, does suggest that such may be the case. The head, throat, nape, mantle, breast, and rump show feather replacement in progress in both adult and first-year birds. This is especially interesting since some quail specimens from Cuba closely approach *C. v. thayeri* in color and pattern and a Mexican origin is postulated for some of the birds introduced into Cuba (Gundlach, 1893).

The extended primary molt in some individual Cuban quail, and in some southern Turkeys mentioned above, seems to parallel the extended prealternate molt. Geographic variation in molt is also known in other species. Salomonsen (1939) found that various populations of the Rock Ptarmigan (*Lagopus mutus*) differed in the extent of the three molts per year depending on climatic conditions. Pitelka (1945) demonstrated geographic variation in extent of the first prebasic molt in jays of the genus *Aphelocoma*. Lynes (1930) found marked geographic differences in the presence or absence of the prealternate molt within various species of *Cisticola*. In equatorial Africa only one yearly molt takes place, but temperate zone populations undergo a prealternate molt. In intermediate populations, an increasing percentage of individuals show prealternate molt the farther they are from the Equator. The same is true in *Prinia subflava* in the Congo (Chapin, 1953), and in three African members of the genus *Ploceus* (Moreau, 1960) in which the prealternate molt is acquired mostly by savanna-inhabiting forms.

FEMALE MOLTS

Specimens of females are far fewer in the sample than males but the evidence indicates that the order of feather replacement and sequence of the plumages is the same as in the male of the corresponding age. Although the prealternate molt may not be quite as extensive as in the male, it is certainly more than previously described by Dwight (1900), who found that U.S. female quail also had a less extensive prealternate molt than U.S. males. The female tends to molt slightly later than the male (see Table 1).

TIMING OF MOLTS

Although the data are meager, it appears that both molts occur slightly later and the prealternate molt may be more prolonged in Cuba than in the Florida Bobwhite populations studied by Stoddard. The dates he gives for molts are prebasic, August to November; and prealternate, February to May (most March and April). In Cuba, specimens collected in all years grouped together, nearly all adult males were in primary or tail molt from August to December and in body molt from January to July. Therefore, individuals in the population may molt in any month of the year. In a given year, although it is possible that the periods of molt are far more restricted, the evidence suggests that the molts in Cuban quail are more prolonged. Of 13 adult males collected from August to early December, only one December specimen is not in prebasic molt. Of 28 January-to-July specimens, four (two February, one March, and one July) are not in prealternate molt. Among the males in first basic plumage, both December specimens are still finishing head (first prebasic) molt, all three January specimens are not molting, and two of the seven February specimens have not yet begun the prealternate molt. Otherwise the molt timing is the same as in the adult males with the prealternate molt extending into July. The smaller female sample suggests that they too have more prolonged molts than Florida females. It is possible that lower January mean temperatures in northern Florida (54.5 F in Tallahassee) where Stoddard's birds were captured has tended to retard the start of the prealternate molt. January mean temperature in Havana is 72.4 F. Retaining a full feather coat during the coldest month of the year is probably of adaptive significance to the northern Florida quail. It is perhaps also significant that first-year Cuban quail similarly tend to retain full plumage in January. If there is a refractive period in the natural molt of an individual papilla (Assenmacher, 1958), then such a lag in initiation of first prealternate molt may be otherwise explainable. The head is always the site of start of the prealternate molt; but it is the last area to complete the first prebasic molt in yearling birds. The head feather papillae then may need a month's refractive period before growth is reinstituted. Prebasic molt is complete on the head of adult birds relatively much earlier.

WEAR

Newly molted body plumage in the fall is fresh and bright in both sexes. The tips of the body feathers tend to become worn or broken with time, however, and some spring specimens no longer show broad gray edges to the mantle feathers. Faint white or buff edging on breast or crown feathers usually disappears in the late spring. Color changes on the breast and flanks are minimal although the intense black of the male's upper breast and head is usually dulled by midsummer. The wings and tail show the greatest evidence of wear and color change with time. The secondaries and especially the outer primaries change from grayish brown to nearly buff at the tips by summer and are very frayed, often with broken tips. Such breakage, especially noticeable in males which have finished spring display posturing, obscures the pointed tips of the juvenal primaries, and necessitates the use of the primary coverts as an aging character. The rectrices become broken or worn so severely that they may lack barbs and not extend beyond the new incoming tail coverts in the early fall.

BREEDING SEASON

Direct evidence of breeding season timing from adult specimens is meager. In 1955, males were collected on 12 August and 10 September which had enlarged testes and had probably recently bred. The first is a first-year bird. A female collected on 10 September was in the process of laying. All November-collected birds had regressed gonads.

A juvenal female just beginning first prebasic molt and weighing 90 grams was also collected on 10 September, while two males showed nearly completed first prebasic molt on 28 September. Because of the range in developmental rates found by both Stoddard (1931) and Petrides and Nestler (1943), these young birds can only be aged within two or three weeks as two and four months, respectively. Several other family groups with young chicks were observed all through September in Pinar del Rio. This evidence would give a minimal breeding season during 1955, lasting from early June to late September and based on a very small sample. Breeding information is not recorded on any of the other specimens from earlier years. Bond (1936), however, states that "in early spring the birds pair, the nesting season lasting from April until July."

Stoddard (1931) and Bent (1932) give a six-month range from April to October for the breeding season of U.S. quail, but this includes records from several years. The most important nesting months are May through August. Late breeding records are attributed by Stoddard (1931) and Latham and Studholme (1952) to second attempts at nesting following destruction of the first brood. Therefore, the height of the quail breeding season may tend to be slightly later in Cuba than in the southern U.S. but it covers approximately the same range of time.

MOLT AND THE BREEDING SEASON

Molting is a complex physiological event in the life of a bird, probably temporally related to other cyclic events such as breeding, but not necessarily directly influenced by the gonads. Evidence available from various species of birds, mostly domestic chickens, implies that although gonadal hormones may help to determine timing of molt through temporary inhibition, the thyroid hormone directly initiates molt (see review by Assenmacher, 1958). Mewaldt (1958) found that some Clark's Nutcrackers (*Nucifraga columbiana*) started molting before the eggs were laid. In California Quail (*Lophortyx californicus*), Genelly (1955) found that the inception of female molt occurred well after hatching of young. In the Cuban Bobwhite collected in 1955, some body feathers were in sheaths on a laying female (10 September) and two males with enlarged gonads (12 August, 10 September) had already begun molting. In Bobwhite, therefore, prebasic molt may start, at least late in the season, before breeding activity has ceased. These may be second nesting attempts, and it is possible that early breeders may not molt until well after the chicks are hatched. This situation is in agreement with recent findings of independent hormonal control of breeding and molt in the yearly cycle and suggests that different thresholds for thyroid initiation and gonadal inhibition of molt exist in early and late breeding birds.

SUMMARY

One hundred thirty specimens of Cuban Bobwhites were examined for molt. First-year birds may be separated on the basis of the outer two pointed juvenal primaries and white-tipped primary coverts retained until the second prebasic molt. The Cuban Bobwhite undergoes two molts a year, a complete prebasic and a partial prealternate. The sequence and timing of these molts is described, and differences between the sequence of molt of various portions of the plumage in first-year and adult birds are pointed out. The prealternate molt in the Cuban population is far more extensive than that described for the Eastern U.S. populations, and it is suggested that this is a southern adaptation shared with some Mexican populations. The breeding season and its relation to the molting cycle is discussed. It is concluded that the two are not directly under the same hormonal control in this species.

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BREEDING BIOLOGY OF THE GADWALL IN NORTHERN UTAH[1]

JOHN M. GATES

The purpose of this paper is to describe the breeding behavior, nesting, renesting, and productivity of a population of Gadwalls (*Anas strepera*) studied in the Salt Lake Valley of northern Utah. Published reports of many studies include scattered information on Gadwall breeding biology. Examples are Williams and Marshall (1938), Miller and Collins (1954), and Anderson (1956) on nesting and production; Hammond and Mann (1956) on the ecology of nesting islands; and Sowls (1955) on migrational homing and renesting. However, to my knowledge there has not been reported a specific study of the breeding habits of the species.

AREA AND METHODS

Study area.—I made this study from March through August 1956 and 1957, at Ogden Bay Refuge, an artificial marsh located on the delta of the Weber River 12 miles west of Ogden, Utah. This 14,000-acre area was constructed during 1938–46 by the Utah Department of Fish and Game. It was built on flat recession lands surrounding Great Salt Lake, most of which were covered by salt water as recently as 20 years prior to construction (Nelson, 1954*a*: 13). Ogden Bay was created primarily to provide public hunting and to alleviate recurrent outbreaks of botulism in late summer due to unstabilized water levels. Following completion, it also became an important duck-nesting area. Nesting populations increased from 300 breeding pairs in 1941 to a peak of 3,500 pairs in 1953 (Nelson, ibid.:67).

At present, Ogden Bay consists of a system of large retaining dikes which impound the Weber River in two separate units. Inside each unit, water is distributed by a secondary system of smaller dikes to provide an interspersion of water with emergent and dry nesting cover. Downstream each unit includes a large, shallow lake serving as a feeding and resting area for migrant waterfowl. A more detailed description of the marsh and an account of the ecological changes in its biota after development is given by Nelson (ibid.).

Ogden Bay's elevation is approximately 4,200 feet. Its climate is semiarid; annual precipitation over a 40-year period averaged 14 in., a mean monthly low of 0.51 in. falling in July and a high of 1.72 in. falling in February. Its mean annual temperature over the same period was 64 F, with recorded ex-

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[1] Contribution of the Utah Cooperative Wildlife Research Unit: U.S. Fish and Wildlife Service, Wildlife Management Institute, Utah Department of Fish and Game, and Utah State University cooperating.

tremes of –25 F and 106 F. Growing seasons average 160 days in length (U.S. Dept. Agr. Yearbook 1941).

I chose a 450-acre area in the northeast corner of the Unit 1 impoundment for my intensive studies of Gadwall nesting. The study area is an upland tract, but includes a number of seasonally flooded and permanent ponds, and is transected by numerous small ditches and a former channel of the Weber River. High ground during the spring runoff is limited largely to channel and dike banks which support rank growths of upland forbs and grasses. This cover type, 10 per cent of the area, is heavily used for nesting, especially early in the season when water levels are still high. Common cattail (*Typha latifolia*), 24 per cent, and bayonet-grass (*Scirpus paludosus*), 5 per cent, occupy low areas that remain wet throughout the growing season, and spike-grass (*Distichlis stricta*), 41 per cent, dominates intermediate elevations between upland and emergent aquatic vegetation. About 20 per cent of the area consists of temporary and permanent ponds and ditches.

Approximately 40 pairs of Gadwalls bred on the area during each year of the study. Waterfowl nesting there in order of decreasing abundance were: Cinnamon Teal (*Anas cyanoptera*), Gadwall, American Coot (*Fulica americana*), Mallard (*A. platyrhynchos*), Shoveler (*Spatula clypeata*), Pintail (*Anas acuta*). Redhead (*Aythya americana*), Blue-winged Teal (*Anas discors*), Ruddy Duck (*Oxyura jamaicensis*), and Canada Goose (*Branta canadensis*).

Methods.—My study was based primarily on observation of marked hens. I trapped nesting hens with nest traps described by Sowls (1955:5–6) and marked them individually with multicolored, "Koroseal"-plastic neck tags of the type designed by Taber (1949). Eighty-three hens, including 17 nest-trapped outside the study area, were marked during the study.

Marked hens provided information on brood movements and renesting in 1956 and renesting in 1957. Fifteen 1956-tagged hens that returned in 1957 provided data on migrational homing and breeding-pair behavior. In 1957, to study renesting, I disrupted nests of marked hens at various stages of egg laying and incubation to simulate nest destruction.

I located nests by walking channel and dike banks and by dragging a long rope over nesting cover. I made observations of breeding pairs from an elevated blind on the nesting-study area. I took weekly censuses on the entire marsh during the spring migration and on the nesting-study area during the breeding season. Brood counts were made on the Unit 1 impoundment.

SPRING ARRIVAL

Spring migration.—Spring migration during 1956 and 1957 followed the same pattern (Fig. 1). Gadwalls first appeared in early March. Early arrivals

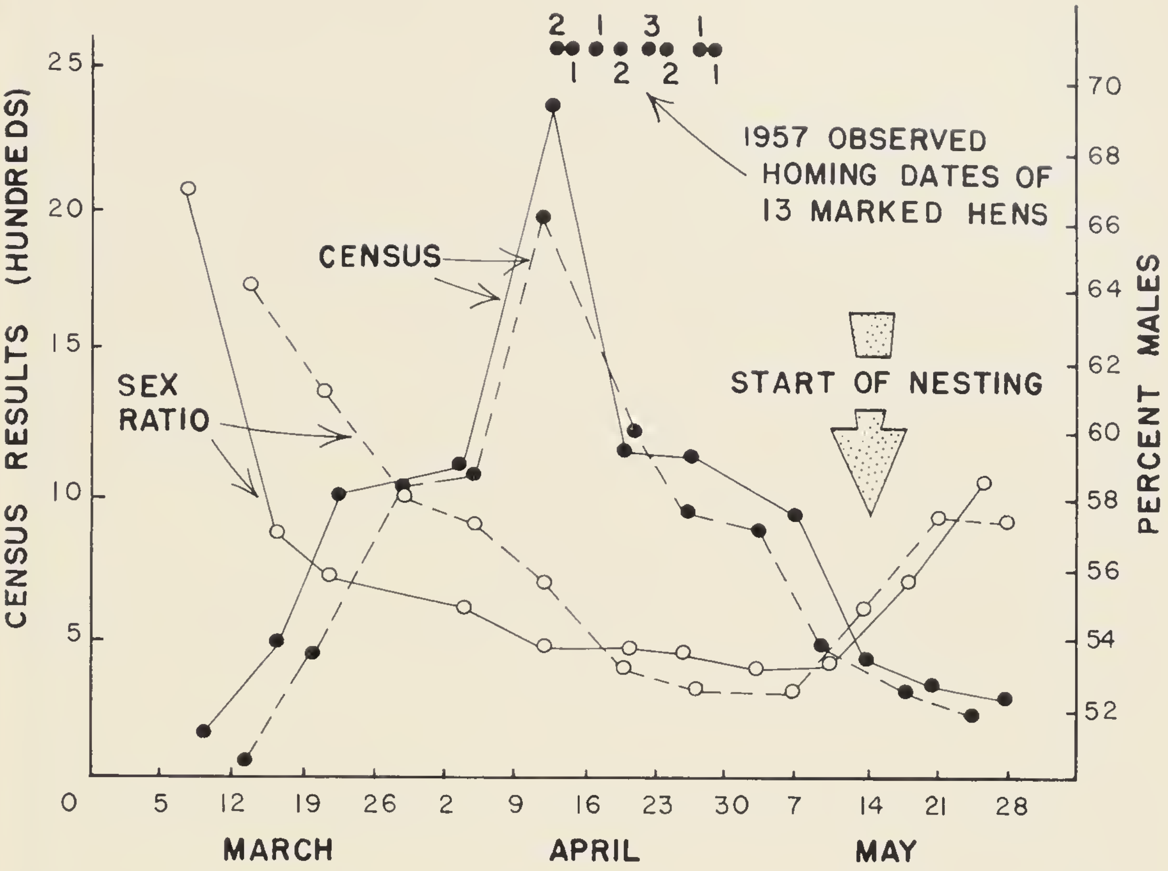

FIG. 1. Results of weekly spring censuses of Gadwalls at Ogden Bay Refuge, 1956 and 1957. Solid lines refer to 1956 data, broken lines refer to 1957 data.

were mostly unpaired and made up largely of drakes. The main passage of Gadwalls occurred during a short period in mid-April and was composed almost exclusively of mated pairs. In both years, spring migration was finished by mid-May. Continued declines in weekly census results after mid-May occurred as some pairs moved to nesting habitats not censused, and others left the marsh to breed on surrounding farmlands. An increased evidence of drakes after mid-May was due to the start of nesting and the onset of territorial behavior. Resident populations of Gadwalls on the marsh eventually numbered 210 and 208 pairs for 1956 and 1957, respectively (Nelson. 1956. 1957).

Gadwalls were among the last ducks to reach Ogden Bay in spring. The chronology of spring migration peaks observed during the study was Mallards and Pintails in late March; Cinnamon Teal, Redheads, and Lesser Scaup (*Aythya affinis*) in early April; Gadwalls in mid-April; followed by Blue-winged Teal and Ruddy Ducks in late April.

Arrival of residents.—Fifteen hens nest-trapped on and adjacent to the study area in 1956 returned in 1957, 13 of which I identified before the start of nesting. Resident hens apparently arrived with the main spring flight of

Gadwalls that occurred in mid-April (Fig. 1). Each of the 13 marked hens was paired at arrival.

The return of adult hens in this study was not in accord with Sowls' (1955: 13–17) findings. At Delta, Canada, he found that Mallards and Pintails which later nested on his area were the first to arrive in spring. The arrival of residents preceded the main flight of migrants by as much as a week. Disagreement between Sowls' findings and those of my study is difficult to explain. Possibly the difference in latitude between Delta and northern Utah, or the differences in species studied are involved. Few Gadwalls were known to winter at Ogden Bay, but the area's close proximity to major Gadwall-wintering areas in central California (Jensen, 1949) might somehow account for the departure from the pattern of spring arrival observed by Sowls on a study area more distant from wintering areas.

Migrational homing.—Fifteen (29 per cent) of the 52 nesting hens marked in 1956 nested at Ogden Bay again in 1957. This does not indicate the actual rate of homing, however, since no allowance is made for the number of hens that did not survive between years.

I have estimated the annual survival rates of Gadwalls from northern Utah by arranging 87 recoveries of 831 Gadwalls banded in the Salt Lake Valley between 1929 and 1953 (344 banded at Bear River Refuge by the U. S. Fish and Wildlife Service, and 414 at Ogden Bay Refuge and 73 at Public Shooting Grounds by the Utah Department of Fish and Game) in a dynamic life table (Hickey, 1952) (Table 1). The bandings consisted of flightless young caught in late summer and of birds treated for and fully recovered from botulism. Many of the latter group were unaged at banding. Thus it was necessary to consider recoveries of aged and unaged birds separately and to omit first-year recoveries of unaged birds from the calculations.

The actual 1956–57 rate of homing is calculated at 60 per cent, based on 48 per cent as the expected survival rate of adult hens (Table 1). I regard this as a minimal estimate of the rate of homing, since it is unlikely that every returning hen was found. In addition, I knew of four individuals that lost neck tags between nesting seasons, and the actual loss of tags probably was even greater. However, it is apparent that at least a majority of the surviving hens marked in 1956 returned in 1957. Sowls (op. cit.:31) observed similarly high rates of homing for adult Gadwall, Pintail, and Shoveler hens at Delta.

Adult hens eventually returned to the immediate vicinity of their original nest (= trapping) sites. The distances between 1956 and 1957 nest sites of 11 marked hens on the study area averaged only 365 yards, with extreme distances of 205 and 510 yards observed.

No information was gained in this study concerning the homing of drakes or juvenile hens. Sowls (ibid.:34–39), however, found the over-all rate of

TABLE 1

CALCULATION OF AVERAGE ANNUAL SURVIVAL RATES OF GADWALLS FROM BANDING IN SALT LAKE VALLEY, UTAH, 1929–53

Year after banding	No. reported shot		No. alive at start of year		No. alive at end of year	
	Banded as juveniles	Banded as adults or unaged	Banded as juveniles	Banded as adults or unaged	Banded as juveniles	Banded as adults or unaged
0–1	41	—	61	—	20	—
1–2	8	17	20	26	12	9
2–3	5	3	12	9	7	6
3–4	4	4	7	6	3	2
4–5	2	2	3	2	1	0
5–6	0	0	1	0	1	0
6–7	0	0	1	0	1	0
7–8	0	0	1	0	1	0
8–9	1	0	1	0	0	0
Totals	61	26	107	43	46	17
Totals exclusive year 0–1	20	26	46	43	26	17

Juvenile survival rate $= \frac{20}{61} = 33$ per cent. Adult survival rate $= \frac{26 + 17}{46 + 43} = 48$ per cent.

homing of juvenile hens of five species (Pintail, Mallard, Gadwall, Shoveler, and Blue-winged Teal) to be less than a third of that of adult hens. The ties to a specific nesting area which account for homing apparently are largely dependent upon a hen having nested there. In passeriforms also, Hickey (op. cit.:16–17) has pointed out the lower rate of homing of juveniles as compared to adults.

NESTING

Prenesting activities.—Resident Gadwalls arrived at Ogden Bay in mid-April (Fig. 1); however, large-scale nesting was delayed nearly until mid-May (Fig. 2). In 1956 and 1957, known first-egg dates were 1 May and 5 May, respectively. The interval between spring arrival and start of nesting, determined by back-dating nest histories of marked hens to first-egg dates, amounted to nearly a month in 1957 (Table 2). This delay consisted of a postarrival period of 17 days between spring arrival and establishment on a breeding home range (or territory) and a prenesting period of 11 days between the latter and start of egg laying.

TABLE 2
PRENESTING RECORDS OF 13 MARKED ADULT GADWALL HENS, OGDEN BAY REFUGE, 1957

Observed date of spring arrival	Observed date of establishment on breeding home range	Calculated date of first-egg laying
11 April	28 April	9 May
11 April	6 May	16 May
12 April	—	—
15 April	3 May	—
18 April	—	21 May
18 April	12 May	—
20 April	9 May	25 May
20 April	—	9 May
20 April	4 May	15 May
22 April	—	15 May
22 April	7 May	17 May
24 April	—	—
29 April	4 May	14 May

Mean
intervals 17 days 11 days

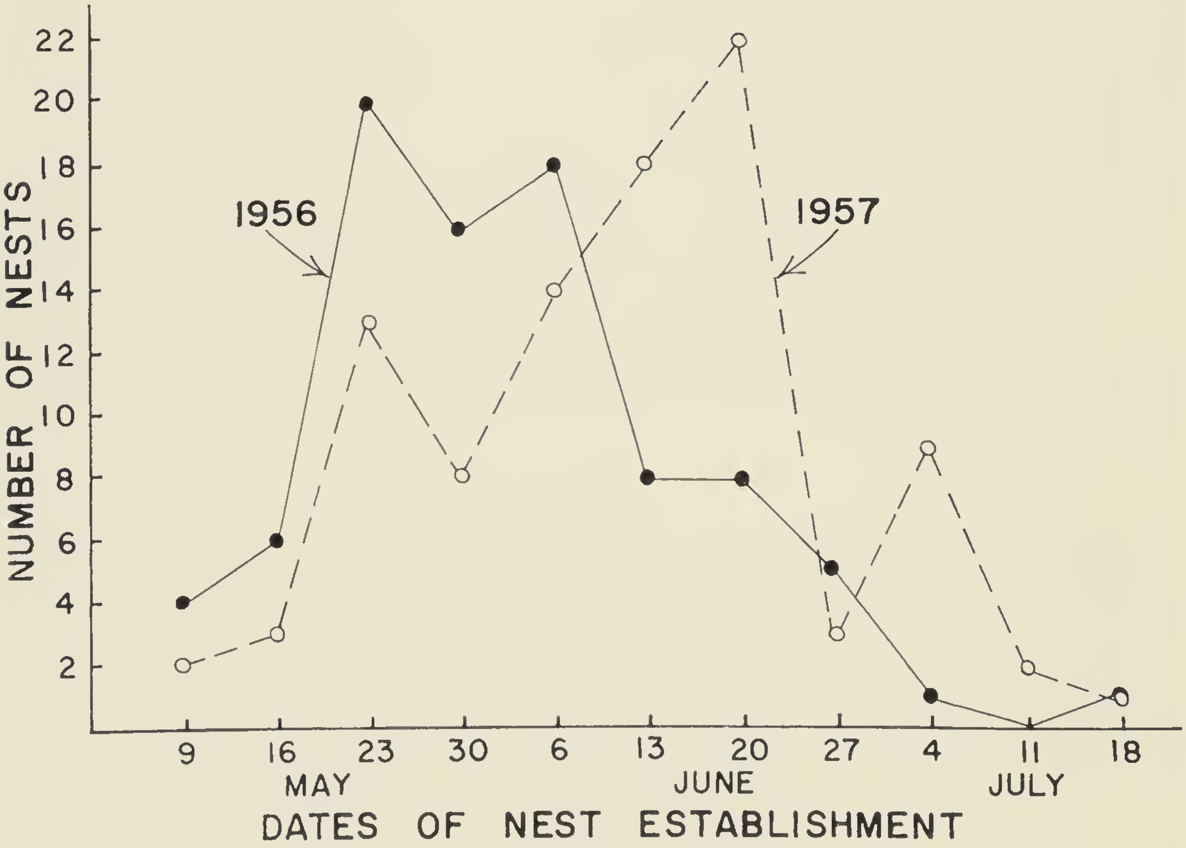

FIG. 2. Phenology of Gadwall nest establishment at Ogden Bay Refuge, 1956 and 1957. The distorted nesting curve in 1957 was the result of renesting experiments.

Resident pairs remained gregarious throughout the postarrival period. Usually I found them grouped with other pairs in small flocks of 2–10 which seemingly remained apart from the much larger flocks I considered to be migrants. At this early stage, I observed no sign of nesting behavior or intolerance between pairs.

Six neck-tagged hens were seen twice or more before the start of nesting, providing information on mobility following spring arrival. All were more than a half mile from where they eventually nested, and two hens were sighted nearly a mile and a half away. I observed none in the same area twice, except on what later proved to be their breeding home ranges. Thus it appeared that resident hens were considerably more mobile during the postarrival period than after they settled down to begin nesting. The nesting-study area, to which all hens originally trapped there eventually returned, was seldom used by Gadwalls before the start of nesting. It was an upland tract, without large feeding and loafing waters on which Gadwalls most commonly gathered in early spring.

Gregariousness ceased and intolerance began when resident pairs established breeding home ranges at the start of the prenesting period. A spacing out of breeding pairs became evident shortly after the earliest pairs took up residence on the study area. I was able to delineate home ranges by plotting the movements of five marked hens and their mates observable from my blind. In each case, breeding home ranges established by marked hens during the prenesting period in 1957 centered closely on their 1956 nest sites (Fig. 3).

In 1957, the movement of breeding Gadwalls onto the study area began in late April and continued until early June (Table 3). However, the eight marked hens (adults) I identified on breeding home ranges were first seen between 28 April and 12 May (Table 2). Thus adult hens were among the earliest to begin nesting. This timing may have been important in their ability to renew residence on specific areas. By being first to establish breeding home ranges in spring, adults probably avoided much of the competition for space occurring later in the season under higher breeding-pair densities which might have interfered with their homing.

Weather conditions during the springs of 1956 and 1957 did not depart from normal. In addition, the phenologies of both spring migration and start of nesting were similar in the two years (Figs. 1 and 2). Accordingly, the timing of Gadwall-breeding events described above appear to be typical for northern Utah.

I am unaware of comparable data on the timing of spring arrival and start of nesting for Gadwalls breeding elsewhere, and thus it is impossible to know whether the near-month interval between the two events observed in this study is characteristic of the species. From Sowls' (1955:12, 86) study, it is evident

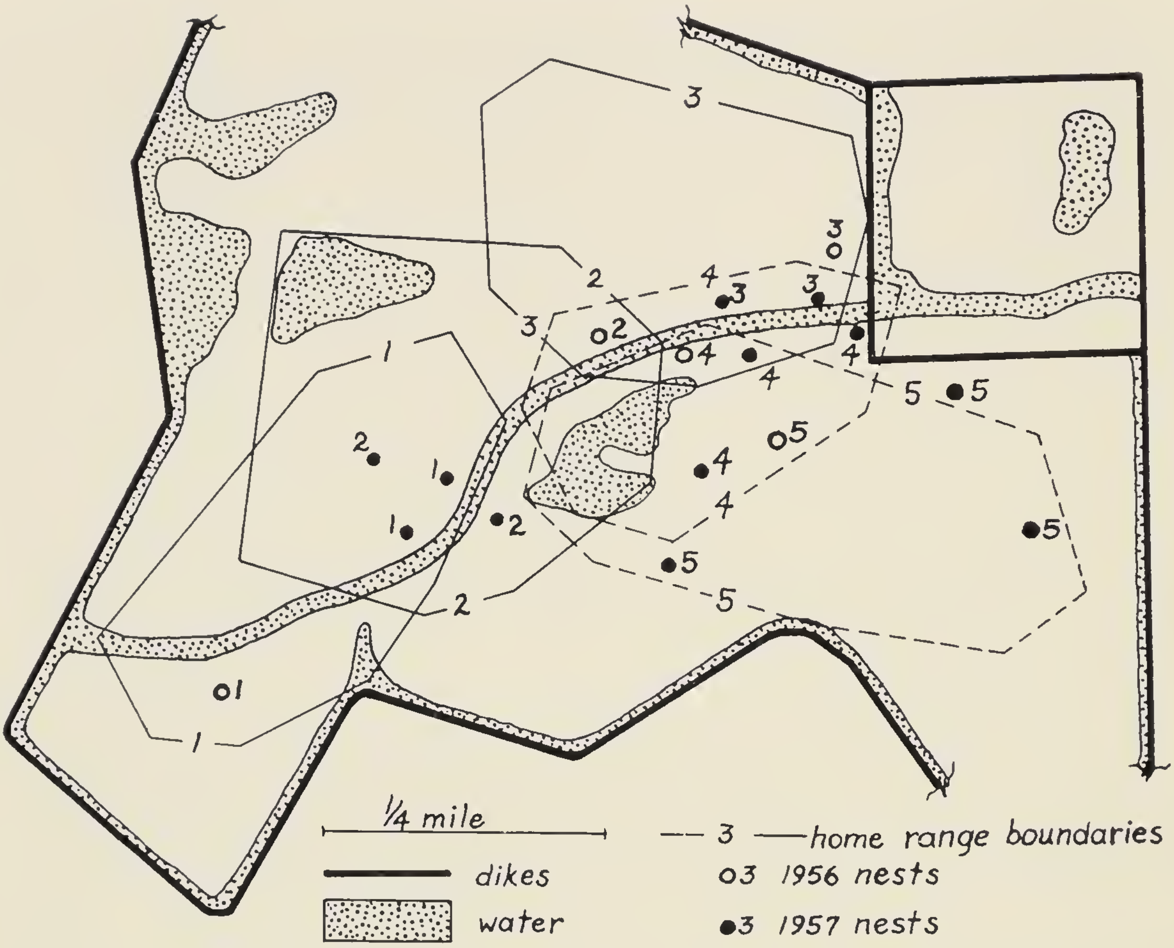

FIG. 3. Breeding home ranges of five marked Gadwall hens during prenesting activities at Ogden Bay Refuge in 1957, showing 1956 and 1957 nest locations.

TABLE 3
RESULTS OF BREEDING-PAIR CENSUSES OF GADWALLS ON STUDY AREA, OGDEN BAY REFUGE, 1957

Date	Pairs	Lone drakes	Total indicated pairs
25 April	2	0	2
3 May	4	1	5
9 May	11	0	11
16 May	12	5	17
22 May	16	10	26
30 May	9	24	33
6 June	14	27	41
14 June	11	21	32

that at Delta, Mallards and Pintails begin egg laying much sooner after spring arrival. For example, in 1950 the arrival of Mallards and Pintails was 17 April and 19 April, respectively, and nesting of both species began by 30

April. Mallards and Pintails are early nesting species, whereas Gadwalls are among the last of the surface-feeding ducks to began nesting. (At Ogden Bay, Mallards and Pintails started nesting by early April, Cinnamon Teal by late April, and Gadwalls not until mid-May.) Thus I suspect the lengthy delay between spring arrival and egg laying observed in this study is related to the Gadwall's late-nesting habit, and perhaps in turn to its well-known dependence on dry and dense nesting cover (Williams and Marshall, 1938; Miller and Collins, 1954; and others) which becomes increasingly available as spring advances.

Breeding home ranges.—One of Hochbaum's (1944:54–86) conclusions on the breeding behavior of surface-feeding ducks was that at the start of egg laying the hen selected a breeding area which the drake defended as a territory for as long as the pair remained together. The defended area included each of the habitat requirements of the breeding pair, i.e., feeding and loafing areas, water, and nesting cover. The function of the territory was to provide isolation for the breeding pair during the copulation link of the reproductive cycle. Later study by Sowls (op. cit.:47–62) and particularly by Dzubin (1955) resulted in several modifications in this interpretation. They observed that breeding pairs resided on larger, more indefinite areas that they termed home ranges. Home ranges were shared by one or more breeding pairs and were defended only in part. Aggressive behavior often shifted with the movements of the pair and was not limited to specific sites.

In 1957, I observed the behavior and plotted the movements of Gadwall hens marked in 1956. Observations were made on a daily basis largely during prenesting and egg-laying activities. I found that Gadwall behavior followed the pattern of home-range occupancy described by Sowls and Dzubin (Fig. 3).

The general location of the home range was determined by the hen. This was evident from the homing of adult hens, all of which returned to the same areas on which they nested the previous year. Each pair I observed included as part of its breeding home range one or more feeding ponds and a section of channel or ditch used for loafing. Nesting cover was abundantly available on the banks of the many ditches and dikes on the area. Breeding home ranges of five marked hens on the study area during prenesting activities and egg laying varied between 34 and 87 acres in size. averaging 67 acres (Fig. 3). Larger ranges existed on other parts of the marsh where hens had to travel greater distances between water and dry nesting cover. Some Gadwalls nested on farmlands nearly a mile from water.

The breeding home range of a given pair overlapped those of at least several other pairs (Fig. 3). A sharing of breeding areas resulted in that two or more pairs usually used the same pond for feeding or the same part of a ditch for loafing. However, at a given time a pair was free to use only those parts of its breeding range not already being occupied by other pairs. Two pairs almost never used the same area simultaneously without a display of intolerance on the part of one of the drakes.

The daily ranges of marked pairs I watched were largest in early May. As the number of breeding pairs on the study area built up, the movements of early nesting pairs became increasingly interfered with by the intolerance of other drakes. Apparently in response, these early nesting pairs spent more time at certain favored feeding and loafing areas and attempted fewer flights to outlying parts of their original breeding home ranges. Thus it appeared that early nesting pairs deliberately reduced their daily ranges in order to minimize the number of possible encounters with other pairs. This behavior probably allowed more pairs to breed on the study area than otherwise might have been possible.

During incubation, nesting hens used only the loafing areas and feeding places nearest their nests. Almost all successful hens left the study area soon after the time of hatching. Drakes became less and less faithful to breeding home ranges after their mates began incubating and generally deserted during early or mid-incubation.

Gadwall breeding home ranges were intermediate in size (average of five = 67 acres) compared to those of other surface-feeding ducks. Shovelers, Cinnamon Teal, and Blue-winged Teal bred on areas estimated no larger than 20 acres. Some pairs of each species usually spent the entire day in full sight from my blind. Mallards and Pintails, on the other hand, ranged so far that I was unable to follow the movements of even a single pair that nested on the study area. Sowls (loc. cit.) and Dzubin (op. cit.) noted similar interspecific differences in home-range sizes. The reasons for these differences in species mobility are obscure, but appear to be at least partly innate. At Ogden Bay I detected no differences in the habitat requirements of the six species great enough to account for the observed differences in mobility.

Intraspecific intolerance.—Breeding intolerance in surface-feeding ducks is manifest largely in the form of aerial chasing. Aerial pursuits that occur in most species during the nesting season are of two recognizable types—territorial chases and harrying chases. Territorial chases are pursuits in which a mated drake chases the hen of an intruding pair away from his breeding area while the hen's mate follows a short distance behind (Hochbaum, loc. cit.; and others). Harrying chases are pursuits in which a group of drakes chases a nesting hen (most commonly an incubating hen) with intent of forcing copulation on her. The exact motivation of these two types of aerial chasing is not clearly understood. Territorial chasing is usually considered an aggressive act concerned with defense of the nesting area or some part of it (Geyr von Schweppenburg, 1953), or defense of the mated hen, although as Weidmann (1956) suggests, it may actually be motivated by a raping drive similarly involved in harrying pursuits.

Both territorial and harrying chases were observed in typical form in Gadwalls. The former occurred largely during prenesting and egg-laying activities and the latter during incubation, especially after drakes abandoned their mates. I was not able to determine the relationship between the two types of pursuits, but my observations did indicate the nature of territorial chasing in this species and its effectiveness in the spacing of breeding pairs.

Territorial chasing began when the pair established a breeding home range. Chasing was most frequent during the prenesting period. During egg laying and early incubation, chasing normally occurred only when the pair was together, and after mid-incubation, when most drakes deserted their mates, it ceased entirely. Thus the intensity of territorial chasing was related to the presence of the mated hen. Chasing did not appear to be limited to any particular part of the breeding home range. The drake launched his pursuits from any part of the area being occupied by the pair when approached by another pair. That many of a drake's territorial chases originated from only several places, especially the areas most often used for loafing, followed only because the pair spent most of its time together at these sites. From these observations, the territorial chasing of Gadwalls in this study appeared to represent the defense of the mated hen rather than defense of the nesting area. Spatial isolation for the breeding pair appeared to be as effectively achieved in this manner and with far less strife than would have been required to defend the entire breeding home range. Dzubin (op. cit.) and others have used the terms "moving territory" and "individual distance" to describe similar drake aggression concerned with defense of mated hens.

Although breeding home ranges apparently were not defended as territories per se, territorial chasing was an obvious deterrent to the establishment of late-nesting pairs on the study area. In late May and early June of 1957, the number of nesting pairs on the study area averaged about 35 (Table 3), roughly one pair per 13 acres. Under this density, competition for space was evident. Unattached pairs were frequently driven completely off the study area by the territorial chasing of resident drakes. I once saw a pair chased by five different drakes before it gave up and flew away. Another pair was pursued a total of seven times by four different drakes before it moved on. However, it is not likely that territorial chasing imposed an actual limit to the number of pairs eventually breeding on the area. Generally if a pair persisted in returning to the study area, it finally found a place to feed and loaf unmolested by resident drakes. At the very height of intolerance in late May, I knew of at least six pairs that established themselves on the study area near my

TABLE 4

SITE LOCATIONS OF 156 GADWALL NESTS AT OGDEN BAY REFUGE, 1956 AND 1957 (Data Tabulated by Dates of Nest Establishment)

Site	5 May–5 June	6 June–20 July	Totals
Dikes	30 (39)[1]	19 (24)	49 (31)
Channel banks	41 (53)	34 (43)	75 (48)
Other	6 (8)	26 (33)	32 (21)
Totals	77	79	156

[1] Figures in parentheses are per cent of total nests.

blind despite repeated encounters with other pairs. Hammond and Mann (1956) describe a similar ineffectiveness of Gadwall territorial behavior in limiting the number of pairs nesting under near-colonial conditions on certain islands in North Dakota.

Nest locations.—Early Gadwall nesting was limited largely to channel and dike banks (92 per cent of 77 nests; Table 4) and to dry, upland vegetation dominating these sites (73 per cent of 77 nests: Table 5). Until early June of each nesting season, all but the higher elevations of dikes and the natural levees along channels were either flooded or recently exposed and still wet. More nests were placed in other sites and cover types, notably in the spike-

TABLE 5

COVER LOCATIONS OF 156 GADWALL NESTS AT OGDEN BAY REFUGE, 1956 AND 1957 (Data Tabulated by Dates of Nest Establishment)

Cover type	5 May–5 June	6 June–20 July	Totals	Nests per acre on study area
Upland forbs and grasses[1]	56 (73)[2]	33 (42)	89 (57)	1.9
Spike-grass (*Distichlis stricta*)	6 (8)	22 (28)	28 (18)	0.2
Spike-rush (*Eleocharis rostellata*)	8 (10)	6 (8)	14 (9)	1.0
Hard-stem bulrush (*Scirpus acutus*)	2 (2)	7 (9)	9 (6)	0.8
Common cattail (*Typha latifolia*)	1 (1)	7 (9)	8 (5)	0.1
Rush (*Juncus balticus*)	4 (5)	3 (4)	7 (4)	1.4
Bayonet-grass (*Scirpus paludosus*)	0 —	1 (1)	1 (1)	0.1
Totals	77	79	156	

[1] Primarily nettle (*Urtica gracilis*), sweet clover (*Melilotus alba*, *M. officinalis*), aster (*Aster adscendens*), bassia (*Bassia hyssopifolia*), marsh-elder (*Iva xanthifolia*), prickly lettuce (*Lactuca Scariola*), common ragweed (*Ambrosia artemisiifolia*), common sunflower (*Helianthus annuus*), common thistle (*Cirsium* spp.), Junegrass (*Poa pratensis*), brome-grass (*Bromus inermis*, *B. tectorum*) and spike-grass.

[2] Figures in parentheses are per cent of total nests.

grass flats and in dried stands of cattail and hard-stem bulrush (*Scirpus acutus*), as water levels dropped, but a definite preference for dry sites (79 per cent of 156 nests; Table 4) and upland vegetation (57 per cent of 156 nests; Table 5) was maintained throughout the nesting season. In general. Gadwalls preferred the densest and driest cover available. As a result of the distribution of preferred sites along channels and dikes, 94 per cent of the nests I discovered were within 50 yards of water. Williams and Marshall (1938), Miller and Collins (1954), Bue, Blankenship, and Marshall (1952), and Anderson (1956) recorded similar nesting-cover preferences by Gadwalls.

Other ducks on the study area appeared to be less dependent on dry and/or dense cover for nesting. Pintails, Shovelers, Blue-winged Teal, and Cinnamon Teal most often nested in short, spike-grass cover, 12–18 in. tall, often while this vegetation was still damp underfoot. Mallards appeared to have the widest range of cover tolerances, nesting in all available cover types. I found some Mallard nests in heavy stands of cattail and hard-stem bulrush growing in more than a foot of water.

The concentration of Gadwall nesting on islands with upland vegetation is mentioned by Miller and Collins (op. cit.) for Tule Lake and Lower Klamath Wildlife Refuges in California, and by Hammond and Mann (op. cit.) for Lower Souris Refuge in North Dakota. I knew of no islands suitable for nesting in northern Utah. However, the concentration of Gadwall nests on elevated sites with upland cover in Utah recorded in the present study and earlier by Williams and Marshall (op. cit.) appears to be a result of the same basic preference that accounts for the heavy use of nesting islands on certain marshes where the availability of this preferred cover apparently is more limited.

Clutch sizes.—Completed clutches averaged 10.0 ± 1.3 eggs (70 clutches) in 1956 and 10.1 ± 1.2 eggs (71 clutches) in 1957. Clutch sizes declined during the nesting season as the result of increasing numbers of renests discovered. Renesting attempts almost invariably had smaller clutches than initial nesting attempts (Table 6). Completed clutches in nests I considered to be initial nesting attempts, as explained below, averaged 11.2 ± 1.1 eggs (50 clutches) in 1956 and 10.9 ± 1.3 eggs (42 clutches) in 1957. The two-year mean clutch size for all nests was 10.0 ± 1.2 eggs (141 clutches) and for initial nesting attempts it was 11.1 ± 0.9 eggs (92 clutches).

Nest success.—Of 75 nests located on the study area in 1956, 35 (47 per cent) succeeded in producing one or more hatched chicks. Predation accounted for the failure of 29 nests (39 per cent), desertion 7 (9 per cent), and observer interference 4 (5 per cent). In 1957, I left only 31 nests undisturbed on the area. Of these, 12 (39 per cent) were successful, 15 (48 per cent) were destroyed by predators, and 4 (13 per cent) were deserted. The

TABLE 6

COMPLETED CLUTCH SIZES OF SUCCESSIVE NESTING ATTEMPTS OF 19 MARKED GADWALL HENS AT OGDEN BAY REFUGE, 1956 AND 1957

First clutch	Second clutch	Third clutch	Fourth clutch
12	9		
12	9		
11	10	8	6
11	9		
11	9		
11	9		
11	9		
11	9		
11	8		
11	8	7	
11	8	6	
11	7		
11	8		
10	8		
10	8	7	
10	7		
10	6		
10	5		
9	6		

two-year success rate of all nests was 45 per cent. I observed no nest losses from flooding or other causes.

During the two years of study, predators destroyed 41 per cent of all nests studied and accounted for roughly 80 per cent of all observed, natural nest mortality. California Gulls (*Larus californicus*) and Striped Skunks (*Mephitis mephitis*) are Ogden Bay's only important nest predators. Common Ravens (*Corvus corax*), Black-billed Magpies (*Pica pica*), and Longtail Weasels (*Mustela frenata*) are also present, but in such limited numbers that their importance as nest predators is slight. Of the 44 nests preyed upon in two seasons, I attributed 25 to gulls and 19 to skunks.

On two waterfowl refuges in California, Miller and Collins (op. cit.) reported that 90 per cent of 381 Gadwall nests succeeded. On Bear River Refuge in Utah, Williams and Marshall (op. cit.) reported that 85 per cent of 6,000 Gadwall eggs hatched. In 1947–49, Nelson (pers. comm.) observed a success rate of 73 per cent of 124 Gadwall nests located on my study area at Ogden Bay.

During Nelson's studies, construction of Ogden Bay was still in progress or only recently completed, and nest predators had not yet significantly populated the marsh. In contrast, during the present study the refuge sustained high populations of nest predators. Numerous dikes built on the marsh provide ideal skunk-denning sites, and the channel and dike banks, along which duck nests are often concentrated, are used as travel lanes by these predators. Several nesting colonies of California Gulls became established on the refuge following its development, and other gulls from colonies located on nearby islands in Great Salt Lake also forage on the marsh. This increase in predator populations, along with the decline in Gadwall nest success from 73 per cent in 1947–49 to 45 per cent in 1956–57, indicates a possible need for the control of nest predators at Ogden Bay. More will be said of this subject below.

RENESTING

The importance of renesting in waterfowl productivity was a subject of much speculation, but of little specific study before that of Sowls (1955:129–142). Some of Sowls' more important findings were that renesting attempts involved smaller clutches, that unsuccessful hens renested near their original nest sites, and that there were apparent differences in the renesting abilities of the five species he studied (Mallard, Pintail, Gadwall, Shoveler, and Blue-winged Teal). Sowls' experiments did not permit him to determine the percentage of unsuccessful hens that renested, but he believed that renesting was important in maintaining duck populations at Delta.

In my study, I attempted to determine renesting rates and to measure the amount of annual production contributed by renesting. Fifty-nine marked Gadwall hens were available for experimentation. Fourteen were 1956 hens, nests of which were destroyed by predators, and 45 were 1957 hens (including 15 originally marked in 1956), nests of which I intentionally disrupted to simulate nest destruction.

Continuous laying.—Four records of re-laying after the destruction of incomplete clutches were obtained. One tagged hen laid a total of 22 eggs in three clutches in 22 days, another laid 12 eggs in two clutches in 12 days, and a third laid 17 eggs in two clutches in 17 days. Each of the three hens moved to new nest sites and resumed egg laying the day after I robbed its nest. I knew of only one laying hen that failed to renest the day after her eggs were taken. This bird had just laid her tenth egg, possibly completing her clutch, and waited three days to re-lay.

Sowls (ibid.:134–137) pointed out that clutch size becomes fixed sometime before the last egg in a clutch is laid, after which the ovary starts regressing. Continuous laying is possible only prior to that time. Otherwise a renewed period of follicle growth and development, the renesting interval, must pass before egg laying can be resumed. Sowls found that the renesting interval lengthened as the stage of incubation at nest destruction advanced. I observed a similar trend in Gadwalls, although in this study renesting intervals were highly variable after 10 days of incubation. Possibly this variation was due to my inaccurate aging of embryos and back-dating of renests discovered during incubation.

Renest clutch sizes.—Completed clutches in renesting attempts of marked hens averaged 7.8 ± 0.7 eggs (24 clutches), as compared to 10.7 ± 0.6 eggs (19 clutches) in initial nesting attempts (Table 6) (P of no difference < 1 per cent). First nests normally had clutches of 10 eggs or more, and renests had nine eggs or less. Sufficient overlap in clutch size occurred to make it impossible to distinguish renests from first nests with absolute certainty, but the amount of error in such a method obviously was slight (Table 6). For purposes of comparing success rates and hatching sizes of renests with first nests, I considered all clutches of nine eggs or less to represent renesting attempts.

Three laying hens collectively lost clutches of 6, 10, and 11 eggs before I allowed them to finish egg laying. Their completed clutches eventually numbered 11, 10, and 11 eggs, respectively, each of which was normal for first nests. Three eggs were taken from a renesting hen later found incubating a clutch of nine eggs. At least in this small sample, the loss of eggs during egg laying had no apparent effect in lowering the number of eggs in the completed clutch.

Location of renests.—The mean distance between 35 successive nesting attempts of 28 marked hens was only 241 yards, with extreme distances of 110 and 525 yards recorded. The five adult hens whose breeding home ranges are shown in Fig. 3 made a total of 12 known nesting attempts in 1957. Eleven of the 12 nests were situated inside the breeding home ranges of the respective hens as originally plotted during the prenesting and egg-laying periods. From these data, it is obvious that Gadwall hens moved little between nesting attempts. Movements of greater consequence might occur where summer drought or other adverse conditions render an area unsuitable after nesting is already under way. However, the fidelity of Gadwalls for specific breeding areas observed in this study suggests that forced abandonment of familiar nesting terrain might lessen the chances of renesting.

Remating.—Elder and Weller (1954), in a study of domestic Mallards, observed that egg fertility dropped rapidly after hens were isolated from drakes. They concluded that if wild ducks were like tame Mallards, it would be impossible for a hen already abandoned by her mate to renest and lay fertile eggs without remating. Hochbaum (1944:193) pointed out that bachelor drakes retained their nuptial plumage (and presumably sexual activity) longer than drakes which had obtained mates and had bred. On this basis. Elder and Weller suggested that unbalanced sex ratios in ducks were at least partly a natural phenomenon. They felt an excess of drakes might be essential to maximum production, since a deserted hen could find a mate and nest again if an earlier clutch was destroyed.

In Gadwalls, desertion by the drake usually occurred before mid-incubation, although I knew of some early nesting pairs that remained together nearly until the time of hatching. Late-nesting and renesting pairs appeared to break up soon after the completion of egg laying. Thus the need for remating varied seasonally and with the stage of incubation at nest destruction. Eight marked, renesting hens were watched specifically for re-pairing, and I knew of only two that did so. However, my observations of these eight hens were limited, and without having marked drakes to study, for evidence of remating I had to rely on finding a marked hen paired with a drake whose plumage showed less sign of molt or varied in some other way from that of her original mate's. Accordingly, I am certain that remating was more frequent than indicated above.

If excess drakes are essential for successful renesting, it may be important to know whether their numbers are sufficient. At the start of nesting, Gadwall sex ratios at Ogden Bay averaged 53 per cent drakes (Fig. 1), or 113 drakes per 100 nesting hens. Data presented in the following section reveal that roughly half of all incubated clutches were unsuccessful, and accordingly at least 50 hens would experience nest destruction sometime during the nesting season. Even considering that some renesting hens would still have had original mates, the indicated ratio of 13 unmated drakes per 50 unsuccessful hens appeared inadequate.

Other observations suggested that drakes which had already abandoned their mates might also remate with unsuccessful hens. Gadwall drakes often started molting body feathers before desertion, but obviously retained sexual vigor for a time before becoming flightless. This was apparent in their attentiveness to lone hens, especially in their readiness to participate in harrying chases and the apparent attempted rape of nesting hens. I feel certain that many of them would have paired a second time if given the opportunity. That such matings would be fertile is indicated by Höhn's (1947) finding that spermatogenesis in the Mallard extends into the period of eclipse plumage.

Renest success.—Comparison of the success of renests with first nests is based on 65 nests in 1956 and 26 nests I left undisturbed during renesting experiments in 1957. Since renests were distinguished from first nests on the basis of clutch size for unmarked hens, comparisons which follow concern completed (= incubated) clutches only.

In 1956, 25 of 47 first nests and 10 of 18 renests were successful. In 1957, 6 of 14 first nests and 6 of 12 renests succeeded. The two-year success rates of first nests and renests were 51 per cent and 53 per cent, respectively, and the combined success rate of all incubated clutches was 52 per cent. Although nesting cover was denser and the total amount of cover available for renesting was greater, success of renests was similar to that of first nests.

Data from 1956 and 1957 revealed mean hatches of 8.1 ± 0.7 chicks per successful first nest and 6.6 ± 1.1 chicks per successful renest.

Renesting rates.—This section of the paper deals with renesting following the destruction of incubated clutches only. That an appreciable number of hens fails to renest when clutches are destroyed during egg laying is unlikely. Since they have fully developed eggs ready for laying, there is no apparent reason for laying hens not to resume nesting elsewhere. A possible exception to this might occur when nest destruction occurs in the very final stages of egg laying.

In 1957, 45 marked hens were available for study. Nineteen of these originally nested just outside the study area or on the dikes which formed the area's boundaries. Some of the 19 might have renested outside the area of intensive nest searching, and thus determination of renesting rates is based on the nesting records of 26 hens that originally nested inside the study area, primarily along the main channel (Fig. 3). Conditions for finding nests of these 26 hens were ideal. Breeding home ranges of Gadwalls on the area were sufficiently small that few hens, if any, would have left the area to renest. In addition, the study area was small enough that all suitable cover could be examined at least once a week during the nesting season, and most of the preferred cover along channel and dike banks was searched every 3 or 4 days. An indication of the efficiency of nest searching is provided by the fact that only 8 of 22 renesting attempts had progressed beyond 12 days of incubation when discovered. For these reasons I believe very few nests were missed. Nonetheless, renesting rates presented below probably should be considered minimal values.

Of the 23 experimental hens that lost incubated first clutches, 74 per cent made second nesting attempts, and of the 19 that lost incubated second or third clutches, 26 per cent renested again. Fifty-two per cent of all hens experiencing nest destruction during the entire course of renesting experiments in 1957 was known to renest (Table 7).

Chi-square values for tests of independence in 2 × 3 contingency tables for renesting versus the stage of incubation at nest destruction and the number of clutches previously produced were 7.79 (P of independence < 2.5 per cent) and 9.34 (P of independence < 1 per cent), respectively. Thus the ability to renest declined as the stage of incubation at nest destruction advanced. In addition, it was lower after the loss of renest clutches than first clutches.

TABLE 7

RENESTING RECORDS OF 23 MARKED GADWALL HENS AT OGDEN BAY REFUGE, 1957

Days of incubation at nest destruction	Per cent of hens renesting			
	After loss of first clutch	After loss of second clutch	After loss of third clutch	Totals
1–6	92 (12)[1]	50 (6)	50 (2)	75 (20)
7–12	67 (6)	14 (7)	0 (2)	33 (15)
13–18	40 (5)	0 (2)	— (0)	29 (7)
Totals	74 (23)	27 (15)	25 (4)	52 (42)

[1] Figures in parentheses are sample sizes.

During renesting experiments in 1957, 6 hens tagged in 1956 (adults) made a total of 14 nesting attempts, 2.3 per hen, as compared to 17 hens tagged in 1957 (unaged; adults and juveniles) that made a total of 34 nesting attempts, 2.0 per hen. This difference falls short of statistical significance, although I suspect adult hens were more persistent renesters than juvenile hens. Since adult hens were found to be among the earliest pairs to begin nesting, a longer period of time apparently is available to them for renesting. More extensive field observations than were made in this study might verify the hypothesis that adults are more persistent in renesting.

In Table 8, which is based on natural nest success rates from 1956–57 and on renesting rates determined by experimental nest predation in 1957, renests account for 29 per cent of the total reproductive effort. In 1956, 65 nests with completed clutches were discovered on the study area. Of these, 18 (28 per cent) were known renests or considered to be renests on the basis of clutch size. Since the success of incubated clutches in 1956 (54 per cent) was

TABLE 8

PRODUCTION OF A HYPOTHETICAL POPULATION OF 100 GADWALL HENS FROM DATA OBTAINED AT OGDEN BAY REFUGE, 1956 AND 1957
(Calculations Carried out through Fourth Nesting Attempt)

Nesting attempt	Number of hens	Renesting rate	Clutches started	Success of incubated clutches	Successful clutches	Young per clutch	Total young produced
1	100	—	100	0.52	52	8.1	421
2	48	0.74	36	0.52	18	6.6	138
3	18	0.27	5	0.52	3		
4	2	0.25	0	0.52	0		
Totals			141		73		559

similar to that used in Table 8 (52 per cent), the similarity in amounts of renesting indicates that the over-all renesting rate determined by experimentation in 1957 also prevailed under conditions of natural nest mortality in 1956.

Renesting abilities appeared to vary considerably between the several species of ducks nesting on the study area. Observations of the comparative time span of nesting activities led me to believe that Mallards and Pintails were more persistent renesters than Gadwalls, and that Blue-winged Teal and Cinnamon Teal were much less persistent. Sowls (op. cit.:139–141) also noted interspecific differences in renesting abilities. Of the five species he investigated (Mallard, Pintail, Gadwall, Shoveler, and Blue-winged Teal), he considered the Pintail the most persistent renester and the Blue-winged Teal the least persistent.

Importance of renesting.—The contribution of renesting to Gadwall production in this study is evident in Table 8 in which a hypothetical breeding population of 100 nesting hens experiences the various production rates observed in this study. In this calculation, 559 young are produced at hatching, 421 (75 per cent) from initial nesting attempts, and 138 (25 per cent) from renesting attempts. The contribution of renesting is substantial. Total production of young at hatching is a third greater than might be expected without any renesting. In the absence of renesting, success of incubated clutches would have to be a third higher (69 per cent versus 52 per cent) to net the same production of young.

BROODS

Movements.—Thirty-five Gadwall broods hatched on the study area in 1956, but only three spent major portions of their rearing periods there. The net movement of Gadwall broods at Ogden Bay was from the heavily used upland nesting areas, on which all but channels and ditches became dry by mid-August, to deep-water marshes and the edges of large impoundments. Broods belonging to 13 marked hens were located after they left the study area. The distances they had traveled from where they hatched varied from 0.26 to 1.15 miles, averaging 0.56 mile.

Brood sizes and mortality.—Data from 1956–57 showed a mean hatch of 7.5 ± 0.8 young from 52 successful nests. Brood counts during the two years revealed means of 6.8 ± 0.7 for 121 Class I broods, 6.3 ± 0.7 for 139 Class II broods, and 5.8 ±0.9 for 57 Class III broods. I observed no evidence of brood combination in broods of marked hens. According to the system of age classification used in this study (Gollop and Marshall, 1954), Class I Gadwalls (downy) are 1–18 days old, Class II (partly feathered) are 19–44 days old, and Class III (fully feathered but incapable of flight) 45–50 days old. These data suggest an over-all mortality rate of 23 per cent between hatching and time of flight, with approximately 43 per cent of the indicated mortality taking place in the first 18 days of life. A similar shrinkage of 23 per cent in Gadwall broods was observed on another Utah marsh by Odin (1957). California Gulls were the only serious predators on young ducks at Ogden Bay (cf Odin, ibid.).

DISCUSSION

Production versus mortality.—Table 8 shows 100 nesting hens producing 559 chicks at hatching, 280 of which can be assumed to be females. About 77 per cent, or 215 young hens, would survive to the age of flight and self-sufficiency. Application of survival rates calculated in Table 1 (48 per cent for adults; 33 per cent for juveniles) shows, on the average, 48 adult hens alive at the start of the following nesting season and 71 juvenile hens alive a year later (late summer). Since some mortality of juvenile hens undoubtedly occurs during the nesting season, the number of juveniles surviving at the start of nesting would be somewhat more than 71, and thus the total number of breeding hens would be somewhat greater than 119. Accordingly an increase in nesting hens in excess of 19 per cent is indicated.

Annual breeding-pair inventories at Ogden Bay, however, show populations of 255, 244, 317, 257, 217, 189, 210, 208, 215, and 205 pairs for the successive years 1950–59 (Nelson, 1950–1959), demonstrating that the refuge population of Gadwalls has, in fact, remained fairly stable, at least since 1954. Apart from sampling errors, at least three conditions may be involved in this discrepancy, each of which might be important in evaluating the results of the present study: (1) Survival rates, calculated from 1929–53 banding, may not have applied to Ogden Bay Gadwalls during the period of study. (2) Production data were gathered on a study area aggregating less than 5 per cent of the entire marsh and may not have applied to the refuge population at large. That nearly 20 per cent of Ogden Bay's Gadwalls nested on this small area in 1956–57 demonstrates the area's attractiveness and suggests that nesting conditions there may have been more favorable than on other parts of the marsh. (3) If in reality production has outweighed mortality in recent years, a limit may exist in the number of breeding Gadwalls Ogden Bay can accommodate under present conditions. In view of the high rate of homing of adult hens observed in this study, the net loss of breeding stock to other areas probably would comprise a disproportionate number of juvenile hens.

Renesting and nest success.—In the population of Gadwalls studied, actual production of young at hatching was a third higher than might have been expected in the absence of renesting. A difference of this magnitude implies that renesting is an important factor in the ability of this population to maintain itself. It is obvious, however, that renesting cannot offset all nest mortality. Had nest success rates of 73 per cent observed on my study area in 1947–49 by Nelson (pers. comm.) applied to the population I studied in 1956–57, production would have been at least 25 per cent higher (701 versus 559 young at hatching). That the productivity of Ogden Bay Gadwalls has, indeed, dropped with declining nest success, in spite of what appears to be a high level of renesting, is indicated by Nelson's (loc. cit.) breeding-pair censuses which show an average of 268 pairs for 1950–53, as compared to an average of 207 pairs for 1954–59.

The decline in Gadwall nest success at Ogden Bay has been shown to correspond to a period of increasing nest-predator numbers on the marsh. A question thus arises concerning the advisability of predator control. No definite answers can be given in the absence of prior information on the costs and effectiveness of possible control measures. However, I believe that the evidence is sufficiently conclusive to justify experimental control, the results of which should be evaluated over a period of several years before a final recommendation is made.

In general, results of this study seem to indicate that even with persistent renesting, serious production losses are likely to occur if nest mortality is excessive. In this connection, measures to improve low nest success on areas that can be managed for nesting ducks probably should not be overlooked in the belief that renesting can offset high nest-mortality rates. This may apply particularly to such species as the Blue-winged Teal and Cinnamon Teal, suspected of being less persistent renesters than Gadwalls, and to areas having importantly lower nest-success rates than observed in this study.

SUMMARY

In 1957, resident Gadwalls arrived at Ogden Bay in mid-April. At least 60 per cent of the surviving hens marked in 1956 returned in 1957 and nested in the immediate vicinity of their 1956 nest sites. Egg laying started nearly a month after spring arrival. This delay was believed to be typical for northern Utah and may have resulted from the Gadwall's dependence on dry and dense cover for nesting.

Gadwall breeding-pair behavior followed the pattern of home-range occupancy described by Sowls (1955) and Dzubin (1955). Breeding home ranges averaged 67 acres in size. Home ranges were shared by two or more breeding pairs. Territorial behavior was apparently concerned with defense of the mated hen instead of defense of the nesting area and was observed to be ineffective in limiting the number of pairs nesting on the study area.

Seventy-nine per cent of all nests studied were situated on elevated sites provided by dike banks and natural levees, and 57 per cent were located in upland vegetation. Nest success for all nests was 45 per cent in 1956–57, compared to 73 per cent in 1947–49. Success of incubated clutches during the study was 52 per cent. Predation was responsible for 80 per cent of all observed, natural nest mortality in 1956–57. Completed clutches

for all nests averaged 10.0 ± 1.2 eggs in 1956–57, and completed clutches in initial nesting attempts averaged 11.1 ± 0.9 eggs.

Completed clutches in renesting attempts of marked hens averaged 7.8 ± 0.7 eggs, compared to 10.7 ± 0.5 eggs in initial nesting attempts. The success of renests, 53 per cent, was similar to that of first nests, 51 per cent. Unsuccessful hens renested near their original nest sites. Fifty-two per cent of all hens experiencing experimental loss of incubated clutches were known to renest. The ability to renest dropped as the stage of incubation at nest destruction advanced and was lower after the loss of renest clutches than first clutches.

Renesting accounted for 25 per cent of Gadwall production during the study, but fell considerably short of compensating for increased nest mortality since 1947–49. On this basis, experimental control of nest predators at Ogden Bay was recommended.

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UTAH COOPERATIVE WILDLIFE RESEARCH UNIT, UTAH STATE UNIVERSITY, LOGAN, UTAH, 17 MARCH 1961 (PRESENT ADDRESS: WISCONSIN CONSERVATION DEPARTMENT, BOX "D," HORICON, WISCONSIN)

NEW LIFE MEMBER

Fernando C. Novaes, an active member of the WOS since 1953, has now become a Life Member. He is a Biologist-Associate in Ornithology with the Departmento de Zoologia—Secretaria da Agricultura, of São Paulo, Brazil; and has done museum work in Rio de Janeiro and Pará, taking many trips on the Amazon. Mr. Novaes is interested primarily in systematics and population ecology of birds, and has published about 20 papers in *The Auk*, *Condor*, *Revista Brasileiro Biologia*, and local journals. He is also a member of the AOU and the Cooper Ornithological Society.

FOOD HABITS AND FEEDING BEHAVIOR OF THE WHITE-EYED VIREO

Val Nolan, Jr., and David P. Wooldridge

The purposes of this paper are to describe and discuss the contents of the stomachs of 67 White-eyed Vireos (*Vireo griseus*) and to report field observations bearing on the food habits and feeding behavior of that species.

An interest in the White-eyed Vireo led Nolan to ask for the material in the food habits collection of the Fish and Wildlife Service of the United States Department of the Interior, when that collection was distributed to biologists. The Service kindly granted this request in 1957. The support of the Graduate School of Indiana University, whose generosity is gratefully acknowledged, made possible the participation of Wooldridge, who is responsible for the identifications of the stomach contents. We solicited and received from Dr. W. L. McAtee helpful advice on methods.

STOMACH CONTENTS

The material.—Of 82 stomachs in the collection, 67 were full, or virtually full, of food capable of being identified and measured as to volume. Eleven of the remaining stomachs held matter too comminuted to reveal more than an occasional identifiable structure, and the other four specimens were empty. Three of these last four were collected at 11 PM on 30 April at Washington, D.C., and were presumably the stomachs of birds killed in nocturnal migration. Only the contents of the 67 stomachs referred to first above will figure in the rest of this report.

Distribution of collection dates through the year is uneven. Only April (16 specimens), May (23), and June (9) provide more than three stomachs, but all months except November are represented. The states in which birds were taken, and the numbers collected, are North Carolina (15), South Carolina (15), Florida (13), Georgia (10), Texas (4), Kentucky (2), Virginia (2), Alabama (1), District of Columbia (1), Kansas (1), Maryland (1), Tennessee (1), and West Virginia (1). Thus, 79 per cent of the material comes from four states in the southeastern corner of the range of the White-eyed Vireo in the United States; indeed, only about 7 per cent is from localities outside the southeast, and none is from the north. Four birds had been designated immature; and of 39 adults which had been sexed, 26 were males. If there were dietary preferences associated with age or sex, they were not apparent.

Methods.—Methods of determining bulk followed procedures described by Martin (1949). In most cases volume could be ascertained with reasonable accuracy by noting the displacement of water in graduated glasses. The advantages of the volumetric method as the primary means of estimating the stomach contents of birds have been set forth by McAtee (1912), who also recognized the additional value of counts of the frequency with which items occur. Table 1, which presents both volumetric percentages and frequency counts, is adapted from tables used by Jones (1940) in his study of the American Coot (*Fulica americana*). Unfortunately, Chapin's (1925) report of the food habits of vireos, although his study included 229 stomachs of the White-eyed Vireo, is somewhat general in its presentation of monthly proportions of items in the diet. We, on the other hand, have felt it undesirable to try to arrive at annual averages for various foods, as Chapin did, because most months are inadequately represented in our collection. Nevertheless, certain comparisons of the results of this study and of Chapin's are possible and are advanced below.

To indicate the volume of a stomach of this vireo we have selected ten stomachs which appeared to us to be typical in size and in contents. The volumes of these ten varied between 0.20 and 0.29 ml and averaged 0.24 ml. These figures may be low, for we have no assurance that the material, which was stored dry, resumed its natural size when we soaked it in 70 per cent alcohol.

Discussion.—Plant material consisted of hard undigested seeds and of a few fragments of seeds. We could not identify these and felt that the circumstances did not warrant submitting them to others. Seeds ranged in diameter to a maximum of about 7 mm, and the numbers in a single stomach varied between one and 13 (average 5). It will be seen that the volumes we assign to vegetable material may sometimes be low, because they do not include any fruit which may have been present with the seeds. The distribution of seeds, by month, in the sample indicates that some vegetable matter is eaten throughout the year, although there was none in the 23 stomachs collected during May. The volume of plant food in autumn and winter cannot be estimated from our scanty material for those seasons, but its importance as compared to its role in spring and summer is suggested: Eight of 11 specimens from October through March contained seeds, whereas only five of 56 stomachs from April through September did so. Chapin's data do not seem to disagree substantially.

Lepidoptera formed much the largest element of the animal food, comprising 46 per cent of the total material in the 48 stomachs from April. May, and June, and little or no less of that from other seasons. (Percentages in this paragraph refer only to the three spring months just mentioned. These percentages are averages of the monthly averages. That is, it seems preferable to assume that the diet may change from month to month and that the sample for

TABLE 1

STOMACH CONTENTS OF 67 WHITE-EYED VIREOS

Kind of food	January 3 stomachs		February 2 stomachs		March 2 stomachs		April 16 stomachs		May 23 stomachs		June 9 stomachs		July 2 stomachs		August 3 stomachs		September 3 stomachs		October 3 stomachs		December 1 stomach	
	%[1]	No.[2]	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.
PLANT																						
Seeds	**47[3]**	**3**	**12**	**2**			**2**	**2**			**4**	**2**			**3**	**1**			**26**	**3**		
ANIMAL																						
Gastropoda																						
Polygyridae or Zonitidae									**x**	**1**												
Arachnida																						
Araneida							**12**	**3**	**8**	**9**	**4**	**2**			**3**	**1**						
other arachnids																			**7**	**1**		
Insecta*	**34**		**63**		**63**		**72**		**75**		**77**		**95**		**77**		**90**		**50**		**100**	
Ephemeroptera																						
Ephemeridae			19	1																		
undetermined	3	1					1	1														
Odonata																						
Coenagrionidae															25	1						
Orthoptera																						
Acrididae											x	1										
undetermined	5	1							1	1												
Hemiptera																						
Phymatidae															2	1						
Tingididae							1	1														
Pentatomidae							4	2	2	2									30	1	30	1
undetermined	10	1	12	1	x	1	x	2	4	6	3	2					12	1	5	1		
Homoptera																						
Cercopidae									1	2												
Cicadellidae							1	1			2	2	10	1								
undetermined							1	1											3	1		
Neuroptera																						
undetermined											x	1										
Coleoptera																						
Cleridae									1	1												
Sandalidae									x	1												
Elateridae							1	1	x	1												
Buprestidae							x	1														
Coccinellidae							1	1														
Anthicidae									2	1												
Tenebrionidae									1	2	1	1	12	1								
Cerambycidae									3	1												
Chrysomelidae			5	1			5	2	7	5	1	1	13	1								
Mylabridae															4	1						
Curculionidae							3	3	1	2					10	1						
Scolytidae															8	1						
undetermined	13	3			18	2	2	3	6	4	13	7	12	1			13	3	12	3		
Lepidoptera																						
adults									2	1	8	1			25	2						
larvae	3	1	27	1	45	2	46	13	35	16	48	8	48	2	3	1	55	3			70	1
Diptera																						
Chironomidae									1	1												
Stratiomyidae							2	1														

Kind of food	January 3 stomachs		February 2 stomachs		March 2 stomachs		April 16 stomachs		May 23 stomachs		June 9 stomachs		July 2 stomachs		August 3 stomachs		September 3 stomachs		October 3 stomachs		December 1 stomach	
	%[1]	No.[2]	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.
Asilidae									2	1												
undetermined			x	1			x	2	5	3	1	1					7	1	x	1		
Hymenoptera																						
Tenthredinidae							1	1	x	1												
Formicidae							1	1	1	1												
undetermined			x	1			2	3									3	1	x	1		
Unidentified	**17**	**1**	**25**	**2**	**37**	**2**	**13**	**8**	**14**	**19**	**11**	**6**			**15**	**2**	**10**	**3**	**17**	**2**		
Eggs, probably insect	**2**	**1**					**1**	**2**	**3**	**5**	**4**	**2**	**5**	**2**	**2**	**1**						

[1] Volumetric percentage.
[2] Number of stomachs in which found.
[3] Numbers in boldface indicate totals.
x=less than one per cent of the indicated material.
*All stomachs contained insects.

each of the three months is representative, rather than to assume no variation from one month to another, and to average the 48 stomachs as one unit.) Butterflies and moths accounted for only 7 per cent of the lepidopterons; the rest were caterpillars. Chapin's specimens, collected throughout the vireo's range, yielded a smaller proportion of this order; maximum consumption was about 38 per cent, in June, and the annual average was about 30 per cent. In our analysis, beetles ranked second, spiders third, and Hemiptera-Homoptera fourth during the spring months; respective percentages for these orders were 16, 8, and 6. Chapin attributes much greater importance to Hemiptera-Homoptera, which placed second in his study with an annual average of nearly 20 per cent and a spring average of apparently about 30 per cent. It is possible but unlikely that the gap between Chapin's figure and ours might be considerably smaller if we had not had 13 per cent unidentifiable fragments in our sample. Beetles ranked third with Chapin's White-eyed Vireos with a percentage in spring comparable to ours, whereas spiders were an unimportant component of his. Other respects in which our analysis differed notably from Chapin's were the insignificance of three major orders of insects as food of our vireos, namely Orthoptera, Diptera, and Hymenoptera; the frequency of insect eggs in ours (sometimes as many as 100 in a stomach); and the occurrence of May flies in our sample. One of our birds, taken in Florida in February, had ingested 15 per cent fine sand.

FIELD OBSERVATIONS

All of the observations reported in this section were made by Nolan at Bloomington, Indiana. Descriptions of the habitat of the White-eyed Vireo near Bloomington have appeared in earlier papers (Nolan, 1955, 1960); the bird occupies typical scrub growth here, perhaps somewhat drier than that described for it in other areas (Bent, 1950).

Arrival dates at Bloomington for eight years between 1952 and 1960 ranged from 17 to 27 April and averaged 20 April. Vegetation at this period retains much of the gross aspect of winter, although leafing out and flowering of some trees has usually begun. Insects, except for a few dragonflies, grasshoppers, and butterflies, are inconspicuous. An idea of the relative meagerness of the supply of animal food available to the White-eyed Vireo may be indicated as follows: On 24 April 1956, on a sunny afternoon when the temperature was about 65 F, a net was swept 55 times through vegetation from 1 to 10 feet in height, in a field inhabited by this vireo. These sweeps yielded two spiders, about 35 homopterons (Chermidae) 2.5 mm long, a neuropteron, and nine small flies. On 22 April 1960, in mid-afternoon with the temperature about 80 F, vigorous beating of five low tree branches just beginning to leaf out knocked a somewhat larger quantity of material onto a sheet. The collection included items comparable to those above but contained also three or four additional spiders, a large pentatomid, a caterpillar about 20 mm long, and two lady beetles.

The last White-eyed Vireos leave Bloomington in October. Four dates of observation believed to mark the end of the bird's stay varied between 3 and 8 October, averaging 6 October. By this date scrub vegetation is usually extremely dry and much reduced by the falling or withering of leaves. We believe that the supply of insects on the vegetation at this time is correspondingly diminished.

White-eyed Vireos feed from the ground to high treetops. The greatest height at which they have been noted is 50 feet, with a number of records of birds as high as 25 and 30 feet. Usually, however, vireos at these heights are singing males which spend little time foraging between their frequent songs. Perhaps 90 per cent of the food of the species is gathered in trees and shrubs at elevations of from 2 to 20 feet, an observation which applies to adults, to independent young, and to family groups. The high proportion of caterpillars in the diet indicates that the bird spends much time foraging among leaves, but in the field observations here reported there has seemed to be an equal concentration on bare branches, that is, on those parts of the limbs nearer the trunks. No preferences for radial or tangential courses through the trees have been detected; foraging vireos proceed in, out, and around a tree or bush, or through it to another, and also make vertical movements.

Progress during feeding is rather slow, deliberate, and steady, as the vireo hops or flies from a few inches to a foot or more at a time. The linear distance covered by a color-banded female foraging steadily at heights of 3 to 10 feet through a clump of sumacs (*Rhus* sp.) was measured as 15 yards in 10 minutes, but this rate is slower than usual. A good many movements involve little or no change of position of the feet; the vireo perches for one or two seconds while peering at a leaf or branch, then abruptly shifts its head or the long axis of its body to face another direction. This peering about is quite noticeable. For example, once a male was observed as it searched along a sassafras (*Sassafras albidum*) branch 4 feet high. It regularly looked below it toward the herbaceous plants of the field cover. Spying a butterfly, apparently a Pearl Crescent (*Phyciodes tharos*), on the ground, the bird descended, caught the insect, returned to the branch, and ate it wings and all. Possibly even more frequently White-eyed Vireos look for food above them and then fly up and hover while they take items from the undersides of leaves or branches.

Hovering is rather frequent, as is chickadee-like hanging from terminal leaf clusters or from small drooping branches. Both adults and young readily hang upside down in order to seize food. On one occasion an immature bird was seen in this position gathering white fruits from a cluster on a small dogwood (*Cornus* sp.) shrub. Another habit of interest is the use of the foot to hold unmanageable food objects. Among the items seen held in this way have been a spider egg case which a male was having great difficulty opening, as well as a brown moth and the Pearl Crescent butterfly mentioned above.

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WEIGHT CHARACTERISTICS OF BIRDS KILLED IN NOCTURNAL MIGRATION

Richard R. Graber and Jean W. Graber

From the toll of nocturnal migrants at ceilometer beams, television towers, and other structures, ornithologists have learned much about migration and about population characteristics of a variety of species. Exemplary studies are those by Tordoff and Mengel (1956) and Brewer and Ellis (1958).

These and a host of other papers on the subject have pointed out the possibilities for research. Specimens from tower kills are a valuable source of information on birds and continue to deserve study.

The present study of organ weights of nocturnal migrants was initiated in the fall of 1958 using specimens collected at the same site described by Brewer and Ellis (1958).

METHODS

In connection with a study program on nocturnal migration in central Illinois, we made daily morning visits in season to the WCIA television tower located about 10 miles west of Champaign, Illinois, to collect fresh specimens in the event of a kill. (For complete information on the tower, see Brewer and Ellis, 1958.) We picked up a few scattered specimens at various times between March 1958 and November 1960, but virtually all of the specimens reported in this paper represent three kills on the nights of 16–17 September 1958; 28–29 September 1959; and 18–19 September 1960.

We collected specimens in the morning following the kill, and recorded gross weights immediately after on a Fisher triple beam, 500-gram capacity, balance. The birds were then sealed in plastic bags and placed in a freezer. Small numbers of specimens (to 35) were thawed at one time and dissected as quickly as possible. Because of the time-consuming nature of the work, as much as two months elapsed before all specimens in a sample were dissected.

In dissecting the specimens, the skin was first removed and the condition of fat deposition noted. Fat condition was subjectively evaluated on a scale from 0 (no fat) to 5 (extremely fat), and more objectively evaluated by measuring with a millimeter rule the cut depth of fat deposit on the sides of the abdomen.

The mass of pectoral muscle was next removed from the sternum and the weight for pectoral mass included all of the muscle lying on the sternum to one side of the keel from the points of origin to insertion. Initially, the mass on both sides of the keel were weighed separately, but no consistent difference was apparent in a sample of 20 birds representing four species. Thereafter,

TABLE 1

WEIGHT CHARACTERISTICS OF THRUSHES KILLED IN NOCTURNAL MIGRATION IN FALL, 1958, 1959, AND 1960 AT CHAMPAIGN, ILLINOIS[1]

Sample size		Gross		Fat condition		Pectoral mass		Brain		Heart		Lung		Liver	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
SWAINSON'S THRUSH															
Adult Male															
1958	23	32.8	0.94	2.6	0.23	2.82	0.04			0.47	0.01	0.23	0.02	1.27	0.07
1959	20	32.0	0.47	2.0	0.18	2.87	0.05			0.45	0.03	0.24	0.03	1.23	0.06
1960	12	30.3	0.46	1.4	0.30	2.57	0.03	0.79	0.01	0.49	0.02	0.23	0.02	1.32	0.07
Adult Female															
1958	11	31.7	1.12	2.4	0.42	2.60	0.06			0.47	0.02	0.22	0.01	1.16	0.04
1959	17	30.8	0.68	1.8	0.29	2.61	0.04			0.44	0.01	0.23	0.01	1.19	0.04
1960	7	28.6		1.1		2.29		0.85	0.05	0.46		0.23		1.23	
GRAY-CHEEKED THRUSH															
Adult Male															
1958	12	34.8	0.70	2.8	0.27	2.93	0.06			0.53	0.02	0.24	0.01	1.42	0.09
1959	3	33.5		2.3		3.16				0.52		0.23		1.32	
1960	10	31.3	0.33	1.7	0.33	2.73	0.08	0.80	0.02	0.52	0.03	0.24	0.01	1.26	0.08

[1] Mean and standard error shown in grams.

only the right breast muscle was weighed unless it was macerated or aberrant.

The sternum was lifted next and the heart removed by cutting blood vessels as close to the structure as possible. No effort was made to remove blood from the hearts' chambers before weighing and our heart weights are high by comparison with those given by Hartman (1955).

The least hemorrhagic of the two lungs was removed and weighed without regard to position. As far as we could determine, there was no consistent difference in weight between right and left lung.

Liver, spleen, and brain were weighed entire.

Organ weights were taken on an analytical balance with a sensitivity of 1 milligram and a capacity of 50 grams. Organs were weighed only if they appeared to be intact.

Statistical evaluations were made on all samples of eight or more items, but to keep Table 2 within reasonable bounds, only the means are presented. Data on variability in the larger samples are presented in Table 1.

Weight differences were considered significant at the 0.10 level.

THE KILLS

Cochran and Graber (1958) and Graber and Cochran (1960) discussed the meteorological conditions which accompany fall kills at the WCIA tower.

TABLE 2

WEIGHT CHARACTERISTICS OF BIRDS KILLED IN NOCTURNAL MIGRATION

Species, sex, and age	Sample size	Gross	Fat class	Pectoral mass		Brain		Heart		Lung		Liver	
				Mean	%	Mean	%	Mean	%	Mean	%	Mean	%
Short-billed Marsh Wren (*Cistothorus platensis*)													
♀ Imm.	5	8.3	2.4	0.448	5.4			0.140	1.7	0.057	0.7	0.325	3.9
Catbird (*Dumetella carolinensis*)													
♂ Ad.	4	40.9	3.7	2.958	7.2			0.572	1.4	0.301	0.7	1.567	3.8
Imm.	3	39.3	3.3	2.748	7.0			0.497	1.3	0.256	0.6	1.748	4.4
♀ Ad.	13	38.3	2.5	2.701	7.0	1.037	2.7	0.524	1.4	0.249	0.6	1.521	4.0
Imm.	9	38.2	2.5	2.644	6.9	1.209	3.2	0.523	1.4	0.246	0.6	1.688	4.4
Wood Thrush (*Hylocichla mustelina*)													
♂ Ad.	1	53.4	2.0	5.146	9.6			0.834	1.6	0.415	0.8	2.040	3.8
Imm.	2	53.8	3.0	4.586	8.5			0.711	1.3	0.448	0.8	2.659	4.9
♀ Ad.													
Imm.	2	51.1	3.0	4.166	8.1			0.615	1.2	0.370	0.7	2.358	4.6
Swainson's Thrush (*Hylocichla ustulata*)													
♂ Ad.	56	32.0	2.3	2.786	8.7	0.786	2.5	0.466	1.5	0.234	0.7	1.265	3.9
Imm.	18	32.8	2.4	2.803	8.5	0.964	2.9	0.486	1.5	0.257	0.8	1.458	4.4
♀ Ad.	37	30.7	1.9	2.552	8.3	0.851	2.8	0.457	1.5	0.226	0.7	1.183	3.8
Imm.	14	31.2	2.0	2.501	8.0	0.964	3.1	0.437	1.4	0.222	0.7	1.218	3.9
Gray-cheeked Thrush (*Hylocichla minima*)													
♂ Ad.	25	33.3	2.3	2.880	8.6	0.799	2.4	0.525	1.6	0.249	0.7	1.346	4.0
Imm.	8	33.6	2.5	2.793	8.3	0.942	2.8	0.507	1.5	0.240	0.7	1.453	4.3
♀ Ad.	19	31.1	1.7	2.675	8.6	0.808	2.6	0.507	1.6	0.242	0.8	1.392	4.5
Imm.	5	31.2	1.8	2.614	8.4	0.911	2.9	0.456	1.5	0.256	0.8	1.327	4.2
Veery (*Hylocichla fuscescens*)													
♂ Ad.	2	33.5	3.5	3.148	9.4			0.555	1.7	0.257	0.8	1.630	4.9
♀ Ad.	1	30.5	1.0	2.789	9.2			0.546	1.8	0.192	0.6	1.151	3.8
Red-eyed Vireo (*Vireo olivaceus*)													
♂ Ad.	7	19.2	2.3	1.611	8.4	0.595	3.1	0.398	2.1	0.208	1.1	0.733	3.8
Imm.	8	19.6	2.2	1.488	7.6	0.685	3.5	0.342	1.7	0.178	0.9	0.871	4.4
♀ Ad.	6	19.1	2.8	1.532	8.0	0.579	3.0	0.332	1.7	0.141	0.7	0.654	3.4
Imm.	9	18.8	2.6	1.468	7.8	0.683	3.6	0.312	1.7	0.140	0.7	0.748	4.0
Philadelphia Vireo (*Vireo philadelphicus*)													
♂ Ad.	2	13.2	2.0	1.060	8.0	0.494	3.7	0.246	1.9	0.108	0.8	0.495	3.7
Imm.	3	12.8	2.0	0.980	7.7	0.552	4.3	0.273	2.1	0.109	0.8	0.574	4.5
♀ Ad.	2	12.4	1.5	0.957	7.7	0.473	3.8	0.238	1.9	0.078	0.6	0.467	3.8
Imm.	2	15.6	4.0	1.131	7.2			0.224	1.4	0.081	0.5	0.535	3.4
Black-and-white Warbler (*Mniotilta varia*)													
♂ Ad.	2	10.7	1.5	0.737	6.9	0.388	3.6	0.153	1.4	0.056	0.5	0.373	3.5
Imm.	2	12.2	1.5	0.801	6.6	0.548	4.5	0.168	1.4	0.074	0.6	0.465	3.8
♀ Ad.	4	10.2	1.5	0.839	8.2	0.348	3.4	0.164	1.6	0.078	0.8	0.391	3.8
Tennessee Warbler (*Vermivora peregrina*)													
♂ Ad.	6	10.3	2.2	0.813	7.9	0.388	3.8	0.204	2.0	0.088	0.8	0.454	4.4
Imm.	2	11.4	3.0	0.801	7.0	0.451	4.0	0.171	1.5	0.079	0.7	0.521	4.6
♀ Ad.	7	9.6	2.2	0.801	8.3			0.173	1.8	0.082	0.8	0.407	4.2

	Imm.	7	10.1	3.0	0.768	7.6	0.455	4.5	0.164	1.6	0.072	0.7	0.470	4.7
Magnolia Warbler (*Dendroica magnolia*)														
♂	Ad.	8	9.0	2.2	0.681	7.6	0.381	4.2	0.148	1.6	0.067	0.7	0.362	4.0
	Imm.	1	8.3	1.0	0.633	7.6	0.421	5.1	0.163	2.0	0.063	0.8	0.431	5.2
♀	Ad.	10	8.7	2.2	0.661	7.6	0.379	4.4	0.135	1.5	0.064	0.7	0.351	4.0
	Imm.	2	8.4	2.0	0.564	6.7			0.115	1.4	0.045	0.5	0.321	3.8
Blackburnian Warbler (*Dendroica fusca*)														
♂	Imm.	1	9.9	1.0	0.695	7.0	0.461	4.7	0.205	2.1	0.092	0.9	0.510	5.1
♀	Ad.	1	9.2	1.0	0.778	8.5			0.150	1.6	0.071	0.8	0.508	5.5
	Imm.	1	7.6		0.500	6.6	0.418	5.5	0.179	2.3	0.071	0.9	0.353	4.6
Chestnut-sided Warbler (*Dendroica pensylvanica*)														
♂	Ad.	4	10.2	1.5	0.842	8.2			0.162	1.6	0.074	0.7	0.424	4.2
	Imm.	1	11.5	2.0	0.713	6.2	0.525	4.6	0.201	1.7	0.056	0.5	0.435	3.8
♀	Ad.	9	9.8	2.0	0.719	7.7	0.390	4.0	0.171	1.7	0.072	0.7	0.411	4.2
	Imm.	1	8.8	3.0	0.699	7.9			0.132	1.5	0.058	0.7	0.471	5.3
Bay-breasted Warbler (*Dendroica castanea*)														
♂	Ad.	3	13.3	2.0	1.134	8.5			0.204	1.5	0.093	0.7	0.501	3.8
	Imm.	1	12.1	1.0	0.993	8.2	0.503	4.2	0.217	1.8	0.078	0.6	0.505	4.2
♀	Ad.	4	11.9	1.5	0.956	8.0	0.405	3.4	0.188	1.6	0.094	0.8	0.491	4.1
	Imm.	1	11.9	1.0	0.934	7.8			0.167	1.4	0.065	0.5	0.507	4.3
Palm Warbler (*Dendroica palmarum*)														
♀	Imm.	3	10.2	4.5	0.914	9.0			0.181	1.8	0.069	0.7	0.480	4.7
Ovenbird (*Seiurus aurocapillus*)														
♂	Ad.	15	20.4	2.5	1.847	9.1	0.640	3.1	0.319	1.6	0.138	0.7	0.648	3.2
	Imm.	5	20.6	2.6	1.711	8.3	0.666	3.2	0.312	1.5	0.141	0.7	0.714	3.5
♀	Ad.	27	19.7	2.0	1.733	8.8	0.662	3.4	0.307	1.6	0.140	0.7	0.689	3.5
	Imm.	11	22.5	3.4	1.881	8.4	0.780	3.5	0.287	1.3	0.134	0.6	0.806	3.6
Yellowthroat (*Geothlypis trichas*)														
♂	Ad.	4	11.9	3.2	0.752	6.3	0.482	4.0	0.191	1.6	0.077	0.6	0.433	3.6
	Imm.													
♀	Ad.	8	11.7	3.2	0.631	5.4	0.465	4.0	0.163	1.4	0.072	0.6	0.443	3.8
	Imm.	3	11.9	3.3	0.668	5.6	0.571	4.8	0.164	1.4	0.067	0.6	0.479	4.0
American Redstart (*Setophaga ruticilla*)														
♂	Ad.	9	8.6	2.0	0.678	7.9	0.313	3.6	0.145	1.7	0.061	0.7	0.355	4.1
	Imm.													
♀	Ad.	8	8.1	2.0	0.578	7.1	0.307	3.8	0.144	1.8	0.065	0.8	0.361	4.5
	Imm.	2	9.1	2.5	0.637	7.0	0.400	4.4	0.141	1.5	0.053	0.6	0.413	4.5
Bobolink (*Dolichonyx oryzivorus*)*														
♂	Ad.	10	50.7	5.0	3.391	6.7	1.064	2.1	0.578	1.1	0.290	0.6	1.224	2.4
♀	Ad.	7	39.9	5.0	2.771	6.9			0.440	1.1	0.201	0.5	0.969	2.4
Scarlet Tanager (*Piranga olivacea*)														
♂	Ad.	3	32.0	2.0	2.716	8.5			0.510	1.6	0.228	0.7	0.794	2.5
♀	Ad.	1	32.8	4.0	2.759	8.4			0.435	1.3	0.235	0.7	1.319	4.0
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)														
♂	Ad.	2	46.6	1.5	4.122	8.8			0.666	1.4	0.355	0.8	1.464	3.1
	Imm.	2	50.0	2.5	4.370	8.7	1.449	2.9	0.807	1.6	0.372	0.7	1.734	3.5
♀	Ad.	8	48.1	2.0	4.023	8.4			0.687	1.4	0.376	0.8	1.573	3.3

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* Because of extreme fat condition, relative organ weights (per cent of gross) are distorted badly in the Bobolink.

The conditions, usually initiated by a slow-moving cold front, are complete overcast and reduced visibility usually with fog or precipitation.

With detailed migration data and weather records available from the University of Illinois airport and Chanute Air Base, we were able to determine precisely when heavy mortality probably occurred during the nights of the kills.

Aural records (Graber and Cochran, 1960) showed that migrants were moving in the vicinity of Champaign throughout the night of 16–17 September 1958, and that flight call density was 10,265 calls per mile per night. Furthermore, the kill conditions of overcast and reduced visibility (4 miles or less in fog and/or drizzle) obtained in the area throughout the night. It is reasonable to assume, then, that some birds were being killed throughout the night.

On the night of 28–29 September 1959, migrants were first heard in the Champaign area at 0030, 29 September, and migration was heavy thereafter until dawn, the flight call density for the night being 14,940 calls per mile. The kill on this night probably occurred between 0030 and 0200 as this was the only time when both the migrants and the kill conditions were present. In this period the overcast lowered to 1,000 feet and visibility was reduced in fog. After 0200, the overcast broke and lifted, the visibility increased to 7 miles or better. From the above, we can place the time of the kill between 0030 and 0200 on 29 September.

In 1960, the kill occurred during the night of 19–20 September. The aural record for this night showed a flight call density of 12,043 per mile. Overcast prevailed from 2130, 19 September until the afternoon of 20 September, but the ceiling was 1,800 feet or more until 0055, 20 September, when it lowered to 1,200 and stayed throughout the night. Visibility was 7 miles until almost dawn of 20 September when visibility was reduced in haze and fog. The probable time of maximum kill was in this period of reduced visibility just at dawn on 20 September.

Because the time of kill is especially important in the ensuing discussion it is worth while to summarize the above data. In 1958, the kill of migrants occurred throughout the night, while in 1959 the peak kill probably occurred at about 0100, and in 1960, at 0500.

WEIGHT CHANGES RELATED TO FLIGHT

Nocturnal migrants probably take off shortly after sundown, and it is reasonable to assume that the samples of specimens from the different kills probably represent different periods of flight; i. e., in 1958, some birds were killed immediately after take-off, others flew most of the night before striking the tower; in 1959, birds were killed at 0100, having flown about seven hours

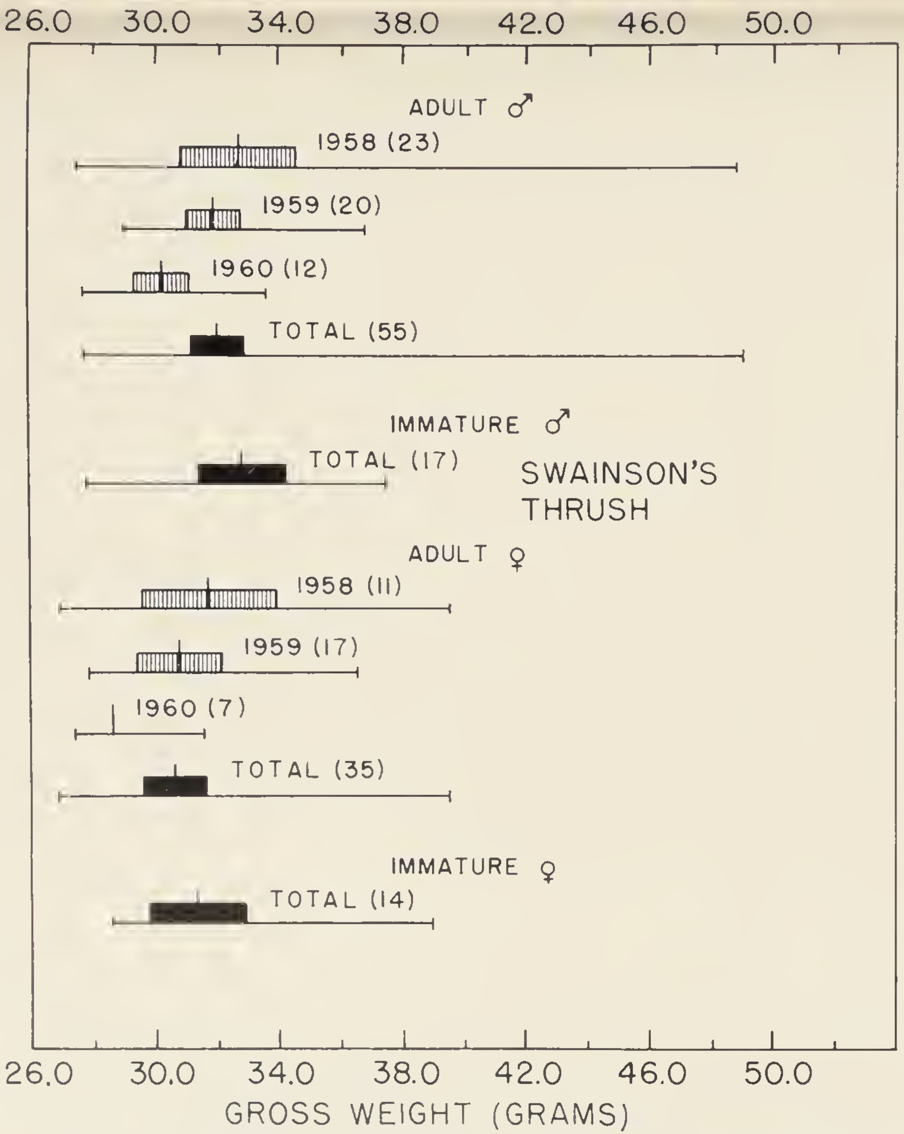

Fig. 1. Variation in gross weight of Swainson's Thrushes killed in nocturnal migration. Figure shows extreme variation and mean plus and minus two standard errors. Time of kills: throughout the night in 1958, 0100 in 1959, and 0500 in 1960.

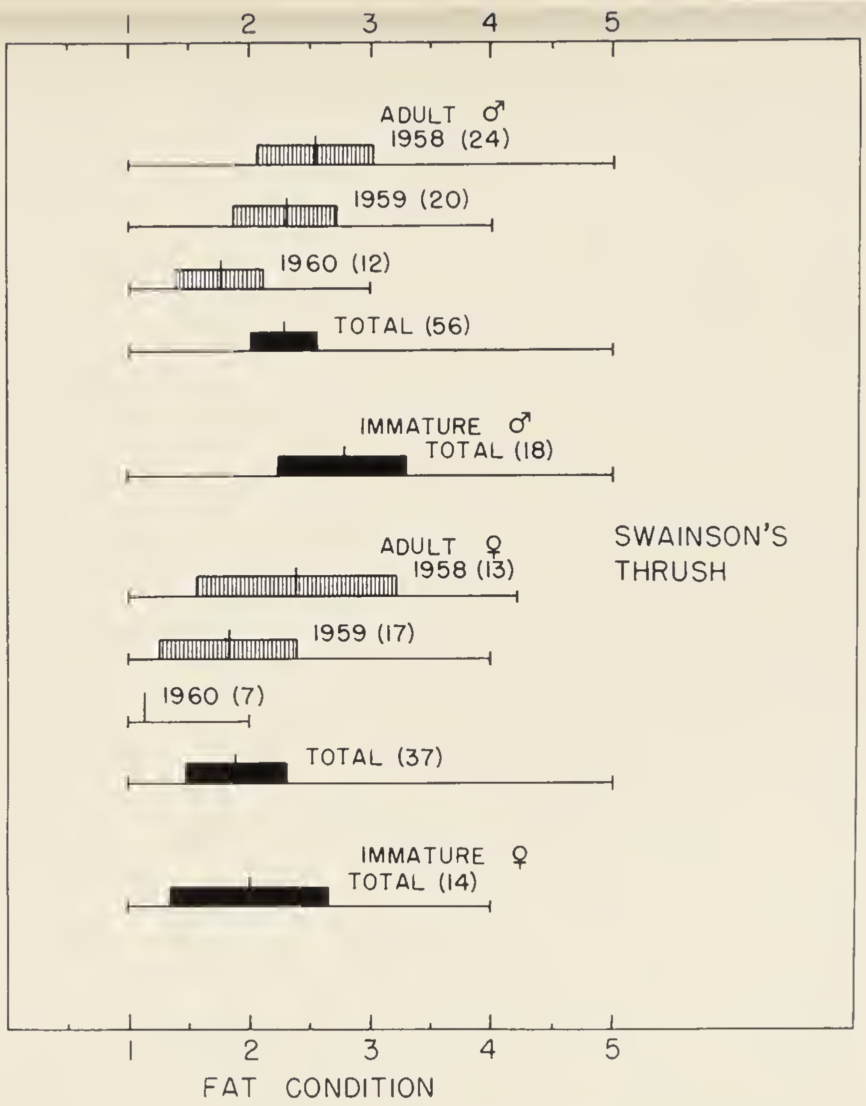

Fig. 2. Variation in fat condition of Swainson's Thrushes killed in nocturnal migration. Figure shows extreme variation and mean plus and minus two standard errors. Time of kills: throughout the night in 1958, 0100 in 1959, and 0500 in 1960.

(since sunset); and in 1960, birds were killed at about 0500, having flown about 11 hours.

More Swainson's Thrushes (126 specimens weighed) were killed than any other species. Gray-cheeked Thrushes were second (57 specimens weighed), and these species were used particularly in studying variability.

Variability in gross weight of Swainson's Thrushes is shown in Fig. 1 and Table 1. In this and other characteristics, variability was consistently higher in 1958 than in the two later kill samples. For instance, in 1958, the mean gross weight of adult male Swainson's Thrushes was 32.8 grams with a standard error of 0.94, while in 1959 the weight was 32.0 (SE = 0.47), and in 1960, 30.3 (SE = 0.46). Other sex and age classes and other organ weights show the same general pattern; i.e., high variability in 1958. There are several possible explanations for this differential in variability. Lacking information about the birds, except that relating to the kill, we can only speculate that the high variability in 1958 reflects the fact that birds from that sample were being killed during a ten-hour period, while the 1959 and 1960 samples represent only one- or two-hour kill periods.

This view is further supported by the fact that thrushes in the three samples become progressively lighter from 1958 to 1960. Migrants are presumably heaviest at the beginning of the night's flight and lightest at the end of it. The 1958 sample represents the entire night, or a mean time of midnight (6 hours of flight); the 1959 sample represents 0100 (7 hours of flight); and the 1960 sample, 0500 (11 hours of flight).

Salt and Zeuthen (1960) calculated a weight loss of 5.5 per cent of body weight per hour for a bird flying 31 mph. For the thrushes this would amount to about 1.8 g/hr or 18–20 g/night. The mean weights in our three samples do not indicate a loss of this magnitude.

The time difference between the kill of 1959 and 1960 was estimated to be four hours, and the mean weight difference in adult male Swainson's Thrushes between the 1959 and 1960 samples was only 1.7 grams or about 0.4 g/hr but both samples may include birds killed at other than the estimated time. Differences in weight between the heaviest adult male thrush in 1958 (presumably killed shortly after sundown) and the heaviest in 1960 (killed at 0500) was 15.4 grams or 1.4 g/hr. Comparable figures for the 1959 and 1960 samples indicate a gross weight loss of 0.8 g/hr.

These figures for gross weight loss are speculative, but weight losses by flying thrushes of 0.8–1.4 g/hr (2.6–4.4 per cent of gross per hour) are reasonable in view of the calculations by Salt and Zeuthen (1960). These authors discussed evaporative loss of water from birds during flight, and pointed out that this loss may amount to a considerable stress to birds in prolonged flight. Graber and Cochran (1960) showed that major night flights of migrants often coincide with overcast conditions. It is conceivable that conditions of overcast with high humidity or even light precipitation may be optimum for migration, because of the effect of such conditions in reducing dehydration. Further, this may be an additional point in favor of nocturnal (with cooler temperatures) versus diurnal migration for small birds.

From data on individual organ weights and fat deposition, we may determine what parts of the migrant are represented in the gross weight loss (Figs. 2–4).

Fat deposits in adult male Swainson's Thrushes decreased progressively in the samples from 1958 (fat index: 2.58) to 1959 (2.05) to 1960 (1.42). The difference in fat between 1959 and 1960 was significant ($t = 2.12$ with 2° of freedom). We cannot say how much weight this represents.

Connell, Odum, and Kale (1960) studied fat-free weights of birds and found this weight to be very constant. Mean fat-free weight of 10 specimens of female Swainson's Thrushes was 26.2 grams—4.6 grams lighter than our 1959 sample (fat factor = 1.8) and 2.4 grams lighter than our 1960 sample (fat factor = 1.1). The differences in weights and fat factors are not quite proportional, but the fat factor is only a rough estimate.

Actual weight data are available for principal organs. The mean weight of pectoral mass was comparable in 1958 (2.82 g) and 1959 (2.87 g) but significantly ($t = 4.41$ with 2° of freedom) lower (2.57 g) in the 1960 sample. The *entire* pectoral mass (both right and left breast muscles) accounts for about 0.60 grams, or about 30 per cent of the mean gross difference between 1959 and 1960. Other musculature might account for some of the difference in gross weight between the two samples. Even the difference in muscle weight in the 1959 and 1960 samples may actually represent fat rather than muscle tissue. George and Naik (1960) found fat content of breast muscle to be as high at 6.3 per cent in certain old world species of birds. This percentage would not account for the total breast weight difference in the two samples, but it is possible that migrants have an even higher fat content in muscle.

Surprisingly, liver weights were not significantly different in the different kill samples. In studying diurnal cycles of liver weights of Red-winged Blackbirds (*Agelaius phoeniceus*) and Starlings, (*Sturnus vulgaris*) Fisher and Bartlett (1957) found that the livers of roosting birds lost about 20 per cent of initial weight during the night. This difference in findings might reflect differences in the species studied, but more likely points out basic differences in the physiology of nutrient utilization between quiet roosting birds and birds in active flight.

None of the other organs weighed (heart, lung, and spleen) were significantly different in the three samples. Brain weights were taken only in 1960.

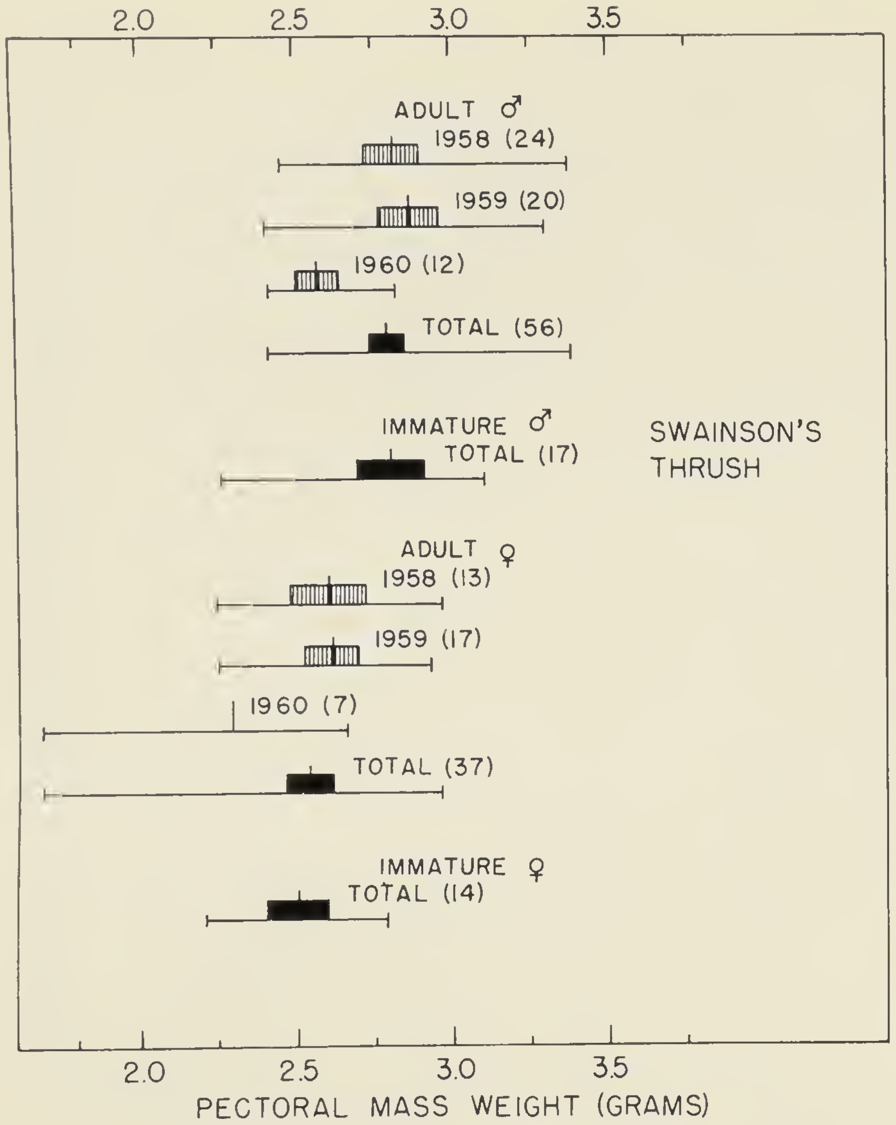

Fig. 3. Variation in pectoral mass weight of Swainson's Thrushes killed in nocturnal migration. Figure shows extreme variation and mean plus and minus two standard errors. Time of kills: throughout the night in 1958, 0100 in 1959, and 0500 in 1960.

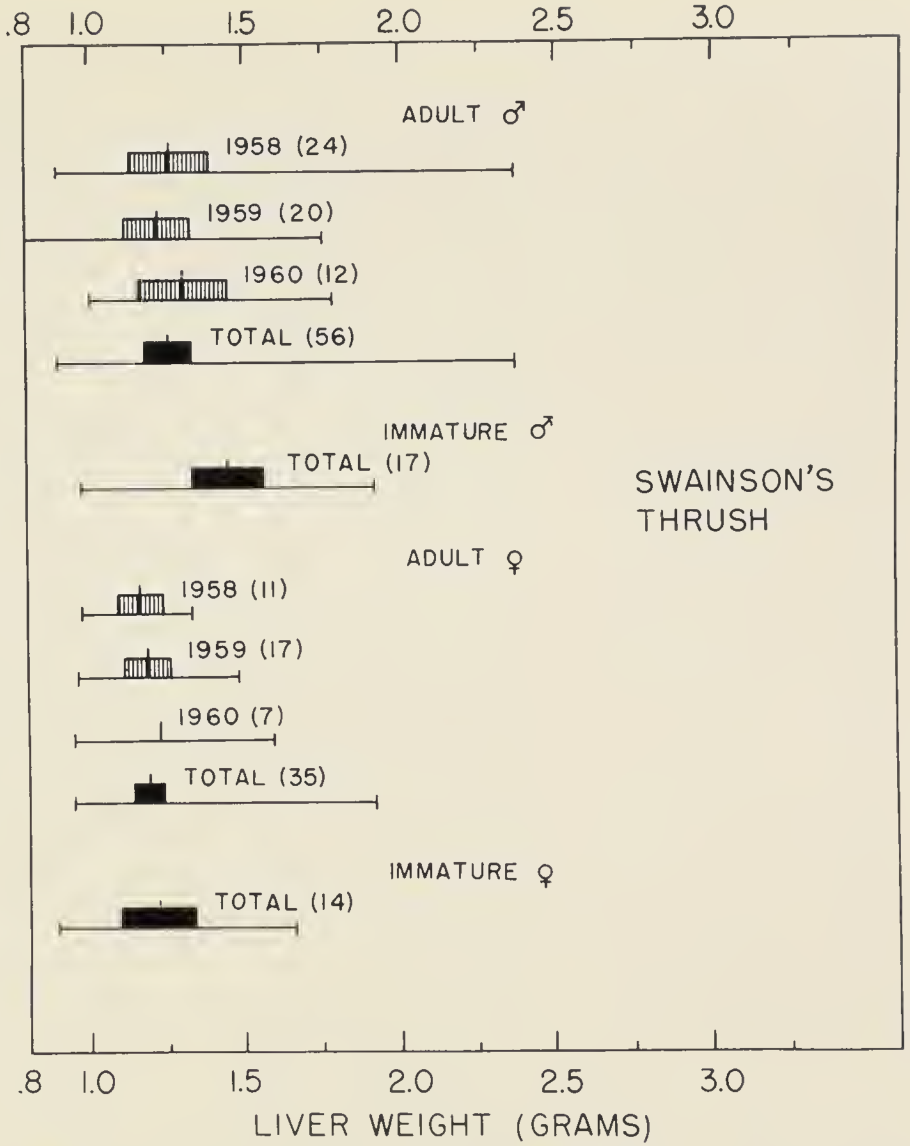

Fig. 4. Variation in liver weight of Swainson's Thrushes killed in nocturnal migration. Figure shows extreme variation and mean plus and minus two standard errors. Time of kills: throughout the night in 1958, 0100 in 1959, and 0500 in 1960.

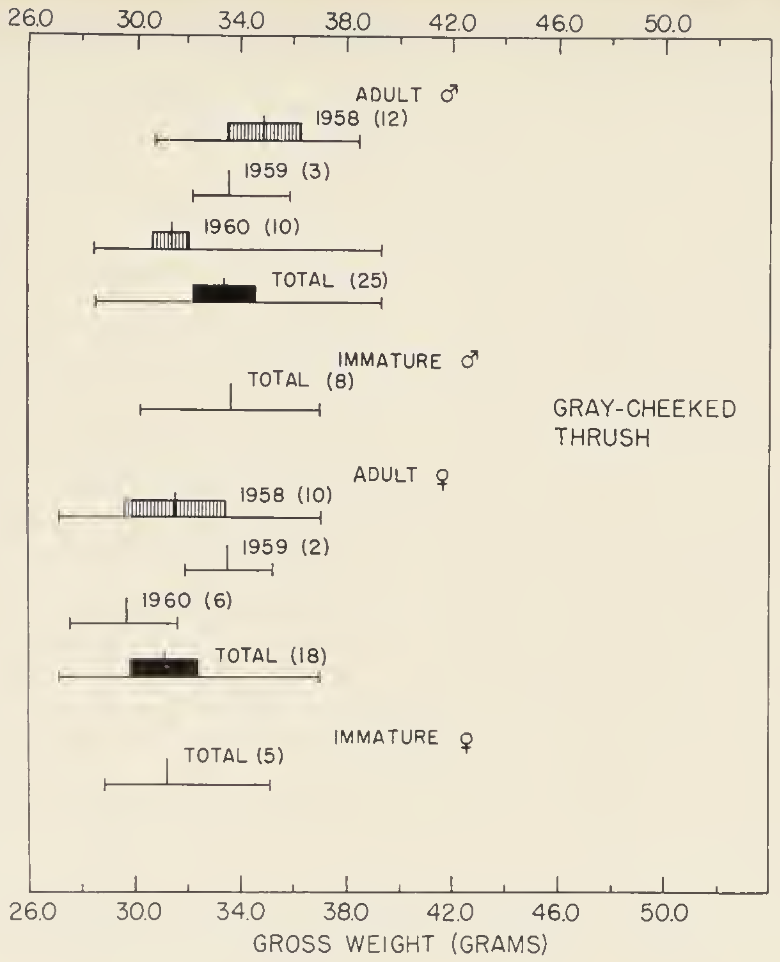

Fig. 5. Variation in gross weight of Gray-cheeked Thrushes killed in nocturnal migration. Figure shows extreme variation and means plus and minus two standard errors. Time of kills: throughout the night in 1958, 0100 in 1959, and 0500 in 1960.

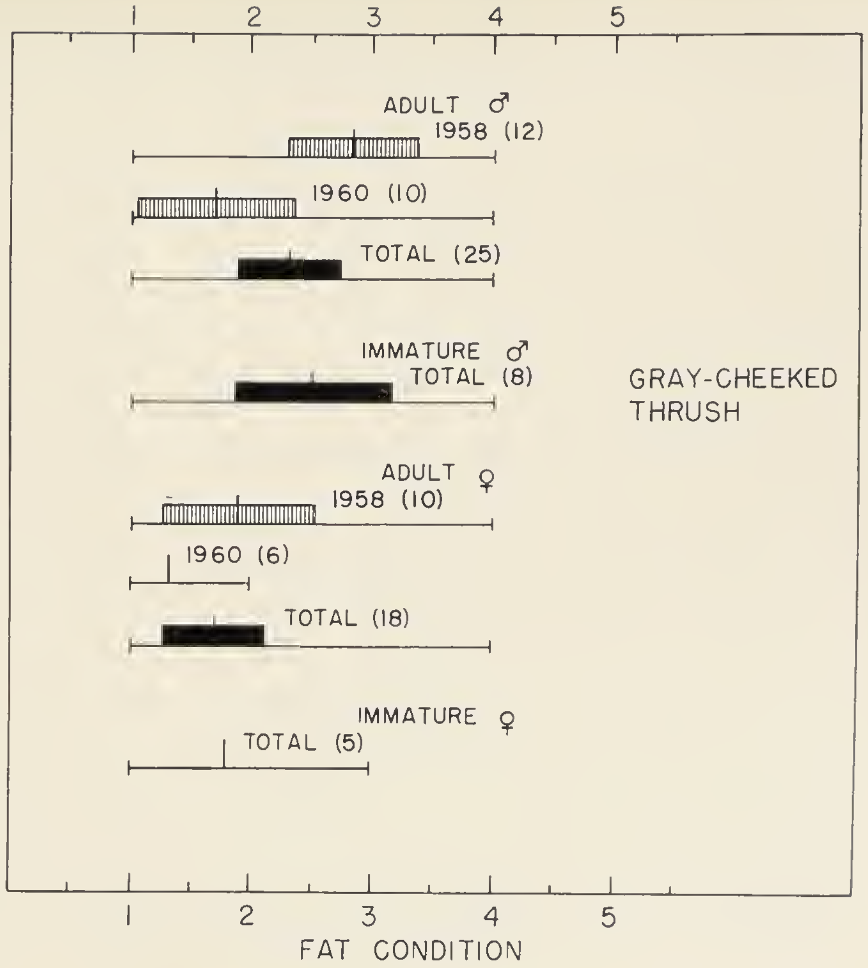

Fig. 6. Variation in fat condition of Gray-cheeked Thrushes killed in nocturnal migration. Figure shows extreme variation and mean plus and minus two standard errors. Time of kills: throughout the night in 1958, 0100 in 1959, and 0500 in 1960.

A large part of the gross weight loss discussed above might represent general dehydration. Of the factors considered, only pectoral muscle and fat contribute to the weight change. It was noted that pectoral muscles account for about 30 per cent of the weight loss. Water and fat apparently account for a large part of the remaining 70 per cent of gross loss.

WEIGHT VARIATIONS RELATED TO SEX, AGE, AND TAXONOMY

Data on variability in organ weights are presented in Figs. 1–8 and Table 1. Though detailed statistics are not available for most of the samples, some trends may be seen in the available data relating particular weight characteristics to certain species or families, and/or sex, and/or age.

Gross weight and fat condition.—In gross weight, males tended generally to be heavier than females, and immatures heavier than adults. The difference in age classes appeared to be related to fat condition, immatures usually being fatter than adults. In the Catbirds, and thrushes, adult males were also fatter than adult females.

There was marked variation in fat condition in different taxonomic groups. Bobolinks were in a class by themselves, all specimens being extremely fat (fat factor = 5). A small sample of immature female Palm Warblers had an average of 4.5, and male Catbirds 3.5. At the other extreme, Blackburnian (1 or less) and Black-and-white Warblers (1.5) were the least fat species.

Pectoral muscle weight.—In considering this and other organ weights, emphasis is placed on weight relative to gross weight, expressed as per cent of gross weight (Table 2). The importance of pectoral muscle weights in evaluating physiological condition in birds undergoing various stresses was first pointed out by Hanson (1958, 1961) in studies on Canada Geese (*Branta canadensis*). He also found heaviest pectoral muscle weights in adult male geese, a differential he has attributed to the nitrogen-conserving effect of the male sex hormone, androgen. In the species considered here it was generally true that males had relatively heavier pectoral muscles than females, and adults heavier than immatures.

Size (weight) of pectoral muscle does not always follow taxonomic lines in the species considered here. Relatively largest pectoral muscles were those of the Palm Warbler (9.0 per cent of gross in immature females), Veery (9.4 per cent of gross in adult males), Wood Thrush (9.6 per cent), and Ovenbird (9.1 per cent). Relatively smallest pectoral muscles were those of the short-billed Marsh Wren (5.4 per cent in immature females), a notably poor flyer: and the Yellowthroat (5.6 per cent in immature females), another poor flyer.

Of larger birds, the Bobolink (6.7 per cent in adult males) and Catbird (7.2 per cent) have light pectoral muscles in relation to gross weight. Actu-

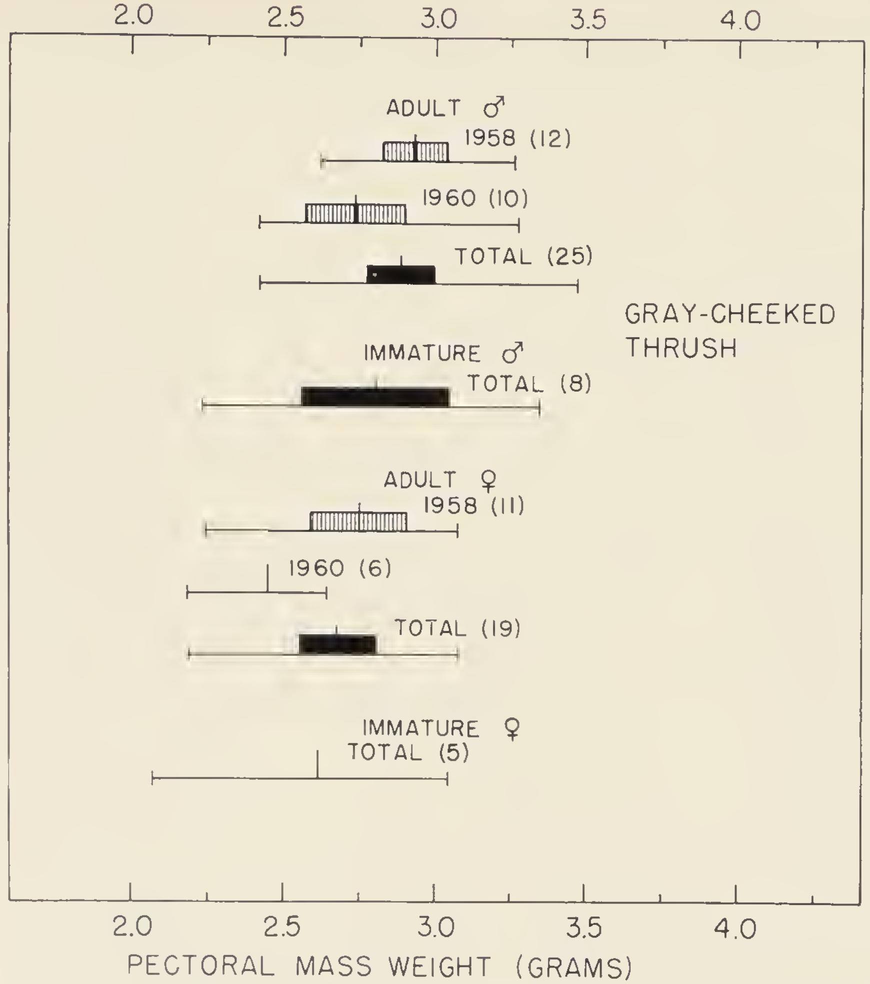

Fig. 7. Variation in pectoral mass weight of Gray-checked Thrushes killed in nocturnal migration. Figure shows extreme variation and mean plus and minus two standard errors. Time of kills: throughout the night in 1958, 0100 in 1959, and 0500 in 1960.

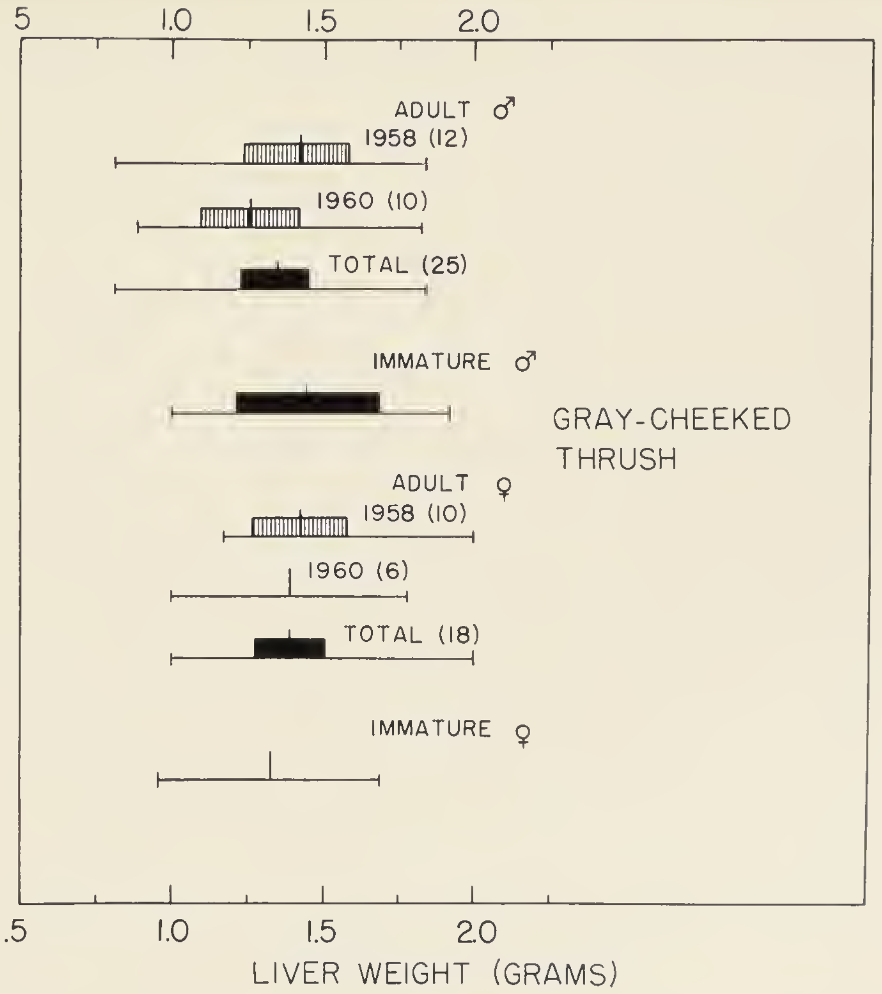

Fig. 8. Variation in liver weight of Gray-cheeked Thrushes killed in nocturnal migration. Figure shows extreme variation and mean plus and minus two standard errors. Time of kills: throughout the night in 1958, 0100 in 1959, and 0500 in 1960.

ally, in relation to body size, Bobolinks have reasonably large pectoral muscles, but the amount of fat carried by Bobolinks puts the gross weight and relative weight out of proportion to other species. Bobolinks appear to migrate both by night and day which poses the question: Do individuals of this species have less opportunity to replenish nutrient reservoirs than the more strictly nocturnal migrants? If they do, this undoubtedly bears on the remarkable fat deposition characteristic of this species.

In evaluating the relative weights of pectoral muscles and other organs in the species considered here, the reader is advised to bear in mind the fat condition factor. For instance, the Palm Warbler has a relatively heavy pectoral mass despite the fact that large fat deposits contribute to the gross weight and tend to reduce the relative value of the organ weight.

Brain weights.—One of the most surprising and, perhaps, potentially useful finds of this investigation was that relating brain weight to age.

Though our sample is admittedly limited, there is consistent indication that immatures have actually and relatively heavier brains than adults. Immature females usually had the heaviest brains of the four age-sex classes, with immature males next. In the thrushes, at least, adult females were also heavier-brained than adult males, so there is a sexual differential as well as a marked age difference.

Whether these weight differences are related to differences in water content or actual tissue structure, we cannot say.

It is conceivable that this information might prove useful in aging populations of birds in the same manner that Lord (1959) has utilized eye lenses to age mammals.

In the taxonomic groups, warblers and vireos appear to be relatively heavy-brained (3.0–5.5 per cent of gross weight) by comparsion with Bobolinks, grosbeaks, Catbirds, and thrushes (2.1–3.2 per cent). Again, fat condition, especially in the case of the Bobolink, tends to distort this percentage.

Heart weights.—Though statistical correlation is poor (correlation coefficient = 0.55, in the case of thrushes), heart weights tended to vary with body weight, showing no consistent variation with sex or age.

Relative heart weights varied from species to species, but the vireos tended to have large hearts (1.7–2.1 per cent of gross weight), the Catbird, thrushes, tanager, and grosbeak. smaller (1.2–1.6 per cent).

Lung weights.—Lung weights, like heart weights, tended to vary with body weight. No consistent variation with sex or age was apparent except in the vireos, among which females were consistently smaller lunged. than males. Largest (relatively) lungs occurred in the vireos, though lung weights were least variable in weights of the organs considered here.

Liver weights.—There was a marked tendency for immatures to have larger (heavier) livers than adults. Though less striking, there was also a sexual difference, males usually being larger than females. Probably in relation to this variation with sex and age there was a suggestion of an inverse relationship between pectoral muscle weight and liver weight. In the Catbird, for instance, adult males had mean pectoral and liver weights of 2.96 and 1.57 grams, respectively. For immature males those weights were 2.75 and 1.75 grams; for adult females: 2.70 and 1.52; for immature females: 2.64 and 1.69.

Relative liver weights were similar (3.5–4.0 per cent of gross) in most species, but those of the Gray-cheeked Thrush, *Dendroica* warblers, Tennessee Warblers and American Redstart tended to be heaviest, while those of the Bobolink, tanager, and grosbeak were on the low end of the scale.

SUMMARY

Gross weights and weights of organs (brain, pectoral mass, heart, lungs, and liver) were collected from 469 specimens (21 species) of nocturnal migrants killed in September 1958, 1959, and 1960 at a television tower near Champaign, Illinois. Migrants were killed throughout the night in 1958, around 0100 in 1959 (7 hours of flight), and 0500 in 1960 (11 hours of flight). For adult male Swanison's Thrushes (largest samples represented), gross weight loss was estimated at 2.6–4.4 per cent of gross per hour. Observable points of weight loss were fat deposition and pectoral mass (about 30 per cent of gross loss). A possible advantage of night (versus daytime) migration and migration under overcast (versus clear) is the reduction in water loss by migrants. Liver, heart, and lung weights did not appear to change in flight.

Gross weight and weights of certain organs appeared to vary with sex and age. Males tended generally to be heavier than females, and immatures heavier than adults. This relationship probably reflected fat condition as immatures were usually fatter than adults.

Pectoral muscle weight was higher in adults than in immatures and highest in adult males. Notably poor flyers had relatively small pectoral muscles.

Brain weights, surprisingly, were greater in immatures than in adults, and greater in females than in males.

Heart and lung weights tended to vary with gross weight.

Liver weights were heavier in immatures than in adults, and tended to be heavier in males than in females.

ACKNOWLEDGMENTS

We are indebted to Donald Hyson who weighed specimens from the 1960 kills, to Jack Ellis, Rex Lord, and Harold C. Hanson who encouraged the study from the start, to Captain John D. Taylor who provided us with weather records from Chanute Air Force Base, and to Glenn Stout and Ken Wilk for weather data from the State Water Survey.

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ILLINOIS NATURAL HISTORY SURVEY, URBANA, ILLINOIS, 31 DECEMBER 1960

GENERAL NOTES

Red-tailed Hawk attacks Long-eared Owl.—On 8 November 1960, I found four Long-eared Owls (*Asio otus*) roosting in brushy second growth, mainly *Crataegus*, four miles south and one mile west of Ann Arbor, Washtenaw County, Michigan. This brushy area is bordered by a mature woodlot on the north and cultivated fields on the other sides. On 12 November the owls were observed roosting as before in two adjacent *Crataegus* trees. As I approached, one owl flushed and flew northward over an open area, where the owl was attacked by a Red-tailed Hawk (*Buteo jamaicensis*). Although I could see that the hawk dived at the owl, intervening brush prevented me from seeing the actual contact. I went to the point of attack and flushed the hawk from the ground in a loose clump of *Crataegus*. The owl was on the ground about ten feet away in the same clump of trees, dazed and helpless. The hawk first landed in a large tree some 120 yards away and flew away when I approached it. The owl, an adult female, soon recovered from its dazed condition and was kept in captivity for several weeks following the incident. Apparent damage resulting from the attack consisted of a slash in the skin of the upper surface of the left wing and a puncture injury to the left eye resulting in blindness in that eye. The Red-tailed Hawk has been recorded as a predator of Screech Owls (*Otus asio*) but I find no previous record of its attacking a Long-eared Owl.—Charles T. Collins, *The University of Michigan Museum of Zoology, Ann Arbor, Michigan, 30 December 1960.*

Red-winged Blackbird killing a Sharp-tailed Sparrow.—In late May 1958, several foraging groups of Sharp-tailed Sparrows (*Ammospiza caudacuta caudacuta* and *A. c. nelsoni*) were feeding on the mud flats and along the dikes of impoundments of the Parker River National Wildlife Refuge on Plum Island, a barrier island off the north shore of Massachusetts near the towns of Newburyport, Newbury, and Rowley. Mr. Murray Gardler and I were banding in the "Hellcat Swamp" area of the refuge during this period. On 1 June, we erected two Japanese mist-nets on a dike to capture several of these sparrows.

These nets were checked at 1000. Two *A. c. caudacuta* were removed and banded (an *A. c. nelsoni* had been captured earlier on the mud flats). Upon approaching the nets at 1100, we noted several captured birds: one Song Sparrow (*Melospiza melodia*) and three *A. c. caudacuta*. A male Red-winged Blackbird (*Agelaius phoeniceus*) appeared to be caught in the net near one of the Sharp-tailed Sparrows. However, the blackbird flew off at our approach, dropping an object about one meter from the net. This object subsequently proved to be the head of a Sharp-tailed Sparrow. The body of the dead sparrow was in the third bag, about eight-tenths of a meter from the ground. There was no evidence to indicate that any portion of the dead sparrow had been eaten.

It seemed possible, at first, that the blackbird might have been poorly bagged on the outside of the net near the sparrow, turning upon it aggressively, killing it, and then escaping upon our approach. However, in my experience with such closely bagged birds, attacks have taken the form of random pecks, rather than the purposeful and somewhat laborious effort required to completely sever the neck of a nearby bird. The body of the sparrow showed no signs of other pecks, and the head was not badly damaged. Red-winged Blackbirds have powerful jaw musculature, sharp mandibles, and a willingness to bite when captured. However, the badly torn skin and muscles of the neck of the sparrow indicated that repeated biting and tearing movements had been necessary to effect decapitation. This suggests that the sparrow was not killed as a result of simple aggression.

It appears, therefore, that the blackbird might have been outside the bag, uncaught, and had killed the Sharp-tailed Sparrow as an item of food, deserting his prey upon our intervention. That the sparrow was not merely killed, but also decapitated, strengthens this contention, as this seems to be a common starting point among avian predators on prey of only slightly smaller size.

A cursory survey of the literature on the Red-winged Blackbird suggests that the species eats nearly all invertebrate prey likely to be encountered by it. Only Bendire (*Life Histories of North American Birds.* 1895. Smithsonian Inst., U.S. Nat. Mus. Spec. Bull. No. 3:1–518) lists vertebrate food, namely, newts. It seems probable from this observation, that other vertebrates, including small birds, may be taken when available.

I am grateful to Mr. Gordon T. Nightingale, Director, Parker River N. W. Refuge, for permission to band on Plum Island, and to Mr. Murray Gardler for his help in the field. This work was supported by National Science Foundation Grant G 4811.—CARL W. HELMS, *Department of Biology, Bucknell University, Lewisburg, Pennsylvania, 18 August 1961*

Breeding of Red-winged Blackbird in captivity.—A pair of Red-winged Blackbirds (*Agelaius phoeniceus*) that had been caught as adults and kept together in captivity for a year was introduced into a screened pen 40 feet long, 20 feet wide, and 6 feet high on the campus of the University of Massachusetts during the winter of 1959–60. These birds nested, laid eggs, and presumedly hatched young. The birds were fed, in addition to water, a high energy ration of the following ingredients in pounds per hundred weight (or grams): ground yellow corn, 79; soybean oil meal (95 per cent protein), 7; menhaden fish meal (60 per cent protein), 6.7; alfalfa leaf meal (20 per cent protein), 5; iodized salt 1; manganese sulfate (70 per cent), 0.025; dicalcium phosphate, 1; ground limestone, 0.25; dry vitamin A (10,000 IU/g), 45 grams; and dry vitamin D_3 (3,000 IU/g), 0.07 grams.

The field pen was planted to clover and grasses. Hussocks of marsh grasses were potted in the otherwise dry ground. Nesting materials, consisting of broken-apart fresh nests of other Red-winged Blackbirds available from a concurrent study, were scattered through the pen. During June the female constructed a nest on one of the purlins of the pen. It is not known how far nesting activity progressed as hatched shells were not discovered until long after the death of the female in late June. In early July a replacement female was introduced. This second bird was taken directly from a wild population that had been intensively studied. She was taken on a nest in the wild containing three slightly incubated eggs—her first clutch of the season (at least in that colony). Within a month after capture this female also built on a purlin instead of in the vegetation provided, laid eggs, and succeeded in hatching at least two young. The young died very soon after hatching presumably because insufficient protein and live food were available in the screened pen. To my knowledge this is the first record of Red-winged Blackbirds breeding in captivity. The possibility of controlled experimental work on reproductive physiology and reproductive behavior of this economically important species is suggested. I acknowledge the aid of Allyn Coombs in this study. The birds were contributed by the Section of Upland Ecology, Patuxent Wildlife Research Center; the diet was formulated and contributed by Dr. D. L. Anderson, Department of Poultry Science, University of Massachusetts.—DAVID KENNETH WETHERBEE, *Massachusetts Cooperative Wildlife Research Unit: University of Massachusetts, Amherst, Massachusetts, 16 November 1960.*

Peanut field next to Dismal Swamp, Suffolk, Virginia.

Feeding behavior of the Red-winged Blackbird in the Dismal Swamp region of Virginia.—The feeding activity of blackbirds on the west side of the Dismal Swamp in the Virginia-Carolina Peanut Belt was observed each fall or winter from 1957 through 1960. Special attention was given to the Red-winged Blackbird (*Agelaius phoeniceus*) because of its importance in damaging cultivated crops along much of the Atlantic Seaboard.

Large numbers of migrant Red-winged Blackbirds begin moving into southeastern Virginia in the latter half of October, about the time of the peanut harvest, and a dense population remains through the winter. Other birds that move in with the Red-winged Blackbirds include Common Grackles (*Quiscalus quiscula*), Rusty Blackbirds (*Euphagus carolinus*), Brown-headed Cowbirds (*Molothrus ater*), and Starlings (*Sturnus vulgaris*).

Field observations and stomach examinations indicated that the diet of Red-winged Blackbirds in the area consisted of peanuts (*Arachis hypogaea*), and corn (*Zea Mays*) supplemented by various native plant foods. Peanuts were much more important in the diet than would have been expected from the records in the literature. Martin, Zim, and Nelson (1951:170) do not mention peanuts in their list of foods of the Red-winged Blackbird. Graham (1941:30–31) includes the Red-winged Blackbird in a list of seven species of birds that feed on peanuts. Crebbs (1960:59) found peanut fragments in the gizzards of 20 of 63 Red-winged Blackbirds collected at Suffolk, Virginia, from October to December.

In this area, after the peanuts are dug from the ground, they are placed in 5-foot shocks to dry for three or four weeks before they are removed from the field. The birds stop in these fields chiefly in the early morning and late afternoon as they are leaving or returning to the swamp roost. They usually feed on the peanut residue that is shattered in the digging operation on or near the ground surface. Thus damage generally is light, contrary to some reports. However, during wet autumn seasons when the drying peanut crop remains in shocks more than the usual three or four weeks, a considerable amount of the crop may be eaten in some fields, particularly those bordering the Dismal Swamp.

The preference for ground feeding over feeding on the shock probably is a result of the birds' customary habit of feeding on the ground, and possibly also reflects the greater ease of extracting the nut from the hull while it is on the ground. A peanut sometimes is removed from a field and taken to a tree, where it is hacked to pieces on a limb. Peanut shells dropped by blackbirds have been found in the Dismal Swamp more than a mile from the nearest peanut field.

The sweet gum (*Liquidambar Styraciflua*) is one of the native foods that supplement the peanut and corn diet of the Red-winged Blackbird in this area. Large mixed blackbird flocks foraging through the farm country were observed to leave a peanut or cornfield from time to time and fly into a sweet gum and oak (*Quercus Phellos*, *Q. nigra*, *Q. Michauxii*) woods bordering the Swamp where the Red-winged Blackbirds fed on sweet gum seed and the grackles fed on acorns or beech (*Fagus grandifolia*) mast. One female Red-winged Blackbird collected in a sweet gum tree had 16 sweet gum seeds in its gizzard.

Cocklebur (*Xanthium*), a food that seems unusual, was found in gizzards of several blackbirds. The seeds of this wild plant may be a rather important food of the Red-winged Blackbird in the southeast at this season because it also was found in birds collected at New Bern, North Carolina; Jacksonboro, South Carolina; Valdosta, Georgia; and Montgomery, Alabama. The manner of extracting the seed from the seemingly tough, prickly hull was observed at Montgomery. A bird would pick up a bur from the ground in an old cornfield, fly to the limb of a tree along the border of the field, place the nut on the limb between its feet, and hack at the husk until the seed was exposed. It is also possible that seeds were easily removed from hulls that had become soft from lying on the damp ground. The recovered seeds all appeared to have been ingested whole, indicating that the birds are quite dexterous in removing them.

The seed of the loblolly pine (*Pinus Taeda*) is another unexpected food item frequently taken in the Dismal Swamp region. Seeds are picked up from the ground and also extracted from the cone on the tree. Fleetwood (1947:10) and Denton (1947:10) observed Red-winged Blackbirds extracting pine seeds from cones in trees in Georgia; Beal (1900:43) also reported this blackbird as feeding on pine seed.

Red-winged Blackbirds also were observed feeding on loblolly pine seeds in Accomac County, Virginia. On six occasions adult male Red-winged Blackbirds were seen removing pine seed from cones in loblolly pines adjacent to a river marsh. The birds usually were in small bands of fewer than 50. Two males were collected on 4 December 1959, while feeding on pine seed. One had taken 10 seeds, the other 20. The birds usually remove the hard seed coat before ingesting the kernel. During bumper-crop years (every three or four years), as in the winter of 1959 and 1960, pine seed is available in great quantities from mid-fall to late winter.

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BROOKE MEANLEY, PATUXENT WILDLIFE RESEARCH CENTER, 9 MARCH 1961

Adaptive feeding in a Ruby-crowned Kinglet.—On 26 January 1961, during a break in a sleet storm, I observed a Ruby-crowned Kinglet (*Regulus calendula*) feeding in an unusual manner. The bird caught my attention as it fluttered, about 8 feet from a well-used walkway, along the base of a wall of a building on the Duke University campus. It first seemed as if it were injured, and I attempted to catch it; but although the bird allowed close approach (4–5 feet), it easily remained out of range. The bird was, in fact, feeding. From the grass which grew between the walk and the wall the kinglet would fly to the wall and either hover close to it, jabbing with its bill into the recesses in the rock, or perch woodpecker-like on the rough surface and explore the depressions more thoroughly. The University buildings are made of rough pieces of a type of metasedimentary rock (known commercially as 'Carolina Slate') possessing numerous crevices. Inspection showed that some of these contained spider webs in which there were occasional remnants of dead, trapped insects. It was upon these that the bird was feeding, as bits of web on the feet and face attested.

Weather conditions probably account for this unusual behavior. A week later (4 February) on the day following a similar storm (a difference in water equivalent of only 0.04 inches), ice coverage of branches was measured. It was then found to vary from 33 per cent to 40 per cent of area in samples which ranged in size from 2.5 to 26 cm in circumference. Small twigs had, in general, no ice; but the trunks of many trees, especially those which were slanted in the direction of the wind, did. The normal feeding behavior of the Ruby-crowned Kinglet has been summarized by Skinner (*in* Bent, 1949. *U.S. Nat. Mus. Bull.*, 196:406) who noted that "they depend chiefly on picking insects from the bark, or catching those that fly from the bark." Under the above conditions of ice coverage, feeding in this manner would be impaired as most of the uncovered area was on the less-accessible bottoms and sides of twigs (however, see below).

Although I could find no references to feeding behavior of the Ruby-crowned Kinglet which mentioned wall-feeding, notes on other kinglet species are instructive. Forbush (1907. "Useful Birds and Their Protection") wrote of the Golden-crowned Kinglet (*R. satrapa*) hovering while feeding at tree trunks. Morris (1903. "A History of British Birds," 3:241) says that in England the Goldcrest (*R. regulus*) in "the extremity of the winter blast. . .will often approach houses in search of food, and enter greenhouses and hothouses." He goes on further to describe the trunk-feeding of this species which is similar to that of the Golden-crowned Kinglet and, in part, to the wall-feeding of the Ruby-crowned Kinglet described above: "It will alight on the branch of a tall tree. . . and after a momentary survey, will dart on its prey reposing on the back of the stem, suspend itself for a moment by a rapid motion of its wings, then return to a branch, again glance at the stem, and flit to it."

Although this particular instance of specialized feeding is of note, the overall effects of the storms on tree-feeding species were probably slight. Most of the ice on branches was lost soon after the storms had passed; more notably, both species of kinglets were observed feeding beneath limbs during the interval before melting—presumedly the usual method under these and similar conditions.

I am grateful to Dr. P. H. Klopfer for reading the manuscript and making several helpful suggestions.—Henry A. Hespenheide, *Box 5898 Duke Station, Durham, North Carolina, 14 May 1961.*

Some foods of the Yellow Rail in Missouri.—On 17 April 1961, a Yellow Rail (*Coturnicops noveboracensis*) was flushed by fire during an experimental burn at Tucker Prairie (a 160-acre tract of virgin prairie owned by the University of Missouri). The rail was captured alive and taken to the Missouri Cooperative Wildlife Research Unit, photographed and put in a large glass cage. The bird adjusted quickly to its new home and soon gave its pebble-clicking call. It was banded and released on 6 May on Tucker Prairie after being kept captive for 29 days.

TABLE 1

YELLOW RAIL GIZZARD AND DROPPING CONTENTS

Food item	Volume in cc gizzard	Dropping
Plants		
Setaria glauca (yellow foxtail)	0.03 cc	
Acalypha virginica (Three-seeded mercury)	Trace	
Viola sagittata (arrow-leaved violet)	Trace	
Rosa sp. (rose)	Trace	
Unidentified	0.10 cc	
Animals		
Diplopoda		
Millipede	0.05 cc	Trace
Hexapoda		
Carabidae (ground beetle)	Trace	Trace
Formicidae (ant)	Trace	
Eggs		Trace
Gravel	0.04 cc	

On 2 May 1961, David Snyder and I flushed another Yellow Rail on Tucker Prairie. It was flushed twice at 7:00 PM without use of a dog. The rail was collected, prepared as a study skin and the gizzard contents saved.

Many references were checked for food habits of the Yellow Rail, but few specific data were found. Wayne (1905. *Auk*, 22:395–400) mentions finding fresh-water snails in the stomachs of eight birds collected in South Carolina in February. "American Wildlife and Plants" (Martin, Zim, and Nelson, 1951) gives the only extensive listing of Yellow Rail foods. Sixteen stomachs of birds collected in the east (four in winter, four in summer, one in spring and seven in fall) contained beetles, snails, grasshoppers, spiders, ants, fly larvae, true bugs, various crustaceans and eight kinds of plants. Sedge, smartweed, nutrush, and bristlegrass were the most important, plus traces of spike-rush, bulrush, common ragweed, and bayberry.

The captive bird did not eat for the first three days, but then began eating once a day when food was put before it. Earthworms and sowbugs always seemed to be the first choice when a dish filled with a variety of invertebrates was offered. When the earthworms and sowbugs were not available, foods next in preference were small snails, carpenter ants, German roaches, black crickets, lepidopterous larvae, spiders, ground beetle larvae, horsefly larvae, and rat-tailed maggots. The dipterous larvae were always eaten last.

Ground beetles, lady beetles, aquatic beetles, and braconid wasps were eaten only if no other food was present. Usually the beetle heads and elytra were not eaten. The bird refused to eat millipedes, slugs, and large land snails. The refusal to eat the large snails probably was due to their large size and heavy shell.

With the help of Leroy Korschgen, Missouri Conservation Commission Biologist, the Yellow Rail gizzard and dropping contents were analyzed. The gizzard contents were from the Yellow Rail collected on 2 May the one dropping was collected from the Yellow Rail on the day that it was captured by hand, 7 April 1961.

The captive rail refused to eat millipedes (although it had previously done so as shown by its droppings). The gizzard contents of the Yellow Rail shot also indicated consumption of millipedes. Either there was a species difference between millipedes fed in captivity and those taken in the wild or the food selection of the captive rail was influenced by the fact that more desirable items (sowbugs, earthworms) were accessible most of the time. Perhaps the bird never became as hungry in captivity as it had been in the wild during this stage in its migration.—DAVID A. EASTERLA, *Missouri Cooperative Wildlife Research Unit, Stephens Hall, Columbia, Missouri, 19 July 1961.*

Winter Barn Owl foods in a Louisiana coastal marsh.—Although the Barn Owl (*Tyto alba*) is usually associated with agricultural or wooded areas, it has been frequently encountered in the coastal marshes of Louisiana (April issues of *Aubulon Field Notes*, 1952–61). During the annual Christmas bird count an average of five Barn Owls per year for a 10-year period was reported in the marsh near the Sabine National Waterfowl Refuge. The Barn Owl was the most common owl, with 14 being reported in 1953. The fact that coastal marshes are a somewhat unique habitat for Barn Owls stimulated our interest in the foods of this bird.

The primary purpose of the study was to determine the foods consumed by winter resident Barn Owls on Marsh Island and to associate this with the availability of such foods. Also, the study was to serve as a check of the relationship between Barn Owls and the young of furbearing animals and game species in a coastal marsh.

Marsh Island Wildlife Refuge, which is owned and managed by the Louisiana Wild Life and Fisheries Commission, consists of 85,000 acres of sub-delta marsh. It lies in the Gulf of Mexico just offshore in south central Louisiana. Over 90 per cent of the island is composed of soft brackish marsh and shallow lakes. The dominant marsh vegetation is salt-meadow grass (*Spartina patens*), three-cornered grass (*Scirpus Olneyi*), and rush (*Juncus Roemerianus*). The only area of firm marsh lies in the southwestern portion of the island adjacent to the Gulf beach. This beach ridge is sparsely covered by hackberry (*Celtis laevagata*), southern prickly ash (*Zanthoxylum Clava-Herculis*), and rattle box (*Daubentonia texana*). The largest trees are about 8 inches in diameter and 50 feet high.

Barn Owls were observed on Marsh Island under a wide variety of conditions. They were seen roosting in trapper's camps, trees, low shrubs, and on the ground. Since there are no trees large enough to contain cavities of a size that could be inhabited by the owls, they were perching on branches. During daylight hours Barn Owls were frequently flushed in the marsh several miles from the nearest trees.

A total of 804 Barn Owl pellets were collected over a six-month period from November 1959 to April 1960. They were collected on the tree-covered portion of the Gulf beach, around a trapper's camp, at the main headquarters camp, and under a steel radio tower on the Refuge. Analysis revealed that the pellets contained remnants of 1,008 vertebrate animals. Of this number, 984 (97.5 per cent) were rice rats (*Oryzomys palustris*) and 24 (2.5 per cent) were small passerine birds. The pellets contained an average of 1.22 rice rat skulls and 0.03 bird skulls. Since the rice rat was the only small mammal found in the pellets, trap sampling was done to determine if other small rodents were present on the island. Snap-type mouse traps were operated for 300 trap-nights. Only ten animals were captured and all were rice rats. Since some traps were set at camp and no house mice were caught, it is assumed that none was present on the island.

Since the rice rat was the only small mammal found in the owl pellets and during the trapping operation, it is probable that it was the only small mammal present on the island in significant numbers; hence, the only one available to Barn Owls.

Although passerine birds were abundant during the time of the study, particularly during fall and spring migrations, they were of little importance in the diet of the owls. Of particular significance is the fact that many of the small birds were in a weakened condition on arrival at the Refuge during spring migration, many barely able to fly. Consequently, they could have easily fallen prey to Barn Owls.

The young of nutria (*Myocastor coypus*), muskrat (*Ondatra zibethica*), swamp rabbit (*Sylvilagus aquaticus*), and mink (*Mustela vison*) did not occur in the pellets. The nutria population was very high. The young of this species are not only nocturnal and precocial but they are also born and suckled on exposed platforms where they are readily exposed to Barn Owls. Evidently the young of nutria are larger than the prey items desired by Barn Owls. At birth the young of the other fur animals are concealed and thus are not available to owls until partially grown.—E. S. JEMISON, *Louisiana State University School of Forestry, Baton Rouge, Louisiana*, and ROBERT H. CHABRECK, *Louisiana Wildlife and Fisheries Commission, Grand Chenier, Louisiana, 10 July 1961.*

Nest sanitation of Yellow-bellied Sapsucker.—Yellow-bellied Sapsuckers (*Sphyrapicus varius*) feed sap to their young along with insects and the fact that nestlings have fairly liquid excreta may account for the somewhat unusual methods which this species uses in nest sanitation. The following observations were made over the course of six years on 20 pairs which nested at Tamworth, New Hampshire.

Male sapsuckers, do most of the nest cleaning. On 17 June 1957, for example, I heard a steady pecking from inside the nest hole of Pair A, then saw the male appear at the entrance with a large billful of mushy feces. He flew to a maple trunk 40 feet away, shook the excreta loose, and wiped his bill on the bark a few times as if cleaning it. The male then returned to the nest. He carried out his routine three times in a row, always flying to the same place on the maple trunk to scatter the feces onto the dry leaves on the ground below. Observations made in 1959 brought out additional aspects of this routine sapsucker behavior. Thus, on 21 June I saw a female emerge from a nest with a billful of feces, then fly to an oak trunk 25 feet away and scatter it. Three days later, I watched the male scattering excreta from the oak. Both members of the pair, therefore, were frequenting the same spot for this purpose and the spattered leaves below indicated that it had been used many times. On inspection I found the accumulations of feces were well mixed with sawdust.

Sapsuckers continue to enlarge the nest cavity after the eggs have hatched, for I have heard males as well as females excavating in nests with young for as long as five minutes at a stretch. The sawdust produced soaks up excreta and appears to facilitate its removal. Another indication of an enlarging process was that a nest collected when the young had just hatched was considerably smaller than one collected at the end of the nesting period when the two nestlings were ready to fly. Early and late measurements of a single nest cavity, however, have not been made.

I began watching Pair C on 14 May 1960. Both male and female were taking turns at excavating the nest hole and each threw repeated billfuls of sawdust from the entrance, and the ground below was well covered. On 20 May the female exhibited a new form of behavior. She had laid her first egg in the morning, but the excavating was continuing as before when she appeared within the entrance with a large billful of fresh sawdust, then flew to a maple trunk 30 feet away, scattered her load, and wiped her bill. She repeated this performance on two other occasions during the afternoon. This early appearance of a behavior pattern characteristic of parents caring for young in the nest suggests that the mechanism for nest sanitation is employed before there is any real need for it. A similar situation among Yellow-shafted Flickers (*Colaptes auratus*) has been described elsewhere (Kilham, 1959. *Wilson Bull.*, 71:323–336).

Flickers have a fecal sac which consists of a tough, white membrane. This sac can be seen clearly when a parent leaves the nest with excreta, and two nestlings which I raised in captivity produced fecal sacs when poked at the cloaca after being fed. Yellow-bellied Sapsuckers, in contrast, do not appear to produce fecal sacs. I never saw any being carried from the nests of the 20 pairs observed, nor were any ever produced by six young sapsuckers which I have raised by hand. The diet of these latter individuals did not include sap. Two of them, however, voided shortly after removal from the nest, one leaving a puddle and the other a wet mash of fecal matter, without enclosing sacs.

However, Wible has written of the Yellow-bellied ("Red-naped") Sapsucker of Montana as having a fecal sac (1960. *Wilson Bull.*, 72:399). It is not clear, however, that she is using the term in the sense that I have used it in regard to flickers, for she stated that the sac she observed was "transparent" and was "eaten by the bird, the fecal contents dropping to the ground." If the fecal matter is picked up with sawdust as I have described, it is difficult to see how it could be enveloped in a fecal sac.—Lawrence Kilham, *Dept. of Microbiology, Dartmouth Medical School, Hanover, N.H., 3 February 1961.*

Wing-flashing of Graceful Mockingbird while assembling sticks.—Hailman (1960. *Wilson Bull.*, 72:346–357) concludes that foraging is probably the main factor involved of wing-flashing in Mockingbirds. In Surinam I regularly observe the wing-flashing of the Graceful Mockingbird (*Mimus gilvus*) when running on lawns and sand-paths. On 3 February 1960, I observed in my garden a different kind. An adult bird was running on the ground picking up sticks, so I got the impression that it was assembling nest material. When it took a stick in its bill, it dropped it and immediately a "hitch" of wing-flashing followed. The wings were held above the horizontal and the tail was lifted and spread like those of the bird in the upper figure opposite page 341 in *Wilson Bull.* 72. Then the wings and tail were closed and the bird ran a few steps to pick up another stick, dropped it and another hitch followed. This was repeated a few times but I omitted to count how many times.—F. Haverschmidt, *Paramaribo, Surinam, 3 February 1961.*

Long drinks by a hummingbird.—It is perhaps well known that the Ruby-throated Hummingbird (*Archilochus colubris*) can drink continuously for several seconds if the supply of fluid is large relative to the bird's capacity. Normally this occurs only when man-made feeders are provided. When estimating the duration of some of these long drinks by counting seconds I also noticed the causes of interruption of drinking. Drinks of six seconds or less were very numerous and were not recorded (Table 1).

TABLE 1
SUMMARY OF 25 LONG DRINKS

Seconds	Number	Seconds	Number
7	7	13	1
8	3	14	1
9	2	16	1
10	1	17	1
11	4	23	1
12	2	24	1

The detectable causes of interruption were: actions of man or of other hummingbirds, approach of bees or wasps, and interruption of the supply of fluid. In many cases no cause was evident. There may well be individual differences. It frequently happens that a bird will take a series of drinks separated by quick withdrawals and reinsertions of the bill, each drink a little shorter than the preceding. If conditions are favorable, five or six pulsations of the gular area per second can be seen. These observations were made at Hillsboro, N.C. So far, no differences can be ascribed to sex.—CHARLES H. BLAKE, *Museum of Comparative Zoology, Cambridge, Massachusetts, 14 August 1961.*

Notes on Least Flycatcher behavior.—While studying the Acadian Flycatcher (*Empidonax virescens*) from 1955 to 1958 in southeastern Michigan, I gathered fragmentary data on the breeding biology of the Least Flycatcher (*E. minimus*). My observations on the latter were of unmarked birds, but the following notes seem significant. This work was done on the University of Michigan's Edwin S. George Reserve, near Pinckney, Livingston County. I wish to thank Dr. Irving J. Cantrall for helping me obtain financial assistance through a Reserve grant.

Only de Kiriline (1948. *Audubon Mag.*, 50:149–153) seems to have published observations on the selection of the nest site by Least Flycatchers; she noted that the female alone selected the site, and described how the female "flitted from crotch to crotch, pressing her breast down into each one to test it for comfort," returned to a particular site again and again, and finally constructed the nest there.

On 2 May 1956, I saw two Least Flycatchers perched 2 feet apart and 30 feet up in an aspen (*Populus*) tree. Both were singing *chebec.* One bird went to an upright crotch and sat in it; the other sang *chebec*, then the bird in the crotch sang *chebec.* At another location, 15 May 1956, a Least Flycatcher came to a particular fork on a limb three times within an hour, perched in the fork, and sat there uttering a long, soft, chattering call. The tail was held straight down and the body quivered as the bird called. Three days later I saw a Least Flycatcher again go to this fork. It sat there giving the chatter call, sang *chebec* twice, then called *wit* several times. After two minutes, a second Least

Flycatcher perched 8 inches from the first and seemed to threaten it, causing the first bird to fly. Thereupon the second bird flew to the fork, sat there 10 seconds, and flew. A nest was begun at this site on 22 May. The sexes of these birds are unknown, but surely the birds represented pairs. If so, both males and females showed interest in potential nest sites.

On 12 May 1957, I saw a Least Flycatcher go to an old nest (which I could not identify) of a previous season, sit on it, give the chattering call, then fly and sing *chebec.* I am not certain of the sex of this bird. Its behavior causes one to speculate whether the old nest was that of a Least Flycatcher, although a bird observed by de Kiriline examined an old nest of the Rose-breasted Grosbeak (*Pheucticus ludovicianus*).

My observations seem to indicate that both the male and the female take an active part in selecting (or inspecting) the nesting site. One alternative may be that the male is only attracted to the spot by the presence of the female there. Someone will have to clarify this point by the study of banded birds.

Secondly, my notes suggest that both sexes sing *chebec.* MacQueen (1950. *Wilson Bull.*, 62:194–205) stated, "The female does little, if any, true singing." Davis (1959. *Wilson Bull.*, 71:73–85) thought only the male gave the *chebec* song. It may well be that female Least Flycatchers sing *chebec* only during the period of nest-site selection, but evidently no one has intensively studied this species during this phase of its reproductive cycle. Acadian Flycatcher females sing at least through the incubation and brooding periods, thus it would not be surprising to learn that female Least Flycatchers also sing.—Russell E. Mumford, *Department of Forestry and Conservation, Purdue University, Lafayette, Indiana, 11 October 1961.*

Total albinism in a Nebraska Bobwhite.—There have been several reports of total albinism in Bobwhites (*Colinus virginianus*) (Sprunt, A., 1928. *Auk*, 45:210–211; Stoddard, H. L., 1931. "The Bobwhite Quail: Its Habits, Preservation, and Increase." Pp. 85–86). Stoddard (op. cit.) states: "While very rare in nature, albinistic examples of bobwhite are by no means rare in museum or in natural history collections. Pure albinistic bobwhites usually show a creamy tint or suffusion." Sprunt (op. cit.) mentioned it was remarkable that a bird of this extraordinary plumage could survive long in the wild.

There seems to be no record of the age of quail which are fully albinistic. On 23 October 1960, a total albino Bobwhite was shot three miles north and three miles east of Arapahoe, Nebraska. It was taken from a covey, all other birds of which appeared of normal coloration. The bird, a male, had pure-white plumage; its bill and feet were magenta; its eyes clear. The ninth and tenth primaries were characteristic of an adult bird and the shape of primary coverts also indicated it to be an adult. From this we may assume that the bird had survived at least 16 months in the wild.—Karl E. Menzel, *Nebraska Game, Forestation and Parks Commission, Lincoln 9, Nebraska, 19 July 1961.*

A record of a puffin in Vermont.—The AOU Checklist (1957) lists only two inland records for the Common Puffin (*Fratercula arctica*). A recent occurrence from Vermont is therefore worthy of note.

On 10 December 1960, the *Rutland Daily Herald* carried a large picture of a "strange bird" which had been picked up by Marshall Fish on Cold River Road, Rutland. The story accompanying the picture gave no indication of the size of the bird, and the picture did not show the bird distinctly, although it was evident that it was an alcid. I wrote, therefore, to Mr. Fish, who kindly sent me a colored photograph which clearly showed the bird to be an immature puffin.

The bird would not eat and was released after a few days.—ALLEN H. BENTON, *State University of New York College of Education, Albany, New York, 19 July 1961.*

A hybrid between a King Eider and Common Eider observed in Iceland.—In an earlier paper (see Pettingill, 1959. *Wilson Bull.*, 71:205–207) I reported two instances in Iceland of a male King Eider (*Somateria spectabilis*) mated with a female Common Eider (*S. mollissima*). These birds I observed in 1958 at their nests in a colony on the farm of Gisli Vagnsson.

Gisli has written me that in 1960 two male King Eiders were again mated with female Common Eiders in his colony and, in addition, a male that was obviously a *spectabilis* × *mollissima* hybrid was mated with another female Common Eider. Gisli's son Einar took several photographs of this pair, one of which was sent me by Dr. Finnur Gudmundsson (see Fig. 1).

The hybrid specimen, according to Gisli's description translated by his son, showed the following hybrid characters: Bill processes slightly higher, more prominent, and deeper yellow than in *mollissima*; cheeks white at the base of the bill, becoming pale

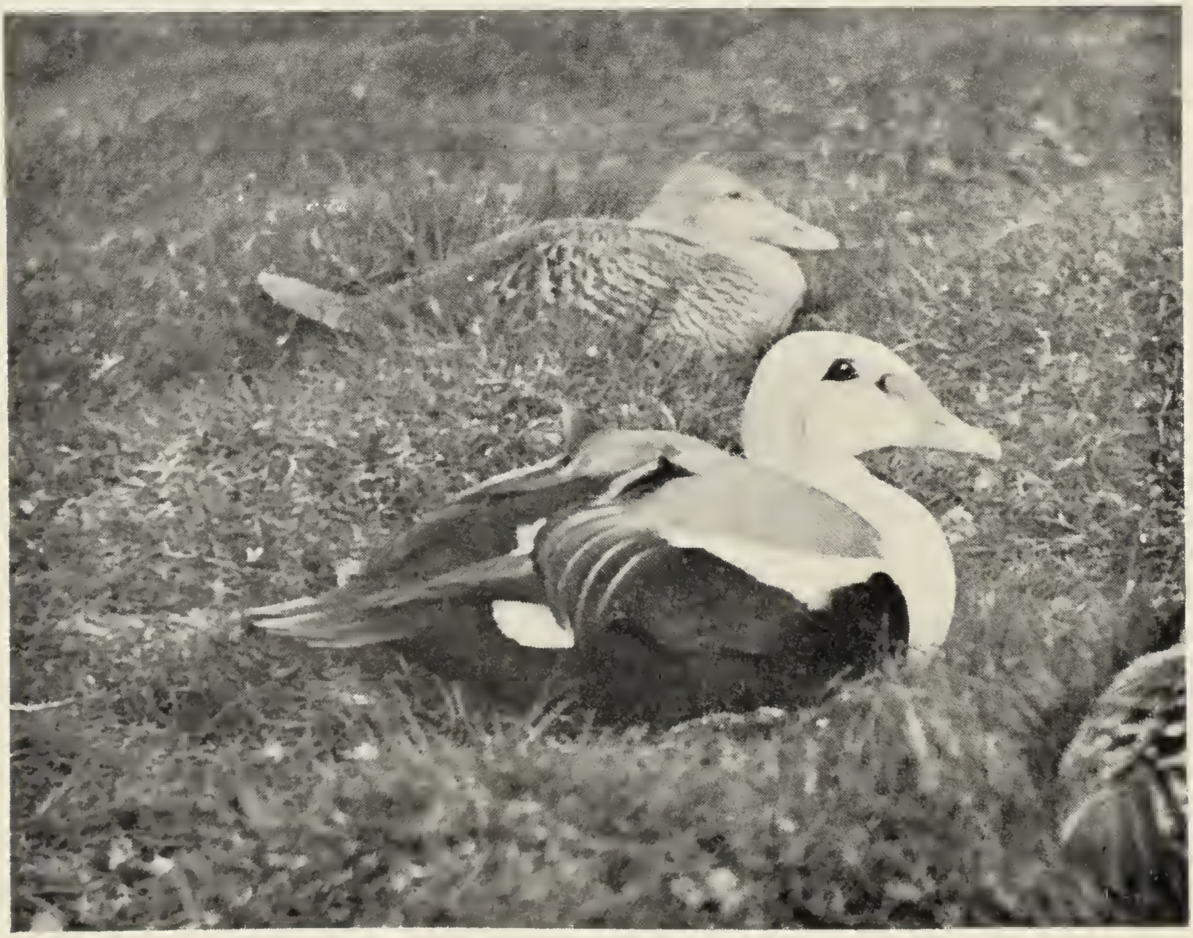

FIG. 1. A male King Eider × Common Eider hybrid mated with a female Common Eider. Photographed in Iceland by Einar Gislason.

gray and finally green posteriorly; crown and nape pale gray; most of back, scapulars, inner secondaries, and all the sickle-shaped tertials grayish to grayish brown.

The eggs from the female mated with the hybrid male proved to be infertile.—Olin Sewall Pettingill, Jr., *Laboratory of Ornithology, Cornell University, Ithaca, New York, 13 March 1961.*

Mourning Doves raise eight young in one year in the same nest.—At least three pairs of Mourning Doves (*Zenaidura macroura*) nested in and adjacent to my mother's large front yard at Ackley Lake, Section 3, Convis Township, Calhoun County, Michigan (T1S, R6W) in 1960. One nest was just east of the yard on a slight rise of ground above a small marsh along the lake border. It was located 3.5 feet from the ground in a small hawthorne surrounded by a dense growth of annual plants 2–3 feet tall. I found this nest with the female incubating one egg and brooding one newly hatched young on 8 June. On 15 June the young were banded and they left the nest about 17 June. On 8 July a female was incubating two eggs in this same nest. The two young were banded on 19 July and they left the nest about 22 July. On 27 July the female was there again, on one egg. I was not able to visit it for several days, but on 3 August she was on two eggs. The two young were banded on 17 August and would have left about 19 August. Unable to examine the nest for several days, I found it contained two eggs on 1 September with the female incubating. Two young were banded on 13 September and they were ready to leave the nest on 15 September. The parents at these nests were not banded, but it seems likely that it was the same female throughout. Probably she may have attempted another nesting prior to the first one recorded above but I do not know. Four more nestings were attempted in this nest during 1961. Although the 2nd nest was unsuccessful six young were again raised. The last two left the nest 12 September 1961.—Lawrence H. Walkinshaw, *819 North Ave., Battle Creek, Michigan, 9 November 1960.*

Breeding American Widgeon in New York.—On 18 July 1960, New York State Conservation Department personnel made a waterfowl brood survey of a newly impounded 1,800-acre marsh lying adjacent to the St. Lawrence Seaway approximately 5 miles west of Massena. Flooded for the first time in 1959, it is called the Wilson Hill Game Management Area. During the two breeding seasons that this area has contained water, it has produced an amazing variety and abundance of waterfowl, including Black Duck, Mallard, Wood Duck, Blue-winged Teal, Green-winged Teal, Pintail and Shoveller.

A breeding bird survey made earlier in the year had indicated the possibility of nesting by several pairs of American Widgeon (*Mareca americana*). They appeared quite territorial, and on 18 July, this possibility became a reality with the observation of an adult female with six young approximately ten days old, and an adult female with ten young approximately 21 days old. In both cases the female put on a classic maternal display, swimming directly at our canoe, turning, wing-flapping and splashing in the opposite direction from which she had sent her brood, and occasionally uttering guttural "quacks" to keep them moving.

To the best of our knowledge, there is no official record of the American Widgeon breeding in New York, so until evidence to the contrary is presented, we would like to add a "first" to the promising future of the Wilson Hill area.—Lee W. DeGraff, and Robert Bauer, *New York State Conservation Department, Albany 1, N.Y., 13 August 1960.*

ORNITHOLOGICAL NEWS

A sum of $500 is available in 1962 for research grants from the Josselyn Van Tyne Memorial Fund. Any student of birds is invited to apply for part or all of this amount. Young men or women just starting their careers, or others not eligible for grants from government or other agencies are especially invited to apply.

Ten duplicate copies of applications should be submitted for distribution to members of the Research Committee who will determine how the funds will be distributed. The applicant should give a full description of the proposed research, the type of help required, the amount of money desired, and the background and training of the applicant. A letter of support from one or more recognized ornithologists would be helpful.

Applications should be submitted not later than 1 June 1962, to S. C. Kendeigh, Chairman, Vivarium Building, University of Illinois, Wright and Healey Streets, Champaign, Illinois.

Ornithologists from other continents intending to work on African birds are invited to make use of the Percy FitzPatrick Institute of African Ornithology, University of Cape Town, as their base. Office or limited laboratory accommodation would be made available; use could be made of the Institute's reference library; access to the collection of the South African Museum could be arranged; and the advice of the staff on matters requiring local knowledge would be at the visitor's disposal. Anybody interested should write to the Director, Percy FitzPatrick Institute of African Ornithology, University of Cape Town, Rondebosch, Cape Province, South Africa.

A study of the Bufflehead is under way, and information on the migration of that species is needed. Data required include first arrival dates, peak date of migration and peak numbers, and departure dates. Only birds actually believed to be migrants should be listed, but, where pertinent, other data on wintering or summering numbers should be included. If only infrequent visits are made to areas frequented by Buffleheads, the statement "present by (date)" is preferable to "arrival (date)," and "last seen (date)" to "departure (date)." Information is solicited particularly for the spring migration of 1962, but it is hoped that interested observers will report any data they may have obtained in the past; requests for fall migration data will be made later. Some Buffleheads were color-marked in Maryland, New York, and Oregon during the winter of 1961–62, and observers should take particular note of any Buffleheads bearing bright patches of red, yellow, or orange. Please send information to: A. J. Erskine, Canadian Wildlife Service, P. O. Box 180, Sackville, New Brunswick, Canada.

The National Science Foundation announces the following changes, effective immediately, in the Graduate-level Research Facilities Program (formerly the Graduate Research Laboratory Development Program):

1) Educational institutions having graduate programs in the life, physical, social, or mathematical sciences, or engineering, and offering at least the master's degree in these areas, are now eligible. Previously, only those departments offering Ph.D.'s were eligible.

2) Funds may now be requested for general purpose research equipment up to a maximum of 10 per cent of total funds otherwise requested in the facility proposal to the Foundation. General purpose research equipment is defined as movable equipment

such as microscopes, centrifuges, calculators, X-ray diffraction equipment, shop equipment, desks, etc. Under the previous rules, institutions could request funds only for construction and fixed laboratory furnishings.

3) Non-profit, non-degree-granting research institutions are now eligible under the program provided they are associated with institutions of higher education in matters of graduate research and training. No non-degree-granting institutions were previously eligible.

It should be noted that there has been no change in the requirement that the institution provide matching funds of at least 50 per cent of the total costs of the project.

Copies of the brochure outlining the requirements for submission of proposals are available without cost upon request to the Office of Institutional Programs, National Science Foundation, Washington 25, D.C.

The National Science Foundation announces that the next closing date for receipt of basic research proposals in the life sciences is 15 May 1962. Proposals received prior to that date will be reviewed at the summer meeting of the Foundation's advisory panels and disposition will be made approximately four months following the closing date. Proposals received after the 15 May 1962 deadline will be reviewed following the fall closing date of 15 September 1962.

Inquiries should be addressed to the Biological and Medical Sciences Division, National Science Foundation, Washington 25, D.C.

JOSSELYN VAN TYNE MEMORIAL LIBRARY

The following gifts have been recently received. From:

Donald S. Burton—1 journal
University of California Museum of Vertebrate Zoology—2 books
F. Haverschmidt—2 reprints
Oscar Hawksley—15 journals, 28 reprints
Donald S. Heintzelman—1 reprint
Leon Kelso—1 book, 2 journals, 5 translations
C. C. Kersting—1 book
Peter H. Klopfer—59 reprints
Karl F. Lagler—1 reprint
James K. Lowther—2 reprints
Richard Manville—11 reprints
Harold F. Mayfield—1 book, 1 journal, 9 reprints
Daniel McKinley—1 book, 3 journals, 11 reprints
Margaret M. Nice—2 journals, 36 reprints
D. F. Owen—5 reprints
Sergej Postupalski—1 book
William B. Robertson—1 pamphlet, 4 reprints
Thane S. Robinson—4 journals
Gerald T. Rogers—190 journals
Lester L. Short, Jr.—2 reprints
Alberto M. Simonetta—2 reprints
William E. Southern—2 reprints
Peter Stettenheim—1 pamphlet
Mrs. Josselyn Van Tyne—85 books, separates equal to 20 additional books
M. G. Vaiden—4 journals
L. H. Walkinshaw—4 reprints
J. Dan Webster—4 reprints
David K. Wetherbee—4 reprints
Leonard Wing—2 journals
University of Wisconsin Dept. of Forestry & Wildlife Management—1 newsletter, 2 reprints
L. R. Wolfe—1 book
Howard F. Young—2 reprints

ORNITHOLOGICAL LITERATURE

Alexander Wilson: Naturalist and Pioneer. By Robert Cantwell. Decorations by Robert Ball. J. B. Lippincott Company, Philadelphia and New York, 1961: 9¼ × 12¼ in., 262 pp. + Appendices, 8 col. and 16 bl. and wh. pls. $15.

With good reason our Society is named for Alexander Wilson (1766–1813). His contribution to ornithology has been great, much greater than many students of birds have realized, and his influence has not disappeared from this science. Wilson's literary and artistic abilities enabled him to stimulate an interest in birds far beyond what his carefully executed life histories would have alone. In addition, Wilson led a life that was both adventurous and inspiring, features which have stimulated biographical studies. Those previously published have been of varying quality, but none has been of the scope which Wilson's significance requires. Yet a knowledge of the incentives of outstanding contributors to a science is quite relevant to understanding why that science has assumed its present form.

Robert Cantwell has published the first detailed biography of Wilson and he has brought to the task literary skill and a fine ability to synthesize scattered information. Because of the diverse and fragmentary data which are available, the writing of Wilson's biography is a greater task than might appear to one who reads Mr. Cantwell's book with no knowledge of the sources. His book is designed for a general public. It has a beautiful format and the narration is extremely interesting throughout. It is of large size to accommodate the plates, all of which are excellent reproductions. In conformity with the plan for a general work, footnotes are omitted and very often sources are not mentioned. This is unfortunate, because Mr. Cantwell usually does not differentiate between definite information and his inferences, which are extrapolated beyond the evidence.

It is disappointing to discover that Mr. Cantwell has made use of this vague documentation in order to inject a sinister undercurrent throughout the book which is contrary to all the evidence. His background as novelist and journalist has evidently led him to feel the need for maintaining tension and suspense. Fortunately, when introducing this sinister theme, he does provide the evidence (court records in the appendix), which the reader can study and judge for himself the validity of Mr. Cantwell's interpretation.

Wilson was convicted of writing a libelous poem and attempting to blackmail the party libeled in order to suppress its publication. A warrant was sworn for his arrest on 26 July 1792. The date of his arrest is not apparent, but he was released on bond on 11 August. Thus he could not have been jailed more than 17 days. There is no evidence of further attempts to imprison him until a warrant was issued for his arrest on 22 January 1793 [incorrectly given as 1792, p. 273] for having allowed the poem to be printed contrary to court order. After two weeks in jail, Wilson was released when he complied with a court order to burn copies of the poem in the market-place and posted bond for two years to insure his good behavior. He had been imprisoned no more than one month under circumstances which might have provoked considerably more severe punishment at such a time of stress in European history. The court document of 23 April and 14 May 1793, which are included, are exceedingly ambiguous and it is not even clear that they in any way pertain to Wilson, because his name is not mentioned on either. Evidence that Wilson was arrested for a third time is dated 4 January 1794. He stated that he was innocent of the charge "of having circulated (six months past) certain Hand Bills" considered seditious [276]. He was released on that date, which seems to have been the date of arrest [77]. Yet, Mr. Cantwell asserts [68], apparently on the strength of the questionable documents of 23 April and 14 May, "that Wilson had been imprisoned a good deal of the time in that period [22 May 1792 to 5 January 1794]."

The motive for such a flimsy assertion is to magnify this experience far beyond its actual proportions. Wilson is then pictured as running away from his stained past for the rest of his life (even though we are asked to believe that he had taken the blame for someone else [78]). There is no doubt that his encounter with the law was a factor in Wilson's decision to emigrate to America, but his failures in Scotland—literary, financial, romantic—were certainly the chief factors. It is evident from the contents of a poem, "Epistle to Thomas Wotherspoon" (1791), that he had contemplated such an action before his entanglement with the law. There is no mention of either this or the fact that Wilson had seen an advertisement in 1793 for the passenger ship he took to America and had then begun to save money for the voyage.

Evidently Mr. Cantwell did not have sufficient confidence either in the inherent interest of Wilson's life for the general public or in his ability to present the material, because he goes to great length to introduce sensational, but extraneous, elements into his narrative. The scandals of Dr. John Witherspoon, James T. Callender, and Alexander Hamilton are described, and then an effort is made to show some faint way in which each was involved in Wilson's life: "In a world dominated by political scandals of this character, and with Scottish refugees creating many of them, Wilson remained in obscurity. He was a convicted blackmailer. . .and it behoved him to be circumspect [93]." This was after Wilson had established himself as a school teacher in America. There were no longer economic oppressors for him to oppose, and he had no lingering fear of further repercussions from his past.

When discussing Wilson's writings, Mr. Cantwell is at his best. He offers a good general evaluation of Wilson's earlier poetry [60, 62] and his extensive paraphrase of Wilson's long nature poem, "The Foresters [127–32]," is most enjoyable. In spite of there being no indication that Mr. Cantwell knows anything about birds which he has not read in "The Foresters" and the "American Ornithology," his extensive paraphrases of them are mostly satisfactory.

There are, however, exceptions which should be mentioned. Wilson is celebrated for the accuracy, clarity, and brevity of his written descriptions no less than for his paintings. A fine example is the plumage description of the American Goldfinch:

> . . .of a rich lemon yellow, fading into white towards the rump and vent. The wings and tail are black, the former tipt and edged with white, the interior webs of the latter are also white; the fore part of the head is black, the bill and legs of a reddish cinnamon color.

Mr. Cantwell's abbreviation of this is unsatisfactory: "the rich lemon-yellow, the reddish cinnamon of the goldfinch. . .[99]." If only two colors are used to describe this bird, they should be yellow and black.

Possibly for poetic effect, Wilson described in "The Foresters" [line 460] an encounter with a Ruffed Grouse, which he calls a pheasant, but in a footnote he gives the correct common and scientific names. Mr. Cantwell misleadingly states that "two pheasants" were shot by Wilson [128]. In similar fashion, Wilson's names are used throughout the book, even when archaic. This would not have been confusing if Mr. Cantwell had made it clear what he was doing, but it does not appear that he realized the names have changed. In three instances he gives the modern name in parentheses (Louisiana tanager = western tanager [141, col. pl. V]; yellow-rump warbler = myrtle warbler [163]; turtle dove or Carolina pigeon = mourning dove [172]), which implies the others are still valid. The confusion is the worst in the labels substituted for Wilson's on the black and white plates. Three warblers are dismissed as "shy and elusive flycatchers" [pl. 7]; Surf Scoter is labeled "black duck" [pl. 10], etc.

In several instances there are errors in the discussions of birds. Clark's Crow is *not* "purely a Pacific Coast native. . .[141]" Wilson did *not* indiscriminately apply the name "snow-bird" "to any one of the winter sparrows [163]" but reserved the name specifically for the Slate-colored Junco. Mr. Cantwell implies [250] that Wilson had no basis for stating in Volume 3 of the "American Ornithology" that the female Black Capt [Blackpoll] Warbler is similar to the male, since in Volume 6 Wilson illustrates and describes it as being different. In the earlier account Wilson was describing the species in the fall plumage in which he discovered it, when, indeed, the sexes are similar. Because Mr. Cantwell did not bother to equate Wilson's names with their modern equivalents, he did not realize that Wilson described the spring plumage of the male under another name in Volume 4.

It is incorrectly stated [175] that Wilson first described the Red-cockaded Woodpecker. This was done by Vieillot, as could easily have been discovered from the AOU Check-list or by comparing Wilson's specific, *querulus*, with the one now employed, *borealis*. However, Mr. Cantwell shows that he has no understanding of procedures in systematics when he states that it is an injustice for Wilson to receive credit in ornithological literature for naming the Black-billed Cuckoo, which was pointed out to him by John Abbot [184–5]. "Credit" is not given to honor the finder, but to stabilize the name of the species, and it is only given for an adequate published description, which in this case never came from Abbot.

Mistakes such as these reveal an inadequate attention to the late Emerson Stringham's summary essay on his study of Wilson's ornithology, and makes desirable the publication of Dr. Stringham's own two-volume study of Wilson's life and work. Dr. Stringham's summary is incorrectly placed under the list of "Supplementary Material" rather than with "Works about Wilson." This is far from being the only shortcoming of the bibliography. Herrick's biased biography of Audubon (1917) is cited rather than the more objective works of Buchanan (1869) and Arthur (1937). Many articles by and about Wilson which were used are not cited. Worst of all is the outrageous treatment of George Ord.

None of the Ord publications which are used are cited at all in the bibliography and only vague references are given for them in the text. Yet many of the important facts which are presented come from Ord's biography of Wilson. Mr. Cantwell goes to excessive extremes to defame Ord, whose crime was the defense of Wilson's name from the unjustified attacks of Audubon (which Mr. Cantwell admits, 250–1). He enlarges upon Ord's eccentricities (understandable in a man whose only child died and whose wife had to be committed to an insane asylum for life) and minimizes his contributions. It is a ridiculous assertion and a disservice to the history of ornithology for Mr. Cantwell to lead his readers to believe that Wilson resented Ord's assistance [250]. This is clearly disproved by Wilson's will which names Ord his literary executor. Ord was Wilson's only student and upon him fell the burden of continuing and completing the work of his master. This Ord did, and produced a respectable contribution to American ornithology and mammalogy. The statement that the discovery of the Cape May Warbler "was George Ord's one claim to ornithological fame [251]" is so preposterous that it needs no refutation. It illustrates Mr. Cantwell's irresponsibility toward history of science.

The treatment of Wilson's relationship with William Bartram also contains a serious distortion (as well as a comparatively minor erroneous statement, that Bartram had ever married [120]). It is stated that Wilson formed the idea for his projected work on ornithology in the summer of 1803, "But years passed before he told Bartram what he meant to do [120]." This is an oversimplification of the facts which implies that Bartram's influence on Wilson was slight, when in fact Bartram was the most important single influence on Wilson as an ornithologist. This is never made clear.

The mistakes and distortions mentioned are but a sampling of those present. Mr. Cantwell's biography may thus be recommended as highly readable but not as authoritative. This is a pity, because he shows the ability to have written a definitive biography, had he shared Wilson's concern for accuracy. Nevertheless, the book should render an important service by drawing attention to the role Wilson has played in the cultural history of America.—FRANK N. EGERTON.

BIRD-SONG. THE BIOLOGY OF VOCAL COMMUNICATION AND EXPRESSION IN BIRDS. By W. H. Thorpe. Cambridge University Press (American Branch), New York, 1961: 5½ × 8½ in., xii + 143 pp., 65 figs., 2 tables. $3.75.

Developments in the last two decades in tape recorders and sound spectrographs have revolutionized the study of animal sounds. The aim of this book is to survey recent developments in the field of bird vocalizations, especially those utilizing these new techniques. The book reviews the findings of the author and others on the musical nature and general character of bird vocalizations, the circumstances under which they are uttered, and their biological significance, and concludes with a discussion of sound production and hearing in birds.

The section and chapter headings indicate the scope of the book: Preface; Notes on the Illustrations; Bird-song as Music and as Language, and Methods for its Study; Call-notes; Song; The Characteristics of Full Song and Subsong; The Development of Song in the Individual; Specific and Subspecific Differences in Vocalisation; Sound-production and Hearing; References; Index; Index to Species (giving scientific names).

Bird vocalizations are considered as a form of language. The chapter on call-notes emphasizes the functions of bird calls, and presents a classification of the various calls. The chapters on song deal with the functions of song, the characteristics which enable songs to perform their functions, the development of song in the individual (based mainly on the Chaffinch) and variation in song (in species and individuals). Field observations and experiments are repeatedly described to illustrate the points under discussion.

The book is profusely illustrated with sound spectrographs. These graphs are reproduced in black and white, and are often somewhat diagrammatic rather than exact reproductions of the original graphs. The result is that many low amplitude sounds are lost, and amplitude variations within the song are not indicated—features which in my opinion detract from the value of the graphs. The time scale in a few graphs is too small to show many of the finer details. The author occasionally misinterprets his graphs, e.g., in Fig. 51, in indicating the frequencies of the energy peaks.

Song is here considered as the utterances of the oscines of the order Passeriformes, but the reader is likely to be misled (p. 14) as to just what families are included in the oscines. The majority of the birds discussed are European species, a feature which may be a little disappointing to bird students in this country.

Subsong (discussed principally in the Chaffinch) is considered as nonterritorial and probably in the nature of practicing, later developing into the full song. The discussion contains no indication that such a thing as a whisper song may be uttered, as Mayfield has shown in the Kirtland's Warbler, in response to playbacks of normal song on a bird's territory, or when another male is nearby.

Much reference is made to the work of other investigators, and approximately 170 references are cited. A feature rarely seen in lists of references, and one certainly worthy of commendation, is the indication in the list of the pages on which each reference is cited. An error in a reference to one paper (Borror and Reese, 1959: the statement that these authors did not indicate the number of recordings from which certain songs were selected, when they gave this information in Table 3 of their paper), and an error in the title of another (Peterson, 1934), make one wonder how many other such errors are present. However, these are minor points, and do not detract from the over-all worth of the discussion.

The book is for the most part very well done, and will be of considerable value to anyone interested in animal behavior in general, or bird vocalizations in particular. It presents an excellent summary of our present knowledge of the nature and significance of bird vocalizations.—DONALD J. BORROR.

ANIMAL SOUNDS AND COMMUNICATION. Edited by W. E. Lanyon and W. N. Tavolga, Publication No. 7, American Institute of Biological Sciences, Washington 6, D.C., 1961: 6¼ × 9¼ in., xiii + 443 pp., 112 figs., 4 tables, and one 12-in. LP demonstration record. $9.50.

The symposium that formed the basis for this publication took place more than three years ago, but time has underlined the wisdom of placing it on public record. The book represents the first authoritative survey of the role and importance of sound communication as a factor in animal behavior, as viewed in the light of recent technical advances made possible by the use of the tape recorder and sound spectrograph.

Each of the book's nine chapters is the work of a different author. Six chapters are based on papers given at the AIBS meeting in 1958, and the remainder were subsequently solicited in order to broaden the coverage of the subject.

Introductory chapters outline the practical problems facing anyone contemplating scientific recording of natural sounds in the field (P. P. Kellogg), and the use of the sound spectrograph for analysis of such sounds (D. J. Borror). They succeed in holding to the middle ground between too superficial and too technically detailed treatment. The next three chapters deal with sound communication in Orthoptera and Cicadidae (R. D. Alexander), Fishes (W. N. Tavolga), and Amphibians and Reptiles (C. M. Bogert). Dr. Alexander covers his subject well and succinctly and Dr. Tavolga outlines what has been accomplished so far in a field that presents its own exceptional difficulties. Mr. Bogert's chapter is something else again—really a book within a book, for it comprises more than 40 per cent of the text. His full and detailed treatment provides a good demonstration of the many avenues of approach that sound communication may now contribute to behavioral and systematic studies of a particular Order (Anura), but I find myself undecided whether this benefit outweighs the imbalance created by its exceptional length in relation to other chapters.

The next three chapters are devoted entirely or largely to bird sounds: "The Ontogeny of Vocalizations in Birds" (W. E. Lanyon); "Bird Songs and Mate Selection" (P. Marler); "An Ecological and Functional Classification of Animal Sounds" (N. E. Collias). These all report on recent experimental work in interesting fashion and make it clear that the present state of our knowledge is still very fragmentary. Extensive bibliographies in these and other chapters form an important contribution to the value of the whole.

It seems strange that, with the coverage as broad as it is, no chapter was devoted specifically to sound communication in (non-human) mammals, a field that might provide the greatest return in terms of our own linguistic experience. However, C. F. Hockett, who was given the opportunity of reading the contributions of the other authors, does use the final chapter to look at sound communications in various animal groups, including mammals, as they relate to what he considers to be 13 critical components of language. For me, the definition and discussion of these terms tended to obscure the sweeping strokes needed for a broad summing up of the subject as a whole.

The long-play record will never become a best-seller, but was not intended as such. The quality of the contributions ranges from very good to very poor but, in the main, they provide provocative and helpful support for the text. This is an idea that could be developed more fully and used more widely in a variety of publications.—WILLIAM W. H. GUNN.

BIRD SONGS IN YOUR GARDEN. By Arthur A. Allen and Peter Paul Kellogg. Cornell University Press, Ithaca, New York, 1961: Bookalbum, 10 × 10 in., 24 pp., 53 illus. (31 col.), and 10 in. 33⅓-rpm vinylite record. $5.95.

The songs of twenty-five species have been faithfully recorded by Dr. Kellogg. Side one contains all the songs, each identified by Dr. Allen. Side two has the same songs without the interruption of human voice. The birds recorded are the Eastern Wood Pewee, Cardinal, Robin, Rose-breasted Grosbeak, Catbird, Scarlet Tanager, Song Sparrow, Chipping Sparrow, Red-eyed Vireo, Wood Thrush, Veery, Cedar Waxwing, Brown-headed Cowbird, Blue Jay, Rufous-sided Towhee, Baltimore Oriole, Orchard Oriole, Purple Finch, Yellow-shafted Flicker, White-breasted Nuthatch, Eastern Kingbird, Eastern Phoebe, Yellow-billed Cuckoo, Black-billed Cuckoo, and Screech Owl.

The album holding this record has excellent color plates of birds represented in the record and some interesting printed information. There are also pictures and printed information on molting changes, plantings to attract birds in gardens, birdhouses and their dimensions, directions for feeding stations and bird baths, and twenty-two references to books in which to learn more about birds.

Dr. Allen and Dr. Kellogg are to be congratulated for producing another excellent work that should find widespread acceptance in homes, schools, and universities.—MERRILL WOOD.

VERTEBRATE SPECIATION. Edited by W. Frank Blair. University of Texas Press, Austin, 1961: 6¼ × 9¼ in., xvi + 642 pp., illus. $8.50.

Ornithologists have for many years considered their science to be in the forefront of vertebrate zoology. This has been true especially in taxonomy, and Mayr's statement that "There is little doubt that birds are better known taxonomically than any other class of animals" is probably as true today as when published 20 years ago ("Systematics and the Origin of Species," p. 5: 1942). As the purely descriptive phase of taxonomy merged almost imperceptibly into the study of speciation, ornithologists (notably Dr. Mayr himself) contributed greatly to the interdisciplinary synthesis that became known as "The New Systematics." We ornithologists dare not rest on our laurels, however, and any tendency toward a smug satisfaction in being the foremost students of vertebrate evolution will quickly be dispelled upon examination of the present volume.

The book consists of 21 papers originally given at a symposium on vertebrate speciation held 27–31 October 1958, at the University of Texas. Of this number, only *three* deal exclusively or primarily with birds. Of the remaining papers, five are based on studies made of fishes, six on amphibia, three on reptiles, and two on mammals. The other two are a broadly based discussion of the subspecies concept by Inger and a survey of recent advances in Pleistocene stratigraphy and biogeography by Deevey.

The papers tend to be of two general types: reports on particular studies or experiments, and broader survey papers, well salted with references, covering recent work in a given aspect of vertebrate speciation. The only paper wholly devoted to birds is somewhat of a blend of these two types: "Habitat distribution and niche relationships in North American species of *Parus*," by Keith L. Dixon. Dr. Dixon's paper is based primarily on his own field work with titmice, but he has used this as a core for a really thorough review, as suggested by his bibliography of 108 titles. He presents an excellent analysis of the ecological factors influencing local distribution of titmice, with special emphasis on those areas in which two or more species are known or said to be sympatric. In the "*Poecile*" group of species (the chickadees), it is quite evident from the number of times Dixon has been forced to rely on inferences based on isolated statements in the literature, that insufficient attention has been paid in the past to exact ecological relationships between such species pairs as *Parus atricapillus* and *P. hudsonicus*, and *P. atricapillus* and *P. gambeli*. And, although this question is barely touched on by Dixon, we need to know much more about the interactions of *P. atricapillus* and *P. carolinensis* where their ranges meet. Although concentrating on the North American titmice, Dixon constantly refers where appropriate to the important work done in Europe by David Snow and others, and to pertinent parallel work on other groups of birds.

Dr. Charles G. Sibley is represented by a paper entitled "Hybridization and isolating mechanisms," which draws most of its examples from ornithology. Most of the material in this paper will be familiar to readers of earlier papers by Dr. Sibley and his students, but it should be useful as a review, especially of material published since Sibley's well-known longer paper on this general subject (*Condor*, 59:166–191, 1957).

In a paper on "The evolution of visual communication," Dr. Peter Marler strives valiantly to stick to his subject, but finds, as he admits himself, that it is impossible to exclude auditory communication from such a discussion. In fact, many of the principles of animal communication have been first derived by the study of vocalizations and then applied to visual signals. This is undoubtedly due in part to the fact that our modern equipment for the recording, analysis, and playback of sound permits a far more objective approach than is yet possible for most kinds of visual communication. Dr. Marler's excellent and well-illustrated paper takes most of its examples from birds.

I will not attempt to review the non-ornithological papers here, but strongly recommend that anyone interested in modern trends in evolutionary thinking read the entire book. A few of the papers are weak, but most, including the review-papers, are of genuine value. The ornithologist cannot help but be jealous of the experimental techniques available to, say, the student of amphibia, in both laboratory (Moore, Pyburn) and field (Twitty).

A particularly useful aspect of the present volume is the publication of the stimulating discussions that followed the oral presentation of these papers. The transcripts also present unexpectedly revealing insights into the thought processes and personalities of the scientists who took part!

University presses in the United States and Canada, being largely free from certain of the economic pressures felt by commercial publishing houses, are widely known for the general excellence of design and manufacture of their books. It comes, then, as a distinct disappointment to have to report that the present volume is hardly better than mediocre in typography and binding design. The only colored plates illustrate a paper on polymorphism in guppies (Haskins, et al.), and are very badly reproduced. In addition, the paper on which the color plates are printed in my copy was creased during some stage of the manufacturing process. Current book prices in general are admittedly high, but $8.50 would seem to be too much for the present volume even had it been published by a firm without a university subsidy. It is to be hoped that individual authors received reprints of their papers for distribution to students who cannot afford to buy the entire volume.—Kenneth C. Parkes.

Biology and Comparative Physiology of Birds. Edited by A. J. Marshall. Academic Press, New York and London. Vol. 1, 1960: xii + 518 pp. Vol. 2, 1961: x + 468 pp., 1 col. pl. Both vols. 6⅛ × 9¼ in., many bl. and wh. figs. inc. photos. $14 per volume.

The editor's intent in compiling these volumes was to provide a comprehensive reference work in English on the biology of birds, covering recent findings as well as basic information. It was surely the great need for such a book which aroused the interest and secured the help of his 24 contributing authors. The first volume opens with chapters on the origin, adaptive radiation, classification, and geographical distribution of birds. These are followed by chapters on embryological development and on the integumentary, skeletal, muscular, blood-vascular, respiratory, digestive, and excretory systems. The second volume continues with the nervous system, endocrine glands, sex, reproduction, and energy metabolism, thermoregulation, and body temperature. The remaining chapters concern flight, breeding seasons and migration, long-distance orientation, behavior, and bird populations.

The chapters vary in approach and fullness but all show that much thought has gone into their preparation. Most of the authors have done an excellent job of assembling and evaluating information, and the best of them, furthermore, have written in a lucid manner. Among the chapters which are especially notable for synthesizing diverse materials are those by Storer on adaptive radiation, Salt and Zeuthen on the respiratory system, and King and Farner on energy metabolism. In some sections about subjects with which I have had experience, I found a few erroneous or misleading statements. Colleagues have told me of similar findings in the chapters of their specialties. Hence, I cannot help but feel some hesitancy about the complete accuracy of those chapters for which I have no background.

Long lists of references are given at the end of each chapter. Impressive as these are, they raise the paradox that while books such as this intend to be one-stop supermarkets, they are often most useful as directories to the specialty shops. This disparity is evident throughout the present book. It is reasonable not to repeat material which is fully given elsewhere, but in many instances the authors have merely provided guides to the literature. In the preface, Marshall expresses his dismay at having to search through references for relatively simple information. Yet he dismisses the subject of migration with a list of eleven important papers and half a page of discussion.

The book contains an abundance of material, but it is less useful than it might have been because the contents are poorly integrated. It is understandable that a subject may have been discussed in several chapters, but at least there should have been cross-references. They would not only facilitate a search for information but would also point out differences in terminology and interpretation. The nasal glands, for example, are discussed both in the chapters on excretion and on olfaction. The latter account follows Technau and Marples in stating that the secretion of these glands has sanitary and protective functions. There is no reference to the other chapter, where recent discoveries on the salt-excreting role of the glands are reviewed. The subject index at the close of each volume is distressingly incomplete as well as inconsistent in style.

The relative merits of the reference books by Groebbels, Stresemann, Grassé, Wolfson, and now Marshall can best be decided by each user on the basis of his requirements and language ability. Certainly the modern approach and coverage of this newest work should make it extremely useful to all concerned with the scientific study of birds.—PETER STETTENHEIM.

A NATURALIST IN ALASKA. By Adolph Murie. Devin-Adair Co., New York, 1961: 6⅛ × 8⅝ in., xii + 302 pp., 16 photo plates. $6.50.

This book is concerned chiefly with accounts of the larger mammals found in Mount McKinley National Park. Treated in greatest detail are the Grizzly Bear and Gray Wolf (Murie is the author of *Wolves of Mt. McKinley*), and more briefly, the Lynx, Moose, Wolverine, Red Fox (erroneously stated "Arctic Fox" on the dust jacket), Alaska Vole, Dall Sheep, and Caribou. The treatment is of particular interest because, whereas popular accounts of these animals are likely to be mostly lore interspersed with a few personal experiences, these accounts are based almost entirely on original observations. The facts are given with the caution of a scientist and the detail of a life-history study.

Since Murie is enthusiastic about the entire wilderness environment and a student of the relationships between living creatures, he gives passing attention also to the birds of the region, especially the Mew Gull (herein called by the former name "Short-billed Gull"), Sandhill Crane, Rock Ptarmigan, Raven, and Magpie. One short chapter is devoted mostly to the gull's practice of dunking mice in water before eating them, presumably as an aid to swallowing.

Murie is unusually well qualified to write a book of this kind. He has lived and traveled at length in the Alaska wilderness, he has had thorough training in biological science, and he writes with clarity and feeling. The book is illustrated with pen sketches by Olaus Murie and with 28 photographs of animals and habitat.—HAROLD F. MAYFIELD.

NATURE'S YEAR: THE SEASONS OF CAPE COD. By John Hay. Doubleday & Co., Garden City, New York, 1961: 5½ × 8½ in., 199 pp., 13 woodcuts by David Grose. $4.50.

This is a wordy recitation, sometimes downright dull, of the outdoors and its wildlife from one winter to the next. The range of species included is wide—from Wood Pewees in July to pill-bugs in February to spring peepers in April. A few of the descriptions, such as those of an Ovenbird feeding in an autumn wood, an eider dying on a winter beach, and alewives rushing toward a spring brook, are original and sharp; the others seem commonplace. Lacking is a feeling for Cape Cod as an entity. The winds and tides, the scurrying shorebirds, and so on that many of us associate with "the Cape" tend to get lost in a welter of irrelevant details and philosophical meanderings. The woodcuts are excellent but, as is the way with woodcuts, lend a somber tone.—OLIN SEWALL PETTINGILL, JR.

This issue of *The Wilson Bulletin* was published on 26 March 1962.

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the AOU Check-list (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited; otherwise, follow the "Style Manual for Biological Journals" (1960. AIBS). Photographs for illustrations should be sharp, have good contrast, and be on gloss paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A WORD TO MEMBERS

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

NOTICE OF CHANGE OF ADDRESS

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, Merrill Wood, Dept. of Zoology and Entomology, Frear Laboratory, Pennsylvania State University, University Park, Pennsylvania. He will notify the printer.

1962 ANNUAL MEETING

The Forty-third Annual Meeting of the Wilson Ornithological Society will be held at Purdue University, Lafayette, Indiana, from Thursday to Sunday, 5 to 8 April. Sponsoring organizations are the Indiana Aububon Society, Purdue University Club (Bird Study Section), Amos W. Butler Audubon Society of Indianapolis, and the South Bend Audubon Society. All regular sessions will be held in the Purdue Memorial Center.

In addition to paper sessions, morning field trips on Friday and Saturday to a marsh 10 miles west of Lafayette will be arranged. Motor trips to prairie areas near Lafayette will also be offered. The major field trip, on Sunday, will be to the Greater Prairie Chicken grounds and the Willow Slough State Game Preserve, 60 miles northwest of Lafayette. At this season, Smith's Longspurs are a good possibility, as are Yellow Rails, flocks of Golden Plover, and waterfowl. Before noon, those who wish will be taken to observe the large concentration of Greater Sandhill Cranes on the Jasper-Pulaski State Game Preserve, 40 miles east of Willow Slough.

For further information write to Mr. Aaron M. Bagg, Farm Street, Dover, Massachusetts.

June 1962

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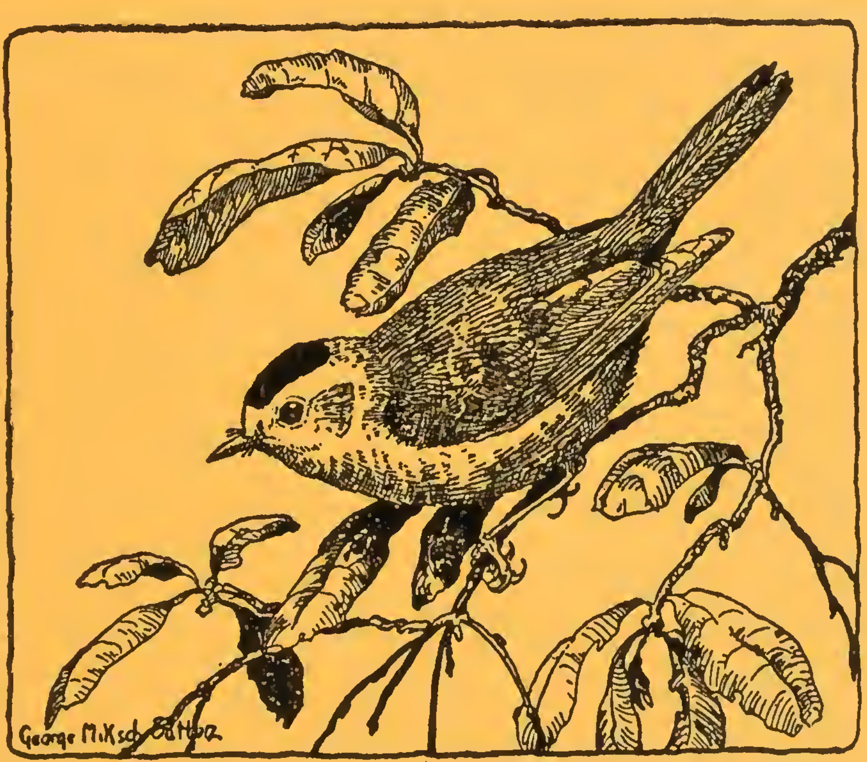

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THE WILSON ORNITHOLOGICAL SOCIETY
FOUNDED DECEMBER 3, 1888

Named after ALEXANDER WILSON, the first American ornithologist.

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

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Elected Council Members—Ernest P. Edwards (term expires 1963); Harvey I. Fisher (term expires 1964); Kenneth C. Parkes (term expires 1965).

Membership dues per calendar year are: Sustaining, $6.00; Active, $4.00.

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 Museum, 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 will be listed periodically.

THE WILSON BULLETIN

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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.

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CONTENTS

THE CONSTANCY OF INCUBATION

Alexander F. Skutch

In an earlier paper (1957) I briefly surveyed the bewildering variety of incubation patterns which birds exhibit and attempted to correlate their incubation habits with their coloration, the form of their nests, their environment, and other factors that seemed to be pertinent. From this survey, it appeared that many modifications in the incubation pattern, especially those involving the participation of the sexes, are non-adaptive, in the sense that they are not more conducive to the reproductive efficiency of a particular species than some alternative pattern might be. The best than can be said in their favor, in the light of our present understanding, is that they are not deleterious.

Even within a single incubation pattern, such as those classified in the above-mentioned paper, the student of the incubation habits of birds discovers bewildering diversity, caused principally by the varying lengths of the birds' continuous sessions on the eggs. Some birds sit for hours or even days at a stretch, others rarely cover their eggs uninterruptedly for as long as half an hour in the daytime. In some species of which only a single parent incubates, its absences are far shorter than its sessions, so that a high constancy of incubation is achieved; in others, the absences are of about the same length as the sessions with which they alternate, so that the eggs are covered only about half of the day. What causes these differences? Can we correlate them with differences in the birds themselves or in their environments—with factors such as size, diet, weather, type of nest, and the like? As, over the years, I have given attention to the incubation habits of a great variety of birds and have tried to explain what I found, these questions have occurred to me again and again. The present paper is a preliminary attempt to answer them.

NOMENCLATURE, METHODS OF OBSERVATION AND COMPUTATION

Scientific names of most species mentioned in the text are given only in the tables.

The rather ponderous terms "attentive period" and "inattentive period" have in the last few decades come into rather general use in the description of the breeding behavior of birds. These designations were introduced by Baldwin and Kendeigh (1927) to serve the theory that at every stage of their reproductive cycle birds devote alternate periods to reproductive activities and self-maintenance. Thus the male sings for a while to advertise his possession of a territory and attract a mate, then eats or preens in silence. During nest construction, periods of active building alternate with intervals dedicated to feeding, bathing, or rest. Later, spells of incubation are separated by absences for foraging or preening; and while in charge of dependent young, the parents alternate between periods devoted to the service of their offspring and those taken up with filling their own vital needs or with resting.

While it is true that birds cannot wholly neglect their own welfare while reproducing their kind, and most small birds shift many times in the course of a day from activities that serve their progeny to those which preserve themselves, in most phases of the nesting operations it is in practice scarcely possible to delimit these alternating periods of attention and inattention. A building bird may indeed bring material to the nest a number of times in quick succession, then remain away for many minutes. But often its visits are so irregularly spaced that it is difficult for the watcher to recognize rhythmically alternating periods of attentiveness and inattentiveness, so that he usually counts visits to the nest, not spells of work. So, too, in feeding nestlings, there are spurts of active food-bringing when the young are hungry and rather long periods of neglect when they are satiated; but between these extremes there are visits with food spaced at all intervals. The observer tries in vain to analyze his record into alternating periods of attention and neglect, and in the end he expresses his data as feedings per hour, or some other unit of time. Only during incubation are periods of attention to the nest and of inattention sharply delimited and accurately measurable. But in this case an attentive period is a continuous spell of sitting and an inattentive period the whole of each absence: and if we call these more briefly "sessions" and "recesses," everyone who has been to school will understand what we mean.

It is of interest to know not only the lengths of the sessions and recesses, or the number of the bird's comings and goings per hour or per day, but the proportion of the day that the eggs are kept covered. Information of the first sort tells us at once whether a bird is a quiet or a restless sitter, which may be an expression of temperament; but the percentage of the daylight hours spent in the nest gives us a better index of the amount of heat applied to the eggs. If we decide to calculate the percentage of time devoted to sitting, we must give careful thought to the methods we shall employ. First of all, how shall we collect our data? Automatic instruments, usually electrical, have been used in both Europe and America for making continuous records of activity at a nest for days together, or even for the entire period of incubation; and in Africa, R. E. Moreau gathered a vast bulk of data by using a relay of native observers who were not trained ornithologists. But most students of breeding behavior watch their nests in person, and this reveals intimate details not to be discovered by any other method.

Ideally, for learning the percentage of time devoted to incubation the watch should begin at daybreak, before the bird becomes active, and continue until after it has settled down to rest for the night. A lone observer will find that this makes a strenuous day, and may prefer the almost equally satisfactory practice of beginning his vigil at about noon, continuing until nightfall, then resuming his watch at daybreak and carrying on until the hour at which he began on the preceding day. If his bird is strictly diurnal, he will then have a continuous record of all its activities in a period of 24 hours, made in two watches rather than in one far more exhausting vigil. In a study of this sort, it is hardly necessary to emphasize the great importance of the observer's being well concealed, if there is the least suspicion that his presence influences the movements of the birds he is watching.

When we have made a continuous dawn-to-nightfall record, or a noon-to-noon record, we can add all the sessions together and all the recesses together to learn how many minutes in the day have been devoted to incubation and how many to absences. From this the percentage of time on the eggs might be calculated. But a perplexity as to the correct mode of procedure is likely to arise. After awaking on her eggs in the morning, the incubating bird may remain sitting after her mate and others of her kind have become active, not starting her first recess until many minutes after it has become light. At the other end of the day, she may end her last absence long before nightfall. I have known birds which most of the day had been taking recesses at less than hourly intervals to settle on their eggs in the middle of the afternoon and stay until the next morning. If we do not include with the diurnal sessions these portions of the long nocturnal session which fall between the afternoon's last return to the nest and nightfall, and between daybreak and the first morning departure, we shall give too low a value to the percentage of the day spent on the eggs. But if we decide to add to the diurnal sessions these extensions of the nocturnal session into the early morning and late afternoon, we shall be puzzled as to how to assess them. In theory, we might delimit the strictly nocturnal period by noting the time when other, non-incubating individuals of the same species begin and end their active day; but in practice we shall find this point hard to determine.

It often happens that we are not able to make an all-day record of events at a nest, but can only watch for a few hours at a stretch. These shorter periods of observation are never so informative as the longer ones; but if long enough to include several sessions and recesses that are complete in the sense that they began and ended spontaneously, and if on different days they come at different hours, so that together they cover most of the daylight period, they can yield much valuable information. Since we often arrive while the bird is absent from the nest and we may be obliged by other duties to leave while it is still sitting, the records of these shorter watches will include incomplete sessions and recesses, which in most cases it is best to omit from the calculations. After the rejection of these fragments, the records may still contain unequal numbers of sessions and recesses, so that if we compute percentage from their totals, we may derive a false notion of the bird's constancy in incubation; for the numerical value will be seriously influenced by whether we happened to watch a greater number of sessions or of recesses. We may overcome these irregularities by computing the average length of the sessions (S), the average length of the recesses (R), then deriving the percentage of time on the nest (T) by the formula

$$T = \frac{100\,S}{S + R}$$

The value of T is then controlled by the ratio of the length of the sessions to the length of the recesses, which in small birds incubating alone seems to be determined by, among other things, the time they require to satisfy their hunger and the rapidity of their digestion, so that it is not an arbitrary value.

The incubating bird's active day begins and ends with a recess, so that if we have watched the nest throughout the day we shall have timed one more recess than session. When we have made such a comprehensive record, it might be held that our result will be more accurate if we compute the percentage of constancy on the basis of the totals of the sessions and of the recesses rather than on the basis of their averages. But the use of the formula will help to compensate for the extensions of the nocturnal session into the species' period of daylight activity at both ends of the day, which are otherwise difficult to handle. For most small birds which take a fairly large number of sessions each day, the two methods of calculation will in this case yield values substantially the same.

A few examples will show the closeness of agreement. I have an all-day record of an incubating White-crested Coquette which began her active day at 5:31 AM and ended it at 5:21 PM. In this interval of 11 hours and 50 minutes, she took 37 sessions, which ranged from less than 1 to 78 minutes and averaged 13.4 minutes. Her 38 recesses varied in length from less than 1 to 22 minutes and averaged 5.7 minutes. Her sessions totaled 494 minutes and her recesses totaled 216 minutes. As computed by the formula, she incubated with a constancy of 70.2 per cent. If we calculate her constancy from the totals of her sessions and recesses, it comes to 69.6 per cent. A Yellow-browed or Speckled Tanager, likewise watched for an entire day, first left her eggs at 6:15 AM and settled down for the night at 5:55 PM, making an active day of 11 hours and 40 minutes. She took 14 sessions, ranging from 20 to 77 minutes, totaling 529 minutes, and averaging 37.8 minutes. Her 15 recesses varied from 3 to 23 minutes, totaled 171 minutes, and averaged 11.4 minutes. By the formula, her constancy was 76.8 per cent; on the basis of total times, it was 75.6 per cent. Less close is the agreement of the two methods of computation in the case of a Thrush-like Manakin whose rhythm of incubation was far slower. Between 6:00 AM and 5:51 PM she took four sessions, which ranged from 97 to 151 minutes, totaled 454 minutes, and averaged 113.5 minutes. Her five recesses varied from 14 to 82 minutes, totaled 257 minutes. and averaged 51.4 minutes. By the formula, her constancy in incubation was 68.8 per cent; calculated from her total times on and off the nest during her active period, it was only 63.9 per cent.

RANGE OF CONSTANCY

When the parents share incubation, they may keep their eggs almost continuously covered, from the day the last or even the first is laid until they

TABLE 1

INCUBATION PATTERNS OF PAIRS OF BIRDS OF 23 SPECIES AT 27 NESTS*

Species	Hours watched	No.	Sessions in minutes		Intervals of neglect in minutes		Constancy %
			Range	Average	Range	Average	
Rufous-tailed Jacamar	10	3	100–113	108.3	1–19	5.8	95
(*Galbula ruficauda*)		2	84–101	92.5			
Black-breasted Puffbird	7	5	7–162	58.2	17–46	25.2	70
(*Notharchus pectoralis*)							
Fiery-billed Araçari	8	12	2–102	25.6	2–53	15.9	64
(*Pteroglossus frantzii*)							
	5	7	12–53	28.1	2–31	14.6	66
Blue-throated Toucanet	6	8	<1–81	33.3	1–18	11.9	74
(*Aulacorhynchus caeruleogularis*)							
Golden-olive Woodpecker	12.5	2	82–118	100.0		0	100
(*Piculus rubiginosus*)		3	51–297	146.3			
Red-crowned Woodpecker	12	4	22–105	62.0	1–12	5.2	96
(*Centurus rubricapillus*)		6	2–80	57.7			
Golden-naped Woodpecker	10	12	4–38	19.3	2–16	4.8	90
(*Tripsurus chrysauchen*)		10	4–44	25.5			
	12.5	21	5–39	17.0	1–7	3.4	89
		22	2–51	13.4			
Olivaceous Piculet	11	5	40–112	66.2		0	100
(*Picumnus olivaceus*)		5	30–69	50.2			
	12	5	2–76	44.4			
		5	7–89	55.2	17–35	27.0	88
Streaked-headed Woodcreeper	12	8	6–37	16.4	4–41	16.9	60
(*Lepidocolaptes souleyetii*)		11	5–57	26.9			
	15	3	15–42	28.3	2–41	21.2	66
		13	7–72+	37.5			
Buff-throated Automolus	18	6	62–138+	96.8	32–122	69.2	58
(*Automolus ochrolaemus*)							
Plain Xenops	11	9	12–118	49.8	25–51	43.5	72
(*Xenops minutus*)							
Slaty Castlebuilder	17.5	28	2–120	25.2	1–48	13.0	82
(*Synallaxis brachyura*)							

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* When the sexes could be distinguished, the alternating sessions of the male and female are given in consecutive lines, those of the male above; when they could not be distinguished, the sessions of the two partners are given in the same line. Constancy was computed from total time in the nest rather than by the formula.

TABLE 1 *(Continued)*

Species	Hours watched	No.	Sessions in minutes		Intervals of neglect in minutes		Constancy %
			Range	Average	Range	Average	
Great Antshrike	11.5	2	146–238	192.0	17	17.0	96
(*Taraba major*)		2	34–188	111.0			
Plain Antvireo	17	5	100+–137	117+	1–18	5.6	95
(*Dysithamnus mentalis*)		4	41–79	65.2			
White-flanked Antwren	13	4	3–174+	83+	11–94	35.6	76
(*Myrmotherula axillaris*)		2	98–140	119.0			
Slaty Antwren	6	3	33–142	73.0	11+	11+	94
(*Myrmotherula schisticolor*)		2	53–66	59.5			
Tyrannine Antbird	14	7	11–153	57.3	1–59+	22+	82
(*Cercomacra tyrannina*)		3	79–124	97.0			
Chestnut-backed Antbird	12	3	45–95	69.3	1–39	18.0	88
(*Myrmeciza exsul*)		2	92–136	114.0			
Spotted Antbird	13	3	44–217	112.7	8–22	13.5	92
(*Hylophylax naevioides*)		3	36–164	109.0			
Blue-and-White Swallow	9	25	3–50	18.6	1–14	6.9	86
(*Pygochelidon cyanoleuca*)							
Black-eared Bushtit	12.5	30	1–31	8.5	1–34	8.3	60
(*Psaltriparus melanotis*)		22	1–22	8.8			
Tropical Gnatcatcher	10	7	19–55	39.3	2–21	9.9	82
(*Polioptila plumbea*)		6	27–34	29.8			
Long-billed Gnatwren	12	5	14–95	67.0		0	100
(*Ramphocaenus rufiventris*)		4	60–90	79.8			

hatch (Table 1); although in some species both parents together devote less time to the nest than do other birds incubating alone. When a single parent incubates, the percentage of the day that it covers the eggs fluctuates widely from species to species and even within a single species. Is it possible to assign limits to this variation, so that we may designate an "average" or "normal" constancy in incubation? I have tables showing the constancy in incubation of 137 individuals of 82 species in which the female incubates alone without receiving much food from her mate or other attendants. They represent 15 families of passerine birds and six species of hummingbirds. These tables were drawn up from data gathered chiefly by myself but in a few cases with the help of students, mostly in Central America but in a few instances in the United States. Each of the birds was watched for five to 20 hours, for the most part in one continuous vigil or a few long periods of observation. Although these records do not cover sufficient time to permit an exhaustive analysis of the rhythm of incubation of any individual bird, they seem to provide a fair "random sample" of the constancy in incubation of a number of avian families as represented in Central America. (Table 2 gives a selection of these records.)

TABLE 2

INCUBATION PATTERNS OF FEMALE BIRDS OF 66 SPECIES AT 119 NESTS

Species	Hours watched	No.*	Sessions in minutes		Recesses in minutes		Constancy %
			Range	Average	Range	Average	
Little Hermit Hummingbird	12	9	16–92	60.7	10–25	18.3	77
(*Phaethornis longuemareus*)	12	14	9–59	27.9	9–29	15.1	65
Cuvier's Hummingbird	12	13	4–99	38.5	1–34	9.3	81
(*Phaeochroa cuvierii*)	12	35	<1–103	14.3	<1–23	6.0	70
Violet-headed Hummingbird	11	11	15–77	40.6	6–28	15.2	73
(*Klais guimeti*)							
White-eared Hummingbird	12	49	<1–24	9.5	1–17	4.9	66
(*Hylocharis leucotis*)	12	59	<1–35	8.7	<1–20	3.3	73
White-crested Coquette	12	38	1–34	10.4	1–23	7.1	59
(*Paphosia adorabilis*)	12	37	<1–78	13.4	<1–22	5.7	70
Tawny-winged Dendrocincla	12	8	16–89	57.0	12–36	26.4	68
(*Dendrocincla anabatina*)	13	10	10–96	45.8	11–51+	29.3	61
Blue-crowned Manakin	8.5	3	74–171	120.7	14–34	25.5	83
(*Pipra coronata*)	9.5	4	44–197	103.8	15–21	18.2	85
Yellow-thighed Manakin	12	7	29–108	65.1	6–21	14.0	82
(*Pipra mentalis*)	6.5	2	98–214	156.0	26–34	30.0	84
Orange-collared Manakin	11	14	10–64	33.9	3–17	7.1	83
(*Manacus aurantiacus*)	12.5	8	17–258	71.4	3–25	12.2	85
Thrush-like Manakin	11	4	44–134	95.5	34–97	75.0	56
(*Schiffornis turdinus*)	12	4	97–151	113.5	14–82	51.4	69
Turquoise Cotinga	12	4	36–156	114.0	35–88	51.0	69
(*Cotinga ridgwayi*)							
White-winged Becard	10	17	6–38	15.2	8–35	18.9	45
(*Pachyramphus polychopterus*)							
Rose-throated Becard	17	49	3–38	11.6	2–19	9.0	56
(*Platypsaris aglaiae*)							
Masked Tityra	10	8	24–49	37.1	13–29	19.6	65
(*Tityra semifasciata*)							
Yellow-bellied Elaenia	7	19	8–22	13.2	4–12	8.2	62
(*Elaenia flavogaster*)	10	27	4–49	15.6	4–13	6.9	69
Bellicose Elaenia	7	41	2–21+	5.6	2–8	5.0	53
(*Elaenia chiriquensis*)	12	42	2–60	13.3	<1–7	3.3	80
Yellow Flycatcher	7	9	12–40	27.8	13–42	21.5	56
(*Capsiempis flaveola*)							
Golden-crowned Spadebill	5	16	3–23	10.6	2–19	8.3	56
(*Platyrinchus coronatus*)	5	10	8–27	16.3	9–20	12.3	57
Bran-colored Flycatcher	6	28	3–14	6.6	2–16	6.5	50
(*Myiophobus fasciatus*)	5	25	<1–18	7.7	<1–9	4.6	63
Tropical Kingbird	8	7	10–56	32.4	9–20	12.1	73
(*Tyrannus melancholicus*)	10	5	19–92	50.8	15–47	24.6	67
Boat-billed Flycatcher	6	5	27–68	44.6	5–20	13.3	77
(*Megarhynchus pitangua*)	10	16	15–77	30.2	2–19	8.3	78
Torrent Flycatcher	5	25	3–13	6.7	1–13	5.2	56
(*Serpophaga cinerea*)	4.5	17	1–14	7.2	2–17	9.1	44
Streaked Flycatcher	12.5	13	15–72	30.3	8–18	12.6	71
(*Myiodynastes maculatus*)							
Gray-capped Flycatcher	12	22	7–42	20.0	7–20	11.8	63
(*Myiozetetes granadensis*)	6	15	6–50	15.5	4–14	8.0	66
Vermilion-crowned Flycatcher	9	25	4–32	12.8	4–27	10.2	56
(*Myiozetetes similis*)	10	12	9–72	30.4	11–31	18.5	62

TABLE 2 *(Continued)*

Species	Hours watched	No.*	Sessions in minutes		Recesses in minutes		Constancy %
			Range	Average	Range	Average	
Piratic Flycatcher	7	8	20–49	34.0	5–18	12.9	73
(*Legatus leucophaius*)	9	13	13–40	26.0	6–22	11.3	70
Paltry Tyranniscus	5	6	8–75	32.5	10–18	12.5	72
(*Tyranniscus villissimus*)	6	8	22–35	27.4	10–24	13.3	67
Slate-headed Tody-Flycatcher	6	10	10–22	17.2	13–25	17.9	49
(*Todirostrum sylvia*)	6	11	14–33	21.0	9–16	12.7	62
	7	11	13–38	20.0	11–29	20.3	50
Sulphury Flat-bill	5.5	9	10–36+	19.7	8–52	18.1	52
(*Tolmomyias sulphurescens*)	7	14	10–28	17.4	7–28	13.5	56
Royal Flycatcher	12	19	4–52	22.4	3–33	13.6	62
(*Onychorhynchus mexicanus*)	6	10	9–32	17.9	4–18	12.0	60
Sulphur-rumped Myiobius	12.5	22	7–33	14.1	8–28	15.6	48
(*Myiobius sulphureipygius*)	5.5	7	15–30	23.1	14–47	24.6	49
Southern House Wren	6	12	8–20	14.1	11–24	15.7	47
(*Troglodytes musculus*)	9.5	14	14–44	25.8	8–29	14.4	64
	6	11	5–26	19.6	6–18	11.4	63
Highland Wood Wren (*Henicorhina leucophrys*)	9	15	8–28	16.4	7–40	16.8	49
Catbird (*Dumetella carolinensis*)	13.5	24	5–61+	23.8	3–12	6.9	78
White-breasted Blue Mockingbird (*Melanotis hypoleucus*)	14	28	8–42	20.8	1–23	7.1	75
Gray's Thrush (*Turdus grayi*)	5	4	34–84	59.0	11–28	20.3	74
	7	5	29–188	73.6	10–14	12.0	86
Orange-billed Nightingale-	6	10	11–39	25.6	8–19	11.9	68
Thrush	11	26	5–56	12.6	5–24	13.2	49
(*Catharus aurantiirostris*)	5	9	7–32	17.2	11–19	15.1	53
Russet Nightingale-Thrush (*Catharus occidentalis*)	8	12	13–42	26.6	8–21	12.4	68
Yellow-green Vireo	6	9	15–61	28.1	6–18	8.5	77
(*Vireo flavoviridis*)	6	4	40–56	49.3	10–55	24.2	67
Gray-headed Greenlet (*Hylophilus decurtatus*)	10	20	7–25	15.3	7–26	14.0	52
Slaty Flower-piercer (*Diglossa baritula*)	12.5	22	4–62	19.1	4–24	10.5	65
Green Honeycreeper (*Chlorophanes spiza*)	10	8	32–149	54.9	6–20	12.2	82
Blue Honeycreeper	5.5	8	16–53	28.6	9–22	13.9	67
(*Cyanerpes cyaneus*)	7.5	11	12–44	27.7	6–19	11.2	71
Turquoise Dacnis (*Dacnis cayana*)	12	20	11–55	23.6	6–18	11.7	66
Bananaquit (*Coereba flaveola*)	12.5	7	47–82	60.7	12–29	17.0	78
Crescent-chested Warbler	6	12	5–37	18.8	2–13	8.1	70
(*Vermivora superciliosa*)	5.5	9	14–28	23.0	7–24	11.8	66
Slate-throated Redstart (*Myioborus miniatus*)	12	11	26–49	37.6	10–37	18.2	67
Pink-headed Warbler (*Ergaticus versicolor*)	13	24	13–35	20.1	4–13	8.3	71

TABLE 2 *(Continued)*

Species	Hours watched	No.*	Sessions in minutes Range	Sessions in minutes Average	Recesses in minutes Range	Recesses in minutes Average	Constancy %
Chestnut-capped Warbler	12	9	27–70	44.6	16–35	23.3	66
(*Basileuterus delattrii*)							
Buff-rumped Warbler	6	5	5–97	38.8	8–30	18.5	68
(*Basileuterus fulvicauda*)	6	3	78–90	85.3	24–37	30.7	74
Scarlet-rumped Black Tanager	12	16	8–102+	29.3	5–32	11.8	71
(*Ramphocelus passerinii*)	16	21	12–104+	33.6	7–19	11.6	74
Crimson-backed Tanager	10	10	16–89	39.0	11–36	21.9	64
(*Ramphocelus dimidiatus*)							
Red Ant-Tanager	7.5	3	88–142+	117+	21–51	32.7	78
(*Habia rubica*)	7.5	4	40–140+	80+	23–44	32.5	71
Golden-masked Tanager	6	6	10–64	29.3	6–29	16.0	65
(*Tangara larvata*)	7	15	6–51	18.9	2–17	7.9	71
	10	20	2–47	22.6	2–11	7.3	76
Speckled Tanager	12.5	14	30–53	39.7	2–27	10.1	80
(*Tangara chrysophrys*)	12.5	14	20–77	37.8	3–23	11.4	77
Silver-throated Tanager	6	12	8–48	21.1	5–12	8.3	72
(*Tangara icterocephala*)	5	10	17–33	24.1	4–14	7.2	77
Gray-headed Tanager	6	4	45–97	60.8	20–55	29.3	68
(*Eucometis penicillata*)	6	3	66–97	76.3	25–66	45.5	63
Tawny-bellied Euphonia	10	5	77–108	86.8	13–43	29.8	74
(*Tanagra imitans*)	4.5	3	55–78	66.5	27–38	31.7	68
Variable Seedeater	8	12	12–33	22.5	7–22	14.4	61
(*Sporophila aurita*)	8	14	2–99	24.9	2–26	8.3	75
	9	5	29–148	74.2	8–22	17.2	81
Yellow-faced Grassquit	9	5	18–89	50.2	22–39	28.2	64
(*Tiaris olivacea*)	6	6	15–61	42.2	9–25	17.8	70
Blue-black Grosbeak	18	7	48–203	105.0	17–70	37.8	74
(*Cyanocompsa cyanoides*)	7.5	3	64–160	107.7	22–57	36.0	75
	12.5	3	99–364	227.7	18–19	18.5	95
	8	2	135–254	194.5	44	44.0	82
Buff-throated Saltator	12	18	6–52	25.7	6–34	13.2	66
(*Saltator maximus*)	6	12	2–39	19.1	2–16	9.7	66
Streaked Saltator	9	21	6–65	18.3	5–12	8.4	69
(*Saltator albicollis*)	4	4	7–108	43.3	7–30	14.2	75
Gray-striped Brush-Finch	9	6	41–70	52.8	21–68	34.0	61
(*Atlapetes assimilis*)	6.5	3	52–128	81.7	31–71	44.7	65
Orange-billed Sparrow	12.5	6	14–102	77.7	29–52	39.1	67
(*Arremon aurantiirostris*)	8.5	3	70–210	128.7	32–52	39.7	76
Black-striped Sparrow	11	7	33–99	59.4	12–25	19.4	75
(*Arremonops conirostris*)	12	7	47–94	70.3	13–35	21.9	76

* Number of sessions. The number of recesses is approximately the same.

Of these 137 birds incubating without help from a mate, 101 kept their eggs covered for from 60 to 80 per cent of the time they were observed, as calculated by the formula given above. Could one infer from this that 60 to 80 per cent of each individual's active day represents "normal" constancy for birds incubating alone and given at most a few billfuls of food by their mates? I began years ago to pay attention to this point in the published reports of other students, but since a large share of the pertinent data in these studies has been summarized in tabular form by Kendeigh (1952), we may most conveniently refer to his tables for the information we need. Tables 44 to 50 provide information on the incubation behavior of 165 individuals of passerine birds representing nearly as many species. Excluding those birds for which I supplied the information and which are accordingly included in the foregoing statements, in 50 cases the female is said to incubate alone receiving little or no food from her mate, and the average length of the sessions and recesses is given. The percentage of time these birds spent on the nest is not directly stated, but from these averages it is possible to pick out by simple mental arithmetic the cases in which this percentage falls below 60 or exceeds 80, if we recall that at 60 per cent constancy the sessions are 1.5 times as long as the recesses, and at 80 per cent constancy they are four times as long. Of these 50 birds, 11 incubated more than 80 per cent of the time and six incubated less than 60 per cent of the time, leaving 33, or approximately two thirds of the total number, that fall within the range of 60 to 80 per cent. Of the 11 birds that incubated more than 80 per cent of the time, five are said to have received a small amount of food from their mates (indicated by a single + in the tables); but possibly the quantity given to them was sufficient to cause a significant reduction in the time these females devoted to foraging. Three of these five individuals were American Redstarts (*Setophaga ruticilla*) that were fed by their mates. A fourth redstart which received no food on the nest incubated only 73 per cent of the time.

In addition to these small birds which take numerous recesses in the course of the day, in many larger species incubation is carried on by a single parent which receives no food from the mate, but takes only one or two recesses each day, so that the time on the nest cannot well be calculated by the formula we have been using. However, it should not be difficult to decide whether they are conspicuously more or less assiduous in incubation than the birds we have been considering. In the Little Tinamou (*Crypturellus soui*), the single bird that attends the nest, probably the male, takes each day one long absence, beginning early or late in the morning and leaving the eggs exposed for four or five hours continuously, so that often it incubates only about 60 per cent of the little more than 12 hours of daylight in Costa Rica. Presumably it sits uninterruptedly through the night. The Marbled Wood Quail (*Odontophorus gujanensis*) likewise takes each morning a single long recess, usually lasting from one hour and 40 minutes to three hours, so that on many days its constancy falls within the 60 to 80 per cent range, although as the eggs near hatching it is likely to exceed 80 per cent of the daylight period.

Although these and some other fairly large birds fail to cover their eggs a greater proportion of the time than do many small passerines that come and go far more frequently, among the non-passerines there are a number of species which incubate much more constantly. Since in most non-passerine families with altricial young both sexes incubate, these constant sitters are nearly all the parents of nidifugous chicks. Among them are a few species (IIA3a and IIB3 in my classification, 1957:72–73) of which the female or less often the male sits without taking food for much or all of the period of incubation. These pheasants, ducks, and emus are big birds which can live for weeks on their internal reserves, in a manner impossible for small passerines; and what is equally important, after the eggs hatch they do not engage in the strenuous occupation of hunting many billfuls of food which they must carry to the nest from a distance. On the contrary, their precocial chicks follow them and pick up the food where it is found. Hence it seems less important for them to pass through the incubation period with weight and strength unimpaired than in the case of parents who, after the eggs hatch, must throw themselves into a protracted course of the most strenuous activity of the whole reproductive cycle.

The attempt to hatch the eggs without taking food may, however, prove too much of a strain, as is evident from Tinbergen's (1958:246–248) observations on Eider Ducks (*Somateria mollissima*). During the four weeks of incubation, the duck leaves her nest for 10 or 15 minutes on every second or third day, to drink but not to seek food. This regimen is so exhausting that the emaciated females are sometimes forced to desert their nests and stagger to the water; they may even abandon eggs on the point of hatching in order to preserve their own lives. Domestic hens (*Gallus gallus*) usually leave their nests for a brief interval each day for food and water, yet even they show the effects of protracted incubation. Three broody hens generally ate one-fifth of their usual ration and took more water than solid food, on which diet they lost from 4 to 20 per cent of their body weight. A cock who was given no more than a broody hen ate died when she, and consequently he, passed three days fasting, while another cock and a non-broody hen lost from 23 to 33 per cent of their weight on the broody hen's diet (Wood-Gush, 1955 : 105).

Apparently the only altricial bird which incubates continuously without taking nourishment is the Emperor Penguin (*Aptenodytes forsteri*). But soon after the egg hatches, the emaciated male Emperor relinquishes the chick to a female, who for months has been away at sea eating and growing fat, and himself walks off to the water to recover from the effects of his long fast before returning with food for the young (Stonehouse, 1953).

In a number of birds, especially penguins and Procellariformes, the parent of either sex may fast for many days, up to 40 in the Adelie Penguin (*Pygoscelis adeliae*) and 32 in the Laysan Albatross (*Diomedea immutabilis*). These sea fowl seem to flout our generalization that in altricial birds incubating individuals not nourished by their mates require in most instances at least 20 per cent of the daily period of activity for finding food. But after fasting on the eggs for a number of days, these birds enjoy an interval of about the same length for rest and recuperation while the mate takes charge of the nest. Thereby they remain in fairly good condition for the strenuous task of nourishing the young with food which must often be brought from a great distance.

I believe that we may fairly conclude that, with the conspicuous exception of some nidifugous species, the great majority of birds which incubate alone, receiving no food from their mates or at most token feedings, cover their eggs from 60 to 80 per cent of the daytime. If they greatly exceed this upper limit, as in the Emperor Penguin, they require a long period of recuperation before they begin to feed their young. In species of which the sexes share incubation, in no case known to me does either partner sit for more than 80 per cent of the day, except in certain penguins, Procellariformes, and a few others, in which one or several days of continuous incubation is followed by an approximately equal period of freedom and foraging. The upper limit of constancy seems to be set by the requirement of self-maintenance in birds whose approaching parental activities demand that they pass through the period of incubation with no impairment of health and strength; for when well nourished by their mates, many birds sit far more continuously; and where precocial chicks can be fed with less strenuous exertion, large birds with considerable internal reserves have in a few instances evolved the habit of incubating continuously without taking food. The lower limit of constancy in incubation is apparently set by the heat requirements of the developing embryo.

Discussion of some extreme cases.—It should be instructive to consider some cases of passerine birds which depart from the 60 to 80 per cent range in one direction or the other. The most numerous examples of less than 60 per cent constancy in my records are provided by the smaller American flycatchers (Tyrannidae), many of which covered their eggs for only 50 to 60 per cent of the five to 12 hours that they were watched, while a few were even less attentive. Included among these flycatchers are two Sulphur-rumped Myiobiuses, one of which sat for 47.5 per cent of 12.5 hours and the other for 48.5 per cent of 5.5 hours; two Slate-headed Tody-Flycatchers, one of which incubated for 50 per cent of seven hours and the other for 49 per cent of six hours; two Golden-crowned Spadebills, of which the first sat for 56 per cent of five hours and the second for 57 per cent of five hours; two Sulphury Flat-bills, of which one incubated for 56 per cent of seven hours and the other for 52 per cent of 5.5 hours; a Yellow Flycatcher which incubated for 56 per cent of seven hours; two Torrent Flycatchers which sat for 56 per cent of five hours and for 44 per cent of 4.5 hours; a Bran-colored Flycatcher which incubated for 50 per cent of six hours; and a Bellicose Elaenia which occupied her nest for 53 per cent of seven hours. Other individuals of some of these species incubated slightly more constantly: a Slate-headed Tody-Flycatcher for 62 per cent of six hours; a Bran-colored Flycatcher for 63 per cent of five hours; and an exceptionally attentive Bellicose Elaenia for 80 per cent of 12 hours.

With the exception of the elaenia, which includes berries and other fruits in its diet, all of these little flycatchers are largely if not wholly insectivorous, and they need much time to catch enough small volitant insects to nourish themselves. Since at the season when these birds chiefly nest in Costa Rica hard afternoon rains are frequent, they must make the best of the sunny hours when flying insects are most active; and in fair weather, when chiefly they were watched, they rarely devote much over half the time to their eggs. That their inconstant incubation is caused by their diet rather than by their diminutive size is suggested by the fact that the Paltry Tyranniscus, one of the smallest of the flycatchers, which includes many mistletoe berries in its diet, incubates far more constantly—one for 67 per cent of six hours and another for 72 per cent of five hours. Even much bigger flycatchers which subsist largely on flying insects, like species of *Myiozetetes*, *Myiodynastes*, and *Tyrannus*, rarely exhibit a constancy in incubation exceeding 70 per cent; and one Vermilion-crowned Flycatcher sat for only 56 per cent of nine hours. But the big Boat-billed Flycatchers, which in the breeding season catch such substantial insects as cicadas, spend in the neighborhood of 80 per cent of the time on their eggs; the most constant in my records covered them for 88 per cent of 4.5 hours.

Among the cotingas, becards are most inconstant sitters. A Rose-throated Becard was in her nest only 56 per cent of 17 hours, and a White-winged Becard sat for only 45 per cent of 10 hours. The latter nested in the Tropical Zone, but the former was in the highlands at about 8,500 feet, in the chill and gloomy weather of the wet season. The thick walls of the bulky closed nests of these becards help to conserve heat and allow the birds to enjoy outings that do not differ much from their sessions in length.

Swallows also tend to spend much time away from their eggs, and their constancy in incubation is likely to fall below 60 per cent. Of the five species in which the female alone incubates for which incubation records are summarized by Allen and Nice (1952, Table 5), two, the Wire-tailed Swallow (*Hirundo smithii*) and the Rough-wing Bank-Martin (*Psalidoprocne holomelaena*) sat for less than 60 per cent of the time. Both are species of tropical Africa watched for many hours by Moreau (1939, 1940) and his helpers. The low constancy of swallows is apparently related to their fare of volitant insects, as with the American flycatchers. Since in the swifts, whose dietary habits are similar, the sexes seem to share incubation rather equally, it is unlikely than one individual will attend the nest much more than half the time. Hummingbirds also eat many tiny insects and spiders, which they either pluck from flowers and foliage or snatch deftly from the air. But, as a rule, they supplement this by much nectar, and this combination forms a very sustaining diet; so that, despite their diminutive size, and the fact that in the morning they often neglect their eggs while seeking cobweb and down to add to their nests, their constancy in incubation rarely falls below 60 per cent, and they sometimes sit an hour at a stretch.

Aside from the foregoing, my records contain only a scattering of instances of less than 60 per cent constancy and some are difficult to explain. One Orange-billed Nightingale-Thrush sat for only 49 per cent of 11 hours and another for 53 per cent of five hours; but a third incubated for 68 per cent of six hours. A Southern House Wren covered her first set of eggs for only 47 per cent of six hours; but while incubating her third set of the same season, this bird sat for 64 per cent of 9.5 hours. A Highland Wood Wren incubated for 49 per cent of nine hours. Kendeigh's (1952:40) very extensive records of incubation in the House Wren (*Troglodytes aedon*), obtained on 30 females over a total of 332 days, showed an average constancy of only 58.2 per cent (or 58.7 per cent if calculated from his data by my formula). But the Carolina Wren (*Thryothorus ludovicianus*) studied by Nice and Thomas (1948) covered her eggs for 73.4 per cent of 92 hours; perhaps this higher constancy was due to the fact that, unlike the other wrens mentioned, she was fed fairly often by her mate. Of my 46 records of incubating tanagers and finches, only one shows a constancy of less than 60 per cent. This was a Turquoise-naped Chlorophonia (*Chlorophonia occipitalis*), which incubated for only 57 per cent of five hours.

Of birds whose constancy exceeded 80 per cent, we need not pause to discuss the goldfinches (*Spinus*), which are fed liberally on the nest by their mates, nor the jays (*Psilorhinus* and *Calocitta*), which are often supplied with food by a number of attendants. Aside from these, the first important examples of extraordinary constancy in my tables are the tiny manakins. One Yellow-thighed Manakin incubated for 82 per cent of 12 hours and another for 84 per cent of 6.5 hours. A Blue-crowned Manakin sat for 83 per cent of 8.5 hours and another incubated for 85 per cent of 9.5 hours. One Orange-collared Manakin covered her eggs for 85 per cent of 12.5 hours, while another did so for 83 per cent of 11 hours. In contrast to these birds, one far larger Thrush-like Manakin sat for only 69 per cent of 12 hours and a second for 56 per cent of 11 hours. Manakins eat many fruits as well as small invertebrates; and in the tropical forest with its many predators, the long periods of immobility of the olive or greenish females on their very slight nests doubtless decrease the probability of drawing attention to them by their approach or departure.

A Blue-black Grosbeak incubated for 95 per cent of 12.5 hours, and another did so for 82 per cent of eight hours. The first was fed at long intervals by her mate. The second was not given food in our presence, although possibly she was fed away from the nest. Since she was within a short flight of a corn granary, where she helped herself to sustaining maize, she could quickly satisfy her appetite. In contrast to these two grosbeaks, another incubated for 73.5 per cent of 18 hours and a fourth for 75 per cent of 7.5 hours. A Variable Seedeater covered her eggs for 81 per cent of nine hours, but three other individuals of the species were considerably less attentive. A Scarlet-rumped Black Tanager incubated for 84.5 per cent of six hours, apparently held to her eggs by mistrust of another of her kind who was actively building only 4 inches away; for all my other Scarlet-rumped Black Tanagers were far less constant. A Green Honeycreeper incubated for 82 per cent of ten hours, and a Gray's Thrush for 86 per cent of seven hours. Leaving aside birds fed by their mates, only 12 of the 137 individuals of 82 species in which one parent incubates that are included in my records covered the eggs for more than 80 per cent of the observation period.

Obviously in an extensive sampling inexplicable extremes will be met. Some of the instances of unusually constant incubation are probably due to the presence of exceptionally favorable sources of food, as some of the cases of outstanding inconstancy may be the result of scarcity. Probably some of the birds which showed extremely high or low attentiveness on the day they happened to be watched would on other days have exhibited more conservative behavior. When we consider all the causes of variability, it is surprising that so large a majority of the recorded instances fall within the relatively narrow range of 60 to 80 per cent constancy. This is the more remarkable when we reflect that the 101 birds which came within this range showed a variation in the lengths of their sessions from less than one minute to 210 minutes, and even the averages of their sessions varied from 7 minutes to 129 minutes. The recesses ranged from less than one minute to 88 minutes, and the averages of the recesses from 3 to 51 minutes. (Longer sessions and recesses were recorded for birds whose constancy exceeded 80 per cent or fell short of 60 per cent.) But in all these so varied birds, with such contrasting rhythms of coming and going, the recesses were so adjusted to the sessions that the average session was not less than 1.5 times nor greater than four times the average recess, corresponding to a constancy in incubation of 60 to 80 per cent of the active period of the day.

ADDITIONAL FACTORS THAT INFLUENCE INCUBATION

In my earlier paper (1957) I searched, largely in vain, for radical changes in the pattern of incubation, involving the acquisition or loss of the habit of sitting on the eggs by one of the sexes, which seemed clearly attributable to the birds' mode of life. Only in the cases of the Emperor Penguin and of Gould's Violet-ear Hummingbird (*Colibri coruscans*) did such an alteration appear to be related to peculiar environments, which caused the male penguin to incubate without his mate's help, and the male hummingbird to take turns on the eggs, although in this family he usually remains aloof from the nest. But I recognized several factors which, although not changing the participation of the sexes in incubation, profoundly modified their movements. A wide separation of the breeding and feeding areas causes each incubating bird to take long sessions on the eggs, amounting to weeks together in some of the penguins and Procellariformes. Danger in approaching the nest also diminishes the frequency of changeovers, as in some of the small petrels; and perhaps the reduction of movement effected by very long sessions increases the security of exposed but inconspicuous nests, as in the diminutive, neutrally colored female manakins of the tropical forest. The necessity to guard the nest against neighbors eager to carry off its materials or to protect the eggs from predators causes each parent to remain on duty until relieved by its mate, as in gulls and many other fairly large birds that nest in colonies; and in a few birds whose exposed nests are solitary, the male guards during his mate's absences although he does not incubate, as in some jays. But when the nest is inconspicuous or well concealed, the two sexes together may fail by a good deal to keep it constantly attended, as in toucans, some antbirds, and a number of ovenbirds (Furnariidae). (See Table 1.)

As we have just noticed, the character of a bird's diet strongly influences the frequency of its comings and goings during incubation. Birds which subsist largely upon small volitant insects, as some of the American flycatchers and swallows, are the most impatient sitters; but if tiny insects and spiders are supplemented by copious draughts of nectar, as with hummingbirds, the more sustaining fare permits more constant incubation. It appears that the more substantial a bird's food, the longer its sessions on the eggs. Females liberally supplied by their mates or other attendants can incubate almost continuously, as do hoopoes, jays, goldfinches, siskins, and waxwings, or even quite uninterruptedly, as do hornbills. All of the foregoing factors may be considered constant, because they are integral parts of a bird's life history and influence it rather equally from day to day. In addition to these, a few other constant factors, such as the bird's size and temperament, seem worthy of our examination; and then there are the variable factors whose intensity often changes from day to day or hour to hour, like temperature and rainfall.

Size of the birds.—When we survey the incubation habits of birds as a whole, we find many of the larger kinds remaining on the nest without taking food for periods which would be fatal to the smaller kinds. The shorter sessions of the latter, their more frequent comings and goings, reflect their more rapid metabolism and their inferior capacity for storage, whether of reserves of fat in their tissues or undigested food in stomach or crop. But the biggest birds are hundreds of times as heavy as the smallest; and we cannot deduce from these facts, without further investigation, that less striking contrasts in size, as between members of the same family, have much effect upon the rhythm of incubation. Yet the discovery by Gibb (1954) that in titmice the time devoted to feeding varies inversely with body weight suggests that even in a single family there may be a positive correlation between size and constancy of incubation. In an investigation of this sort, it is desirable to know the weights of the birds; but since in many cases this information is lacking, I shall use their lengths as given in Ridgway's "Birds of North and Middle America." The dimensions of the eggs will also be employed as an indication of the birds' relative bulk and weight. Amadon (1943) demonstrated that, in a homogeneous taxonomic group, the weight of a bird may be calculated from the measurements of its eggs.

Of the birds whose nesting I have studied, the woodpeckers exhibit the greatest range in size. The largest is the Pale-billed Woodpecker (*Phloeoceastes guatemalensis*), about 32 cm in length. I spent all of one afternoon and all of the following morning watching a nest of this big woodpecker that contained two eggs. The female sat continuously for 266 minutes in the forenoon. The male, who was in the hole nearly all the rest of the time and took charge by night, remained at his post continuously for 1174 minutes (19 hours, 34 minutes), which is the longest period of attendance that I have timed for any woodpecker. But the single session which the female took in the course of the day was exceeded by a session of a female Golden-olive Woodpecker, a bird only 20 cm long, which sat for 297 minutes (nearly five hours) continuously, although all the other diurnal sessions by both sexes were much shorter. In contrast to the Pale-billed Woodpecker, the far larger Ivory-billed (*Campephilus principalis*), about 46 cm long, exchanged places on the eggs about eight times a day, thus taking sessions that averaged less than two hours (Tanner, 1941). Leaving aside the relatively huge Pale-billed Woodpecker, my records reveal no correlation between the bird's size and the length of its sessions in this family. The Olivaceous Piculet, a pygmy woodpecker only 8.5 cm long, frequently sits for over an hour at a stretch and sometimes remains in the hole for nearly two hours. In sharp contrast to this, in 38 hours of watching at five nests of the Golden-naped Woodpecker, whose length is about 17 cm, the longest session that I observed lasted only 51 minutes, and sessions exceeding 40 minutes in length were rare. In the slightly smaller Red-crowned Woodpecker each sex may take sessions which average about an hour, but some pairs incubate much less constantly.

The pigeons and doves show a considerable range in size. Of those that I have watched, the largest, the Band-tailed Pigeon (*Columba fasciata*) is about 35 cm long and lays eggs about five times the volume of those of the smallest, the Ruddy Ground-Dove (*Columbigallina talpacoti*), which is about 16.5 cm long. Yet these two pigeons and all those intermediate in size incubate in essentially the same fashion, the male sitting continuously for seven to nine hours each day, and the female normally covering the eggs all the rest of the time.

In the American kingfishers, on the contrary, the larger and smaller species have radically different incubation patterns. A pair of big Ringed Kingfishers (*Ceryle torquata*), whose length is about 38 cm, replaced each other once daily, in the morning, so that the male and female sat through alternate days and nights. In the smaller Amazon Kingfisher (*Chloroceryle amazona*), length 27.5 cm, and Green Kingfisher (*C. americana*), length 19 cm, I found that the mates changed places in the burrow several times daily and the females incubated every night. But the big Ringed Kingfishers seemed unable to take their 24-hour periods in charge of the eggs in a single unbroken session, and each afternoon the member of the pair on duty sallied forth from the burrow for refreshment. The longest uninterrupted diurnal sessions that I timed lasted from five to seven hours, which is about the same as the longest sessions of the far smaller Amazon Kingfisher. Moreau (1944) found that the Half-collared Kingfisher (*Alcedo semitorquata*) takes sessions an hour or two in length in tropical Africa.

Among the trogons, the largest species that I studied, the Quetzal (*Pharomachrus mocinno*) is 35 cm long without including the male's long upper tail-coverts, and it lays eggs about 2.5 times the volume of those of the smallest, the Black-throated Trogon (*Trogon rufus*), which is about 23.5 cm long. Yet the big Quetzal takes shorter sessions, for those that I watched divided the day into three shifts and rarely stayed in the nest as much as four hours at a stretch by daylight. The male Black-throated Trogon, on the contrary, may sit for about eight hours without a break. Most of the other trogons I have watched resemble the Black-throated Trogon in their pattern of incubation, except the Mexican Trogon (*T. mexicanus*), in which I found considerable variation from pair to pair. One female Mexican Trogon, after spending the night on the nest, sat continuously through the morning and until 1:10 PM. Her unbroken fast of 19 or 20 hours was far longer than any I recorded for the larger Quetzal. In this family, as with the pigeons, there seems to be no relation between the size of the birds and the lengths of their sessions on the eggs. Perhaps the more frequent changeovers of the highland Quetzal are caused by the lower temperatures and more rapid expenditure of energy at greater altitudes.

Of the antbirds I have studied, the largest, the Great Antshrike, 19 cm long, was watched for a whole day, during which the male's sessions averaged 192 minutes and the female's 111 minutes. One of the smallest was the White-flanked Antwren, whose length is only nine cm. In this species, the male's sessions averaged more than 83 minutes, the female's 119 minutes. The male antshrike's longest session was 238 minutes, his mate's 188 minutes; the corresponding figures for the little antwren are more than 174 minutes and 140 minutes. But the antshrikes kept their eggs covered 96 per cent of the time; while the antwrens, which took surprisingly long intermissions between the sessions of male and female, warmed theirs only 76 per cent of the day. An antbird of intermediate size, the Plain Antvireo, 10.5 cm long, was watched for 17 hours, in which the male's sessions averaged more than 117 minutes, the female's 65 minutes, and the eggs were covered 95 per cent of the time. A nest of the Spotted Antbird, very nearly the size of the last species, was studied for 13 hours, during which the male's sessions averaged 113 minutes, the female's 109 minutes, and the eggs were covered 92 per cent of the day. In this family my records show slightly more constant incubation by the larger species; but the differences are not so great as one might expect from the great disparity in the sizes of the birds, which is suggested by the fact that the eggs of the Great Antshrike are about 5.5 times the volume of those of the White-flanked Antwren, 2.7 times the volume of those of the Spotted Antbird.

Among the American flycatchers, the biggest species, the Boat-billed Flycatcher, 22.5 cm long, was by far the most steadfast sitter. One female took sessions which averaged 45 minutes and covered her eggs for 77 per cent of six hours; the sessions of another averaged 30 minutes, and she was on the nest for 78 per cent of ten hours. Some of the very small flycatchers are, as we have learned above, most inconstant sitters. On the other hand, some of the larger flycatchers are no more assiduous than others much smaller. During ten hours, one Tropical Kingbird, whose length is 21 cm, took sessions averaging 51 minutes and was in the nest 67 per cent of the time. During eight hours, another kingbird's sessions averaged 32 minutes and she was on her eggs 73 per cent of the time. Watched all day, a Streaked Flycatcher, 20 cm long, took sessions averaging 30 minutes and was in her nest box 71 per cent of the time. Turning now to the far smaller Paltry Tyranniscus, which is only 9.5 cm long, my records show that during five hours one female's sessions averaged 32.5 minutes and she was attentive 72 per cent of the time. In six hours, the sessions of a second tyranniscus averaged 27 minutes and she covered her eggs 67 per cent of the observation period. As already suggested, the tyranniscus's constancy, unusual for so small a flycatcher, is a consequence of her diet of mistletoe berries.

These and a number of other records of incubation that I have analyzed suggest some correlation between size or weight and the constancy of sitting of birds in the same family. The larger birds tend to take longer sessions and to keep their eggs covered a greater proportion of the day. But there are many irregularities and exceptions, and some small birds sit far more steadfastly than related species several times as big. Even in a single species in the same locality, some individuals may come and go twice as often as others, although the percentage of the day which they spend on the nest may be about the same. Differences in food, and perhaps also in temperament, seem to be in part responsible for these variations in attentiveness.

Number of participants.—Does a bird sharing incubation with its mate, and perhaps also with other individuals, take sessions longer or shorter than it would take if it had sole charge of the eggs? Because birds on the whole adhere so strictly to their hereditary pattern of incubation, it is difficult to find in a single species nests at which both sexes incubate and others where a single parent is in charge, which would provide the best material for investigating this point.

Only a few instances of such a radical departure from the normal pattern of incubation have been reported. One of the most interesting is that of a domestic pigeon (*Columba livia*) which undertook to incubate alone a set of eggs which had been fertilized by a male with whom she did not form a pair. She sat almost continuously and, except for brief absences for food and drink, remained covering her eggs during the middle hours of the day, when the male would ordinarily have been present (Goodwin, 1947).

In contrast to this, when two male Ring-necked Doves (*Streptopelia risoria*) formed a pair, built a nest in an aviary, and were given the egg of another pigeon to incubate, they sat side by side upon the nest all day, but at night left the egg exposed while they went to roost on a perch (Neff, 1944). The sex which does not normally incubate or brood the young by night scarcely ever does so in response to unusual circumstances. Although a male Mockingbird (*Mimus polyglottos*) assumed sole charge of four nestlings a few days old, whose mother had been eaten by a cat, and fed them faithfully, he neglected the maternal role of covering them by night, with the result that they soon died of exposure (Laskey, 1936). When a male Eastern Bluebird lost to a cat his mate which had been incubating for nine days, he did not himself attempt to hatch the eggs, but went off and on the second day returned with a new partner, who strangely enough took over the incubation of the eggs she had not laid, and despite their two days' exposure to chilling temperatures, hatched four of the set of six (Hamilton, 1943).

On the other hand, Walkinshaw (1944) reported on a male Field Sparrow (*Spizella pusilla*) which on one occasion brooded by night young a few days old; but sporadic sitting of this sort is most unusual. Almost unique in the annals of ornithology is the case of the male Tree Swallow (*Iridoprocne bicolor*) whose mate died three days after she started to incubate, and who then assumed full charge of the nest, hatching all five eggs on the fifteenth day (Kuerzi, 1941). Similar behavior is exhibited by the male Bobwhite, which, when his incubating mate is lost, may take over the eggs, attending them by day and night (Stoddard, 1946). Yet even if the hen does not die, the male Bobwhite may hatch the eggs; and this habit is evidently related to the simultaneous incubation by the male and female of a pair of Red-legged Partridges (*Alectoris rufa*) of two sets laid by the female. So, too, does Skead's (1954) observation that in the Cape Wagtail (*Motacilla capensis*) either sex may incubate by night become explicable when we recall that in other wagtails both parents regularly sleep on the nest (Moreau, 1949*a*).

But such departures from the normal routine of incubation and brooding the young are rare among birds, so that, when we wish to investigate the influence of the number of participants on the constancy of sitting, we must on the whole be content to compare different species of approximately the same size and diet, in one of which both sexes incubate and in the other a single sex; although this method leads to rather precarious conclusions, as the two species will probably differ in other ways.

When the sexes alternate on the nest, two factors are at work to modify the lengths of the sessions in contrary directions. On the one hand, the longer periods which one bird enjoys for feeding, while its mate takes charge of the eggs, should allow it to fortify itself well in preparation for a long session when it returns to the nest. One sometimes observes this effect at a nest where a single parent incubates, for often an unusually long session follows an exceptionally long recess, whereas a short session follows a short absence. On the other hand, the absent partner's eagerness to return to the eggs may curtail the session of its mate, who without this interruption would remain longer on the nest. When each bird stays at its post until relieved by its mate, the absent rather than the sitting partner usually determines the length of the session: but it is probable that over the generations the recesses of one partner have been nicely adjusted to the needs of its fasting mate. Thus, in the Paradise Flycatcher (*Tchitrea perspicillata*), Moreau (1949*b*) found that the most frequent duration of the sessions, 30 to 40 minutes, was the same whether the session was terminated by the arrival of the mate or the incubating bird left spontaneously without awaiting relief. This suggested that the birds' movements were regulated by an internal rhythm, whose tempo was the same whether they were on or off the nest.

In a number of ovenbirds and toucans, the incubating bird frequently leaves the nest before its mate's return, as though tired of sitting in the dimly lighted nest chamber; and the eggs are in consequence left unattended for many minutes each day, as in small birds of which a single sex incubates. In these cases there is no suspicion that the sessions have been curtailed by the partner's eagerness to take over the eggs. The sessions of toucans are short for such large birds, those of *Aulacorhynchus* and *Pteroglossus* rarely exceeding an hour and averaging about half an hour (Table 1). Van Tyne (1929) found that even the larger *Ramphastos sulphuratus* were during the first few days of incubation surprisingly restless and frequently stayed with their eggs only 20 minutes to an hour before being relieved, or went off leaving the nest unattended. The sessions of *Xenops, Automolus,* and *Sclerurus* among the ovenbirds are perhaps no longer than one would expect of birds of their size and habits if a single parent incubated. On the other hand, the very long sessions of some of the small antbirds, often lasting two or even three hours, suggest an increased capacity for fasting resulting from the long recesses each enjoys while the mate takes charge of the nest. One would not expect a small insectivorous bird, incubating alone, to sit continuously for such long periods. The long sessions of both male and female Long-billed Gnatwrens, averaging over an hour and sometimes continued for an hour and a half, point to a similar conclusion, for this is a very small insectivorous bird.

Instances of the opposite effect of incubation by both sexes, the shortening of sessions caused by the mate's eagerness to return, are less dubious; for we often witness the reluctance to leave of the bird who has been sitting. Golden-naped Woodpeckers and Olivaceous Piculets at times linger in the nest with the mate who has returned prematurely to take over the eggs. For a woodpecker, the Golden-nape takes short sessions, rarely exceeding half an hour and never in my experience continuing for an hour; and I believe that this is caused by their great attachment to their nest hole, which serves as their dormitory through much of the year, and to which each is eager to return after a short absence.

When more than two birds share incubation, as in the anis (*Crotophaga*) and the Acorn Woodpecker (*Melanerpes formicivorus*), the shortening of sessions may be still more pronounced; for when four or more individuals desire turns on the eggs, none is allowed to remain long. Moreover, in these highly sociable birds the urge to be abroad with their companions is strong and frequently drives them from the nest even before relief has arrived. At a high, inaccessible nest of the Acorn Woodpecker which I watched for nearly 12 hours, four or possibly five birds of both sexes were incubating, and one replaced another every few minutes. The average of 108 sessions by all the cooperating woodpeckers was only 5.1 minutes. Once three changeovers took place in slightly over a minute; and the longest continuous session that I timed lasted only 17 minutes. Yet these birds did not always remain in the nest until relief arrived, and the four or five of them together attended the eggs for only 80 per cent of the 12 hours—although in other kinds of woodpeckers a single pair achieves a higher constancy in incubation. In California, Leach (1925) found Acorn Woodpeckers equally restless when attending their eggs.

Influence of the male on his mate's constancy in incubation.—When only the female incubates, the male, if he brings abundant food, may, as we have seen, greatly increase his mate's time on the eggs. In the Pied Flycatcher (*Ficedula hypoleuca*), von Haartman (1958) found a positive correlation between the frequency with which the male fed his incubating partner and the time she spent on her nest. When the male of one pair was removed, both the sessions and the recesses of his mate became longer, but the latter increased more than the former, with the result that her constancy in incubation fell from 79 to 58 per cent; and despite the longer intervals which she devoted to foraging, she lost weight.

If the male frequently approaches the nest without bringing food, he may be responsible for decreasing his mate's constancy of sitting, for his calls may draw her from the nest to fly and forage with him. Without this disturbing influence, she would remain longer on the eggs. Even if he stays to guard the nest instead of accompanying his partner on her outing, his too prompt return to assume this duty may bring her away before she has sat her full period. An Orange-billed Nightingale-Thrush whose mate never came near the nest took longer sessions than a neighboring female whose mate through much of the day returned, after she had been sitting for ten minutes or so, to resume his guardianship of the nest, which was the signal for her to begin her recess. Likewise, a Streaked Saltator whose mate seldom came to watch over the nest took longer sessions than another saltator whose partner was more eager to perform this service. The longest morning sessions of the second female were made during an interval of two hours in the middle of the forenoon when the male stayed beyond sight and hearing. The shortest session of the first saltator was the fault of her mate, who called her from the nest only seven minutes after her return from an outing. Except in large, powerful birds like jays and the biggest flycatchers, the habit of guarding the nest is not equally developed in all males, nor consistently followed by the same individual. On this point, the testimony of Nice (1937) for the Song

Sparrow (*Melospiza melodia*) and of Mickey (1943) for McCown's Longspur (*Rhynchophanes mccownii*) is in accord with my experience with the Orange-billed Nightingale-Thrush, the Streaked Saltator, and the Bran-colored Flycatcher. In birds like these, the unpredictable behavior of the males is responsible for wide fluctuations in the constancy of their incubating mates.

Influence of the type of nest.—Birds which build extraordinarily large or elaborate nests are often poor sitters, spending short periods on their eggs. I found this true of the castlebuilders (*Synallaxis*) with their great strongholds of sticks, the becards (*Platypsaris* and *Pachyramphus*) in their relatively huge nests entered through a narrow orifice in the side or bottom, and the bushtits (*Psaltriparus*) with their exquisite, lichen-covered, downy pouches. These birds neglect their eggs while they seek new materials for their cherished edifices or carefully put them in order. But the eggs in these thick-walled containers doubtless retain their heat better than in open, cuplike nests. The birds apparently enjoy active building more than inactive sitting in the dim interior; and everything works out well in the end—unless, indeed, the bulky, conspicuous nest attracts the attention of some despoiler. Hummingbirds, too, devote much time to adding material to their nests when they might well be incubating. Their beautiful, little, lichen-studded chalices, no matter how well insulated on the bottom and sides, let the heat escape above when the bird is absent, and in this case the time lost to incubation by the bird's preoccupation with building is not compensated by the greater heat-retention of the nest. All these indefatigable builders bring additional materials chiefly during the sunny hours, when the eggs can best withstand exposure.

Temperament.—The constancy of incubation cannot be wholly accounted for by the birds' food, habits, and the number of cooperating partners. When all the obvious determining influences have been assessed, there remain inexplicable vagaries which we can attribute only to that mysterious factor in bird behavior which for want of a better term we call "temperament." Some birds are stolid and restful, others mercurial and restless. There seems to be no reason, either from size, diet, or mutual assistance, why the toucans should not incubate as constantly as their neighbors of the tropical forest, the trogons; but anyone who has watched those nervous, active, sociable, huge-billed avian clowns will understand that it must be more difficult for them to sit still for long periods than for the quiet, dignified, contemplative trogons. When suspicious of the watcher's blind, trogons bringing food to their nestlings will at times delay for seemingly interminable periods holding an insect in their bills.

When I studied the nesting habits of the Ringed Kingfishers along a Guatemalan river years ago, I marvelled that they could endure to pass such long, inactive periods at the end of their long tunnels in the sandy bank. But one day I watched a female who rested in a balsa tree with a large fish dangling crosswise in her heavy bill. For over two and a half hours, by my watch, she held it so, changing her position only from one limb to another of the same tree. The reason for this long period of abstention from her food I could not tell; but I knew then that extended intervals of inactivity were wholly in keeping with the kingfisher's nature—it is, after all, a typical angler!

On the other hand, some active, restless birds may take long sessions on their eggs. Among them are female jays, which while incubating are fed by their mates and sometimes also by other attendants, and jacamars of both sexes, which receive no food while in their burrows. Even in a single species, one finds individual differences in behavior of the sort that we ascribe to temperament. Thus Kendeigh (1952:67) noticed differences in the average rates of feeding the young of House Wrens which "must lie in the innate psychological or physiological constitution of the birds themselves."

Stage of incubation.—Do birds begin at once to incubate with the same assiduity they will display a few days later, or do they gradually "warm up" to their task? Are they more reluctant to stay away as their eggs near the point of hatching than they have been during the greater part of the incubation period? These, like so many others of the questions we have considered, have not yet been exhaustively investigated; yet answers are available for a growing number of birds. And as we might suppose, the answer varies with the kind of bird, and also the individual.

At times birds sit less constantly at the very beginning of incubation. Nice (1937:124) says of the Song Sparrow that in every case except K2's second record the longer periods off the nest came during the first two days of incubation. At a nest of the Scarlet-rumped Black Tanager, I watched for two hours in the middle of the morning and two in the middle of the afternoon during the period of egg laying and the beginning of incubation. On the day she laid her first egg, the female tanager sat for only 11 per cent of the four hours. On the next day, after she deposited the second egg, which completed her set, she incubated for 30 per cent of the four hours. On the following day, she was in the nest for 55 per cent of the same period, and five days later she incubated for 67 per cent of the four hours, which is almost full constancy for this tanager. But other Scarlet-rumped Black Tanagers worked up more rapidly to high constancy (Skutch, 1954:138). On the third or possibly fourth day after their set of four eggs was complete, a pair of Black-eared Bushtits together attended the nest for only 43.5 per cent of the first four hours of the morning. But nine days later, in the same period of the morning, they sat for 74.5 per cent of the time. The longest interval of neglect on the first morning was more than 78 minutes (I grew tired of waiting for their return), but on the later morning they were never absent more than 13 minutes at a stretch. They became far more attentive to their eggs as incubation advanced. In Honduras, I watched a pair of Groove-billed Anis (*Crotophaga sulcirostris*) that on the morning of the fifth day after their set was complete covered the eggs only 59 per cent of the time; but on the next-to-last and final days of incubation these same birds left their eggs unattended for only two minutes in the course of five hours. Davis (1940) found that the Smooth-billed Ani is similarly slow to begin incubation in earnest. On the other hand, Ruddy Ground Doves and other pigeons keep their two eggs almost continuously covered from the moment the second is laid.

In contrast to the slow increase in constancy of some tropical birds, northern birds often show a more rapid rise to full attentiveness after the completion of their set. Kendeigh's (1952) vast bulk of data on the House Wren revealed that although practically full constancy in incubation is attained by the day the last egg is laid, there is a slight increase in assiduity during the next three days, after which the female's total daily time on the nest remains fairly constant until the eggs hatch. Likewise in the Cedar Waxwing (*Bombycilla cedrorum*), Putnam (1949) found a slight increase in the percentage of time on the nest for the first three days after the completion of the set. On the other hand, Conder's (1948) study of the European Goldfinch (*Carduelis carduelis*) showed that practically full constancy was reached by the time the last egg was laid; and the same was found to be true of American Goldfinch, the Robin (*Turdus migratorius*), and the Yellow Warbler (*Dendroica petechia*) by Kendeigh, the American Redstart by Sturm (1945), and the tropical Bananaquit by Biaggi (1955). In all of these species, only the female incubates; but in the Black-headed Grosbeak (*Pheucticus melanocephalus*), in which both sexes cover the eggs, Weston (1947) found that continuous incubation began with the laying of the next-to-last egg. These and other birds show relatively slight daily changes in attentiveness after the completion of their set; and the fluctuations in constancy which occur in the course of the incubation period are likely to reflect variations in temperature or other environmental factors rather than growing attachment to the eggs.

Since many birds begin to sit in at least a desultory fashion on the day they lay their first egg and each succeeding day increase their time on the nest, we might expect that the larger the set, and the greater the number of days required to complete it, the more closely they would approach full constancy on the day the last egg is laid and we begin to measure the incubation period. Hence northern birds which lay large sets would reach normal constancy in incubation by the time they have finished laying, but tropical birds with smaller sets would require a few days longer. Although this consideration will help us to understand some of the observed divergences, it will not apply in all cases. Pigeons lay small sets yet begin at once to incubate continuously;

bushtits and anis produce sets twice as large yet require a number of additional days to warm up to their task of incubation. And in the Netherlands, the Great Tit (*Parus major*), despite its set of ten eggs, failed to incubate in the mornings of the two days following the laying of the last, not reaching high constancy until the third day. This was for first broods, but with second broods full constancy was attained by the time the set was complete (Kluijver, 1950).

It is a common observation that, as the day of hatching approaches, birds cling more steadfastly to their nests when we come near them, and are more likely to permit us to touch them than at earlier stages of the nesting. This increased attachment leads us to suspect that they devote a greater part of the day to sitting; but careful watching from concealment, or mechanical recording. usually fails to confirm this. One of the Ovenbirds (*Seiurus aurocapillus*) studied by Hann (1937) showed increased constancy in incubation as the date of hatching approached in 1936, but in the preceding year this same bird (No. 15, Table 2) failed to increase her total time on the nest as the days passed. A female Bananaquit watched for 102 hours by Biaggi (1955) sat less constantly during the last four days of incubation than during the seven preceding days, although some of these days had been just as warm. One of the Marbled Wood-quails (*Odontophorus gujanensis*) that I studied showed a tendency to shorten her morning outing toward the end of the incubation period, but the other quail did not.

The majority of studies fail to demonstrate an increase in attentiveness to the eggs as they approach the point of hatching, and we must conclude that, on the whole, the greater stanchness of the sitting parent in the face of apparent danger is not an indication of more constant incubation. After a bird has reached its normal attentiveness, which it generally does a few days after laying the last egg if not by the time the set is complete, it maintains this degree of constancy, often with irregular daily fluctuations, to the end of incubation, with rarely a definite increase as the chicks begin to chip their shells. As soon as the young escape and require food, the parent's constancy in sitting typically enters a period of steady decline, especially if only one parent incubates and broods. But if the male begins to bring food very soon after the nestlings hatch, he may in an initial spurt of activity fetch more than the little ones can eat. The female profits by this, and sometimes she is able to cover newly hatched young more constantly than she incubated her eggs (Skutch, 1953).

Rain.—The effect of rain on the length of the sessions and recesses of incubating birds may vary considerably according to whether it comes in the form of a short, swift shower or a long-continued downpour. The sudden, hard rainstorm sends birds to their nests and often keeps them there, shielding their eggs or nestlings. But if the rain is of long duration, it may make food more difficult to find, and so lengthen the bird's absences from the nest.

A sudden, hard shower may cause a bird to go to her nest to protect her eggs even before she has completed her set and begun to incubate, as I once witnessed at a nest of the Bellicose Elaenia. During a violent afternoon rainstorm, she covered her single egg in the wind-tossed open cup; but not until the second day following did she lay her second egg and begin regular incubation. At the other end of the nesting cycle, I once saw a female Yellow-green Vireo brood her three well-feathered nestlings in a hard downpour. Otherwise she had quite ceased to cover them by day or by night, and the following morning they left the nest.

The longest diurnal sessions of incubating birds are frequently taken during storms and showers. Nice (1937:124) reported of the Song Sparrow: "Two of K2's very long periods on—63 and 68 minutes—were both during storms, while the longest—71 minutes—occurred on a bleak and windy afternoon." Moreau (1940) said of the African Rough-wing Bank-Martin: "Very few spells of incubation by the Rough-wings exceeded 30 minutes. The longest, which lasted 50 minutes, was while rain was falling at nearly the rate of 1 mm a minute. There is no other indication of rain affecting brooding spells." The two longest sessions which the same author (1939) recorded for the Wire-tailed Swallow, lasting 23 and 61 minutes, were both associated with periods of rain. These long spells on the nest are the more significant when we recall that about 70 per cent of the sessions of this restless swallow lasted seven minutes or less.

In my own experience, too, several birds have taken their longest recorded sessions while rain fell. In 12 hours of watching, I timed 42 sessions of a Bellicose Elaenia, only two of which exceeded 27 minutes; these lasted 32 and 60 minutes, respectively, and were taken while rain fell. An Orange-billed Nightingale-Thrush sat continuously for 56 minutes beneath a slow rain in the late afternoon, although in ten hours of rainless weather her longest session was 21 minutes. A Streaked Saltator incubated for 65 minutes continuously in the rain, but her longest session otherwise was only 31 minutes. A Golden-masked Tanager sat for 51 minutes in a heavy shower; in rainless weather the longest session that I recorded for her was 27 minutes. A Silver-throated Tanager took a session of 43 minutes beneath the light rain that followed a torrential downpour. Her next longest session, in drier weather, lasted only 33 minutes. Although she sat in a closed nest, a Rose-throated Becard increased the lengths of both her sessions and her recesses during a hard rain in the afternoon. Other birds, however, have failed to lengthen their sessions while I watched them in the rain; but they were not exposed to the hardest downpours.

It is more revealing to consider, not the longest single session, but the general change in the character of incubation which rain, especially if long-continued, may effect. In the Guatemalan highlands at an altitude of 8,500 feet, I devoted a day to watching a nest of the White-breasted Blue Mockingbird which, unlike most passerines of the region, nests chiefly in the wet season. The morning was cloudy with a disagreeable chill in the air, but the rainfall was generally light and came in little showers of brief duration. In the afternoon, cold rain fell strongly and steadily. For the morning period (until 2 PM) the mockingbird's sessions on her eggs ranged from 12 to 42 minutes and averaged 20.6 minutes. Her recesses varied from 3 to 23 and averaged 9.2 minutes. During the afternoon of hard rain, her sessions ranged from 8 to 42 and averaged 21.2 minutes; her recesses ranged from 1 to 7 and averaged 3.7 minutes. Accordingly the rain caused scarcely any change in the average length of her sessions, but a marked reduction in that of her recesses. It brought her back sooner to her exposed and chilling eggs.

On a more heavily wooded part of the same mountain slope, a Slate-throated Redstart had her covered nest. An afternoon of hard rain affected her mode of sitting in a manner just the reverse of that of her neighbor the mockingbird. During 2½ hours of hard rain, her two sessions lasted 42 and 49 minutes, her two recesses 37 and 35 minutes. The average length of her sessions during the first eight hours of the day, when no rain fell, had been 35.9 minutes, the average of her recesses 14.6 minutes. The rain caused her to increase her sessions by about 25 per cent; but her recesses more than doubled in length.

I believe that we can account for the difference in the effect of hard rain upon these two birds by a consideration of their modes of finding food. The redstart breeds chiefly in the dry season and was caught in the midst of her nesting by the first hard rains of the year. She found in the air and amidst the foliage the small insects on which she chiefly subsisted. By washing and beating these to the ground, the rain made it more difficult for her to satisfy her appetite, hence her far longer absences from her eggs. The mockingbird. a wet-season nester, nourished herself principally with berries and small creatures she picked up from the ground. The rain hardly affected the abundance of the berries, and possibly even made her terrestrial prey more available by bringing the small invertebrates out from beneath the ground litter where there they lurked. Hence the mockingbird could eat her fill in a few minutes and return promptly to her rain-splashed eggs.

During a rainy afternoon, both the sessions and recesses of a Highland Wood Wren were shorter than on a sunny morning. While the sun shone, eight sessions averaged 19.0 minutes and eight recesses 20.1 minutes. On the rainy afternoon, seven sessions averaged 13.4 minutes and six recesses 12.3 minutes. This bird dwelt upon an excessively wet mountain, where cold, long-continued rains were of common occurrence, and she should have been adept at finding her food in the rain.

Very different behavior was exhibited by a Piratic Flycatcher incubating in a nest she had stolen from a Gray-capped Flycatcher. During a rainless morning she had taken sessions varying from 20 to 49 minutes, and recesses ranging from 5 to 18 minutes. But on an afternoon of slow, intermittent rain, I found her in the nest at 2:35; and she sat without interruption until nightfall. Such a radical change in the mode of incubation of a small bird, accustomed to taking short sessions and frequent recesses, is almost without parallel in my experience. She did not even take advantage of the lulls in the rain to sally forth for food, and she was not fed by her mate.

Temperature.—The relation between constancy of incubation and the temperature of the outer air has been discussed by Nice and Thomas (1948) and Kendeigh (1952). There is now available a considerable mass of observations showing that with passerine birds of a number of species the proportion of the day spent on the eggs drops as temperature increases. Birds tend to cover their eggs more continuously in cool weather than in warm, thereby compensating for the more rapid chilling of exposed eggs when temperatures are low. Such an adjustment might be achieved in three ways: by shortening the absences, by lengthening the sessions, or by both augmenting the sessions and reducing the recesses—which last would have the most pronounced effect.

Although the inverse correlation of temperature and attentiveness appears to be fairly general, at least in the passerines, the method by which this adjustment is effected varies from species to species and even within a species. Perhaps the most common method is the simultaneous shortening of sessions and lengthening of recesses as the temperature rises. This is shown clearly by Kendeigh's (1952) records for the Barn Swallow (*Hirundo rustica*), which by this double shift effected great changes in constancy with varying temperature, incubating 80.5 per cent of the time when the thermometer stood below 70 F (21.1 C), 72.4 per cent between 70 F and 75 F, 58.6 per cent between 75 F and 80 F, 38.0 per cent between 80 and 85 F, and 31.6 per cent above 85 F (29.4 C). A similar but less pronounced reaction to changes in temperature is suggested by Kendeigh's records for the Eastern Bluebird and the Chipping Sparrow (*Spizella passerina*). In the House Wren, the sessions became much shorter as the temperature rose, although the recesses first diminished, then increased slightly in length. In the Robin, the sessions were likewise abbreviated with rising temperature, although no consistent change in the length of the recesses was evident; and the percentage of the daytime spent on the nest fell from 78.1 per cent at 58 F (14.4 C) to 60.7 at 83 F (28.3 C). In the Catbird (*Dumetella carolinensis*) the recesses also changed little with variations in temperature, but the sessions first lengthened, then became shorter, as the thermometer rose from 63 F to 79 F. Unlike the other birds reported on by Kendeigh, the Wood Pewee (*Contopus virens*) took the longest sessions on the warmest days, her recesses remaining about the same.

The Great Tits studied in the Netherlands by Kluijver (1950) showed the double adjustment very clearly, reducing their sessions and prolonging their recesses as the temperature rose. Kluijver calculated that for first broods a rise of 1 C caused a reduction of eight minutes per day in the time spent on the eggs; but for second broods there was a reduction of 15 minutes per day for each additional degree of temperature. Although all nests showed lower constancy of incubation with higher temperature, the actual falling-off varied somewhat with the individual bird. In the Pied Flycatcher, experimental increases in the temperature of the nest box caused shortening of the female's sessions on the eggs, while her recesses remained the same (von Haartman, 1956).

In the nonpasserines, little attention appears to have been given to the influence of temperature on constancy of incubation. In the Redhead (*Aythya americana*), Low (1945) found that a female incubating in a replacement nest left her eggs more often and spent fewer hours on them than did females with first layings, and he attributed this lower constancy to the higher temperature prevailing when the duck renested. Stoddard (1946) stated that the single daily recess of the incubating Bobwhite varied in length from an hour or two when the weather was cool and showery to as much as seven hours on fine, warm days.

These variations in the constancy of sitting are not always evident when we compare records of the same bird made on two days which differ considerably in temperature. Thus, in the Rufous-sided Towhee (*Pipilo erythophthalmus*), Davis (1960) found no consistent correlation between constancy of incubation and temperature; two females who were watched for many hours responded to fluctuations in daily temperature in diametrically opposite ways. Temperature is only one of the factors which affect the constancy of attendance, and it is sometimes necessary to have a considerable mass of data in order to demonstrate the temperature effect.

The influence of temperature on incubation is shown not only by the different constancy of sitting on colder or warmer days, but likewise by hourly variations on the same day. Many birds spend more time on their eggs in the cool of the morning and evening than in the middle of the day when the air is usually warmest, although this daily march of attentiveness is by no means universal. I have noticed the decline in constancy as the morning grows older especially in small flycatchers; but it is difficult to decide whether this is a direct effect on the birds of the rising temperature, or whether they sit less constantly after the sun is high because insects become more active and flycatching yields higher returns. At these times, an insect which blunders temptingly close entices them from the nest to snatch it up. In very warm weather, however, birds may remain away from their eggs, especially if these are in a box or hollow tree heated by the sun, although they do nothing but loaf in a cooler spot.

In unseasonably cool weather, which increases the bird's need of nourishment at the same time that it makes insects harder to find, the normal relation between temperature and constancy of sitting may break down completely, for the parent neglects the eggs for long periods while it searches for food. This effect of cold and wet or snowy weather is especially noticeable in small insectivorous birds like swallows and flycatchers. Among the latter, the Eastern Phoebe (*Sayornis phoebe*) will sometimes permit its early sets of eggs to chill in a late snowstorm, which scarcely affects the incubation of hardier birds that are sustained on their nests by their mates, like siskins and jays.

THE RHYTHM OF INCUBATION

The comings and goings of some incubating birds are so regular that they almost seem to be governed by the clock. The phrase "rhythm of incubation" aptly describes their movements. Other birds are far more erratic. Possibly this contrast arises from the circumstance that the former enjoy a steady, dependable supply of food, whereas the latter have variable luck in foraging, sometimes satisfying their hunger quickly, at other times taking long to find enough food, often no doubt returning to the nest before they are satisfied, with the result that they fly off to forage again after a session shorter than normal. In other cases, it appears that interference by the male causes irregularities in the lengths of the female's sessions.

As an example of a bird with a remarkably regular rhythm we may take a Collared Redstart (*Myioborus torquatus*) nesting in the Costa Rican highlands, which on the morning of 23 April 1938 incubated in minutes as follows:

Sessions 27 30 28 28 29 29 28 29
Recesses 9 9 7 8 12 9 11 13

A Silver-throated Tanager, whose nest I watched on the morning of 29 May 1943, was almost as regular in her movements. Her record in minutes is:

Sessions 25 25 29 20 17 20 23 22 27 33
Recesses 5 7 5 7 4 7 14 5 11

As an example of extreme and most unusual irregularity in coming and going, we may take the four-hour record of a Streaked Saltator whose mate was inconsistent in guarding the nest in her absence. Save for the erratic conduct of her partner, there appeared to be no disturbing element in her surroundings. On 29 May 1939 her periods in minutes were:

Sessions 27 108 7 31
Recesses 7 8 10 16 30

In the regularity of their movements, most of the birds that I have watched during incubation have fallen somewhere between these extreme examples.

THE DURATION OF INCUBATION

We know the normal duration of incubation in all those species of birds of which the incubation period—in the technical sense—has been measured. But the incubation period is determined by the speed of embryonic development, and its termination puts an end to typical incubation behavior by providing other occupations for the parents, who now devote an increasing pro-

Table 3

Incubation of Infertile or Spoiled Eggs

Species	Length of attendance in days	Incubation period in days	Authority
*Black-crowned Night Heron (*Nycticorax nycticorax*)	40, 49, 51	22–24	Noble and Wurm, 1942
Wood Duck (*Aix sponsa*)	62	about 30	Leopold, 1951
Bobwhite (*Colinus virginianus*)	56	23	Stoddard, 1946
*Sarus Crane (*Grus antigone*)	70–72	about 32	Walkinshaw, 1947
Smooth-billed Ani (*Crotophaga ani*)	24	13–15	Davis, 1940
Black-chinned Hummingbird (*Archilochus alexandri*)	24	14	Bené, 1946
White-tailed Trogon (*Trogon viridis*)	51	about 17	Original
Yellow-shafted Flicker (*Colaptes auratus*)	30	11–12	Sherman, 1952
Common Crow (*Corvus brachyrhynchos*)	21, 22, 24 26, 28, 32	16–18	Emlen, 1942
Carolina Chickadee (*Parus carolinensis*)	24	12–13	Odum, 1942
Blue Tit (*Parus caeruleus*)	25	13–15	Gibb, 1950
European Wren (*Troglodytes troglodytes*)	25, 26, 51	15–17	Armstrong, 1955
Gray's Thrush (*Turdus grayi*)	17–18, 19	12	Original
European Robin (*Erithacus rubecula*)	35, 48	13–15	Lack, 1953
Eastern Bluebird (*Sialia sialis*)	21, 21, 21	13–14	Laskey, 1940
	33		Thomas, 1946
Chestnut-capped Brush-finch (*Atlapetes brunnei-nucha*)	19	about 15	Original
American Goldfinch (*Spinus tristis*)	23	13	Berger, 1953

* In captivity.

portion of their time to feeding their young. Only when the eggs fail to hatch can the bird's impulse to incubate run its full course and spontaneously exhaust itself. Hence observations on the period that infertile or spoiled eggs are attended provides an index of the duration of the internal drive that expresses itself in sitting in the nest. Table 3 gives a number of instances of this sort that have come to my attention, and additional cases are recorded by Nice (1943:222–223) and Berger (1953). Most birds seem to remain faithful to their eggs for an interval at least 50 per cent longer than is normally required to hatch them, and many continue to incubate for twice the usual period, or even more. Thus the strength of the impulse to incubate provides a wide margin of safety; for if eggs fail to hatch within a few days of the normal time, they scarcely ever produce living chicks.

In sharp contrast to many other kinds of birds, some pigeons will desert their eggs if they fail to hatch in the normal time. They abandon eggs whose hatching is overdue, even if the chicks are already breaking out of the shell and peeping, as can be proved by removing the eggs from the nest for one day, so that they hatch 24 hours late. In these pigeons, the cessation of incubation is caused by the formation of "pigeon milk" in the parents' crop, whereas in other birds the shift from incubation to other parental activities is caused by the actual appearance of the young. Some domestic pigeons, however, have lost this fine adjustment and will continue to attend the eggs longer than the normal incubation period (Heinroth and Heinroth, 1959: 31–32).

Nice (1943:223–224) has collected a number of records of incubation by birds who either had not laid eggs or had lost them. Such behavior is far from common, and only one example of it has come to my attention in the field. In May of 1959, I found a Gray-headed Tanager incubating in an empty nest in a privet hedge in front of my house. She continued to sit by day and by night for at least two weeks—long enough to hatch eggs if they had been present. One morning I watched for five hours, during which she took three sessions, lasting 25, 70, and 61 minutes, and three recesses which continued for 29, 48, and 52 minutes. Her constancy was only slightly less than that of other Gray-headed Tanagers which I watched while they incubated eggs in the normal manner. This erratic female was attended by a mate. Whether she laid and lost eggs or never had any, I do not know.

IS HIGH CONSTANCY IN INCUBATION AN ADVANTAGE?

When we recall that many birds manage to hatch out their eggs by covering them for short stretches and leaving them exposed much of the day, we may well ask why others practice such long and, from the human point of view, tiresome sessions in their nests. What are the advantages of more continuous sitting? We might look for such advantages in two directions: constant sitting might increase the safety of the parents or nest, or of both, or it might accelerate the hatching of the eggs. This reduction of the incubation period should less directly reduce losses by diminishing the time the eggs are exposed to predation. A population of birds whose incubation period is 15 days and which loses 30 per cent of its nests to predators before hatching—not an unusually high mortality in some regions—suffers an average loss of 2 per cent per day; so that a reduction of the incubation period to 12 days should increase its hatching success by about 6 per cent.

In a bird like Leach's Petrel (*Oceanodroma leucorhoa*), which runs the gantlet of the Great Black-backed Gulls (*Larus marinus*) every time it approaches its nesting ground except on moonless nights, the long intervals between changeovers, which reduce the number of the parents' visits to the islands, are an obvious advantage and even necessary for the continued existence of these little birds of the high seas (Gross, 1935). In this instance, it is the parent rather than the egg in its subterranean chamber which is jeopardized by the bird's approach or departure. More often the adult bird incurs no special perils in the vicinity of its nest, although the latter may be betrayed to predators by the revealing movements of its attendants. The avoidance of unnecessary approaches and departures assumes special importance in small, inconspicuous nests exposed to high predation, like those of many antbirds, manakins, and cotingas of the tropical forest. While the dull-colored birds sit motionless on their diminutive nests they are inconspicuous enough, but the movement of coming or going is likely to cancel the value of their cryptic attire. Hence long sessions with infrequent recesses or changeovers seem an integral part of the system of concealment of these forest birds. On the other hand, those flycatchers which hang their pensile nests conspicuously from a dangling twig may come and go as freely as they please; for with them the nest's safety seems to depend upon its inaccessibility rather than its invisibility.

The eggs in these small, inconspicuous nests of the tropical forest frequently require long to hatch, which makes it obvious that short incubation periods depend upon something more than long periods of patient sitting. So many factors conspire to determine the lengths of incubation periods, and the subject is shrouded in such great complexities, that it is only by comparing species rather closely related that we can hope to discover some connection between constancy of sitting and rapidity of embryonic development. Fortunately, certain families provide the materials we need for such a comparison. Among the swallows, the Rough-wing Bank-Martin studied by Moreau (1940) had the exceptionally long incubation period of 19 days and showed the unusually low constancy of 31 to 66 per cent. Since other swallows that incubate more assiduously hatch their eggs in 14 to 16 days, this appears to be an instance of retarded embryonic development caused by inconstant warming. Such a long incubation period is apparently not detrimental to a bird that nests in a burrow. In the thrushes, a number of studies show that species of *Turdus*, including the Robin and Gray's Thrush, incubate more steadily than bluebirds (*Sialia*) and nightingale-thrushes (*Catharus*), and it is perhaps for this reason that the larger eggs of the first-mentioned genus hatch in 12 or 13 days, whereas those of the last two require 13 to 15 days of incubation. I have found two species of wood wrens (*Henicorhina*) inconstant sitters, and their eggs hatch in the remarkably long period of 18 to 20 days. It is noteworthy that in these cases where it seems that exceptionally long incubation periods are the result of inconstant sitting, the birds' constancy falls below 60 per cent. Some of the small American flycatchers with pensile nests have very long incubation periods, up to 18 or even 23 days; and this may be a consequence of their restless sitting; yet other small flycatchers with cup-like nests hatch their eggs in much less time, even if they are scarcely more attentive to them, so that other factors seem to be at work here (Skutch, 1945).

Instances of the acceleration of embryonic development by exceptionally constant sitting are difficult to find. In the Fringillidae, the high constancy of goldfinches, siskins, and other cardueline finches that are supported on the nest by their mates, does not seem to have caused a reduction of incubation periods, which in this group are 11 to 13 days, as in many other finches whose constancy in incubation rarely exceeds 80 per cent. So, too, the eggs of the Black-headed Grosbeak and the Rose-breasted Grosbeak (*Pheucticus ludovicianus*), in which the male and female together keep the nest almost continuously covered, hatch in 12 or 13 days, like those of finches in which only the female sits. Possibly the incubation by the male grosbeaks fails to be effective because they lack bare brood patches. In the wood warblers, for which a generous amount of information has become available, I can detect no certain correlation between the attentiveness of the incubating female and the length of the incubation period. But Stoddard (1946) stated that when eggs of the Bobwhite are incubated by bantam hens, which take a daily recess of about an hour instead of the quail's several hours, they hatch in 22 to 23 days (average 22½) instead of 23 to 23½ days, as when they are attended by the Bobwhites themselves.

To sum up, there is some evidence that when the constancy of sitting falls below 60 per cent it retards hatching, but it does not appear that an increase of constancy above 70 or 80 per cent abridges the incubation period, at least in passerines and in the milder weather when most birds nest. In this connection, it is of great interest that the shortest incubation period recorded by Kendeigh (1952:44) for a House Wren whose constancy in incubation was known, one of 12 days (13 days by the more usual method of reckoning), was achieved by a bird which incubated only 43.6 per cent of the day, but in a box exposed throughout the day to the full glare of the sun, which sometimes raised the temperature of the interior to 100 F in the middle of the day. Thirty-two other incubation periods were one to three days longer, by House Wrens which sat approximately 58 per cent of the daytime, but at lower average air temperatures. It may be significant that with constant heat in an incubator the eggs of the Skylark (*Alauda arvensis*) hatched in 13 to 14 days, although with the less constant heating that they receive from the female lark they hatch in 11 or 12 days (Jourdain *in* Bent, 1942:317). Perhaps in the incubator the humidity was less favorable. On the whole, it does not appear that the more constant incubation which might be achieved by many passerine birds if the male shared in this occupation, or fed his mate liberally while she sat, would significantly accelerate hatching. In this respect, as in others that were considered earlier, incubation or non-incubation by the male appears to be largely indifferent to the welfare of many species, so that we may regard this as a non-adaptive character, resulting from chance mutations, and not closely controlled by natural selection.

SUMMARY

The terms "sessions" and "recesses" are suggested as the least cumbersome designations of a bird's periods on and off the nest. Methods of computing the percentage of time devoted to incubation are discussed. In those species in which a single parent incubates, most individuals keep the eggs covered from 60 to 80 per cent of their period of diurnal activity; and this may be regarded as average or normal constancy. Constancy above 80 per cent is shown chiefly by birds well nourished on the nest by attendants and by those which enjoy exceptional advantages in finding food during their recesses. Constancy below 60 per cent is shown chiefly by small birds, such as American flycatchers, which subsist largely on small volitant insects. Nidicolous birds which fast on the nest for several days together require correspondingly long periods for foraging and recuperation, so that with them such protracted sitting is feasible only when the sexes alternate on the eggs. But nidifugous birds, which provide for their chicks with less strenuous exertion, so that it is less imperative for them to pass through the period of incubation without loss of vital reserves, may fast throughout this period. Sometimes, however, their attempt to do so causes their exhaustion and consequent abandonment of the eggs.

Other factors which influence the constancy or rhythm of sitting are the size of the birds, the number which share incubation at the same nest, the behavior of the male when he does not incubate, the type of the nest (whether open or covered, etc.), the bird's temperament, rainfall, and the temperature of the air. Although there may be a slight or, in some species, a pronounced increase in attentiveness during the first few days after the completion of the set, the stage of incubation has on the whole little influence on constancy of sitting.

When their eggs fail to hatch, most birds continue to incubate them at least 50 per cent longer than is normally required to hatch them, and they may continue for twice or even three times the normal period. An outstanding exception is provided by pigeons, some of which fail to incubate even a day beyond the usual time of hatching.

In species of birds whose constancy of incubation falls below 60 per cent, the incubation period is sometimes longer than in related species which sit more assiduously. Those exceptional birds which nest amid snow and ice must keep their eggs constantly covered lest they freeze. But in the milder weather when most birds breed, it does not appear that a constancy above the 60–80 per cent range, which might readily be effected if the male shared incubation or fed his mate liberally on the nest, would materially reduce the length of the incubation period, thus diminishing losses to predators by decreasing the time the eggs are available to them. In this respect, as in several others, incubation or non-incubation by the male appears largely indifferent to the welfare of the species, especially in passerine birds.

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MAINTENANCE ACTIVITIES OF THE AMERICAN REDSTART

Millicent S. Ficken

The maintenance activities of the American Redstart (*Setophaga ruticilla*) were studied as part of a more comprehensive study of the behavior of this species. Marler (1956) defines maintenance activities as "those activities which are concerned with locomotion and the general health and efficiency of the body, mostly occurring throughout the year." Flight and flight intention movements are not included in this study.

Maintenance activities often serve as evolutionary precursors of signal characters (Daanje, 1950), and a study of such behavior is imperative for an analysis of the displays of a species. However, even those motor patterns which do not become display components are interesting from an evolutionary standpoint, and comparisons among related species are needed. They also may be useful as taxonomic characters. For example, the Columbidae and Pteroclidae can be separated from all other groups (Finn, 1919; Lorenz, 1956), except the estrildine finches (Poulsen, 1953), on the basis of their water-sucking method of drinking. In addition, a study of the ontogeny of maintenance activities furnishes insight concerning the development of behavior.

METHODS

Five adult redstarts were used in this study. They were fed Dandee Mynah Bird Food and the larvae, pupae, and adults of the wax moth (*Galleria mellonella*). In addition, seven young were removed from two nests at the age of six days and were hand-raised on a diet of earthworms, wax moth larvae, and vitamin supplements.

Data from a single captive Bay-breasted Warbler (*Dendroica castanea*) are included. It is impossible to make any conclusive comparisons using only one individual. However, there was very little individual variation in the redstarts studied, and this is probably true of the Bay-breasted Warbler as well.

Most of the observations on the redstarts were made using captive birds, but observations of adults in the wild indicate that these activities are not influenced by captivity, except for the fact that such movements as stretching, bathing, and various feather settling movements apparently occur more frequently in captive birds. This is probably because the birds are less occupied with foraging and other activities which take a large part of their time in the wild.

MAINTENANCE ACTIVITIES

Locomotion.—Redstarts hop forward when on the ground and sideways along a perch. They also have another locomotory pattern which is probably a modified hop. I have termed this movement a "pirouette," and it involves a rapid turning movement in which a small, quick hop results in a 180° turn. The bird turns first one way and then the other and moves several inches during the process. Much of the movement along branches is by this method rather than by ordinary hopping.

Pirouetting has been noted in the Bay-breasted Warbler, the Blue-gray Gnatcatcher (*Polioptila caerulea*), and the Baltimore Oriole (*Icterus galbula*).

Pirouetting probably enables the bird to glance more readily in different directions as it moves along the perch. This would be advantageous in scanning the environment for food and predators. The Bay-breasted Warbler performs fewer and slower pirouettes than the redstart which is probably a reflection of its more sluggish feeding habits. Pirouetting was first noted in young redstarts three days after they left the nest.

Foraging.—Foraging was studied at Renwick, a deciduous woodland with much undergrowth, in Ithaca, New York. Here, the redstarts feed primarily 10 to 35 feet up, but occasionally feed on the ground or in low herbaceous plants. MacArthur (1958) studied their foraging range during the winter in Costa Rica and found it extended from 5 to 50 feet. Early in the morning the birds feed higher in the trees but by midday may be feeding near the ground. This shift probably reflects a change in the activity of insects. Redstarts procure food from the leaves, twigs, branches, and trunks of trees, vines, low herbaceous plants, and in mid-air.

Insects are obtained by gleaning, hovering, and mid-air catches. In gleaning, the bird moves along a limb or vine by pirouetting or hopping and picks insects off the leaves or branches. In hovering, the bird flies out (generally a short distance) and picks insects from the undersides of leaves while hovering under them with rapid wing beats. Mid-air catches are the usual method of obtaining flying insects and consist of flights from a perch out as far as 15 feet. Unlike some flycatchers (Tyrannidae), the redstart does not usually return to the point of origin of the flight, but continues feeding in a new location.

The Bay-breasted Warbler is rather sluggish in its movements as compared to most other warblers, and rarely uses its wings in foraging (MacArthur, 1958). The redstart, on the other hand, captures much of its food by mid-air sallies. If a fly or moth enters a cage with a redstart, the bird immediately captures it in mid-air. However, under similar circumstances, the Bay-breasted Warbler peers at the insect but rarely makes an attempt to catch it. It is possible that the Bay-breasted Warbler learns that it is generally too slow with its motor equipment to catch a flying insect while the redstart, on the other hand, is constantly reinforced with successful catches. Hinde (1959) states: "Structure and feeding patterns available influence the course of individual learning, and are thus instrumental in controlling the food objects taken."

The highly diverse diet (Forbush, 1907; Benson, 1939) of the redstart is coincident with its variety of foraging methods and its wide vertical foraging range. Although the redstart is certainly a specialized feeder in that it is almost completely insectivorous, compared to other warblers (for studies of *Dendroica* spp. see MacArthur, 1958) it is broadly adapted within this category. The broad feeding adaptations of this species may help explain its extensive geographical range.

Ontogeny of feeding behavior.—Observations were made on four hand-raised redstarts. At eight days of age (one day before leaving the nest) the birds were noticed following moving objects with their eyes for the first time. The birds can fly as soon as they leave the nest. Not until they were 12 days old did they exhibit any intention movements to approach potential food objects. At this time, a young bird sleeked its feathers and crouched while watching a fly moving below him. At this age the birds lose interest in moving objects very quickly. Although moving objects were followed visually, the birds did not show much interest in still objects. At 13 days of age a bird picked up a bit of clay but soon dropped it. At 15 days of age a bird grabbed a squirming caterpillar from forceps held several inches away. The same day a bird leaned toward and snapped at a fly two inches away but missed. At this age the birds showed increased picking at motionless objects such as a nail head and bits of clay. At 18 days, a bird first made a flight toward a fly but did not succeed in capturing it. At 20 days of age the birds were still begging from me. When an insect that I was feeding them was dropped, they begged at it; then one picked it up and ate it. The birds finally fed independently at 30 days of age, which is about the same age that they become independent in the wild (Benson, 1939). The birds still directed food calls and wing flutterings at me but no longer gaped at me.

Treatment of food.—Different species of birds prepare insects for ingestion in diverse ways. The Red-eyed Vireo (*Vireo olivaceus*) and the Baltimore Oriole hold insects between the feet and the perch.

Another common method is holding the insect in the bill and banging the insect on a perch or on the ground. This method is employed by the American Redstart, Bay-breasted Warbler, and Yellow Warbler (*Dendroica petechia*). These species apparently never use the feet as an aid in feeding.

Two captive redstarts (both three to four months old) and an adult Bay-breasted Warbler were used for studies of food treatment. The pupae. adults. and particularly the larvae of the wax moth were used to study this behavior. The white larvae are soft-bodied and have a brown marking at the anterior end. The pupae are a fairly uniform brown and more heavily sclerotized.

TABLE 1
TREATMENT OF WAX MOTH LARVAE

	Redstart No. 1	Redstart No. 2	Bay-breasted Warbler
Seizes at anterior end	14	50	50
Seizes at posterior end	1	0	1
Bangs anterior end	8	39	30
Bangs posterior end	8	26	8
Swallows anterior end first	9	36	40
Swallows posterior end first	5	11	2

The adult has a rather uniformly colored body and slightly mottled gray wings.

The treatment of larvae by both species is summarized in Table 1. Both species seize a larva by the thorax and squeeze it between the mandibles; this is probably an effective way of stunning it. The insect is held at a right angle to the bill.

The bird orients its body parallel to the perch. and bangs the larva on the perch with a whiplash action. The banging actually breaks the body of the larva, often spilling out the gut.

The differences in treatment of larvae by the two individual redstarts are small (Table 1). The differences between the redstarts and the Bay-breasted Warbler are more marked. The redstarts banged the posterior end of the larvae almost as frequently as the anterior end: the Bay-breasted Warbler banged the posterior end more infrequently. The Bay-breasted Warbler was more consistent in the end swallowed first. However. the end swallowed first may be modified by learning as is suggested by the fact that when redstarts were first given these insects they swallowed the posterior end first for the first eight or ten feedings. Then there was a gradual transition until swallowing head first became typical. The older Bay-breasted Warbler, however, did not swallow the posterior end first even initially, which may indicate that the bird had more experience in dealing with this type of insect rather than indicating any innate differences in the food treatment of these two species.

When a redstart flies out and seizes a larva as it is falling into the cage, it usually grasps it by the thorax. although sometimes it catches it by the posterior end. If the bird seizes the larva by the posterior end, he bangs the anterior end lightly several times on the perch. Since this is the reverse of what typically occurs, it indicates that subsequent acts are dependent upon the initial position in which the larva is held. In other cases, however, the bird initially grasps the posterior end. starts the "wrong" way, and then "corrects" himself part way through the sequence. Thus there is not always a rigid sequence with successive patterns determined by the preceding ones. Rather, there is apparently some feedback of stimuli during the operation which sometimes results in adaptive corrections.

In both species, variation occurs in the amount of banging and the degree of completeness of the sequence. Hunger has an influence on food treatment. Birds were deprived of food (generally for about one-half hour) until they began performing intensive locomotory activity and also started giving "hunger" calls. The larvae were only banged in four cases in 19 trials. On the other hand in birds which were not deprived of food the larvae were banged in 11 out of 15 cases.

Another factor of importance in determining the relative completeness of the food preparation sequence is the size of the larva. Large larvae are generally banged while small ones are almost invariably eaten without previous treatment.

The factors causing redstarts to react to one end of the larva in preference to the other were investigated. Since live larvae were used, it was possible that the birds seized the end which was moving forward; so larvae were immobilized by drowning and then given to the birds. The anterior end was selected each time in 11 trials. Thus mobility is apparently not a feature determining the end seized.

Since there is a brown marking at the anterior end of the larva, color might serve as a cue. A simple experiment was performed to test this. A brown spot, made with liquid vitamins to which the birds had become accustomed, was placed on both ends of drowned larvae. In 14 trials the anterior end was seized seven times, the posterior end six, and the middle once. The birds thus showed no preference for either end. Twice an insect which was in a transition between the larval and pupal stages, and which was completely lacking in markings, was given to the bird and it was seized by the posterior end. Thus it seems that the bird directs its seizing response to the anterior end and the dark marking there serves as a releaser.

Tinbergen (1958) notes that hand-raised Yellowhammers (*Emberiza citrinella*) attacked mealworms by pecks aimed at the anterior or the posterior end, but slightly more often at the anterior end. However, mealworms are more uniformly colored than wax moth larvae and hence there are no distinctive markings to serve as releasers.

The birds often seized pupae by the middle and showed no apparent preference for either end; they were swallowed either anterior or posterior end first. This again would point to a distinctive marking as being the releaser for their more stereotyped behavior with the larvae.

Moths were almost always seized and swallowed anterior end first, but the factors releasing seizure at the anterior end were not investigated. The size of the moth apparently has an important influence on treatment. In dealing with large moths, the bird holds the moth by a wing and bangs the body. Next, the bird drops the fragment of the wing which has broken off and grasps another wing and continues banging until most of the wings break off. The moth is then eaten. This elaborate sequence usually does not occur with small moths. Occasionally these were banged, but more often the bird held the body, not a wing, and the insect was then swallowed wings and all.

Stretching movements.—There are three stretching patterns in the adult redstart, and this is true for the other passerine species studied thus far (Nice, 1943). In one stretching pattern the wing is extended downward and outward from the body as the ipsilateral leg is lifted from the perch and stretched outward with the wing. During this movement the rectrices are also widely spread, apparently on the side that the wing and leg are stretched. Thus this pattern involves the stretching of a leg, wing, and the tail. This movement will be referred to as the wing and leg sideways stretch. Another stretching movement is the one referred to as the both wings-up stretch. Both wings (unfolded) are lifted simultaneously above the back. The third stretching posture involves an extension of both legs; this will be called the both legs stretch.

Young redstarts exhibit, in addition to the movements described above, a movement in which both wings are simultaneously stretched downward, but not stretched outward much. This pattern has also been noted in young birds of other species (Nice. loc. cit.; Andrew, 1956). Andrew notes that a tail stretch may be associated with this stretching posture in certain emberizines, but this was never seen in redstarts.

At the age of six days, when the young birds were first studied, they performed the both wings down, both wings up, and both legs stretches. Birds of this age, however, do not perform the wing and leg sideways stretch. This stretching movement first appeared at eight days of age, in the seven birds studied. It initially consists of one wing stretched downward close to the body and is thus apparently the same in form as the both wings down stretch except that only one wing is involved. The both wings down stretch decreases in frequency and was last seen on the same day that this new stretch first appeared. The both wings down stretch was never observed in adult redstarts and occupies only a short period in the young bird. This stretch only lasts two days in the Song Sparrow (*Melospiza melodia*) (Nice. loc. cit.). However. Andrew (loc. cit.) notes that adult buntings (*Emberiza* spp.) occasionally perform the both wings down stretch.

The both wings down stretch is apparently a transitional movement which gives rise to the wing and leg sideways stretch. This is indicated by the initial similarity in form, and the fact that its appearance coincides with the disappearance of the other movement.

There is a pattern to the stretching movements and there are changes in the sequence during the life of the nestling. The both legs stretch is performed just as the bird completes the both wings down stretch in the six- and seven-day-old birds. Andrew (loc. cit.) mentions the same sequence in *Emberiza* spp. However, by the eighth day (and the last day that it is present) it is followed by the both wings up stretch more often than the both legs stretch.

The main difference in the stretching sequence of a Bay-breasted Warbler was that the both legs stretch appeared more frequently and was part of the wing stretching sequence, which did not seem to be the case in adult redstarts. The most frequent stretching sequence of the Bay-breasted Warbler is: both wings up. wing and leg sideways, both legs stretch. This sequence may be extended to include the other wing and leg in this type of sequence: both wings up, right wing and leg sideways, both wings up, left wing and leg sideways, both legs. The most frequent stretching sequence of the adult redstart is: both wings up, one wing and leg sideways. Andrew (loc. cit.) notes that in *Emberiza* spp. the wing and leg sideways stretch is usually followed by the both wings up stretch which is the opposite situation of the two warbler species. Marler (1956) found that after rest the Chaffinch (*Fringilla coelebs*) usually does a both legs stretch, one wing and leg sideways, followed by both wings up. Thus there may be species differences in the typical stretching sequence.

My findings are in accord with those of Andrew (1956) that stretchings occur most frequently following rest. The stretching movements are performed by the young bird when he awakes to be fed and generally more than one is performed at a time. Occasionally a bird will stretch after a period of locomotory activity, but generally only one stretch is given and apparently never more than three. After rest there are often sequences of four or five stretching movements. Andrew (loc. cit.) suggests that the preponderance of stretching movements following rest may be due to the fact that the bird becomes cramped while inactive and the stretchings occur because of proprioceptive feedback from the muscles.

There are at least two discernible intensities (degrees) of the both legs and the both wings up stretches. In the higher intensity of the both legs stretch the legs are stretched so far that the bird almost topples forward. If the bird performs the low intensity form of one of these stretches, it usually performs the higher intensity form in the same bout.

Resting.—The body feathers are fluffed in the resting bird. The bill may point upward somewhat and the eyes may be closed for short periods, but the bird is still alert and looks around frequently.

Sleeping.—In adults, sleeping is preceded by the resting posture. The bird closes its eyes and the bill is often then rested on top of the scapulars. The bird may make several incomplete head turning movements before it finally rests its head there. Then with a quick movement the bill is tucked under the fluffed feathers.

In the course of ontogenetic development there are several changes in sleeping postures. Very young nestlings sleep with their heads and bodies flopped in almost any position. At six days of age the birds sleep with their heads turned sideways and often rest them against a nestmate. They also sleep with their necks outstretched and with the head resting on the rim of the nest. By eight days of age they often sleep with the head on top of the shoulder. However, the birds have not completely abandoned their earlier sleeping postures, but they have become more infrequent.

By the time that the young have left the nest at the age of nine days, they sleep solely in the adult manner. When birds of this age were awakened they usually turned the head to the opposite side when they went back to sleep again.

Dilger (1956) has described the sleeping postures of young Swainson's Thrushes (*Hylocichla ustulata*). These birds have a sleeping posture which is somewhat different from that of young redstarts. The neck is retracted and the bill is pointed upward (rather than horizontally or slightly downward as in the redstart). Otherwise the sequence of appearance and the form of the sleeping postures are similar.

It appears that sleeping postures are similar in most passerine species (Nice, loc. cit.; Dilger, loc. cit.: pers. obs.). Thus this is a very conservative behavior pattern.

Head-scratching.—Head-scratching is performed by placing the leg over the wing in all individuals of this species that were observed. Several species of Parulidae scratch under the wing, and there is often individual variation (Ficken and Ficken, 1958: Nice and Schantz, 1959).

The foot is used to scratch the chin, the cheek, the base of the bill, and the upper part of the neck as well as the head. The wing is usually drooped during this operation. There appear to be two different scratching postures. The first occurs when the bird scratches the crown (or possibly nearby areas). The crown feathers are erected and the bill is closed or opened only slightly, and the head is pointed downward or to the side. In the second scratching posture the neck is extended straight forward and the bill is opened widely. The feathers of the neck and head are generally sleeked. Both postures have also been seen in a Bay-breasted Warbler and the Ovenbird (*Seiurus auro-*

capillus). The eyes are often closed during head-scratching and this is evidently an adaptation to protect the eyes while the foot is brought into this area.

Since the bird is unable to reach the head area with its normal preening movements, there are two other movements which are used to remove foreign substances in this region. One of these is by rubbing the side of the head on the perch, the other involves scratching this area with the foot.

Head-scratching in the redstart occurs most frequently during preening bouts. It followed preening in 41 instances, stretching 12, and no other comfort movements preceded or followed in only 5 cases. Nice (1943) notes that in the Song Sparrow this activity frequently occurs after touching the uropygial gland, but this does not seem to be the case in the redstart.

Head-scratching was first noted in six-day-old young. At this time the movement is incomplete and the foot does not quite reach the head. The wing is first drooped and then the bird reaches over it with the leg. At seven days of age the birds were able to reach the head. Sometimes the young birds move the head during the scratching and the foot has access to several different areas. In older birds the foot is sometimes moved to several different areas during one scratching, but the head is not moved. For several days after they leave the nest, the young have trouble maintaining their balance during head-scratching since they must perform it while standing on one leg and no longer have the support of the nest. During this period the young birds often make several incomplete movements to scratch the head before they perform it successfully.

Bathing.—The bathing sequence of the redstart and the Bay-breasted Warbler is similar to that of the Song Sparrow (Nice. loc. cit.). First the bird dips the bill into the water and flips the water sideways. Then the bird with breast immersed in the water throws water over the back with motions of the wings.

Bathing was first noticed in hand-raised birds when they were 18 days old, although a bathing dish had been available prior to that time. Wing shuffling which typically occurs after bathing was first noted at 13 days of age after a young bird fell into the water, although he made no bathing movements at this time. An instance of "dry bathing" was noted in a 20-day-old bird. The bird performed all the typical bathing movements, including the wing movements, on the paper of the cage floor next to the bathing dish. This occurred just after the other bird in the cage had bathed. It is probable that the other bird in bathing splashed water on him and this stimulated the bathing. This particular bird had bathed in the normal manner several hours previously.

In the wild the birds bathe in shallow, sometimes quite muddy puddles.

A Bay-breasted Warbler was once observed performing bathing movements on a large wet leaf.

Post-bathing movements.—Wing shuffling starts as soon as the bird has completed the bath. The closed wings are moved upward and may extend outward from the body somewhat. In high intensities a whirring noise is produced and the force of the movements almost propels the bird off the perch. These wing shufflings are often performed in synchrony with rapid tail fanning. The tail fanning consists of rapid fanning of the rectrices and the outer feathers move slightly upward as they move outward.

A bird is often unable to fly immediately following a bath because of the wetness of the plumage, and then performs many wing shufflings on the cage bottom. Only when the bird is able to reach a perch does preening commence and then it is interspersed with wing shufflings which decrease as the bird becomes drier.

When fresh water is placed in the cage of a bird that has not bathed that day, the bird often immediately exhibits wing shufflings and tail fannings. These two movements may exist separately. When they occur together both movements are generally of the same intensity. Both of these movements may be given in conjunction with a body shake.

The drying movements of *Emberiza* spp. are described by Andrew (1956) and appear to be similar to those of the redstart and the Bay-breasted Warbler.

Body shake.—The feathers of the breast and back are fluffed and then the body is shaken. The feather erection component may be quite slight. The bird may fluff its feathers and then relax them without performing the body shake. The body shake apparently consists of two different components—the fluff and the shake. Wing shufflings may occur during the body shake as do tail fannings. Body shakes most frequently occur in context with other maintenance activities, particularly drying movements. Wing shuffling, body shakes. and tail fanning apparently function as feather settling movements (Andrew, loc. cit.).

Preening.—Preening consists of nibbling movements of the bill on a feather or several feathers. Preening movements are one of the first comfort movements to appear in the young bird. The exact time of their appearance was not obtained, but preening occurs before the young are six days old, even before the feathers have burst through the sheaths extensively. The adaptive significance of the early development of this movement seems clear. By preening, the birds aid in breaking the sheaths enclosing the feathers. Young birds occasionally grab plant fibers of the nest instead of feathers but they do not continue bill movements on these. It thus appears that there is some sensory feedback during preening.

The birds were first noted touching the uropygial gland with the bill when they were 12 days old. The uropygial gland is touched soon after bathing, and less frequently during preening bouts at other times. The tail is spread and turned toward the head and the feathers near the gland are raised. The bird then obtains oil from the gland by touching it with the bill. Preening always follows. Andrew (loc. cit.) states that in *Emberiza* after oil is taken from the uropygial gland the bird often rubs its head on its shoulder which may transfer the oil. This movement did not occur in the two warbler species studied.

When the bird preens its primaries it moves from the base to the tip of the feather in rapid movements. The bird generally preens the primaries soon after a bath and performs wing shufflings in between preenings. The outermost primaries are preened first.

Tarsal preening.—On several occasions two captive redstarts ran their slightly opened bills the complete length of the tarsus and sometimes continued this movement down over the middle toe. This was observed during or just following the postjuvenal molt. Whitaker (1957) describes a similar movement in the Lark Sparrow (*Chondestes grammacus*), in which these movements followed touching the uropygial gland, and this was preceded by bathing. However, this was not the case in the redstart and it does not seem justified to term this movement oiling of the tarsus which is the function this movement seems to serve in the Lark Sparrow.

Cleaning the feet.—The feet are usually cleaned by the bird bending over and pecking the toes. However, on one occasion, a bird raised its foot about halfway to its bill and then pecked at the stationary raised foot. Whitaker (loc. cit.) describes a foot-cleaning method in the Lark Sparrow where the foot was raised and the bill lowered to meet it, but the bill and foot both made circular movements, and this was never observed in the redstart.

Bill-wiping.—This movement involves quick strokes of the bill on alternate sides of the perch. Bill-wiping generally follows feeding or drinking, and serves to remove foreign material from the bill. Food is also sometimes removed from the bill by a rapid sideways flick of the head. The young were first observed to bill-wipe at eight days of age, and they performed these movements on the nest rim after being fed.

Cleaning the base of the bill.—The feathers near the base of the bill and this area of the bill itself are cleaned by a slow rubbing of this area on the perch. The bill is usually opened during this action. This movement, unlike bill-wiping, often consists of only one such action, and the other side of the face is generally not rubbed.

SUMMARY

The maintenance activities of the American Redstart are described and their ontogeny traced wherever possible. A few observations of a Bay-breasted Warbler are included.

The redstart employs three principal foraging patterns: gleaning, hovering, and mid-air catches. This variety of foraging behavior patterns is coincident with a diverse insect diet.

The food treatment sequence of the redstart is described. The completeness of the sequence is dependent on the degree of hunger and the size of the insect. It was found using wax moth larvae that the brown spot at the anterior end serves as a releaser for seizure at that point.

The three stretching movements of the adult bird are both wings up stretch, both legs stretch, and a wing and leg sideways stretch. In addition, the young bird performs a both wings down stretch which shows a transition in form to the wing and leg sideways stretch which soon replaces it. The stretching sequence follows a pattern which may be species-typical.

The ontogeny of such activities as stretching, scratching, and sleeping postures is marked by gradual changes. The young bird performs these in the adult form, before, or shortly after leaving the nest.

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LABORATORY OF ORNITHOLOGY, CORNELL UNIVERSITY, ITHACA, NEW YORK, 24 APRIL 1961

NEW LIFE MEMBER

Thomas G. Scott, Game Specialist and Head of the Section of Wildlife Research of the Illinois State Natural History Survey Division, is a new Life Member of the WOS. Dr. Scott is now retiring from the Chairmanship of the Society's Conservation Committee, a position he held for two years. Under his very active leadership, this committee's annual reports and special reports have summarized carefully the committee's detailed surveys of such current conservation matters as wildfowl conservation in North America, status and problems of North American grouse, effects of insecticides on terrestrial birdlife in the Middle West, trends in conservation education, and a general summary of the ornithologist's responsibility to the future. These interesting and pertinent reports already have had wide use, and requests for copies of the reports continue to be received.

Dr. Scott is a Fellow of the AAAS, a Life Member of the Society of Mammalogists, and a member of the AOU, the Wildlife Society, Ecological Society of America, and the Illinois Academy of Science. His research interests lie mainly in mammal and upland game bird ecology. To date he has published 65 papers and notes on various subjects related to these interests.

THE HATCHING MUSCLE IN FRANKLIN'S GULL

Harvey I. Fisher

At present the hatching muscle is known in chickens (Keibel, 1912; Pohlman, 1919; Fisher, 1958) and in North American grebes (Fisher, 1961). It is desirable, then, to record its occurrence and development in additional species.

This pair of muscles, M. complexus or, preferably, the caput portion of M. cucullaris, originates on the dorsal lateral surface of the anterior part of the neck and inserts on the back of the skull. It is thus in an excellent position to raise the head and bill. Although the muscle functions throughout the postnatal life of the bird, it is thought that its most critical function is to raise the egg-tooth against the shell to produce the "pip" in the shell that is the first outward manifestation of hatching. Reference may be made to Fisher (1958) for a discussion of this function.

Our interest here is to present the grosser features of the morphological development of this muscle in Franklin's Gull (*Larus pipixcan*).

MATERIALS AND METHODS

Eggs and young birds were taken from one of the several gull colonies in the Delta marshes at the south end of Lake Manitoba, Canada. The specimens included: 127 eggs, eight young birds from the nest, and two adult Franklin's Gulls; six eggs of the Common Tern (*Sterna hirundo*); and four eggs of the Black Tern (*Chlidonias niger*).

All eggs of the gulls were collected one day; one-fourth of them were sampled immediately and the remainder incubated at 99.5 F and approximately 60–70 per cent relative humidity. Samples of the incubated eggs were taken daily. When the first gull eggs pipped, the embryos had great difficulty in emerging; some eggs were pipped for three days before the chicks came out, and some died in the egg. The difficulty seemed to lie in low humidity. Therefore, additional trays of water were placed beneath the eggs, with the top of the water about an inch below the bottom of the eggs, or some two inches closer to the eggs than formerly. Thereafter, chicks emerged within 24 hours of pipping.

Although it was possible to keep young gulls alive at least as long as 14 days on a diet of turkey "pre-starter" food, it was felt that their growth was probably not normal. Therefore, data on birds maintained longer than two days after hatching were not included.

Since the age of the embryo could not be determined accurately, body weight was used as the criterion for the stage of development. The data on body weight, particularly those of embryos just before and just after hatching,

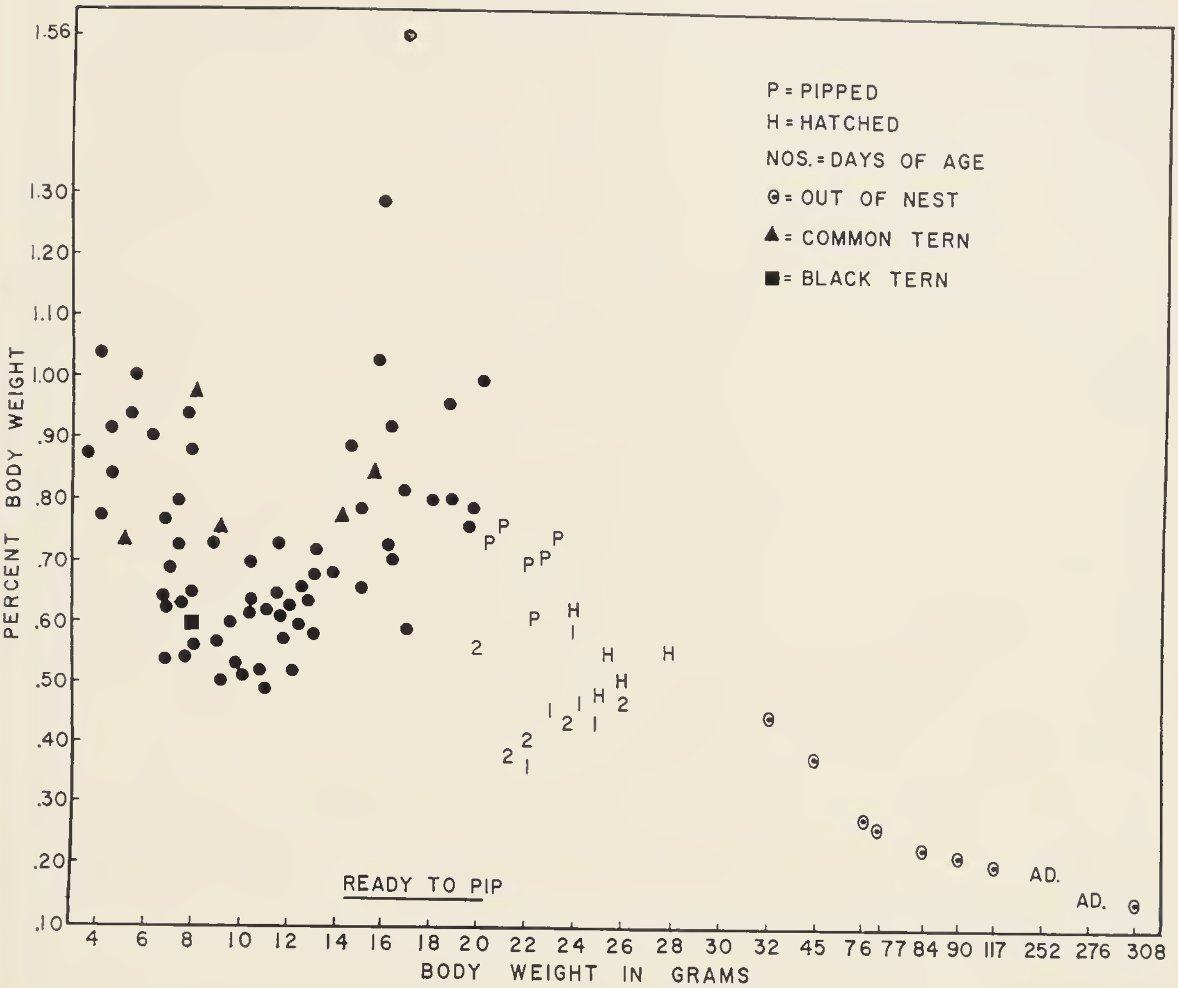

Fig. 1. The development of the hatching muscle in Franklin's Gull as indicated by ratios of muscle weight to total body weight. A few specimens of Common Terns and Black Terns are included.

must be viewed with caution. Yolk was drawn from the bodies of embryos near hatching; this was necessary to insure uniformity in weights of true body tissues because at this stage varying quantities of yolk remained externally in the yolk sac. Thus, body weights of "pipped" embryos appear to be less in Fig. 1 than do weights of "hatched" embryos; probably these weights should be nearly the same, aside from individual variation.

When the embryo was taken from the shell the extra-embryonic membranes were cut away, and it was gently blotted several times on newspaper to remove surface moisture, before being weighed to the nearest tenth of a gram. The hatching muscles were easily excised with iridectomy scissors and weighed in milligrams on a Roller-Smith Precision Balance. Removal and weighing took less than a minute, once the muscle was exposed; thus undue desiccation did not occur.

RESULTS

In Franklin's Gull and the two terns the basic morphological pattern of the hatching muscle was the same as in the chicken and grebes previously described. Differences in structure and in development between the species were primarily related to differences in body size and in length of incubation period.

Three segments were most frequently found (78 birds). but eight birds had four segments in the muscle. The posterior segment of the three was always smallest, sometimes extremely so. When a fourth segment was present it was the smallest. In one Common Tern the large first segment was partly divided into two segments by transverse raphae extending medially from the lateral edges of the first segments. Segmentation in the definitive muscle was not visible, even faintly, until the 7-gram stage and remained faint until the 9- or 10-gram stage. In specimens of 10 grams to 16 or 18 grams in body weight the segments were obvious. At this later stage the segmentation began to be obliterated; in approximately 50 per cent of the specimens no segments were visible just before hatching. Immediately after hatching the segments were faintly discernible and they remained so in the adult.

Another feature showing change during development was the extent of medial contact between the muscles of the two sides. This contact was not found in embryos weighing less than 5 grams. At the 7- to 10-gram stage the muscles were touching each other in the anterior one-third to one-half of their lengths; in other words, the first segments and parts or all of the second segments were in contact. From 11 to 20 grams the medial juxtaposition involved the first two pairs of segments. In the "pip" stage (20–23 grams) there was nearly total contact throughout the length of the muscle. and this was maintained until about the 80-gram stage. Thereafter the posterior ends of the muscles appeared to separate: actually, the medial portions regressed and the lateral edges maintained their positions. This "separation" progressed until less than the anterior third of the length was in contact in the adult gulls.

At the 4-gram stage the hatching muscle weighed approximately 0.035 gram. There was a straight-line. gradual increase to 0.080 gram at a body weight of 13 grams. At this later stage there was a strong upsurge in absolute weight of the muscle. that sometimes reached 0.260 gram at 17 grams of body weight. but was usually about 0.170 gram. Muscle weights declined during pipping (0.16 gram). hatching (0.13). and the first two post-natal days (0.10). There was a slow increase in the muscle weight of the chick in the nest: at 70 to 90 grams of body weight the muscle weighed approximately 0.19 gram or only slightly more than at the pre-pip stage. In adults. the muscle weight of approximately 0.40 gram was only slightly more than twice the muscle weight of the newly hatched chicks: body weight in this same period increased more than 10 times.

In Fig. 1 are plotted the quantitative changes in the muscle, as compared to body weight. It may be noted that there were two peaks of development—the first as the embryo began to develop and the second at the "ready-to-pip" stage. The first was the result of the early cephalic development typical of all embryos; the relative recession between the peaks, reaching a low at 10 to 12 grams, was more than compensated for by the later, progressive, caudad development of the young gull.

The most significant change in relative size occurred at the pre-pip stage, when muscle weights were as much as 1.5 per cent of body weight, or some three times as much, relatively, as at the 10-gram stage. During the pipping process the muscle became considerably smaller, and it was still smaller after hatching. Muscle size continued to decline gradually, until in the adult it was only 10 per cent of the relative size it was just before pipping and only 15 per cent of the relative size attained at the 4-gram stage.

The few examples of the Common Tern seemed to indicate a similar prenatal history for the hatching muscle, and the one Black Tern embryo was not inconsistent.

Changes in color of the muscle were apparent; it was thought that these were related to the infiltration of lymph. The lymph color first appeared in the anterior pair of segments, in some specimens, at the 8-gram stage of body weight. It is recognized that the color of lymph is variable, perhaps depending upon the source of the lymph, but in these studies whitish-yellow to yellow were the colors we associated with a supposed increased lymph content. This color was frequent in 10-gram specimens and consistently appeared in 12-gram embryos in which the color occasionally was found in the second pair of segments. All segments were lymph-colored by the 14-gram stage, and the infiltration in some individuals was sufficient to produce noticeable swelling. The infiltration and consequent swelling were frequent in specimens weighing 16 to 18 grams. At 19 grams and continuing through the pipping phase, the muscles of all embryos were filled with lymph.

In general, the development and regression of the lymph nodes, lying on either side of the pair of hatching muscles, followed the chronology of these muscles. The nodes were first visible as one or more granules on either side; by the 10-gram stage the nodes had started to elongate. The elongation proceeded much more rapidly than the increase in width and reached its maximum just after hatching. These increases were in the order of 20 times for length and 2 times for width. After the second day, nodular length was sharply decreased, but width increased to as much as 4 times the width at the 6-gram stage. These lymph nodes were not found in a non-flying young (308 grams), out of the nest, or in two adults.

The measurements (Table 1) of these nodes do not give an accurate portrayal of the mass of the lymph tissue present or, of course, of the activity

TABLE 1
AVERAGE MEASUREMENTS (MM) OF LYMPH NODES OF FRANKLIN'S GULL[1]

Body Weight or Stage	Left Side	Right Side
less than 5.0 grams	one or two granules or absent	
6–7	1.5 × 1.7	1.7 × 0.5
7–8	1.9 × 1.5	1.4 × 1.6
8–9	1.5 × 0.7	1.7 × 1.7
9–10	2.3 × 1.0	2.0 × 0.7
10–11	4.3 × 1.7	3.7 × 1.9
11–12	6.5 × 2.2	5.2 × 2.7
12–13	5.8 × 1.8	4.6 × 2.8
13–14	6.8 × 1.8	5.5 × 2.8
15–16	10.4 × 2.8	7.2 × 3.1
16–17	10.0 × 2.7	7.5 × 2.8
18–19	9.3 × 3.3	8.3 × 3.3
19–20	9.0 × 2.0	8.5 × 2.5
early pip	29.8 × 2.1	27.5 × 2.3
just hatched	26.4 × 2.4	29.6 × 2.0
one day of age	29.6 × 2.2	26.6 × 2.0
two days of age	27.4 × 1.8	23.6 × 1.1
32 grams	2.0 × 2.0	7.0 × 3.0
45	4.0 × 2.0	few granules
76	16.3 × 4.1	12.6 × 1.1
77	4.1 × 4.3	6.2 × 3.1
84	2.7 × 3.3	6.4 × 5.4
90	12.3 × 7.7	12.1 × 5.2
117	10.6 × 7.3	12.0 × 3.6
308	not found	not found
adult	not found	not found

[1] Numbers of specimens may be obtained from Fig. 1.

of the nodes. They do give, however, a rough index. The difficulty is that the nodes in their early and late stages often consisted of scattered granules or separated lobes, and the measurements simply indicated the overall, maximum *area* occupied by these lobes or granules. From the 13-gram stage to the "pre-pip" stage (about 20 grams) the nodes were a fairly homogeneous, solid mass of tissue. During pipping this mass became differentiated as an elongated continuous string of beads. At hatching some beads were missing from the string and, by the second day after hatching, many beads were gone.

Some incidental observations on the lymph nodes included: (1) the node on the right was larger in 27 birds, while the left node was larger in 47 instances; and (2) no node was found on the right side in five birds and none on the left in four birds.

General miscellaneous observations included: (1) Franklin's Gulls hatched at 24 to 28 grams of body weight, Common Terns at 14 grams; (2) humidity was an important factor in hatchability in the gull—relative humidities of nearly 90 per cent seemed best; (3) only three of 110 gull eggs were infertile; and (4) there was an obviously increased fragility of the shell as hatching approached.

DISCUSSION AND SUMMARY

The general conformation of the hatching muscle and its topographical relationships in Franklin's Gull are the same as in chickens and in North American grebes. It is a paired muscle of three (sometimes four) segments arising from the anterior part of the dorsal cervical region and inserting on the posterior dorsal part of the skull.

In the beginning the members of this pair of muscles are rather widely separated. Gradually, medial contact is established, anteriorly at first. The contact proceeds posteriorly until, just before hatching, the muscles are touching in nearly all their length. Slowly the contact decreases, beginning posteriorly, until in the adult only a portion of the inner edges of the members of the first pair of segments touch each other.

As in the other species, the muscle of the gull is largest just before pipping. However, there are species differences in the relative magnitude at this time: chick, 1.9 per cent of body weight; grebes, 0.7 per cent; and gull, 0.9 per cent. The close similarity between grebes and gulls may be related to similarities in structure, strength and moisture of the shell, as discussed by Fisher (1961). The decline in size of the muscle in the first two days after hatching is slight in grebes, from 0.6 per cent of body weight to 0.4 per cent in the gull, and from 1.9 to 1.0 per cent in the chick. The resurgence of the muscle prior to pipping, that is, the increase from the prenatal low, is nearly a fivefold increase in relative weight in the chick, three times in the gull, and less than twice in grebes.

Other manifestations accompanying the rapid development of weight of the muscle prior to hatching include increased lymph coloration of the muscle, which culminates in the muscle and surrounding tissues becoming lymph-filled. The muscle becomes turgid, so much so that the segments appear swollen and the raphae between segments appear as tight, constricting bands. Indeed, the raphae are virtually covered.

In the gull and chick, it is thought that the lymph comes from the lymph node lateral to each muscle. The development and the regression of the nodes parallel these features of the muscle. However, the nodes are much larger in the gull than in the chick, despite the lesser body weight of the gull. In grebes, at most only a few lymph granules are present in the above-described position. Any explanation for the rapid decrease in the size and the eventual disappearance of these nodes must await histological examination to ascertain their nature, and biochemical studies to determine the materials produced. It is possible that these nodes are of mixed function.

ACKNOWLEDGMENTS

Sincere thanks go to my wife, Mildred, and to my son, James, for considerable aid in the collecting of eggs and birds and in making measurements in the laboratory. I wish to express my appreciation to Mr. Albert Hochbaum, Director, Delta Waterfowl Research Station, for the use of the facilities there, and to the Graduate School of Southern Illinois University and to the Wildlife Management Institute for funds.

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DEPARTMENT OF ZOOLOGY, SOUTHERN ILLINOIS UNIVERSITY, CARBONDALE, ILLINOIS. 20 JANUARY 1961

NEW LIFE MEMBER

Harriet Bergtold Woolfenden, of Ipperwash Beach, Forest, Ontario, Canada (formerly of Dearborn, Michigan), an active member of the Society since 1951, has now become a new Life Member. Mrs. Woolfenden, a graduate of Smith College, is very active in the Detroit and Michigan Audubon Societies, having been a member of both boards of directors. She is a member also of the AOU, Wilderness Society, National Parks Association, and the Federation of Ontario Naturalists. Her four privately printed books of poetry contain "nothing ornithological," but her chief interest is field bird study and the sharing of her experiences with others; and her poems reflect a keen awareness of natural phenomena and a compatibility with them.

NOTEWORTHY RECORDS OF BIRDS FROM THE REPUBLIC OF MEXICO

Max C. Thompson

Since 1882, when the University of Kansas Museum of Natural History received from George F. Gaumer a collection of birds taken in Yucatán, many additional specimens and written records in the journals of the collectors, providing new records of occurrence of Mexican birds, have accumulated in the museum. I wish to place on record some of these interesting occurrences.

The nomenclature used here is that of Friedmann, Griscom, and Moore (1950), and Miller et al. (1957), except where noted otherwise. Dr. Richard F. Johnston identified some of the specimens and critically read the manuscript. Prof. E. R. Hall also read the manuscript and made many helpful suggestions. Herbert G. Deignan and Thomas D. Burleigh kindly examined some of the specimens, and Emil K. Urban brought certain unreported specimens to my attention.

Catalogue numbers refer to The University of Kansas Museum of Natural History. Specimens and sight records that provide first occurrences in Mexican states are indicated by an asterisk (*).

******Mycterica americana.* Wood Ibis. ♀ (skel.) 30867. Laguna Rusias, 6,000 feet, San Luis Potosí, 10 August 1951 (Richard R. Graber).

**Cairina moschata.* Muscovy Duck. Sex ? (head, wing, tarsus saved) 28524. 5 miles S Purificación, Jalisco, 20 May 1949 (J. R. Alcorn).

**Coragyps atratus.* Black Vulture. ♂ (skel.) 36009. 1 mile SE Puerto Madera, Chiapas, 21 July 1955 (J. R. Alcorn). I also saw this species many times in Puebla along the road from Puebla to Orizaba in November and December 1959.

**Accipiter striatus velox.* Sharp-shinned Hawk. ♂ 4418, ♂ 4419. Cozumel Island, Quintana Roo (G. F. Gaumer). These specimens are both immature birds.

**Buteo albicaudatus hypospodius.* White-tailed Hawk. ♀ 29667, ♀ (skel.) 29668. 21 miles SW Guadalajara, Jalisco, 23 April 1950 (J. R. Alcorn).

**Buteo albonotatus.* Zone-tailed Hawk. ♂ (skel.) 30868. 10 miles E Paso del Carmen, 6,600 feet, San Luis Potosí, 16 August 1951 (Richard R. Graber).

Callipepla squamata squamata. Scaled Quail. ♀ 31598, 28 January 1954; ♀ 31599, 29 January 1954, 8 miles S Majoma, 7,700 feet, Zacatecas. Collected from a creosote-yucca-shrub association along a grassy savannah. This species has been reported previously from Zacateeas by Webster and Orr (1952:310).

Philortyx fasciatus. Barred Quail. ♂ 28250, ♂ 28251, ♀ 28252. 2.5 miles NNE Autlán, 3,000 feet, Jalisco. ♂ 29431, ♂ 29434, ♂29435, ♀ 29432, ♀ 29433. 5 miles S and 1 mile W Pihuamo, Jalisco, 20 March 1950 (J. R. Alcorn). This species has been previously reported from Autlán, Jalisco, by Zimmerman and Harry (1951:305).

**Limosa fedoa.* Marbled Godwit. ♀ 38042. San Blas, Nayarit, 10 December 1959 (Max C. Thompson).

**Capella gallinago.* Wilson Snipe. I observed two individuals at a marsh 1 mile E San Blas, Nayarit, 10 December 1959. No specimen.

**Larus delawarensis.* Ring-billed Gull. I observed this bird several times at San Blas, Nayarit, from 8–11 December 1959. No specimen.

**Hydroprogne caspia.* Caspian Tern. ♀ (skel.) 38045. San Blas, Nayarit, 11 December 1959 (Max. C. Thompson).

**Pionopsitta haematotis haematotis.* Red-eared Parrot. ♀ 32645, ♀ 32646. 2 miles S Tollocita, Oaxaca, 20 July 1955 (R. W. Dickerman). ♂ 38079, ♂ 38080. Vista Hermosa, 5,200 feet, Oaxaca (97 km W Ciudad Aleman, Veracruz) 3 December 1959 (R. F. Johnston). The first two specimens were collected in a rain forest association. Johnston's specimens were taken in dense cloud forest from two groups of parrots, each of about six birds, seen intermittently through the day. Blake (1953:196) states that Red-eared Parrots occur in tropical lowlands, but apparently they move also to higher slopes in the post-breeding season.

**Coccyzus americanus americanus.* Yellow-billed Cuckoo. ♀ 29988. 10 miles NE San Luis Potosí, 6,000 feet, San Luis Potosí, 28 July 1950 (J. R. Alcorn). This species has been previously reported from the State by Friedmann et al. (1950:132). Their record refers to the species only. ♀ 31435. 1 mile NNE Acatlán, Puebla, 15 August 1954 (R. W. Dickerman). This also is a new state record.

**Coccyzus minor continentalis.* Mangrove Cuckoo. ♀ 35067. Cantemo, Tabasco, 9 May 1955 (R. W. Dickerman).

**Crotophaga sulcirostris sulcirostris.* Groove-billed Ani. ♀ 31436. 8 miles NE Durango, Durango, 3 June 1954 (R. W. Dickerman). The specimen was taken in a willow-mesquite association bordering a partially dry river.

Dromococcyx phasianellus rufigularis. Pheasant-Cuckoo. Sex ? 2281, 2282, 2283. Yucatán (G. F. Gaumer). These three are mentioned only because of the scarcity of known specimens (Paynter, 1955:132).

**Otus barbarus.* Bearded Screech Owl (Ridgway, 1914:723). ♀ 35072. 8 miles E San Cristobal de las Casas, Chiapas, 3 March 1955 (R. W. Dickerman). The ovary was enlarged and the oviduct evident, which indicate that this owl may breed in Chiapas. This species has been known previously only from the mountains of Guatemala.

**Ciccaba virgata centralis.* Squamulated Owl. Sex ? (both downy young) 35076, 35079. 5 miles SW Teapa, Tabasco, 24 May 1955 (R. W. Dickerman). ♂ 35077. Macuspana, Tabasco, 3 May 1955 (R. W. Dickerman).

**Caprimulgus ridgwayi ridgwayi.* Ridgway Whip-poor-will. ♀ 31448. 1.5 miles W Tehuitzingo, 3,570 feet, Puebla, 15 August 1954 (R. W. Dickerman).

**Caprimulgus vociferus chiapensis.* Whip-poor-will. ♀ 28537. 12 miles W Ciudad Hidalgo, 9,150 feet, Michoacán, 28 April 1949 (R. W. Dickerman).

**Stellula calliope calliope.* Calliope Hummingbird. ♀ 35445. 2 miles S and 8 miles W San Francisco, Chihuahua, 28 June 1957 (P. Ogilvie). The largest ovum was 1 mm.

**Euptilotis neoxenus.* Eared Trogon. ♂ 28274. La Barranca de Agua, 9,200 feet, 19 miles S and 8 miles W Guadalajara, Jalisco, 14 February 1949 (J. R. Alcorn).

**Ramphastos sulfuratus.* Keel-billed Toucan. ♂ (skel.) 30893. Rancho Sabinal, San Luis Potosí, 16 November 1951 (Richard R. Graber).

Dryocopus lineatus similis. Tropical Pilcated Woodpecker. ♂ 2126, ♀ 2128. Cozumel Island, Quintana Roo (G. F. Gaumer). This is the first known record for Cozumel Island.

Cotinga amabilis. Lovely Cotinga. ♀ 32714. 2 miles S Tollocita, Oaxaca, 20 July 1955 (R. W. Dickerman). There is one previous record for Oaxaca listed by Miller et al. (1957:59).

**Schiffornis turdinus verae-pacis.* Thrush-like Manakin. ♂ 32720. 2 miles S Tollocita, Oaxaca, 19 July 1955 (J. W. Hardy).

**Muscivora tyrannus*. Fork-tailed Flycatcher. Sex ? 5099. Yucatán (G. F. Gaumer).

Megarhynchus pitangua caniceps. Boat-billed Flycatcher. ♀ 28562, ♀ 28563. 5 miles S Purificación, Jalisco, 20 May 1949 (J. R. Alcorn). These specimens are the third and fourth known skins of this subspecies. Comparison with the type specimen of *caniceps* in the United States National Museum suggests that the two specimens from 5 miles S Purificación are intergrades between *M. p. caniceps* and *M. p. mexicanus*.

**Tyrannus verticalis*. Western Kingbird. Sex ? 5003. Yucatán (G. F. Gaumer).

**Contopus sordidulus amplus*. Western Wood Pewee. ♂ 32743. 6.5 miles SW Izúcar de Matamoros, Puebla, 14 July 1955 (S. G. Van Hoose). This specimen was identified by Thomas D. Burleigh and his proposed nomenclature is used (1960).

Empidonax traillii brewsteri. Traill Flycatcher. ♂ 32749. 1 mile S and ½ mile W La Casita, 3,800 feet, Sonora, 17 June 1955 (J. W. Hardy). Blake (1953:353) mentions that this species breeds in northwestern México, but cites no records. Miller et al. (1957: 87) state that this species has been "erroneously reported as breeding in Sonora." This specimen, taken in cottonwood-willow vegetation, had testes (8 × 4 mm) of breeding size. This species nests in southern Arizona; the present record is not particularly surprising.

**Todirostrum cinereum finitimum*. Common Tody-Flycatcher. Sex ? 2078. Yucatán (G. F. Gaumer).

**Camptostoma imberbe imberbe*. Beardless Flycatcher. Sex ? 28306. 3 miles ENE Santa Cruz de los Flores, Jalisco, 31 January 1949 (J. R. Alcorn).

**Stelgidopteryx ruficollis serripennis*. Rough-winged Swallow. ♂ 28583. 27 miles S and 12 miles W Guadalajara, Jalisco, 29 April 1949 (J. R. Alcorn).

**Tachycineta thalassina lepida*. Violet-green Swallow. ♂ 1914. Port of Silam (= Dzilam Puerto), Yucatán (G. F. Gaumer).

**Calocitta formosa formosa*. Magpie-Jay. ♀ 28586. 5 miles S Purificación, Jalisco, 20 May 1949 (J. R. Alcorn).

**Psaltriparus melanotis iulus*. Black-eared Bush-tit. ♂ 36124, ♀ 36125. Miquihuana, 6,700 feet, Tamaulipas, 19 July 1953 (G. R. Heinrich).

**Cistothorus platensis tinnulus*. Sedge wren. ♂ 31478, ♂ 31479, ♀ 31480. 1.5 miles S Valle de Bravo, 6,050 feet, México, 25 July 1954 (R. W. Dickerman).

**Cistothorus platensis elegans*. Sedge Wren. ♂ 35179, ♂ 35180, ♀ 35181, ♀ 35182, ♂ 35183. 3 miles E Macuspana, Tabasco, 3 May 1955 (R. W. Dickerman).

**Melanotis caerulescens caerulescens*. Blue Mockingbird. ♀ 31615. 7 miles S Aramberri, 3,800 feet, Nuevo León, 22 February 1954 (R. W. Dickerman).

**Toxostoma dorsale dorsale*. Crissal Thrasher. ♂ 32837. Hda. Atotonilico, 6,680 feet, Durango, 1 July 1955 (S. G. Van Hoose).

**Turdus grayi*. Clay-colored Robin. ♀ (skel.) 36015. 3 miles WSW Mazamitla, Jalisco, 16 June 1955 (J. R. Alcorn).

**Hylocichla minima minima*. Gray-cheeked Thrush. ♀ 35201. 10 miles E and 19 miles N Macuspana, Tabasco, 5 May 1955 (R. W. Dickerman).

**Catharus mexicanus*. Black-headed Nightingale-thrush. ♂ (skel.) 30947. 6 miles W Ahuacatlan, 6,000 feet, San Luis Potosí, 2 August 1951 (Richard R. Graber).

**Cyclarhis gujanensis*. Pepper-shrike. ♂ (skel.) 35215. Cantemo, Tabasco, 9 May 1955 (R. W. Dickerman).

**Vermivora celata orestera*. Orange-crowned Warbler. Sex ? 1762. Yucatán (G. F. Gaumer).

**Vermivora ruficapilla ruficapilla*. Nashville Warbler. ♂ 1763. Yucatán (G. F. Gaumer).

***Dendroica petechia sonorana.* Yellow Warbler. ♂ 29451. 2 miles N Ciudad Guzman, 5,000 feet, Jalisco, 9 February 1950 (J. R. Alcorn).

***Dendroica discolor discolor.* Prairie Warbler. ♀ 37905. 1 mile NW Ojinaga, 2,400 feet, Chihuahua, 20 June 1959 (C. E. Nelson).

***Seiurus noveboracensis noveboracensis.* Northern Water-thrush. Sex ? 1799. Yucatán (G. F. Gaumer).

***Wilsonia pusilla pileolata.* Pileolated Warbler. ♂ 1815, ♂ 1816, ♀ 1817, ♀ 1818. Yucatán (G. F. Gaumer).

***Icterus galbula.* Baltimore Oriole. ♂ 1558. Yucatán (G. F. Gaumer).

***Gymnostinops montezuma.* Montezuma Oropendola. ♂ 1314. Yucatán (G. F. Gaumer).

***Piranga ludoviciana.* Western Tanager. ♂ 1748, ♀ 1747. Yucatán (G. F. Gaumer).

***Pheucticus melanocephalus melanocephalus.* Black-headed Grosbeak. ♂ 1113, ♀ 1116. Yucatán (G. F. Gaumer).

***Aimophila petenica petenica.* Petén Sparrow. ♂ 35318. 3 miles E Macuspana, Tabasco, 3 May 1955 (R. W. Dickerman).

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WHY DO BIRDS SING?

Olaus J. Murie

The concept of territory and the defense of territory in the nesting cycle of birds is of course well established. The concept itself hardly needs defense. Moreover, it need not apply exclusively to birds. It may be traced throughout some other animal groups, and perhaps has reached its most complex development in man, particularly on the interspecific basis.

Together with the development of our understanding of territory has emerged a rather well-recognized interpretation of bird song, as proclaiming, or defending, territory. This interpretation has become so well fixed in our literature that writers on specific bird studies refer to bird song as proclaiming or defending territory as a matter of course. I have heard popular writers and lecturers explain bird song to laymen in the terms of our newfound understanding of such things, carefully explaining that bird song is not an expression of happiness, but only means: "This is mine! You keep out of here! If you dare to come into my territory . . . ."

I would not attempt to argue that bird song is not involved in the bird's concept of territory. But, are we not oversimplifying this matter? We are trying to interpret actions, not simply gathering scientific facts, and we have to guess. As scientists, we are extremely timid about assigning to other animals any of the mental or psychological traits of man. One would think that the scientist is the perfect fundamentalist, carefully maintaining a wall between man and other animals.

This wall, however, is breaking down somewhat. We are finding that other animals share to a recognizable degree some characteristics of human behavior that we were unwilling to acknowledge at one time, and conversely that many behavior patterns of man have an "instinctual" basis, if we may use the term loosely here, similar to those of the other animals.

Here are two instances that come to mind to illustrate this. Some road work was going on and I had to wait for the go-ahead signal. The employee giving the signal was sitting by the road. He picked up a pebble on one side, tossed it over to the other side. Another pebble, and another, while he was gazing at the road work. Scientifically we could not assign any purpose or use in the tossing of these pebbles.

One day on the tide flats of Bering Sea I was approaching the nest of a Snowy Owl. Both parents were disturbed by my approach. They flew about, landing on the ground in various places, calling anxiously. Once the male happened to land beside the female, and hopped on her in a breeding attitude, momentarily.

In the case of the road employee and the Snowy Owl we could not assign any conscious purpose to their actions; I would say that they were instinctual, a response to some stimulus that neither was aware of.

We must realize that the interpretation of animal action is not easy—much harder than simply recording observations. We have to use our imagination, properly. We must see our problem whole.

In 1892, in "The Grammar of Science," Karl Pearson discusses science and the imagination. He says: "There is an element in our being which is not satisfied by the formal processes of reasoning; it is the imaginative or aesthetic side, the side to which the poets and philosophers appeal, and one which science cannot, to be scientific, disregard."

We have seen that the imagination must not replace the reason in the deduction of relation and law from classified facts. But, nonetheless, disciplined imagination has been at the bottom of all great scientific discoveries.

> In "Evolution: The Modern Synthesis," Huxley says:
>
> "Undoubtedly true song has important functions, notably as territorial threat and advertiscment (Huxley 1938 c). But given the complex emotional make-up of song birds, song is uttered in many circumstances where it has other functions, produced 'for its own sake.' The sedge warbler (*Acrocephalus schoenobaenus*) will sing as an expression of anger. Many birds sing as an expression of general well-being, the autumn recrudescence of song in many species would seem to be due to this and to have no function."

Why do many birds sing during specific periods in the morning or evening, or both? Does the territory require proclamation or defense by song only then? As I have listened to bird song over a period of many years, and the trilling of frogs, fiddling of insects, howling, bugling, and roaring of mammals, I have tried hard to reach an understanding of the stimulation for such efforts. I have recollections as a boy in Minnesota that bird song in the spring became much more noticeable after a light shower of rain, when the air was bracing. I have noticed in later years that when I have listened to the early morning singing of a Robin, for example, the atmosphere was such that I too felt stimulated. Evenings have an influence on the human animal, of which the individual can be very conscious if he gives attention to it. People also are stirred especially to song or whistling or similar manifestations under certain meteorological conditions. Noonday is the least inspiring time for man or any others.

In the woods about our home we have a considerable Ruffed Grouse population. Within a radius of a few hundred yards of our house six or more drum regularly in the spring. In the fall, when the languid air of summer is past and the bracing nights have come again, the grouse begin to drum again, and I have heard them as late as 5 December.

Here in the lower part of the mountains a moonlit autumn night can become highly vocal—with constant bugling of elk, singing of coyotes, and hooting of Great Horned Owls. I would not overlook moonlight itself as a stimulant.

We know that birds will sing in migration. They will sing in flocks. At one of our camps in the Fiordlands of New Zealand, in the month of April (when winter was approaching) several bell birds remained about our tents feeding on berries of *Caprosma*, and several were singing every day. There was no hint of rivalry that we could see, no obvious question of territory.

One day, on a tramp in the native forest out from Wellington, I was discussing this with Dr. R. A. Falla, Director of New Zealand's Dominion Museum. As we were speaking a flock of small birds appeared in the trees overhead, singing. My recollection is that they were white-eyes, though I did not make written record of it. Those birds constituted a roving flock, presumably a social group with no present obsession about individual territory, and they were singing.

I believe it is a mistake to establish interpretation of specific behavior in one group without seriously considering other groups. Song is universal. We speak of the "howling" of wolves and coyotes. That is merely a human designation, which does not necessarily speak for what it means to the coyote. If we believe in evolution, we must be aware of the general trend in forms of life to get pleasure from what the physiological senses can produce. Producing sound is one of them—certain aspects of which we call music. But it had its evolutionary roots somewhere, and we are overlooking something important if we do not trace our own reactions back to other animals.

Perhaps it is well to explain what I mean by song, especially bird song. We should have in mind that we are dealing with a human term, a human concept. We human beings have begun to combine poetry with music, to put words into song, a complication which birds do not have. Often I cannot interpret the words when I hear a good human song and I have sometimes only listened to the sounds produced, the rhythms, the transitions from low to high notes. I think I have enjoyed in a fundamental way the sounds produced, their variations and relationships. It is this I have in mind when I speak of bird song, the enjoyment of a sound as an end in itself. Sometimes when I hear two Great Horned Owls hooting at night, one in a low tone, the other in a higher tone, back and forth, one after the other, for a long time, I wonder: are they saying something to each other, and what could they be repeating over and over again? Is it not more logical, more scientific, to assume that they like to hear each other's voices, to use a human term, a kind of duet?

It is true, many birds have certain calls, that may be interpreted vaguely as the forerunner of language, as we know it. But I have in mind, as song, the sounds produced by an impulse to produce sounds, merely because they like to do it.

I have not worked with amphibians enough to speak authoritatively on their motivation, but it seems to me we should give more attention to the piping chorus of frogs in spring. And insects "sing" in the more universal sense. Do they too proclaim territory? When a grasshopper flies off in more or less aimless fashion, it will produce a *tic-tac* sort of sound. How are we to interpret that? Is it possible that such creatures have a certain pleasure in producing sound, music in human terminology?

I have listened to coyotes carefully. They will "sing" at various times throughout the year, including the winter. Captive coyotes can be stimulated to sing by a loud whistle, or by a high-pitched voice, or by the playing of a piano. Some dogs are stimulated the same way. Occasionally by giving the coyote howl in the mountains I have had a response from an unseen coyote that happened to be near. In an Alaska village one husky dog howling would set off a chorus of howling among the many dogs in the village.

The bugling of elk is popularly supposed to be a challenge to possible rivals, a form of "territorialism" in its broad sense. I do not discount the element of challenge. Certainly, in the height of the rut, the bull elk is in a challenging mood. But at the beginning of the rutting season several bulls may be seen together and bugling may take place without any overt move toward any of them. Furthermore, in the height of the rut, a lone bull may be found, obviously seeking a harem. He has none to defend. He is listening, looking, moving through the woods in the hope of finding cows, giving expression of his strong feelings by bugling at intervals.

Of course there is rivalry. Particularly in the case of a bull in possession, with consequent psychological advantage, the bugle may have an element of challenge. But as I have watched them at close range, I have been impressed with the probability that the animal is primarily giving expression to his tremendous pent-up energy, combining many psychological impulses—such as eagerness, a sense of dominance, elation over possession, challenge perhaps, and a plain urge to give voice to his feelings.

The lone bull would not have the elation of possession, or sense of dominance, yet he bugles vigorously. In his case, if we grant these multiple impulses—their individual values must be different, and probably his dominant urges are an intense eagerness and sexual hunger.

Furthermore, I have seen and heard cow elk bugling in the spring, a lesser version of the loud bull bugle. This was at the near approach of the fawning season. Does some form of the sexual complex have something to do with bugling?

Mammals probably have somewhat greater facility of expression than birds.

But I have had the same impressions from bird song. I cannot help feeling that the bird is responsive to climatic influences—perhaps temperature, relative humidity, degree and kind of light—as well as the excitement of the sexual urge, elation of possession or hunger for possession, and probably a degree of defiance. If we grant the psychological turmoil of the breeding season, we must grant a more complex origin of song than the simple proclaiming of territory. Perhaps many would interpret the autumn drumming of the Ruffed Grouse as simply a wistful recollection of spring territory. But I believe we are overlooking important elements if we neglect to give attention to the stimuli of autumn as well.

In a number of recent ornithological articles the authors have found it necessary to allocate some bird song types to other motives than territory. In much of the literature too there are recorded numerous observations that are suggestive. When I first thought of presenting my views on this subject I had planned to document my remarks fully from the literature, but that would be voluminous. My purpose here, then, is merely to make suggestions, largely to suggest a new approach.

I would urge the validity of drawing upon human experience in the interpretation of bird song. This sentence by itself can be shocking to the scientist and misleading. What I mean is this. Science should recognize the common origin of animal life. Science does recognize some reactions of man and other animals as similar. To be more specific, it appears silly to deny to other animals a sense of well-being, of satisfaction, enthusiasm—many of the fundamental reactions that we all share. Of course we must be extremely cautious in imputing to other animals the more specialized reactions of man, especially those resulting from his cultural experience. To say that a bird sings "in praise of his maker" may be logically assailed by the scientist, since it is a concept out of man's formalized organization of thought. But to say that a bird sings because it is happy may not be incorrect, if we will consent to use terms out of the vernacular, with their fundamental meanings. One difficulty is that we have observed so much anthropomorphic thinking on such matters that we have created an abhorrence of everyday language, and lean over too far backward so as not to be contaminated.

To pursue this a little further, we know that somewhere in the universe has arisen the fact of esthetics. This is a broad, very inclusive term. Many writers have done their best to define art, beauty, esthetics. At any rate we have a general notion of what it all is. It would be conceded that we receive our esthetic expressions through several of our senses. In our well-organized field of art we recognize music, painting, drawing, dancing. To some extent we might include taste.

Perhaps we should not consider it merely accidental that birds also react to stimuli of vision (certain colorful and elaborate display) and to hearing. And we would have to include other major animal groups. W. Craig in "The Song of the Wood Pewee *Myochanes virens* Linnaeus: a study of bird music" (*New York State Mus. Bull.* 334), made a notable study of the Wood Pewee and reports that this simple song reveals musical principle as we know it. We are not the only organisms which dance. When a Raven goes through his aerial evolutions I cannot believe that he does not enjoy the gliding sensations. I have seen a Golden Eagle mount steeply, dive, mount again, in several waves, one after another. The New Zealand Pigeon has a beautiful gliding dip and up-swoop that must give a definite satisfaction to the bird.

My thesis is that through our sensory apparatus we are in contact with the universe. We, as human beings, have learned to organize our impressions into various patterns, consciously, and more recently with inventive purpose. It would be unrealistic, and illogical, to assume that other animals do not derive somewhat similar satisfactions from their apparently deliberate experimentation in feeling out their environment. We are all apparently in the same life pattern—some more specialized in various directions—but with the same fundamental responses.

I suspect that bird song has a much deeper significance than advertising alone. I believe we are overlooking possibilities, and retarding the progress of science, if we close our minds and fail to see the picture whole, if we shrink from the task of probing the more intangible concepts that may be in bird song.

MOOSE, WYOMING, 21 NOVEMBER 1961

GENERAL NOTES

A Catbird helper at a House Wren nest.—Despite the thoroughness of the recent review of the subject of helpers by Skutch (1961. *Condor*, 63:198–226), it may be well to record the behavior of a Catbird (*Dumatella carolinensis*) that fed nestling House Wrens (*Troglodytes aëdon*) during the period of incubation of its own eggs. The location was Bloomington, Indiana.

Catbirds have been known to feed fledgling Cardinals (*Richmondena cardinalis*) (Brooks, 1922. *Bird-Lore*, 24:343–344) and a fledgling flicker (*Colaptes* sp.) (Hayward, 1937. *Wilson Bull.*, 49:47), while young House Wrens have been tended by an Eastern Bluebird (*Sialia sialis*) (Forbush, 1929. "Birds of Massachusetts and other New England states," 3:420–421). Nevertheless, the present case seems especially interesting in that an open-nesting bird brought food to nestlings in a cavity, behavior for which Skutch (loc. cit.) seems to have only one clear parallel. In the latter instance, an Eastern Phoebe (*Sayornis phoebe*), a bird which does sometimes nest in situations approximating cavities with large apertures, fed nestling Tree Swallows (*Iridoprocne bicolor*) in a bird house (Deck, 1945. *Nature Mag.*, 38:241–242, 272). Also of interest in the interspecific relationship reported herein is the disparity in sizes of the two species.

We are indebted to Mrs. Angela Beatty, who called the incident to our attention, permitted us to observe and photograph the birds from her windows (Figure), and generously supplied many of the following details.

On 12 June 1961, Mrs. Beatty noticed a Catbird alighting on a wren house suspended 10 feet above the ground on the support of an awning. Information we acquired later indicates that on this date the box contained nestling House Wrens a few days old and that the Catbird was a female just completing the laying of a set of four eggs in a nest about 5 feet away. Mrs. Beatty's efforts to frighten the Catbird from the box were unsuccessful, and the bird persisted in its interest until 14 June, when it became necessary to move the wren house to make way for painters and carpenters. In its new position on a porch railing, the box was 3 feet from, and at the height (6 feet) of, the Catbird's nest, which as yet was undiscovered by Mrs. Beatty. At about this time Mrs. Beatty first noticed that the Catbird was feeding the young wrens. Although the adult wrens gave no noticeable signs of anxiety, Mrs. Beatty tried repeatedly to scare away the Catbird. She was unsuccessful; indeed, its feeding visits seemed as frequent as those of the wrens.

When we first watched the wren house, for nearly an hour on 15 June, the Catbird was still bringing food, on an average of about once every 10 minutes. It was often accompanied by a noticeably larger Catbird whose size (Forbush, op. cit., 3:322) and frequent song led us to believe that it was a male and therefore that the food-carrying bird was a female. At all times, whether with or without food, the smaller bird engaged in nearly constant fluttering of its half-drooping wings, in this respect resembling a fledgling begging for food. When a parent wren arrived with food and found the helper at the nest box, the wren perched quietly several yards away until the larger bird left. Once the Catbird brought food while an adult wren was in the box, and we believe that we saw the item transferred to the adult rather than fed directly to a nestling. Later that day Mrs. Beatty saw the Catbird jerk its head from the hole of the wren house as though it had been pecked by an adult wren.

By 17 June, the Catbird's visits with food had become much less frequent; e. g., we saw four trips in 150 minutes, beginning at noon. It was at this time that we discovered the Catbird nest, in an ornamental bush so impenetrable that we could not see into it in order to correlate the Catbird's attentive periods on its own eggs with its visits to the wren box. Twice, however, when we pulled the branches aside the Catbird was incubating, and the evidence suggested that it was now spending most of its time on its own nest and carrying food to the wrens as it returned at the end of inattentive periods. There were two other developments of 16 and 17 June: Both Catbirds now sometimes chased the wrens when they met them; and the nestling wrens did not always accept the items brought by the Catbird, which then usually left with the food after 30 to 60 seconds at the wren house. Wing-quivering continued to mark the smaller Catbird's behavior, and at times it or its supposed mate called *chuck* in the immediate vicinity of the wren house.

A few days later, Mrs. Beatty found the wren house on the ground below the railing, and when she attempted to hang it in a new position the young wrens left it. The noise of the departure of the wrens brought a Catbird to the scene, but no attentiveness to the fledglings was noticed. Shortly after this, the Catbird eggs hatched, and the young ultimately left the nest.—VAL NOLAN, JR., *Indiana University, and* RAYMOND SCHNEIDER, *2805 Headley Road, Bloomington, Indiana, 21 December 1961.*

Meadowlark killed by electric fence.—In early September 1955, near Waterman, DeKalb County, Illinois, I discovered an Eastern Meadowlark (*Sturnella magna*) hanging by one foot from the corner of a fence row. The dead bird was suspended from a brace wire running from the top of the corner post to the ground at the next post. About two inches from this wire was a fence wire carrying a pulsating six-volt shock alternated with a twelve-volt shock every sixth time. The extra strong sixth shock of this popularly named "weed burner" fence is for the purpose of burning off plants that would normally grow up around the fence and short it out. The bird was apparently shocked and killed when attempting to step from the grounded brace wire to the electric wire. The foot, by which the bird was hanging, was badly scorched and the mark of the wire was embedded in the flesh of the toes. The free-hanging foot was badly burned; two toes remained intact. The bird probably died instantly because when I moved it the attached foot fell free; had the bird struggled much it would certainly have fallen from the wire. —JAMES TATE, JR., *Northern Illinois University, DeKalb, Illinois, 16 October 1961.*

Wing length, body weight, and geography.—Rand (1961, *Wilson Bull.*, 73:46–56) has questioned the use of length as a reflection of body size in birds, and suggests that weights are more reliable. But unless a very large sample of weights is available misleading results will be obtained.

Baldwin and Kendeigh (1938. *Auk*, 55:416–467) analyzed a large series of weights of many passerine species and found striking variations which could be correlated with air temperature, time of day, and season. In addition, much individual variation was found. Recently, several authors have made similar analyses of various passerine species and genera and the same trends have been found. For instance, Kluijver (1952. *Ardea*, 40: 123–141) weighed 26 Great Tits (*Parus major*) in the evening preceding a cold winter night; the birds were kept until the following morning and during the night they lost nearly 10 per cent of their total body weight. A single Greater Redpoll (*Acanthis linaria*) showed diurnal variation of up to 15 per cent of its total body weight (Shaub, 1950. *Bird-Banding*, 21:105–111). Many other examples could be cited (see general summaries of the problem in Baldwin & Kendeigh, op. cit.; and Owen, 1954. *Ibis*, 96: 299–309). Variations in the weight of small birds are much greater than would be expected simply by the filling and emptying of the digestive tract. Hence, the use of body weight as an indicator of geographical trends in size is likely to give misleading results unless a large sample is available, and allowance is made for variation caused by season, time of day, and air temperature. Many of the differences presented by Rand (op. cit.) as being indicative of geographical variation in size are smaller than one might expect in a single bird in a restricted area.

Rand (ibid.) has rightly criticized the indiscriminant use of wing length as an indicator of size. But he omits discussion of the great variation among individuals of a population. Many of the wing lengths he gives are said to be from "standard taxonomic sources," and no mention is made of the size of the sample. Almost all the mean weights he gives are based upon very small samples. He does not give the standard deviations, and no estimate of the dispersion about the mean can be made. The standard deviation is a useful calculation to make. From it the variance and coefficient of variability can be found, and differences between populations can be more readily detected. It is not possible, for instance, to judge whether the differences in mean weight of various population of Downy Woodpeckers (*Dendrocopos pubescens*) given in Table 3 of Rand's papers are real or simply the effect of small samples. It would be nice to know this, since much of his criticism of the works of others depends upon these differences.—D. F. Owen, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan, 31 March 1961.*

A count of Bald Eagles summering along a shallow New England lake.—In view of the current concern over the spectacular decline in our eastern population of the Bald Eagle (*Haliaeetus leucocephalus*), the following observation seems worthy of record.

Several years ago I was told by a ranger who knew of my continuing survey of Appalachian eagles, that he had seen eagles regularly along the shores of a nearby lake. A hydroelectric project in the 1940's flooded a lowland stream running mostly through wilderness country. The resulting lake, irregular in outline, planimeters on my topographic map as some 25 square miles, and is bordered by roughly 90 miles of shore line most of which is of wilderness bogs, cut-over and burned-over forest lands, but with considerable forest along both the eastern and western sections. Stumps and snags line much of the shore and extend into the shallower bays.

On 13 July 1958, the ranger took me in his boat along some 30 miles of the shore line in the central, wilder section. We did not go into the western arms near a highway, where there are said to be no eagles, or into the deeper water eastern section which is also bordered by a road. We soon saw an eagle perched in a tall dead tree, and a mile away a second. Allowing for duplication of eagles recorded, I estimated that on our two-hour trip I had seen 14 eagles in 21 sightings, of which 10 were in adult plumage.

Three years later I repeated this count of eagles, but prepared with a map and a determination to try to make a systematic count. On 30 July 1961, the ranger took me on a boat trip lasting three hours and covering not only the central sections but also the eastern deeper water as well. During the trip of about 50 miles we passed approximately 60 miles of shore, but omitted the western half of a basin-like section on the north side because of poor visibility and many underwater stumps and logs, a section yielding four eagles in the 1958 count.

Each eagle sighted was marked on the map, and if it was flying or taking flight, an arrow was drawn to indicate both direction and extent of the observed flight. I estimated 23 eagles from the 29 sightings. Only two were not adults, of which one was a fresh-feathered juvenile and one an older sub-adult. Most of the eagles were seen singly, perched on trees or snags along the shore. In hot summer weather they seek out white pines where they must be searched for by looking for a white head or tail among the branches halfway up the tree. The ranger without binoculars spotted them on most occasions before I did with my 10× glasses. On one occasion there were two adults side by side in the dense pine foliage; the second was seen only when the first flew. At another spot, an adult and the juvenile were perched in a dead tree overlooking an old "burn." On two occasions there were four eagles flying ahead of the boat. Of the 23 seen, 13 were in the section censused in 1958, 5 more were along an adjoining shallow section, and the other 5 were scattered along 20 miles of the deeper lake.

I believe that the count must have included three-quarters of the eagles present, but this is not easily established. I think that most eagles are along the shore where they may be found by boat, and I also believe that some which do not fly are overlooked. Why the eagles come here is not certain. Dr. Joseph Howell told me last March that he had found that in Florida eagles liked shallow water, but not swamps. This is a new lake and, of course, the eagles are newly there. The fishing is not spectacular but sometimes good, according to the ranger. He had never seen the eagles feeding, nor did I, but we did count 11 Ospreys (*Pandion haliaetus*) in the same region, and two active nests. No eagle nest was seen, but I was reliably informed of a nest active within the last few years some distance below the dam and along a boggy section of the stream.

An older nest, now fallen, was located in the swamp woods of the small basin referred to above, in the 1940's. We looked for it in 1958 without finding any trace.

It is interesting to speculate upon the origin of this eagle population. Perhaps it is most likely that a substantial part are Florida eagles summering in the north as suggested by H. K. Job (1908. "The Sport of Bird Study") and confirmed by Broley (1947. *Wilson Bull.*, 59:3–20), but this remains a speculation until more data are obtained. A study of arrival and departure dates for this eagle concentration may shed some light upon this question. Deep lakes nearby do not have eagles, I have been assured both by fishermen and guides, and the concentration described above is certainly seldom found anywhere in the northern Appalachian region.—Walter R. Spofford, *State University of N. Y. Medical College, Syracuse, N.Y., 6 September 1961.*

Anting behavior of a Wood Thrush with a snail.—On 30 April 1961, in a wooded tract called Meeting of the Waters, owned by the University of North Carolina at Chapel Hill, I sat down on a foot-bridge at a small stream to watch and listen for warblers. A pair of Wood Thrushes (*Hylocichla mustelina*), foraging on the woodland floor only 30 feet away, were raking aside dead leaves with quick thrusts of their bills. As I watched, one of them seized an object in its bill and ran with it to the nearby woodland trail. There, on more solid ground, it began to hammer the object on the path in an obvious effort to break it. Through my binocular, I could see that the object was a snail, and a relatively large one. The glimpse I had of its flattened shell and spiral suggested that it belonged to *Polygyra*, a genus of land snails with which I am somewhat familiar, and which contains a large number of species.

Suddenly the Wood Thrush did an astonishing thing. Between moments of hammering the snail on the ground, it began in lightning-quick stabs to thrust the snail under its wings, along its flanks, and beneath its under tail coverts, just as a bird will do when anting. It dabbed the snail in its feathers a number of times before it finally broke the snail's shell into two parts and quickly bolted down the larger part, shell and all. Before I could move toward it to recover the remaining piece of shell, with a view to identifying the snail, the thrush ran to the smaller piece and swallowed it.

According to food-habits studies of birds (Junius Henderson, 1933. "The Practical Value of Birds," The Macmillan Company), all of our native thrushes, including the Robin (*Turdus migratorius*) and Varied Thrush (*Ixoreus naevius*), eat some snails. W. L. McAtee, former food-habits investigator with whom I discussed this experience, said that it is likely that many birds eat the shells of snails for their lime content, as well as the meat of the snail itself.

In a search of the literature, I could find no previous record of a bird anting with a snail, though the possibility of it may help to explain the transportation of snails by birds.—John K. Terres, *P.O. Box 571, Chapel Hill, North Carolina, 3 May 1961.*

A prolonged Starling fight.—On 23 May 1959, while in Spotswood, Middlesex County, New Jersey, I watched an unusually prolonged fight between two Starlings (*Sturnus vulgaris*). The encounter took place between 11:00 AM and 12:15 PM DST on a flat, tar-papered porch roof about 15 feet above the ground. The following is a résumé of notes taken while watching the combatants at a distance of 5 to 10 feet from a window overlooking the roof:

11:00—two Starlings (males, based on length of the hackles on the breast and darkness of the eye) have been rolling around and fighting for two minutes—clawing, biting, and grasping. They finally assume the pose shown in Fig. 1, at 11:02,

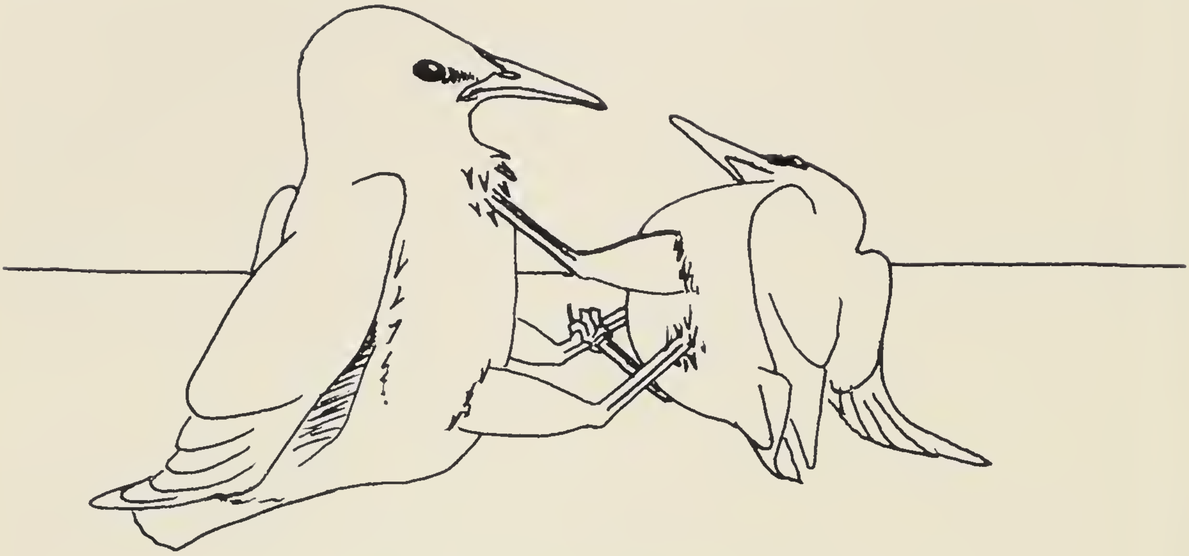

FIG. 1. Starlings locked in battle.

and remain essentially in this position until 11:35. During this time they remain motionless until one or the other renews its grip, and then a brief struggle ensues. During the initial stages of the fight, Starling *A* gave a few alarm notes and at 11:28, while renewing its grip spasmodically, twitched its wings, and gave elements of a song (especially noticeable was the "wolf whistle"). This is followed at 11:29 by sustained *sotto voce* singing.

11:30—both are doing quite a bit of jerking back and forth, but their position remains the same. Starling *B* is now wing-twitching a little.

11:34—*A* is doing quite a bit of backward jerking; *B* lies motionless.

11:35—position is changed and now both are lying on their sides. Both close eyes from time to time.

11:39—both still lying on sides, with *B* mostly lying on *A*; *A* is twitching his wings and *quirrt*ing.

11:42—both are now singing *sotto voce.*

11:45—another violent struggle—*A* is now grasping *B* by the bill and head, covering *B* with outspread wings and tail. They alternately struggle and become quiet, remaining locked in this position until 12:15.

12:00—both are now lying on their sides and each has the other by the head with one foot. Each has one or more claws caught in the membrane surrounding eye.

12:13—struggle again for two minutes.

12:15—one breaks away and flies off, followed shortly by the other, but not apparently in chase.

Kessel (1957. *Amer. Mid. Nat.*, 58:257–331), cites such fighting as a territorial dispute and it is obvious from her account that they are not uncommon; indeed, intraspecific contact fights are frequently reported for many other species. However, most of these described fights are of short duration, lasting from a few seconds to a few minutes. Prolonged fights (such as I described) apparently are not common. This is hardly surprising, since selection must be heavy against individuals engaging in intense, prolonged fights.

One other point which warrants further attention is the singing during the fighting—performed by both of the combatants. Song and various other vocalizations are an integral part of most passerines' breeding behavior, perhaps serving in part to prevent physical contact between competing males. Since this is apparently also true of the Starling (Kessel, op. cit.), further explanation is needed for the above observation.

As defined by Van Tyne and Berger (1959. "Fundamentals of Ornithology"), primary song is the term given to the full-voiced utterings of a bird that serve to attract a mate, or warn away competing males; the secondary song is low and inward, inaudible beyond a few yards, and has no territorial significance. It was this latter "whispering" song that was rendered by both Starlings during the fight. However, this song occurred only during passive periods, not during the actual fighting—thus, it could be interpreted as another instance of "emotional song," given during the resting periods of an intense encounter. This explanation exceeds the terms of "emotional song" as given by Van Tyne and Berger (who include it as a type of primary song): ". . . a variety of songs that cannot be associated directly with securing a mate and defense of territory." But—it was a subsong, it did appear "emotional," and it was certainly, in the broadest sense, given in defense of territory.

I wish to thank Dr. Andrew J. Meyerriecks for his valued advice and assistance in the preparation of this manuscript.—James Baird, *Massachusetts Audubon Society, South Lincoln, Massachusetts, 27 April 1961.*

Dowitcher attacks Willet.—On 3 July 1961, at Beach Haven, N.J., a small group of shore birds were resting and feeding at high tide when I noticed that a Short-billed Dowitcher (*Limnodromus griseus*) had hold of the tarsus of a Willet (*Catoptrophorus semipalmatus*) with his bill. The Willet tried to escape by running on one leg and fluttering. The dowitcher kept bracing himself to hold back the Willet. The Willet dragged the dowitcher about 200 feet in about four minutes. Finally, after the Willet fell down the third time, the dowitcher released the foot and grabbed the Willet by the neck, holding on about three seconds before the Willet escaped and flew away. The original flock, including about 10 Willets and 30 dowitchers seemed unconcerned.—E. I. Stearns, *206 Lynn Lane, Westfield, N.J., 19 July 1961.*

An opossum-titmouse incident.—On the morning of 2 May 1961, while checking a grid of rodent livetraps at the south end of Lake Carl Blackwell, near Stillwater, Oklahoma, I noticed a pair of opossums (*Didelphis virginiana*). Startled by my presence, they at first remained still; but when I made no further movement they wandered off slowly in the dry oak leaves, amid poison ivy and coralberry. The female stopped and rooted something edible from beneath the leaves. The male followed and attempted to mate, but the female turned and bit him. Followed by the male, the female then climbed a 30–40-foot blackjack oak, to a horizontal limb some 25 feet from the ground. At the same time, I moved to a closer vantage point. Each time the male approached the female too closely, she repulsed him with mouth agape or with a quick sharp bite to the head or ear.

After observing this behavior for 45 minutes I saw a pair of Tufted Titmice (*Parus bicolor*) fly to the tree. Without much hesitation, the bird believed to be the female flew to the back of the male opossum and began plucking out hair. The opossum, at first somewhat startled, made various movements to chase the bird, which flew to a nearby branch, only to return for more hair. Each time the opossum moved she flew away, but soon returned to either the back, the rump, or the base of the tail to pull out more hairs. When the male opossum became too restless the bird flew to the back of the female for hair. After 15 or 20 trips to the back of either opossum, then to a branch and back to an opossum, she flew southeast with her bill full of grey hair. This was of such quantity, and so carried, that it gave the appearance of a handle-bar mustache.

The same titmouse made 15 trips to the tree where the opossums were and back to her nesting site. During this time she made some 225–300 landings on the back of one opossum or the other. Eventually, the opossums became almost passive, so that with less trouble and chirping than at first, the bird got its billful of hair. It was estimated that 75–100 pecks were required to gather the 100 or so hairs carried on each trip to the nest. Thus, in some 1,125–1,500 pecks, the titmouse gathered at least 1,500 hairs. During the half-hour following the fifteenth trip, she returned no more. The opossums had napped, scratched, licked their fur and moistened their feet (with their tongues) in order to "wash" their backs, necks, and ears, during the antics of the bird. When I left, the opossums had been in the tree two and three-quarter hours and the titmouse had pulled hairs, at intervals, for one and one-half hours. While the female titmouse gathered hair, the male sang, fed, and followed the female back and forth. Five times between hair-gathering trips the female stopped to feed, and on seven occasions was fed large caterpillars by the male. When being fed, the female fluttered her wings and twittered like a fledgling.

Bent (1946. *U.S. Nat. Mus. Bull.* 191:394–397) gives instances of titmice collecting hair from living animals, these animals being the red squirrel, woodchuck, and man. Other fibrous material found in various nests, along with vegetation and mud were: horse hair, pig bristles, cat fur, wool, cotton, fibrous bark, Spanish moss, snakeskins, and feathers.—John W. Goertz, *Oklahoma Cooperative Wildlife Research Unit, Oklahoma State University, Stillwater, Oklahoma. Contribution No. 333, Department of Zoology, Oklahoma State University, 8 May 1961.*

An unusual Brown Thrasher fatality.—On 16 April 1961, while conducting a field census in connection with certain fire ant investigations, I observed the following incident near Macon, Noxubee County, Mississippi.

In mid-morning, extremely strong and persistent winds were blowing from the northwest, and the temperature was in the low 60's. As I approached a farm pond (ca. 5 acres) from the northwest, a Brown Thrasher (*Toxostoma rufum*), came out of a patch of tall grass and flew to the levee which was devoid of vegetation other than short grass. In flight it was apparent that the bird was barely able to cope with the wind and considerable effort was required to maintain proper equilibrium.

A few minutes later, I climbed the levee and noted the thrasher still present some 60 yards away and that three pigs were approaching from the other side. As the pigs came near, the thrasher appeared to become frightened and flew down over the levee to the edge of the water, seemingly reluctant to fly into the wind. When the pigs reached a point opposite the bird, it flew out across the water, at a right angle to the wind and about 10 feet above the surface. After proceeding nearly 65 yards with obvious difficulty, the thrasher attempted to turn and return in the direction from which it had come. In so doing, the wind caught it, the bird lost equilibrium and plunged into the water. My first impulse was to attempt to rescue. However, the water was some 4 feet deep at the point of entry. As I observed with binoculars, the thrasher attempted several times to become airborne, but when its wings were lifted, the wind caught and forced them into an unusable position. After a minute or so the bird ceased to struggle and permitted its head to submerge. Later, the wind moved it to the center of the pond where the body became lodged in some aquatic vegetation.

The thrasher's short, broad wings and unusually great tail surface undoubtedly are well adapted for an existence requiring the intricacies of controlled flight in dense thickets and shrubs, the normal habitat of the species. The foregoing account appears to be an instance where an individual, caught in a marginal environment under unusual circumstances, found these same adaptations to be ill suited for the occasion.

It is interesting that three Blue-winged Teal (*Anas discors*) on the same pond refused to depart when disturbed, although they flew back and forth across the pond, again with some difficulty. Savannah Sparrows (*Passerculus sandwichensis*) and meadowlarks were noted to take refuge on the lee side of the levee away from the full force of the wind.—Denzel E. Ferguson, *Department of Zoology and Entomology, Mississippi State University, State College, Mississippi, 18 April 1961.*

Observations of birds feeding on overwintering corn borer.—During the annual spring corn borer survey for Delaware in early March 1959, entomologists at the University of Delaware found that many of the cornstalks examined had holes pecked in them. The holes, empty when examined, almost invariably opened into chambers once occupied by larvae of the European corn borer (*Pyrausta nubilalis*). Blackbirds were conspicuously numerous in cornfields at this time and were suspected of taking corn borers.

Being officially engaged in blackbird studies, I was particularly interested in these findings. Baker, Bradley, and Clark (1949. "Biological Control of the European Corn Borer in the United States." Tech. Bull. No. 983), list the following birds as being seen feeding on European corn borer:

Downy Woodpecker (*Dendrocopos pubescens*)
Robin (*Turdus migratorius*)
Common Crow (*Corvus brachyrhynchos*)
Rusty Blackbird (*Euphagus carolinus*)
Red-winged Blackbird (*Agelaius phoeniceus*)
Common Grackle (*Quiscalus quiscula*)
Black-capped Chickadee (*Parus atricapillus*)
Ring-necked Pheasant (*Phasianus colchicus*)
Starling (*Sturnus vulgaris*)

They credit particularly the Downy Woodpecker and the Red-winged Blackbird with having been frequently observed removing large numbers of corn borer larvae and eggs from specific fields.

During 1959 and 1960 I made numerous observations of all species of birds seen in cornfields within 50 miles of Newark, Delaware. Downy Woodpeckers were the only birds seen pecking holes in dead cornstalks and removing and eating the larvae found inside. In November 1959, at the University of Delaware, two stalks of corn containing corn borers were placed upright in a cage containing 15 Red-winged Blackbirds and several Common Grackles. The stalks were examined over a month later and showed no evidence of bird feeding. They were then cut open and four living European corn borer larvae were removed from one stalk and one from the other.—Don Fankhauser, *Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service, Laurel, Maryland, 16 June 1961.*

ORNITHOLOGICAL NEWS

The Forty-fourth Annual Meeting of the Wilson Ornithological Society will be held at the Charleston Museum, Charleston, South Carolina, from 2–5 May 1963.

The Wilson Ornithological Society now has a total of 1,556 members categorized as follows (with net gain or loss over last year):

Active	1,224	(–9)
Sustaining	141	(–3)
Life	187	(7)
Patron	4	(0)

In addition, the Society is filling 255 subscriptions to *The Wilson Bulletin*, and receives 86 publications in exchange for it.

The Frank M. Chapman Memorial Fund Committee of the American Museum of Natural History has awarded Dr. Douglas A. Lancaster of Northwestern State College of Louisiana a two-year, post-doctoral fellowship for research on tinamous. Beginning in August he will be in Argentina to study several grassland species.

On 2 April 1962, at the annual birthday celebration of the John Burroughs Association, in New York City, Dr. George Miksch Sutton was presented the John Burroughs Medal. This award is made for the previous year's foremost example of fine nature writing. Dr. Sutton received it for his book, "Iceland Summer."

Dr. John LeGay Brereton, New South Wales, Australia, is currently a Visiting Fellow at the Laboratory of Ornithology, Cornell University. With Dr. William C. Dilger he is doing research on population ecology, behavior, and evolution in parrots.

The Gromaco Foundation for Natural Science, affiliated with the University of Miami, is a field station for scientific investigation in southeastern Costa Rica. It is set in 1,000 square miles of virgin jungle reaching from lowlands to paramo—untouched floral and faunal associations under tropic, subtropic, and cloud forest conditions. Scientists and advanced students are welcome. Comfortable housing and meals are furnished at $3.00 per day.

No laboratory equipment is available yet except roomy workshops with tables, storage space, and heated drying closets for plant presses or faunal specimens. This is a non-profit organization established for the benefit of science and education. Inquiries are invited and should be addressed to: Rex R. Benson, Director, The Gromaco Foundation for Natural Science, Apartado 2752, San Jose, Costa Rica.

The Frank M. Chapman Memorial Fund of The American Museum of Natural History is administered by a committee which meets twice annually to review applications for grants and fellowships. Applications should be submitted not later than 15 February and 15 September. The Chapman Fund is intended to support and foster research in ornithology from a broad and international point of view. There are no restrictions as to the formal qualifications of applicants or the locality in which research is to be conducted. Detailed information and application forms may be obtained from the Museum at Central Park West at 79th Street, New York 24, New York.

Don Bleitz wants to obtain a "complete ornithological library." Anyone who believes that he can assist Mr. Bleitz should send information to him at 1001 N. McCadden Place, Los Angeles 38, California.

The National Science Foundation has appointed Dr. Walter Hendricks Hodge as Program Director for Systematic Biology in the Foundation's Division of Biological and Medical Sciences. Before coming to the Foundation, Dr. Hodge was Head of the Department of Education and Research of the Longwood Gardens, Kennett Square, Pa. At that time, he also served as special consultant to NSF for tropical biology.

Mr. J. C. Finlay of 6710-102 A Avenue, Edmonton, Alberta, Canada, is studying the Purple Martin (*Progne subis*) and its movements throughout the continent. He plans an extensive banding program this year and is interested in corresponding with others having a similar interest or having knowledge of any aspect of the biology of this species.

The Ring is an international, quarterly bulletin devoted mainly to bird banding and migration studies. It contains a comprehensive section on recent literature, and it has been adopted by the International Committee for Bird Banding as the medium of publication for all official recommendations and announcements of the Committee.

Editorial offices are at the Laboratory of Ornithology, Sienkiewicza 21, Wroclaw, Poland. *The Ring* may be obtained for $1.50 per year from European Publishers Representatives, Inc., Times Building, 1475 Broadway, New York 36, New York.

Dr. Philip S. Humphrey has been appointed Curator of Birds at the United States National Museum and will assume the position beginning 1 June 1962.

LETTER TO THE EDITOR

One or two comments about the article, "Kermadec Petrel in Pennsylvania" by Donald S. Heintzelman in the *Wilson Bulletin* for September 1961 seem in order. The observation upon which this article is based was discussed by Mr. Heintzelman and others in three numbers of the *Linnaean News-Letter* in 1959 and 1960. In the issue of that publication for January 1960, vol. 13, no. 7, Mr. Eugene Eisenmann listed a number of reasons why many will consider this record doubtful. He also pointed out that the only previous record of this South Pacific species in the Atlantic, a specimen reportedly picked up in England on April Fool's Day, 1908, has been rejected by Bannerman (1959. Birds of the British Isles, vol. 8, pp. 150–153).

Some observers who saw the bird at Hawk Mountain and subsequently examined both photographs and skins were not satisfied that the bird was *Pterodroma neglecta* and thought it more like *Pterodroma arminjoniana* of the Atlantic. Most of these considerations were known to Mr. Heintzelman who discussed Eisenmann's comments in the same issue of the *Linnaean News-Letter.* One would have expected some mention of them in the article thereafter submitted to the *Wilson Bulletin.*

Sincerely yours,
Dean Amadon

LETTER TO THE EDITOR

Mr. Ted T. Allen's "Notes on the Breeding Behavior of the Anhinga" (1961. *Wilson Bull.*, 73:115–124) elicits my comment with respect to certain aspects of the external features as well as of the behavior of breeding Anhingas which he either did not call attention to or, in some cases, noted that he did not observe. It is important that assumption not be made that these do not exist or may not occur. My comments are in no way intended as deprecative of Mr. Allen's interesting reporting.

In considering external features of breeding Anhingas, certain modifications were incompletely diagnosed. First, birds with yellow lores are, from my experience, those which have not yet reached the zenith of sexual development or have passed beyond it. Males and females which I have collected and those which I have observed during the breeding cycle developed lores uniform in color with the bluish bare skin about the eye. This uniformity of coloration develops shortly before actual pairing; it persists into early or middle stages of incubation. Courtship behavior, of course, may begin before the blue lores are attained (see beyond). Second, although mention is made of the female developing a black mark "beginning on the rictus and extending down into the gular sac," no mention is made of the entire gular area becoming black in both sexes at full-breeding. This is of significance during behavior characterized by presentation of the open mouth to the opposite bird. Such display, elements of which I describe beyond, may not have been entirely appreciated by the observer. Third, the female, as well as the male, develops light-colored feathers on the head and neck (see, e.g., Sharpe. 1898. *Cat. Birds Brit. Mus.*, 26:421) and erection of these also figures prominently in courtship. Fourth, in enumerating visual stimuli involved in courtship, no mention is made of the tail. After prenuptial molt the rectrices have a grayish-white terminal band which contrasts sharply with the remaining black portion of the feather. In post-breeding birds this band is largely, sometimes entirely lost through wear. Significance of the elevation and spreading of the tail during courtship behavior cannot be fully appreciated unless this pronounced color contrast is taken into consideration. It may be added that after the prenuptial molt the central pair of rectrices displays flutings or corrugations which are far more obvious than those of post-breeding birds in which the flutings are becoming shallower, those of the distal ends of the rectrices becoming so shallow as to be scarcely discernible. Owre (1959. Unpub. Ph.D. dissertation, Univ. Mich.: 121) points out that these flutings cause reflections of light which contrast with the black feather background and that such contrasts may also be functional in display (flutings of the scapulars no doubt have similar significance).

Allen found that Anhingas began concentrating at Lake Alice in late March and that pairing, which occurred "rather rapidly," was preceded by "rapid initiation of display behavior." One may assume that the main portion of this population must have been elsewhere prior to breeding. I have observed behavior of Anhingas in wintering assemblages that is of significance with respect to the sudden initiation of display noted in the Lake Alice birds. As winter progresses in south Florida, water levels in the Everglades and cypress swamps usually drop considerably. At these times Anhingas either move to the coastal mangrove swamps or concentrate about canals, cypress runs, ponds, etc., which afford sufficient water for fishing. Through the course of one winter I kept under regular observation a group of Anhingas gathered at a cypress run in Collier County. No birds eventually nested in that immediate area. Indications of awakening sexual interest were first seen in birds which began plucking at twigs and vegetation. Such were often carried about for a few seconds and then dropped. Later, cypress and willow branchlets, bare or foliated, clumps of epiphytic orchids, Spanish moss, etc., were seized and vigorously wrestled with, such efforts becoming increasingly persevering. Loose pieces might now be carried about for several minutes, juggled, and sometimes tossed into the air and caught, much as fish are prior to swallowing. At approximately this stage of behavior advances toward birds of the opposite sex became obvious. The male was usually the advancing bird, and he often carried with him, sometimes interrupting an advance to secure, twigs or branches. At first, advances were seemingly haphazard and rarely of long duration. As a bird drew near, the other would move away or fly, occasionally pausing to spar briefly with the advancer. Sparrings between two individuals became increasingly common. Sometimes birds moving along different levels of the large cypress boughs would spar vigorously at those of the opposite sex, the latter often being taken by surprise. With the increasing frequency of advances and sparrings, the usual *arr, arr, arr*-call quickened in tempo and became of greater range of scale, often stimulating a wave of calling by neighboring birds. As changes in the color of the bare skin of the head developed, the birds left the assemblage, those in advanced stage of color change apparently not remaining for any length of time. By mid-February the group had dwindled from an estimated 70 or more present in early January to only an occasional immature or obviously non-breeding bird. Thus it is clear that early courtship behavior does not necessarily begin at the actual nesting site. In fact, Meanley (1954. *Wilson Bull.*, 66:83) suggested that pairing might have occurred before some of the Anhingas reached the Swan Lake, Arkansas, colony upon which he reported.

Allen noted that "completed nests appeared to be lined copiously with leafy willow twigs which show against the rim," yet he failed to note that the Lake Alice breeding birds exhibited any particular ceremony or otherwise noteworthy behavior involved in nest-relief. Those breeding birds I have observed added fresh vegetation to the nest throughout the period of incubation. (Nests with only dried, brown leaves showing are thus easily recognized as in disuse.) Incubating birds may spend considerable time breaking off branches which are within reach of the sitting bird. Without shifting positions the birds place these about the inside and along the rim of the nest, always more or less anterior to the position of the bird's breast. I frequently observed Anhingas pause and break off foliated twigs from the nesting tree itself as they climbed toward the incubating partner. I have observed them carrying branches while they were in flight to the nest. Presentation of this material to the incubating bird figures prominently in ceremonies of greeting, copulation, and incubation-relief. A typical passage from my field notes is illustrative: "♂ surfaces under nest tree with a small branch in mouth; he dives and resurfaces with only aquatic plants. ♂ begins climbing upward in willow [to the nest five feet above]. As ♂ climbs, incubating ♀, neck arched, head pointed down, mandibles agape, and calling loudly and continuously, shakes her head vigorously from side to side. ♀ seizes material from mandibles of ♂ as his head reaches the nest rim. ♂ now, mandibles agape, head moving vigorously, calls loudly for several seconds. ♀ positions material into nest. ♂ hops to exposed limb three feet away and begins to sun." In this instance the male broke off a willow branch and presented it to the female when he relieved her of incubation some time later.

Allen's observations were made at a distance from the rookery and he was unable to detect vocalizations of the nesting adults. At nesting both sexes emit loud, excited calls which I have heard at no other season. These are exchanged as a bird approaches its incubating partner and during ceremonies at the nest. My notes describe the calls as squealing-raucus, rapidly uttered series of *chitter, chitter, chitter, chee, cheur, chitter, chitter*, often rising, then falling as they are uttered. Since these calls are so loud and characteristic and, since they are confined to the immediate vicinity of the nest, one can chart the directions from which the calls emanate over a period of time and gain a rather good idea of the number of nests in an area as well as the general location of them.

I have observed that these calls are accompanied by characteristic motions of the head. Allen reports that the female at pair formation opens her bill, vibrates her throat, and makes sweeping motions with her head. I have found it characteristic of birds at the nest that the head is drawn up and back, the neck arched, and the mouth opened, displaying its black interior as it is swayed about. As calling is terminated, the open mandibles may be thrust downward toward the nest, sometimes shoved repeatedly into the nest material itself. This I have observed in birds of both sexes.

Composition of soaring groups and the distances and positions from which these must be observed render it difficult, as Allen found, to attach sexual significance to soaring. (It is not unlikely, however, that the spread-winged attitudes of perched birds may afford important visual clues to flying birds during the period of courtship and nesting as well as at other seasons.) Allen noted no courtship behavior by birds in either soaring or, apparently, non-soaring flight. On 7 November 1953, I watched for approximately 20 minutes a male and female Anhinga in flight. During the first 15 minutes they were flying within approximately 100 feet of each other and moving, alternately flapping and gliding, in a wide circle approximately a mile in diameter. A strong wind was blowing and advantage was obviously being taken of obstruction currents rising from the irregular terrain. In unison they would ascend to possibly 400 feet in altitude, then glide back down to almost tree-top level. During the last few minutes they proceeded in a straight line along the road I was on, utilizing air currents rising from its embankments. The female kept the lead during much of this flight. Flapping vigorously, the male would overtake to a point usually directly below, sometimes directly above her. Both would then glide briefly, craning heads about as they appeared to gaze at each other. They continued in this manner for approximately a mile, the male finally circling apart. This may well have been a display flight (the early date notwithstanding since Anhingas are known to breed sparingly in south Florida in fall and winter). Although Bent (1922. *U.S. Nat. Mus. Bull.*, 121:230) speaks of Anhingas courting on the wing, the only actual description I know of in the literature is that of Audubon's (1838. *Ornith. Biog.* 4.).

I should point out that my comments are based upon observations made in south Florida, ecological factors of which differ from those at Lake Alice. Furthermore, my observations of breeding birds have been from relatively small groups of only Anhingas, not from the large assemblages of mixed species of which Allen reported.

Very truly yours,
Oscar T. Owre

ORNITHOLOGICAL LITERATURE

My Wilderness East to Katahdin. By William O. Douglas. Doubleday & Company, Garden City, New York, 1961: 6¼ × 9½ in., 190 pp., 16 line drawings by Francis Lee Jaques, end-paper maps. $4.95.

Mr. Justice Douglas of the United States Supreme Court is one of the few persons prominent in offical Washington who undertake personally to focus attention on conservation matters. This, his latest book, is an example of his personal effort to make us appreciate the nation's wealth of natural beauty and resources and at the same time to show how flagrantly we are despoiling our priceless heritage.

The chapters, 11 in all, are accounts of his visits to well-known wilderness areas, some preserved and others needing preservation, in the United States from Wyoming, Colorado, and Arizona eastward. His writing is lacking in verve and humor; his comments on natural history, though frequent and informative, are as dry as an encyclopedia's. But no one reading a chapter will fail to sense his sincerity and dedication. Seldom does he miss the opportunity to point out the plight of an animal species or the fate in store for a wilderness area unless stern measures are taken. The many fine drawings by Mr. Jaques are a great asset to the book, providing the eloquence which the text lacks.—Olin Sewall Pettingill, Jr.

Bird Doctor. By Katherine Tottenheim. Thomas Nelson and Sons, Ltd. Edinburgh, 1961. 5½ × 8¼ in., vi + 162 pp. 19 photos. $3.00 (from Thomas Nelson and Sons, New York).

Like many of us, the author of this little book acquired more or less accidentally the reputation of being the local "bird doctor" at her home in North Devon, and soon had a procession of injured and orphaned avian guests, from swans to swifts. Unlike many of us, she has made a lengthy and determined effort to develop satisfactory methods of caring for a variety of patients. She has put in writing here, in a thoroughly readable form, her trial-and-error experiences in attempting "to cure sometimes, to relieve often, to comfort always." By no means a complete handbook, "Bird Doctor" still contains a lot of helpful information, particularly about the care of injured and exhausted seabirds. We learn, for instance, that mishandling of waterbirds may interfere with feather buoyancy, that most deaths in captivity, of rescued, injured birds are from pneumonia, kidney degeneration, or heart disease, that feather shafts make the best splints, that gin is better than brandy for sick birds.

Mrs. Tottenheim is best known for her dedicated attempt to find ways of caring for victims of oil pollution and the common "wet-feather" problem of waterbirds in captivity. Some of her ideas, especially on bird behavior and its interpretation, may not have wide acceptance and she may, in a few cases, be accused of generalizing from too few examples. But her humor is delightful (the reader will find amusing her description of the problems with mice in the aviary, and her choice of names for pets—for example, Vermintrude for a House Sparrow). Her patience and ingenuity, and her efforts in the field of conservation, are completely admirable.

The book will be useful to all who must occasionally care for birds in captivity. It would be even more useful if the so-called "Index" had page references rather than being just an alphabetical list of the birds in the text, with scientific names.

It is somewhat revealing to read, in bald sentences, the conservation-minded British viewpoint with regard to the American spray program and the future of our wildlife.—Sally F. Hoyt.

THE CLOUD FOREST: A Chronicle of the South American Wilderness. By Peter Matthiessen. The Viking Press, New York, 1961: 5¾ × 8½ in., viii + 280 pp., 44 photos. by author, 2 maps in text and other maps on end papers. $6.50.

This is an adventure book of the highest order and certain to interest naturalists with South America in mind for one of their future expeditions. (Parts of the book were published in *The New Yorker.*) Himself a naturalist, Mr. Matthiessen writes with the expected attention to birds, other animals, flora, climate, human inhabitants of the hinterland, living conditions, transportation—matters other naturalists want to know about. But his work is by no means a guide to, or discourse on, South American natural history. It is, rather, a spirited account, frequently with day-to-day impressions and experiences in the present tense, of a 20,000-mile journey that includes a boat excursion up the Amazon, explorations in the high Peruvian Andes, and even a sampling of Patagonia and Tierra del Fuego.

The excellence of Mr. Matthiessen's pen was readily apparent in his "Wildlife in America" (see review in *The Wilson Bulletin*, vol. 73, p. 111, 1961), but the subject matter of "The Cloud Forest" permits a fuller range to his versatility as a writer. Young naturalists who aspire to publish their own experiences for popular enlightenment will do well to take a few pointers from this book, especially the brisk pace of the narrative, the clever method by which natural-history facts and observations are woven into the story, the easy style of writing, and the generous use of quiet, sometimes wry, humor. Mr. Matthiessen obivously enjoys people—all classes including primitive—and, while never speaking about them condecendingly, he is quick to show the lighter side of their peculiarities and foibles. As for storytelling, he has few peers. His descent made by raft through the gorge (Pongo de Mainique) of Peru's torrential Rio Urubamba is a masterpiece of description, comedy, and suspense.—OLIN SEWALL PETTINGILL, JR.

BIRDS IN MY INDIAN GARDEN. By Malcolm MacDonald. Alfred A. Knopf, New York, 1961: 9½ × 13 in., 192 pp., 98 photos. (1 col.). $11.45.

Mr. MacDonald wrote this book in 1959 while serving in India as High Commissioner for the United Kingdom. His "garden" consists of less than three acres of "lawns, flower-beds, vegetable patches, and shrubberies" about his house which was "within a few stone's throws" of the Government buildings in New Delhi, India's capital. In the course of three years he found 30 species nesting in this small plot and saw 106 more. Owing to the demands on his time as a member of the diplomatic corps, he was usually free to watch birds only in mornings between 6:00 and 8:00. His text is based primarily on observations made during these early hours over a three-year period.

Neither the author nor the publisher claims that this work is any more than what it is, namely, the account of man's hobby, bird watching. Mr. MacDonald genuinely enjoys birds and finds observing them a refreshing escape from official routine and responsibilities. He also enjoys writing about them, and does so with light-hearted sophistication and charm. His eye is sharp, he describes actions vividly, and he manages to give distinctive and engaging impressions of various species. The seriously minded ornithologist or ethologist will no doubt object to the generous use of anthropomorphisms, but he will not deny that the anthropomorphisms applied to courtship performances and mating offer a new approach in bird books. Certainly this is the first bird book I have read that could be called "sexy"!

Mrs. Loke's photographs, all reproduced full-page and bled, are close to perfection in clarity and composition, and have been judiciously selected to invite interest in the text. A third were actually taken on Mr. MacDonald's premises; the others were obtained elsewhere in New Delhi or its immediate vicinity. Through the use of the high-speed flash, many of the birds were caught in flight going to or from their nests. The captions include the name of the species depicted and usually a quotation from the text about the species but not about what the bird is doing. As there is rarely any direct reference in the text to the photographs, the viewer is sometimes left uninformed on the particular action shown, precise location of the nest, and so on. Regrettably, the handsome color photograph (of an Indian Roller) on the jacket is not repeated in the text, which leaves the frontispiece of the Golden Oriole as the only color picture between the covers.

The book is splendid in all its physical aspects and its production from start to finish is a credit to international enterprise, being based on Indian subject matter, authored by a Scotsman, illustrated by a Malaysian, printed in Holland and Great Britain, and (this edition) published in the United States.—OLIN SEWALL PETTINGILL, JR.

THE CONTINENT WE LIVE ON. By Ivan T. Sanderson. Random House, New York, 1961: 9⅞ × 12⅜ in., 299 pp., 235 photos. (109 col.). $20.00.

Here is a grandiose book embodying a sound idea that failed miserably between conception and fulfillment. The book was evidently intended as an authoritative, readable treatise on the origin, structure, scenic aspects, climate, and natural resources of the North American continent. To make it an irresistible "gift" item for the Christmas trade, no cost was to be spared in making it elegant and illustrating it with the most striking photographs available. On first turning the pages of this book one would conclude that its aims have been met. The text looks impressive (140,000 words, according to the jacket) and the illustrations are superbly reproduced and altogether stunning photographs of scenery, habitats, and wildlife. Only one picture (p. 271), of an obviously mounted jackrabbit in a museum habitat group, mars an otherwise eye-catching assemblage of the best in nature photography. The failure of the book becomes quickly apparent with the reading of the captions accompanying photographs and, later, the text.

Very few of the 235 captions are in every sense correct. Most are either plainly wrong, owing to carelessness and/or ignorance, or woefully ambiguous. Examples: P. 81, "Mute swans in the Great Lakes area" (the photograph shows Trumpeter Swans in a lake bordered with western conifers) ; p. 26, "Great colonies of gannets. . . nest along the Atlantic coast" of Labrador and "around the Gulf of St. Lawrence"; p. 190, the Roseate Spoonbill "appears in great flocks all around the Gulf coast"; p. 87, the "Cackling Goose" is "found and may even breed on the Great Lakes" and the Mandarin Duck is referred to as established in the North American wild and migrating annually.

The author of the text, perhaps for convenience but certainly not following any profound geographical or ecological concept, takes up the continent in terms of 21 "natural provinces" (shown by maps, pp. 9 and 10, in color as garish as their boundaries are absurd). Breathlessly he writes about each province, keeping up a steady flow of adjectives, adverbs, and extravagant phrases. What he says, invariably at great length, often proves on analysis either to be erroneous (as much so as the captions) or overstated. The latter fault is particularly serious when he writes about our natural resources because time and again he gives the impression that their abundance is undiminished. All the provinces would seem to be teeming with wildlife—e.g., in northwestern Canada, Golden Eagles "are common all over" and "there are places. . . where they positively swarm" (p. 44).

Once again we have the example of a respected publisher spending thousands of dollars on a production that winds up being superlative in appearance but inferior in substance.—OLIN SEWALL PETTINGILL, JR.

New Mexico Birds and Where to Find Them. By J. Stokley Ligon. University of New Mexico Press, Albuquerque, 1961: 6⅞ × 10 in., xxii + 360 pp., 86 photos., maps, drawings, 34 col. pls. by Allan Brooks, Peter Hurd, E. R. Kalmbach, Donald Radovich, Orville Rice, and Walter A. Weber. $8.50.

For many years an up-to-date work on New Mexican birds has been desired by all persons interested in the state's bird life. This need was realized by J. Stokley Ligon who labored on the present volume for several years. Although he lived to approve the proofs, Mr. Ligon missed seeing his book as a finished product; he died in Carlsbad on 23 April 1961, shortly before its publication.

Stokley Ligon's serious bird study in New Mexico began in 1913 when he investigated breeding waterfowl for the U.S. Biological Survey, although as early as 1905 he had submitted to the Survey notes on bird migration in the state. Probably he covered New Mexico more thoroughly than any other naturalist before or during his lifetime. Many of his early records were published by Florence M. Bailey in her "Birds of New Mexico" (1928), and a year earlier the New Mexico State Game Commission published his "Wildlife of New Mexico." In and out of government service and in all parts of the state, Ligon continued to amass bird records and specimens, often, in his later years, undertaking field excursions considered arduous by much younger men. A large percentage of the material in the present volume reflects the author's personal experience with the many species and the areas in which they are found.

According to the jacket, the book's 20-page introduction "delineates topography, climate and life zones . .; it explains classification and identification of birds, biological and aesthetic factors and bird conservation." It also includes interesting accounts of ornithological literature and pioneer ornithologists of the Southwest.

The systematic list occupies the next 283 pages. Each account begins with a description, followed by a lengthy paragraph on distribution in New Mexico, then by a section entitled "Nesting."

There is a series of appendices, the first dealing with "Rare and Stray Birds"—a bare list of species, locations, observers, and dates. The second is entitled "Flyway Records," and discusses New Mexico's "three rather distinctive migratory bird passways"—the Rio Grande Valley, the Pecos Valley, and the High Plains. This appendix presents detailed lists of birds found in selected localities lying in each of these migration routes. For example, the list of 264 species known to occur on the Bosque del Apache National Wildlife Refuge, compiled by Refuge staff members between 1940 and 1957 appears here, as does a Christmas count list made on the Refuge in 1953. Similar long lists and selected Christmas counts for the Roswell-Bitter Lakes area and the Clayton vicinity represent the other two "sub-flyways." Although this information has been published elsewhere it is convenient to have it in one book.

Next is a 22-page chapter entitled "Bird Watching" which deals primarily with bird-finding areas in New Mexico. The author divides the state into four regions and discusses favored birding areas in each, presenting occasional lists of breeding birds and Christmas counts. This section is particularly valuable for visitors to New Mexico. It is interestingly written and highly informative. Certain errors (see below) are unfortunate.

The short glossary (76 terms) is not very useful. Some definitions are inadequate (e.g., "Species: Related individuals with differences that distinguish them from others"). Following the glossary are 32 of the 34 color plates.

As a "popular" bird book Ligon's volume is already rather successful in New Mexico. Many readers knew the author or at least knew about him. Conservationists will be pleased with the book for its pages reflect knowledge gained from years of painstaking field work with game and predatory species, and are filled with sound advice and comments on various conservation measures which are sorely needed in New Mexico. Nevertheless, from a strictly ornithological viewpoint, "New Mexico Birds" is disappointing.

In no sense can the book be considered an accurate check-list, even of species. Subspecies are ignored except in a few cases (Masked Bobwhite and the races of Turkey—birds of particular interest to the author) where they are given a separate heading and the detailed treatment accorded full species. There are very few references to the ornithological literature, and no effort was made to seek out New Mexico specimens scattered in various American museums. Specimens, in fact, are rarely mentioned, and the reader often cannot determine if a species' occurrence in New Mexico is based on a casual sight record or on a preserved specimen.

The book lists 399 species "recorded in the state." The 247 species "known to nest" in New Mexico are indicated by a symbol in the text. Of these, the author states, "82 may be regarded as resident, with more-or-less fixed habitat; 77 are semiresident, but may be observed within the state throughout the year; while 91 species known to nest in New Mexico are absent during the severe part of the winter." Unfortunately, the ornithologist cannot accept these figures at face value. A perusal of the species accounts leaves one with the feeling that no strict criteria for inclusion or rejection of a species were used. It is regrettable that even in a "popular" book so little attention was given to critical evaluation of records.

Any review of the present volume invites a comparison with Mrs. Bailey's monumental "Birds of New Mexico": Adjusting for taxonomic changes since 1928, we see that Mrs. Bailey listed 345 full species plus 12 of hypothetical occurrence. Seven of those on her main list (Arctic Loon, Red-shouldered Hawk, Swallow-tailed Kite, Eskimo Curlew, Sulphur-bellied Flycatcher, Varied Thrush, Cerulean Warbler) and three on her hypothetical list (Scarlet Ibis, Eastern Bluebird. Golden-winged Warbler) are not mentioned anywhere by Ligon. Eight of Mrs. Bailey's 12 "hypotheticals," however, are listed in the present volume. These are the Stilt Sandpiper, Coppery-tailed Trogon, Green Kingfisher, Carolina Wren, Olive Warbler, Ovenbird, Bobolink, and Fox Sparrow. Some of these evidently are admitted to the list on the basis of sight records. Others (Olive Warbler, Fox Sparrow) are supported by specimens. Several species collected in the state several years prior to publication are not included. The record of at least one of these (Purple Finch) was known to Mr. Ligon as acknowledged to me in correspondence.

Some species' right to inclusion on the New Mexico list is highly questionable. Among these are the Greater Scaup (for which Ligon cites no specific records other than the old observations of Willett in 1916); Whooping Crane (based on Henry's vague remarks in 1855 which referred only to "cranes," the adults of which were assumed by Mrs. Bailey to have been Whoopers); Common Tern (no specific record cited); Coppery-tailed Trogon (the only New Mexico specimen allegedly taken in Guadalupe Canyon in 1957 seems likely to have been collected in Arizona's Chiricahua Mountains and erroneously labelled); Green Kingfisher and Rose-throated Becard (both included only on the basis of probability; neither has been seen in New Mexico).

Other inclusions make the critical reader wonder. Was the Long-tailed Jaeger, found dead along the Rio Grande, identified as that species by an ornithologist? Was the specimen preserved or photographed? The same can be asked for the White-winged Crossbill found dead near Clayton in 1954. There is no way of telling from the brief statements in the book.

The jaeger mentioned above and 34 other "rare and stray" birds in Appendix I are species recorded "not in sufficient numbers to justify their inclusion in the general text." Selection of rare species to be relegated to this appendix and of those to occupy positions in the text was evidently arbitrary. Several of the latter (including the White-winged Crossbill) are listed on the basis of a single record, whereas some in Appendix I are supported by three of four records. The Nashville and Hermit Warblers (both in the rare and stray list) occur rather regularly in southwestern New Mexico. This list, like the text, makes no distinction between sight and specimen records, hence a Barrow's Goldeneye reported on a "Christmas Count," and a Frigate-bird seen by "Refuge Personnel" are listed alongside specimen records like those of the Surf Scoter and Heermann's Gull collected, respectively, by William S. Huey and R. T. Kellogg who, like all others in the list, are referred to as "observers."

Too many mistakes mar this volume. A few typographical errors are scattered throughout, and some of these are most annoying (e.g., alula spelled "ulula" in the drawing on page 15; *Colinus* written with a lower case "*c*" on page 95). One ornithologist's name is misspelled. More serious are the outright errors of fact, some of which should be pointed out here. The title of Roger Peterson's book is not "*Western Bird Guide*" (page 13). The Double-crested Cormorant is not "formerly known as the Mexican Cormorant" (page 28). (Both species occur in New Mexico, and although Mr. Ligon did not have opportunity to examine the recent specimen of *Phalacrocorax olivaceus*, he apparently ignored rather than re-examined the specimen cited by Mrs. Bailey (1928:85), who listed only that species; Ligon listed only *P. auritus.*) The Green Heron is not "the smallest of the Heron family" (page 30), a statement also applied three pages later to the Least Bittern. The "Black Hawk" drawing on page 71 is a copy of the photograph of a Zone-tailed Hawk which originally appeared, misnamed, in *The Condor* (59:143, 1957) to substantiate a northeastern New Mexico nesting record. The original error was later corrected in *The Condor* (60:139, 1958) and the record is properly listed in Ligon's text under Zone-tailed Hawk. Another apparent case of misidentification of Zone-tails as Black Hawks is reflected in the list of Guadalupe Canyon birds on page 322. Only the Zone-tail has been recorded there. (A specimen taken a few years ago was misidentified by the collector and presumably Mr. Ligon did not see the skin.)

I know of no basis for the statement, on page 87, that the seasonal plumage change in White-tailed Ptarmigan "presumably is achieved through a process known as 'feather-wear.' " The air sacs of the Lesser Prairie Chicken are reddish, decidedly not orange as stated on page 89. The caption of the owl plate (page 145) refers to the Screech Owl as a Great Horned and the Flammulated as a Screech. Blue-throated Hummingbirds do not occur in Cherry Creek Canyon or elsewhere near Silver City as stated on page 323. Vester Montgomery's observation of a Carolina Wren at Roswell was on 8 May 1951 (*Condor*, 54:204–205, 1952), not on 6 June 1951 as stated on page 220. The Black-and-white Warbler is not a resident or "summer-dwelling" bird of southwestern New Mexico (page 322). In the Bronzed Cowbird account, on page 267, is the quotation, " 'Breeds in southwestern New Mexico (Guadalupe Canyon)' (A.O.U. *Check-list*)." The Check-list merely states that the species occurs in "southwestern New Mexico"; it does not indicate that the bird breeds in Guadalupe Canyon or anywhere else in the state. The rosy finches reported east of Albuquerque by James Findley on 26 November 1955, are attributed to the Gray-crowned by Ligon (page 277), this record placing "the species a hundred miles farther south than indicated by any previous record." These birds were not specifically identified by the observer who reported them merely as "rosy finches." Of my July specimen of Lawrence's Goldfinch at Silver City the author states, "This is approaching a breeding record. . . ." Data furnished the author specifically stated that there was absolutely no evidence of breeding; the bird's gonads were very small. Too frequently the author assumed that the mere presence of birds in an area indicated nesting. Although Lawrence's Goldfinch is not so marked, numerous other species are listed as "known to nest" in New Mexico when there is no evidence that they do.

The bird called "Mexican Junco" in the plate on page 295 is hard to place in any described species, but it certainly is not the yellow-eyed *Junco phaeonotus.* Likewise, the one termed Slate-colored Junco is clearly a White-winged (*J. aikeni*). The yellow iris is not mentioned in the description of *J. phaeonotus.* That this species is listed among the species occurring at the Bosque del Apache Refuge in the Rio Grande Valley (page 312) is an example of the uncritical copying of published bird lists. The Fish and Wildlife Service's list of Refuge birds includes this species (not even in the casual and accidental column), but certainly in error.

The book's illustrations have received occasional mention in the preceding paragraphs but a few words must be said of the color plates. The first one, a pleasing field-guide type painting by Walter Weber, appears as a frontispiece. It allegedly depicts "representative breeding birds of New Mexico's life zones," and has opposite it a brief definition of each zone in terms of elevation, temperature, precipitation, characteristic trees, and birds. It is indeed strange to see the Bridled Titmouse and Blue-gray Gnatcatcher shown as characteristic birds of the Lower Sonoran Zone (as stated by Ligon, from 2,850 to 4,200 feet elevation). The text correctly states that the titmouse occurs from 5,500 feet to 6,500 feet elevation (page 209) and that the gnatcatcher is "most common in the wooded foothills. . . around 5,000 to 6,500 feet." Both of these species are typical Upper Sonoran Zone birds. One wonders why they were selected in view of so many species restricted to low elevations from which to choose. Certain other choices are likewise peculiar and misleading, especially the Horned Lark (here considered representative of the Upper Sonoran Zone) which occurs from lowland desert to alpine tundra.

The quality of the plates varies considerably. Some are quite good—the egrets and Robin by Weber; those of the orioles by Orville Rice, and the familiar Blue Grouse, Pyrrhuloxia, and Lazuli Bunting paintings by Allan Brooks, which first appeared in Mrs. Bailey's "Birds of New Mexico," and which are inferiorly reproduced here. One wonders why the Roadrunner picture (opposite title page) was accepted for publication. The duck plates and those of the woodpeckers and Painted Bunting, by E. R. Kalmbach, are satisfactory, but those of the hawks, corvids, and sparrows are extremely poor, many of the figures badly out of proportion and important plumage characters obscure. The pictures of female Cassin's and House Finches are worthless for identification purposes. The sparrow plate fails to show important differences between genera and species; several birds are far too short-tailed. The Lincoln's Sparrow is barely recognizable, and the Chipping Sparrow is not only shown with a brown rump but with a white loral spot instead of a superciliary line. Some of the other plates are better but nonetheless disturbing. Too many are amateurish and not of the quality which should grace a state bird book. I find displeasing not only the poor individual plates but the great lack of uniformity in style to be expected in a miscellaneous collection of paintings by a half-dozen different artists. I think the black-and-white shorebird painting by Rice (page 111) is very good. Kalmbach's plate (page 58) of hawks in flight is pleasing except for the misleading figures of the Zone-tailed and Gray Hawks.

The generally inferior illustrations, the numerous errors and misleading statements, and the uncritical acceptance of records materially reduce the usefulness of this volume. A thorough, careful account of New Mexican birds is as desirable now as it was before publication of this book. Until such is available, Mrs. Bailey's "Birds of New Mexico," although 34 years out of date, will continue to be the best source of information on the state's avifauna.—DALE A. ZIMMERMAN.

THE MURRES: THEIR DISTRIBUTION, POPULATIONS AND BIOLOGY. A STUDY OF THE GENUS URIA. By Leslie M. Tuck. Canadian Wildlife Series 1, Canadian Wildlife Service, Department of Northern Affairs and National Resources, Ottawa, 1960 (1961): 6 × 9 in., 260 pp., 14 pls. (1 col.), 34 figs., incl. 14 maps. $2.50.

This attractive volume will claim the attention of ornithologists for two reasons: First, it is an excellent, broad treatise on the two species of murre, *U. lomvia* and *U. aalge*, throughout their range in the northern hemisphere; second, it is the first in a new "Canadian Wildlife Series" of monographs resulting from the vigorous research program of the Canadian Wildlife Service.

Leslie M. Tuck has been observing murres and other seabirds in the splendid nesting colonies and on the offshore waters of his native Newfoundland for more than 20 years. Almost immediately on joining the Canadian Wildlife Service, he was given the opportunity to concentrate on a study of the biology and ecology of murres, which are "of substantial economic importance" in Newfoundland and in the Canadian arctic. He has visited all known nesting colonies in Newfoundland and Labrador, and several large colonies in the arctic. His studies of populations and of behavior were encouraged by a period of time spent at Oxford. Mr. Tuck's monograph is pleasingly written, attractively laid out, and well illustrated.

The treatise comprises five parts, among which emphasis is by no means equally distributed. Parts II and III, covering distribution and populations, and breeding biology, respectively, are strong and well-documented. They make up one-half of the text. Part I entitled "Evolution and Adaptation" only sketches the subject by mentioning habits and physical adaptations of which many are treated more fully elsewhere. In Part IV, on factors affecting populations, the discussion of food habits is excellent, but disease receives two short paragraphs, and parasitism only one. The murre tick, *Ixodes uriae*, may be of little importance as a pathogen, but I was disappointed not to find it even mentioned. Part V, on economics, presents an interesting discussion on the importance of murres to mankind in the past, at present, and in the future. Regulation of fowling and egging, refuge establishment, and improvement of rocky islands for new colonies may serve to perpetuate the murre as a source of rich food and as a contributor to arctic economy.

One finds some statements repeated several times through the book. For example, Mr. Tuck seems to be convinced by Upenski's suggestion that the rolling radius of a murre egg is reduced during incubation and has important survival value. This is discussed on p. 25, and again on p. 128. A few desktop experiments with weighted murre eggs cause me to doubt the validity and importance of Upenski's conclusions.

The book is profusely illustrated. The half-tones are rather coarse-grained but the maps are a reader's delight. The printer has handled pagination like a modern artist—leaving the subject more or less to the reader's interpretation! For example, Page 1 of the text is numbered 13; eight pages of half-tones at the beginning are not counted at all, while 16 pages of half-tones in the middle of the book are counted but not numbered.

These minor points do not detract from the value of an excellent contribution, of which the author and the Canadian Wildlife Service should be proud.—OLIVER H. HEWITT.

ANNUAL REPORT OF THE CONSERVATION COMMITTEE

The objective of this Committee report constitutes an annual stocktaking of the status of matters having a relation to the conservation of bird life. The rapid tempo of modern civilization magnifies the importance of such yearly evaluations. It is our hope that the report will serve to allay fears in some instances, to alert ornithologists to problems of special concern, and to stimulate corrective action where needed.

The present Committee will complete its term in office with submission of the present report. The Committee has found the dispatching of its responsibilities both stimulating and satisfying. In simple words, we have enjoyed serving the Society in this manner. In addition to last year's annual report (Scott et al., 1961), the present Committee has contributed special reports on waterfowl conservation (Jahn, 1961), the status of grouse populations in North America (Hamerstrom, 1961), and the effects of insecticides on terrestrial birdlife in the Middle West (Hickey, 1961). We owe a debt of gratitude to many people who assisted with the work of the Committee.

Your Committee has been most encouraged during the past two years by evidence indicating that conservation related to birdlife is very much a live issue. While there have been some defeats and some delays, ornithologists have every reason to feel good about the progress being made.

The subject matter of this report has been organized by categories as in last year's report (Scott et al., 1961): Conservation Education, Land-Use Problems, Habitat Pollution, Control of Bird Populations, and Endangered Species and Subspecies.

CONSERVATION EDUCATION

Members of this Conservation Committee have experienced times of great concern about the apparent failure of conservation education. Evidence of the inability of substantial segments of the public to grasp the real meaning of conservation readily makes itself apparent in many forms. Often, after parks, nature trails, and recreation areas have been made available to the public at great expense and effort, an inability to understand and use such facilities properly is reflected in extensive vandalism. An increasing human population with more and more leisure time and a greater capability of using it (Scott, 1959: 385–386) makes corrective action a matter of considerable urgency.

It seems obvious to this Committee that conservation education, the common denominator in all conservation problems, is in serious need of revitalization and increased emphasis, beginning at the elementary school level.

Conservation is everyone's concern, and all people must be exposed to an understanding of the relationship of conservation to the well-being of our civilization. Thus, public and private schools become the most logical place for providing the basic training.

Elementary School Level.—Because, in our opinion, conservation is primarily a point of view, we believe that it can best be inculcated in children of grade-school age. At this time, children are most aware of and most curious about their natural environment: it is at this time, also, that they establish their relationship to the world around them and their basic attitude toward conservation is molded.

This educational philosophy has been actually tested in a very successful way in Elm Place and Green Bay Road Schools in Highland Park, Illinois, where an integrated curricular program, with natural history as its core, was set up for grades 1 through 8 by the superintendent, Mr. Jesse Lowe Smith. Children under his care were taught to appreciate the myriad life forms of nature and to desire their preservation. Under his direction, the schools maintained garden plots which the children tended, and a plant house where native plants were studied and work was done with bulbs, seedlings, and specimen plants for home, garden, and classroom. The science room and many of the classrooms frequently had a wide variety of animal and bird visitors which teachers or pupils brought in for observation, and several grades maintained aquariums. There were numerous class field trips and projects, as well as individual ones, connected with contemporary environmental studies which were integrated with all branches of the curriculum. Responses from the children in all grades were enthusiastic; they worked hard on their own initiative, were vitally interested and, as many of them have later testified, acquired a life-long interest in conservation practices and natural history.

An example of the method used in Elm Place School may be taken from a third-grade project. The children built a replica of a pioneer village in their manual-training class, reproducing the natural surroundings of pioneer times in the prairie states and necessitating the learning of linear measurements. Flax and vegetables were grown; maple trees were tapped; hominy, crabapple jelly, and soap were made; earth pits were dug for the storage of root crops; vegetable dyes were prepared from wild plants; amber cane was crushed and boiled for syrup; books were read, either individually or in class sessions, describing the native flora and fauna and the agricultural, hunting, and land-improvement activities of the early settlers; pictures representing scenes of pioneer life were drawn and painted; stores and plays based on likely episodes in forest or village life were written and acted out by groups of children; the "pretend" pioneer tradesmen and craftsmen sold or bartered their goods, weighed and measured, and wrote up accounts.

The class made field trips to nearby woods, natural prairie sites, and neighboring farms (including a goat ranch) to learn something of regional plants and trees, cultivated crops, and farm animals. Only single plant specimens were taken for the class collection except when fruits, flowers, leaves, or bark were to be used in pioneer activity projects such as making ink and dyes from pokeweed, elderberry, and walnut hulls or gathering mustard greens for a pioneer "feast."

Mr. Smith's tenure lasted 32 years, and many grade-school generations have attested to the efficacy of his program. At his death in 1934, the schools continued to maintain his successful curriculum. It is significant that in the last two years modified requirements of the High Schools have made necessary a reduction of natural history studies in the seventh and eighth grades in order to place more emphasis on aspects of science connected with the space age. We feel that such demands on the curriculum constitute another reason for beginning the study of conservation in the elementary grades.

In Ohio, two conservation education guides for teachers in elementary grades are reported to have received national attention: *Chart of Conservation Concepts for Elementary Grades* and *A Guide to Teaching Conservation in Ohio Elementary Schools.*

Secondary School Level.—A new trend in conservation education which may lead the way in this much needed revitalization of our conservation program is being tested at the secondary-school level. The biology course needed at this level has been described by Dr. John Moore (Grobman, 1961:1255) of Columbia University as one which should provide the student with

> "an understanding of: his own place in the scheme of nature, namely that he is a living organism and has much in common with all living organisms; the diversity of life and of the interrelations of all creatures; what man presently knows and believes regarding basic biological problems of evolution, development, and inheritance; the biological basis of many of the problems and procedures in medicine, public health, agriculture, and conservation; and examples of the historical development of the concepts of biology to show that these are dependent on the contemporary techniques,

technology, and the nature of society." It should also provide him with "an appreciation of the beauty, drama and tragedy of the living world."

While there is some evidence that biological science is unfortunately losing ground to space-age science in secondary and higher educational levels, there are also reassuring signs that the word *ecology* is going to receive greater attention than ever in high school biology. The new trend constitutes, in the opinion of this Committee, a most promising current development affecting conservation education and the most likely, therefore, to influence the future public and private management of birds as well as other renewable resources. As the new emphasis on ecology makes itself felt in the schools (Grobman, 1961), this trend, along with the new economic and political emphasis on outdoor recreation (Kennedy, 1962; ORRRC, 1962), could present a tide of opportunities that conservationists, who have long groped for ways to reach future citizens, should prepare themselves to take at the flood.

Ecology is receiving new emphasis among educators who are concerned about and responsible for instruction in the biological sciences. A remaking of teaching methods has been set in motion through the Biological Sciences Curriculum Study of the American Institute of Biological Sciences. This work was started on 1 January 1959, when the AIBS received a small initial grant from the National Science Foundation to organize the Biological Sciences Curriculum Study (Grobman, 1961). The project has proceeded under the general direction of a steering committee headed by Dr. Bentley Glass of Johns Hopkins University. Staff and direction from headquarters in Boulder, Colorado, have been supplied by Dr. Arnold B. Grobman.

Three experimental versions of *BSCS High School Biology* (text materials and teachers' handbooks) were tested during the 1960–61 school year by 118 teachers in different parts of the country, with 14,000 students involved. Traditional high-school biology books and teaching give greatest emphasis to the organ-tissue level of biology. The BSCS versions all give relatively less attention to the organ-tissue level and reflect new scientific discoveries and concepts on the molecular, cellular, and community (ecological) levels.

On the basis of the first-year tests, the preliminary versions were revised during a summer writing conference. The revised edition is being evaluated during the current term (1961–62) with 541 teachers and 52,000 students participating.

The "Green Version" in particular, which has been developed under the supervision of Dr. Marston Bates of the University of Michigan, uses the ecological approach. It (Grobman, 1961:1258)

> takes the individual organism as the primary unit of study. It is concerned with how individuals are organized into populations, species, and communities, and with what organisms do and how they do it. It starts with cycles of energy and materials in the biosphere, then turns to such structural units as individuals, populations, and communities. Following the taxonomic diversity of animals, plants and micro-organisms, it deals with ecological diversity on land, in fresh water, in the seas; with geographical diversity among the continents and oceans; and then with the history of life and the problem of evolution. The student studies the cellular structures of organisms; genetics; the physiology and development of plants and animals; animal behavior, the relations of the parts to the functioning of the whole organism; and the human animal in the perspective of his biological setting.
>
> The Blue Version (supervisor: Dr. Ingrith Deyrup, Barnard College) develops the fundamental biological concepts with stress on the ideas and experimental approach of physiology and biochemistry. It begins with the basis of life in the properties and organization of matter. It then moves to the activities of these organizations as seen in the capture and use of energy, then to the organ level, and finally to the level of the whole organism and of populations. Genetics is couched in terms of the conservation and modification of molecular organization from generation to generation; evolu-

> tion is the basis for long-term changes in the development of diversity among living organisms. The treatment of certain open-ended biological problems which face man as a citizen of a socially organized community concludes the text presentation. Grobman, 1961: 1257–1258).
>
> The Yellow Version (supervisor: Dr. John Moore, Columbia University) begins with the whole organism, and man as exemplar of the animal, from a functional point of view. The traditional major functions are treated system by system, rarely going below the organ level. Next is a similar treatment for the green plant. . . . Concepts of evolution and adaptation are emphasized. . . . Then the student is confronted with the fundamental chemistry and dynamics of the living cell. . . . The remaining chapters concern microbiology, diversity in the plant and animal kingdoms, genetics, reproduction and development, and evolution. (Grobman, 1961:1258).

In all three versions, laboratory and field experience is more important than in most current biology courses, and the emphasis is different. Students not only examine materials but experiment and investigate open-end problems.

Dr. Hiden T. Cox (1962:3), executive director of the American Institute of Biological Sciences, regards the BSCS project as "the most important single contribution" the Institute has made, and reports that the anticipated "catalytic action" and "new vitality" for biology teaching "already has surpassed expectation."

Commercial publishers of textbooks have been asked to submit bids for publication of BSCS materials. These are expected to be generally available for classroom use in September 1963.

Outdoor Nature Centers.—For the effective teaching of ecology in biology courses, the outdoor laboratory would seem to be essential and irreplaceable. This is basic to the purpose for which four model Audubon Centers have been operated by the National Audubon Society and in the activities of the Society's Nature Centers Division, which seeks to encourage the establishment of Nature Centers under local sponsorship. The Natural Science For Youth Foundation, and the outdoor nature centers it sponsors, also have the objective of contributing to a better understanding of natural history and its related fields. This is also the aim of the "Natural Areas for Schools" program of the Nature Conservancy. There is evidence that this movement is also gathering momentum under community sponsorship as well as under sponsorship of national agencies. It would seem desirable that assistance be given to nature centers for schools by the open space and areas for recreation programs.

LAND-USE PROBLEMS

Refuges.—It is contended by conservationists that $200 million is needed over a period of the next 10 years for acquisition of 4.5 million acres of wetlands by the Federal Government (Nat. Wildl. Fed., 1961:296). Part of the money would be spent to purchase lands for inclusion in the national wildlife refuge system, and part would be used to maintain duck production habitat. It is estimated that approximately $50 million may be derived from Duck Stamp Sales during this period. Thus, an advance of $150 million from the Federal Treasury is believed to be essential for adequate conservation of waterfowl. Long-range management includes the purchase of an additional 2.5 million acres by state governments. The total of 7 million acres is in addition to the 5.5 million acres presently in public ownership, 3.5 million acres by the Federal Government and 2 million acres by the states.

In response to this need for wetlands, a compromise bill was passed by the Senate and the House of Representatives. This bill, signed by the President on 4 October 1961, became Public Law 87-383. It authorizes $105 million within seven years, beginning with the fiscal year 1962–63. Funds must be appropriated annually during this period.

This interest-free loan is to be returned to the Federal Treasury through payment of 75 per cent of the annual receipts from Duck Stamp sales, beginning in 1969.

At the present time, we have little information on the amount of appropriation which will be approved to carry out the legislation. The only information which we have is that the President's budget (sent to Congress on 18 January 1962) included an item of only $7 million which, if approved, would be available starting 1 July 1962, to implement the intent of this law. It is thought that expenditures demanded by the world situation have caused a reduction of funds to be used for habitat acquisition.

At the 57th Annual Convention of the National Audubon Society, on 30 October 1961, Carl W. Buchheister proposed a $2 Migratory Wildlife Conservation Stamp to be issued as an admittance pass for bird watchers, photographers, picnickers, and others who visit national wildlife refuges. The receipts would be used to add to federal refuges administered by the U.S. Fish and Wildlife Service. At a subsequent meeting, Mr. Buchheister further explained his proposal (Natl. Aud. Soc., 1961*a*).

> This kind of fee system can be a useful tool in preventing too much public use of a refuge when too many trampling feet or too many automobiles would damage the habitat.
>
> A certain number of citizens make special recreational use of the refuges because the refuges make wild animals accessible, available or visible. It seems only fair that these citizens make an extra contribution to the establishment and maintenance of the Refuge system.

It is believed that this proposal has additional value in that the receipts are likely to be more stable than those from Duck Stamps. The sale of Conservation Stamps will probably also show a direct relationship to increases in the human population and increased leisure time. The sale of Duck Stamps declines sharply when the waterfowl population is down and hunting tends to be unrewarding. In 1956–57, a record of 2,369,940 Duck Stamps were sold. The price was increased from $2.00 to $3.00, beginning 1 July 1959. In 1959–60, 1,628,365 Duck Stamps were sold, and, in 1960–61, 1,727,534. The low sales in 1959–60 are believed to have resulted more from the reduction of waterfowl numbers as a consequence of drought on the breeding grounds than from the increased price of the stamp. Even the modest increase in stamp sales from 1959–60 to 1960–61 is thought to reflect a slight improvement in waterfowl production during the breeding season in 1960.

Action to establish this proposal was taken by Congressman John D. Dingell when he introduced H.R. 10035, *National Wildlife Refuge Stamp Act*, on 1 February 1962. The bill requires the possession of a Duck Stamp or a Refuge Stamp for entry on national wildlife refuges. The revenues will go to the Migratory Bird Conservation Fund along with receipts from Duck Stamp sales. Existing law requires that this Fund be used for migratory game refuges. Conservationists will be pleased that a feature of the new act will permit revenues from sale of the Refuge Stamp to be used to acquire refuge areas for any species of wildlife in danger of extinction.

How fast the habitat-preservation program progresses will be determined largely by the wishes of local people, especially local and state governments. No land can be acquired under Public Law 87-383 without approval by the state involved. Removal of land from tax rolls is becoming a potential roadblock of enlarging dimensions in certain states. Bills (S. 2678 and S. 2770), drawn up to help solve the tax issue, are now pending.

Some progress was made during the year toward establishment of national wildlife refuges. The Wyandotte National Wildlife Refuge, which includes Grassy and Mammy Juda islands and adjacent marshy areas in the Detroit River near Wyandotte, Michigan.

was established on 3 August 1961 (Public Law 87-119). This new refuge is believed to be of particular value to the protection of Canvasbacks and Redheads. Best of all, establishment of the refuge did not involve expensive land acquisition, merely a transfer of jurisdiction from the Army Corps of Engineers to the U.S. Fish and Wildlife Service.

Ornithologists should be alert to other possibilities for procurement of refuge areas by transfer of jurisdiction. For example, the U.S. Bureau of Land Management administers 180 million acres of land in the Nation's western states and nearly 300 million in Alaska. Surely some of this has some value for refuge areas.

Subjects of other pending bills directly affecting the welfare of waterfowl include: (1) the permanent status to be given to Tule Lake, Lower Klamath and Upper Klamath National Wildlife Refuges in California and Oregon (S. 1988); (2) provision for fish, wildlife, and other recreational benefits in the Garrison Diversion irrigation project in North Dakota (S. 230); (3) protection for fish and wildlife in highway construction (S. 2767); and (4) qualifying state wildlife agencies to receive surplus property of the United States for promoting fish and wildlife management activities (H.R. 6301 and S. 2173). It is significant that S. 1988 was endorsed by a "do pass" recommendation by Secretary of the Interior, S. L. Udall, on 15 November 1961. The preservation of these refuges is considered essential to waterfowl conservation in the Pacific Flyway. At present, their usefulness is being threatened by land speculation and irrigation interests.

In a precedent-setting action, $275,000 was approved in the Public Works Appropriations Bill for 1962 for the Choctaw National Wildlife Refuge in Alabama. The Corps of Engineers is proceeding with land acquisition in conjunction with the Jackson Lock and Dam Project. This significant development establishes the precedent that wildlife values shall be provided for by construction agencies as integral parts of projects. It is anticipated that the area will be made available to the U.S. Bureau of Sport Fisheries and Wildlife in 1962.

Two policy changes of the Federal Government should help recreation, fish, and wildlife receive greater attention on military lands (Wildl. Mgmt. Inst., 1962*b*:3) and at federal reservoirs (Wildl. Mgmt. Inst., 1962*c*:4). The Secretary of Defense issued a new directive dated 16 February 1962, on the management, conservation, and harvesting of fish and game resources on military reservations and facilities. Under the new directive, all base commanders are required to take the initiative to seek out help and to work effectively and in harmony with federal, state, and local conservation officials and with conservation agencies. Prior to the issuance of this statement, conservation programs had been carried out at the discretion of the individual commanders.

A new policy recently signed by the Interior and Army Departments changes the old policy which prevented these federal agencies from purchasing more than a narrow strip of land around impoundments. Both agencies now can acquire lands at federal reservoirs for public access, fish, wildlife, and recreational purposes. In view of the large number and wide distribution of construction projects of these two departments, potential benefits to wildlife could be substantial.

In Canada, two noteworthy advances have been made to benefit waterfowl. Six new wildlife refuges, totaling 37,870 square miles, were established in the western Arctic to protect waterfowl nesting grounds of continental significance. Establishment of the sanctuaries effects some measure of control but does not limit mineral exploration and development in the areas. Changes in habitat resulting from uncontrolled mining activity could seriously lower population levels of waterfowl. With the addition of the new refuges, Canada now has 108 migratory bird refuges covering more than 39,000 square miles (Wildl. Mgmt. Inst., 1962*a*:5).

During late spring of 1961, Secretaries Stewart L. Udall and Orville L. Freeman of the U.S. Departments of Interior and Agriculture, met with Alvin Hamilton, Canada's Minister of Agriculture, and Frank Dinsdale, Minister of Northern Affairs and National Resources. Following this meeting, a joint committee was appointed, with representatives from both countries, to study the waterfowl situation and to develop methods whereby the United States and Canada can work together to improve waterfowl-conservation programs.

Drainage Subsidies.—One of the inconsistencies in Federal policy to be singled out by President Kennedy in his message to Congress on 23 February 1961, was that of assisting with the drainage of wetlands, on the one hand, while purchasing such lands for wildlife refuges on the other. Federal encouragement of drainage has been described (Natl. Aud. Soc., 1961*b*) as follows:

> The Department of Agriculture, through the so-called "Agricultural Conservation Program," now reimburses farmers for one-half the cost of draining wetlands. The Soil Conservation Service also provides technical (engineering) assistance. Thus, aided by funds collected from U.S. taxpayers, the drainage program has blotted out marshes far faster than the U.S. Fish and Wildlife Service, using Duck Stamp revenues, can acquire and save other marshes. Surveys have shown that subsidized drainage has been instrumental in destroying one-third of the small marshes in the nation's most productive waterfowl-nesting region, the prairie-pothole country of the Dakotas, Minnesota and eastern Montana.

In 1960, drainage proceeded on 77 per cent of 553 projects opposed by the Department of the Interior. In 1961, 87 per cent of 527 projects opposed by the Department were processed for drainage.

An attempt to amend the general farm bill to prevent the Secretary of Agriculture from giving assistance with a drainage project if the Secretary of the Interior considered such drainage materially harmful to wildlife failed narrowly. Several bills were almost immediately introduced into the House and one in the Senate (S. 2417) to accomplish the necessary prohibitions of assistance with drainage harmful to wildlife. One of these bills, H.R. 8520, was passed by the House on 12 September 1961. It amends the Soil Conservation and Domestic Allotment Act by adding a new subsection which reads as follows:

> (e) The Secretary of Agriculture shall not enter into an agreement *in the States of North Dakota, South Dakota and Minnesota* to provide financial or technical assistance for wetland drainage on a farm under authority of this Act if the Secretary of the Interior has made a finding that waterfowl preservation will be materially harmed on that farm by such drainage and such finding identifying specifically the farm and the land on that farm with respect to which the finding was made, has been filed with the Secretary of Agriculture: *Provided, that the limitation against offering such financial and technical assistance shall terminate one year after the date on which the adverse finding of the Secretary of the Interior was filed unless during that time an offer has been made by the Secretary of the Interior or a State Government Agency to lease or to purchase the wetland area from the owner thereof as a waterfowl resource. The provisions of this subsection shall become effective July 1, 1962.*

It should be noted that the bill does not interfere with the land owner's freedom to drain at his own expense. At this writing, the bill is before the Senate Committee on Agriculture and Forestry. In a National Wildlife Federation press release dated 28 February 1962, Congressman Henry S. Reuss (Wis.), following examination of a report by Assistant Secretary of the Interior, Frank P. Briggs, is quoted as follows:

> As a result of subsidized farm drainage in the "prairie pot-hole" area in the last ten years, almost half of the tri-state area's 1,350,000 acres of wetlands has been drained. Our North American waterfowl population is at a dangerously low point. The De-

> partment of the Interior is now engaged in a crash program, fully backed by Congress, to buy up wetlands before it is too late. Yet while this is going on, the Department of Agriculture is busier than ever paying farmers to drain wetlands that Interior says ought to be saved.

The Department of Agriculture appears to be caught in a squeeze-play. Drainage to improve lands for agriculture is an approved, effective land-management practice desired by many landowners. The extent to which a given land-use practice is employed locally is determined by a committtee of local citizens. With use of ACP funds for approved practices determined by such committees, we doubt that major changes in the drainage trend will take place under existing procedures. We believe a major change would occur in designated areas, if federal legislation relating to subsidized drainage was modified.

Recreation Areas.—There is considerable activity directed toward acquisition of state and federal lands, primarily for recreational purposes. It seems highly desirable that ornithologists endeavor to participate in this program by submitting proposals and by evaluating the relationship of acquired land to the bird fauna affected.

The first addition to the National Park System, since our one and only national seashore area at Cape Hatteras in North Carolina was established in 1937, was assured by President Kennedy when he signed into law on 7 August 1961, legislation to establish the Cape Cod National Seashore.

A bill (S. 543) which authorizes the U.S. Park Service and U.S. Forest Service to study potential seashore recreational areas and bills (S. 476 and H.R. 2775) to establish the Point Reyes National Seashore in California have been passed by the Senate. The Point Reyes bill has been reported favorably by the House Interior and Insular Affairs Committee and, at this writing, awaits final passage.

Proposals to establish the Sleeping Bear Dunes Recreation Area or Seashore in Michigan, the Great Basin National Park in Nevada, the Prairie National Park in Kansas, and to protect the Indiana Dunes in Indiana, the Oregon Dunes in Oregon, and an Ozark Refuge Area in Missouri are now before Interior and Insular Affairs Committees of both the House and Senate. S.4, to establish the Padre Island National Seashore in Texas, has been reported favorably by the Senate committee.

It should be remembered that these seashore areas will safeguard some habitat for shore birds and waterfowl.

To "increase public benefits," bills (H.R. 1171 and H.R. 77) have been introduced to permit recreation as an incidental or secondary use of national wildlife refuges, fish hatcheries, game ranges, and other areas. The Fish and Wildlife Service now lacks specific authority to provide minimum facilities such as picnic tables, fireplaces, etc., for the more than 10 million people presently visiting the areas annually (Wildl. Mgmt. Inst., 1961*a*:5-6). An amended version of H.R. 1171 has been reported by the House Committee on Merchant Marine and Fisheries.

A provision of the Housing Act of 1961, Public Law 87-70, authorizes $50 million in federal funds to assist cities and counties to preserve open spaces for parks and playgrounds. In view of the rapidly expanding urban areas, this legislation could be of considerable significance to birdlife and conservation education efforts. Outdoor education areas could be maintained within reasonable distances from schools.

There is evidence of a growing awareness on the part of state governments of such conservation needs as parks, recreation areas, and conservation programs. Voters in New York and New Jersey have approved bond issues of $75 million and $60 million, respectively, for acquiring and developing recreation facilities, and California is considering a $100 million bond issue for beach and park purchase. In Pennsylvania, legislation (Project 70, so-called because the target date is 1970) has been introduced in the General Assembly which, if passed and later endorsed by the voters, would make possible the purchase of lands for hunting and fishing sites, parks, and scenic areas. Florida has initiated a program to develop about a half-million acres of state-owned land for game preserves, parks, recreational areas, water-retention sites, and natural history preserves. Minnesota has a $1.00 surcharge on the small game hunting license, the proceeds to be used for habitat acquisition. In South Dakota, $9.00 of the $25.00 nonresident small-game hunting-license fee is used for a habitat-management program. In Wisconsin, the State Legislature considered, with bipartisan support, a proposed program for acquiring, developing, and maintaining suitable state lands as parks, forest recreation areas, fish and game habitat, youth conservation camps, and other allied purposes. A 1-cent tax on cigarettes was legislated which is expected to yield $50 million over the next 10 years. About $9 million would be used for fish and game habitat as provided for in Chapter 427 of the Laws of Wisconsin, 1961. It seems likely that this program will have an important effect on the development of Wisconsin's system of "scientific areas"; 32 have now been officially designated, but approximately 300 will need to be set aside by 1980 as outdoor laboratories and study areas, according to an estimate made by Albert Fuller. A Middle Western group of citizens has also formed Wetlands for Wildlife to complement existing state and federal programs of habitat preservation and restoration. During March, this organization turned $2,600 over to the Wisconsin Conservation Department for land acquisition purposes. In Michigan, a cigarette tax proposal similar to that in Wisconsin is under study.

Wilderness Bill.—Legislation to provide a National Wilderness Preservation System has been in the making for a long time. News that the wilderness bill, S. 174, had passed the Senate on 6 September 1961, by the overwhelming margin of 78 to 8 was most encouraging. Several crippling amendments were defeated, but another weakening amendment which permitted the Federal Power Commission to license power dams in wilderness areas was accepted. Hearings on the bill were held in the West during the fall by the Public Lands Subcommittee of the House Committee on Interior and Insular Affairs. The results of these hearings are reported upon in "Hearings before the Committee on Interior and Insular Affairs, United States Senate, Eighty-seventh Congress, First Session, on S.174, February 27 and 28, 1961" (United States Congress, 1961).

Some of the major proponents who appeared as witnesses during the hearings on the wilderness bill were: Carl W. Buchheister, President, National Audubon Society; Sigurd F. Olson, former president of the National Parks Association, at present a member of the advisory board to the Secretary of the Interior on parks and monuments, and consultant to the President's Quetico-Superior Committee; Olaus J. Murie, Director, The Wilderness Society; J. W. Penfold, Conservation Director, Izaak Walton League of America; Howard Zahniser on behalf of Trustees for Conservation; Louis S. Clapper, Chief, Division of Conservation Education, National Wildlife Federation.

Among those speaking for the opposition were: W. Howard Gray, Chairman, Public Lands Committee of the American Mining Congress; Russell Chadwick, Exploration Geologist, on behalf of the Northwest Mining Association; Leonard E. Pasek, Vice Chairman, Conservation and Management of Natural Resources Committee, National Association of Manufacturers; Jay Gruenfeld, Tacoma, Washington, Chamber of Commerce; W. D. Hagenstein, Executive Vice President, Industrial Forestry Association, and William C. Hammerle, Forester, American Pulpwood Association.

Opposition by commercial interests has been severe. C. R. Gutermuth (Wildl. Mgmt. Inst. 1962*d*:3) recently expressed the belief that opponents to wilderness

> . . . speak for those commercial interests that want to get the last dollar from the timber, forage, minerals, and other resources in the pitifully few acres of irreplaceable wilderness. . . .
>
> The fury of the opposition is centered on S.174 . . . . because it is the principal public lands legislation now before Congress. Their distortions echo time-worn cliches —destruction of community growth, loss of revenues and taxes, damage to timber interests, interference with livestock operations, discrimination against miners. All these have been disproved before and will be disproved again.
>
> S.174 would create no new federal agency. It would not interfere with the purposes for which the wilderness areas in the national forests, parks, and wildlife refuges already may be used. It would not surrender congressional prerogatives in public land matters. In no way would it disrupt established, legitimate activities of any commercial interest on the public lands.
>
> The bill merely provides a procedure whereby federal lands, already in wilderness condition, shall continue to serve their present national forest, park, and wildlife refuge purposes, but in a way that would preserve their wilderness character.

The most recent information available indicates that the wilderness bill is still being held by the House Committee on Interior and Insular Affairs.

A concise but comprehensive account of this legislation can be found in a special issue of THE LIVING WILDERNESS for Autumn-Winter, 1961–62 (available from The Wilderness Society, 2144 P. Street, Washington 7, D.C.). The issue contains: (1) designation of some advocates and opponents of the bill; (2) S.174, "ordered to be printed as passed" by the Senate; (3) pertinent discussions by Clinton P. Anderson, Michael Nadel, and Charles Callison; (4) quotes from leading newspapers and informed individuals in the field of natural resources; (5) a report by the U.S. Senate Committee on Interior and Insular Affairs (maps and charts); and (6) expressions of minority views.

Habitat Modification.—Operations which are bringing about extensive modification of environment are in motion. Attention has been directed to the use of herbicides to relieve pines from competition with hardwoods in southern United States and the expansion of pasture areas in southeastern United States (Scott, 1959:387–390). Adolph Stebler (personal communication, 5 March 1962) has called attention to the eradication of shrubs advocated in range-improvement programs and the possible serious consequences for the Lesser Prairie Chicken, which is considered an endangered species, and possibly other forms of birdlife. Park (1961) has advocated study of animals in environment modified by predetermined design. The practices mentioned above provide an opportunity for ornithologists to study the response of birds to environmental modifications on a scale which would be prohibitive to the budgets of most research projects. Unfortunately, most research groups lack the flexibility to tackle these essential, basic investigations as opportunities develop.

On the continental United States, we are all well aware of examples of encroachment on wildlife areas by highways, airports, waste-disposal areas, urban development, and industry. In many cases, this is not intolerable because there are alternate courses of action which may be taken. An event which is taking place on St. Croix Island of the Virgin Islands, however, is of a more serious nature. The Committee has been advised that the Governor of the Virgin Islands has signed a contract, ratified by the Legislature, to turn over to the Harvey Aluminum Company 700 acres of land and also Krause Lagoon. The company proposes to import bauxite, separate the alumina for reshipment, and dump the separated clay into the lagoon. The mangroves in Krause

Lagoon presently support the only remaining nesting colony of White-crowned Pigeons in the Virgin Islands. The flatland around the lagoon is also the only place on St. Croix in which the Antillean Nighthawk has been collected. The lagoon offers the best bone fishing known in the Virgin Islands and is the most productive area for the local clam.

It is rapidly becoming evident that the delicately balanced ecology of southern Florida is being damaged beyond repair by water manipulation attending expansion of residential, agricultural, and industrial projects. The water which percolates southward from Lake Okeechobee is being diverted, impounded, and consumed to such an extent that it is doubtful whether the wetland flora and fauna presently characteristic of the region can be maintained. Such recreational areas as the Everglades National Park, Florida Everglades Conservation Areas, Loxahatchee National Wildlife Refuge, and the National Audubon Society's Corkscrew Swamp Sanctuary are endangered. Some observers believe that this water manipulation has already advanced beyond the point of no return.

For the first time, the 1962 Agricultural Conservation Program included cost-sharing practices to benefit wildlife on individual farms. Up to one-half the cost of eligible practices are paid by ACP. Permitted wildlife practices include: (1) restoration of wetlands of value to fish and wildlife; (2) construction of water areas; and (3) planting of vegetation that provides food, shelter, and habitat for game animals. Regulations allowing for development and approval of additional wildlife-conserving practices on farms are appended to a description of the "G practices . . . and other wildlife practices with substantial soil- and water-conservation values as well as wildlife benefits to the farmlands of the persons who carry them out" (Wildl. Mgmt. Inst., 1961*b*:3). State and county committees that handle other phases of the over-all ACP program determine which, if any, wildlife practices are included in state and county programs. Hence, to a large degree, local people determine the number of wildlife practices employed.

Other adjustments made or pending in the agricultural program of the United States have benefited or will benefit wildlife, including waterfowl. In his State of the Union Message, President Kennedy called for a new, long-range conservation and recreation program. Later, in a message on management of agricultural resources, the President requested the use of unneeded crop lands for wildlife and recreational developments. He reported:

> In spite of a 65 million increase in population by 1980, our farms will be able to produce all we need with 50 million fewer acres than we have in cropland today (Natl. Wildl. Fed., 1962:33).

At a conference on Land and People, called by Secretary of Agriculture, Orville L. Freeman, a discussion was held on ways of designing public policy to encourage the maximum effective use of resources in rural America for service to all Americans (Wildl. Mgmt. Inst., 1962*e*:4). Bills (S. 2786 and H.R. 10010) to implement the President's farm bill are now pending.

HABITAT POLLUTION

That the Surgeon General established a Committee on Environmental Health Problems during August 1961, is believed worthy of mention because these problems relate to wildlife conservation. Members of the Wilson Society may wish to examine the published report of the Committee on Environmental Health Problems (U.S. Pub. Health Ser., 1962). The Committee (U.S. Pub. Health Ser., 1962:1) concluded:

> That a national need exists for establishment and maintenance of a vigorous and integrated effort to maintain controls over the human environment compatible with projections of change in both population and the environment itself.

That the current "categorical" approaches represented by Public Health Service divisional programs are incapable of providing either (*a*) the necessary cognizance of combined multiple effects of environmental impacts or (*b*) the depth of effort required by individual divisional programs.

That accommodation to the national needs in environmental health will require the establishment of a strong focal center adequately staffed and equipped to prosecute an effective and integrated program within the Public Health Service and to manage and coordinate a strong extra-mural research, training, and technical support program utilizing the available institutional resources of the nation.

That an adequate legislative basis for a sufficient national program in environmental health does not exist at present.

Pesticides.—The thorough review of the effects of insecticides on terrestrial bird life in the Middle West by Hickey (1961) leaves only relatively recent developments for evaluation by the Committee. In addition to Hickey's review, Brown's (1961) appraisal of mass insect-control programs is recommended for reading.

The National Academy of Sciences-National Research Council has published reports (Part I, Evaluation of Pesticide-Wildlife Problems, and Part II, Policy and procedures for Pest Control, designated Publication 920-A and Publication 920-B, respectively) by two subcommittees of the Academy's Committee on Pest Control and Wildlife-Relationships. They may be obtained from the Printing and Publishing Office, NAS-NRC, 2101 Constitution Avenue, Washington, D.C., at $1.25 each.

Part I, Evaluation of Pesticide Wildlife Problems, has been examined. We are disappointed in it. The stature of the National Academy of Sciences-National Research Council will not be enhanced by this publication. The fear expressed in the last annual report of the Conservation Committee (Scott et al., 1961:316) is realized. The report is neither detailed nor documented, and there is a stiffness about it which marks it as a forced compromise instead of an unbiased, philosophical evaluation of the problem. Perhaps this could have been avoided if the report had been prepared by scholars who were not so closely associated with the problem. An important theme centers around a defense of pesticides. No one stands to profit from this, and something is lost. The problem, as we see it, does not lie with whether the wise use of pesticides in general is justifiable. The problem lies in the question of whether the utmost intelligence is employed in decisions to use or not to use a pesticide in a particular situation and, if so, whether operating specifications such as kind and form of pesticide, rate of application, time of application, etc., reflect consideration of wildlife and other values.

With the announcement of the formation of a Federal Pest Control Review Board, 1 October 1961, another step was taken toward reduction of inconsistencies in federal policy.

By contrast with the National Academy of Sciences-National Research Council study of pest control and wildlife relationships, we hold forth more hope for improvement of this serious problem through the work of the Federal Pest Control Review Board. While the Board is advisory in nature, it was established at the request of the President and also reflects the authority of the offices of the participating Secretaries. The Board consists of two members from each of the following Departments: Agriculture, Defense, Interior, and Health, Education, and Welfare. The establishment of this Review Board provides wholesome evidence of recognition of an important problem. It has enormous potential for public good. It is to be hoped that the committee will prove effective in eliminating, or at least restraining, large-scale pest control operations which are poorly conceived or poorly executed and which ignore or neglect wildlife and other values. It is probable that the action of the Board will also affect state control operations by setting an example of carefully planned and executed control measures and by the fact that many large-scale operations constitute cooperative federal and state programs.

Further evidence of concern for coordination is the establishment of a National Mosquito Control-Fish and Wildlife Coordination Committee. The objectives of the committee have been set forth as:

1. Coordinate mosquito control and fish and wildlife management policies on national, state, and local levels.
2. Gather and disseminate relevant information and suggest standards on mosquito-control techniques consistent with sound fish- and wildlife-management objectives.
3. Gather and disseminate relevant information and suggest standards on fish- and wildlife-management techniques consistent with sound mosquito-control objectives.
4. Stimulate needed research and demonstration projects relating to mosquito-control and fish- and wildlife-management practices.
5. Sponsor suitable meetings to further the purposes of this Committee.
6. Cooperate with agencies, organizations, and all others whose activities and interests may relate to those of this Committee.

There has been a continuing failure of Midwest entomologists to explain why sanitation programs will not work in this region without complementary use of insecticides in the control of Dutch elm disease. A small trend toward the substitution of methoxychlor for DDT should give some relief to the songbird populations that have been decimated by heavy applications of DDT in Middle Western cities and their suburbs; but the long-term effects of DDT usage have yet to be evaluated under Midwest conditions. In the eyes of wildlife conservationists, the DED-control program in this region continues to remain in a state of confusion.

Oil.—Last year the Conservation Committee reported that the *International Convention for Prevention of the Pollution of the Sea by Oil, 1954*, had received the necessary two-thirds favorable vote of the Senate for international treaties on 16 May 1961, and that formal ratification was awaiting implementing legislation. This legislation was provided when the Senate passed S. 2187 on 14 August 1961, and when the House passed an identical measure, H.R. 8152, on 21 August 1961. It received formal ratification and became Public Law 87-167 when signed by the President on 30 August 1961. The instrument of acceptance was deposited with the Intergovernmental Maritime Consultative Organization on 8 September 1961. It came into force with regard to the United States three months later on 8 December 1961. The terms of the law make "it unlawful to discharge oil in zones varying from 20 to 100 miles from coast lines except under specified conditions" (Natl. Aud. Soc., 1961*c*). It seems apparent that this law will mitigate against mortality among marine birds. The nature and extent of damage caused by oil pollution of the seas has recently been reviewed by Hawkes (1961). It will not affect potential oil pollution from tankers sunk during World War II for which

> it is estimated that 15 to 20 years may pass before sea pressure finally bursts the steel casings to release hundreds of gallons of imprisoned oil (Tottenham, 1959:28).

We must not forget that bird mortality resulting from oil pollution is not limited to the high seas. In January of 1962, about 1,000 ducks, Mallards (5%) and Black Ducks (95%), were estimated to have been killed by oil pollution in Peoria Lake along the Illinois River. Hunt (1961:25) concluded from examination of 2,173 dead ducks on the lower Detroit River during seven winters that about 21 per cent had died from oil pollution. R. W. Vaught of the Missouri Conservation Commission, on 20–21 December 1961, while investigating a report of ducks and geese rendered flightless along the

Missouri River found evidence of some oil pollution from Jefferson City to Kansas City, the oil slick being virtually bank to bank from Boonville to Miami (unpubl. rept.). Twenty-four oil-soaked Blue and Snow Geese were collected. Three of 40 to 50 Mallards seen were oil-soaked.

Federal Water Pollution Control Act.—During 1961, the 87th Congress amended the Federal Water Pollution Control Act of 1956 to provide for more effective enforcement, expansion of research, increased financial assistance to interstate agencies, states, and municipalities. The President signed this legislation into Public Law 87–88 on 20 July 1961. Appropriations to support the improved version of the Act were also approved. This will provide a means of restoring wildlife water areas which have become virtually unusable or hazardous as a result of excessive pollution.

Aquatic Pollution and Food Chains.—The effect of pollutants on aquatic-plant and animal-food organisms utilized by birds needs investigation. Frank C. Bellrose, Section of Wildlife Research, Illinois Natural History Survey, reports (Bellrose, personal communication) that populations of Ring-necked Ducks, Canvasbacks, Lesser Scaups, Goldeneyes, and Ruddy Ducks declined sharply in the Illinois River Valley from 1954 to 1955 while not declining similarly in the Mississippi River Valley. The average of peak numbers of Lesser Scaups and Canvasbacks for the period 1949–54 was reduced by 89 per cent and 94 per cent, respectively, for the period 1955–60 in the Illinois River Valley; by comparison, in the Mississippi River Valley the average of peak numbers of Lesser Scaups for the same 6-year period increased by 3.6 per cent and, for Canvasbacks, decreased by only 6 per cent. In the light of this, it is of interest to find evidence that the molluscan population in a bottomland lake along the Illinois River declined sharply between 1952 and 1954 and remained severely reduced during 1954–58 (Paloumpis and Starrett, 1960: 431–432). The latter investigators express the opinion that this was possibly a natural decline following overpopulation but concede that it also may have been induced by pollution of the river with one or more of the new organic chemical exotics such as detergents. Milton B. Trautman (personal communication 9 March 1962) is obtaining evidence in Ohio that "detergents are becoming an increasing threat to . . . fish life, both directly and indirectly through destruction of aquatic insects and other fish foods."

Research on Water Pollution.—A broad range of research is now in evidence on means of preventing or combating the effects of water pollution. Federal, state, and local governments as well as industrial groups are taking part in the effort to solve the complex problems caused by the discharge of foreign matter into lakes, rivers, and streams.

Of the two major sources of water pollution, sewage, and industrial waste, the latter presents the most problems. Accordingly, it is encouraging to note that industry is increasingly active in its efforts to safely dispose of its wastes. A spokesman for the National Association of Manufacturers recently stated that part of these efforts are in self-defense, but a great part are in self-interest. Many plants now being built are equipped with better facilities for treatment than required by law because it is more economical to plan them from the start than to add them later. Improved community relations are another important element in the reduction of water pollution by industry. The wood pulp and paper, fermentation, and petroleum industries are examples of industrial groups which have made significant advances in the reduction of their wastes (N.Y. *Times*, 25 March 1962).

CONTROL OF BIRD POPULATIONS

There is great need for caution in bird-control programs. This is another of those subjects which bring emotions into play, and action based on emotion must be avoided.

Buchheister (1961:174) refers to proposed legislation on bird-control programs in Connecticut which would remove protection from all species of birds "when in the act or when attempting to destroy cultivated crops." Such a proposal is unrealistic. Relatively few species of birds are likely to do notable damage to crops, and the proposed legislation mentioned, therefore, constitutes a step backward in civilized, practical conservation. On the other hand, the farmers' problem must be considered. While the nation must contend with crop surpluses, the individual farmer who loses part of his crop to bird depredation may be faced with bankruptcy. Most farmers cannot identify birds, except for very common species, so it is as unrealistic to designate by law the species from which he may protect his crops as it is to remove from protection "all species of birds."

Buchheister (1961:174) also points out that

> The fearsome lengths to which the "control" psychosis can go is indicated by a suggestion that has been made seriously by agricultural geneticists. Some geneticists have said, with reference to birds labeled as "farm pests," that the time is near at hand when an entire species may be eliminated through introduction of fatally defective genes.

It is a regrettable truism of human history that man does not always possess knowledge essential to the intelligent conduction of his action programs. The possibility of eliminating whole bird populations with gene-influencing techniques points up the question of the ecological relationship of one species to another; when we eliminate the one, what have we done to others in the same ecosystem? We continue to need basic deep-probing ecological research.

To further emphasize this need, we can point to the increasing interest in what might be called "positive bird control," the encouragement of high populations of certain species of birds for the purpose of predation on insects, that is, bird control for insect control. MacLellan (1961: 17–25) discussed an attempt to increase populations of *Dendrocopos* Woodpeckers in Nova Scotia orchards for the purpose of eliminating codling moths (*Carpocapsa pomonella*). It is pertinent to mention here the recent translation (to English) of a Russian (U.S.S.R., 1956) publication, "Ways and Means of Using Birds in Combatting Noxious Insects." At this point, we do not even know how to manipulate bird populations effectively and economically, let alone the effects of doing so, but manipulation of bird populations may ultimately prove more effective than the use of chemicals for controlling insects. In either case, caution cannot be overemphasized, because we are playing, so to speak, with ecological dynamite.

The problem of birds at airports continues to crop up and could, indeed, flare up at any time in the event of an accident. Barnes (1961:83–84) discusses this matter, pointing out a few incidents such as the closing of a runway at Idlewild Airport because of flocks of Tree Swallows in the area. He suggests that we have at least three responsibilities relating to the problem: (1) to aid in understanding the reasons why birds congregate on airports and how control of habitat may remove or reduce the danger; (2) to support sound measures for removing hazards to safety which involve birds; (3) to oppose ineffective programs which bring about the needless killing of birds. Again, we are dealing basically with an ecological problem—that of creating airport habitats which are not attractive to birds.

Throughout any appraisal of this problem, we are constantly reminded of our continuing need for good, deep, ecological, and behavioral research to enable us to make intelligent recommendations for bird control.

ENDANGERED SPECIES AND SUBSPECIES

Giant Canada Goose.—Exciting news for bird conservationists has just been realized. It has long been assumed that the large race of the Canada Goose that once nested in the Great Plains of the United States—the Dakotas, Minnesota, and, presumably, adjacent Manitoba, and south to western Tennessee—has been extinct since around the turn of the century. Delacour (1951:5) described the race on the basis of early specimens and named it *Branta canadensis maxima.* Three years later he (Delacour, 1954:163) wrote: "The Giant Canada Goose appears to be extinct."

In January of this year, the Minnesota Department of Conservation with the cooperation of the U.S. Bureau of Sport Fisheries and Wildlife invited Harold C. Hanson of the Illinois Natural History Survey, Urbana, to study the Canada Geese wintering at Rochester, Minnesota. Dr. Hanson had been observing these geese each autumn for a number of years and was convinced on the basis of his 18 years of experience with Canada Geese of the Mississippi Flyway (*Branta canadensis interior*) that the geese at Rochester were indeed of a different population. Over a hundred of the geese that winter in the vicinity of Rochester, Minnesota, and roost nightly on the lake in the city park were studied and banded. Measurements, coloration, and weights of these geese agreed closely with Delacour's description of *Branta canadensis maxima.* Skins of the ten geese sacrificed for various studies were recently compared by Dr. Hanson with the series of *maxima* in the American Museum of Natural History, the National Museum, and the Chicago Museum of Natural History. His findings make it certain that the Rochester flock, now happily totaling 6,000 birds, is indeed *maxima.*

Prairie Chickens.—The Greater Prairie Chicken in Illinois, Indiana, Missouri, and Wisconsin remains in danger of local extirpation; however, considerable progress toward reduction of this danger has been made in Missouri and Wisconsin by acquisition and protection of undisturbed nesting areas.

Last winter, Frederick N. and Frances Hamerstrom reported a marked and very encouraging increase in the number of Wisconsin prairie chickens, largely a result of modification of habitat by predetermined design. Acquisition of key areas for chicken management is proceeding at an accelerated rate in the central part of the state, all of the funds being raised by private subscription. Much credit for this interesting program goes to Paul J. Olson of The Prairie Chicken Foundation and to Willis G. Sullivan of the Society of Typanuchus Cupido Pinneatus, Ltd. As of 1 March 1962, 3,300 acres had been acquired by these organizations and their conservation allies in Wisconsin at a total cost of $98,000.

Larry R. Gale, Chief, Division of Fish and Game, Missouri Conservation Commission, recently reported (letter to Max McGraw, 25 September 1961):

> Our surveys indicate that there are about 5,000 prairie chickens in Missouri, mainly in the southwestern part of the State. We have been well pleased with apparent increases in the numbers of chickens in that area recently.

A discouraging evaluation of the situation in Indiana has come from R. E. Mumford (personal communication, 1 March 1962) who believes that

> This species is about gone in Indiana, and there is absolutely no hope for it. . . . The remnant population, all on private land, is going to be further subjected to adverse land-use practices this spring, when one of the few remaining wintering areas will be plowed.

In Illinois, the breeding population was roughly estimated to have been about 2,000 birds in the spring of 1961, primarily in southeastern Illinois. The following table docu-

TABLE 1

POPULATION TRENDS FOR GREATER PRAIRIE CHICKENS IN INDIANA AND ILLINOIS AS INDICATED BY CENSUSES OF MALES ON BOOMING GROUNDS

Year	Number of booming males	
	State-wide counts in Indiana	Jasper County study area, Illinois
1936		76
1937		65
1938		90
1939		131
1940		67
1941		95
1942		66
1943		44
1944		58
1945		88
1946		92
1947		54
1948		37
1949		44
1950		37
1951	325	43
1952	221	40
1953	196	47
1954	184	38
1955	140	33
1956	119	29
1957	124	23
1958	92	23
1959	87	30
1960	49	28
1961	21	7

ments the decline of prairie chicken populations in Indiana and for one study area in Illinois. The data for Indiana were supplied by R. E. Mumford; those for Illinois by R. E. Yeatter.

Clarence Cottam (personal communication, 5 March 1962) recently appraised the status of the Attwater Prairie Chicken as follows:

> In the past 30 years, I suspect the Attwater has decreased by 90–95%. Its range, likewise, has shriveled almost proportionately. The species now occurs only in a number of disjunct localities. I fear it is on the road out unless progressive action is taken.

Eagles.—Growing concern about the status of the Bald Eagle led to a winter inventory in January 1961. The National Audubon Society (1961*d*) reported that the first inventory "produced an actual count of 3,642 eagles in the 48 contiguous states." These birds were largely concentrated in three areas: Middle West, 1,790 or 49 per cent; Pacific Northwest, 742 or 20 per cent; and Florida, 392 or 10 per cent. An inventory has not been attempted in Alaska. Because young Bald Eagles, until they develop the white head and tail feathers in their fourth year, arc killed by hunters mistaking them for the unprotected Golden Eagle which is being shot to supply a demand for eagle feathers among craft hobbyists and souvenir hunters, legislation to amend the Bald Eagle Act of 1940 has been introduced in the Senate (S.J. Res. 105) and the House of Representatives (H.J. Res. 479, 487, and 489). The Senate Joint Resolution is presently before the Senate Commerce Committee. H.J. Res. 489, the bill to protect the Golden Eagle was passed by the House on 2 April. It awaits Senate action.

King Rails.—Milton B. Trautman has reported concern over a drastic numerical decrease in the King Rail population in Ohio and othcr northern states. Between 1922 and 1930, Trautman (1940:229) obtained data indicating that more than 50 pairs of King Rails nested annually in the Buckeye Lake area, Ohio; thereafter, until 1940, there were 45 or fewer nesting pairs. The last breeding rails were two or possibly three pairs observed by Trautman in 1959 (personal communication, 9 March 1962). Inasmuch as many states have open seasons on rails, including the King Rail, it would seem highly desirable for ornithologists to give consideration to the status of the King Rail.

Two Eskimo Curlews were seen together near Galveston, Texas, by George H. Lowery on 31 March 1962. William B. Robertson (personal communication, 27 March 1962) advised that "Latest rcports this spring indicate that the Florida population of the Everglade Kite numbers 7 individuals."

List of Endangered American Birds.—Roger T. Peterson (personal communication, 24 February 1962) recently listed "North American birds which are cndangered because of low numbers or restrictive or demanding environmental conditions" as follows:

Nene
Kaloa (Hawaiian duck)
Laysan Duck (in good shape at the moment)
Tule White-fronted Goose
Aleutian Canada Goose
Mexican Duck
Ross' Goose (it must be watched, although probably not endangered)
Kirtland's Warbler (approximately 1,000 individuals at this time; well studied)
Bachman's Warbler (a puzzler)
Whooping Crane (receiving good attention)
Lesser Prairie Chicken
White Pelican (not endangered yet but should be reassessed)
Trumpeter Swan (perhaps safe now)
Puerto Rican Parrot
Harlequin Quail
Hudsonian Godwit (seems to be in much better shape now than a few years back)
Ivory-billed Woodpecker (any left? What about recent reports from east Texas?)
Swallow-tailed Kite
Everglade Kite (low U.S. population but abundant in the American tropics)
California Condor (being studied again by National Audubon Society)
Golden Eagle (What is the U.S. population? The Bald Eagle is being studied at this time but not thc Golden.)

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Editor of The Wilson Bulletin
H. LEWIS BATTS, JR.
Department of Biology
Kalamazoo College
Kalamazoo, Michigan

Ornithological Literature Editor
Olin Sewall Pettingill, Jr.
Laboratory of Ornithology, Cornell University, Ithaca, N.Y.

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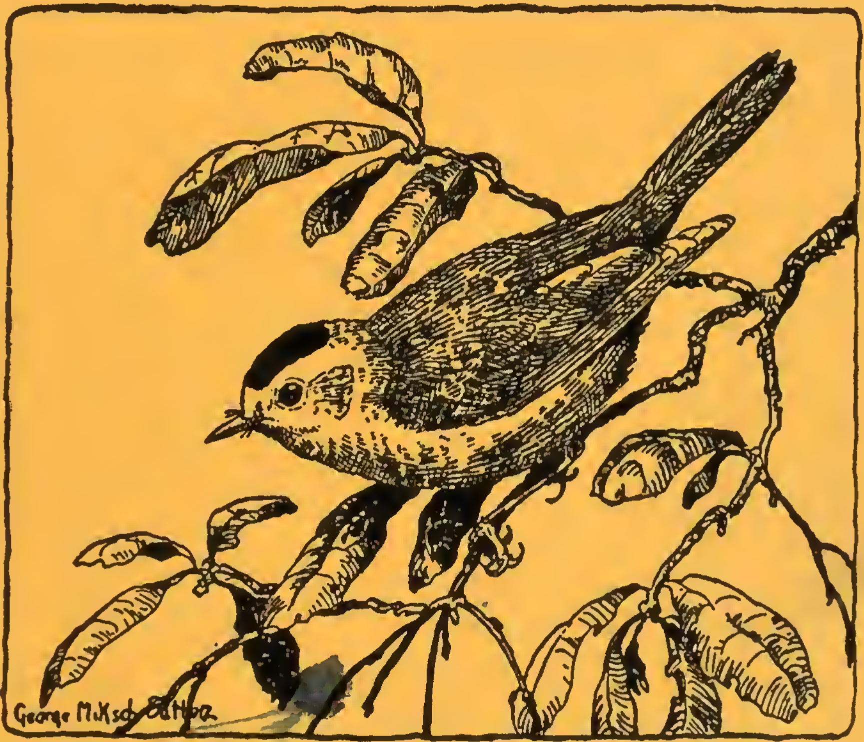

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CONTENTS

THE PREDATION OF GOSHAWKS UPON RUFFED GROUSE ON THE CLOQUET FOREST RESEARCH CENTER, MINNESOTA[1]

Robert L. Eng and Gordon W. Gullion

The Goshawk (*Accipiter gentilis*), normally nesting in remote boreal or montane forest regions, is seldom considered a significant problem in small game management programs. Darrow (*in* Bump, et al., 1947) considered the Goshawk to be unimportant as a predator upon Ruffed Grouse (*Bonasa umbellus*) in New York state, stating (p. 327), "During the winters in which goshawks appeared grouse kills attributable to them were found but the net effect on overwinter loss was not appreciable." Roberts (1936) and Grange (1948) similarly considered the Goshawk unimportant as a threat to small game populations because of its seasonal and/or sporadic appearance in areas where this species' depredations come into conflict with man's interests.

However, Edminster (1947:197) lists the Goshawk as a grouse predator of "primary importance" in the northeast, and notes (p. 206) "The goshawk is the one species of predator for which ruffed grouse furnishes a really big proportion of the food." He also comments (loc. cit.), "It may be fortunate for grouse that the goshawk is not more generally plentiful." Few reports dealing with the Ruffed Grouse and the factors causing decimation of its populations fail to mention the Goshawk.

Fisher (1893), and most subsequent authors discussing the Goshawk (including McAtee, 1935; Roberts, op. cit.; Bent, 1937; and Mendall, 1944) agree that the largest of the so-called "bird hawks" is bold and rapacious. Fisher (op. cit.:45) comments, "In some parts of the country the Goshawk hunts the ruffed grouse so persistently that it is known by the name of 'Partridge Hawk', and this bird probably has no worse enemy except man."

Nearly every report on the food habits of Goshawks lists a high incidence of small game species, particularly Ruffed Grouse, in the diet. Latham (1950) lists Ruffed Grouse as being one of the most frequent prey of Goshawks in the northeastern United States. In a listing (p. 8–9) of the contents of 1,105 Goshawk stomachs, Ruffed Grouse remains occurred in 255 instances (23 per cent of the stomachs). Only domestic poultry (with 301 occurrences) exceeded Ruffed Grouse in the sample. On the other hand Meng (1959) found remains of only five Ruffed Grouse among 185 prey items brought to 14 Goshawk nests studied in New York and Pennsylvania.

During the course of five years (1956–1961) of Ruffed Grouse investiga-

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[1] Paper No. 4592, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul, Minnesota.

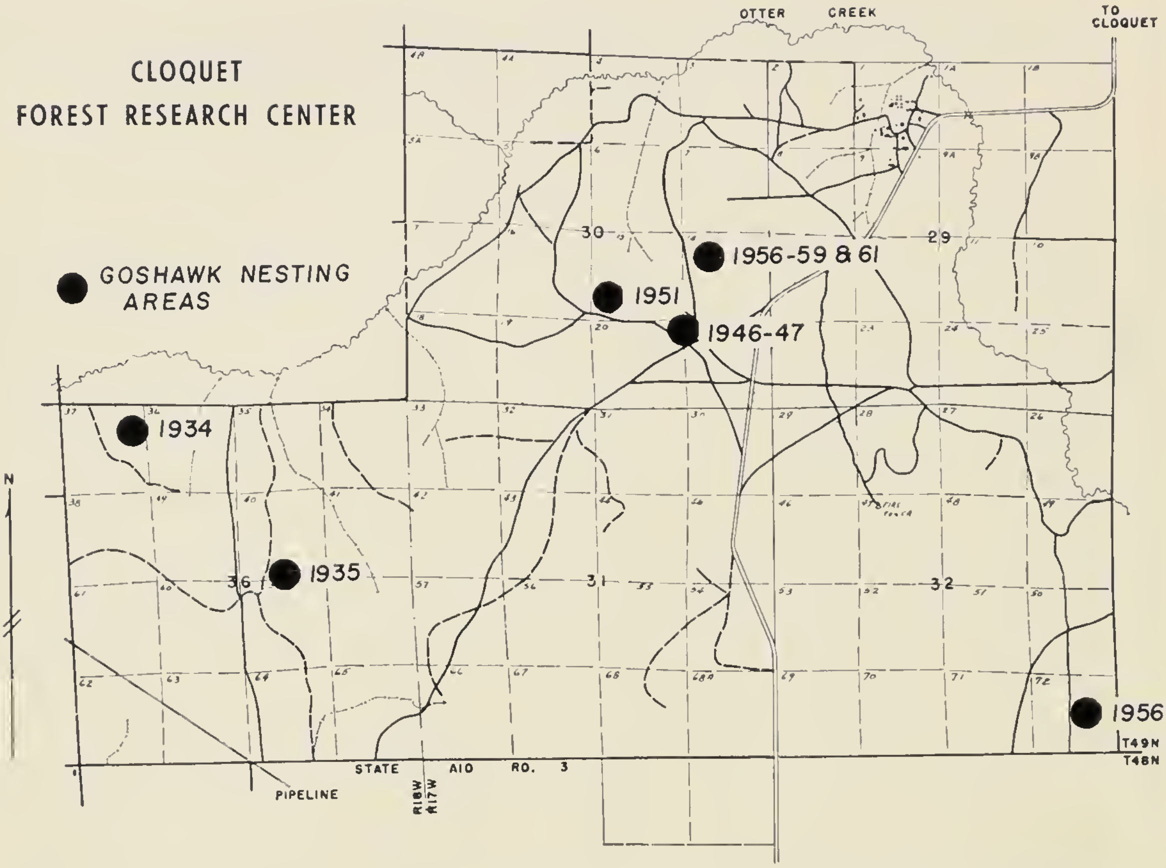

FIG. 1. Location and years of use of Goshawk nesting areas on the Cloquet Forest Research Center, Minnesota.

tions on the Cloquet Forest Research Center, 25 miles west of Duluth, Minnesota, we have had an opportunity to observe the depredations of Goshawks upon Ruffed Grouse, and to partially evaluate the effect of this predation upon over-all grouse populations (cf. Eng, 1959). This grouse population is essentially unhunted since the Research Forest is closed to small game hunting. The hunting harvest of grouse banded on this area is largely restricted to birds that have dispersed from the Forest.

HISTORICAL RECORD

Although Roberts (op. cit.:302–304) notes a scarcity of Goshawk nesting records for northern Minnesota, there is a 27-year history of Goshawk nesting on the Cloquet Research Forest (see Burcalow and Marshall, 1958, for a description of this area).

Morse (1934) reported the presence of a pair of nesting Goshawks on the western part of the Research Forest in 1934 (Fig. 1). In 1959, William L. Webb remarked (verbal communication) that Ralph T. King, formerly engaged in Ruffed Grouse research on this area, believed the 1934 record to be the first report of nesting Goshawks on the Research Forest. But ample evidence of Goshawk predation on Ruffed Grouse on this Forest is contained in King's unpublished notes as early as November 1931. Of 85 predator kills of grouse noted by King from 1931 to 1934, at least 10 appear to be characteristic of Goshawk predation.

From about 1936 to 1956, wildlife investigations were of sporadic nature on the Research Forest, and Goshawk records are scanty. Raymond A. Jensen recalls the presence of a Goshawk nest in the central part of the Forest in 1946 or 1947 and in 1951 (Fig. 1).

The current history of Goshawks on this area begins in 1956, with a pair of Goshawks nesting in the southeastern corner of the Forest (Fig. 1). Their three fledglings left the nest shortly before 26 July. Since this pair was present only one season, and apparently took few, if any, Ruffed Grouse during their nesting period, the remainder of the discussion will deal largely with the hawks nesting in the north-central part of the Forest.

From 1956 to 1961 a pair of Goshawks had a focal point of activity and their nests in an area of about five acres in the north-central part of the Forest (Fig. 1). These birds were not banded so we do not know that the same pair occupied this area throughout this period. The 1956 nest was about 25 feet up in a jack pine (*Pinus Banksiana*), and fledged at least three young. In 1957 the nest was 24 feet above the ground in a 50-foot 8″ dbh jack pine, and three young left the nest on about 20 July. The 1958 nest was 34 feet off the ground, in a 55-foot 8″ dbh jack pine, and fledged an unknown number of young. In 1959, the nest was 32 feet up in a 50-foot, 12″ dbh jack pine, and three fledglings left the nest on about 20 July. They used the 1959 nest again in 1961, rearing three young which left the nest in late June. The nests were all essentially as described by Bent (op. cit.:126–127), except that they have all been situated in jack pine, in preference to hardwoods.

In 1960, Goshawks were present on the Forest, but they did not utilize the nesting area occupied the preceding four years, and their activity center could not be located.

This nesting area is now classed as a jack-pine, pole-stage, heavily stocked forest type by forest management standards, consisting of a fairly dense mixed stand of 50–60-foot, 64-year-old jack and red pines (*Pinus resinosa*) (resembling in general character the situation studied by Schnell (1958) in California's Sierra Nevada). A few quaking aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) are scattered among the pines.

There are several small openings in the forest canopy 100 to 200 feet west of the nesting area, partly created by fallen aspen and pines. Several of these trees are broken, the trunks forming horizontal perches 2 to 6 feet above the ground (Fig. 2A). These perches have been favored by Goshawks for dismembering and devouring their prey, and it has been under these sites

Fig. 2. (A) Fallen tree regularly used as a "plucking" or feeding perch by Goshawks in the spring of 1961; (B) Typical remains of six Ruffed Grouse after Goshawks have finished feeding; (C) Drumming Log 19G2, as it appeared during the height of the drumming season in April 1959; (D) DL 19G2, after the surrounding vegetation has leafed out, in late May 1959. This log has been used by a different bird each spring since 1957. The drumming site is about one foot to the right of the target stake—as indicated by the pointer.

that we have found most of the prey remains (Fig. 2B). This area of about one acre in extent will be called the "feeding area" in the remainder of this paper (as distinguished from the "foraging range," the area over which the Goshawks hunt in search of prey).

Although Schnell (op. cit.:379) uses the term "plucking perch" to describe the horizontal logs used by Goshawks in their nesting area in California we cannot use this term on this Forest. since plucking of grouse (and most other prey) was invariably done afield, probably at or near the site of capture, and the perches in the feeding area were used for dismembering and devouring plucked prey.

METHOD OF OBTAINING DATA

Records of predator losses on the Cloquet Forest have been obtained in large part by forest management students from the St. Paul campus of the University of Minnesota, who spend a spring term on this Forest. Each team of two students is assigned part of the Forest to be forest-typed and inventoried, and it is during these activities that most of the predator-kill records are obtained. Since all upland parts of the Forest have been worked in approximately the same manner, by about the same number of students each of the years covered by this study, we believe that sampling has been fairly consistent. All kills reported by students have been examined by Wildlife Project personnel.

Determination of species responsible for predation is a problem. There has been little doubt as to the species involved in the 73 grouse remains found in the Goshawk feeding area, or among the grouse whose bands were found in bobcat scats, owl or Goshawk pellets, or where tracks were evident in the snow or dust. Among the remaining kills the presence of hawk or owl "whites" and plucked remiges, was considered indicative of raptor kills, whereas sheared remiges suggested mammalian predation. Goshawks frequently leave the larger grouse bones uneaten, such as the sternum and legs, whereas the larger owls seldom leave any scraps of meat or bone.

Goshawk feeding habits made the examination of their pellets and nests virtually useless in this area (in contrast to Meng's (op. cit.) dependence upon these sources for his data). The stripping of feathers from carcasses before they are brought to the feeding area, and the stripping of meat from the larger bones mean that little evidence of grouse remains can be expected in pellets (cf. Glading, et al., 1943). We did examine pellets whenever encountered for grouse bands. Also, as Table 1 demonstrates, less than 15 per cent of known grouse kills occurred while Goshawk nestlings were being fed.

One problem complicating the evaluation of the extent of Goshawk predation upon Ruffed Grouse is the matter of separation of remains. There undoubtedly were instances in which the plucked feathers from a kill were located at one site and the sternum, legs, bands or back-tag from the same grouse was counted again when recovered at the Goshawk feeding area. However, the percentage (25 per cent) of known banded grouse in the recorded kill compares favorably with the percentage of grouse known to be banded in the general population, and it is hard to believe that this duplication is too extensive. In the fall and winter of 1956–57, 40 per cent of the

TABLE 1

PERIOD OF KNOWN RUFFED GROUSE LOSSES TO GOSHAWKS

	Spring				Summer				Fall				Winter					
Year	Mar.	Apr.	May	?	June	July	Aug.	?	Sept.	Oct.	Nov.	?	Dec.	Jan.	Feb.	?	Unknown	Totals
1956	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2
1957	0	2	0	0	3	0	0	0	0	0	1	0	0	1	0	0	1	8
1958	1	8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	16*	30
1959	0	14	4	0	1	0	0	1	0	0	0	0	0	0	0	0	7†	27
1960	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4
1961	3	12	7	1	4	–	–	–	–	–	–	–	–	0	0	0	0	27
Totals	4	37	17	1	8	0	0	1	0	0	2	1	0	1	0	1	25	98

* These kills were made between August 1957 and 25 April 1958, three banded grouse included in this group were all alive as late as 10–19 October 1957—these were probably mostly spring, 1958, kills.

† These kills were made between 4 June 1958 and 10 April 1959—the one banded grouse included was believed to have survived the fall, 1958, drumming season, and to have been active in early April 1959.

192 grouse satisfactorily observed during field observations on the northeastern two square miles of the Forest proved to be back-tagged and/or banded. This figure climbed to 56 per cent of the 86 satisfactory observations in the fall and winter of 1957–58. (These figures for 1957–58 are believed comparable to the banded–unbanded ratio of preyed-upon grouse, since the observations sampled about one-third of the Goshawk foraging area, and there were probably few banded grouse in the unsampled area.)

SPECIES PREYED UPON BY GOSHAWKS

Systematic recording of prey species taken by Goshawks on the Forest has not been maintained, and often predator (and sometimes prey) species are uncertain. However, in addition to Ruffed Grouse, we have definite records of Goshawks taking snowshoe hares (*Lepus americanus*), cottontails (*Sylvilagus floridanus*), red squirrels (*Tamiasciurus hudsonicus*), flying squirrels (*Glaucomys* sp.), an unidentified duck (Mallard?), Blue-winged Teal (*Anas discors*), Common Nighthawks (*Chordeiles minor*), Pileated Woodpeckers (*Dryocopus pileatus*), Yellow-shafted Flickers (*Colaptes auratus*), Blue Jays (*Cyanocitta cristata*), Eastern Meadowlarks (*Sturnella magna*), and Robins (*Turdus migratorius*).

In 1956, 1959, and 1961, a significant portion of the remains found under the active Goshawk nests represented Common Crows (*Corvus brachyrhynchos*), although crows are not known to nest on the Forest or within three-quarters of a mile of the Goshawk nesting area. In 1956 the remains of no less than 11 to 13 crows were recovered from under the two Goshawk nests, and in 1959 at least 9 crows were fed to the hawk nestlings in the north-

TABLE 2

AGENTS RESPONSIBLE FOR KNOWN RUFFED GROUSE LOSSES ON THE CLOQUET FOREST RESEARCH CENTER, 1956–1961

Responsible agent	Total losses	Numbers of banded grouse taken	
		Total	Drumming ♂♂
Goshawk	98	24	15
Owls (mostly Horned)	17	6	6
Undetermined raptor	19	5	1
Fox	10	7	2
Bobcat	3	1	0
Undetermined mammal	10	5	3
Undetermined predator	14	3	1
Hunter kill*	16	12	12
Road kill	15	5	2
Miscellaneous and unknown†	30	12	8
Totals	232	80	50

* Hunter kills on or immediately adjacent to the Forest only; 10 more grouse which dispersed off the Forest have been taken by hunters.

† Mostly birds killed by predators in traps, and various accidental losses.

central area. The structure of bones and parts of mandibles recovered from these sites indicated that most of the crows were either nestlings or fledglings recently out of the nest.

PREDATION UPON RUFFED GROUSE

It is exceedingly difficult to assess fully the influence of Goshawk depredations upon Ruffed Grouse populations. However, our present data indicate that Goshawk predation constitutes the most important single factor decimating Ruffed Grouse populations on the Cloquet Research Forest.

From the spring of 1956 through the spring of 1961, 501 Ruffed Grouse were banded on the Research Forest. Of the 80 recoveries from among these banded grouse (to the end of June 1961), 24 (30 per cent) of the kills can be attributed to Goshawk predation. This compares with 12 (15 per cent) taken on or adjacent to the Forest by hunters; 27 (34 per cent) taken by all other predators; and 17 (21 per cent) lost to miscellaneous or unknown causes (see Table 2).

Among 232 records of grouse kills (banded and unbanded) on 3,352 acres during the study period, at least 98 (42 per cent) were the result of Goshawk activity. This represents 58 per cent of the kills attributed to non-human predators.

Sixty-three per cent of the banded grouse known to have been taken by Goshawks were males active in drumming activity centers (cf. Gullion, et al., 1962*a*). However, Goshawk predation is by no means restricted to the drumming males, although it appears to be somewhat heavier on this segment of the population. Ratio of identifiable remains (banded and unbanded) has been 141♂♂ : 100♀♀, which differs somewhat from the trapped bird ratio of 101♂♂ : 100♀♀ for this same period.

Of importance is the fact that recovered remains (from all decimating agents) have accounted for only about 24 per cent of the banded male Ruffed Grouse believed to have been lost from the Cloquet Forest population during the 1956–1960 period. Since male grouse normally spend the remainder of their life in a certain activity area once established in it, their disappearance and replacement by other males can generally be regarded as evidence that the missing birds are no longer extant (we have recorded at least one exception to this, however).

Using this information, plus other data, we have calculated that this one pair of Goshawks has killed approximately 190 grouse on this forest during 1956 to 1960. These figures are not exact, but are given merely to indicate the probable order of magnitude of this factor in the dynamics of this grouse population. Several assumptions have been made which may introduce an error of up to 20 per cent in the total figure. For example, there are an additional 19 records of grouse killed by unknown avian predators, and 14 more by totally unknown predators, some of which were probably Goshawk prey. Also, we do not know how many grouse have been taken into fox dens, leaving behind no trace of their fate.

Since Goshawks are seldom present on the Forest during the winter, most of this predation has occurred in the fall and spring, mostly during April and May (Table 1). This period is the drumming season for the male Ruffed Grouse, and is also the period during which cover is seasonally poorest. In 1959, for example, the ground was bare of snow shortly after the end of March, and the leaves of beaked hazel (*Corylus cornuta*) and bracken (*Pteridium aquilinum*), which provide the major cover for grouse in this Forest, did not become an effective canopy of cover until the last week in May (Fig. 2C & D). Also, during this early spring period there are only a few large prey species available to Goshawks, of which Ruffed Grouse are probably as readily available as any others. In May the arrival of migrant birds from the south provides a great diversity of prey species. This, coinciding with the development of vegetative cover, is reflected in the decided decrease in the numbers of grouse taken by Goshawks while feeding their nestlings.

AREA OF GOSHAWK INFLUENCE

Figure 3 shows the distribution of known Goshawk kills in the 1956–1961 period (and the location of unclassified raptor kills, some of which probably involved Goshawks). Among the 37 kills whose origin could be determined,

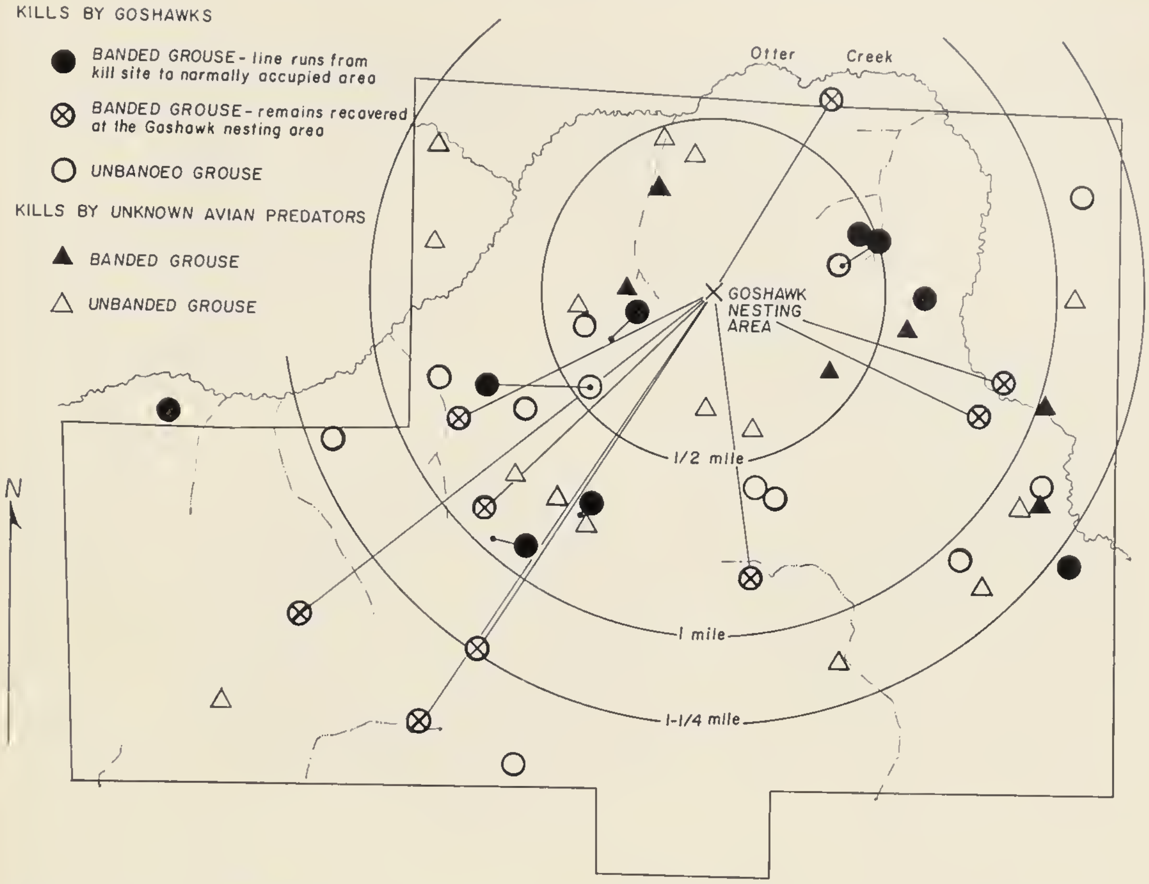

FIG. 3. The location of known Goshawk and unidentified avian predator kills of Ruffed Grouse on the Cloquet Forest Research Center, 1956–1961. Not shown are the remains of five banded grouse of unknown origin and 37 unbanded grouse recovered in the Goshawk nesting area.

all but five were made within a 1¼-mile radius of the Goshawk feeding area, and 26 of the kills were within a 1 mile radius. The nine banded males brought into the feeding area from their drumming territories were probably killed at distances ranging from approximately 3,600 to 8,250 feet (a mean distance of 5,460 feet) from the Goshawk nest. These data indicate that the Goshawks foraged primarily in an area of about 3,200 acres (5 square miles).

Of interest is the scarcity of records of banded grouse taken within a ½-mile radius of the feeding area. We believe that this reflects the effectiveness of the Goshawk predation within this area, indicating that grouse entering this area seldom survive long enough to be trapped and banded. In fact, grouse populations within this "circle of suppression" have been so consistently low that there has been little reason to conduct trapping within this area. Trapping, including mirror-trapping for drumming males, has been done at 16 sites within this circle in the past three years, producing 48 grouse (0.96 bird/acre), while within the next ¼-mile-wide concentric ring trapping has been carried on at 39 sites, resulting in the banding of 146 grouse (2.3 birds/acre).

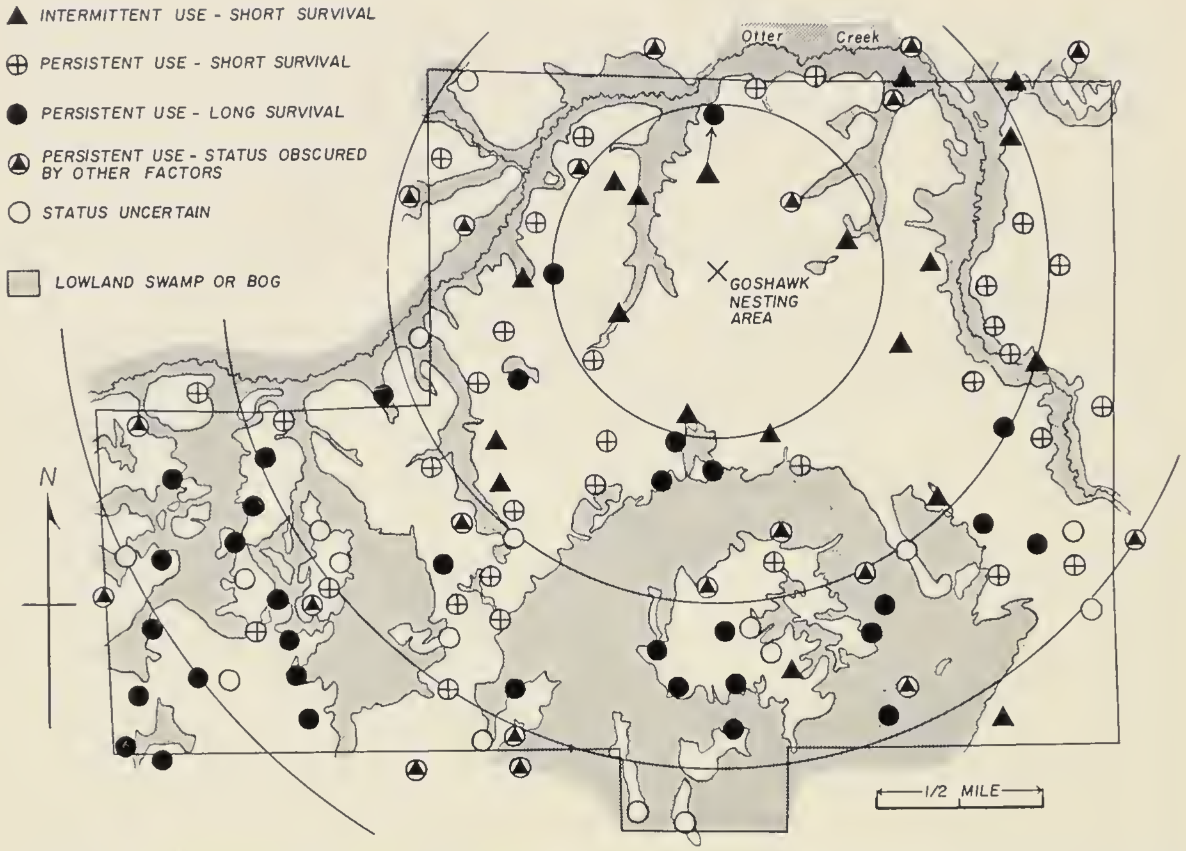

FIG. 4. Distribution and use of grouse drumming activity centers, and normal survival of male grouse occupying each activity center, in relation to distance from the Goshawk nesting area, Cloquet Forest Research Center, 1956–1960. Short survival is less than one full year of activity center occupancy; long survival means the drumming male survived to use his activity center at least a second spring. Intermittent use—activity center not occupied every spring; persistent use—activity center occupied every spring.

The efficiency of predation within this 1-mile-diameter "circle of suppression" is partially reflected by the scarcity of active drumming male grouse within this area. As shown in Fig. 4, this "circle" is the only extensive upland area on the Cloquet Forest which is nearly devoid of established drumming activity centers. In 1959, the 2,200 acres of upland on the Forest averaged one drumming male grouse per 34 acres, or one drumming male per 29 acres if the area of this "circle" is subtracted from the total. By contrast, in 1959, within the 448 acres of upland included in the "circle of suppression" there were only four actively and persistently drumming male grouse (all of these being located more than ¼ mile from the Goshawk feeding area, with a mean distance of 2,180 feet from this area), or one drumming activity center per 112 acres.

Table 3 presents another evaluation of the effectiveness of predation in relation to the distance drumming activity centers are located from the Goshawk feeding area (see also Fig. 4). In only one drumming activity center within the "circle of suppression" has a male grouse survived to drum

TABLE 3

SECURITY STATUS OF DRUMMING ACTIVITY CENTERS IN RELATION TO THEIR DISTANCE FROM GOSHAWK FEEDING AREA—CLOQUET FOREST RESEARCH CENTER

Distance from Goshawk feeding area (in miles)	Intermittent use—short survival	Persistent use—short survival	Persistent use —2+ years survival	Persistent use—status obscured by other factors	Status uncertain—short history	Totals
<½	5	1	1	1	0	8
½ to ¾	4	8	5	3	0	20
¾ to 1	6	9	1	6	2	24
1 to 1¼	2	6	7	1	4	20
1¼ to 1½	0	4	8	1	4	17
1½ to 1¾	1	2	4	5	3	15
1¾ to 2	0	1	5	1	2	9
2+	0	0	4	1	0	5

a second spring—this bird survived from the spring of 1957 to the winter of 1959–60. In fact, only one activity center (19G2) within this circle has been used perennially during the past 5 years, but by a different male grouse each spring (Fig. 2C–D).

As the radii from the feeding area lengthen, more drumming activity centers are persistently occupied. However, it is not until a radius of 1¼ miles is exceeded that we reach an area where the majority of the drumming males survive to drum a second year.

We do have some evidence which suggests the efficiency of predation within this "circle of suppression," and how rapidly the Goshawks remove any male grouse bold enough to drum within this area. During the spring of 1959, 11 forestry students were hired to be out early every morning throughout April, searching for new drumming logs, and recording activity on known logs. The efforts of these men, plus the two men currently working on the grouse research project (John J. Kupa and the junior author), resulted in intensive coverage of the entire Forest, which we believe succeeded in locating nearly every drumming grouse on or within ⅛ mile of the Research Forest (78 of the 82 male grouse located were trapped or identified). One of the results of this intensive coverage was the repeated crisscrossing of the area within ½ mile of the Goshawk feeding area by three different men.

One morning two grouse were heard drumming within about 800 feet of one another (at a point about 2,000 feet ENE of the Goshawk area). One bird was located at about 7 AM (CST), but by noon of that same day it had been taken by a Goshawk. The other bird's log was not located, and since another grouse immediately replaced the killed bird, we believe that the replacement was the second grouse.

Another drumming grouse was heard on two consecutive mornings in an area about 1,500 feet to the northwest of the Goshawk feeding area. This bird was not heard again, nor was his drumming site ever located.

At least two factors appear to contribute considerably toward the presence of this ½-mile "circle of suppression," namely the logistics involved in the activities of the Goshawk and the vegetation present in the area.

The first factor is apparent. The foraging trips from the focal point of Goshawk activity (nest and feeding area) would provide coverage in decreasing intensity outward from this point. Schnell (op. cit.:381) notes female Goshawks dropping directly off the nest to take nearby prey. Thus the area immediately adjacent to the nest would be subjected to the greatest degree of surveillance by the Goshawk.

The second factor concerns the cover type involved. Habitat on this forest most commonly used by drumming Ruffed Grouse (cf. Eng, op. cit.) consists of an upland type but often in the vicinity of an upland–lowland edge. This "circle" embraces a portion of the largest segment of continuous upland area on the forest (Fig. 4) and includes one of the more uniform stands of mature jack pine. Thus with the exception of the edge along the lowland in the west half of the "circle," this area cannot clearly be called high security Ruffed Grouse drumming habitat.

Forty-one drumming logs recorded from this area by Ralph T. King (MS) during the four seasons from 1931 to 1934, and the 22 drumming sites recorded by William H. Marshall (MS) between 1946 and 1953, possibly contradict the idea that this is a lower security area. Our records have shown but nine sites in this area during the six seasons from 1956 through 1961. However, the spring grouse densities reported by Marshall (1954) for the periods 1931–34 and 1946–53 included spring populations which were approximately three to five times the size of comparable populations observed by us during the 1956–61 period. Evidence is present (cf. Eng, op. cit.) to suggest that during population highs, additional drumming sites would undoubtedly be established in less secure areas, probably in adequate numbers to be observed even in the face of rapid removal due to this insecurity.

DISCUSSION AND CONCLUSIONS

Combining the data on the foraging radius of these Goshawks, plus that on survival of males occupying specific drumming activity centers, it seems apparent that this predation appreciably lowers the security of Ruffed Grouse living within the hawks' foraging range (an area of about 5 square miles).

There is possibly a significant suppression of the grouse population within a ½-mile radius of the hawks' feeding area. The data indicate that the Goshawks' foraging efforts regularly extended out to a radius of at least 1¼ miles from the nest, but with decreasing effectiveness. The area involved in the "circle of suppression" is approximately 16 per cent of that in the entire foraging area. We cannot accurately measure how much of this lower population within the ½-mile "circle of suppression" is due to less satisfactory habitat and how much is due to the effects of predation by a single species.

The predation by these Goshawks within their foraging range appears significant as a mortality factor in this grouse population. Over the past four seasons (1957–1960), the Goshawk toll is calculated to be at least 9.7 grouse per square mile per year, as compared to spring breeding populations of 21 to 28 grouse per square mile. Our first year fall-to-spring grouse population decline of each cohort exceeds 50 per cent, almost wholly due to natural mortality. Among the natural decimating factors, Goshawks have taken at least 58 per cent of known losses. Therefore, we can say with some certainty that Goshawk predation has been responsible for probably more than 50 per cent of the overwinter losses from each age class of Ruffed Grouse on the Cloquet Forest during the past several years, or a take equalling more than 25 per cent of each year's fall juvenile grouse population.

We cannot say whether or not this predation has seriously affected grouse population trends on this area. Our records show the population trends to be comparable to those in adjacent areas. On the other hand, a small area of depression could readily and fairly constantly be restocked by birds from surrounding areas, without a noticeable depression in numbers in these adjacent areas.

Although a reservoir of "non-drumming" males appears to exist in most Ruffed Grouse populations, this reservoir seems to be smaller within the area influenced by Goshawks, and replacement on logs is less certain (Fig. 3). In the area most affected by Goshawks there has been no replacement of lost drummers by adult males from the nondrumming reservoir, something that occurs occasionally in other areas. The regularity with which drumming grouse are taken from certain, specific logs, suggests that some sites may be subjected to more than random hunting.

One factor of probable importance in the effectiveness of Goshawk predation upon Ruffed Grouse on the Cloquet Forest has been the back-tagging of grouse to aid in field identification of individual birds, similar to the technique described by Blank and Ash (1956). Most of the back-tagging was done between the fall of 1956 and the spring of 1958, which coincides with the period of heaviest recorded grouse losses to Goshawks (Table 1). Other data on the survival of back-tagged grouse have shown it to be considerably less than for birds that are only leg banded (cf. Gullion, et al., 1962*b*). At least 17 of the 24 banded grouse taken by Goshawks were known to be back-tagged when taken, or shortly before.

The threat Goshawks pose to an area-wide Ruffed Grouse population is probably insignificant. These accipiters are comparatively rare and the scarcity of nesting records for Minnesota (cf. Roberts, loc. cit.) indicates that there are probably very few grouse populations subjected to this intensity of predation in this state. Only in 1956 did more than one pair of Goshawks nest on this Forest.

The seasonal heavy loss of the more vulnerable drumming males cannot be regarded a hazard to production since, even during the comparatively low grouse population encountered during this study, there was evidence of an ample reservoir of nondrumming replacement males in surrounding areas.

In conclusion, this study indicates that Goshawk predation in this area does not conflict with the management of this game bird for two reasons. Firstly, this refuge does not contribute significantly to the harvestable populations of grouse in the adjacent hunted area (cf. Gullion and Marshall, 1960). The lack of hunter competition for grouse on the refuge may even enhance the Goshawks' existence. Secondly, even in areas subjected to hunting pressure, the period of greatest predation on grouse by Goshawks occurs in the spring, well after the hunting season, and is directed primarily toward males. In the final analysis it seems probable that a large portion of the Ruffed Grouse lost to Goshawk predation in this general area represents surplus birds, many of which were available to, but not taken by hunters during the hunting season.

We do not agree with Meng's suggested conclusion (op. cit.:173) that Goshawks do not affect grouse abundance within local areas, and in fact "may even be instrumental in increasing the numbers of grouse by removing numerous crows." Whether or not grouse abundance influences the locale of Goshawk nesting cannot be answered, but it is certain on this Forest that Ruffed Grouse constitute a large proportion of the food consumed by Goshawks during the prenesting and incubation periods.

We do agree that the Goshawk should be afforded legal protection, not because it is a "harmless" predator, but because it is a noble, interesting and uncommon part of our nation's wildlife heritage.

Our rather limited observations on Goshawk nesting behavior generally agree with those reported by Zirrer (1947) and Schnell (op. cit.). Here the male appears to be in the nesting area more often than Schnell reported. On several occasions after nestlings were well grown the male was the only bird in the area when the nest was visited. He never attacked an intruder but always made a loud vocal protest while flying back and forth above the forest canopy. Frequently the female would return to the nest site within a few minutes, perhaps in response to the male's calling, and she would aggressively attack a single person in the vicinity of the nest, but only protested vocally if there were more than one person present.

SUMMARY

Ruffed Grouse investigations on the Cloquet Forest Research Center, Minnesota, from 1956 through 1961 have permitted observations on the predatory activities of Goshawks on this grouse. Intensive Ruffed Grouse population and banding studies plus continued occupancy of a Goshawk nesting and feeding site have provided the basis for these observations.

Goshawk predation was the most important single mortality factor for full-grown Ruffed Grouse in this unhunted population, accounting for 30 per cent of the known losses of banded grouse.

These losses were heaviest during the spring period when cover was considered to be lowest in quality and quantity. Male grouse, and more specifically males active in drumming activity centers, made up the largest segment of these losses.

Thirty-two of 37 grouse kills of known origin were made within 1¼ miles of the Goshawk feeding site. Twenty-six of these kills were within a one-mile radius. Nine banded males brought in from their drumming activity centers were probably killed at a mean distance of about 5,460 feet from the Goshawk nest site. Thus the Goshawk predatory efforts were extended to an area of about 5 square miles.

The data obtained suggested the presence of a "circle of suppression" with a ½-mile radius from the Goshawk nest and feeding area. Evidence is presented substantiating the existence of this area. The presence of this area is believed to be due in part to the increased coverage given it by the foraging Goshawks and to the quality of grouse habitat in the "circle."

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BEHAVIOR OF THE PURPLE MARTIN

Richard F. Johnston and John William Hardy

This paper is a descriptive account of reproductive, aggressive, and group behavior of Purple Martins (*Progne subis*). Both of us took field notes concurrently in 1959 and 1960 at a colony of Purple Martins in Lawrence, Douglas County, Kansas, and these notes form the chief materials of this report. Hardy has additional, qualitative notes on martins at a colony-house in Murphysboro, Jackson County, Illinois, covering the period 1938 to 1952. Both of us also used other colonies, chiefly in Kansas, to study certain matters that could not be studied at a single colony. The colony-house in Kansas had eight compartments and housed six pairs of martins both in 1959 and 1960. The colony-house in Illinois had 14 compartments. Notes were taken on the spot at the time of observation; 6× and 7× binoculars and a small tape recorder, from which notes were later transcribed onto paper, were also used. Birds were marked individually with paints and colored plastic leg-bands. Observations on contents of compartments were made possible by use of sliding panels on the compartments.

BREEDING SCHEDULE, PAIR-FORMATION, AND NEST-BUILDING

Breeding schedule.—The timing of events in the annual reproductive cycle of the Purple Martin is unusual in that the several activities are greatly spread out in time, compared with other birds. Purple Martins arrive in Kansas each year between 5 and 31 March; modal date of arrival is in the five-day period 21 to 25 March. Remarkably, it is not until after mid-May that eggs are laid, and the peak of egg-laying occurs in the first week of June. Thus, there is a time interval of about two months between dates of arrival and of egg-laying by martins. The prolonged gap between arrival and egg-laying could conceivably be due to either early arrival or late egg-laying (without attempting in these words to explain the gap). We may presume that timing of inception of breeding is partly a function of adaptation by the species to the seasonality of its food supply. Moreover, inception of breeding in May is advantageous in that the birds are able to meet the many hazards of late spring storms without the added responsibility of caring for eggs or young. Both of these considerations are useful in our thinking, for they emphasize that the known timing of breeding by martins has adaptive value. It is, as we shall see later, early arrival, rather than late breeding, that is responsible for the characteristic schedule of martins in spring.

A comparable schedule in spring is characteristic of the species in other regions of the United States. In Jackson County, Illinois, Hardy found that martins usually arrive between 5 and 15 March, and that most of the adult birds are established in colony-houses by 25 March; yet, egg-laying usually occurs from mid-May to early June. In the vicinity of Ann Arbor, Michigan, martins arrive in the first week of April and lay eggs in the first week of June (Allen and Nice, 1952:611, 624); in South Carolina, martins arrive in early or mid-February and lay eggs in late April and early May (Sprunt and Chamberlain, 1949:366–367); in Minnesota, martins arrive in the first week of April and lay eggs in late May and early June (Roberts, 1932:53); in Maine, martins arrive in late April and lay eggs in early or mid-June (Knight, 1908:450–451). The period between arrival and egg-laying at any locality is about two months. This is in contrast with other North American swallows at mid-latitudes, most of which show a period of four to six weeks between arrival and egg-laying at one locality.

We are aware of only one exception to the characteristic long delay between arrival and egg-laying in the martin, but this exception is an important one. In 1946, at Murphysboro, Illinois, Hardy recorded the first arrival of martins on 5 March; most adults were in residence by mid-March, nest-building began on 24 March, eggs were laid about mid-April, and young were on the wing by early June. The delay in 1946 was therefore about six weeks for some birds, and less for others, demonstrating that modification of the characteristic time-lag is possible. The significance of this unusual schedule lies in the fact that the growing season in southern Illinois was exceptionally early in 1946; the general climate was mild, warm temperatures predominated, and trees were fully leaved by early April.

An even more unusual response by the Illinois martins to the environment of that year was that a few birds had two broods; second sets of young were on the wing in late July and early August. Parenthetically, we may note that double-broodedness has heretofore been claimed for the Purple Martin only by Audubon (1832:119) for the southern United States, eliciting long-term discussion to the contrary (see Allen and Nice, 1952:624–625). Audubon said two broods were regular, rather than exceptional, and that three broods were raised in Louisiana; this must be discounted and attributed to excessive zeal (Lowery, 1955:376).

The information discussed above suggests that time of breeding is a correlate of favorable weather and its associated influence on the timing of the biological growing season. In the absence of quantitative data it is difficult to assign chief importance to any one environmental factor or to any set of such factors, but we assume that unusual, mild weather and an early growing season are closely associated with an unusual, early breeding season in martins. By extension, we also assume that normal weather and regular timing of the growing season are associated with regular timing of breeding in martins.

Schedules of breeding of martins in northeastern Kansas are what would be expected on the basis of evidence on breeding of other swallows in the area. Data collected over several years concerning timing of breeding of five species of swallows in northeastern Kansas (Fig. 1) show that for all single-brooded species most clutches of eggs are laid in the first third of June, and the lone double-brooded species is not far from this in its first nesting effort. Such concordance in schedule in five related species suggests common response to dominant features of the general environment (those features that are factors of and responsible for the timing of the biological growing season). Because these breeding schedules show average responses of these birds to average environmental conditions, we feel reasonably sure that timing of egg-laying in the martin can be considered completely "normal." This allows us to focus on the significant aspect of the spring schedule of martins: the two-month delay between arrival and egg-laying is truly a result of early arrival, not late egg-laying.

A satisfactory case can be made for the thesis that early arrival of martins is related to problems involved in securing a nesting cavity, something with which secondary hole-nesters generally have to contend (see, for example, Nice, 1957:315). If this is true, the character of early arrival must be a result of intraspecific "competition" for nesting cavities in past time, prior to the relatively recent availability of man-made colony-houses. Up to a point, individuals arriving early have little difficulty in finding a hole-cavity for breeding; with a scarcity of cavities, late arrivals would find fewer breeding sites than early arrivals. Such differential distribution of breeding sites would tend to give early birds a pronounced reproductive advantage over late birds, and if the tendency to arrive early on breeding grounds were genetically based, "early" genotypes would eventually come to predominate in populations. Exceedingly early birds, on the other hand, would tend over all to leave fewer offspring than others, for such individuals are periodically eliminated by severe spring weather and associated starvation. We must at this time assume that general time of arrival in martins is genetically determined.

Some support for this idea comes from the migratory and breeding chronologies of Tree Swallows (*Iridoprocne bicolor*). In this species the time between arrival and egg-laying is also prolonged and is second in magnitude only to that of the martin (see Paynter, 1954:36). The Tree Swallow is the only other North American swallow that is basically a secondary tree-hole nester.

Formation of the pair-bond.—Perhaps one-quarter of adult pairs arrive in Kansas as pairs; formation of the pair-bond presumably has occurred the previous year, for we think it unlikely that pair-formation occurs away from

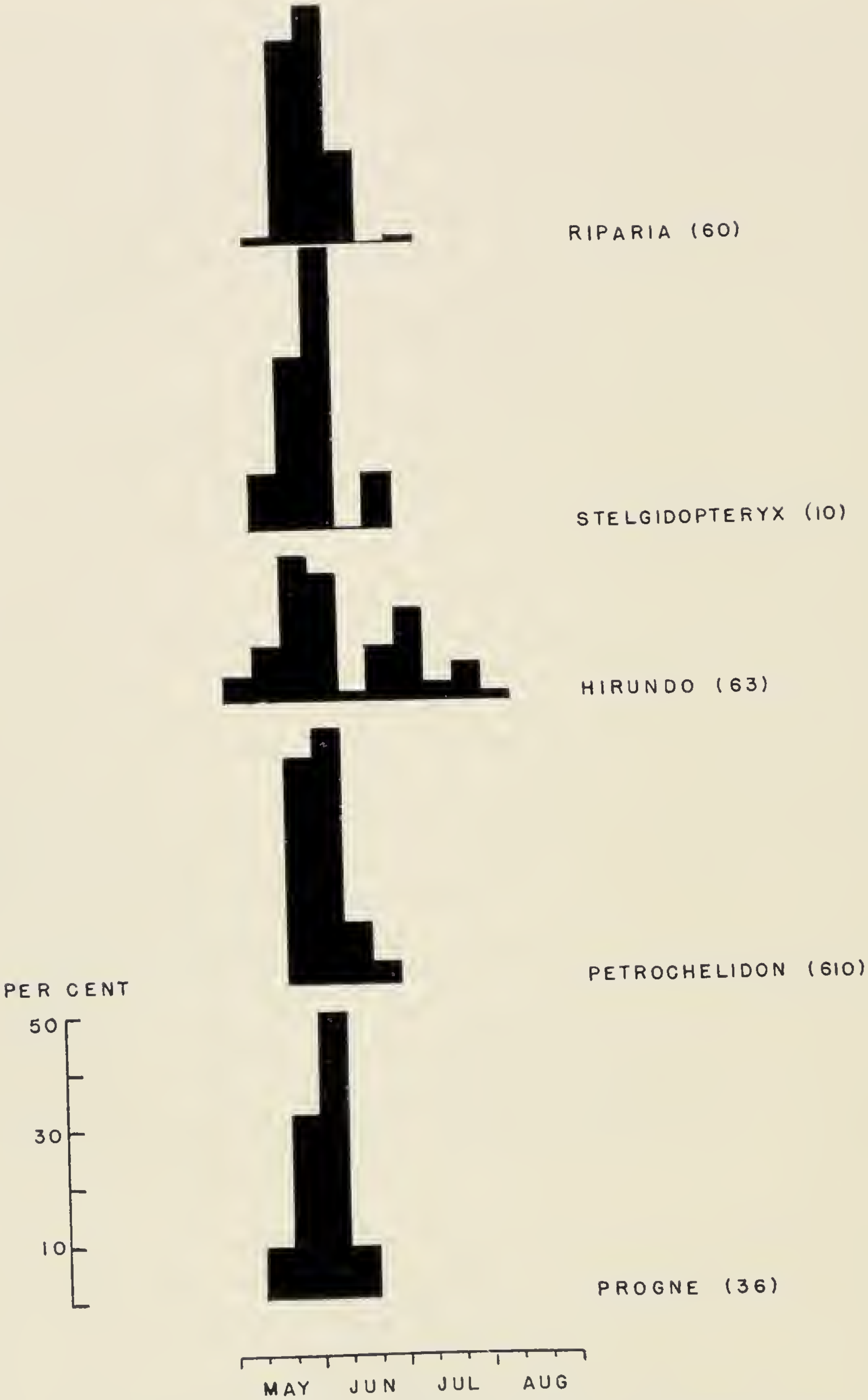

Fig. 1. Breeding seasons of five species of swallows in northeastern Kansas as indicated by dates of completion of clutches. Columns represent per cent frequency of clutch completion in 10-day intervals, with the 5th, 15th, and 25th of each month as medians. Single-peaked histograms for the Bank Swallow, Rough-winged Swallow, Cliff Swallow, and Purple Martin are representative of breeding seasons of single-brooded species; the bimodal histogram for the Barn Swallow is characteristic of a double-brooded species.

colony-houses. Nearly all birds arriving in the first migratory wave are paired on arrival, but those of later arrival are less frequently paired. All first-year birds seem to arrive without mates, and this supports the idea that pair-formation does not occur on wintering grounds. Unpaired birds, adults and first-year individuals alike, show varying degrees of a tendency toward sexual behavior. Those most likely to form pairs soon after arrival are those that seem least aggressive toward members of the opposite sex.

No postures of any degree of ritual expression are involved in epigamy; the vocalizations and physical attitudes are the same as those that result in the formation of temporary social units, such as groups "investigating" a set of nest boxes or groups engaged in preening or foraging. This is well to emphasize, because formation of pairs seems in part dependent on the fact that the birds engage in periodic flurries of group behavior. Yet, in the final analysis, it is not such group behavior that results in formation of the pair-bond; given the matrix of social interaction around colony-houses, the final establishment of a pair is a function of choice by a female.

The typical pair-bond comes about in the following way. A male sets up operations at one or two compartments in a colony-house; here he roosts, sits when calling to other martins, and acts aggressively in the presence of other males. Eventually, among the many females that periodically visit the colony-house, one or two display interest in the male and his site. Initially it is the site that seems to be most attractive to the females, but those sites lacking males are never used as much as those having males in attendance. Females go in and out of the boxes, fight among themselves, and accompany the male, and *vice versa*, in aerial activities. A male seems to show no preference for one female but is likely to encourage the entry of any female into a compartment; "encouragement" is effected by the male going into and out of the aperture, and by his profuse song and a display flight probably identical with the Claiming–Reclaiming display (which see below under aggressive behavior). These display flights often terminate in a dive toward and rapid entry into the compartment, and may serve to "steer" to the box females that seem on the verge of leaving the vicinity of the colony-house. In time the male and a female show some increased awareness of the presence of each other, and with no overt sign that a bond has been established, subsequently behave as a pair: they tend to forage, preen, loaf, and fly with the group together; they have elaborate "greeting" vocalizations; and they show excitement at seeing each other at a distance. It may take from three hours to three days for such a pair to become established, but in the absence of extensive observations on marked individuals we do not know what the most characteristic time period really is.

The events mentioned above that contribute to formation of the pair-bond are most evident in birds active in early morning hours, from dawn until 9:00 to 10:00 AM. It is in this time that the social activity of the flock is greatest, and the time that individual martins having weak bonds to the colony-house and to other individuals are most likely to strengthen these bonds. This is probably because all the resident birds are present, are strongly advertising their ownership of compartments, but at the same time are most active in encouraging the presence of new birds at the colony-house. The least aggressive birds can at this time appear to lose their equivocal behavior and assume the attitudes characteristic of established, resident birds.

Pair-bonds seemingly formed in morning hours are subject to a kind of test in the evening prior to roosting. At this time birds with established residency and strong pair-bonds act with an air of confidence and forcefully exhibit ownership of a part of the colony-house. More importantly, in the evening established birds show a lesser tendency to accept the presence of new pairs. Thus, new pair-bonds (and "residence-bonds") that seemed strong eight hours earlier can disintegrate at nightfall. Results of such disintegration vary; the pair may actually separate and occupy different compartments, one or both birds may depart, or they may attempt singly to crowd in with established pairs and usually end up roosting on porches of the colony-house.

Pair-formation, establishment of residence, and formation of the colony are closely bound together, as indicated above. The following examination of these activities will emphasize just how close such relationships can be.

In 1959, the first pair of adults, P-1, to establish residence at the colony-house of eight compartments showed marked aggressive behavior throughout the season. This behavior possibly was responsible for a relatively slow increase in colony size and the ultimate number of but six breeding pairs. Five of these were of first-year birds and only one of these managed to occupy a compartment on the side of the colony-house occupied by P-1. P-1 established residence on 10 April and initially claimed all eight compartments in the house, roosting at one time or another in most of them. Gradually they concentrated their activity on two compartments, one above the other, on the southeast side of the house.

A second pair of adults, P-2, arrived at the house shortly after P-1 and likewise showed preference for the southeast side of the house, although the entire northwest side was empty. There was much aggressive interference by P-1 into the activities of P-2, and consequently we were never certain that P-2 was firmly paired. They usually roosted in separate compartments and were nearly always silent, which may be taken as evidence of an equivocal relationship to each other and to the house. Male No. 2 frequently showed behavior typical of an established male in the morning, but his behavior at dusk was that of a nonresident.

Until 22 April P-2 was in evidence, but the two only occasionally showed attachment to one another. Once it seemed that they might roost together, but the male attacked the female, they fought, and eventually roosted in separate compartments. By 26 April P-2 had deserted the house. P-1 participated in the failure of P-2 to establish at the colony by occasionally preventing their entrance into compartments, causing them to fly from the house, and by interfering at their attempts at intrapair sociality.

On 22 April P-1 began to collect nesting material and to carry it to compartments on both sides of the house. However, by 26 April the building activity was confined to two compartments on the southeast side of the house. Other martins then became frequent visitors to the house. On 1 May another adult pair, P-3, appeared; P-3 seemed to have a strong pair-bond and they began to contend with P-1 for space on the southeast side of the house. The fighting was occasionally severe, but P-3 did acquire use of the two remaining compartments on the southeast side. Yet, conflict did not cease at this point, for P-3 also showed tendencies toward using all compartments on the southeast side. P-3 remained at the house only until early June.

The ultimate failure of P-3 to maintain residence probably was the result of their increased fighting with other birds, all of which were subadults. These increased in numbers after the second week in May. Adult birds are clearly dominant in aggression with younger birds, but as long as conditions of space permit, little conflict occurs between the two age groups. Thus, three first-year pairs became established on the northwest side of the house with no aggressive interaction from P-1 or P-3. Two of these pairs themselves attempted to hold the one remaining compartment on the northwest and vigorously attacked any birds attempting to claim the box.

This concerted action by these first-year pairs seemed to result in the fact that the next three males (all of the first year) that attempted to establish residence did so first on the southeast, where two compartments seemed to be available. The three males appeared in succession so that there was continual conflict on the southeast between them and P-1 and P-3. P-1 seemed to have no difficulty holding two compartments, but P-3 was unsuccessful. On 2 June all other established pairs had at least one egg, but P-3, the second pair to become established, had none.

P-3 did in fact maintain residence in the face of conflict with Male 6 (which left the colony) and Male 7 (which with great difficulty claimed the remaining compartment on the northwest), but deserted the colony following challenge from P-10, a first-year pair that of necessity tried to claim space on the southeast. P-10 eventually laid eggs in the compartment farthest from the main compartment of P-1.

The first-year pairs that established residence on the northwest side were intially represented by males and each was later joined by a female. There was no "competition" between males for females. In each instance females seemed to choose a combination of a male and compartment. Once a female for several days delayed "choice" between two males. The choice of one of the males was influenced by the intermittent hostility of the other male toward the female. Significantly, this male frequently prevented the female from entering his compartment.

We may summarize the main points concerning pair-formation and establishment of residence as follows:

(1) Males select compartments as sites of social and (ultimately) sexual activity.

(2) Being variably sporadic to concerted heterosexual group behavior allows individuals, chiefly females, to find sites of eventual sexual activity.

(3) Partial disappearance of dominant aggressive behavior in both sexes enhances formation of the pair-bond.

(4) Females have definitive control over pair-formation, because they choose a nest box–male combination, and not a male alone or a nest box alone.

These points apply equally to adults and first-year birds. It should be emphasized, however, that first-year birds arrive on breeding grounds later than adults and probably never, or infrequently, are paired on arrival. They avoid conflict with adults more often than adults avoid conflict with each other. Yet, first-year birds occasionally contend more readily against small numbers of established adults than against large numbers of established subadults. The description of pair-formation by Allen and Nice (1952:617–619) essentially agrees with ours.

It is evident that formation of the pair-bond can be relatively obscure, especially with any one pair, but the bond itself is not obscure; it is typical of pair-bonds found in migratory passerine birds. As such it differs notably from the pair-bonds of certain other swallows. Emlen (1954:28) wrote of "mutual tolerance" in Cliff Swallows (*Petrochelidon pyrrhonota*), a pair-bond similar to an armed truce, resulting from a welter of vague, early meetings, chaotic aggression, and site-tenacity. Peterson's remarks (1955:240–241) concerning Bank Swallows (*Riparia riparia*) suggest that this species has a pair-bond similar to that of the Cliff Swallow. It is possible that "mutual tolerance" describes a condition characteristic only of sexually isomorphic swallows. Adult martins are clearly dimorphic sexually: males know males from females, and *vice versa.* The important thing is that there is no ill-defined aggression in martins, as there is in Cliff Swallows; males treat females one way and males another. That the primary factor governing this dichotomous aggressive behavior is visual perception of sex is strongly indicated by the fact that adult males usually treat first-year males as though they were females, which they resemble in plumage.

However, visual perception of sex includes awareness both of morphological and behavioral characters. This is shown by the behavior of established adults toward the occasional male in adult plumage that arrives late in the season. These atypical adult males are not only late, as are first-year birds, but behave otherwise like younger birds. This may be due to a hormonal regime similar to that of first-year birds. In any event, although they are indistinguishable by plumage from adult males, they are reacted to by adults in precisely the same manner as are first-year birds, and they typically contend with first-year birds for space in the colony-house. On 12 May 1959, such an adult male appeared at the colony in Lawrence and began to investigate the northwest side of the house, where one empty compartment existed amid three others held by first-year birds. This adult ignored the southeast side of the house where two compartments were potentially available but where two pairs of adults were established. This late adult was eventually driven from the colony by actions of two first-year males that attempted to hold the empty compartment.

Nest-building.—Purple Martins start to bring nesting material to compartments about a month before eggs are laid. In 1959 building began on 22 April and first eggs were laid on 30 May; in 1960 building began on 16 April and first eggs were laid on 19 May. Typically, building proceeds for about three days, ceases for perhaps two weeks, and then is evident in morning hours until eggs are laid. Materials brought in the first three days include dead leaves, sticks, and papers; in the week or two prior to laying eggs, mud and sticks are brought, to form a relatively solid mat near the entry hole. The mat slopes toward the rear of the box and has a small, shallow cup.

Also just prior to laying eggs, and continuing through much of the time of incubation, pieces of fresh, green leaves are brought by both sexes to the nest. This material is not nesting material in one sense, for not only is the nest essentially completed when the pieces are brought, but the leaves are placed around the rim of the cup, not initially in the cup as Allen claimed (Allen and Nice, 1952:622). Eventually the pieces of leaves dry out, curl up and get worked into the body of the nest. Their primary function, however, is still to be determined; this function probably has nothing to do with nest-building. The oldest hypothesis concerning use of the leaves is that, as the leaves dry, moisture is given off that makes the microclimate of the eggs more nearly optimal. There is no good evidence that this is so.

Another, and more nearly plausible, hypothesis can be derived from the work of Dr. Frank W. Preston and Mr. Earl Shriver (personal communication). Preston and Shriver have been investigating the habit of certain hawks (Accipitridae) in bringing green tree limbs to nest sites in time of late incubation and feeding young. At present it appears that decay of the vegetation results in release of hydrocyanic acid, notably toxic to animals. The HCN is conceivably a control of numbers of the variable and numerous arthropod and bacterial parasites that habitually live in the detritus of a hawk's nest and which occasionally contribute to mortality of nestling hawks. A martin nest also offers an exceedingly rich medium in which parasites, chiefly bird mites in Kansas, develop large populations. It is possible that the green leaves brought by martins also release a fumigant and thus act as a check on the development of large populations of such parasites.

AGGRESSIVE BEHAVIOR

Aggression in Purple Martins is effected by a few simple postures and sounds. This is true when territory is being maintained and in interspecific exchanges. Aggressive behavior in martins may occasionally be as vigorous as any recorded in birds, but most often consists of postural and auditory threat. Although most birds rely on threat, rather than actual physical contact, the large role that threat plays in martin aggression seems particularly adaptive because these birds are organized at all times of the year into working social units: they migrate, roost, forage, preen, seek nesting material, etc., in flocks, and they breed in colonies. Any tendency toward a breaking up of such groups would presumably rank as non-adaptive. Thus, the only real instances of physical violence to be seen in martins result from flagrant trespass of the ultimate territorial bound, the nest box itself. Moreover, such flagrant trespass can itself be tolerated, and trespassers are frequently allowed to move away without being bitten, hit with wings, or otherwise assaulted.

Such variation in response to trespass is not an indication of territorial ambivalence in martins, for individuals do maintain areas of exclusive use in and around compartments. One of the first activities of the newly arrived male is to find and take possession of a compartment, or if early in the season, two nest boxes. The box itself and the perch around the entry hole are maintained by the male, and later the pair, for his or their exclusive use. Territorial agonism drops in intensity as eggs and young appear and the adults are occupied with primary breeding activities. The frequency of occurrence of intruders also drops at this time because most potential intruders are themselves occupied with breeding activities.

Artificial nest boxes probably only in part duplicate the naturally occurring cavities to which the birds are primarily adapted. The chief new element in the artificial situation is one of increase in colonial density, and it would be to this feature that martins might be expected to be least well adapted. Nevertheless, the only significant item of behavior supporting such expectation is the action of a strong male holding exclusively more than one compartment throughout one season. This conceivably can be considered not a true adaptation to colonial nesting, because it obviously prevents at least one additional pair from nesting and attempting to raise young. We think it is unlikely that this behavior is a part of a mechanism limiting density, for less than half the adult males behave in this fashion, and its incidence does not seem to rise under conditions of high density.

Postures.—The chief posture of threat may be called the Horizontal Threat posture: individuals orient on a perch so that the axes of their bodies run parallel with the surface on which they are perched, their necks are neither extended nor withdrawn, and their feathers are moderately appressed save for those of the nuchal area, which are usually erected in a short crest. The wings and tails are flicked upward repeatedly; such flicking is, however, typical of anxiety in any context, not only that associated with threatening attitudes. In territorial agonism singing is frequent. In a period of intense social activity around the colony-house, a frequently singing and aggressive male seems to proclaim residence by song; the more another male exhibits exploratory behavior toward the house or one of its compartments, the more vigorous and frequent is the song of the resident.

Song also accompanies another non-ritualized display that we call the Claiming–Reclaiming display. A male thus engaged exhibits occupancy of a compartment over and over again by repeatedly entering and emerging from the compartment, usually about as fast as he can move. This process is punctuated by occasional stops for song when the bird perches in the compartment and projects its head slightly through the hole. The bright yellow lining of the mouth is strikingly revealed by song in such a situation, for the color is emphasized by its contrast with the bird's dark head in the even darker hole.

Claiming and reclaiming of the compartment involves a flight display (which we consider also to be an element in group behavior). A male flies from the house, sails in a wide arc having as much as a half-mile radius, and abruptly returns to the house, terminating the flight in a steep dive with wings flapping as brakes in a curiously lowered fashion. In the same motion of landing the bird enters the compartment, turns, projects its head slightly from the hole, and sings vociferously. Claiming–Reclaiming as such seems to be chiefly a territorial display with some aggressive content. It probably prevents naive, nonresident birds from investigating an occupied compartment and thus eliminates one cause of physical contact. The behavior may also reinforce the bond of residence of the displaying bird.

On the other hand, the flight component of the Claiming–Reclaiming display unquestionably serves to attract other birds to the colony-house, especially early in the season. Such attraction is discussed below under considerations of group behavior.

The Gape, in which the mouth is opened widely directly toward an individual to be threatened and which is sometimes accompanied by a short lunge or feint, is used chiefly in high-intensity threat display. Gaping is also used under conditions of low-intensity threat, or interspecifically (most frequently with House Sparrows, *Passer domesticus*). In any such rendering, gaping is almost always effected from the Horizontal Threat posture with the bird standing on extended legs. Gaping sometimes precedes an actual attack; the Gape can therefore be considered to be a signal of intention to attack. Both sexes use the Gape. Females occasionally thereby threaten males, and the rare instances of females attacking males are always signaled by a Gape.

What may be called heterosexual gaping, wherein a squatting male gapes at a female (the reverse seems not to occur), seems to be of a different order of behavior, possibly related to solicitation of some thing or action, and is at present obscure. However, the male uses a posture characteristic of nestlings begging food, suggesting an "appeasement" display. "Appeasement" seemingly to reduce intraspecific aggression has been commented on for finches (Hinde, 1956:12–13). Hinde made the point that "appeasement" associated with connubial or courtship feeding has a possible function in habituating the male and female of a pair to one another. Although it is necessary to note the possible operation of such a mechanism in Purple Martins, because the posture suggests that of a fledgling begging for food, connubial feeding has never been recorded for these birds.

Bill-snapping, in which the mandibles are forcibly brought together in an audible, high-frequency *click*, is a frequent accompaniment of the feints or lunges from the Horizontal Threat posture; such snapping is less common than gaping.

The Stooped–Submissive posture is relatively infrequent but is one of the most distinctive attitudes of Purple Martins. It is assumed by a male that has been decisively defeated in an aggressive encounter with another male. The defeated martin flies with the upper back humped, with head lowered, and with the tail held low; the rectrices are abnormally constricted so that the tail resembles a tapered spine (Fig. 2). The action in flight is labored and seems to lack the coordination otherwise typical of martins. The bird may remain in this posture when perched; the wings are drooped and the crown feathers are greatly appressed. Such a posture may be maintained for a few seconds or as long as a half-hour. Emergence from the posture, however, is usually gradual. The posture seems to indicate complete defeat of the individual; it is significant that no further aggression is directed toward

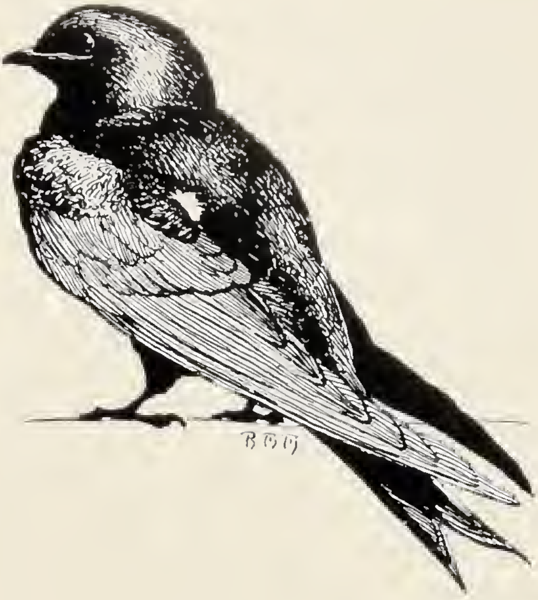

Fig. 2 (upper left). The Stooped–Submissive flight posture, a signal of defeat following a fight in male Purple Martins; abnormally uncoordinated flight and constricted rectrices are characteristic.

Fig. 3 (upper right). Male Purple Martin showing the white tuft of feathers exposed laterodorsally following scratching of the head.

Fig. 4 (lower). Sunning posture of the Purple Martin. There are various degrees of expression of this posture; the feathers of head and rump may be ruffled more extensively, the wings may be partly opened, and the bird may be lying nearly on its side. Drawing made from a 35 mm Ektachrome transparency.

Drawings by Robert M. Mengel.

the vanquished bird so long as it maintains the Stooped–Submissive posture. We have never seen a female martin in this posture.

Vocalizations.—The song of the male martin is a complex series of distinct notes running three or four seconds in time. An initial series of notes, most frequently just two (phonetically, *chürr*), is followed by two notes (*sweet*) of different quality, and is rounded off by a warbled set of heavy, guttural, but musical clicks. The song may be given in aggressive interchanges, in the greeting of a mate on its return, or in proclamation of territoriality. Only in aggression is the song rendered from the Horizontal Threat posture so that apparently the same set of sounds has different meanings when used with different postural attitudes and in different social situations. It is well to emphasize that the distinct elements of this complex song (but, chiefly the doublets) are frequently used by themselves, and usually not in aggressive exchanges; such use is described below under considerations of group behavior.

The notes of alarm, given when the birds are frightened by a hawk or cat or human are *kiv-kiv, kiv kiv keer keer keer keer, kiv keer keer. Kiv* is uninflected; *keer* has a downward inflection. The initial notes *kiv-kiv* may actually be the important notes of stress and alarm; the notes *keer*, etc., are given while the birds are in flight or engaged in mobbing the agent of alarm. *Kiv* and *keer* may also be given under conditions of intraspecific stress, but more commonly the birds use the social calls *chürr* and *sweet.* Infrequently (specifically, near a mounted dummy Long-eared Owl, *Asio otus*, placed near the colony), a note of possible alarm, probably denoting strong fear, is given; phonetically this is *yenk.*

The note of high-intensity aggression is *zwrack*! This note was used by a single male in aerial pursuit of a Sparrow Hawk (*Falco sparverius*) and by two birds harassing a House Wren (*Troglodytes aedon*) that ventured onto the colony-house.

There are minor differences between vocalizations of males and females and of adults and first-year birds. Most of the notes of females are slightly muffled counterparts of the notes of males. However, what seems to be the counterpart of male song in females is a hardly describable series of grunts, phonetically something like *gerunkee-gerui, gerunkee-gerui.* Hardy heard an adult male give this song once and also recorded a female, mated to an adult male, rendering a male-like song. The only consistent difference between vocalizations of first-year birds and adults is also in the song; the song of many first-year males is shorter than songs of most adults, lacking so full a series of guttural clicks in the terminal part.

GROUP BEHAVIOR

The Purple Martin maintains itself in groups of one kind or other at all times of the year, and, to paraphrase Köhler (1959), a single martin is not really a martin at all. Much of the behavior of the species is thus geared to forming or maintaining the several kinds of groups that may be evident in one day. We have already noted that some of the territorial mannerisms are attractive to other martins, as well as being responsible for spacing in the colony. Such duality in response to signal behavior is characteristic of martins, and is exactly the kind of behavior that would seem to be adaptive for a bird that on the one hand is monogamous and territorial and on the other hand colonial and group-oriented. We would like to emphasize that this duality in response is achieved without any apparent conflict in behavioral tendencies.

The generalized group.—This heading refers to the social units of martins that engage in loafing or resting, and in investigation of neighboring colonies. Individuals composing such groups are those recently arrived from wintering grounds or those recently completing breeding activities. Three birds is the minimum number of individuals in such groups but the upper limit cannot be effectively set; ordinarily less than 15 birds are involved. These generalized groups are usually conspicuous in the time prior to and coincident with pair-formation, but established pairs frequently join groups, especially as they move around to various colonies. It is difficult to assess just what the birds are doing in such activity; we know that they "investigate" neighboring colonies, but this in no way tells us what the birds are really doing. It is possible that some group interaction, of doing something in a group, is all that is involved. Yet, the birds in fact learn about their immediate environment (as, isolated food sources, disposition of neighboring colonies, the place of nearest water, etc.), and this is clearly adaptive. In the end, however, it is not obvious why a group has to be the behavioral unit; therefore, the moving, loafing, and chattering communication may be engaged in for their own sakes.

A few examples of activities of martins in early spring are of use in consideration of generalized groups. In February 1959, we established a new colony-house about a quarter of a mile from a set of three colony-houses, two of which had been used by martins for more than 15 years. A pair of martins and one or two other individuals appeared at the new house in late March and continued to visit for several days. On one or two occasions the pair roosted, but mostly their visits and those of the others were confined to early morning and evening hours. Meanwhile, by the second week in April, the three-house colony had increased to six pairs. In all this time the pair that occasionally roosted in the new house showed strong ties to the old colony-houses, and at dusk usually flew from the new house to the old houses to roost or to attempt to roost. This pair actually had difficulty finding a space at the old colony. So the birds went back and forth between the old and new colonies many times a day, and several times each evening, seemingly attracted by the concentration of their fellows (but finding competition for space rigorous) and at the same time also attracted by the new, suitable but, significantly, unoccupied house. For the first two weeks only one or two other martins ever accompanied the pair to the new house in midday; all of these were residents of the older colony.

The new colony-house ultimately attracted none of the birds already established at the older colony. Additional residents at the new house were adults and first-year birds that arrived late in migration, after the older, established colonies had acquired most of their residents. Gradually the one pair broke its social ties to the older colony, and, especially in midday, spent more time at the new house. Concurrently, more birds arrived and seemed to be partly responsible for the pair finally establishing residence at the new house; conversely, the pair in a real way attracted newly arrived birds to the new house. Late migrants probably always are attracted first to the old, thriving colonies, where most of the martin activity is actually occurring. Attempts to gain space at full colonies are, as has been described, severely discouraged, but at new houses such attempts are "encouraged," up to a point. So it is that in April and May the morning hours are taken up with these groups of birds visiting one house after another, remaining or leaving after investigation, depending partly on the availability of compartments not defended by residents.

One way that newly arrived birds learn about the availability of colonies at a distance is by means of the flight display of Claiming–Reclaiming activity, described earlier. Such flight seems to be initiated by a male when other martins are nearby but not right at the colony-house. Presence of the group may effect cessation of the behavior. In the absence of success in attracting other birds by means of this display, the flights are infrequent. Yet, some individuals persist in the behavior for prolonged periods of time without attracting other birds. Hardy saw a lone male use the display flight about 20 times within one hour in early March when no other martins were known to be in the area. Although one stimulus for such flight is presumptive availability of other birds, the autochthonously motivated flight is qualitatively identical with that used in the presence of other birds.

The last houses to be occupied are variously unsuitable, as ones with excessively small openings, ones with small compartments, ones situated too low to the ground, or ones packed with nesting material of House Sparrows and Starlings (*Sturnus vulgaris*). Suitable, new houses made available after the majority of adults have been established are also colonized late, as would be expected. One such house was erected in southern Illinois on 30 April. It was visited by an adult male for several days but finally was completely occupied by first-year birds, the first of which were attracted to the house by the actions of the adult male. First-year birds were seemingly attracted by adult males established nearby to two other houses erected in late May.

The criteria of suitability differ according to the histories of individual houses. An originally suitable house tends to keep its colony of birds, even after undesirable changes have occurred, such as trees growing up around the house, or heavy use of the house by Starlings. Yet, martins avoid houses that are unsuitable from the start. Also, houses originally unsuitable that have been modified to suitability without changing their locations may continue to be ignored by the birds. Such behavior by martins probably shows that habituation learning is an important modifier of the behavior of the birds; old birds tend to respond to a colony-house as if it were in the condition it was when they originally learned about it. There may also be "traditional" or nongenetic transmission of information about colony-houses from old birds to young birds.

Foraging.—Groups of martins forage together, especially early in the season of breeding. Birds most frequently fly at about 100 to 200 feet above the ground, but may operate from a few feet to more than 500 feet; the organization of flocks in flight is loose and fluid. There are social calls given by the birds when foraging, so it may be presumed that there are at least vocal attempts made to maintain a foraging flock. A real value can be attached to group foraging, particularly early in the year. A group of birds is more likely to find food of restricted occurrence than is a single bird. Small samples of data from northeastern Kansas strongly suggest that the food of martins in March and April is localized, and for these months group foraging would seem to be highly adaptive.

Preening.—Small groups, ordinarily but not necessarily from one colony, periodically engage in preening; preening usually follows a successful foraging bout and is most frequently seen in late afternoon. There is less vocal communication between preening and non-preening individuals than among any other groupings of martins. To compensate, as it were, for this lack of vocal signal another sign seems to be used; this signal is a patch of white feathers that is brought into view at the level of the tertial feathers on either side of midline following scratching of the head by a preening bird (Fig. 3). Martins bring their legs up and over their shoulders to reach their heads. In so doing a tuft of silky, white feathers on the anterior flank, ordinarily covered by the dark feathers of the middorsal region of the spinal feather tract, and, when perched, by the folded wing, is uncovered and brought to lie exposed laterodorsally. In adult males this white spot can be seen by a man from a distance of perhaps 50 yards, and in first-year males and females from nearly as great a distance, although the contrast is somewhat reduced.

The white tufts are never fully exposed except under the routine of movements associated with preening, but the tuft can be partly exposed under other conditions, as in a bird with ruffled feathers of the sunning posture (Fig. 4). It would thus seem that the significance of the white tuft is associated with preening and, because little vocal communication is involved with preening, the tuft could serve simply to indicate martins that are preening.

Sunning.—The least social behavior of Purple Martins is that of sunning.

Some other swallows engage in group or socially oriented sunning (Jon Barlow, unpublished field notes), but martins seems to restrict sunning behavior to individual efforts. Martins assume an obligatory, Level III posture in sunning, to use the terminology of Hauser (1957). The rump and head feathers are ruffled, the bird visibly pants with mouth agape and tongue extended, the wings are drooped, and the body is partly rolled over on one side (Fig. 4). The eyes remain open and there is no conspicuous action of the lids or nictitating membranes, in spite of the fact that one eye is exposed to direct sunlight. The posture can be held for three to five minutes in the absence of disturbance.

Colonial nesting and the Fraser Darling Effect.—In certain respects (extremely high density, restriction of territory to a small region around the nest, a tendency to maintain flocks at all times) Purple Martins are like various colonial sea birds in general pattern of nesting. Emlen (1952:196) maintained this to be true also for the Cliff Swallow and suggested that some social coordination of nesting phenomena was evident. Specifically, the synchronization of nesting activities, presumably enhancing reproductive success, "social facilitation" or the Fraser Darling Effect (Darling, 1938), was the chief element suggested by Emlen to be of consequence for Cliff Swallows. The Fraser Darling Effect has been cited by numerous workers as potentially operative in diverse species, and has received considerable recent attention; Fisher (1954) and Coulson and White (1956, 1960) have presented the only real evidence against its operation (in Fulmars, *Fulmarus glacialis*, and in Black-legged Kittiwakes, *Rissa tridactyla*), but others, notably Lehrman (1959:490), still feel that it is ethologically, if not ecologically, a useful construct.

Our evidence bearing on this point is ecological, as far as it goes. If the hypothesis concerning social facilitation were valid, we should expect Purple Martins to show (1) close synchrony of inception of breeding within any one colony, especially in large ones, (2) earlier breeding in large colonies and later breeding in small ones, and (3) a high efficiency in reproductive effort (best possible ratio between number of eggs laid and number of young fledged) in those colonies showing high degree of synchrony of breeding. The most interesting ramification of point 3 cannot be pursued here, due to lack of information, but points 1 and 2 are not supported by martins in northeastern Kansas.

The reason individual colonies lack synchrony to any phase of the breeding cycle is that adult and first-year birds alike are found in all colonies, and adults breed relatively early and first-year birds relatively late. There can be as much as a month's delay in any one phase of breeding in first-year birds *versus* adults. An implication of this is that a colony composed strictly of one age-class would show close synchrony in breeding effort; at present this would seem to be true, judging from the timing of inception of breeding in adults only or first-year birds only at a colony in fact composed of mixed age-classes. But, basically, no colony of any size shows real synchrony to inception of breeding or to any other phase of breeding. These observations are nearly parallel to those of Fisher and Coulson and White (op. cit.); namely, the relative timing of events and success in the breeding cycle is a function primarily of age, and any tendency toward colonial synchrony is a result of birds of like ages being together.

SUMMARY

This report describes some elements of the reproductive, aggressive, and group behavior of the Purple Martin in spring and summer in Kansas and Illinois.

Purple Martins arrive on breeding grounds some two months before they lay eggs. Such timing is unusual for a swallow and is a result of early arrival, for their breeding schedules seem to be wholly in line with schedules characteristic of other swallows in temperate North America. Early arrival is advantageous in securing a nesting cavity.

Formation of the pair-bond is accomplished without ritualization of behavioral elements. Pair-formation is a function of interaction between a male, a female, and a colony-site. Females exert ultimate control over pair-formation because they choose a nest-box–male combination, and not one of these alone.

Nest-building is sporadically engaged in for about a month prior to egg-laying. The green leaves brought to nests by both sexes may serve as a source of fumigant acting against ectoparasites developing in the detritus of the nest.

Aggression is effected by few and simple postural and auditory mechanisms. Horizontal Threat, Gaping, Bill-snapping, Claiming–Reclaiming, and several vocalizations are described. The Stooped–Submissive posture is a notable sign of defeat in a male martin.

Purple Martins operate at all times of the year in groups. Activities significant in formation of colonies include general investigatory behavior and Claiming–Reclaiming. Formation of preening groups seems to be facilitated by a white signal-mark on the backs of the birds. An obligatory (and probably nonsocial) sunning posture is described.

Social facilitation of reproductive activities seems not to be significant for Purple Martins. It is fairly clear that timing of the reproductive effort is partly dependent on ages of the birds, and any tendency toward colonial synchrony and increase in reproductive success is a result of birds of like ages being together.

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DEPARTMENT OF ZOOLOGY, THE UNIVERSITY OF KANSAS, LAWRENCE, AND DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CALIFORNIA, LOS ANGELES, CALIFORNIA, 25 APRIL 1961

OCCURRENCE OF EASTERN ENCEPHALITIS VIRUS IN HOUSE SPARROWS

L. N. Locke, J. E. Scanlon, R. J. Byrne, and J. O. Knisley, Jr.

During the late summer and fall of 1959 a die-off occurred among House Sparrows (*Passer domesticus*) in Prince George's County, Maryland, simultaneously with an epizootic of eastern equine encephalomyelitis (EEE) in horses on the Eastern Shore of Maryland (Bryne, et al., in press). This paper reports the results of our investigation of the sparrow die-off which may have been due to this viral disease and reports the first isolation of the EEE virus from House Sparrows collected in Maryland.

During the period 1950–1958 occasional reports of sick and dying House Sparrows were received at the Patuxent Wildlife Research Center, Laurel, Maryland. Some of the birds were subjected to extensive tests, but no diagnosis was made. Many of the others were received in too poor a condition for study. The reported symptoms of these birds were those characteristic of brain damage, chiefly circling or loss of coordination of movement and general malaise (personal communication from C. M. Herman, 1961).

On 15 July 1959, a sick adult male House Sparrow was received from John S. Frankenfeld, Glen Moore, Pennsylvania. The bird was extremely depressed, unable to fly or to hold its head erect. The vent was soiled with greenish feces. When the bird was placed on a hard surface it would tumble over onto its left side. It was placed in a cage for further observation. The bird became comatose and finally died on 17 July. Microscopic examination of sections taken from the cerebral cortex and from the cerebellum revealed no pathological changes. No diagnosis was made.

On 6 August 1959, sick and dying House Sparrows were reported from the vicinity of Laurel, Maryland. None of these sparrows was obtained for examination. During September. reports of sick or dead sparrows were received from Laurel, College Park, Oxon Hill, and the Agricultural Research Center, Beltsville, Maryland. A die-off among sparrows was reported in a rural area bordering the Patuxent Wildlife Research Center. The same general symptoms were reported. Upon investigation at the last site, three partially decomposed House Sparrows were found on a lawn. Two other carcasses. probably House Sparrows, were found beneath trees adjacent to the lawn. A neighbor reported that she had seen several sparrows behaving abnormally around her chicken yard. These sparrows exhibited incoordination, falling over when alighting, and flew with considerable difficulty. A few dead sparrows had been found.

On 15 September 1959, a sick male House Sparrow was received from Mrs. Fred Maxwell, Laurel, Maryland. This bird had been observed for two days at a bird-feeding station and had shown incoordination, as evidenced by falling forward after alighting on the feeding tray. When feeding on the ground, the sparrow used its wings to help support its weight. Gross examination showed the bird to be depressed and very thin; the feathers were badly ruffled; the beak was fouled with keratinous material; and the vent area was stained with greenish feces. The same premises were searched on the day the sick bird was received and a sick female sparrow was found huddled in a clump of greenbrier. This bird did not flush when found; it was captured by simply picking it up. It was extremely thin, and the beak was fouled with food debris and keratinous flakes. Both sparrows were brought to the laboratory for diagnostic tests.

The male had an impaction of the esophagus, but no other gross lesions. The female was grossly normal. Fecal smears of both were negative for coccidial oocysts. Nutrient agar and brilliant green agar plates, inoculated with fecal material, failed to demonstrate any *Salmonella.*

The liver of the female was placed in sterile saline and ground into a suspension. Two canaries were inoculated intramuscularly with this liver suspension. The left legs of two additional canaries were scarified and liver-suspension material rubbed into the bleeding area. All four canaries remained normal until 5 November, when they were killed. Grossly, the canaries were normal except for the healing scars on the scarified areas.

Absorbent paper discs were soaked in the heart blood of the female sparrow. These discs were forwarded to Dr. Robert P. Hanson, University of Wisconsin, who tested for evidence of Newcastle disease virus. None was found.

The spleens were frozen and subsequently tested for virus isolation by inoculation into day-old chicks. No evidence of virus was uncovered.

During the period 15–25 September 1959, seven apparently normal sparrows were collected at the Agricultural Research Center, Beltsville, Maryland, where sick birds had been reported. The spleens were removed aseptically and tested by inoculation into day-old chicks. All the inoculated chicks were moribund in 24 hours; their plasma, inoculated intracerebrally in adult mice, produced death in 48 hours. The virus thus isolated was reisolated several times from the sparrow spleens and the suspension was shown to be bacteria free. The agent was identified as EEE virus by serum-neutralization test (using adult white mice) and by hemagglutination-inhibition test.

DISCUSSION

Van Roekel and Clarke (1939) inoculated six House Sparrows intracerebrally with a brain-saline suspension of EEE virus prepared from a ninthserial-passage chick. The sparrows exhibited symptoms within 16 hours after injection. An initial period of reduced activity was followed by somnolence, inability to fly, marked weakness, prostration, coma, and death. Death occurred within 19 to 24 hours after inoculation. Davis (1940) found that the mosquito (*Aedes sollicitans*) was capable of infecting House Sparrows with EEE virus. Dardiri, et al. (1957), reported the isolation of eastern equine encephalitis from one of two dead sparrows collected on a game farm where several pheasants had died of the infection. These workers stated that several persons who raised game birds in Rhode Island had reported observing sick sparrows before and during an outbreak of encephalitis in pheasants.

In view of the known susceptibility of the House Sparrow to the virus of EEE, it seems likely that at least some of the sparrow deaths noted in Maryland in recent years were due to this virus. The isolation of EEE virus reported herein (the first from birds in Maryland) lends greater weight to this possibility. The isolation of virus from apparently healthy birds is in agreement with the findings of Stamm (1958) in Louisiana and Alabama and indicates the desirability of examining both apparently well and sick birds when an avian epizootic is suspected.

The Patuxent Wildlife Research Center has received several reports of birds exhibiting symptoms of incoordination, such as tumbling when alighting and flying abnormally. Although the "cataleptic fit" behavior of some kinds of birds, particularly chickadees (*Parus*), seems to be a response to nervous stress (Cade, 1953), such behavior by birds of other genera should prompt ornithologists to request virological assistance.

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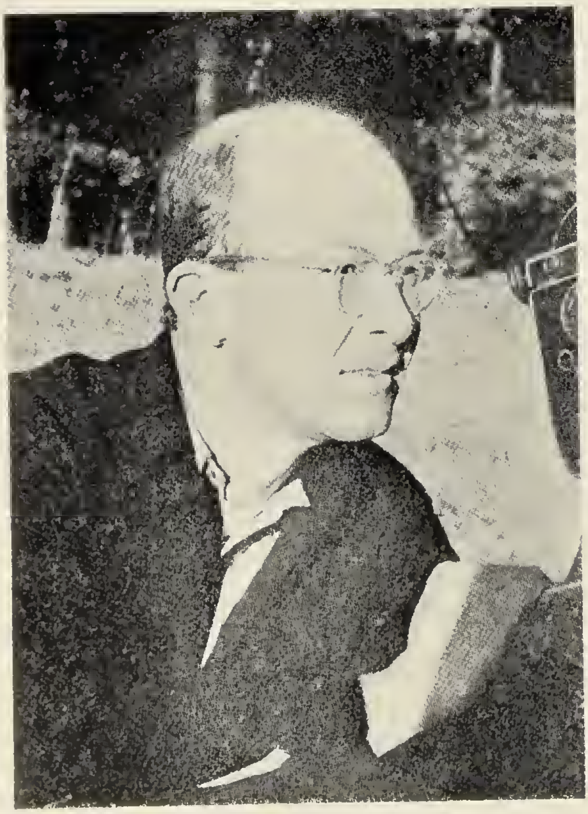
PATUXENT WILDLIFE RESEARCH CENTER, U.S. FISH AND WILDLIFE SERVICE, LAUREL, MARYLAND; DEPARTMENT OF ENTOMOLOGY, WALTER REED ARMY INSTITUTE OF RESEARCH, WASHINGTON, D.C.; DEPARTMENT OF VETERINARY SCIENCE, UNIVERSITY OF MARYLAND, COLLEGE PARK, MARYLAND; AND PATUXENT WILDLIFE RESEARCH CENTER, U.S. FISH AND WILDLIFE SERVICE, LAUREL, MARYLAND, 23 JUNE 1961

NEW LIFE MEMBER



William H. Drury, Jr., Director of Adult Education and Director of Research of the Massachusetts Audubon Society, is a new Life Member of the WOS, having been an active member since 1951. Dr. Drury is interested primarily in population problems and ecological aspects of behavior, chiefly of plovers. He has published numerous papers on these and related subjects. He studied in Haleybury College, England, one year and graduated from Harvard College with B.A. and Ph.D. degrees. His graduate research, following four years of service in the U.S. Navy, was in botany and his thesis was on the formation of bogs in the arctic. At present he is also a member of the AOU, BOU, Cooper Ornithological Society, Rhode Island, Massachusetts, and National Audubon Societies, Arctic Institute of North America, etc., and was secretary and later president of the Nuttall Club.

A COLLECTION OF BIRDS FROM THE SIERRA DE LAS MINAS, GUATEMALA

Hugh C. Land

From 7 July 1958 to 3 April 1959, I conducted a field study of the birds in the Sierra de las Minas and adjacent valleys in eastern Guatemala. I was assisted throughout this period by my wife Margaret and by Larry L. Wolf, and in March by Dr. and Mrs. Richard R. Graber.

The activities of the expedition included collecting specimens and gathering data on ecology, nesting, and behavior. The study area included parts of the departments of Zacapa, Izabal, Alta Vera Paz, and Baja Vera Paz. In the Sierra de las Minas above 3,500 feet elevation, the region covered in this paper, we listed 123 resident and 37 migratory species. Our studies in the humid lowlands north of the Sierra de las Minas (Polochic Valley) and the arid interior to the south (Motagua Valley) will be discussed in future reports.

Eighty miles long, 20 miles wide, and rising almost 2 miles above sea level, the "Mountain of the Mines" extends from San Jerónimo and Tactic in the Vera Paz highlands east to the village of Izabal. Just south of this lowland village it merges with the Sierra del Mico (a minor range reaching eastward 40 more miles before dipping into the Caribbean Sea).

Within the last six years two lumber roads were bulldozed up the south slope to elevations of about 7,000 feet. The present effect of lumbering operations on the pine forests is minor and local. Sporadic farming has been more important in destroying the original vegetation. However, virgin forest, or at least mature growth, still occurs throughout most of the mountains.

On the north slope of the range only a few foot trails exist. The best of these connects Río Hondo in the Motagua Valley to Zarco in the Polochic.

Geologically the Sierra de las Minas is made up of Paleozoic and Mesozoic deposits. Along with the Chiapas highlands and the *altos* of western Guatemala, this area formed a refuge for terrestrial life during the early Tertiary when other parts of Central America were inundated. The higher parts of the range have been available to vegetation since the end of the Cretaceous. As might be expected, many ancient forms of life persist here.

Daily temperatures vary with elevation from 100 F in the foothills to 50 F or lower on the ridges; there is little seasonal change. The northeast trade winds, which sweep in from the Caribbean continuously, annually deposit as much as 200 inches of rain on the windward side of the mountains. Rainfall is much reduced on the leeward slopes, especially at lower elevations.

Five collecting stations were utilized in the highlands. Because of the paucity of villages above 3,500 feet, several of the localities are identified with the name of a nearby lowland town.

Most of the field work was done on the south slope of the Minas above Usumatlán. At this locality we were able to climb to 9,400 feet, the highest peak in the immediate area. The visible ridges appear to be forested with pine. There is no alpine tundra in eastern Guatemala.

The other four collecting stations, all situated along the highway leading around the west end of the Sierra de las Minas, were utilized occasionally.

HIGHLAND COLLECTING STATIONS

(1) *Usumatlán.* Field work on the south slope of the Minas above Usumatlán was carried on during the following periods: 27 July to 7 August, 26 August to 9 September, 28 November to 24 December, 3 to 8 March.

Four major habitats occur at elevations from 4,000 feet to 9,400 feet: heavy brush, the direct result of recent farming and lumbering operations, extends from 4,500 to 6,500 feet; oak-pine, a brushy woodland covering much of the south slope of the mountains in the rain shadow of the higher ridges, is scattered from 4,000 to 8,000 feet; cloud forest is found on a nearly level shelf sloping from 6,400 to 7,000 feet, where poor drainage keeps the soil sufficiently moist to support a luxuriant growth; and, finally, a magnificent pine forest with a grassy understory forms a "park" on top of the Sierra de las Minas from 8,000 to 9,400 feet.

(2) *San Jerónimo.* The well-drained slopes of the ridge just south of San Jerónimo supports a pine forest; the top itself is more moist, and deciduous trees including oaks, sweet gum, and maples dominate.

Collecting was carried on from 3,500 to 5,000 feet on 29 September, 14 November, and 10 January.

(3) *Salamá.* The high terrain north of Salamá, the capital of the department of Baja Vera Paz, is covered by an extensive pine woodland from 4,500 to 6,500 feet.

Specimens were taken in this area on 30 September, 13 November, 11 January, 24 February, and 27 March.

(4) *Purulhá.* Field work was done in a narrow valley, the floor of which is nearly covered by a marsh several miles long. Two habitats received attention, the marsh and the brushy hillsides, both at 5,000 feet.

Collecting dates were 30 September, 13 November, 11 January, 24 February, and 27 March.

(5) *Tactic.* Only a few records were made near Tactic, mostly in humid forest from 4,800 to 5,000 feet.

Specimens were taken on 11 January and 24 February.

The only part of the year not covered by this study is the late spring and early summer. The number of observer-days (days in the field multiplied by the number in the party) totaled 241.

PREVIOUS COLLECTING

In July 1897, W. B. Richardson did some collecting in the Sierra de las Minas. Richardson's list, published by Griscom (1935), included 114 species, all from the broad locality "Sierra de las Minas," but including records from

TABLE 1

NUMBERS OF RESIDENT SPECIES BY FAMILY AND OF SPECIES LIMITED TO THE HIGHLANDS

Family	Resident Species	Highland Species	Family	Resident Species	Highland Species
Ardeidae	1	0	Dendrocolaptidae	4	3
Cathartidae	3	0	Furnariidae	2	1
Accipitridae	2	1	Formicariidae	1	0
Falconidae	1	0	Cotingidae	1	0
Cracidae	2	1	Tyrannidae	12	6
Phasianidae	2	2	Hirundinidae	1	1
Rallidae	1	0	Corvidae	4	3
Columbidae	4	1	Certhiidae	1	1
Psittacidae	2	1	Troglodytidae	5	2
Cuculidae	2	0	Mimidae	1	1
Strigidae	2	1	Turdidae	8	8
Caprimulgidae	2	0	Ptilogonatidae	1	1
Apodidae	2	1	Cyclarhidae	1	1
Trochilidae	12	10	Vireonidae	3	3
Trogonidae	3	2	Coerebidae	2	1
Alcedinidae	1	0	Parulidae	9	7
Momotidae	1	1	Icteridae	4	2
Ramphastidae	1	0	Thraupidae	2	2
Picidae	6	2	Fringillidae	11	6

the Motagua and Polochic Valleys. Griscom attempted to place each bird on the north or south slope of the mountain, or in the high country, on the basis of known habitat requirements of the species. In his list for the arid tropics (south slope of the Sierra and the Motagua Valley), he included the Plain Wren (*Thryothorus modestus*) and the Yellow-winged Tanager (*Thraupis abbas*), which we found common in the humid tropics north of the Minas and completely lacking in the arid tropics. Conversely, he listed the Clay-colored Robin (*Turdus grayi*) and the White-collared Seedeater (*Sporophila torqueola*) as occurring in the humid tropics only. Our records show these species to be common in both valleys. Minor differences of this sort serve to show the incompleteness of the data available to Griscom.

There are no other published accounts of specimens taken in the Sierra de las Minas, though some of the early specimens, labeled simply "Cobán," could have come from here.

DISCUSSION

Of the 37 transient species recorded in the highlands in the present study, only six were not found also in the lowlands near the mountains. These were:

Hammond's Flycatcher (*Empidonax hammondi*)

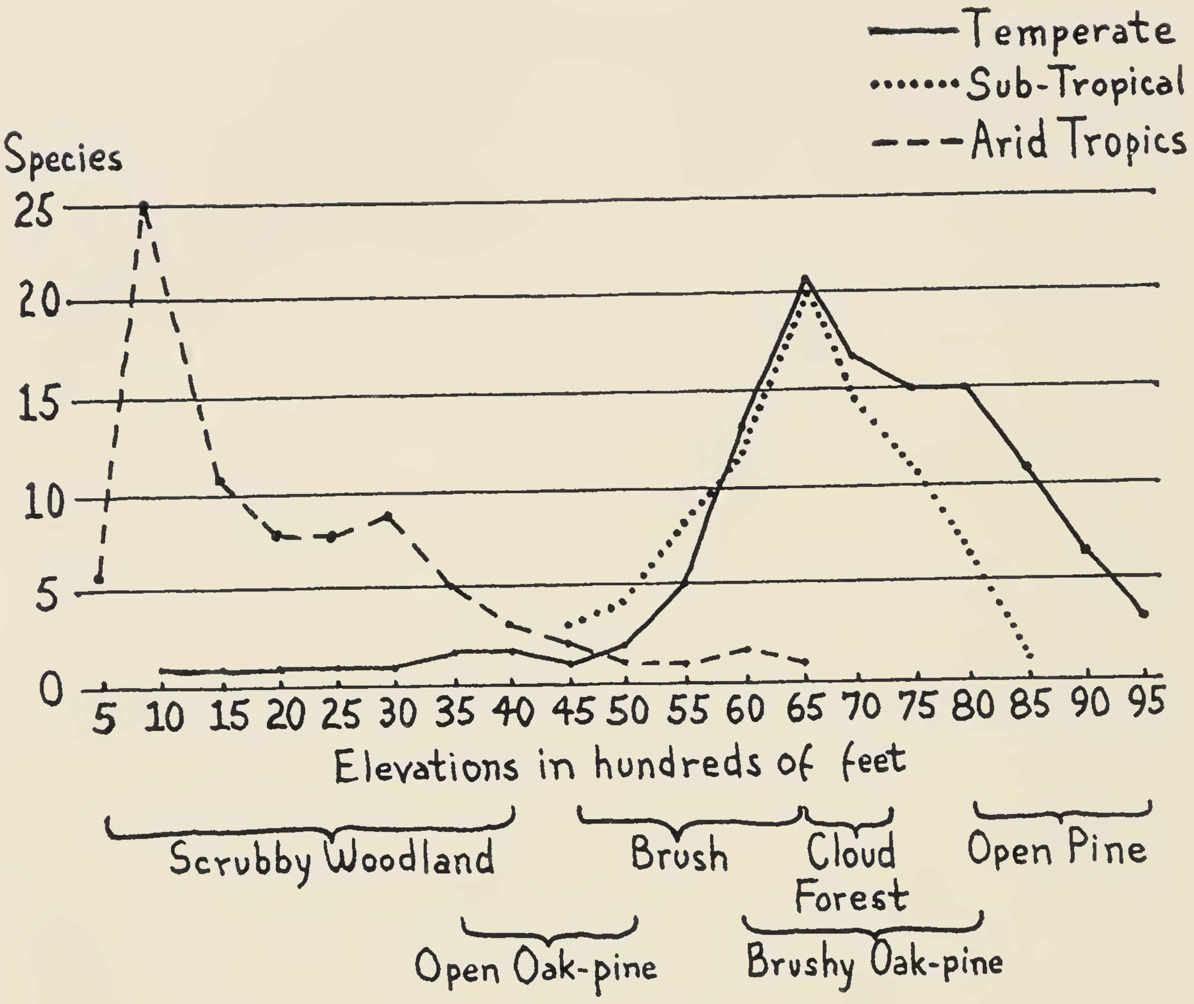


FIG. 1. The distribution of species within life zones and the major habitats on the south slope of the Sierra de las Minas.

Cedar Waxwing (*Bombycilla cedrorum*)
Audubon's Warbler (*Dendroica auduboni*)
Golden-cheeked Warbler (*Dendroica chrysoparia*)
Hermit Warbler (*Dendroica occidentalis*)
Lincoln's Sparrow (*Melospiza lincolni*)

The Cedar Waxwing has been found at lower elevation in other parts of Guatemala.

Sixty per cent, or 72, of the resident species found in the highlands did not occur in the adjacent lowlands. Table 1 gives the total number of breeding species in each family.

No attempt is made to divide the Sierra de las Minas into Subtropical and Temperate Zones. Griscom (1932:33) points out that the Subtropical Zone is poorly developed in Guatemala; this is certainly true on the south slope of the Sierra de las Minas. Figure 1 compares our elevational records of birds of three life zones. These zonal groups, based upon Griscom (1932:47, 54, and 67), are made up of species characteristic of (1) the high Temperate Zone, (2) the Subtropical Zone, and (3) the Arid Tropical Region. The latter area, which extends from the Motagua River up to 4,000 feet elevation, is included to show the transition from the lowlands to the highlands.

The distinctness between the Arid Tropical Region and the highlands is evident. However, the Subtropical and Temperate populations reside in nearly the same areas. Were the mountains greater in elevation, as in western Guatemala, a more distinct separation between life zones might exist.

ANNOTATED LIST

The following list covers all of the forms collected or recorded in the Sierra de las Minas by the present expedition. For each species the material is organized in this order: (1) common and scientific name; (2) localities at which specimens were taken and observations made (collecting stations are italicized); (3) altitudinal range (in forms occurring in the adjacent valleys as well as in the highlands, the lower elevation limit is given as "lowlands"); (4) relative abundance and major habitats; (5) data on nesting, molts, gonad size, and, where necessary, subspecific characters; (6) number of specimens taken of each sex.

No attempt is made in these accounts to include information obtained, or to list specimens collected, on previous expeditions to the Sierra de las Minas. Common names of species and, for the most part, scientific names follow Eisenmann (1955).

Green Heron (*Butorides virescens*). Purulhá. Lowlands to 5,000 feet. A single bird was seen on 30 September in a swampy valley.

King Vulture (*Sarcoramphus papa*). Usumatlán. Lowlands to 8,300 feet. Two immature birds were seen on 15 December. They were perched on a dead limb near the top of an 80-foot pine tree on a high mountain ridge.

Black Vulture (*Coragyps atratus*). Purulhá, Usumatlán. Lowlands to 5,900 feet. A few were seen in the mountains in early March.

Turkey Vulture (*Cathartes aura*). Salamá, Usumatlán, Purulhá. Lowlands to 8,000 feet. More common than *Coragyps* in the highlands, though we never saw more than a few in a group.

White-breasted Hawk (*Accipter chionogaster chionogaster*). *Usumatlán.* 6,200 to 8,500 feet. Fairly common resident in cutover and mature pine forest. All records, except two seen circling on 4 September, were of single birds. 2 females.

Red-tailed Hawk (*Buteo jamaicensis*). Usumatlán. Lowlands to 9,500 feet. A pair or two were seen regularly.

American Sparrow Hawk (*Falco sparverius tropicalis*). *San Jerónimo.* 3,300 to 4,800 feet. Two males collected 29 September and 10 January are small (wing: 177, 166 mm) and have no reddish-brown in the crown. They agree with the race *F. s. tropicalis*, which was a fairly common resident in the dry pine forests. The nominate race wintered abundantly in the lowlands. 2 males.

Plain Chachalaca (*Ortalis vetula*). Purulhá. Lowlands to 5,000 feet. Fairly common in the highlands at the head of the Polochic Valley in heavy brush, thickets, and brushy woodland.

Black Chachalaca (*Penelopina nigra nigra*). *Usumatlán*, Purulhá. 5,000 to 8,000 feet. Resident in the moist mountain forests. A female taken 16 December had an enlarged ovary. 2 males, 1 female.

Buffy-crowned Wood-Partridge (*Dendrortyx leucophrys*). Usumatlán, Purulhá. 5,500 to 8,000 feet. Recorded in March in the brushy understory of a pine forest.

Ocellated Quail (*Cyrtonyx ocellatus*). *Usumatlán*. 8,100 to 8,300 feet. Uncommon resident in the grassy understory of the pine forest topping the higher ridges. Three specimens were taken in December, each from a covey of about 10 birds. A pair was flushed in March. 2 males, 1 female.

Ruddy Crake (*Laterallus ruber*). Purulhá. Lowlands to 5,000 feet. A single bird was flushed from the marsh near Purulhá on 17 March. The species is fairly common in the humid lowlands.

Rock Dove (*Columba livia*). Usumatlán. Lowlands to 5,800 feet. A few groups of white or largely white birds were noted near human habitations. No populations were found established in the wild.

Band-tailed Pigeon (*Columba fasciata fasciata*). *Usumatlán*. 2,400 to 8,500 feet. Fairly common resident in pine forest at high elevations; usually seen in flocks of 10 to 25 in flight or perched on high exposed limbs. A male taken 23 December had enlarged testes. The specimens measure: male, wing, 194–210 mm (202.3); tail, 132–146 (140.7); female, wing 197; tail missing. 3 males, 1 female.

Mourning Dove (*Zenaidura macroura marginella*). *Usumatlán*. Lowlands to 6,600 feet. Uncommon winter visitor on the south slope of the mountains; becoming more common in spring. A male collected 7 March was molting some of the body feathers. It measures: wing, 153 mm; tail, 151. 1 male.

White-winged Dove (*Zenaida asiatica asiatica*). *San Jerónimo*, Usumatlán. Lowlands to 5,100 feet. A small flock was seen on 3 March in pine woodland at 5,100 feet; another flock (20), from which a specimen was taken, was recorded on 14 November at 3,600 feet. The species was more common in the arid lowlands. 1 female.

Maroon-chested Ground-Dove (*Claravis mondetoura salvini*). *Usumatlán*. 5,700 to 6,300 feet. A flock of 10 to 20 birds wintered in a brushy woodland. A female collected 1 August had two large ova, one almost fully formed.

C. m. salvini is slightly smaller, more extensively white on the abdomen, and more uniformly slaty on the underwing than *C. m. mondetoura*. In color my four males are *salvini* except that the only fully adult male is largely brown on the underwing. The wing of this adult male measures 110 mm. 4 males, 4 females.

Green Parakeet (*Aratinga holochlora rubitorquis*). *Usumatlán*. 5,700 to 6,100 feet (the form *A. h. strenua* occurred in the arid lowlands). Uncommon resident in cultivated areas and scrubby woodland. A male taken 1 August had enlarged testes; another male, collected 14 December, was molting in the primaries. These two males are largely red on the throat and upper breast. They measure: wing, 157, 160 mm; tail, 116, 122; culmen, 24, 24. 2 males.

White-crowned Parrot (*Pionus senilis senilis*). *Usumatlán*. Lowlands to 7,500 feet. Widespread but not common; flocks of two to eight individuals were seen occasionally in brushy woodland and pine forest. Two specimens (taken 6 September and 1 August) were molting in the throat. My specimens are brighter and have redder tail coverts than *P. s. decoloratus*. 1 male, 1 ?.

Squirrel Cuckoo (*Piaya cayana thermophila*). *Usumatlán*. Lowlands to 6,300 feet.

Widespread in most woodland habitats in eastern Guatemala. The primaries were molting in a specimen taken 30 July. 1 male, 1 female.

Groove-billed Ani (*Crotophaga sulcirostris*). Purulhá. Lowlands to 5,000 feet. Several were seen in second-growth along a road on 11 January. The species was abundant in the lowlands.

Mottled Owl (*Ciccaba virgata*). Usumatlán. Lowlands to 5,700 feet. Heard calling occasionally.

Fulvous Owl (*Strix fulvescens*). *Usumatlán.* 6,500 to 7,500 feet. First recorded 5 March when Richard Graber collected two in cloud forest. Others were heard calling in the same area on 6 and 8 March. 1 male, 1 female.

Lesser Nighthawk (*Chordeiles acutipennis texensis*). *Usumatlán.* 8,000 to 8,200 feet. On 7 March a migrating group of 8 to 10 nighthawks circled through the pine forest at dusk on top of the Sierra de las Minas. Three males, wing, 184 to 193 mm (188.3), were taken from this flock. 3 males.

Pauraque (*Nyctidromus albicollis albicollis*). *Salamá,* Usumatlán. Lowlands to 5,700 feet. A specimen was taken on the ground in a small pine woods at 5,000 feet on 24 February. Others were seen and heard in December. The species was abundant in the lowlands. 1 male.

Whip-poor-will (*Caprimulgus vociferus chiapensis*). *San Jerónimo,* Usumatlán. 3,400 to 8,000 feet. Fairly common resident in the brushy pine forests. A female taken 16 March was in breeding condition (one ovum very large). 1 female.

White-collared Swift (*Streptoprocne zonaris*). Usumatlán. Lowlands to 6,100 feet. A small flock was seen at 6,100 feet on 10 December.

White-throated Swift (*Aëronautes saxatalis*). Usumatlán. 8,000 feet. Seen in the air over a pine-covered ridge 6 September and 7 March. The fall group was a loose flock of 12 to 15 individuals; the spring records were of a flock of three and, later in the day, one of five.

Green Violet-ear (*Colibri thalassinus thalassinus*). *Usumatlán.* 5,700 to 7,800 feet. Fairly common resident in brush and second-growth; heard frequently in December but apparently not calling in March. A female collected 7 March was molting in the wing. 1 male, 2 females, 1 ?.

White-eared Hummingbird (*Hylocharis leucotis leucotis*). *Usumatlán.* 5,700 to 8,100 feet. Abundant in the mountains in open pine-oak woodland and brushy areas. A male collected 31 August was molting both rectrices and remiges. Excluding this molting specimen the male series measures: wing, 50 to 56 mm (54); tail, 30 to 35 (32.7). 13 males, 3 females.

Red-billed Azurecrown (*Amazilia cyanocephala guatemalensis*). *Usumatlán.* Lowlands to 6,500 feet. Fairly common in second-growth and brush, usually within 15 feet of the ground. Two males collected, respectively, 5 September and 30 November were molting, the former in the wing, the latter in the tail. Males taken in July and early September had enlarged testes. 8 males, 6 females, 3 ?.

Berylline Hummingbird (*Amazilia beryllina devillei*). *Usumatlán.* 4,900 feet. Collected 24 December in brushy second-growth next to a field. 1 female.

Amethyst-throated Hummingbird (*Lampornis amethystinus salvini*). *Usumatlán.* 6,000 to 6,300 feet. Recorded only in December when fairly common in brush and second-growth. 5 males, 5 females.

Green-throated Mountain-gem (*Lampornis viridi-pallens viridi-pallens*). *Usumatlán.* 5,700 to 7,000 feet. Resident in brushy woods and cloud forest. Conspicuous during December, when a specimen molting its flight feathers and three specimens with slightly enlarged gonads were taken. 14 males, 6 females.

Garnet-throated Hummingbird (*Lamprolaima rhami rhami*). *Usumatlán.* 7,200 to 8,000 feet. A small flock was seen in the top of a flowering tree on several occasions in December and March. A male collected 10 December was molting. 1 male, 5 females.

Magnificent Hummingbird (*Eugenes fulgens viridiceps*). *Usumatlán.* 6,100 to 8,200 feet. Fairly common in summer on the ridge at 8,000 feet in pine forest; in December common in woodland and brush below 6,300 feet; in March, again seen in the pines at 7,700 feet. This is a good example of altitudinal migration. Specimens collected 6 September and in early December were molting. 11 males, 2 females.

Slender Sheartail (*Doricha enicura*). *Usumatlán, Purulhá.* 4,700 to 5,800 feet. Rare; inhabited heavy brush. 1 male, 1 female.

Sparkling-tailed Hummingbird (*Tilmatura duponti*). *Usumatlán.* 6,200 feet. A specimen, molting in the tail and with slightly enlarged testes, was taken 28 August. 1 male.

Ruby-throated Hummingbird (*Archilochus colubris*). *Usumatlán.* Lowlands to 7,300 feet. The earliest fall record was a specimen taken 29 August. Wintered sparingly in brushy woodland. 2 males, 2 females.

Wine-throated Hummingbird (*Atthis ellioti ellioti*). *Usumatlán.* 8,300 feet. A specimen was taken 4 September in a brushy part of an oak-pine forest. 1 ? (female plumage).

Broad-tailed Hummingbird (*Selasphorus platycercus guatemalae*). *Usumatlán.* 8,000 feet. Collected 3 September in a brushy area in a pine forest. 1 ? (female plumage).

Quetzal (*Pharomachrus mocinno*). Usumatlán. 6,400 to 7,000 feet. Quetzals were fairly common in the cloud forest. They were particularly noisy and conspicuous in December.

Mountain Trogon (*Trogon mexicanus mexicanus*). *Usumatlán.* 5,800 to 8,000 feet (recorded once at 1,000 feet). Uncommon resident in the cloud forest and brushy woodland. A male collected 5 September was molting both remiges and rectrices; two females taken in early December were molting their body plumage. 2 males, 2 females.

Bar-tailed Trogon (*Trogon collaris puella*). *Usumatlán.* Lowlands to 6,500 feet. Uncommon resident found principally in cloud forest. Specimens taken in July and August were molting. A female collected 6 March was ovulating. 5 females.

Belted Kingfisher (*Ceryle alcyon*). Purulhá, Tactic. Lowlands to 5,000 feet. Fairly common in winter in suitable habitat.

Green Kingfisher (*Chloroceryle americana septentrionalis*). *Purulhá.* Lowlands to 5,000 feet. A specimen was taken in a marsh 30 September. 1 female.

Blue-throated Motmot (*Aspatha gularis*). *Usumatlán.* 6,500 to 8,100 feet. Rarely seen resident in cloud forest; recorded once, 5 September, in pines. A female taken 5 August and a male 6 August were molting heavily. 1 male, 1 female.

Emerald Toucanet (*Aulacorhynchus prasinus prasinus*). *Usumatlán.* 6,000 to 8,000 feet (also recorded twice in the lowlands). Fairly common in cloud forest. Two specimens taken in August and one in December were molting.

In describing *A. p. stenorhabdus*, Dickey and van Rossem (1930) state that the mandibular tomium has a narrower dark margin than in *A. p. prasinus* (1.5 to 3 mm as opposed to 4 to 8 in the nominate form) and a wider embossed ridge at the base of the bill. In my three males the mandibular dark area averages 4.2 mm in width; in three females, 4.3, so they fit within the limits of *prasinus.* However, in my birds the width of the embossed ridge leans toward *stenorhabdus.* Since the boundary between these two races falls within Guatemala, it is not surprising that the specimens are intermediate. One immature male was not included in the measurements. 4 males, 3 females.

Red-shafted Flicker (*Colaptes cafer mexicanoïdes*). *Usumatlán*, Purulhá. 5,000 to 9,200 feet. Fairly common in pines and brushy woodland. 4 males.

Golden-olive Woodpecker (*Piculus rubiginosus yucatanensis*). *Usumatlán, Salamá*, Purulhá. Lowlands to 6,400 feet. Uncommon in open or brushy woodland. The testes of a male taken 24 February were somewhat enlarged. Three males measure: wing, 121 to 132 mm (126); tail, 67 to 78 (72); culmen, 25 to 29 (27.3). 3 males.

Lineated Woodpecker (*Dryocopus lineatus*). San Jerónimo. Lowlands to 3,200 feet. One seen in pine woodland on 17 September. Fairly common in the lowlands.

Acorn Woodpecker (*Melanerpes formicivorus lineatus*). *Usumatlán*, San Jerónimo. Lowlands to 9,000 feet. The most common woodpecker in pine forest; less common where the pines reach into lower country. A female collected 29 July had an enlarged ovary. 1 male, 7 females.

Yellow-bellied Sapsucker (*Sphyrapicus varius*). Usumatlán. Lowlands to 8,500 feet. Recorded on 20 December and from 4 to 7 March.

Hairy Woodpecker (*Dendrocopos villosus sanctorum*). *Usumatlán*. 5,700 to 7,200 feet. Fairly common in the cutover pine and oak forests; not found in the pines on top of the ridges. Molting birds were taken from 30 July to 2 December. The testes of a male collected 6 March were enlarged. The males measure: wing, 104 to 111 mm (107.5); tail, 59 to 63 (60.8); culmen, 24 to 27 (25.4). 7 males, 4 females.

Pale-billed Woodpecker (*Phloeoceastes guatemalensis guatemalensis*). *Usumatlán*. Lowlands to 6,700 feet. Fairly common in heavy forest. Birds taken on 4 August and 30 November were molting. 1 male, 1 female.

Strong-billed Woodcreeper (*Xiphocolaptes promeropirhynchus emigrans*). *Usumatlán*. Lowlands (once) to 7,200 feet. Uncommon resident at the edge of the cloud forest and in open oak-pine woodland. A female taken 5 August was molting. Two males taken in early March were nearly in breeding condition. 3 males, 2 females.

Black-banded Woodcreeper (*Dendrocolaptes picumnus puncticollis*). *Usumatlán*. 6,000 to 7,500 feet. Fairly common in open cutover woodland and cloud forest. A female collected 6 August was molting. A male taken 5 March was in breeding condition. 3 males, 5 females.

Spotted Woodcreeper (*Xiphorhynchus erythropygius erythropygius*). *Usumatlán*. 6,500 to 7,800 feet. Rare; found in cloud forest and pines. A male taken 17 December had enlarged testes; a female collected 8 March had a slightly enlarged ovary. The wing in the males measures 114 and 127 mm. 2 males, 1 female.

Spot-crowned Woodcreeper (*Lepidocolaptes affinis affinis*). *Usumatlán*. 6,500 feet. The common woodcreeper of the cloud forest; often seen with flocks of smaller birds. A specimen taken 31 July was molting. 5 males, 4 females, 1 ?.

Scaly-throated Foliage-gleaner (*Anabacerthia variegaticeps*). *Usumatlán*. 6,500 feet (there is also one lowland record). Collected in dense forest 7 December. 1 ?.

Ruddy Foliage-gleaner (*Automolus rubiginosus rubiginosus*). *Usumatlán*. 6,000 to 7,600 feet. Rare; found in cloud forest and brushy oak woodland. A nest was found in the process of construction 9 December. The remiges of a female collected on 30 August were molting. 1 male, 2 females.

Barred Antshrike (*Thamnophilus doliatus intermedius*). *Usumatlán*. Lowlands to 6,300 feet. Fairly common in brush and thickets; heard more often than seen. A female taken 29 July had an enlarged ovary (one egg in the oviduct). 1 male, 1 female.

Masked Tityra (*Tityra semifasciata personata*). *Usumatlán*. Lowlands to 6,400 feet. A male, with enlarged testes, was taken 6 March in pines. 1 male.

Black Phoebe (*Sayornis nigricans aquatica*). *Salamá.* Lowlands to 4,900 feet. Fairly common along the rapid streams of the Polochic drainage. 1 male, 1 female, 1 ?.

Tropical Kingbird (*Tyrannus melancholicus chloronotus*). *Purulhá.* Lowlands to 5,000 feet. Collected on 17 March. Fairly common in the lowlands. 1 male.

Social Flycatcher (*Myiozetetes similis texensis*). *Purulhá.* Lowlands to 5,000 feet. Collected from a group of three or four in a clump of bushes in a flooded meadow. 1 female.

Dusky-capped Flycatcher (*Myiarchus tuberculifer lawrencei*). *Usumatlán.* 6,300 feet (the race *M. t. connectens* was common in the lowlands). A male (wing 86 mm) was taken in brushy second-growth 18 December. The specimen is paler and more olivaceous on the back than any of my lowland material. 1 male.

Olive-sided Flycatcher (*Nuttallornis borealis*). *Usumatlán.* Lowlands to 8,200 feet. Uncommon winter visitor; usually seen perched in exposed dead trees in brushy areas or in pine woodland. A bird collected in December was molting. A male taken 7 March had slightly enlarged testes. 6 males, 1 female.

Western Wood-Pewee (*Contopus richardsoni richardsoni*). *Usumatlán.* Lowlands to 8,700 feet. Fairly common transient; recorded from 18 August to 30 October. Two specimens taken in late August had slightly enlarged gonads. Measurements of males: wing, 83–92 mm (87.8); tail, 63–71 (66.4). 5 males, 3 females.

Greater Pewee (*Contopus pertinax pertinax*). *Usumatlán, Salamá.* 3,500 to 7,600 feet. Fairly common resident; generally seen well above the ground on exposed perches in cutover or open oak and pine woodland. Two immature birds were taken in late July. A specimen taken 11 March was molting. 2 males, 6 females, 1 ?.

Yellow-bellied Flycatcher (*Empidonax flaviventris*). *Usumatlán.* Lowlands to 8,000 feet. Collected 31 July and 3 September. 1 male, 1 ?.

Hammond's Flycatcher (*Empidonax hammondi*). *Usumatlán.* 5,900 to 6,600 feet. Fairly common in brush and second-growth from 2 December to 8 March. 7 males, 5 females, 1 ?.

Yellowish Flycatcher (*Empidonax flavescens dwighti*). *Usumatlán.* 6,300 to 7,200 feet. Fairly common resident of the cloud forest and its brushy edges. Two males, taken 3 December and 5 March had incompletely ossified skulls. Four specimens collected in early March had enlarged gonads. 6 males, 5 females, 1 ?.

White-throated Flycatcher (*Empidonax albigularis axillaris*). *Usumatlán.* Lowlands to 5,900 feet. Recorded in July and August only; immature specimens were taken 30 July and 6 August. 1 male, 2 ?.

Buff-breasted Flycatcher (*Empidonax fulvifrons fusciceps*). *Purulhá.* 5,000 feet. Recorded in a marshy meadow in middle and late winter. A male taken 17 March had enlarged testes. 2 males, 1 female.

Belted Flycatcher (*Xenotriccus callizonus*). *Purulhá.* 5,100 feet. Larry Wolf took a female of this rare species in heavy brush on 11 January. The specimen has a darker crown than the type, which is possibly a sub-adult. 1 female.

Tufted Flycatcher (*Mitrephanes phaeocercus quercinus*). *Usumatlán.* 6,000 to 8,500 feet. Fairly common resident in oak, pine, and cloud forest. An immature bird was taken 28 August. The remiges and rectrices of a specimen taken 3 September were molting. The ovary of a female collected 4 March was somewhat enlarged. 5 males, 1 female, 1 ?.

Mountain Elaenia (*Elaenia frantzi ultima*). *Usumatlán.* 6,200 feet. Collected on 23 December in brushy woodland. 1 male.

Paltry Tyrannulet (*Tyranniscus vilissimus vilissimus*). *Usumatlán.* Lowlands to 8,000 feet. Fairly common in pine and mixed woodland in December. 6 males, 1 female.

Rough-winged Swallow (*Stelgidopteryx ruficollis*). *Purulhá.* Lowlands to 5,000 feet. Uncommon winter visitor. Specimens collected 25 October, 13 November, and 11 January were molting. Three dark specimens, whose under tail-covert shafts are dark subterminally, represent the race *S. r. fulvipennis.* The remaining two specimens, both somewhat paler and with immaculate white crissum, represent *S. r. serripennis.* None of my specimens has dark tipped under tail-coverts or is as dark generally as *S. r. stuarti,* which is said to breed in the Vera Paz highlands. 3 males, 2 females.

Black-capped Swallow (*Notiochelidon pileata*). *Usumatlán, Tactic.* 4,800 to 7,500 feet. Uncommon resident; nesting in cutaway banks. At Tactic on 11 January at least eight birds were seen going in and out of the same hole, which was near the top of a road-cut 35 feet high. An immature specimen was collected 6 August. Two specimens taken in early December were molting. 1 male, 2 females, 2 ?.

Violet-green Swallow (*Tachycineta thalassina lepida*). *Usumatlán.* Lowlands to 5,900 feet. Common in winter; usually seen in flocks of up to 50 individuals. The remiges of three males taken in early December were molting. As a series the specimens probably represent the race *T. t. lepida,* but in rump coloration some of them are intermediate between *T. t. lepida* and *T. t. thalassina.* The males measure: wing, 112 to 117 mm (116); tail, 44 to 48 (46). 7 males, 1 female.

Bushy-crested Jay (*Cissilopha melanocyanea melanocyanea*). *Usumatlán, San Jerónimo, Purulhá,* Tactic. Lowlands (1,500 feet) to 6,500 feet. Fairly common in open deciduous woodland and second-growth; seen occasionally in cloud forest. Yellow-billed immature birds were taken in August and December. Molting specimens were collected in August, September, and December. 4 males, 4 females, 1 ?.

Black-throated Jay (*Cyanolyca pumilo*). *Usumatlán.* 5,700 to 7,000 feet. Recorded three times: twice in the cloud forest in early March and on 29 July, when an immature was taken in dense second-growth. Immature birds cannot be identified with certainty, but on geographic grounds the specimen probably belongs to the nominate race. 1 male.

Unicolored Jay (*Aphelocoma unicolor unicolor*). *Usumatlán.* 5,700 to 8,000 feet. The most common jay in the highlands; found in open pines, cutover oak-pine, and cloud forest. Yellow-billed immature birds were taken in July and December. Two males collected 4 March were in breeding condition. Two specimens taken in July were molting. Measurements of males: wing, 155–168 mm (162.3); tail, 144–155 (151). 7 males, 3 females, 1 ?.

Steller's Jay (*Cyanocitta stelleri ridgwayi*). *Usumatlán.* 5,100 to 8,800 feet. Rare resident; seen mostly in pines. The only specimen, taken 27 July, was molting its flight feathers. 1 female.

Brown Creeper (*Certhia familiaris pernigra*). *Usumatlán.* 5,900 to 8,400 feet. Fairly common resident; found in pines and cutover oak-pine woodland. A specimen taken in September was molting. A male collected 5 March had partially enlarged testes. Measurements of males: wing, 62 to 65 mm (63); tail, 54 to 62 (59); culmen, all 17. 5 males, 2 females, 2 ?.

American Dipper (*Cinclus mexicanus anthonyi*). 2,300 to 3,900 feet. Seen regularly in the steep canyons of the upper Polochic River near Tamahú, Alta Vera Paz. The flora and fauna of this area are humid tropical and not highland, but the dipper is mentioned here because of its status as a highland form in most of its range. 2 males.

Band-backed Wren (*Campylorhynchus zonatus vulcanius*). *Usumatlán,* San Jerónimo. Lowlands to 8,300 feet. Fairly common in brushy woodland and second-growth. Specimens taken in July, August, and October were molting. Throughout the highland series the rufous of the abdomen does not extend forward onto the breast, the ventral spotting is sparse, and the back is more rufous than in specimens taken in the lowlands (which represent *C. z. restrictus*). 6 males, 3 females.

Plain Wren (*Thryothorus modestus pullus*). *Usumatlán.* Lowlands to 6,400 feet. Uncommon in brushy areas. A male taken 1 August had enlarged testes. 2 males, 2 females.

Southern House Wren (*Troglodytes musculus intermedius*). *Usumatlán, Purulhá.* Lowlands to 9,300 feet. Fairly common in forest edge and second-growth. Two males collected 28 July had enlarged testes. A male taken 9 December was molting its flight feathers. 4 males, 4 females.

Rufous-browed Wren (*Troglodytes rufociliatus rufociliatus*). *Usumatlán.* 5,900 to 8,400 feet. Fairly common resident in brush and cutover pine-oak woodland. A juvenile was taken 1 September. 6 males, 3 females, 3 ?.

Gray-breasted Wood-Wren (*Henicorhina leucophrys castanea*). *Usumatlán.* 4,700 to 6,700 feet. Fairly common in the undergrowth of the cloud forest. A female taken near a new nest on 15 March was in breeding condition. A male collected 1 September was molting. The culmen in the males measures: 14.5–15 mm (14.7); in the females: 12.5–14 (13.5). 3 males, 5 females.

Blue-and-white Mockingbird (*Melanotis hypoleucus*). *Usumatlán,* Tactic. 4,800 to 7,900 feet. Uncommon and difficult to approach; found in brush and second-growth. 3 males, 1 female.

Common Catbird (*Dumetella carolinensis*). *Usumatlán.* Lowlands to 5,900 feet. Collected 23 December in a brushy field; common in winter in the lowlands. 1 male.

Rufous-collared Robin (*Turdus rufitorques*). *Usumatlán.* 5,900 to 8,600 feet. Fairly common resident in cutover mixed forest, pines, and cloud forest; flocks of 15 to 20 seen in December. Immature specimens were taken 2 December and 8 March. 4 males, 2 females.

Mountain Robin (*Turdus plebejus differens*). *Usumatlán.* 6,300 and 6,400 feet. Two specimens were taken in late December along the brushy edge of the cloud forest. 2 females.

Black Robin (*Turdus infuscatus*). *Usumatlán.* 6,200 to 6,500 feet. Collected in mid-December in the brushy edge of the cloud forest. 1 male, 1 ?.

Brown-backed Solitaire (*Myadestes obscurus oberholseri*). *Usumatlán, San Jerónimo.* 4,700 to 7,300 feet. Fairly common resident in cloud forest and brushy woodland. A male collected 6 March was in breeding condition. Molting specimens were taken in August. 3 males, 7 females.

Wood Thrush (*Hylocichla mustelina*). *Usumatlán.* Lowlands to 7,300 feet. Recorded 4 December and 6 March in cloud forest. 1 male.

Spotted Nightingale-Thrush (*Catharus dryas dryas*). *Usumatlán.* 6,500 to 7,300 feet. Rare resident in cloud forest. A pair taken 1 August had enlarged gonads, though the male's remiges were molting. 2 males, 2 females.

Ruddy-capped Nightingale-Thrush (*Catharus frantzi alticola*). *Usumatlán.* 6,300 to 7,800 feet. Uncommon resident in cloud forest and brush. Birds taken in August and early March had enlarged gonads. 4 males, 1 female, 1 ?.

Orange-billed Nightingale-Thrush (*Catharus aurantiirostris bangsi*). *Usumatlán.* 5,500 to 5,900 feet. Uncommon resident; seen mostly in patches of pines in brushy areas. A male taken 6 August was molting its remiges. 3 males, 1 female.

Common Bluebird (*Sialia sialis guatemalae*). *Usumatlán, Purulhá, Tactic.* 4,900 to

9,200 feet. Fairly common resident in cutover woodland and pine forest, especially at higher elevations. A juvenile male was taken 29 August. 3 males, 7 females.

Cedar Waxwing (*Bombycilla cedrorum*). *Usumatlán, Salamá.* 5,500 to 6,600 feet. A few flocks of 20 to 30 birds were seen in late winter; one specimen was taken 8 March. 1 female.

Gray Silky-flycatcher (*Ptilogonys cinereus molybdophanes*). *Usumatlán.* 5,800 to 7,500 feet. Fairly common resident; conspicuous in the treetops of the cutover pine woodland. A male taken 16 December had somewhat enlarged testes. Specimens collected in August and September were molting. 7 males, 2 females.

Rufous-browed Peppershrike (*Cyclarhis gujanensis flaviventris*). *Usumatlán, Purulhá.* 5,000 to 6,500 feet. Collected in young pines 7 December and in second-growth in a swampy valley on 17 March. 1 male, 1 female.

Hutton's Vireo (*Vireo huttoni vulcani*). *Usumatlán.* 6,000 to 6,500 feet. Found in brushy woodland. Specimens were taken in September and December. 3 males, 2 females, 1 ?.

Solitary Vireo (*Vireo solitarius*). *Usumatlán, Salamá.* Lowlands to 7,000 feet. Fairly common and widespread in winter in all types of woodland. Four specimens represent the nominate race; a female (wing, 68 mm; tail, 51), taken 3 March at 3,500 feet, is dull colored and greenish and seems to be close to *V. s. montanus*, a resident form. 3 males, 1 female, 1 ?.

Warbling Vireo (*Vireo gilvus*). Usumatlán. Lowlands to 7,300 feet. Seen and heard singing in March.

Brown-capped Vireo (*Vireo leucophrys strenuus*). *Usumatlán.* 6,300 feet. A female collected 18 December in open woodland closely resembles the type of the Chiapas subspecies, *V. l. strenuus.* 1 female.

Cinnamon-bellied Flower-piercer (*Diglossa baritula parva*). *Usumatlán.* 5,500 to 9,300 feet. Common resident in brush and dense second-growth. A male collected 2 August had enlarged gonads. Several specimens taken in December were molting.

The specimens differ noticeably from a series of *D. b. montana* taken in western Guatemala by Baepler (1960) in being darker on the head, deeper cinnamon on the breast, shorter billed, and smaller in wing and tail. My males measure: wing, 54 to 57 mm (55.5); tail, 43 to 45 (44.2); culmen, 9 to 10 (9.2). My material seems to compare favorably with *D. b. parva.* 7 males, 6 females, 1 ?.

Red-legged Honeycreeper (*Cyanerpes cyaneus carneipes*). *Usumatlán.* Lowlands to 6,300 feet. Collected in heavy brush on 9 December; fairly common in the lowlands. 1 female.

Black-and-white Warbler (*Mniotilta varia*). *Usumatlán, Salamá, San Jerónimo.* Lowlands to 7,300 feet. Abundant winter visitor in most types of woodland. 4 males, 2 females, 1 ?.

Blue-winged Warbler (*Vermivora pinus*). *Usumatlán.* Lowlands to 6,500 feet. Collected in cloud forest 16 December. 1 male.

Tennessee Warbler (*Vermivora peregrina*). *Usumatlán.* Lowlands to 6,500 feet. Recorded in early December in second-growth. 3 females.

Nashville Warbler (*Vermivora ruficapilla ridgwayi*). *Usumatlán.* Lowlands to 6,300 feet. Recorded in December in brush and open woods. 1 male, 1 ?.

Crescent-chested Warbler (*Vermivora superciliosa superciliosa*). *Usumatlán.* 6,100 to 8,500 feet. Fairly common resident in cloud forest and pines. 6 males, 1 female, 6 ?.

Olive Warbler (*Peucedramus taeniatus taeniatus*). *Usumatlán.* 6,200 to 8,600 feet. Uncommon resident in pine forest. 4 males, 2 females.

Magnolia Warbler (*Dendroica magnolia*). *Purulhá.* Lowlands to 4,600 feet. An immature female collected 30 September was the first record of the fall. Wintered abundantly in the lowlands. 1 female.

Audubon's Warbler (*Dendroica auduboni memorabilis*). *Usumatlán.* 7,900 to 8,500 feet. Recorded in December and March in the pine forest on top of the ridges. The males measure: wing, 81 to 82 mm (81.5); tail, 61 to 63 (61.7); the females: wing, 71.5 to 74 (73); tail, 55.5 to 57.5 (56.5). 3 males, 4 females, 2 ?.

Townsend's Warbler (*Dendroica townsendi*). *Usumatlán.* Lowlands (once) to 9,300 feet. An abundant wintering form in pines and open woods. 12 males, 6 females, 1 ?.

Black-throated Green Warbler (*Dendroica virens virens*). *Salamá, Usumatlán.* Lowlands to 7,000 feet. Fairly common in winter in open woodland and cloud forest. 4 males.

Golden-cheeked Warbler (*Dendroica chrysoparia*). *Usumatlán.* 5,900 to 8,400 feet. Recorded in August and December in pine forest, deciduous woods, and second-growth. 3 males, 2 females, 1 ?.

Hermit Warbler (*Dendroica occidentalis*). *Usumatlán.* 6,200 to 8,400 feet. Uncommon in winter in pine forests. 2 males, 3 females.

Grace's Warbler (*Dendroica graciae decora*). *Salamá, Usumatlán.* 3,800 feet. The Salamá specimen was taken on 30 September, the Usumatlán specimen, one of two seen, on 3 March; both were in pines. 2 females.

Ovenbird (*Seiurus aurocapillus*). *Usumatlán.* Lowlands to 6,300 feet. Uncommon in winter in brushy woodland. Two of the specimens represent the nominate race. An unsexed bird, taken 17 December, seems to agree with the brown-backed race *S. a. furvior.* 1 male, 2 ?.

Louisiana Waterthrush (*Seiurus motacilla*). *Usumatlán.* Lowlands to 6,000 feet. Collected 13 December. 1 female.

MacGillivray's Warbler (*Oporornis tolmiei*). *Usumatlán.* Lowlands to 8,000 feet. Fairly common in winter in brushy areas. Following the criteria of Phillips (1947), four of the specimens (1 male: tail, 54 mm; difference between tail and wing, 6; 3 specimens, sex unknown: tail, 52 to 53.5 (53); difference between tail and wing, 4.5 to 6.5) represent the nominate form. Eight specimens (3 males: tail, 54 to 61 (57); difference between tail and wing, 0.5 to 5.5; 5 females: tail, 53 to 57.5 (55.5); difference between tail and wing, 0.5 to 6.5), which are less green in the back, agree with the race *O. t. monticola.* To me the distinctions between these two races are not great. 4 males, 5 females, 3 ?.

Common Yellowthroat (*Geothlypis trichas trichas*). *Purulhá.* Lowlands to 5,000 feet. Collected in a swamp on 11 January. Others were seen in the same area. 1 male.

Hooded Warbler (*Wilsonia citrina*). *Usumatlán.* Lowlands to 7,300 feet. One seen 4 March in a brushy area.

Pileolated Warbler (*Wilsonia pusilla*). *Usumatlán, Purulhá, San Jerónimo.* Lowlands to 8,300 feet. Abundant in winter. Both *W. p. pusilla* and *W. p. pileolata* are well represented, with the latter predominating in the highlands. 10 males, 4 females, 6 ?.

Red-faced Warbler (*Cardellina rubrifrons*). *Usumatlán.* 6,500 to 8,700 feet. Uncommon in cloud forest and pine woodland. 2 males, 1 female.

Painted Redstart (*Setophaga picta guatemalae*). *Usumatlán, Salamá.* 3,500 to 9,300 feet. Common in pine forest and open woodland. 3 males, 9 females.

Slate-throated Redstart (*Myioborus miniatus intermedius*). *Usumatlán, Purulhá.* Lowlands (2,400 feet) to 7,900 feet. Common in cloud forest, pines, and cutover woodland. Birds were singing and courtship behavior was noted in early March. 9 males, 3 females.

Pink-headed Warbler (*Ergaticus versicolor*). *Usumatlán.* 6,300 to 9,400 feet. Fairly common resident in cloud forest, pines, and second-growth. 3 males, 3 females, 3 ?.

Golden-browed Warbler (*Basileuterus belli scitulus*). *Usumatlán.* 6,100 to 7,800 feet. Fairly common in cloud forest and brushy areas. 3 males, 10 females, 1 ?.

Rufous-capped Warbler (*Basileuterus rufifrons*). *Usumatlán, Tactic, Purulhá.* Lowlands (once) to 6,600 feet. Fairly common in brushy areas. In one male (Purulhá, 17 March), which represents the nominate race, the abdomen is whitish; the remainder of the series is completely yellow below and represents the race *B. r. salvini.* 3 males, 5 females, 3 ?.

Boat-tailed Grackle (*Cassidix mexicanus mexicanus*). *Purulhá.* Lowlands to 4,800 feet. Seen occasionally in villages and cultivated areas. 1 male.

Melodious Blackbird (*Dives dives dives*). *Usumatlán.* Lowlands to 6,100 feet. Uncommon in woodland. 1 male, 1 female.

Black-vented Oriole (*Icterus wagleri wagleri*). *Usumatlán.* 5,700 to 6,500 feet. Rare resident in brushy second-growth. Molting birds were taken 6 August and 7 December. 2 males.

Yellow-backed Oriole (*Icterus chrysater chrysater*). *Usumatlán*, Purulhá. Lowlands (2,600 feet) to 6,100 feet. Uncommon in brush and second-growth. 2 males.

Baltimore Oriole (*Icterus galbula*). *Usumatlán, Salamá.* Lowlands to 8,700 feet. Fairly common in winter. 3 males, 2 females, 1 ?.

Bullock's Oriole (*Icterus bullocki*). Usumatlán. 7,800 feet. A single adult male was seen in a flowering tree in a brushy woodland, 7 March.

Summer Tanager (*Piranga rubra rubra*). *Usumatlán.* Lowlands to 6,300 feet. Collected in open deciduous woods 6 December; wintered abundantly in the lowlands. 1 male.

Flame-colored Tanager (*Piranga bidentata sanguinolenta*). *Usumatlán.* 6,500 to 7,300 feet. A male with enlarged testes collected in cloud forest on 4 March; others seen in the same area 6 March. 1 male.

Common Bush-Tanager (*Chlorospingus ophthalmicus dwighti*). *Usumatlán.* 5,700 to 7,800 feet. Abundant in cloud forest; occasionally seen in brushy second-growth. A male collected 4 March had enlarged testes. 9 males, 7 females.

Rose-breasted Grosbeak (*Pheucticus ludovicianus*). *Usumatlán.* Lowlands to 7,000 feet. Widespread and fairly common in winter in brush and forest edge. 4 males, 2 females, 3 ?.

Indigo Bunting (*Passerina cyanea*). *Usumatlán.* Lowlands to 6,000 feet. Fairly common in winter in brushy meadows and second-growth. 2 males, 1 female, 1 ?.

Hooded Grosbeak (*Hesperiphona abeillei cobanensis*). *Usumatlán.* 7,000 to 7,500 feet. Rare in cutover pine and cloud forest edge; recorded 6 August (specimen), 10 December, and 4 March. 1 male.

White-collared Seedeater (*Sporophila torqueola morelleti*). *Usumatlán*, Purulhá. Lowlands to 5,900 feet. Common resident in brushy meadows. Molting specimens were taken in August. 5 males.

Blue-black Grassquit (*Volatinia jacarina splendens*). *Usumatlán.* Lowlands to 6,000 feet. Common resident in meadows and brush. A male taken 6 December was molting into the adult plumage. Breeding specimens were collected in July and August. 3 males, 1 female, 1 ?.

Black-headed Siskin (*Spinus notatus notatus*). *Usumatlán, Purulhá.* 3,500 to 8,200 feet. Fairly common in pine forest, mixed woodland, and brushy second-growth. In males taken 7 August, 18 December, and 11 January the testes were enlarged. An immature male collected 30 July was undergoing a general molt. 3 males, 2 females, 3 ?.

Dark-backed Goldfinch (*Spinus psaltria colombianus*). *Purulhá, Salamá.* Lowlands to 5,000 feet. A few small flocks were seen, mostly in meadows and brush. 1 male, 1 female, 1 ?.

Red Crossbill (*Loxia curvirostra stricklandi*). *Usumatlán.* 8,000 to 8,800 feet. Two specimens (wing, 92 and 95 mm; tail, 53 and 55) were taken from groups of two or three birds on 10 December and 7 March. 2 males.

Yellow-throated Brush-Finch (*Atlapetes gutturalis griseipectus*). *Usumatlán.* 5,700 to 7,900 feet. Fairly common in brush. Breeding birds were taken from 27 July to 8 September. An immature, streaked on the breast, was collected 31 August. Two molting specimens were taken in December. 8 males, 2 females, 3 ?.

Chestnut-capped Brush-Finch (*Atlapetes brunnei-nucha macrourus*). *Usumatlán.* 6,500 to 6,900 feet. Uncommon resident in the cloud forest understory. Two molting birds were taken in August. A male and female in breeding condition were collected 6 March. The specimens resemble *A. b. macrourous* of western Guatemala in color; however, they are somewhat small. The males measure: wing, 78 to 89 mm (83.7); tail, 81 to 91 (85); the females: wing, 79 to 87 (82.5); tail, 82 to 86 (84.8). 3 males, 4 females.

Rusty-crowned Ground-Sparrow (*Melozone biarcuatum biarcuatum*). *Usumatlán, Purulhá, Tactic.* Lowlands (once) to 5,800 feet. Uncommon in brushy second-growth. 1 male, 2 females.

Rusty Sparrow (*Aimophila rufescens pyrgitoïdes*). *Usumatlán, San Jerónimo.* Lowlands to 8,500 feet. Fairly common in brushy second-growth and pine forest. The series is dark; the males measure: wing, 72 to 78 mm (75.2); tail, 77 to 86 (80.5); the female: wing, 73; tail, 67. 6 males, 1 female.

Rufous-collared Sparrow (*Zonotrichia capensis septentrionalis*). *Usumatlán*, Salamá, Purulhá. 4,700 to 5,900 feet. Fairly common in brushy fields. Specimens taken from 27 July to 9 September were in breeding condition; males were heard singing into early September. An immature bird was taken 16 December. 6 males, 3 females, 2 ?.

Lincoln's Sparrow (*Melospiza lincolni alticola*). *Usumatlán.* 5,800 to 5,900 feet. A small population wintered in an extensive meadow. An immature male was taken 1 December. 3 males, 3 females, 2 ?.

SUMMARY

In a field study in the Sierra de las Minas, the major mountain mass in eastern Guatemala, 123 resident and 37 migratory species were listed. Five collecting stations were utilized, but most of the time was spent on the south slope of the mountains above the lowland town of Usumatlán. Elevation ranged from 3,000 to 9,400 feet.

There is no clear-cut Subtropical Zone on the Sierra de las Minas. Subtropical and Temperate species occupy the same areas in the middle and upper parts of the range.

An annotated list of species is given.

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Most of the specimens are currently in my possession.

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DEPARTMENT OF BIOLOGY, CONCORD COLLEGE, ATHENS, WEST VIRGINIA, 13 FEBRUARY 1961

GENERAL NOTES

Attempted re-use of old nest by Chimney Swift.—Between 1944 and 1961, I have observed 316 nests of Chimney Swifts (*Chaetura pelagica*) on the campus of Kent State University, Kent, Ohio. These had been placed in 35 airshafts of four adjacent buildings. Ordinarily one-fourth of the nests fall from the wall by the end of the summer season; one-half of them are gone by the end of the winter season; and only one-fourth remain by the time the swifts return in the third week of April. The remaining nests soon disappear at that time, probably from being touched by the birds. By that time the nests are very brittle, and a slight pressure is enough to knock them from the wall. Only five nests have remained on the wall until a second nesting season was well under way. Three of the nests were constructed beneath a shallow overhang which offered sufficient protection so that the nests did not weather as usual. The other two nests had no protection. An attempt was made to use the old nest in three instances, with complete failure on two occasions, and only partial success on the other.

In 1944, a nest was constructed under a narrow shelf in Shaft M7. This was 22.8 feet down on the west wall. Being protected from the elements by this shelf, the nest remained on the wall through the season of 1948. However, it was never used again. Swifts nesting in this shaft built new ones on the south or east wall. The one under the ledge remained attached to the wall longer than any other during my 18 years of observations.

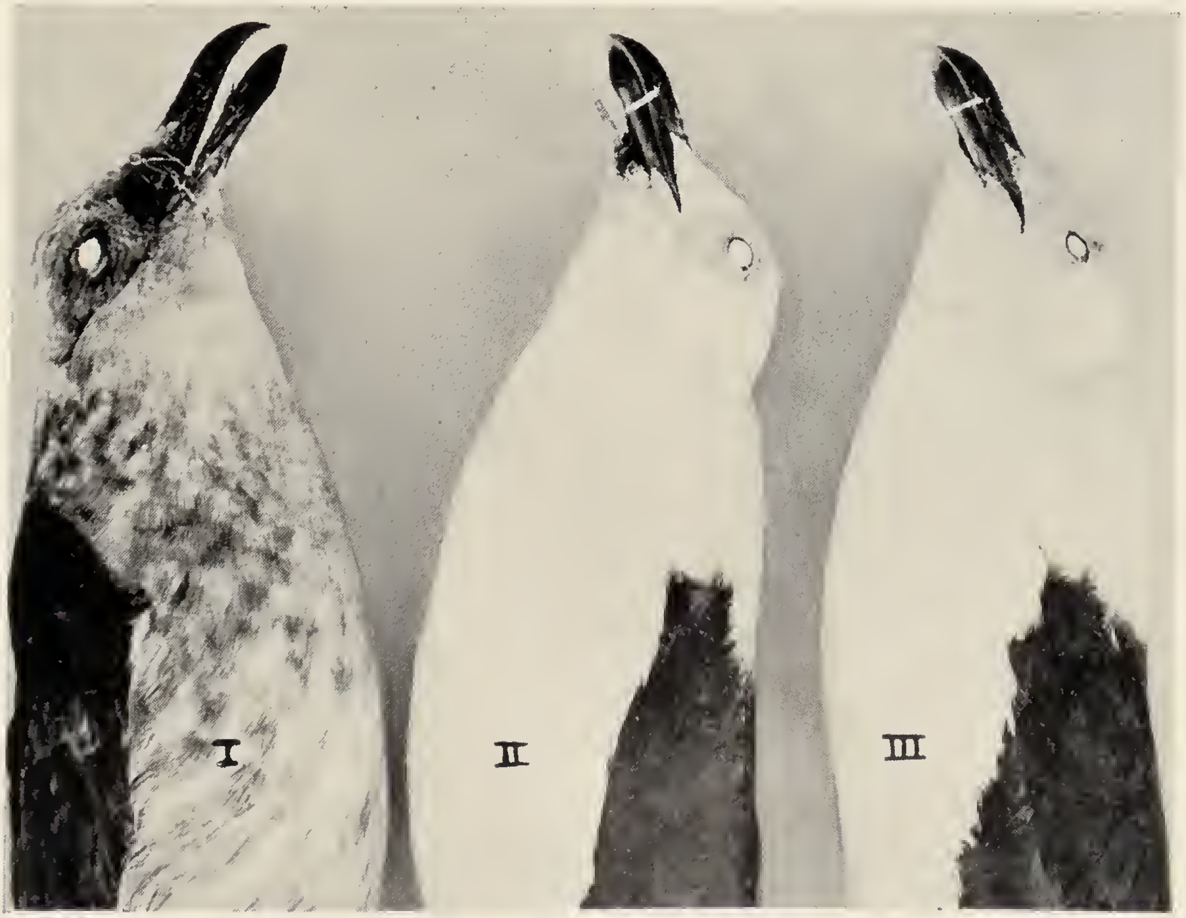
In 1950, Chimney Swifts made a nest in Shaft G3, 12.5 feet down on the west wall. This remained attached until March 1952, but it was not used a second time. Swifts did not nest in that shaft in 1951. This nest remained on the wall the longest period of time for those exposed to the elements.

In 1957, the nest made the previous year in Shaft E1 remained on the wall. When swifts returned for nesting an attempt was made to use this nest again, but after a few days the nest fell from the wall and a new one was subsequently constructed.

An attempt was also made to re-use the nest which had been constructed in Shaft C3 in 1959. This had been made under a shallow overhang 6.8 feet down on the south wall. Both of the mates in C3 had been observed sitting on the old nest at one time or another, but on 3 June 1960, the old nest fell from the wall. Three days later a new nest was started at the same place on the wall which held the previous one. This was completed in seven days. It was used successfully and remained on the wall until the following summer. The same male returned to this shaft in 1961, but with a new mate; his previous mate failed to return to the campus. One or both of the new pair sat on the old nest at night, and it was somewhat repaired and reinforced to correct winter damage. On 11 June, the first egg was found and three more followed. The pair took turns incubating the four eggs and occasionally both birds sat on the nest at night. On 7 July, the nest fell from the wall. Two naked, pink nestlings and two smashed eggs were found at the bottom of the shaft. The nestlings survived for a short period of time during which the adults continued to attend them. Within a week, however, both nestlings died. The parents remained for awhile, but did not construct a new nest.

Fischer (1958. Bulletin 368, N.Y. State Museum and Science Service) described the re-use of nests by Chimney Swifts, but those he observed were made inside a building where they were protected from the elements. The only nest I have observed actually used for nesting a second season did not hold up long enough for successful nesting the second year. It is unlikely that this species makes use of old nests which are not protected from the weather.—Ralph W. Dexter, *Kent State University, Kent, Ohio, 2 April 1962.*

Injured Western Gulls.—While collecting nine specimens of Western Gulls (*Larus occidentalis*) to demonstrate the sequence of plumage change from the juvenile to that of the adult, we secured two gulls which evidenced odd circumstances involving the bill region. Gull I (Figure), a first year juvenile male, was collected on 30 August 1961, at Arroyo Burro Beach in Santa Barbara County. Upon examination of the specimen, we observed that the gull had a fish hook and line entangled around the head. The fish hook's barb is caught in the roof of the mouth penetrating the right maxillary palatine plate, with the shank of the hook circling the right side of the bill (Figure). The nylon leader is wrapped around the bill in a figure-eight pattern as follows: from the hook eye the line goes over the upper bill, from right to left, then through the mouth, wraps around the lower bill four times, passes over the upper bill again in reverse direction from left to right, into the mouth again, twists around two of the strands of leader already through the mouth 12 times, leaving two of the four strands free, out the left side and completely around the head passing below the eyes and across the nape and back into the mouth again, with a small piece hanging out the left side. The line has caused considerable injury to the sides of both the upper and lower portions of the bill. At the point where the right side of the mandible comes into contact with the arch of the fish hook the horny covering of the bill is fractured and broken away. The tongue was beginning to dry and as might be expected, the gull with its bridle was emaciated and



probably near death from starvation. Gull II, an adult female, was taken on 20 July 1961, at the Santa Barbara City Dump. When it was examined we found that the tongue protruded from under the bill through a round hole in the inter-ramal region, or the skin area between the fork of the lower bill (Figure). The hole is surrounded by thickened scar tissue and is an orifice through which the tongue probably moved back and forth to a limited extent when the bird used its bill. However, the distal half of the tongue is hard and dried from prolonged exposure, indicating that the gull probably could not withdraw its tongue into the mouth cavity, even though we were able to bend the tongue enough to move it back into the mouth and out again through the hole. There are no feathers around the opening. In spite of the externalized tongue the gull was in good body condition and also showed recent molt. From our examination of the specimen we believe that the external position of the tongue was not due to an abnormality in development, but the result of an old healed injury, perhaps a fish hook incident similar to that of Gull I. Gull III (Figure), an adult female, taken the same day and place as Gull II is a normal specimen for comparison.—Jodi Bennett and Mary M. Erickson, *Department of Biological Sciences, University of California, Santa Barbara, California, 21 October 1961.*

A nesting of Amazonian terns and skimmers.—Once in about five years or so the River Amazon drops in the dry season (August to November) to abnormally low levels: 1961 was such a year. The Solimoes, or Upper Amazon above Manaus, carries a vast load of sand, silt, and mud, which is dropped on the bottom wherever the water is slack, and ultimately rises to water level. The river rises and falls some 40 feet, and in early September 1961 was already 2½ feet below normal minimum and was falling at the rate of three inches a day. The M.V. *Venimos* went aground on a submerged bank at 8:30 AM 9 September, at the western end of Ilha Piranhas, the Island of "Cannibal Fish," about 500 land miles upstream from Manaus. A mile farther west an extensive sand bar had formed and was now above water level. A sizable colony of Large-billed Terns (*Phaetusa simplex*) and Black Skimmers (*Rynchops nigra*) had taken possession of it, and were beginning to nest there. Probably there were around 100 pairs of each species. Their "scrapes" were 3″ to 4″ deep and 8″ to 10″ in diameter. Indian women from a hut on the north bank, across the main channel of the Solimoes, took notice, and every morning at the streak of dawn were out on the island gathering the new-laid eggs. On 14 September they had gathered about 70 eggs of which 8 were skimmers' (*Cortaguas* or Cutwaters) and the rest terns' (*Gaivotas,* literally "gulls"). From this it seems probable that the skimmers were not yet in full production, and are normally behind the terns, a situation similar to that at Stone Harbor, New Jersey.

It would seem that, since the Amazon is virtually on the Equator, and the Ilha Piranhas is at Lat 2½° S, Long 65½° W, there is nothing to determine the nesting season except the behavior of the River. The birds nest while the River is falling, the sandbanks emerging and the time for rising water so far off that there is time to lay and incubate the eggs and to raise the young to the flying stage.

River pilots said this particular sand bar was not normally above water level and so far as they knew had never been seen before. The local Indians confirmed this. Thus the colony of skimmers and terns is a new one, and the birds had adopted it very promptly.

On 11 September, very early in the morning, four birds came aboard the stranded *Venimos,* and found the forecastle quiet and deserted. A large coil of rope covered with a tarpaulin seemed to them an acceptable substitute for the sand bar, from which presumably the women had disturbed them, and there they laid one egg each, three terns and one skimmer. The bosun saw the birds and he later collected the eggs, which he brought to me. Obviously the birds were not intending to nest, four to a square yard of tarpaulin, and they did not return on subsequent days.

Birds have often been observed on ships, and in fact several spine-tails and perhaps other birds came aboard the *Venimos* and stayed many hours; but the casual or emergency laying of eggs on shipboard must be a rather rare event.—F. W. Preston, *Box 149, Butler, Pennsylvania, 11 September 1961.*

Lesser Nighthawk in Oklahoma.—On 22–23 April 1961, I visited Cimarron County at the western end of the Oklahoma Panhandle. While driving in a residential area of Boise City on 23 April, I observed a caprimulgid perched on a horizontal tree branch which impressed me as being too small to be a Common Nighthawk (*Chordeiles minor*). When the bird flew I was able to note the presence and position of white wing marks indicative of the Lesser Nighthawk (*Chordeiles acutipennis*). The bird was lost from view soon after taking flight; however, when I returned one hour later with John P. O'Neill and Odis A. Cook, it was found again in the same vicinity and was viewed both perched and in flight. It did not call during the time of observation. I collected the bird and it proved to be a very fat male weighing 65.1 grams, and with testes measuring about 3.0 × 3.5 mm. The identification was confirmed by Dr. George M. Sutton, and the specimen is No. 4794 in the University of Oklahoma Museum of Zoology. There is no previous specimen, and to my knowledge no previous sighting of this species in Oklahoma. The Lesser Nighthawk has not been recorded from Kansas or from the Texas Panhandle, however, the Fifth A.O.U. Check-list mentions a casual occurrence at Trinidad, Colorado, about 110 miles northwest of Boise City. The A.O.U. Check-list and Wolfe (1956. "Check-list of the Birds of Texas") indicate that the limits of its breeding range in west Texas lie about 360 miles south to 385 miles southeast of Boise City.

Ligon (1961. "New Mexico Birds") comments that the Lesser Nighthawk is among the latest spring migrants to arrive and gives usual dates as 6 to 10 May in southern and southeastern New Mexico. The earliness of the 23 April 1961 date in Cimarron County, Oklahoma, is thus rather striking. No Common Nighthawk was seen by us on 22–23 April 1961 in Cimarron County, and judging from other areas of Oklahoma it would not be expected to arrive until a week or more later.

A second unusual species on 23 April in Boise City was a warbler that was almost certainly a female of the genus *Parula*. John O'Neill and I observed it briefly but clearly at close range and in bright light but were not able to collect the bird. We both noted the small size, yellow throat and breast, white wing-bars, and bluish upperparts with a greenish patch on the back. A breast band was very indistinct or perhaps completely absent. We cannot state for certain that an eye-ring was present. Therefore, we cannot exclude positively the Olive-backed Warbler (*Parula pitiayumi*). Except for the presence of the Lesser Nighthawk, another Rio Grande Valley inhabitant, we would hesitate to suggest the possibility of such an accidental occurrence. Certainly the greater likelihood is that the bird was a Parula Warbler (*Parula americana*). Since the Parula Warbler has not been found previously in Oklahoma west of the central portion of the state, even its occurrence in Cimarron County probably would be classified as casual.

The finding of both the nighthawk and the warbler on the same date displaced from their normal ranges or migratory paths might be related to a common factor. An analysis of weather relative to the 1961 spring migration has been presented by Bagg and Baird (1961. *Aud. Field Notes*, 15:380–389). Their discussion emphasizes a strong, sustained flow of tropical air northwestward from Yucatan into south Texas and on northward into Oklahoma between 19 and 24 April 1961. Thus, conditions favorable to rapid north-northwestward movement from the known wintering areas of the species involved occurred at about the time of our unusual observations. It would seem that these weather conditions might have been the cause for the displacements in direction, distance, and time which are described above.—W. Marvin Davis, *College of Pharmacy, University of Oklahoma, Norman, Oklahoma, 23 October 1961.*

Grasshopper Sparrow wintering in central Missouri.—On 14 January 1961, David Snyder, James Gilmore, and I visited an area approximately 16 miles south of Sedalia, Benton County, Missouri, for the purpose of listing birds wintering in grassland.

A visit to a one-half acre pond surrounded by tall grasses and weeds located in the center of a timothy (*Phleum pratense*) stubble field, revealed the presence of two Grasshopper Sparrows (*Ammodramus savannarum*). A male was mist-netted, photographed, sacrificed for food habits study, and preserved as a study skin. According to Widmann (1907. "Birds of Missouri," *Trans. Acad. of Sci., St. Louis*, 17:1–296) and Bennitt (1932. "Check-list of the Birds of Missouri," *Univ. of Mo. Studies*, 7(3):1–81) this seems to be the first record of a Grasshopper Sparrow wintering in Missouri. The area of collecting had a great variety of tall and short grasses and many weeds and herbaceous plants. The dominants were: foxtail (*Setaria*), millet (*Echinochloa*), spike-rush (*Eleocharis*), Indian grass (*Sorghastrum nutans*), cord-grass (*Spartina*), switchgrass (*Panicum virgatum*), big bluestem (*Andropogon Gerardi*) and false loosestrife (*Ludwigia*).

On a subsequent visit to the area on 24 January 1961, when the temperature was –10 F, we found one Grasshopper Sparrow, which again eluded our nets.—David A. Easterla, *Missouri Cooperative Wildlife Research Unit, Stephens Hall, Columbia, Missouri, 15 December 1961.*

Red Phalarope in West Virginia.—On 3 November 1961, I was informed by Mr. Norville Hall that he had just seen a phalarope on one of the ponds in Oglebay Park. near Wheeling, Ohio County, West Virginia.

Later, in the company of James Denham, Miss Dorothy Broemsen and Mr. Hall, I observed the bird at close range. It was identified as an adult Red Phalarope (*Phalaropus fulicarius*) in winter plumage.

The next morning, Mr. Denham returned to the impoundment, was unable to locate the bird at first, but eventually found it dead at the mouth of the spillway of the dam. The specimen was retrieved and put in refrigeration.

Several days later a study skin was prepared and internal examination revealed that the bird was a female showing signs of emaciation. The identification was verified by Dr. Kenneth C. Parkes of The Carnegie Museum, where the specimen has been deposited.

So far as is known, this is the first record of the Red Phalarope for West Virginia.—George H. Breiding, *Oglebay Institute, Oglebay Park, Wheeling, West Virginia, 20 March 1962.*

Specimens of unusual Indiana birds.—Over the past several years, the Purdue University Wildlife Laboratory Collection has acquired a number of interesting bird specimens from Indiana. Some of these represent first records (those marked with an asterisk), and others are of birds sufficiently uncommon in the state to warrant notice.

I wish to thank Willard Kaehler and Kenneth C. Nettles for donating waterfowl specimens they shot or obtained from other hunters.

*Brant (*Branta bernicla*).—On 26 October 1957, ten of us observed two Brant at Michigan City, Laporte Co. One bird, incapable of flight because of a fresh shot wound, was captured by hand. It was an immature male weighing 1,079 grams and bore little fat; the testes measured 3 × 12 mm and the bursa 10 × 15 mm. Raymond Grow and August Verhoestra had seen three Brant at Michigan City on 19 October.

Greater Scaup (*Aythya marila*).—Twelve specimens of this duck were shot from 27 January 1955 to 30 December 1961 at Whiting, Lake Co., or Michigan City, along the southern shore of Lake Michigan, where the species appears to be a regular winter visitor. All were taken in December or January and, except for two sick birds, had heavy fat. Four adult males weighed from 1,124 to 1,282 grams (avg. 1,222); two immature males weighed 965 and 1,213 grams; three adult females weighed from 1,008 to 1,140 grams (avg. 1,093).

*Harlequin Duck (*Histrionicus histrionicus*).—On 3 January 1961, Charles M. Kirkpatrick and I collected an immature female at Michigan City. It weighed 437 grams and had little fat.

King Eider (*Somateria spectabilis*).—Willard Kaehler obtained five specimens from hunters between 16 December 1956 and 26 November 1959. Four were shot at Whiting and one at Gary, Lake Co., along Lake Michigan. Two immature males weighed 1,180 and 1,205 grams; two immature females weighed 1,071 and 1,162 grams.

*Common Scoter (*Oidemia nigra*).—On 8 December 1959, John Louis observed a sick bird of this species at Gary; Louis found the bird dead there on 10 December. An immature male was shot at Whiting on 15 November 1960 by G. Brown; it weighed 746 grams, had testes measuring 2 × 10 mm, and bore little fat. Kaehler shot an immature female at Whiting on 19 December 1960; it weighed 814 grams and had scarcely any fat.

Knot (*Calidris canutus*).—A female was obtained by Kenneth Nettles from boys who had been plinking with pellet guns along Lake Michigan, at Whiting, on 13 September 1961. It had heavy fat and weighed 128.8 grams.

*Purple Sandpiper (*Erolia maritima*).—On 30 January 1958, five of us collected a female at Michigan City. It weighed 67.5 grams, was moderately fat, and had a bursa 2.5 mm in length.

Red Phalarope (*Phalaropus fulicarius*).—Seven were found feeding along the beach at Michigan City on 30 October 1959. A fat female weighing 60.9 grams was collected. The stomach contents included midge larvae of the family Chironomidae, fragments of an amphipod of the genus *Gammarus* (probably *limnaeus*), mayfly nymphs, and remains of an isopod (*Asellus communis*). According to William R. Eberly, who made the determinations, midge larvae and amphipods were most numerous.

Franklin's Gull (*Larus pipixcan*).—Two were found on a small, overflow pond in a cornfield 15 miles N of Greencastle, Putnam Co., on 16 June 1958. The bird collected was a male weighing 240 grams; it had testes measuring 3 × 7 mm and no fat was present. The head was in heavy molt and was only partially black.—Russell E. Mumford, *Department of Forestry and Conservation, Purdue University, Lafayette, Indiana, 2 April 1962.*

Recent sight record of Kirtland's Warbler in the Bahamas.—At about 2:00 PM on 27 March 1957, two companions and I saw a male Kirtland's Warbler (*Dendroica kirtlandii*) in some low, broad-leafed scrub on Hog Island, directly across the harbor from Nassau, B.W.I. No specimens of this species have been taken from these wintering grounds since 1913, although sight records were reported by a group from the Florida Audubon Society in the northern islands of the Bahamas in the fall of 1960 and 1961. The scrub, in which we saw the bird, was growing along a path through a plantation of Australian pine (*Casuarina equisetifolia*). The bird stayed within 20 or 30 feet for about two minutes and all field marks were clearly visible. It appeared to be catching insects on the wing and each time it returned to perch, it jerked its tail in a characteristic fashion. This report is being made to alert other visitors to these islands to the presence of this rare warbler.—DAVID CHALLINOR, JR., *Peabody Museum, New Haven, Connecticut, 27 March 1962.*

NEW LIFE MEMBER

Peter C. Petersen, Jr., holder of a B.S. degree from Iowa State University, has been an active member of the WOS since 1951 and is now a new Life Member of the Society. Mr. Petersen is Vice-President of the Inland Bird Banding Association, Editor of *Iowa Bird Life*, past president of The Iowa Ornithologist Union, Director of the Illinois Audubon Society, a life member of the AOU and Cooper Ornithological Society, and a member of the Iowa Academy of Science and numerous midwestern state bird clubs. He was a naturalist with the Davenport (Iowa) Public Museum and is now in Quality Control at the Crescent Macaroni and Cracker Company. His principal interests in ornithology include bird-banding of nestling gulls and migrants, the latter especially through the use of mist nets. Results of his field studies have been published in *Iowa Bird Life* and the Illinois *Audubon Bulletin*. Mr. Petersen also has co-authored "A Field List of the Birds of the Tri-city Area."

ORNITHOLOGICAL NEWS

On 3 June 1962 Mrs. Margaret Morse Nice, past president of the WOS, received an honorary degree of Doctor of Science from Elmira College (New York). The following citation was read on that occasion by Richard R. Bond, Dean of the Elmira College Faculty.

"Mr. President, I have the honor and pleasure of presenting Margaret Morse Nice for the honorary degree of Doctor of Science.

"A graduate of Mt. Holyoke College and a recipient of the master's degree from Clark University, she is an embodiment of our concept of an educated woman. Daughter of a historian at Amherst, married to a distinguished physiologist, mother of a fine family of four daughters, one of whom holds the Ph.D., grandmother of seven boys, five of whom are currently in college or graduate school, she has successfully combined her family life with her strong scientific interests. While and after rearing her family she actively engaged in study and research on biological problems, using the outdoors near her home as her laboratory and common species of birds as her subjects. In so doing, she joined the ranks of the eminent naturalists of all time who saw so much in what appeared common to so many. As she specifically became interested in the problems of population dynamics and individual behavior of the species with which she worked, as she shared her work with the scientific world through numerous publications, and as she brought the work of ornithologists around the world into focus as review editor of a national journal, she rose to eminence as a biologist. Indeed, she has recently been called by one scientist the "grandmother of ethology"—the newly emerging field of the scientific study of animal behavior. Her most famous work, a two-volume monograph on the Song Sparrow, the result of years of careful observation and experimentation with generations of individual birds, gained for her in 1942 the coveted Brewster medal, an award for the most significant ornithological publication. This pioneer study was a model of careful and thorough analysis of the life history and behavior of a species and has been a pattern for numerous subsequent Ph.D. theses. Among her many dozens of publications are works on territoriality, incubation periods, and the development of behavior in birds. She has also published 13 papers on the speech development of children.

"Her international reputation is evidenced by her election as Fellow of the American Ornithologists' Union, as President of the Wilson Ornithological Society for a term, and to Honorary Membership in the Linnaean Society of New York, the British Ornithologists' Union, and the professional ornithological societies of Holland, Germany, and Hungary. She will be an active participant at the 13th International Ornithological Congress to be held at Cornell University later this month.

"Mr. President, because of her accomplishments as a woman and as a scientist, I am honored to present to you both on behalf of all professional ornithologists and on behalf of the faculty of Elmira College, which, with the Board of Trustees, has recommended her for the degree of Doctor of Science, Mrs. Margaret Morse Nice."

It is with sincere regret that we announce the death of Harold H. Bailey, of Rockbridge Alum Springs Biological Laboratory, Goshen, Virginia, on 23 July 1962. Mr. Bailey had been an active member of the Wilson Ornithological Society since 1908.

ORNITHOLOGICAL LITERATURE

Mark Catesby: The Colonial Audubon. By George Frederick Frick and Raymond Phineas Stearns. University of Illinois Press, Urbana, 1961: 8½ × 11⅛ in., x + 137 pp., 16 bl. and wh. pls. $5.00.

For this attractive book the authors, Messrs. Frick and Stearns, are assured of a large audience at once because of their secondary title, "The Colonial Audubon." This device is a little worn by now but it will serve to capture the legions of bird watchers here and abroad, who may never have heard of Catesby but somehow know the popular figure of Audubon, already publicized by many books. Zoologists and botanists will be delighted to see this careful biography of such an important figure in their fields of study. It is a charming book at moderate cost.

The book opens with a meticulous search into the occupations and interests of Mark Catesby's forebears. Catesby's interest in nature comes from the Jekyll or mother's side of his family. The authors think that Mark remained in his natal area of Sudbury, with a few journeys to London, until his trip to America; but there is evidence that he was employed in London, although the exact dates, so far as I know, are not published.

Catesby first thought of going to Africa, but he preferred America, and the marriage of his sister, Elizabeth, to William Cocke of Williamsburg, Virginia, was the entering wedge for convincing his father that he should go to America even though his father had disapproved of his daughter's marriage. With relatives in Virginia, Mark had entrée to the prominent families of Williamsburg, including William Byrd; and these good contacts eased his travels through the country so that he could go unmolested and collect plants for shipment home. With these trophies his botanical and gardening friends—John Ray, George Edwards, Thomas Fairchild, and Samuel Dale to mention only a few—were fascinated.

The authors searched the correspondence relative to this first trip by Catesby to America and they examined the minutes of the Royal Society to find the sequence of events that led to Catesby's second voyage. The tragic fate of John Lawson at the hands of the Tuscarora Indians in 1710 was still fresh in the minds of the group of botanists who were eager for more specimens. Catesby had shown ability in drawing and painting and this enhanced his eligibility for a second trip. Two years elapsed between his return from Virginia and his embarkation for Charles Town in February of 1722.

An auspicious circumstance was the departure of Colonel Francis Nicholson for his post as Governor for South Carolina. Though not a botanist he favored the Catesby project and contributed to the costs of the expedition. Others then saw fit to contribute also, and Catesby set off with the personal support of several members of the Royal Society as his sponsors, and the real interest of the Society itself behind him. He continued collecting plants and seeds to further the popular trend to naturalize exotic species in England, but he also collected birds extensively and made drawings from living specimens in their natural environments. He was no skilled taxidermist but the birds were eviscerated, dried, and packed in tobacco dust for shipment, and many, together with his drawings, furnished the first descriptions of their species.

At home at last in England in 1726, Catesby was eager to get his work into print but he had no conception of the time and work needed to accomplish this task. It was necessary that he take engraving lessons and water color instruction. Thus the entire work, "The Natural History of Carolina, Florida, and the Bahama Islands," was published during the years between 1731 and 1743.

Despite much rewarding recognition for this great work, and his election to the Royal Society and the Gentlemen's Society at Spalding, Catesby appears to have fallen on hard times and shifted his residence from St. Paul's Parish Covent Garden to St. Luke's Parish in Old Street, a rather poor part of London. This appears to have occurred about 1742. Apparently, too, Mark Catesby married, but there is definite difference of opinion on this event in Catesby's life.

Messrs. Frick and Stearns state that Catesby's clandestine marriage in 1747 to Elizabeth Rowland was evidently his first venture into matrimony. However, I have published the will of Mrs. Elizabeth Catesby, the first wife (see "The History of American Ornithology before Audubon" by Elsa G. Allen in *Trans. Amer. Phil. Soc.*: 41:470. 1951). In this it is clear that Elizabeth Rowland was Mrs. Catesby's "loving daughter" and probably also Mark's. Mrs. Catesby also had a son Mark and a daughter Ann. Messrs. Frick and Stearns fail to regard it as important that Elizabeth Rowland was "Mrs." at the time of her clandestine marriage to Mark Catesby on 8 October 1747. At any rate, "Rowland" was her probable married name and she was presumably a widow.

The authors suggest that the children, Mark and Ann Catesby, "may well have been the natural offspring of Catesby and Elizabeth Rowland, with possibly both their births preceding a marriage which added a certain solemnity—if little more legality—to an existing relationship." This seems unlikely to me in view of the first Mrs. Catesby's will in which she claims the children as her own. (Of course it is conceivable that she could have agreed to take them into her home, to ease a bad situation.) A brief search has been made to find the birth or christening dates of these two children but so far without success. If found, they will help to clarify this puzzle.

The first Mrs. Catesby lived until 1753, in which year she wrote her will and appointed her husband's brother, Jekyll Catesby, as her sole executor. Peter Collinson, Catesby's staunch friend, witnessed the document, as did a woman friend or relative of Mrs. Catesby, Martha Arther, who was a member of her household.

As for the record of Mark Catesby going to the seas, there is a will in the Principal Probate Registry, London, which I found in 1936. This gives much evidence of being the will of Mark Catesby, the naturalist. Messrs. Frick and Stearns, however, summarily dismiss this idea, although the signature to the document appears exactly as in Mark Catesby's letters. There is the additional fact that Catesby's brother, Jekyll Catesby, was the sole executor of this will (made the 30th of October 1749, just before Catesby set out on his intended voyage) and he was also the sole executor of Catesby's wife's will three years later.

The description of Catesby's death published in *Gentleman's Magazine*, 1750, notwithstanding, I am of the opinion that the voyage in the ship *Portfield* was Catesby's escape from the intolerable situation. We do not know with what remorse and suffering, but he died aboard the ship on 20 April 1750, and "amid faint airs and a calm sea his body was committed to the deep." I had previously searched St. Luke's registers in London for Mark Catesby's burial as reported in the *Papers of the Bibliographical Society of America* by Mr. Frick, but there is no such entry. Catesby was said to have been buried in St. Luke's churchyard but I could find no such grave or record.

As previously mentioned, Mark made his own illustrations first in the field and then laboriously engraved and colored them himself over a long period of years. Sixteen of his illustrations are reproduced in this book.

The book's appendix is devoted to a discussion of Thomas More, apparently an erratic but energetic seeker after adventure, somewhat tolerated by the savants of England because of his desire to travel to far places for little money in order to indulge in his hobby of collecting. More seems to have little bearing on the dynamic Catesby story except that he went to New England and Pennsylvania about the same time that Catesby went to the southern part of the Colonies.

Messrs. Frick and Stearns have produced a useful addition to the literary and historical source books for the present, growing interest in the history of science. However, it does not seem quite appropriate for them to say that they have rescued Mark Catesby "from unwarranted oblivion" when many scientists from George Edwards to the present have written on Catesby's contributions to colonial botany and in larger measure to American ornithology.—Elsa Guerdrum (Mrs. A. A.) Allen.

Birds of the World: A Survey of the One Hundred and Fifty-five Families. By Oliver L. Austin, Jr. Illustrations by Arthur Singer. Edited by Herbert S. Zim. Golden Press, New York, 1961: 10¼ × 13½ in., 316 pp., numerous col. illus., maps, and diagrams; illus. lining-papers. $17.50 (Goldencraft edition $11.98).

"Birds of the World" is a non-technical survey of the 150-odd families of birds. It is a well-written, well-illustrated book, with a highly attractive format, that snugly fits a long-felt gap in ornithological literature.

In a brief introduction the Class is defined, its evolution is sketched, and the recent history of extinction is considered. A rather disproportionate amount of space, including a two-page diagram, is given to the highly speculative subject of the relative number of species in the major groups throughout their evolution.

The text follows the usual sequence of orders and the more or less conventional arrangement of families. The latter is very conservatively handled, in that, for example, the Boatbilled Heron ("*Cochlearius*") is afforded familial rank, the thrushes, babblers, Old World flycatchers, Old World warblers, etc. are treated as separate families, and the waxbills, weavers, and Carduelinae are grouped in the Ploceidae. The author does note, however, that these arrangements are currently questioned by some ornithologists.

Under each ordinal heading there are a few paragraphs in which the morphology of the group is broadly characterized and its geographical distribution is outlined. The features differentiating the families are sometimes given, although frequently this is reserved for discussion under the individual families.

The treatment of each family differs widely in length and scope. The range (often shown on a colored map), number of species, and physical characteristics are always considered, but in one group the peculiarities of its range may be dealt with in detail, while in another family this may be presented in the briefest manner and considerable attention is devoted to its ethology or breeding biology. Much of this pleasing diversification of treatment is doubtless a reflection of how well a family is known generally, as well as by the author, but it also indicates an attempt to highlight the most interesting features of each group. Austin possesses a talent, rare among scientists, for presenting an enormous wealth of sound information interestingly, as well as succinctly.

The art work, all of which is in color, is superb and is an integral part of the book, rather than merely an embellishment. About 700 species are illustrated, including a number which never before have been depicted in color. Some birds are shown singly but most are arranged in groups on a branch, which often is in flower or fruit, or against a similarly suitable background. The illustrations are scattered through the text; some appear on the margins of the page, others in the center or in place of one column of text, and others occupy much of one or two pages with the type filling the irregular gaps. The vernacular and scientific names, range, and dimensions of each species appear next to the illustration.

The colors are generally excellent, although there is an ashy quality to them because of the uncoated paper on which they are printed. A more serious criticism is the matter of perspective. A number of species, of varying sizes, appear next to one another but the degree to which they are reduced varies enormously, and without regard to perspective. For example, the Great Hornbill, which is five feet in length, is depicted in the foreground at about one-fifth life size, while in the same group of birds the Jamaican Tody, which is roughly four inches long, is shown in the background at about one-half its actual size. Even though the dimensions of the living bird are adjacent to each species, and one may be thoroughly familiar with the birds (which the general reader is probably not), the eye is unaccustomed to such manipulations with perspective. The effect is disturbing.

Austin is known to be a careful, even pedantic, author and a severe editor and critic, but this book is marred by a profusion of errors, ranging from misspelled scientific names to incorrectly identified birds and a few minor factual inaccuracies. One suspects that the publisher, in order to meet the Christmas book trade, hurried the author and slighted the editor, Herbert S. Zim. The errors are, for the most part, of no real importance but they are annoying to a critical reader. The layman, for whom this book was written, might be confused by an occasional transposed caption, but he doubtless will read most of the book without awareness that, for example, "*Leptoptilus*" should be written *Leptoptilos* or that cedillas are lacking on "Jacana" and "Aracari."—RAYMOND A. PAYNTER, JR.

MORPHOLOGICAL DIFFERENTIATION AND ADAPTATION IN THE GALAPAGOS FINCHES. By Robert I. Bowman. University of California Publications in Zoology, Vol. 58; 1961: vii + 302 pp., 22 pls., 74 figs., 63 tables. $6.00.

Bowman's work represents a renewed study on a famous and much discussed group of birds, the Galapagos finches. The focus of the entire study is on the adaptive responses by these birds to the molding forces associated with each type of food niche exploited. The paper therefore is largely concerned with food-getting apparatus. This includes the bill, the tongue, the skeletal form of the jaws and cranium, and the musculature of the head. The author explores the architecture of the cranial vault and the connections of the cranium with the jaws in terms of mechanical stresses arising in cracking hard seeds and in biting tough wood and bark. He finds that (p. 203), "In large measure, the array of morphological modifications exhibited in the geospizine skulls may be interpreted as osteological adaptations designed to resist the forces of compression and tension that arise in the processes of food getting—probing, tip biting, crushing."

Bowman's extensive field work in the Galapagos Islands provides a strong basis for his interpretations. He has observed the feeding behavior of several species of the finches in detail, and he has collected the finches and analyzed the foods found within the stomachs. He describes the physical and ecological characteristics of each food, so that our knowledge of this phase of the subject is greatly extended.

Bowman summarizes his findings with an outline of the adaptive radiation of the Galapagos finches. Among the 14 present-day species, all presumed derived from a single ancestral immigrant, he discerns six general adaptations, and each one of the latter represents a genus. *Geospiza* has finch-like habits, *Camarhynchus* has parid-like and parrot-bill-like habits, *Cactospiza* has tree-foraging habits, *Platyspiza* has plant-eating habits, *Certhidea* has warbler-like habits, and *Pinaroloxias* has honeycreeper-like habits. Within each of these general types he describes specializing adaptations which relate to individual species. Thus, in brief, *Geospiza magnirostris* feeds on a small variety of very hard, generally large seeds, *G. fortis* feeds on a large variety of moderately hard, small to large seeds, and *G. fuliginosa* feeds on a large variety of soft, generally small seeds (p. 287). The clear and detailed contrast of the food niches developed in geospizine finches is one of the outstanding contributions of Bowman's efforts.

Of course the development of food niches is related to the opportunities presented by the environment, itself evolving. Bowman says (p. 289), "The array of relatively large, sparrow-like bills . . . is a reflection of the abundance of hard-coated seeds. Hard, impervious seed coats are typical of many species of angiosperms in arid regions of the world. The 'problem' of exploiting the insect food, mainly concealed beneath bark and wood during most of the daylight hours, has been 'solved' through the evolution of powerful probing and tip-biting bills . . . ." The ecological diversification of the environment, the fragmentation of the environment in the form of isolated island units, and the known history of the Galapagos environment are all considered in relation to the evolution of the geospizine finches.

Unquestionably, in certain features Bowman has carried his analysis beyond any point attained in previous studies. Principally, these would be in his detailed analysis of skeletal and muscular morphology and of the nature of the foods taken. In addition to a large quantity of original data, Bowman also offers ingenious explanations demonstrating an adaptive basis for each variation in structure. In one of the more surprising instances, Bowman interprets the peculiar location of persistent skull windows at the rear of the parietal part of the geospizine skull as an adaptation providing for increased resistance to fracture stresses that are relayed along the frame of the cranium to converge upon the windowed part of the vault.

Much of Bowman's discussion is devoted to evolutionary processes that have produced the adaptive radiation now found in the Galapagos finches. One important point concerns competition, for Bowman concludes that competition cannot be discerned today as an effective selective force maintaining diversity in the Galapagos finches. "Individuals of one species do not now 'compete' for food with certain other individuals of the same species (e.g., large-billed versus small-billed individuals of *G. fortis*), or with individuals of another sympatric species, or at least not in any manner that has evolutionary significance today . . ." (p. 275). From this he concludes further that competition has not been a molding force in the past—"since there is no direct evidence that competition is occurring at the present time, I see no logical reason to assume that it must have occurred in the past." A clear definition of the concept of competition is essential to this discussion, but unfortunately Bowman's position does not seem completely clear. He defines competition as involving struggle (p. 273), but nevertheless at times he seems to imply selective forces that arise when there is overlap of two species which utilize the same environmental resource in part but without struggle. Certainly competition is present today if competition is to be defined in this latter sense. I feel that he is not as convincing on competition as he is on other matters, and I look forward to amplification when he has more facts with which to deal.

On the basis of the very substantial contributions in this volume, the promise is great that Dr. Bowman's continuing field study in the Galapagos Islands will yield still more new information of fundamental value. We could hope for additional field evidence in support of his view that the particular proportions of brown and black in the variable plumages of the finches are each an adaptation to provide a maximum of concealment from predators. We can also hope that future work will explore more adaptations only indirectly or not at all concerned with food getting.—PAUL H. BALDWIN.

WATCHERS AT THE POND. By Franklin Russell. Alfred A. Knopf, New York, 1961: 5¾ × 8½ in., iv + 265 pp., line drawing by Robert W. Arnold. $4.50.

We are informed by this book's jacket that its author has been "variously a farmer, a contractor and auto mechanic, a laborer, a truck driver, and a streetcar conductor." Later he was a newspaper man turned free-lance writer. Born 40 years ago in New Zealand, and after having lived there, in Australia, and in England, he came to this continent in 1954, settling in Toronto, Canada. This, his first book, is "A pinnacle of the natural historian's art," an "unexpectedly dramatic story," "sharply observant," and so on.

On the assumption that the publisher has discovered a talented author–naturalist, however unusual his background, writing of the North American scene to which he was only recently a stranger, we proceed to read hopefully, expecting a fresh approach. The words flow nicely with seeming authority—we agree with the publisher. Then suddenly we find ourselves being told about a muskrat's "short, flattened tail . . . ready to whack down on the water as a danger signal," a phoebe that would nest in a tree, a Red-tailed Hawk that "smashed ducks to earth in showers of feathers," leopard frogs singing from trees—whereupon we ask, has the publisher been fooled or is he trying to fool us?

When this book first appeared it was given high praise by Orville Prescott in *The New York Times* for 11 December 1961. No naturalist himself by his own admission but a literary critic, Mr. Prescott was taken in by the quality of the writing *per se*. The responsibility for foisting this delusive book on the public is entirely the publisher's. His innocence, if such was the case, is inexcusable. Well aware of the author's background, he should have turned the manuscript over to a qualified naturalist for checking before accepting it for publication.—OLIN SEWALL PETTINGILL, JR.

WISCONSIN'S FAVORITE BIRD HAUNTS: A Guide to 30 of Wisconsin's Most Favored Locations for Bird Study, with Individual Maps. Compiled and edited by Samuel D. Robbins, Jr. Wisconsin Society for Ornithology, Madison, 1961: 6 × 9 in., viii + 77 pp., many maps. Paper-covered. $1.75.

In 1953 the Wisconsin Society for Ornithology began publishing in its journal, *The Passenger Pigeon*, a series of articles by its members on areas for bird finding in the state. Usually devoted to one area, each article described the physical features, mentioned the more noteworthy birds with hints on where and when to expect them, and gave specific route directions, accompanied by a map, to the best vantage points for observations. The articles have now been brought together between the covers of this attractive booklet which cannot fail to stimulate wider interest in Wisconsin's bird life. Other state ornithological societies that publish journals would do well to follow the Wisconsin Society's lead, for here is a means of encouraging members to contribute to journals, of getting significant subject matter (editors sometimes have trouble in this regard!), and of producing a useful and saleable publication.—OLIN SEWALL PETTINGILL, JR.

The New Handbook of Attracting Birds. By Thomas P. McElroy, Jr. Second edition. Alfred A. Knopf, New York, 1960: 6 × 8 in. XIX + 262 pp., 65 figs. $4.00.

Mr. McElroy states in his preface, "This book is written for everyone who would attract and enjoy the birdlife of our land" (east of the Mississippi River exclusive of semitropical species found in Florida and the coastal states). This intent is clearly accomplished through careful instructions ranging from how to build a wren nest-box or a suet-feeder to how to improve conditions for birds on an entire estate or to set up the Articles of Association to establish a Community Wildlife Sanctuary. Some of the 19 chapter topics are: (1) Feeding Songbirds, (2) Attracting With Water, (3) Attracting by Planting, (4) Homes for Birds, (5) How to Attract Hummingbirds, (6) Attracting Game Birds, (7) Attracting Waterfowl, and (8) Care of Young and Wounded Birds.

A chapter on aids to bird study briefly instructs the beginner concerning such matters as bird songs, binoculars, record-keeping, and photography. An appendix supplies basic lists of bird-song recordings, bird books, suppliers of bird items, and a state-by-state list of sources of information on birds.

The numerous line-drawn figures of feeders, nest-box construction plans, food plants, garden plans, etc. are excellent. However, at times it is difficult for the reader to find the appropriate figure referred to in the text material (unfortunately also, the book contains a very large number of typographical errors).

This book is not merely a cut-and-dried tabulation of methods and materials for attracting birds. It is a result of the author's combined skills as a carpenter, naturalist, and former director of the National Audubon Society's Aullwood Nature Center in Ohio. It is a fine source of practical information and also has many parts which are interesting and informative ornithological reading for the person not faced with an immediate problem concerning attracting birds. The reader can sense the author's personal appreciation of a well-constructed nest box, a properly planted shrub, and an appropriate pond for local waterfowl—and the relationship of the bird to these man-made efforts to attract it.—Nicholas L. Cuthbert.

Discovery: Great Moments in the Lives of Outstanding Naturalists. Edited by John K. Terres. J. B. Lippincott Company, Philadelphia and New York, 1961: 6 × 8½ in., xiii + 338 pp., many wood engravings by Thomas W. Nason. $6.50.

Terres had a bright idea for a book. At his request 36 first-rate, well-known naturalists such as A. A. Allen, Darling, Lack, Peterson, Pettingill, and Sutton, among others, wrote accounts of "one memorable experience about the discovery of a fascinating fact about nature." Each of these accounts, preceded by a brief biographical sketch written by the editor, became a chapter of the book. As would be expected, some of the contributors are better writers than others, and some have selected subject matter more nearly in line with the theme than others. Nevertheless, all the chapters are interesting, most are stimulating, and a few are downright exciting.—Edward F. Dana.

Wideawake Island: The Story of the B.O.U. Centenary Expedition to Ascension. By Bernard Stonehouse. Hutchinson & Co., Ltd., London, 1960: 5¾ × 9 in., 224 pp., 37 photos, numerous sketches. 35s (about $4.90).

This is the day-by-day story of the British Ornithologists' Union's centenary expedition to Ascension Island (1957–59), the scientific results of which are being published separately in *The Ibis.* If the "methods and materials" sections of many scientific papers were allowed the luxury of full details, informal style, and a fair share of humor, we would have more accounts of this sort. The book is a valuable eye-opener to those who have not had extensive field experience in that it vividly presents the innumerable preparations, pre-arrangements, hard labor, discomfort, organization, and crucial decisions of which a successful expedition is made. The amount of time and energy spent in survival and the routines of daily existence, which directly affect the scientific results of an expedition, should not be forgotten when reading about the number of birds banded, the behavior of the boobies, and the reproductive cycles of each species.

The primary purposes of the 16-month sojourn on Ascension—an isolated, equatorial island in the South Atlantic—were to study the ecology, behavior, and breeding biology of the 11 sea-bird species which breed there and on its tiny satellite, Boatswain Bird Island. To this end each person concentrated on certain species—Bernard Stonehouse on the two boatswain-birds (tropic-birds) and the Frigate-bird, his wife Sally and Dick Allan on the Madeiran Storm Petrel and the land birds (waxbills, canaries, mynahs, and francolins), Philip Ashmole on the Wideawake (Sooty Tern) and two noddies, Douglas Dorward on the Fairy Tern and two boobies. Only the rare Red-footed Booby was not intensively studied. Michael Cullen concentrated on the behavior of various species and Eric Duffey made an ecological survey of the island.

After one month on Ascension, the advance party of two had explored the island, made the acquaintance of those who were to be most helpful during their stay, chosen a camp site, constructed a camp of several huts complete with generator and electric lights, and made arrangements with the Americans at the missile-testing base to obtain fresh water. Still ahead were the caulking and painting of the motor launch, *Ibis*, and the problem of mooring *Ibis*, and landing on Boatswain Bird Island—a more or less sheer, rocky nubbin off the main island, on which many sea birds nest—and the building of a hut on this small island where considerable time was to be spent.

One of the first ornithological tasks, after the arrival of the other members, was the banding of as many individuals as possible of each species early in the breeding season to serve as an aid in behavior studies and to provide solid evidence concerning the length of time between breeding cycles. Their efforts, though often laborious or frustrating, were eventually rewarded; they found that two consecutive breeding seasons of individual Wideawake Terns (*Sterna fuscata*), and also Yellow-billed Boatswain-birds (*Phaëthon lepturus*), were separated by only nine to ten months. The Black Noddy and Brown Booby were also suspected of a less than yearly breeding cycle, whereas the other sea birds appeared to have annual cycles. (Previous studies of the breeding cycle of the Sooty Tern were based on unbanded birds.)

Among the natural-history tidbits presented are a description of the breeding of sea turtles, the role of cats as predators, and the discovery of bones of Wideawake Terns, boobies, and a rail in fumaroles. The bird life, environment, and expedition activities are well documented with photographs and pen-and-ink sketches. The author's search through documents in the courthouse resulted in an interesting section on the history of Ascension. Despite the many activities of the expedition members and their rather successful attempts to get caught up in the social whirl, the year and a half of primitive living on the hot, parched, volcanic landscape must have had its monotonous aspects. These are barely hinted at, and the tone of the narrative remains light and humorous. —RICHARD L. ZUSI.

THE LONELY LAND. By Sigurd F. Olson. Alfred A. Knopf, New York, 1961: 5¾ × 8½ in., x + 273 pp., line drawings by Francis Lee Jaques. $4.50.

In accepting the John Burroughs Medal for his book, "Iceland Summer," Dr. George Miksch Sutton remarked: "No person in our world should be denied the privilege of getting lost.... There must be wilderness areas in which man can pit himself against nature, recognize his dependence on God, and discover himself through being threatened with losing his way."

Mr. Olson and five members of his party, which included a diplomat and a bank president, found their "place to be lost" in northwestern Saskatchewan where they followed the Churchill River from its headwaters at the height of land near Ile à la Crosse for five hundred miles to Cumberland House—a trail relatively unchanged since the explorers and voyageurs traveled it so long ago.

This is a pleasant book. The author is constantly aware of the birds and mammals and plants, of the geology, and of the changing scene along the River. There is no crisis, no hair-breadth escape from death, no "getting lost"—but there could have been. The possibility was always there. The men were alone in their fragile canoes, making split-second judgments in the white-water of a swift stream, using their last ounces of strength against the huge waves of a wind-tossed lake, trying to follow the main channel through the maze of cattails and willows in a great swamp.

Quotations from the diaries of the earlier explorers and voyageurs add interest to the text and Mr. Jaques' illustration for each chapter heading artfully sets the stage for the story that follows.—OLIN SEWALL PETTINGILL, JR.

ANIMAL ECOLOGY. By S. Charles Kendeigh. Prentice-Hall, Englewood Cliffs, New Jersey, 1961: 8 × 11 in., x + 468 pp., 196 illus. $11.00.

"Animal Ecology" was "designed for a course given at the junior–senior–graduate level, to students who have at least a year's background in zoology." In an effort to stress principles and basic concepts, Dr. Kendeigh has divided his book into four major sections: I. "Background" (4 chapters); II. "Local Habitats, Communities, Succession" (5 chapters); III. "Ecological Processes and Community Dynamics" (10 chapters); IV. "Geographic Distribution of Communities" (9 chapters). In general, the major headings suggest the subjects discussed under each section, but one is not always certain from a chapter title what subjects may be found there. The subjects dispersal, migration, and ecesis are discussed in the chapter so titled (Chapter 10); emigration is treated in Chapter 16, and irruptions in Chapter 17. Dr. Kendeigh considers the terms irruption, outbreak, and plague to be synonymous. In "Food and Feeding Relationships" (Chapter 13), one finds a discussion of cryptic coloration, deflective colors, directive markings, counter-shading, aggressive resemblance, aposematic coloration, and others, under the general heading "Protective devices." Dr. Kendeigh did not think it "desirable to devote a special chapter to applied ecology or, more particularly, to wildlife management," but he did include short sections on applied ecology in several chapters. "Physiological ecology, the study of the manner in which organisms respond and adjust to environmental factors, is dealt with sparingly." Some consideration of physiological ecology by an author with physiological interests, however, would have added immeasurably to the discussion of "Speciation" (Chapter 19). The text is followed by a 31-page "Bibliography," a 45-page "Subject Index," and a 20-page "Species Index." Some readers may object to the double-column offset printing on relatively thin paper.

I liked the historical emphasis throughout much of the book because the beginning student should learn about the pioneer workers in a given discipline. I also liked the generally straight-forward definitions of the countless ecological terms and references to the definitions in the Subject Index. A broad spectrum of the animal kingdom, from protozoa to mammals, is given in the examples cited to illustrate ecological principles. Although probably only a reflection of my own preoccupation with the significance of population dynamics and ecological peculiarities of the Kirtland's Warbler, I was surprised to find no mention of this remarkable species. Dr. Kendeigh has discussed a vast array of subjects, mostly in a cursory and superficial style in keeping with the aims of the book.

Dr. Kendeigh considers the science of ethology "an essential branch of ecology" (page 14). It may come as somewhat of a shock to ethologists, psychologists, and neurophysiologists, however, to read that "ethology differs from psychology in that it is concerned with understanding not only the causality of behavior but also the *survival value* of behavior patterns under natural conditions, and the *evolution* of these patterns. Psychology is concerned more with analyzing the nervous mechanisms that are involved." This may be a useful pedagogical distinction for an ecologist, but it also is typical of the widespread naive concept about the basic nature of ethological theory. As such it does much to brand ethological research as a superficial "descriptive science" without a sound foundation, for it is virtually impossible to think in terms of the "causality of behavior" without considering the underlying neurophysiological mechanisms.

Ornithologists will be interested in the presentations on the zoological regions of the world, paleo-ecology, and the major biomes and their characteristic bird species (Chapters 20 through 28), as well as the discussion and outline for the study of a "complete ecological life history of a species" (page 16). The life histories presented in the book, however, are not written in accordance with this admirable outline.

Despite Dr. Kendeigh's statement in the preface that "the science of ecology, born at the beginning of the present century after a gestation period of several hundreds of years, has now matured into an honored and respected scholarly discipline and field of research," one still has the feeling that some ecologists continue to confuse "scholarly discipline" with superficial research couched in a welter of ecological terminology contrived to create the impression of profundity and scholarship.—Andrew J. Berger.

A Synopsis of the Birds of India and Pakistan, Together with Those of Nepal, Sikkim, Bhutan and Ceylon. By Sidney Dillon Ripley II. Bombay Natural History Society, 1961: 6¾ × 9½ in., xxxvi + 703 pp., 2 maps (1 col.). Rs 25. (Available from Peabody Museum of Natural History, Yale University, for $6.50.)

All Indian ornithology takes as a touchstone Stuart Baker's monumental seven-volume work on birds in "The Fauna of British India" (1922–30), the final volume of which appeared more than thirty years ago. The period when this classic was prepared, and for about ten years after, were the heydays of Indian ornithology, as well as a time of profound changes in avian systematics. As a consequence, the portions of Baker's work concerned with distribution and taxonomy became outmoded nearly as soon as published, although the life history studies remain of paramount importance. An up-to-date check-list has been greatly needed. Ripley's "Synopsis" meets this need admirably.

The area covered by the "Synopsis" is similar to that in the "Fauna," except for the omission of Burma, which has been adequately treated by Smythies' "The Birds of Burma" (1953). About one-seventh of the world's avifauna occurs on the Indo-Pakistan subcontinent. In this region the author recognizes about 1,200 species, with an aggregate of 2,060 species and subspecies; about 1,750 forms are resident.

The introductory portion of this volume is important, for in addition to the usual acknowledgments, definitions, and similar matter, it covers the recent history of ornithology on the subcontinent, defines the 15 vegetational zones recognized (following Champion's classic "A Preliminary Survey of the Forest Types of India and Burma," *Indian Forest Records*, 1:1–286, 1936), and considers the zoogeographical affinities of the avifauna. The latter section, most of which is a recapitulation of earlier work, stresses the importance of an Ethiopean element in the composition of avifauna and the relatively minor influence of Palaearctic species.

Two useful maps are included. The first, entitled "India and Pakistan before the 1956 reorganization of the Indian States," is actually a map of India before the 1947 partition of India and Pakistan. This is accompanied by a clear overlay outlining the present international boundaries, the Indian states after 1956, and the nearly 400 districts (roughly comparable to counties) into which Pakistan and India are divided. Unfortunately, the key to the districts is separated from the map by some twenty pages of text. The second is an orographic map, in color, with an overlay depicting the 15 vegetation zones, although it is entitled "Distribution of Climatic Types." One wishes it had been possible to include a map showing the locations of the more important collecting stations.

The check-list presents the orders and families in what is a more or less conventional sequence, with the Fringillidae and Emberizidae ending the list. The Babblers, Flycatchers, Warblers, and Thrushes are considered to be subfamilies of the Muscicapidae, and the House Sparrows, Weavers, and Waxbills are treated as subfamilies of the Ploceidae. The latter arrangement is debatable. The generic and specific treatment, particularly among the Muscicapidae, is sometimes not that which is generally accepted by taxonomists. One might prefer a more conservative approach in a list which doubtless will be the standard work on the region for many years. For example, some may question the use of *Microura* for the Wren-Babbler long known as *Pnoepyga*, or the lumping of *Luscinia* and *Tarsiger* under *Erithacus*, or the combining of *Ficedula* and *Niltava* with *Muscicapa*. The subspecies frequently are divided rather minutely.

The list is amplified beyond the usual check-list approach with liberal references to recent revisions of families, genera, and species. Footnotes abound, pointing out differences of opinion, the reasons for changes, etc. The author is to be commended for this, since too often a check-list seems to imply finality and hides existing problems. A worker in Indian ornithology could spend a lifetime of research merely resolving the points raised in the footnotes.

The distribution of each form is traced in convenient detail and its habitat preferences are described. There is considerable duplication, as one would expect, in sketching the biotopes of contiguous subspecies and it is obvious that the author often searched for synonyms to avoid monotony. A substantial reduction in the size of the volume might have been made if the habitat had been broadly outlined under the species heading and the variations, if any, had been noted under each subspecies.

This book not merely meets a long-felt need but does it with great competency. For this ornithologists may be particularly grateful, since Ripley is the only taxonomist with sufficient experience with Indian birds to have prepared such a list. Had his work been poor we might have waited an additional thirty years for an adequate study.—RAYMOND A. PAYNTER, JR.

THE EYE OF THE WIND. By Peter Scott. Houghton Mifflin Co., Boston, 1961: 6 × 9 in., XXII + 679 pp., 4 col. pls., 50 bl. and wh. photos. $10.00.

Naturalists who have known Peter Scott chiefly from his splendid pictures of waterfowl have now in this autobiography an opportunity to learn about some of his other interests. The result is more acquaintance than intimacy with the author for, as he says, his story tells what has happened to him rather than what he is or has been, but a good many interesting things have happened to him and he recounts them vividly and enthusiastically.

Scott's interest in natural history dates from his earliest memories. Much of the first part of the book recounts his growing interest in shooting and hunting, his exploits in pursuit of wildfowl, and the gradual change from wanting to kill birds to wanting to study and paint them. This change in attitude led to the founding and development of the Severn Wildfowl Trust after the war at Slimbridge where Scott now makes his home, and where there is a living collection of nearly all the waterfowl of the world.

More than a third of the book is devoted to the war. Scott recounts many of his experiences on destroyers and steam gunboats which were exactly to his adventurous taste. He writes with enthusiasm which is contagious and for the most part carries the reader along with him through extensive details and technical descriptions. There are times when the story lags but soon exciting action speeds it on its way again.

Scott is an outstanding yachtsman and, in addition to developing new racing techniques and winning the Prince of Wales's Cup, as President of the International Yacht Racing Union, he was instrumental in the adoption of a uniform Code of Racing Rules. From sailing what could be more natural than to take up gliding as an adventurous recreation? Scott quickly became an enthusiastic and proficient pilot and competitor. A trip to Australia with skindiving on the Barrier Reef has recently opened a significantly new field of activity which in all probability will result in another book and more beautiful paintings.

"The Eye of the Wind" is more adventure story than autobiography. Scott is an "incurable recorder" and at times allows his "capacity for recording useless details" to get out of control. On the other hand, though long, the book is lively, interesting and at times revealing of character. It is printed in England and handsomely put together and jacketed.—EDWARD F. DANA.

BIRDS OF THE CARIBBEAN. By Robert Porter Allen. The Viking Press, 1961: 8½ × 11½ in., 156 pp., 107 color photos. $15.00.

This is one of the best of the "picture books" I have seen. Although basically a volume of superb color photographs, the text is interesting, informative, and accurate, which is a notable contrast to the verbal pap which publishers often sandwich between the pictures.

"The Caribbean," which the author suggests is perhaps a state of mind, as well as a sea and a region, is defined as including the Antilles, Trinidad and Tobago, and the mainland coast from Yucatán through Central America and northern South America. Inland The Caribbean extends to where "the natives have never heard of the merengue or of a steel band."

Within the area are about 1,000 species of birds, 98 of which are pictured. Each species is allotted one "plate," although here a plate is synonymous with "one species," since it may consist of one to four photographs, printed on a portion of one page to two full pages. Although an unusual concept, the reader expecting 98 photographs is pleasantly surprised to discover a ten per cent bonus.

The photographs range from the more conventional, but lovely, ones of graceful egrets to the seldom-photographed Pale-breasted Spinetail (*Synallaxis albescens*), Blue-gray Tanager (*Thraupis virens*), and Grayish Saltator (*Saltator coerulescens*). My favorite is a full-page portrait of the King Vulture (*Sarcoramphus papa*). The color reproduction is generally excellent; a notable exception is the aquamarine Little Blue Heron (*Florida caerulea*).

The purist may be disturbed to learn that about one-third of the pictures are of captive birds. This is sometimes very evident, as in the case of the Channel-billed Toucan (*Ramphastos vitellinus*) and the Scarlet Macaw (*Ara macao*), the latter of which looks like the prized snapshot of a Florida vacationist.

The work of 23 photographers, ranging from A. A. Allen, A. D. Cruickshank, and C. H. Greenewalt to K. H. Maslowski, P. A. Schwartz, and K. Weidman, appears. A section, "The Photographers," is devoted to a brief biography of each and to photographic data concerning his contributions. Unfortunately, there is no way readily to determine which picture was taken by whom. One must search the biographies for the answer.

For each species there is about one page of text. This is of a broad scope, and no set pattern, often touching on distribution, behavior, breeding biology, and the author's own experiences. There is little that is new, but many an author of a scientific paper will be pleased to see his data deftly, yet accurately, "popularized."

A section entitled "Identification Guide," follows the main text. For each species is given its vernacular names, a brief morphological description, and its distribution.

The bibliography contains most of the literature on the avifauna of the region which an amateur would find helpful.

A novelty, which I have not seen in a bird book before, is the use of different colored paper (gray, blue, tan, salmon, etc.) for the signatures containing the text. It is attractive and lends variety, although the literal-minded, as this reviewer, may initially hunt for some significance beyond the esthetic.—RAYMOND A. PAYNTER, JR.

BIRDS OF REGINA. By Margaret Belcher. Saskatchewan Natural History Society, Special Publication No. 3, Regina, 1961: 5½ × 8¼ in., 76 pp., many drawings by Fred W. Lahrman, 9 photos, 2 maps. $1.00.

As a treatment of bird life in a small area, "Birds of Regina" leaves little to be desired. The species accounts give status, habitat preferences, and a digest of records from widely scattered sources, including the literature. (Overlooked is a note in *The Wilson Bulletin*, vol. 58 (1946), p. 53, on an occupied Barn Swallow nest at Regina on 22 September, a few days later than the record cited.) Preceding the species accounts, which take up all but 17 pages of the booklet, is a careful description, involving 12 pages, of the different major habitats, with indication of where one may see them and mention of their occupant bird species. Mr. Lahrman's drawings, though varying greatly in style, are nonetheless pleasing.—OLIN SEWALL PETTINGILL, JR.

PROCEEDINGS OF THE FORTY-THIRD ANNUAL MEETING

By Aaron M. Bagg, Secretary

The Forty-third Annual Meeting of the Wilson Ornithological Society was held at Purdue University, Lafayette, Indiana, from Thursday, 5 April, to Sunday, 8 April 1962. The meeting was sponsored by the Indiana Audubon Society, the Purdue University Club (Bird Study Section), the Amos W. Butler Audubon Society of Indianapolis, and the South Bend Audubon Society. The Local Committee, under the efficient direction of Dr. R. E. Mumford, Chairman, organized an excellent meeting, which was greatly enjoyed by the 232 registered members and guests who attended.

Four sessions were devoted to papers, and two business meetings were held, in the Purdue Memorial Center. The meeting opened with an informal reception in the Memorial Union on Thursday evening, for which the South Bend Audubon Society and the Amos W. Butler Audubon Society of Indianapolis acted as hosts. Thursday evening was also the occasion for the meeting of the Executive Council, in the Memorial Center. On Friday evening, there was a fascinating colored slide program on the Timber Wolf and Moose populations of Isle Royale National Park. The Annual Dinner was held on Saturday evening in the Memorial Union. The President's Address was presented by Harold F. Mayfield, and was followed by an illustrated program, by Robert A. Mann, on "The Physiography and Natural History of the Indiana Dunes." The Local Committee had decorated the dinner tables attractively, and at each place setting there was a souvenir ash tray shaped in the outline of Indiana and carrying the portrait of a Cardinal.

Early-morning field trips were scheduled for Friday and Saturday. On Sunday, there were field trips to the Willow Slough State Game Preserve, Jasper-Pulaski, and the Greater Prairie Chicken grounds; some of the more interesting species seen included Sandhill Cranes, a few Prairie Chickens, 22 Smith's Longspurs, Yellow Rail, and—as a remarkable bonus—a rare gull which, when subsequently collected, proved to be a Lesser Black-backed Gull.

First Business Session

President Mayfield called the meeting to order at 9:30 AM, Friday, 6 April. Dr. W. L. Ayres, Dean of the School of Science, Education, and Humanities, Purdue University, welcomed the members and guests of the Wilson Ornithological Society. President Mayfield responded on behalf of the Society.

The Proceedings of the Forty-second Annual Meeting were approved as published in *The Wilson Bulletin* for September 1961.

Secretary's Report

The secretary, Aaron M. Bagg, summarized the principal actions taken at the Thursday evening meeting of the Executive Council, as follows:

1. The Council heard further plans for the previously accepted invitation to the Wilson Society to hold its 1963 meeting at Charleston, S.C., during 2–5 May 1963. The sponsoring organizations will be the Charleston Museum, the Charleston Natural History Society, and the Carolina Bird Club.

2. The Council voted to accept the invitation of Western Michigan University, Kalamazoo College, Michigan Audubon Society, the Audubon Society of Kalamazoo, and the Kalamazoo Nature Center, to hold the 1964 meeting of the Wilson Society in Kalamazoo, Michigan, in late April or early May 1964.

3. The Council voted tentative acceptance of an invitation from the South Dakota Ornithological Society to meet in the Black Hills of South Dakota in June 1965.

4. The Council accepted the report of the Louis Agassiz Fuertes Research Committee and voted an award of $100 to Donald S. Heintzelman for his research project.

5. The Council re-elected Dr. H. Lewis Batts, Jr., as Editor of *The Wilson Bulletin.*

Treasurer's Report

The treasurer, Merrill Wood, submitted the following report on the finances of the Society:

Report of the Treasurer for 1961

General Fund

Balance as shown by last report dated 31 December 1960			$ 4,426.26
RECEIPTS			
Dues:			
Active Memberships	$4,922.60		
Sustaining Membership	912.00	$5,834.60	
Subscriptions to *The Wilson Bulletin*		835.25	
Sale of back issues of *The Wilson Bulletin*		521.85	
Interest and dividends on savings and investments		1,139.95	
Transfer from Special Publications Fund (closed)		5.00	
Gifts		11.00	
Miscellaneous		43.93	$ 8,391.58
Total Receipts			$12,817.84
DISBURSEMENTS			
The Wilson Bulletin (printing and engraving)		$6,757.37	
The Wilson Bulletin (mailing and maintenance of mailing)		932.40	
Secretary's expense		64.19	
Treasurer's expense (printing, postage, safe deposit box)		276.62	
Back issue expense (postage and purchases)		50.00	
International Council for Bird Preservation (1961 dues)		25.00	
Annual Meeting expense		236.88	
Transfer to Fuertes' Research Fund		56.00	
Miscellaneous		16.46	
Total Disbursements			$ 8,414.92
Balance on hand in First National Bank, State College, Pennsylvania, 31 December 1961			$ 4,402.92

Josselyn Van Tyne Memorial Library Book Fund

Balance as shown by last report dated 31 December 1960		$ 300.16
RECEIPTS		
Sale of duplicates and gifts	$ 342.05	
Total Receipts		$ 642.21
DISBURSEMENTS		
Purchase of books		$ 40.12
Balance on hand in First National Bank, State College, Pennsylvania, 31 December 1961		$ 602.09

Louis Agassiz Fuertes Research Fund

Balance as shown by last report dated 31 December 1960		$ 127.00
RECEIPTS		
Contributions	$ 17.00	
Transfer from General Fund (Council action)	56.00	$ 73.00
Total Receipts		$ 200.00
DISBURSEMENTS		
Award to Frances (Mrs. Douglas A.) James		$ 100.00
Balance on hand in First National Bank, State College, Pennsylvania, 31 December 1961		$ 100.00

Endowment Fund

Balance in Savings Account as shown by last report dated 31 December 1960		$ 2,088.66
RECEIPTS		
Life Membership payments	$1,232.00	$ 1,232.00
Stock dividends received (included below)		
5 shares of Massachusetts Investors Trust		
Total Receipts		$ 3,320.66
DISBURSEMENTS		
Purchase of 70 shares of M. A. Hanna Co.	$2,380.00	$ 2,380.00
Balance in Savings Account, First National Bank, State College, Pennsylvania, 31 December 1961		$ 940.66
Total		$ 3,320.66
SECURITIES OWNED		
\$5,000 U.S. Treas. 4% Notes due 15 May 1963 at $100\frac{28}{32}$	$5,043.75	
\$5,000 U.S. Treas. 4% Bonds due 1 October 1969 at $100\frac{22}{32}$	5,034.40	
\$3,000 Phillips Petroleum 4½% Bonds due 15 February 1987 at 123	3,690.00	
70 shares M. A. Hanna Co. at 33⅛	2,318.75	
15 shares Kaiser Aluminum & Chemical Co. 4¾% cum. cvt. pft. (1957 series) at 106¾	1,601.25	
401 shares Massachusetts Investors Trust at 15.55	6,235.55	
100 shares Fireman's Fund Insurance at 63½	6,350.00	
25 shares Owens-Illinois Glass Co. 4% com. pfd. at 114	2,850.00	
(Securities listed at closing prices 29 December 1961)		
Total Securities Owned		$33,123.70
Total in Endowment Fund, 31 December 1961		$34,064.36

Respectfully submitted,
/s/ MERRILL WOOD
Treasurer

The Society voted to accept the Treasurer's Report.

Research Grant Committee

Pershing B. Hofslund spoke briefly on the work of the committee, of which Harvey I. Fisher is Chairman.

Membership Committee

Hazel Bradley Lory, Chairman, reported as follows:

The Membership Committee this year has consisted of 18 members, well distributed over the United States, and one in Canada.

For my part, I have endeavored to keep my assistants supplied with the necessary leaflets, application-for-membership cards and past numbers of the *Bulletin,* wherever usable. I have also taken care of individual requests for information about membership that have been sent to me.

Before last year's annual meeting I requested that a list of all people attending, with their addresses, be supplied to me following the meeting. This was sent to me very promptly and I used it for listing prospective members. It was checked against our latest membership list and I found 76 non-members had attended. Their names, in groups of 8 to 12, were sent to members of our committee, who then wrote to these people inviting them to join W.O.S. Twelve members were secured in this way.

According to a report from the Treasurer on the number of new members obtained through sponsorship of W.O.S. members, *ten* members of our committee secured *31* new members. Twenty joined without sponsorship and the rest were sponsored by other members not on our committee.

For the 1962 meeting I have brought a supply of application cards, leaflets and *Bulletins* to be given out to anyone interested in joining. Also, at the suggestion of our President, I have prepared packets of *Bulletins* to be given as "bonuses" to those who join the Society during this meeting.

Library Committee

William A. Lunk, Chairman, reported by letter as follows:

During the past year the business of the Library Committee has been largely of a routine nature—no formal meetings have been called.

In line with the continuing policy of reducing the supply of back issues, certain contributions of *Wilson Bulletins* have been made to particularly worthy institutions or organizations, particularly overseas, where it has appeared that the journal would receive wide use and that it would be otherwise unavailable.

Sale of duplicates from the Josselyn Van Tyne Memorial Library, with proceeds to go into the New Book Fund, is continuing, and being increasingly emphasized. Donors should understand that salable duplicates can ultimately be of just as much value to the organization as entirely new items. As the New Book Fund has grown, increased use is being made of it to purchase needed publications. Those requested, which we cannot furnish, will be considered for purchase. It is also contemplated that certain valuable works could, by binding, be made far more durable and usable through judicious use of this fund. Up-to-date figures on the present standing of the fund and on our income and disbursements are not immediately available, but should appear in the Treasurer's report.

Through a new plan tentatively being put into effect at the present meeting, newly acquired books are to be exhibited at the annual meeting. Arrangements with one publisher, and perhaps later with others, provide for a contribution of current books to the library, in exchange for the publicity afforded by their display to our membership in this manner.

The formal incorporation of the library of the late Josselyn Van Tyne continues, this year with Mrs. Van Tyne's gift of 85 books and the equivalent of 20 volumes of separates.

Total acquisitions, from 70 gifts by 63 donors were: 162 books, 251 journals, 6 pamphlets, 14 translations, and 625 reprints. The 107 journals regularly received, 82 by exchange and 25 as gifts, remain as last year.

During the year, 35 out-of-town loans were made to 30 individuals. By far the greatest use is still made of the library by those who come in person.

It is hoped that increased publicity may lead to far greater use, by the members, of our rapidly growing library resources—and in turn to even better support of our endeavors. The thanks of the Committee are extended to all those who have contributed.

Temporary Committees

The President appointed the following temporary committees:

Auditing Committee

David E. Davis, Chairman
George Grube
Carl W. Helms

Nominating Committee

Burt L. Monroe, Sr., Chairman
Maurice G. Brooks
John T. Emlen, Jr.

Resolutions Committee

Haven H. Spencer, Chairman
Leonard Brecher
Ralph Dexter

SECOND BUSINESS SESSION

The final business session was called to order at 3:00 PM, Saturday, 7 April.

On motion duly made and seconded, the report of the Membership Committee was accepted, and the candidates (as posted) were elected to membership in the Society.

Report of the Auditing Committee

The committee reported by letter that they had examined the books of the Wilson Ornithological Society at State College, Pennsylvania, on 2 April 1962, and found them in good order. The report added: "Dr. Wood should be commended for the excellent condition, neat and prompt entries" in the books.

On motion duly made and seconded, the report of the Auditing Committee was accepted.

Report of the Resolutions Committee

Haven H. Spencer, Chairman, read the following report:

WHEREAS the Wilson Ornithological Society is in session at its Forty-third Annual Meeting at Purdue University, Lafayette, Indiana,

BE IT RESOLVED that the Society express its appreciation to the Local Committee under the leadership of Dr. Russell E. Mumford, chairman, and Mrs. William L. Ayres, Mrs. Arthur M. Brunson, Dr. and Mrs. Irving W. Burr, Mrs. Donald T. Canfield, Prof. and Mrs. Karleton W. Crain, Mrs. Samuel S. Cromer, Mrs. Marvin W. DeJonge, Dr. and Mrs. H. D. Jackson, Dr. and Mrs. Charles M. Kirkpatrick, Mrs. Warren M. McVey, Dr. and Mrs. George P. Salen, Dr. and Mrs. Aubrey H. Smith, Dr. J. Dan Webster, and Dr. and Mrs. Merritt S. Webster, for the careful planning and organization which has made this meeting so enjoyable and interesting to the Wilson Ornithological Society's members and friends,

AND BE IT FURTHER RESOLVED that the Society express its thanks to the Indiana Audubon Society, to the Purdue University Club (Bird Study Section), to the Amos W. Butler Audubon Society of Indianapolis, and to the South Bend Audubon Society, for their hospitality in providing refreshments, transportation, and leadership for field trips,

AND BE IT FURTHER RESOLVED that the Society express its appreciation to the Administration and Faculty of Purdue University for their cooperation in the use of their excellent facilities,

AND BE IT FURTHER RESOLVED that the Society express its appreciation to Mr. Harold F. Mayfield for his devoted service and leadership in his two years as president of the Wilson Ornithological Society, and to Mr. Aaron Bagg for his years of devoted service to the Society,

AND BE IT FURTHER RESOLVED that the Society urge its members, as individuals, to participate more actively in correspondence with their governmental representatives concerning conservation issues, the need for wilderness areas, and better-administrated predator, pesticide, and vegetative controls in the management of our wildlife,

AND BE IT FURTHER RESOLVED that the Society express its support of Senate Bill S-1797 that proposes to create an Indiana Dunes National Park, as a unique biological preserve.

On motion duly made and seconded, the report of the Resolutions Committee was accepted.

Election of Officers

The Nominating Committee proposed the following officers for the coming year: President, Phillips B. Street; First Vice-President, Roger Tory Peterson; Second Vice-President, Aaron M. Bagg; Secretary, Pershing B. Hofslund; Treasurer, Merrill Wood; Elective Member of the Executive Council, Kenneth C. Parkes (term expiring 1965).

The report of the committee being accepted, and there being no nominations from the floor, the Secretary was instructed to cast a unanimous ballot for these nominees.

PAPERS SESSIONS

Friday, 6 April

1. Robert W. Storer, Museum of Zoology, University of Michigan. *Observations on the Great Grebe.*
2. Lawrence H. Walkinshaw, Battle Creek, Michigan. *Observations on Three of Africa's Crowned Cranes.*
3. R. M. Evans, University of Wisconsin. *Measurement of Dancing Ground Territories in Sharp-tailed Grouse (*Pedioecetes phasianellus*).*
4. Elden W. Martin, University of Illinois. *Body Weight, and Molt Effects in House Sparrows (*Passer domesticus domesticus*) Fed Diets of Different Protein Levels.*
5. S. Charles Kendeigh, University of Illinois. *Regulation of Nesting Time in the House Wren.*
6. Ralph W. Dexter, Kent State University, Kent, Ohio. *Orientation of the Common Nighthawk to Direction of Sunlight on the Nesting Grounds.*
7. Richard Brewer, Western Michigan University. *Parental Care in the Great Crested Flycatcher and Eastern Kingbird.*

8. John A. Wiens, University of Wisconsin. *Aspects of Cowbird Parasitism in Southern Oklahoma.*

Saturday, 7 April

9. John L. Zimmerman, University of Illinois. *The Vernal Migration of the Dickcissel, a Winter Resident in the Tropics.*
10. James E. Landing, Michigan City, Indiana. *Geographic Field Work in the Study of Avian Migration.*
11. Pershing B. Hofslund, University of Minnesota, Duluth. *The Duluth Hawk Flyway: 1951–1961.*
12. Francois Vuilleumier, Schweizerische Vogelwarte, and University of Illinois. *Fall Migration of Birds over the Swiss Alps.*
13. William L. Thompson and Ellen L. Coutlee, Wayne State University, Detroit. *Biology and Population Structure of Starlings at an Urban Roost.*
14. Irving W. Burr, Purdue University. *Statistical Methods Useful to Ornithologists.*
15. J. Hill Hamon, Indiana State College. *The Avifauna of the Reddick, Florida, Pleistocene.*
16. Harold F. Mayfield, Waterville, Ohio. *Changes in the Bird Life of the Toledo Region Since the Coming of the White Man.*
17. Leon Kelso, Washington, D.C., and Margaret M. Nice, Chicago, Illinois. *A Russian Contribution to Anting and Feather Mites.*
18. Hugh C. Land, Concord College, Athens, West Virginia. *A Tropical "Feeding Tree."*

ATTENDANCE

Members and guests who registered totaled 232 persons. Fifteen states, plus the District of Columbia, were represented.

From **Connecticut**: 1—*New Haven*, Mary Heimerdinger.

From **Illinois**: 26—*Champaign*, S. Charles Kendeigh, Francois Vuilleumier, John E. Williams, John L. Zimmerman; *Chicago*, Albert Gilbert, Mr. and Mrs. L. B. Nice, Dr. and Mrs. A. L. Rand; *Danforth*, Herman Smith; *Decatur*, Mr. and Mrs. C. Turner Nearing; *Dekalb*, Fred Moyer, William E. Southern, James Tate, Jr., Jerold Zar; *East Moline*, Mr. and Mrs. Elton Fawks; *Momence*, Mr. and Mrs. William T. Lory, Mrs. R. J. Sprinkle; *Peoria*, Ferd Luthy; *Quincy*, T. E. Musselman; *Urbana*, T. C. Jegla, Elden Martin, R. E. Yeatter.

From **Indiana**: 101—*Bloomington*, Robert A. Johnston; *Connersville*, Edna Banta; *Culver*, Mr. and Mrs. Robert McIlwain; *Fort Wayne*, Marie Miller, Edith Paul, Iva Spangler, Mabel Thorne; *Gary*, Raymond Grow; *Hamlet*, Mr. and Mrs. J. P. Buck; *Hanover*, J. Dan Webster; *Huntington*, Mayretha Plasterer; *Indianapolis*, Mrs. Ferd Barnickle, Charles S. Berriman III, Robert Buskirk, William Buskirk, Mrs. S. G. Campbell, Mildred Campbell, Paul K. Cullen, Peter D. Cullen, Charles E. Keller, Mrs. Dorothy Luther, Betty Jean Moore, Clara Alma Moore, John Satter, Mrs. Dollie Stuck, Henry C. West, Dorothy White; *Lafayette*, Mr. and Mrs. W. L. Ayres, Henrietta Ball, Mr. and Mrs. John H. Miller, Dr. and Mrs. Russell Mumford, Mary Frances Seever; *LaGrange*, Mrs. Bertha Thompson; *La Porte*, Mr. and Mrs. W. W. Nicholson; *Marion*, Mrs. Ella Hart; *Michigan City*, James Landing, Mr. and Mrs. Robert A. Mann; *Muncie*, Mrs. Robert H. Allen, Thomas G. Overmire, Mr. and Mrs. Harold Zimmerman; *New Castle*, Mr. and Mrs. C. L. Gough; *Pendleton*, Mr. and Mrs. Joseph Brinduse, Ruth Dickenson, Robert Martin, Mr. and Mrs. Fred

Miller, David Smith, Steven Smith, David Walker; *Richmond*, Wilson Baker, James Cope, James Gesseman, Cameron Gifford, Mrs. C. S. Snow, Gertrude Ward; *South Bend*, Mr. and Mrs. John Groet, Mr. and Mrs. R. V. Rea, Mr. and Mrs. G. W. Vesey; *Terre Haute*, Mrs. Edward Erickson, J. Hill Hamon, Mrs. Edward Malooley, Mrs. James H. Mason; *West Lafayette*, Mr. and Mrs. A. M. Brunson, Mr. and Mrs. Irving Burr, Peter Burr, Mr. and Mrs. D. T. Canfield, Mrs. S. S. Cromer, Mr. and Mrs. Harold Dick, Mr. and Mrs. Clarence Goodnight, Mr. and Mrs. H. D. Jackson, Karl Jackson, Mr. and Mrs. Charles Kirkpatrick, Mrs. C. Mahan, Mr. and Mrs. Stuart McLain, Mrs. Beatrice Meehan, Mr. and Mrs. Howard Michaud, Mrs. A. H. Smith, Mr. and Mrs. Merritt S. Webster.

From **Iowa**: 2—*Davenport*, Mary Lou Petersen, Pete Petersen, Jr.

From **Kentucky**: 11—*Anchorage*, Mr. and Mrs. Burt L. Monroe, Sr.; *Louisville*, Mr. and Mrs. Leonard Brecher, Evelyn J. Schneider, Mabel Slack, Mr. and Mrs. Frederick Stamm, Audrey A. Wright; *Richmond*, Tom Hutto, Dan Schreiber.

From **Massachusetts**: 2—*Dover*, Mr. and Mrs. Aaron M. Bagg.

From **Michigan**: 35—*Ann Arbor*, Paul R. Barker, A. J. Berger, Jean Cohn, Norman L. Ford, John Hubbard, Bertram Murray, Jr., Haven Spencer, Robert W. Storer, H. B. Tordoff; *Battle Creek*, Dr. and Mrs. Lawrence H. Walkinshaw; *Detroit*, William Thompson, Elsie Townsend; *East Lansing*, Robert Fleming, R. M. Naik, George J. Wallace; *Grand Haven*, Jack Kammeraad; *Kalamazoo*, Lewis Batts, Richard Brewer, Helen E. Burrell, Charlotte Calhoun, Monica Evans, Anne V. Fuller, Richard Koerker, Thane Robinson, James Spaulding, Marie E. Thompson; *Leonard*, Mrs. Alice D. Miller; *Marquette*, Mary Ross; *Mount Pleasant*, Larry D. Caldwell, N. L. Cuthbert, Harold D. Mahan; *Union City*, Mr. and Mrs. W. A. Dyer; *Warren*, Sergej Postupalsky.

From **Minnesota**: 2—*Duluth*, P. B. Hofslund; *Minneapolis*, Walter J. Breckenridge.

From **Nebraska**: 2—*Wisner*, Mr. and Mrs. John Lueshen.

From **New York**: 5—*Buffalo*, Mrs. Kathleen Allen, Richard C. Rosche; *Hamburg*, Kenneth Able; *Ithaca*, Dr. and Mrs. O. S. Pettingill, Jr.

From **Ohio**: 24—*Ashtabula*, Howard E. Blakeslee; *Chardon*, Marjorie Ramisch; *Cincinnati*, E. Kemsies; *Cleveland*, Adela Gaede, Mildred Stewart; *Columbus*, W. T. Furniss, Charles B. Wheeler; *Dayton*, Mr. and Mrs. Kenneth L. Meyers; *East Cleveland*, Vera Carrothers; *Kent*, Ralph Dexter; *Lakewood*, Mr. and Mrs. William A. Klamm; *Momence*, Mrs. Lessly Fieleke; *Steubenville*, Earl Farmer; *Toledo*, John M. McCormick, Lois McCormick; *Utica*, Mr. and Mrs. C. R. Wagner; *Waterville*, Charles Mayfield, Mr. and Mrs. Harold Mayfield, John Mayfield, Melinda Mayfield.

From **Pennsylvania**: 5—*Chester Springs*, Phillips B. Street; *Philadelphia*, C. Chandler Ross; *Pittsburgh*, Kenneth Parkes; *State College*, Dr. and Mrs. Merrill Wood.

From **Tennessee**: 2—*Nashville*, Albert J. Ganier, John Ogden.

From **West Virginia**: 4—*Athens*, Mr. and Mrs. Hugh Land; *Ona*, Mrs. Ben W. Kiff, Lloyd Kiff.

From **Wisconsin**: 9—*Madison*, Earl Bishop, Dr. and Mrs. John T. Emlen, Roger Evans, Don E. Miller, Helmut Mueller, Victor Rabinowitch, Emil K. Urban, John A. Wiens.

From the **District of Columbia**: 1—Orville W. Crowder.

THE WILSON ORNITHOLOGICAL SOCIETY

MEMBERSHIP ROLL*

Patrons

Carnes, Mrs. Herbert A., 31 Dogwood Lane, Tenafly, New Jersey	1944
Peterson, Roger Tory, Neck Rd., Old Lyme, Connecticut	1942
Strong, Reuben M., 5716 Stony Island Ave., Chicago 37, Illinois	Founder
Van Tyne, Josselyn	Deceased

†Life Member *Sustaining Member Others—Active Members

Abbott, Jackson Miles, 1100 Doter Dr., Waynewood, Alexandria, Virginia	1948
Abraitys, Vincent, Sergeantsville, New Jersey	1956
Ackermann, Fred J., 1298 Edanola Ave., Lakewood 7, Ohio	1956
*Adams, C(lyde) Bruce, 40 Summit Rd., Riverside, Connecticut	1959
Adams, Heman P(urdy), 7 Highland Ave., Maplewood, New Jersey	1959
*Adelson, Richard Henry, Remsen's Lane, RD 1, Oyster Bay, L.I., New York	1938
Agey, H. Norton, 908 Avenue H, N.E., Winter Haven, Florida	1960
Ahlquist, Jon Edward, 2014 West 16 St., Ashtabula, Ohio	1959
Aiken, Carl Howard, 3767 Georgetown, Houston 5, Texas	1959
Aldrich, John Warren, 7725 Lakeview Dr., Falls Church, Virginia	1930
*Alexander, Donald C(hild), 16 Pleasant St., Nahant, Massachusetts	1937
*Alexander, Gordon, Dept. of Biology, University of Colorado, Boulder, Colorado	1936
Alexander, Horace G(undry), 26 Bon Acord Rd., Swanage, Dorset, England	1962
Allen, Arthur A(ugustus), Laboratory of Ornithology, 33 Sapsucker Woods Rd., Ithaca, New York	1914
Allen, Arthur W(esley), 561 Eastern Blvd., Watertown, New York	1959
Allen, Ted T(ipton), Dept. of Biology, Jacksonville University, Jacksonville, Florida	1958
†Allin, A(lbert) E(llis), Provincial Laboratory, Fort William, Ontario, Canada	1943
Allyn, (Paul) Richard, 709 Myers Building, Springfield, Illinois	1944
Almon, Lois, 2946 Cambridge Ave., Milwaukee 11, Wisconsin	1958
Alperin, Irwin M., 187 Cedar Lane, Babylon, New York	1939
Altemus, Edward Lee, Lafayette Ave., Fort Washington, Pennsylvania	1954
Altsheler, Mrs. Yancey R(oberts), 2412 Dundee Rd., Louisville 5, Kentucky	1954
Amadon, Dean, American Museum of Natural History, Central Park West at 79th St., New York 24, New York	1935
Ammon, Walter L., 2607 Kessler, Midland, Texas	1958
Anaka, William, Spirit Lake, Saskatchewan, Canada	1957
Anderson, Anders H(arold), 3221 E. Kleindale Rd., Tucson, Arizona	1937
Anderson, Henry A., Route 4, Pelican Rapids, Minnesota	1961
Anderson, John M., R.R. 4, Winous Point Club, Box 359, Port Clinton, Ohio	1938
Anderson, Mrs. Paul T., Wolf Trap Hill, RFD 2, Winter St., Middleborough, Massachusetts	1961
Anderson, R. K., 936 College Ave., Stevens Point, Wisconsin	1962
Angstadt, Robert B., 103 Elmwood Ave., Ithaca, New York	1962
Annan, Ormsby, Dept. of Biology, Stephen F. Austin State College, Nacogdoches, Texas	1956
Anthers, Clarence A(lvin), 707 N. Moreland Blvd., Waukesha, Wisconsin	1939
*Arbib, Robert S(imeon), Jr., 226 Guion Dr., Mamaroneck, New York	1947
Armington, Sven, Blanchegatan 18, Stockholm No., Sweden	1948
*Armstrong, Virginia, Old Concord Rd., South Lincoln, Massachusetts	1939
Arnold, Elting, 4914 Dorset Ave., Chevy Chase 15, Maryland	1941
Arnold, Keith A(lan), 826 Steward Ave., Jackson, Michigan	1960
Arny, Samuel A., 7432 Hamlet St., Springfield, Virginia	1947
Atkeson, Thomas Zephaniah, P.O. Box 1643, Decatur, Alabama	1953
Austin, Mrs. Harold C., 1116 Mandana Rd., Oakland 10, California	1950
Austin, Oliver L(uther), Florida State Museum, Gainesville, Florida	1930
Avent, Carrie Pillow, Minter City, Mississippi	1959
Axtell, Harold H., Buffalo Museum of Science, Humboldt Park, Buffalo 11, New York	1950

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* Correct to 15 June 1962.

Babcock, Charles D., 127 Jefferson St., Cattaraugus, New York 1959
Badger, Lester R., Route 1, Box 528, Excelsior, Minnesota 1957
Baepler, Donald H(enry), Div. of Science & Mathematics, Central Washington College of Education, Ellensburg, Washington 1955
†Bagg, Aaron Moore, Farm St., Dover, Massachusetts 1948
Bailey, Alfred Marshall, Denver Museum of Natural History, City Park, Denver 6, Colorado 1928
*Bailey, Harold H(arris), Rockbridge Alum Springs Biological Laboratory, Route 2, Goshen, Virginia 1908
Bailey, W. Wallace, Wellfleet Bay Wildlife Sanctuary, Box 171, South Wellfleet, Massachusetts 1959
Baillie, James Little, Royal Ontario Museum, 100 Queen's Park, Toronto 5, Ontario, Canada 1939
Baird, James, South Great Rd., South Lincoln, Massachusetts 1954
†Baker, Bernard W., RD 1, Judson Rd., Spring Lake, Michigan 1938
Baker, Mrs. H. A., R.R. 1, New Castle, Indiana 1960
*Baker, John H(opkinson), 169 East 78th St., New York 21, New York 1930
*Baker, Paul S(eaman), 21 Woodlot Lane, Huntington, L.I., New York 1946
Baker, Rollin Harold, The Museum, Michigan State University, East Lansing, Michigan 1938
Baker, William C(alvin), 559 Euclid St., Salem, Ohio 1931
Baldwin, Mrs. Amy G., 6335 Kimbark Ave., Chicago 37, Illinois 1943
Baldwin, Paul H., Dept. of Zoology, Colorado State University, Fort Collins, Colorado 1956
Baldwin, William Grove, 601 Douglas, Box 1627, Wenatchee, Washington 1959
*Ball, Kathleen E., 11719 - 133rd St., Edmonton, Alberta, Canada 1946
Ball, W(illiam) Howard, 5818 - 30th Ave., Hyattsville, Maryland 1961
Balsom, Mrs. Amos Parker, 2209 E. Stratford Ct., Milwaukee 11, Wisconsin 1949
Banks, Clinton S(eeger), 202 Wilma Ave., Steubenville, Ohio 1945
Banks, Richard C(harles), Natural History Museum, P.O. Box 1390, San Diego 12, California 1959
Banta, Edna, Mary Gray Bird Sanctuary, Route 6, Connersville, Indiana 1945
Barbour, Llewellyn P(helps), 4780 Wood St., Willoughby, Ohio 1948
Bard, Fred George, Museum of Natural History, Albert St. & College Ave., Regina, Saskatchewan, Canada 1946
Barker, Paul R(aymond), 18 Ridgeway, Ann Arbor, Michigan 1962
Barlow, Jon Charles, Dept. of Zoology, University of Kansas, Lawrence, Kansas 1959
†Bartel, Karl E(mil) Edgar, 2528 West Collins St., Blue Island, Illinois 1934
Bartleson, Fred D(urant), Jr., U.S. Air Force Academy, Colorado 1952
*Bartlett, Guy, 1053 Parkwood Blvd., Schenectady 8, New York 1938
Bartlett, L(awrence) M(atthews), Dept. of Zoology, University of Massachusetts, Amherst, Massachusetts 1957
Bartlett, Wesley H., 122 South Ridgley Ave., Algona, Iowa 1936
Barton, Roger, 22 Arlington Ave., Caldwell, New Jersey 1960
Bastin, Eric W(alter), Shalamar, Apt. 305, 40 Robinson St., Hamilton, Ontario, Canada 1951
Batchelder, Edgar M(arden), 56 Orchard St., Marblehead, Massachusetts 1941
Bates, Rex J(ames), 108 Willow St., Park Forest, Illinois 1960
†Batts, H(enry) Lewis, Jr., 2315 Angling Rd., Kalamazoo, Michigan 1946
Batts, H(enry) Lewis, Sr., Mercer University, Macon, Georgia 1959
*Baxter, William, Route 2, Middletown, Delaware 1945
Baylor, L(eslie) M(ilton), 1302 South Fourth Ave., Pocatello, Idaho 1954
Bayly, James C(artwright), 19 Grenville Ct., Brockville, Ontario, Canada 1961
Beardsley, M(argaret) Hortense, 330 North Chestnut St., Ravenna, Ohio 1941
Bebb, Forrest, 1300 Boston Ave., Muskogee, Oklahoma 1955
*Beddall, Mrs. Barbara G(ould), 2502 Bronson Rd., Fairfield Connecticut 1958
Beecher, William J(ohn), Chicago Academy of Sciences, 2001 North Clark St., Chicago 14, Illinois 1948
Beer, James R(obert), Dept. of Entomology & Econ. Zoology, University of Minnesota, St. Paul 1, Minnesota 1957
†Behle, William H(arroun), Dept. of Biology, University of Utah, Salt Lake City 1, Utah 1935

Behrens, Harry Carl, Box 1055, Rapid City, South Dakota	1950
†Belcher, Paul Eugene, 230 Mineola Ave., Akron 13, Ohio	1938
Belknap, John B(alcom), 92 Clinton St., Gouverneur, New York	1959
Bell, Henry III, U.S. Geol. Sur., Agri. Research Center, Beltsville, Maryland	1946
*Bell, Mariam, Toledo State Hospital, P.O. Box 1438, Toledo 3, Ohio	1958
Bender, Charles R(ichard), 364 Alex Hamilton, San Antonio 28, Texas	1960
Bennett, Esther (Vorena), S.I.U. Museum, Carbondale, Illinois	1954
Bennett, Holly Reed, 2457 Orchard St., Chicago 14, Illinois	1949
Benson, Seth Bertram, 645 Coventry Rd., Berkeley 7, California	1930
Bent, Mrs. M. V., 275 Monroe Ave., Rochester, New York	1955
Benton, Allen H(aydon), Dept. of Biology, New York State College for Teachers, Albany, New York	1953
†Berger, Andrew J(ohn), Dept. of Anatomy, University of Michigan, Ann Arbor, Michigan	1940
Berger, Daniel D(avid), 510 East MacArthur Rd., Milwaukee 17, Wisconsin	1953
†Bergstrom, E(dward) Alexander, 37 Old Brook Rd., West Hartford 7, Connecticut	1943
*Berkowitz, Albert Clarence, P.O. Box 1341, Des Moines 5, Iowa	1946
Berrett, Delwyn Green, Museum of Zoology, Louisiana State University, Baton Rouge 3, Louisiana	1959
Betts, Amelia J(eannette), Baldwin City, Kansas	1953
Biaggi, Virgilio, Jr., College of Agriculture, Mayaguez, Puerto Rico	1945
Bibbee, P. C., Dept. of Biology, Davis & Elkins College, Elkins, West Virginia	1958
†Biddle, E. Turner, Leiters Ford, Indiana	1960
Binford, L(aurie) C(harles), Museum of Natural History, Louisiana State University, Baton Rouge 3, Louisiana	1954
Birch, Robert Lee, Dept. of Biology, West Virginia University, Morgantown, West Virginia	1950
Birkenholz, Dale E(ugene), Dept. of Biological Science, Illinois State Normal University, Normal, Illinois	1957
Bishop, Earl, 1325 Milton St., Madison 5, Wisconsin	1962
Black, Charles T(heodore), Route 1, Box 480, East Lansing, Michigan	1935
Black, W. F., Dept. of Biology, Sir George Williams University, Montreal 25, Quebec, Canada	1962
Blades, Herbert, 1708 West Gilpin Dr., Willow Run, Wilmington 5, Delaware	1962
Blake, Charles H(enry), P.O. Box 613, Hillsboro, North Carolina	1950
Blake. Emmet R., Chicago Natural History Museum, Roosevelt Rd. & Lake Shore Dr., Chicago 5, Illinois	1939
Blake, Mrs. Grace R., 1933 Westwood Dr., Topeka, Kansas	1950
Blakeslee, Howard E., 1722 East 45th St., Ashtabula, Ohio	1959
Blanchard, Harold H(ooper), 32 Calumet Rd., Winchester, Massachusetts	1946
Blanchet, Helen, 1406 Southfield Rd., Lincoln Park, Michigan	1954
Blaney, John L., 4444 R.TS. Sq., Shaw A.T.B., South Carolina	1958
†Bleitz, Donald Lewis, 1001 North McCadden Pl., Los Angeles 38, California	1948
Bliese, John C(arl) W(illiam), Dept. of Biology, Nebraska State Teachers College, Kearney, Nebraska	1951
Blount. Elizabeth R(ose), 741 Ruiz St., San Antonio 7, Texas	1961
Bock, Walter (Joseph), Dept. of Zoology, University of Illinois, Urbana, Illinois	1953
Bodsworth, Fred, 294 Beech Ave., Toronto 13, Ontario, Canada	1956
†Bond, James, 1900 Race St., Philadelphia 3, Pennsylvania	1945
Bond. Richard M(arshall), Kingshill, St. Croix, U.S. Virgin Islands	1936
Bond, Richard R(andolph), Elmira College, Elmira, New York	1955
Bondi, Joseph, 355 Hutchinson Blvd., Mt. Vernon, New York	1960
Boone, George C., 511 Ohio St., Lawrence, Kansas	1961
†Booth, Mrs. Robert V. D., 1085 Bank Street, Painesville, Ohio	1949
Bordley, James III, 13 Main St., Cooperstown, New York	1957
Bordner, Dorothy L., 926 West Beaver Ave., State College, Pennsylvania	1959
Borell, Adrey Edwin, Soil Conservation Service, Bldg. 50, Federal Center, Denver 25, Colorado	1936
Borgelt, Leo H., 219 North Promenade St., Havana, Illinois	1961
*Borror, Donald J(oyce), Dept. of Zoology & Entomology, Ohio State University, Columbus 10, Ohio	1927
Boughner, W. C., 51 Claire Dr., Somerville, New Jersey	1956

†Boulton, Rudyerd, Box 8305 Causeway, Salisbury, South Rhodesia	1957
Bourdo, Eric Albert, Jr., Ford Forestry Center, L'Anse, Michigan	1951
Bowdish, Beecher S(coville), 16 Van Horn St., Demarest, New Jersey	1921
Bower, Mrs. F. L., R.F.D. 1, Lee's Hill Rd., Basking Ridge, New Jersey	1954
Bowman, Robert I., Dept of Biology, San Francisco State College, 1600 Holloway Ave., San Francisco 27, California	1962
Boyd, Elizabeth M(argaret), Mount Holyoke College, South Hadley, Massachusetts	1941
Boyd, Ivan L., Dept. of Biology, Baker University, Baldwin, Kansas	1951
Boyer, G(ertrude) Paula, 420 East 2nd Ave., Roselle, New Jersey	1953
*Brackbill, Hervey G(roff), 2620 Poplar Dr., Baltimore 7, Maryland	1942
Bradburn, Donald Muir, 440 Bellaire Dr., New Orleans 24, Louisiana	1950
Brady, Alan, RD 1, Bridgetown Pike, Box 424, Langhorne, Pennsylvania	1959
*Branch, Mrs. Margaret G(amble), 1324 Wells St., Ann Arbor, Michigan	1952
Brandes, K(enneth) W(illiam), 51 Stevens St., Wellsville, New York	1959
Branum, Florence (Pauline), 117 North Ewing St., Lancaster, Ohio	1946
Brauner, Joseph, 521 Glenrock Ave., Los Angeles 24, California	1942
Braunschweig, Mrs. Lee W(elsh), 712 East Montgomery Ave., North Wales, Pennsylvania	1953
†Brecher, Leonard C(harles), 1900 Spring Dr., Louisville 5, Kentucky	1939
†Breckenridge, Walter J(ohn), Museum of Natural History, University of Minnesota, Minneapolis, Minnesota	1929
Breiding, George H(erbert), Oglebay Institute, Wheeling, West Virginia	1942
Brewer, Richard Dean, Dept. of Biology, Western Michigan University, Kalamazoo, Michigan	1949
Brigham, Edward M(orris), Jr., Kingman Memorial Museum, Battle Creek, Michigan	1931
Brigham, Edward M(orris) III, 404 Balsam Dr., Davison, Michigan	1960
Broadbrooks, Harold E(ugene), Southern Illinois University, Alton Residence Center, Alton, Illinois	1948
Brodkorb, Pierce, Dept. of Biology, University of Florida, Gainesville, Florida	1951
Brooke, Mrs. Margaret, 126 51st St., Des Moines 12, Iowa	1958
†Brooks, Maurice Graham, Div. of Forestry, University of West Virginia, Morgantown, West Virginia	1927
Broun, Maurice, Route 2, Kempton, Pennsylvania	1935
Brown, Jerram L., Physiologisches Institut, Universität Zurich, Ramistrasse 69, Zurich, Switzerland	1950
Brown, John Warner, Oatka Farm, Scottsville, New York	1959
†Brown, Lawrence A(llyn), Jr., 434 Marlborough St., Boston 15, Massachusetts	1958
Brown, N(orman) Rae, Faculty of Forestry, University of New Brunswick, Frederickton, New Brunswick, Canada	1945
Brown, Woodward H(art), 4815 Ingersoll Ave., Des Moines 12, Iowa	1949
Bruce, James A(ddison), 565 Spring St., Wooster, Ohio	1952
Brueggemann, Anna L(ouise), 584 Sheridan Ave., Columbus 9, Ohio	1943
†Bruns, James Henry, 1529 Henry Clay Ave., New Orleans 18, Louisiana	1941
Bryan, Burton Donald, Box 2, Adamsville, Rhode Island	1949
*Bryens, Oscar McKinley, Route 1, White Pigeon, Michigan	1924
*Buchheister, Carl W., 1130 Fifth Ave., New York 28, New York	1943
Buck, Mrs. J(ohn) P(aul), R.R. 1, Box 332, Hamlet, Indiana	1960
†Bucknell, Donald N(eedham), 134 Wonham, Ingersoll, Ontario, Canada	1953
Burk, Myrle M., R.R. 2, Waterloo, Iowa	1960
Bull, John L., 1148 Virginia St., Far Rockaway, New York	1952
Bullard, Ralph T(illman), Jr., 5427 Slayton Ave., Chattanooga 10, Tennessee	1960
Bunnell, John R., 3867 Edgewood Ave., Fort Myers, Florida	1953
Burner, Florence H(elen), 1336 Crofton Rd., Baltimore 12, Maryland	1948
Burnham, Gladys L(ou), Howard County Junior College, Big Spring, Texas	1954
Burns, Robert David, Dept. of Zoology, University of Oklahoma, Norman, Oklahoma	1948
Burr, Irving W(ingate), 1141 Glenway, West Lafayette, Indiana	1945
Burrell, Helen E., 1523 Orchard Dr., Kalamazoo, Michigan	1962
Burt, William Henry, Museum of Zoology, University of Michigan, Ann Arbor, Michigan	1928
Burton, Donald E(rnest), 171 Strathearn Rd., Toronto 10, Ontario, Canada	1953
Burtt, Benjamin P., 109 Haffenden Rd., Syracuse 10, New York	1956

Burtt, Harold E., 2163 North Starr Ave., Columbus 21, Ohio 1953
Bush, Harry L(eonard), 210 East Saint Joseph St., Paw Paw, Michigan 1962
Bushman, John, Ecological Research, University of Utah, Dugway, Utah 1951
Buskirk, Robert, 9500 East 86th St., Indianapolis 26, Indiana 1962
Buskirk, William, 9500 East 86th St., Indianapolis 26, Indiana 1962
Butsch, Robert Stearns, Exhibit Museum, University of Michigan, Ann Arbor, Michigan 1947

Cade, Tom, Dept. of Zoology, Syracuse University, Syracuse 10, New York 1950
Cahalane, Victor H(arrison), 80 Fernbank Ave., Delmar, New York 1933
Calef, Robert, Delta College, University Center, Michigan 1954
Callison, Charles H., National Audubon Society, 1130 Fifth Ave., New York 28, New York 1960
Calvert, Earl Wellington, R.R. 2, County Home, Lindsay, Ontario, Canada 1937
Calvin, Robert L(eal), R.D. 3, Pulaski Rd., New Castle, Pennsylvania 1951
Camp, Mrs. Dorothy I(rene), R.D. 1, Stuart Lake, Marshall, Michigan 1957
Campbell, Louis W(alter), 4531 Walker Ave., Toledo 12, Ohio 1926
Campbell, Mildred F(lorence), 29 North Hawthorne Lane, Indianapolis 19, Indiana 1938
Cantwell, Mrs. L. R., R.D. 2, Mattoon, Illinois 1959
Carl, Harry G., 2304 Davie St., Davenport, Iowa 1949
Carpenter, Charles C., Dept. of Zoology, University of Oklahoma, Norman, Oklahoma 1951
Carpenter, Floyd S., 2402 Longest Ave., Louisville 4, Kentucky 1934
Carrick, W(illiam) H(enesey), R.R. 2, Uxbridge, Ontario, Canada 1960
Carroll, Robert P., Dept. of Biology, Virginia Military Institute, Lexington, Virginia 1942
†Carrothers, Vera, 14704 Alder Ave., East Cleveland 12, Ohio 1938
Carruth, Gorton, Thomas Y. Crowell Co., 432 Park Ave. South, New York 16, New York 1960
Carson, L(enwood) B(allard), 1306 Lincoln St., Topeka, Kansas 1948
Carter, Charles E(dward), 1339 30th St., Orlando, Florida 1958
Carter, Dennis (Lee), 857 8th St., Boulder, Colorado 1947
*Carter, Mrs. E. W., Route 2, Perrysburg, Ohio 1946
Carter, William A., 317½ North Duncan, Stillwater, Oklahoma 1961
Cassel, J(oseph) Frank(lin), Dept. of Zoology, North Dakota State University, Fargo, North Dakota 1940
Castles, Ruth Palmer, 2600 21st Ave. South, Forrest Hills Apt. B-7, Nashville 12, Tennessee 1960
Caswell, Herbert H(all), 223 North Summit St., Ypsilanti, Michigan 1959
Cater, Milan B(rison), P.O. Box 146, Madison Heights, Virginia 1944
Centa, Judith A(nne), Kalamazoo College, Kalamazoo, Michigan 1962
†Chalif, Edward Louis, 37 Barnsdale Rd., Short Hills, New Jersey 1947
Chamberlain, Ann, 607 Hill St., Ann Arbor, Michigan 1960
Chamberlain, B(arnwell) Rhett, Wadmalaw Island, South Carolina 1957
Chamberlaine, Lee B., 5830 South Salina St., Syracuse 5, New York 1957
Chambers, Glenn D., 1703 Highridge Dr., Columbia, Missouri 1959
*Chambers, W(illie) Lee, 830 Robinson Rd., Route 1, Box 410, Topanga, California 1909
Chaniot, George E., Jr., Museum of Vertebrate Zoology, University of California, Berkeley 4, California 1956
Chapelle, Francis O(berlin), 98th General Hospital, APO 34, New York, New York 1954
Chapin, James P(aul), American Museum of Natural History, Central Park West at 79th St., New York 24, New York 1945
Chapman, Blanche Hammond, 1325 South 19th St., Birmingham, Alabama 1953
Chapman, Herman Floraine, 712 South Dakota Ave., Sioux Falls, South Dakota 1947
Chapman, Lawrence B., R.F.D. Box 87, Hubbardston, Massachusetts 1940
Chase, Charles Greenough, Mere Place, R.D., Brunswick, Maine 1959
Chase, Theodore, Jr., 2404 Dana St., Berkeley 4, California 1960
Choate, Ernest A., 411 Rodman Ave., Jenkintown, Pennsylvania 1954
Chutter, Mildred C., Box 229, Athens, Ohio 1936
Clark, Mrs. Ben P., Whitesburg, Kentucky 1952
Clark, George A(lfred), Jr., 435 West 119th St., Apt. 7-H, New York 27, New York 1955
Clark, George C(lifford), 897 Avenue Rd., Toronto 7, Ontario, Canada 1961
Clarke, C. H. D., Fish and Wildlife Branch, Room 3502, East Block, Parliament Building, Toronto, Ontario, Canada 1961

†Clarkson, Mrs. Edwin O., Wing Haven, 248 Ridgewood Ave., Charlotte 7, North Carolina 1940
Clement, Roland C(harles), 18 Senga Rd., South Norwalk, Connecticut 1941
†Clements, H(iram) Everest, 35 Argyle St., Rochester 7, New York 1949
Clise, Mrs. Charles Frances, 1030 39th Ave. East, Seattle 2, Washington 1957
*Clow, Marion, Box 163, Lake Forest, Illinois 1929
†Coffey, Ben Barry, Jr., 672 North Belvedere, Memphis 7, Tennessee 1927
Coffey, Mrs. Lulu C(ooper), 672 North Belvedere, Memphis 7, Tennessee 1952
Coggeshall, Robert D., Billington Rd., East Aurora, New York 1956
Cogswell, Howard L(yman), Dept. of Biological Sciences, Box 9486, Mills College, Oakland 13, California 1944
*Cohn, Mrs. Jean W., Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1954
Cole, Mrs. Richard D., 625 Valley Lane, Towson 4, Maryland 1955
Cole, Mrs. Whiteford R., Jr., 1746 Sulgrave Rd., Louisville 5, Kentucky 1956
*Collier, Gerald, Dept. of Zoology, San Diego State College, San Diego 15, California 1956
Collins, Charles T(hompson), Bird Division, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1959
Compton, L. E., R.D. 1, Genessee Rd., Waukesha, Wisconsin 1957
Compton, Lawrence Verlyn, Biology Division, Soil Conservation Service, Washington 25, D. C. 1923
Compton, Robert A., R.D. 2, Kempton, Pennsylvania 1960
†Conboy, Mrs. John William, 417 Studebaker St., Mishawaka, Indiana 1954
Conkey, John H., 11 Chestnut St., Ware, Massachusetts 1947
Conn, Robert Carland, 755 Ross Lane, Bound Brook, New Jersey 1945
Conrad, Charles L(ouis), 137 North 11th St., Wheeling, West Virginia 1937
Conway, Albert E., 932 Sconnelltown Rd., West Chester, Pennsylvania 1962
Conway, William G., New York Zoological Park, 185th St. & Southern Blvd., New York 60, New York 1959
Cook, Fannye A(dine), 270 East Georgetown, Crystal Springs, Mississippi 1923
Cooke, Thomas Turner, 71 MacCulloch Ave., Morristown, New Jersey 1959
Cooper, Judith Helen, 1415 Broadway, Boulder, Colorado 1961
*Cooper, Kenneth K(ing), Dunster Rd., Stanwood, Mount Kisco, New York 1958
Cope, James B(onwill), Earlham College, Richmond, Indiana 1949
Corbett, Kenneth B., R.D. 1, Box 67, Lancaster, Pennsylvania 1957
Cornwell, George W(illiam), Dept. of Wildlife Management, University of Michigan, Ann Arbor, Michigan 1962
Cors, Paul B(eaumont), 241½ West May Ave., Las Cruces, New Mexico 1952
*Cottam, Clarence, Welder Wildlife Foundation, P.O. Box 1396, Sinton, Texas 1929
Cottrell, George William, Jr., Route 2, Hillsboro, New Hampshire 1941
Cottrille, W(illiam) Powell, 6075 Brown's Lake, Jackson, Michigan 1949
Cottrille, Mrs. W(illiam) Powell, 6075 Brown's Lake, Jackson, Michigan 1950
Coutlee, Ellen L(orraine), Dept. of Biology, Wayne State University, Detroit 2, Michigan 1961
Cox, George W., Dept. of Zoology, San Diego State College, San Diego 5, California 1954
Coy, Roy E., St. Joseph Museum, St. Joseph, Missouri 1953
Cracraft, Joel Lester, 4616 Weehaven Dr., Dallas 32, Texas 1961
Crawford, Alan, Jr., White Horse Rd., Devon, Pennsylvania 1949
Creager, Joe C(lyde), L.A. Cann Rd., Route 2, Ponca City, Oklahoma 1947
Cringan, A. T., Dept. of Zoology, Ontario Agricultural College, Guelph, Ontario, Canada 1961
†Crockett, David B., 3933 Kirkland Ct., Bloomfield Hills, Michigan 1955
Croft, Joseph E., 2366 Gladstone Ave., Louisville 5, Kentucky 1956
Crofts, Robert J., 468 Thurston St., Toledo 5, Ohio 1957
Crowder, Orville W., Box 2247, Washington 13, D. C. 1961
Crowell, John B., Jr., 1227 Hallinan Circle, Lake Oswego, Oregon 1952
Crowell, Kenneth L(eland), 72 Gould Pl., Caldwell, New Jersey 1961
Cruickshank, Allan Dudley, 1925 Indian River Dr., Rockledge, Florida 1939
Cullen, Peter, 5115 Graceland, Indianapolis 8, Indiana 1956
Cumming, Fairman Preston, 824 Sutton Hill Rd., Nashville 4, Tennessee 1950
Cunningham, James W., 3009 East 19th Terrace, Kansas City, Missouri 1935
*Currie, Mrs. Neill Alexander, Jr., 1104 Brook St., Fayetteville, North Carolina 1958

*Curtis, Gordon (Hubert), 3461 Polo Dr., Aptos. California 1961
Curtis, Mrs. Vee K(aelin), 2412 Cohasset Rd., Chico, California 1950
Cuthbert, Nicholas, Dept. of Biology, Central Michigan University, Mt. Pleasant, Michigan 1950
Cutler, Mrs. Betsey D., 2128 Great Highway, San Francisco 16, California 1959

Dana, Edward Fox, 57 Exchange St., Portland 3, Maine 1939
Dane, Benjamin, 101 Indian Ave., Middletown, Rhode Island 1957
*D'Angelo, Angelo (Ralph), 32 Hamilton Ave., Hasrouck Heights, New Jersey 1949
Daniels, Estrilla (Myrtle), 270 South Prospect St., Ravenna, Ohio 1959
Daniels, Mildred, 21925 McCauley Rd., Cleveland 22, Ohio 1959
Darby, Richard T(horn), Prospect St., Sherborn, Massachusetts 1948
*Darden, Mrs. Colgate W(hitehead), Flicker Point, Algonquin Park, Norfolk 5, Virginia 1943
Dater, Mrs. John Y., 259 Grove St., Ramsey, New Jersey 1949
Davant, Mary, 861 North McLean Blvd., Memphis 7, Tennessee 1952
*Davenport, Mrs. Allan G., 39 Walcott Ave., Jamestown, Rhode Island 1959
Davey, Winthrop N(ewbury), 495 Hillspur Rd., Ann Arbor, Michigan 1941
Davidson, Mrs. W. F., 332 Summit Ave., St. Paul 2, Minnesota 1953
Davis, Clifford Vernon, Dept. of Zoology & Entomology, Montana State College, Bozeman, Montana 1945
Davis, David E(dward), Dept. of Zoology & Entomology, The Pennsylvania State University, University Park, Pennsylvania 1940
Davis, Mrs. Robert M., Route 1, Box 497, Kalamazoo, Michigan 1948
Davis, John, Hastings Natural History Reservation, Carmel Valley, California 1939
Davis, L(ouie) Irby, Box 988, Harlingen, Texas 1933
†Davis, W(illiam) B., Dept. of Wildlife Management, College Station, Texas 1938
Davis, William Franklin, 423 West 46th St., Ashtabula, Ohio 1947
Davis, W. Marvin, Faculty Exchange, University of Oklahoma, Norman, Oklahoma 1956
Davison, Verne E., Soil Conservation Service, P.O. Box 832, Athens, Georgia 1960
Davy, Roger H(ewson), 5547 North 13th Ave., Phoenix 13, Arizona 1957
Dawn, Walter H(enry), 49–15 Skillman Ave., Woodside 77, New York 1945
Dean, Mrs. Blanche Evans, 2100 20th Ave. South, Birmingham 9, Alabama 1947
Dcek, Robert Eugene, R.D. 1, Mechanicsburg, Pennsylvania 1959
Deevey, Edward S(mith), Jr., Osborn Zoological Laboratory, Yale University, New Haven 11, Connecticut 1948
DeGarmo, William Russell, Kents Hill, Maine 1946
Degenhardt, Mrs. Paula Braden, Dept. of Biology, University of New Mexico, Albuquerque, New Mexico 1953
DeGroot, Dudley Sargent, 9170 Fletcher Dr., La Mesa, California 1948
Dehner, Eugene W(illiam), St. Benedict's College, Atchison, Kansas 1944
†Delacour, Jean Theodore, c/o American Museum of Natural History, Central Park West at 79th St., New York 24, New York 1944
Dempster, Rulon T., Chestnut Pkwy. at Ridley Creek, Waterville, Chester, Pennsylvania 1959
Denham, Reginald (Francis), 100 Central Park South, New York 19, New York 1948
Dennis, James R(obert), 1777 S.E. 15th St., Pompano Beach, Florida 1961
Denton, J(ames) Fred, 1510 Pendleton Rd., Augusta, Georgia 1935
de Schauensee, Rodolphe Meyer, Devon, Pennsylvania 1945
†Desmond, Thomas C(harles), Box 670, Newburgh, New York 1942
Devlin, Joseph M(ark), 218 South 43rd St., Philadelphia 4, Pennsylvania 1953
Dexter, Ralph W., Dept. of Biology, Kent State University, Kent, Ohio 1958
*Dick, John Henry, Dixie Plantation, Meggett, South Carolina 1949
Dickerman, Robert W(illiam), Museum of Natural History, University of Minnesota, Minneapolis, Minnesota 1955
†Dickerson, Stanley S., 222 DeVoe Ave., Spotswood, New Jersey 1959
Dickerson, Mrs. Stanley S., 222 DeVoe Ave., Spotswood, New Jersey 1956
Dickinson, J(oshua) C(lifton), Jr., Florida State Museum, University of Florida, Gainesville, Florida 1939
Dilger, William C., Laboratory of Ornithology, Cornell University, Ithaca, New York 1957
*Dillon, Olan W(illiam), Jr., Room 438 Warren Hall, Cornell University, Ithaca, New York 1960

Dilts, Robert L., 5702 East 38th St., Indianapolis 26, Indiana 1960
Dingle, Edward von Siebold, Huger, South Carolina 1921
Dixon, James B(enjamin), 2266 Cranston Dr., Escondido, California 1936
Dixon, Keith Lee, Dept. of Zoology, Utah State University, Logan, Utah 1946
†Doering, Hubert R., 242 East Walton Place, Chicago 11, Illinois 1945
Domm, Lincoln V(alentine), Dept. of Anatomy, Stritch School of Medicine, Loyola University, 706 South Wolcott Ave., Chicago 12, Illinois 1936
Donald, Mary (Frances), 6918 Belmont Lane, Milwaukee 11, Wisconsin 1951
Donegan, Marie, 920 East Ann St., Ann Arbor, Michigan 1953
*Dorsey, George A., Darlington School, Rome, Georgia 1956
*Douglass, Donald W., Game Division, Michigan Dept. of Conservation, Lansing 26, Michigan 1929
Dowling, Paul Bruce, 3505 Cameron Mills Rd., Alexandria, Virginia 1950
Down, Edward H., 28 Lynton Mead, Totteridge, London N 20, England 1957
Downs, Mrs. James R(euel), Glebe Farm, South Londonderry, Vermont 1959
*Dressel, Evan C., 509 East Western Reserve Rd., Poland 14, Ohio 1956
*Drinkwater, Howard (Frank), P.O. Box 83, Whitehouse Station, New Jersey 1954
*Drummond, Mrs. Joseph Blake, 10 Ship Channel Rd., South Portland, Maine 1959
†Drury, William H(olland), Jr., Drumlin Farms, South Lincoln, Massachusetts 1951
Dubke, Kenneth Howard, Box 984, Elizabethton, Tennessee 1960
Du Bois, Charlotte A., 1000 Aullwood Rd., Dayton 14, Ohio 1962
Duce, Mrs. Elizabeth R(andall), P.O. Box 396, Damoroscotta, Maine 1959
†Ducks Unlimited (Canada), 389 Main St., Room 606, Winnipeg 2, Manitoba, Canada 1957
Duebbert, H(arold) F(ranklin), P.O. Box 159-D, Devils Lake, North Dakota 1957
Duffield, Mrs. John W., 1472 Eskridge Way, Olympia, Washington 1948
†Dugan, William Dunbar, 221 Pierce Ave., Hamburg, New York 1945
DuMont, Philip A(tkinson), 4114 Fessenden St., N. W., Washington 16, D. C. 1928
Duncan, Robert, 1151 Fulton Ave., San Antonio 1, Texas 1956
Dunn, Lawrence E., R.F.D., Gate, Oklahoma 1956
Dunson, William A., 1055 Yale Station, New Haven, Connecticut 1960
Dunstan, Girvin Raleigh, 5030 Huron River Dr., Route 1, Dexter, Michigan 1950
Dusi, Julian L(uigi), Dept. of Zoology & Entomology, Auburn University, Auburn, Alabama 1941
†Duval, Allan J., Patuxent Wildlife Research Center, Laurel, Maryland 1958
Dvorak, J. L., 6125 Eddy St., Chicago 34, Illinois 1958
Dyer, William A., 402 John St., Union City, Michigan 1947
*Dzubin, Alex, 306 W. P. Thompson Building, University of Saskatchewan, Saskatoon, Saskatchewan, Canada 1956

Easterla, David Arlen, Wildlife Conservation Building, University of Missouri, Columbia, Missouri 1959
†Eastman, Whitney H(askins), 7000 Valley View Rd., Minneapolis 24, Minnesota 1941
†Eaton, Stephen W(oodman), Dept. of Biological Sciences, St. Bonaventure University, St. Bonaventure, New York 1942
Eckelberry, Don (Richard), 180 Woodsome Rd., Babylon, New York 1948
Eddy, Garrett, 4515 Ruffner St., Seattle 99, Washington 1947
†Edeburn, Ralph M(ilton), Dept. of Zoology, Marshall University, Huntington 1, West Virginia 1947
Edge, Mrs. Charles N(oel), 1215 Fifth Ave., New York 29, New York 1931
Edwards, Ernest P(reston), University of the Pacific, Stockton, California 1947
Edwards, Mrs. Howard, 435 Munson Ave., Traverse City, Michigan 1960
*Edwards, James L., 27 Stanford Pl., Montclair, New Jersey 1947
Edwards, K(enneth) F(rederick), P.O. Box 250, Collins Bay, Ontario, Canada 1953
Edwards, N. Kavanaugh, 67 Nash Lane, Bridgeport 5, Connecticut 1961
Edwards, R(oger) York, Parks Branch, Dept. of Recreation & Conservation, Victoria, British Columbia, Canada 1948
Egerton, Frank N(icholas) III, Birge Hall, University of Wisconsin, Madison 6, Wisconsin 1952
Eiseman, Ralph M(ilton), Highland Park High School, 433 Vine Ave., Highland Park, Illinois 1955
†Eisenmann, Eugene, 110 West 86th St., New York 24, New York 1942
Ekblaw, George Elbert, 511 West Main St., Urbana, Illinois 1914

Ekdahl, Conrad H(oward), Box 1246, Daytona Beach, Florida	1949
*Eklund, Carl M(ilton), Rocky Mountain Laboratory, Hamilton, Montana	1945
Elder, William H(anna), Wildlife Conservation Building, University of Missouri, Columbia, Missouri	1938
Elitharp, Marie, 221 Ten Eyck St., Watertown, New York	1959
Ellarson, Robert S(cott), 424 University Farm Pl., Madison 5, Wisconsin	1948
Elliott, Richard M., 1564 Vincent St., St. Paul 8, Minnesota	1940
Elson, John, 2001 Ogden Ave., Knoxville 16, Tennessee	1960
Ely, Charles A(delbert), Dept. of Zoology, Fort Hays Kansas State College, Hays, Kansas	1960
Emerson, David L(owell), 155 Burt St., Taunton, Massachusetts	1939
†Emerson, Guy, 16 East 11th St., New York 3, New York	1938
Emerson, William S(tevenson), c/o Arthur D. Little, Inc., Acorn Park, Cambridge 40, Massachusetts	1953
*Emlen, John Thompson, Jr., Dept. of Zoology, University of Wisconsin, Madison 6, Wisconsin	1936
Enderson, James Harris, Dept. of Zoology & Physiology, University of Wyoming, Laramie, Wyoming	1960
Ennis, J(ames) Harold, Cornell College, Mount Vernon, Iowa	1942
Erickson, Elsie C., Box 114, Allport, Pennsylvania	1951
Erickson, Homer T., APO 676, USOM, New York, New York	1959
Erickson, John G(erhard), 1344 South Second St., Stillwater, Minnesota	1949
†Erickson, Mary M(arilla), University of California, Goleta, California	1930
Erickson, Ruth C., 3166 Merrill, Apt. 204, Royal Oak, Michigan	1961
*Ernst, Mrs. Roger, 170 Sargent Rd., Brookline, Massachusetts	1951
Errington, Paul L(ester), Science Bldg., Iowa State University, Ames, Iowa	1932
Evans, Monica A(nn), 477 Academy St., Kalamazoo, Michigan	1955
Evenden, Fred G(eorge), 1336 Fitch Way, Sacramento, California	1948
Eyer, Lester E., 515 College St., Alma, Michigan	1954
Eynon, Alfred E., Dept. of Zoology, University of Wisconsin, Madison 6, Wisconsin	1947
Eyster, Marshall Blackwell, 124 Dolores Dr., Lafayette, Louisiana	1947

Fales, John (House), 1917 Elkhart St., Silver Spring, Maryland	1939
Falls, J. Bruce, 14 Tottenham Rd., Don Mills, Ontario, Canada	1948
*Farmer, Earl Wilson, 611 North 4th St., Steubenville, Ohio	1946
Farrand, H. F., 7 Guest Lane, Wilmington 3, Delaware	1950
Farrel, Franklin III, Northrup Rd., Woodbridge, Connecticut	1959
Faver, Mrs. W. H., Eastover, South Carolina	1959
Fawks, Elton, Box 112, Route 1, East Moline, Illinois	1951
Feenaty, L(eland) N(ewman), 9514 California Ave., Apt. C, South Gate, California	1953
†Feigley, Margaret D(enny), 5616 Oleatha, St. Louis, Missouri	1944
Feist, Irving, 58 Park Pl., Newark, New Jersey	1958
Fennell, Chester M(artin), 19291 Westover Ave., Rocky River, Ohio	1949
Ferguson, David S(owers), R.D. Box 53, Philipsburg, Pennsylvania	1962
Ferren, Richard Luther, 144 Center St., Rumford 16, Rhode Island	1959
Fichter, Edson Harvey, 256 South 11th Ave., Pocatello, Idaho	1948
Ficken, Robert W., Laboratory of Ornithology, Cornell University, Ithaca, New York	1957
Fieleke, Mrs. Catharine Nicholson, 407 North Walnut, Momence, Illinois	1962
Fillebrown, T(homas) S(cott), R.F.D., Lakeville, Connecticut	1951
Findley, J(ohn) Scott, 1201 S. Center Ave., Sioux Falls, South Dakota	1949
Finucane, Thomas Wellington, 1434 Watauga St., Kingsport, Tennessee	1960
Fischer, Richard B(ernard), Stone Hall, Cornell University, Ithaca, New York	1942
Fish, William Ralph, 5548 Linda La., Carmichael, California	1950
Fisher, Harvey I(rvin), Dept. of Zoology, Southern Illinois University, Carbondale, Illinois	1949
Fisher, James (Maxwell) (McConnell), Old Rectory, Ashton, Northampton, England	1960
Fisler, George F., Hastings Reservation, Carmel Valley, California	1954
Fleugel, James Bush, Box 53, Grand Beach, Michigan	1942
Foote, R(obert) T(haddeus), 221 E. Buffalo St., Milwaukee, Wisconsin	1957
*Forbes, John Ripley, 5 Big Pines Rd., Westport, Connecticut	1961

Ford, Norman L(ee), Museum of Zoology, University of Michigan, Ann Arbor, Michigan	1959
Ford, Robert Bruce, 163 Tyson Ave., Glenside, Pennsylvania	1960
Ford, Thomas R(obert), 156 South St., Cadiz, Ohio	1958
Fordham, Stephen Crane, Jr., Delmar Game Farm, Delmar, New York	1948
*Forsythe, Dennis Martin, 341 Mentor Dr., Toledo 8, Ohio	1962
†Foster, John H(awley), P.O. Box 204, Wayne, Pennsylvania	1952
*Foster, Thomas Henry, Monument Rd., Bennington, Vermont	1950
Foster, William L(uther), Richmond High School, Richmond, Missouri	1961
Fowler, Ronald L(ynn), 2210 Shoreline Dr., Abilene, Texas	1962
Fox, Adrian C., Box 521, Ben Franklin Station, Washington 4, D. C.	1937
Fox, Glen A., Box 783, Kindersley, Saskatchewan, Canada	1960
Fox, Robert P., 311 Beale St., Wollaston 70, Massachusetts	1953
Francis, George (Reid), 382 Hillsdale Ave., E., Toronto 12, Ontario, Canada	1949
Fraser, Samuel, 113 Court St., Houlton, Maine	1957
Frazier, Frank P(earsall), 424 Highland Ave., Upper Montclair, New Jersey	1953
Fredrickson, Richard William, Dept. of Biology, Queens College, Flushing 67, New York	1947
Freeman, William, 1603 Wagonwheel Lane, Lansing, Michigan	1959
Fretwell, Stephen DeWitt, 203 South Third St., Lewisburg, Pennsylvania	1958
*Fries, Waldemar Hans, 86 Cushing St., Providence 6, Rhode Island	1947
Frohling, Robert C(harles), Ludlow Ave., Belle Meade, New Jersey	1949
Frost, Herbert Hamilton, Dept. of Zoology & Entomology, Brigham Young University, Provo, Utah	1941
Frye, O. Earle, Jr., Game & Fresh Water Fish Com., Tallahassee, Florida	1940
Fuller, A(nne) Verne, Western Michigan University, Kalamazoo, Michigan	1952
Fuller, Margaret, R.D. 2, Frazeysburg, Ohio	1960
*Fuller, William A., Woodcrest Parkway, Rockford, Illinois	1961
Funderburg, John B(roadus), Jr., Dept. of Biology, Florida Southern College, Lakeland, Florida	1957
†Furman, Robert H(oward), 12 Oakwood Dr., Oklahoma City 16, Oklahoma	1955
Furniss, W. Todd, 129 Indian Springs Dr., Columbus 14, Ohio	1961

Gabrielson, Ira N(oel), R.D. 1, Box 349, Oakton, Virginia	1913
Gadacz, Thomas R., 1844 North Adams St., South Bend, Indiana	1961
Gaede, Adela, 3903 East 176th St., Cleveland 28, Ohio	1951
Galati, Robert, 628 West Ave., Fullerton, California	1955
Gale, Larry R(ichard), 1204 Winston Dr., Jefferson City, Missouri	1948
Galley, John E(dmond), 1610 West Holloway Ave., Midland, Texas	1945
Gambrill, Mrs. Richard, Vernon Manor, Peapack, New Jersey	1958
†Gammell, R(obert) T(heodore), Kenmore, North Dakota	1943
†Ganier, Albert F(ranklin), 2112 Woodlawn Dr., Nashville 5, Tennessee	1915
Garlinghouse, Mrs. Harold C., 2012 Cedar Dr., Knoxville 18, Tennessee	1960
Garrey, Mrs. Walter E., 39 Orchard Ave., Waban 68, Massachusetts	1959
Garrity, Devin A(dair), 682 Forest Ave., Rye, New York	1949
Gasche, Mrs. Arthur S., 1297 N.E. 103rd St., Miami 38, Florida	1956
*Gaschen, Ronald C(aryl), 30 Roxborough St. East, Toronto, Ontario, Canada	1961
Gates, Doris (Berta), Nebraska State Teachers College, Chadron, Nebraska	1948
Gates, John M., Wisconsin Conservation Dept., Box D, Horicon, Wisconsin	1957
Gehman, Richard, 3643 43rd St., San Diego 5, California	1959
Gensch, Robert Henry, 3018 Pillsbury Ave. S., Apt. 101, Minneapolis 8, Minnesota	1939
George, John L(othar), 20 Williams St., Chappaqua, New York	1939
George, William G(ordon), Dept. of Ornithology, American Museum of Natural History, Central Park West at 79th St., New York 24, New York	1957
Gerstell, Richard, 1046 Buchanan Ave., Lancaster, Pennsylvania	1939
Gibbons, G(areth) W(illiams), USS REQUIN (SS 481), c/o Fleet Post Office, New York, New York	1961
Gier, Herschel T(homas), Dept. of Zoology, Kansas State University, Manhattan, Kansas	1937
Gifford, Harold, 3636 Burt, Omaha 3, Nebraska	1936
Gilbert, Albert E(arl), 2231 North Menard Ave., Chicago 39, Illinois	1957

Gill, Frank B., 493 Warwick Ave., West Englewood, New Jersey 1960
†Gilliard, Ernest Thomas, American Museum of Natural History, Central Park West at 79th St., New York 24, New York 1949
Gilreath, M. Ruth, Route 1, Jackson Grove Rd., Travelers Rest, South Carolina 1952
Glenny, Fred H(arry), Dept. of Biology, Nasson College, Springvale, Maine 1958
Glick, Bruce, Box 185, State College, Mississippi 1949
Glover, Fred, 2211 Holmes Run Dr., Falls Church, Virginia 1947
Gochfeld, Michael, R.F.D. 1, Lexington Ave., Mohegan Lake, New York 1961
Goebel, Herman J(ohn), 78–52 80th St., Brooklyn 27, New York 1946
†Goelet, Robert G., 425 Park Ave., New York 22, New York 1953
†Goetz, Christian John, 3503 Middleton Ave., Cincinnati 20, Ohio 1930
Good, Ernest E(ugene), Dept. of Zoology & Entomology, Ohio State University, Columbus 10, Ohio 1937
Goodman, John David, Dept. of Biology, University of Redlands, Redlands, California 1944
Goodpasture, Mrs. Ernest W., 3407 Hopkins Lane, Nashville 12, Tennessee 1950
Goodridge, Alan G(ardner), 3421 Edgewood, Pittsfield Village, Ann Arbor, Michigan 1958
Goodwin, Clive Edmund, 11 Waterton Rd., Weston, Ontario, Canada 1952
Goodwin, Margaret S(hippen), 38 Oakbourne Rd., West Chester, Pennsylvania 1953
Gorton, Ralph J(ames), Box 211, 322 North Center St., Buelah, Michigan 1959
Goslin, Charles R(ussell), 726 East King St., Lancaster, Ohio 1940
*Graber, Richard R., 109 West Franklin, Urbana, Illinois 1949
Grace, Mrs. Charles J., Wells Rd., Cheshire, Massachusetts 1959
Grant, Cleveland P(utnam), 245 Davis St., Mineral Point, Wisconsin 1928
Grant, Richard, 1808 Malvern St., St. Paul 13, Minnesota 1961
†Greeley, Fred(erick), Dept. of Forestry & Wildlife Management, University of Massachusetts, Amherst, Massachusetts 1942
Green, Mrs. Janet Curtis, 1923 Greysdon Rd., Duluth, Minnesota 1960
Green, N(orman) Bayard, Dept. of Zoology, Marshall College, Huntington 1, West Virginia 1943
Greenig, Mrs. Patricia, 25 Sutton Pl. South, Apt. 16–0, New York 22, New York 1957
†Greenewalt, Crawford H(allock), Greenville, Wilmington 7, Delaware 1960
Greenwalt, Leon, 911 South Seventh St., Goshen, Indiana 1953
Greer, Theodore R., Joy, Illinois 1956
Gregory, Stephen S(trong), Box N, Winnetka. Illinois 1922
Griffee, W(illet) E., 510 Yeon Bldg., Portland 4, Oregon 1947
Griffin, Daude N., Dept. of Biology, East Texas State College, East Texas Station, Commerce, Texas 1958
Griffin, William W(elcome), 1225 Pine Ridge Rd. N.E., Atlanta 5, Georgia 1946
Griffith, Roger Braden, 547 Prindle St., Sharon, Pennsylvania 1962
*Grimes, S(amuel) A(ndrew), 4627 Peachtree Circle, E., Jacksonville 7, Florida 1924
Grimm, William C(arey), Blueberry Park, Route 3, Greenville, South Carolina 1939
†Grinnell, Lawrence I(rving), 710 Triphammer Rd., Ithaca, New York 1939
Groesbeck, William M(aynard), 376 Seneca Rd., Hornell, New York 1947
Groot, Hermando, Universidad de Los Andes, Apartado Aeris No. 4976, Bogota, D.E., Colombia 1960
Gross, Alfred Otto, 11 Boody St., Brunswick, Maine 1927
Grow, Raymond J., 513 West Fifth Ave., Apt. 7, Gary, Indiana 1951
Grube, G(eorge) E(dward), Dept. of Science, Lock Haven State College, Lock Haven, Pennsylvania 1948
Gruenewald, Robert Franklin, Clifton, Illinois 1948
Guhl, A(lphaeus) M(atthew), Dept. of Zoology, Kansas State University, Manhattan, Kansas 1948
Guillauden, Robert L., Professional Building, Park Ave. & Little Falls Rd., Falls Church, Virginia 1956
Gullion, Gordon W(right), Forest Research Center, University of Minnesota, Cloquet, Minnesota 1947
Gumbart, William B., P.O. Box 1936, New Haven 9, Connecticut 1952
Gunderson, Harvey Lorraine, Museum of Natural History, University of Minnesota, Minneapolis 14, Minnesota 1941
*Gunn, W(illiam) W(alker) H(amilton), 178 Glenview Ave., Toronto 12, Ontario, Canada 1945

Gunther, Klaus, Wilseder Strasse 21, Berlin Steglitz, Germany 1952
Gwathmey, M(ary) Tayloe, 143 Lake Shore Dr., Bay Colony, Virginia Beach, Virginia 1960

Hacker, Carl S(idney), P.O. Box 50, Williamsburg, Virginia 1961
*Hadley, Joel W., 6123 North Park Ave., Indianapolis 20, Indiana 1962
Haffner, Annette Petrina, 1704 Tremont St., Cedar Falls, Iowa 1961
*Hagar, Joseph A., Pleasant St., Marshfield Hills, Massachusetts 1949
*Hague, Florence S., 4815 Boonsboro Rd., Lynchburg, Virginia 1931
†Hailman, Jack P., Dept. of Zoology, Duke University, Durham, North Carolina 1956
Haines, Robert L(ee), 54 East Main St., Moorestown, New Jersey 1947
Haines, T. P., 1395 Adams St., Apt. E, Macon, Georgia 1941
Haker, Mrs. Floyd H., 5727 Gaston, Apt. 219, Dallas 14, Texas 1950
Halberg, Mrs. Henry N., 5809 North Country Club Blvd., Little Rock, Arkansas 1953
†Hall, Fred T., Buffalo Museum of Science, Humboldt Park, Buffalo 11, New York 1937
†Hall, George A(rthur), Dept. of Chemistry, West Virginia University, Morgantown, West Virginia 1946
Hall, Mrs. Gladys A(reta), 912 Douglas Ave., Kalamazoo 52, Michigan 1947
Hallauer, James E(dward), 338 North Hill Circle, Rochester, Michigan 1958
Hallenbeck, Esly, Washington Rd. 14, Scotia 2, New York 1958
†Haller, Karl W., 1101 Yorktown Dr., Abilene, Texas 1934
Hallman, Roy Cline, 800 Florida Ave., Panama City, Florida 1928
Hallowell, A(lban) Thomas, 33 Rosslyn Ct., Little Silver, New Jersey 1959
†Hamann, Carl F(erdinand), Maple Lane, Aurora, Ohio 1947
Hamerstrom, Frederick N., Jr., Plainfield, Wisconsin 1934
†Hamilton, Charles W(hiteley), 2639 Fenwood Rd., Houston 5, Texas 1948
Hamilton, Robert B(ruce), Lot 19, 4025 46th Ave. N., St. Petersburg, Florida 1961
Hamilton, William J(ohn), Jr., Dept. of Conservation, Cornell University, Ithaca, New York 1933
Hamilton, William J(ohn) III, 61 La Campana, Orinda, California 1953
*Hammond, Merrill C(lyde), Lower Souris Refuge, Upham, North Dakota 1939
Hamon, J. Hill, Dept. of Zoology, Indiana State College, Terre Haute, Indiana 1958
Hampe, Irving E., 5559 Ashbourne Rd., Halethorpe, Baltimore 27, Maryland 1945
Handley, Charles O(verton), 6571 Roosevelt Ave. S.E., Charleston 4, West Virginia 1925
Handley, Charles O(verton), Jr., Division of Mammals, U.S. National Museum, Washington 25, D. C. 1941
*Hann, Harry W(ilbur), 1127 Church St., Ann Arbor, Michigan 1930
Hanna, Wilson Creal, 712 North 8th St., Colton, California 1936
Hardy, (Cecil) Ross, Long Beach State College, 6101 East Seventh St., Long Beach 4, California 1940
Hardy, John William, Moore Laboratory of Zoology, Occidental College, Los Angeles 41, California 1952
Harford, Henry M(inor), P. O. Box 4, La Grange, Missouri 1946
Harger, Elsworth M(ilton), Cusine Wildlife Experiment Station, Shingleton, Michigan 1955
Hargrave, Lyndon L(ane), Box 1979, Globe, Arizona 1952
Harrington, Paul, 813 Bathhurst St., Toronto 4, Ontario, Canada 1948
*Harriot, Samuel C(arman), 200 West 58th St., New York 19, New York 1934
Harris, William G(eorge) F., 147 Hillside St., Milton 86, Massachusetts 1951
Harrison, Ed N., 1145 Clendon Ave., Suite 6, Los Angeles 24, California 1959
Harrison, Hal H., 1102 Highland St., Tarentum, Pennsylvania 1941
Harte, Ken(neth) (J.), 34 Irving St., Apt. 22, Cambridge 38, Massachusetts 1953
Hartman, Frank A(lexander), Hamilton Hall, Ohio State University, Columbus 10, Ohio 1941
Hartshorne, Charles, 1695 Ridgewood Dr. N.E., Atlanta 7, Georgia 1953
†Hartshorne, James M(ott), 108 Kay St., Ithaca, New York 1955
Hath, Earl H(erbert), 2109 Briargate Lane, Kirkwood 22, Missouri 1957
Hauser, Mrs. Doris C., 309 Sylvan Rd., Fayetteville, North Carolina 1955
*Havemeyer, Henry O(sborne), Mountainside Farm, Mahwah, New Jersey 1930
Haverschmidt, F(rançois), P.O. Box 644, Paramaribo, Surinam, Dutch Guiana 1946
Hawk, Grover C., R.F.D. 2, Hedrick, Iowa 1951
Hawksley, Oscar, Dept. of Biology, Central Missouri State College, Warrensburg, Missouri 1948

Hays, Herbert E., R.D. 1, Mechanicsburg, Pennsylvania	1956
Hazard, Frank Orlando, Wilmington College, Wilmington, Ohio	1946
Hearne, Mrs. Katherine Marston, 1029 Delaware St., Shreveport, Louisiana	1960
†Hebard, Frederick V(anuxem), Jr., Room 2010, c/o Craig & Craig, 2 Penn Center, Philadelphia 2, Pennsylvania	1958
Hefley, Harold M(artin), Panhandle A. & M. College, Goodwell, Oklahoma	1942
Heimerdinger, Mary A(nne), Room 309, O. & O. Wing, Peabody Museum, Yale University, New Haven 11, Connecticut	1955
Heintzelman, Donald S., 629 Green St., Allentown, Pennsylvania	1960
Heiser, J(oseph) M(atthew), Jr., 1724 Kipling St., Houston 6, Texas	1939
Helbert, Hollen G(arber), 338 Monticello Ave., Harrisonburg, Virginia	1952
†Helleiner, Frederick M., Box 14, Swastika, Ontario, Canada	1952
†Helms, Carl W., Dept. of Biology, Bucknell University, Lewisburg, Pennsylvania	1952
Henderson, James C., P.O. Box 1532, Midland, Texas	1961
Henderson, J(ames) Neil, 623 Tyler Ave., Cuyahoga Falls, Ohio	1957
Henderson, Susan W(addell), Museum of Zoology, University of Michigan, Ann Arbor, Michigan	1962
Hengst, Mrs. James M., 2111 Park Hill Dr., Columbus 9, Ohio	1948
Hensley, M(arvin) Max, Dept. of Zoology, Michigan State University, East Lansing, Michigan	1947
Henwood, Mrs. Ethel May, 306 West Michigan, Urbana, Illinois	1941
Herbert, Mrs. Richard A., Middleton, Delaware	1949
Herman, Carlton M., Patuxent Wildlife Research Center, Laurel, Maryland	1946
Herndon, Dr. Lee R(oy), 1533 Burgie Place, Elizabeth, Tennessee	1960
Herrick, Mrs. Walter D(evitt), Jr., 847 Clinton Pl., River Forest, Illinois	1959
Herzog, David, H.Q. Company III Corps, Ft. Hood, Texas	1956
Hespenheide, Henry (August), 1315 Sussex Pl., Norfolk, Virginia	1958
Hewitt, Oliver R., Fernow Hall, Cornell University, Ithaca, New York	1943
Heye, Paul L., Dept. of Biology, Southeast Missouri State College, Cape Girardeau, Missouri	1961
Heywood, Philip B., 63 Beechmont St., Worcester 9, Massachusetts	1959
Hibbard, Edmund Arthur, R.D. 1, St. Cloud, Minnesota	1950
Hickey, J(oseph) J(ames), 424 University Farm Pl., Madison 5, Wisconsin	1940
Hicks, Thomas W(illiam), 1249 Drake St., Madison 5, Wisconsin	1949
Hiett, Mrs. C. W. III, Route 1, Box 174, Herwood, Maryland	1962
Hiett, Lawrence D(avison), R.D. 1, Box 287, Grand Rapids, Ohio	1929
Higgins, Thomas Francis, 85 Cornell St., Williston Park, New York	1947
*Highhouse, William, 8 Fourth Ave., Warren, Pennsylvania	1957
Hill, David O., 213 River Rd., Grand View-on-Hudson, Nyack, New York	1959
Hill, Herbert Oliver, 8861 Lookout Mt. Ave., Los Angeles 46, California	1938
Hill, Julian Werner, 1106 Green Hill Ave., Wilmington 5, Delaware	1935
Hill, Margaret Louise, 4200 Shoal Creek Blvd., Austin 5, Texas	1959
*Hill, Mrs. Marion B(ertha), Limberlost Lodge, via Huntsville, Muskoka, Ontario, Canada	1962
Hill, Robert B., 2410 Rawhide Lane, San Antonio 27, Texas	1959
Hinds, Frank J., Dept. of Biology, Western Michigan University, Kalamazoo, Michigan	1935
Hinrichsen, Donald, R.R. 1, Devils Glen Rd., Bettendorf, Iowa	1962
Hinshaw, Thomas D(oane), 1827 San Juan Ave., Berkeley 7, California	1926
Hipple, Byron T., 56½ Spring St., Albany 10, New York	1952
Hockbaum, Hans Albert, Delta Waterfowl Research Station, Delta, Manitoba, Canada	1942
Hodges, James, 1229 4th Ave. North, Clinton, Iowa	1946
†Hoffmann, L(ukas), Station Biologique de la Tour du Valat, Le Sambuc, B.d. Rh., France	1955
Hoffmeister, Linus C(hristian), 504 West Ripa Ave., Lemay 25, Missouri	1939
Hofslund, Pershing B(ernard), Dept. of Biology, Duluth Branch, University of Minnesota, Duluth, Minnesota	1944
Hoger, Richard B., 2s101 Park Blvd., Glen Ellyn, Illinois	1960
Hoiberg, Arnold, Research Laboratories, The Flintkote Co., Whippany, New Jersey	1951
Holden, Mrs. David J., Route 1, Box 80, Brookings, South Dakota	1953
†Holden, Fenn M(itchell), Box 428, Grayling, Michigan	1947
Holgersen, Norman Erik, 207 Old Main St., Rock Hill, Connecticut	1959

Holland, Harold May, Box 615, Galesburg, Illinois 1915
Holzbach, John Edward, 229 Maywood Dr., Youngstown, Ohio 1959
Horst, Roy, 15 Frawley St., Boston, Massachusetts 1961
Hosford, Harold V(ere), 4116 Roblin Blvd., Charleswood, Manitoba, Canada 1962
Hostetter, D(avid) Ralph, Eastern Mennonite College, Harrisonburg, Virginia 1937
Hough, Mrs. Eleanor Sloan, 1515 Mariposa Ave., Boulder, Colorado 1941
†Houston, C(larence) Stuart, 30 Erie Ave., Newton Highlands, Massachusetts 1948
Howard, Mrs. Ruby T., 330 Fernwood Rd., Miami 49, Florida 1954
Howe, P(ercival) S(ourr), Jr., P.O. Box 586, Short Hills, New Jersey 1962
Howell, Joseph C., Dept. of Zoology & Entomology, University of Tennessee, Knoxville 16, Tennessee 1938
Howell, Thomas R(aymond), Dept. of Zoology, University of California, Los Angeles 24, California 1947
†Hoyt, Mrs. Sally F., Box 54, "Aviana," Etna, New York 1952
Hudgeon, Eleanore M., 20209 Shakerwood Rd., Cleveland 22, Ohio 1958
Hudson, Roy D(avid), 215 Essex Dr., Ormond Beach, Florida 1960
Huey, Lawrence M., 2629 32nd St., San Diego 4, California 1957
Hughes, Gilbert C. III, Dept. of Biological Sciences, University of the Pacific, Stockton 4, California 1952
Humphrey, Philip Strong, Peabody Museum, Yale University, New Haven 11, Connecticut 1948
Hundley, Mrs. Margaret H., Box 158, Stonington, Maine 1959
Hunt, George L(ester), Adams I–22, Harvard University, Cambridge, Massachusetts 1959
Hunt, L(awrence) Barrie, Forestry & Wildlife Management, 424 University Farm Place, Madison 5, Wisconsin 1954
Hunter, William F., Chelsea High School, Chelsea, Michigan 1961
†Huntington, Charles Ellsworth, Dept. of Biology, Bowdoin College, Brunswick, Maine 1950
†Hurlock, Phyllis Lorraine, R.D. 1, Coatsville, Pennsylvania 1959
Hurrie, David, 71 Brookview Pl., Brockville, Ontario, Canada 1952
Hussell, D. J. T., 17 Farnsworth Dr., Weston, Ontario, Canada 1959
Hutto, Thomas A(ugust), Eastern Kentucky State College, Richmond, Kentucky 1962

Ilnicky, Nicholas Jon, 1226 North Front, Marquette, Michigan 1958
Imhof, Thomas A(nthony), 1036 Pike Rd., Birmingham 8, Alabama 1950
Irving, Mrs. William Gary, 60 Van Houten Fields, West Nyack, New York 1959
Irwin, Oliver F(rancis), 1789 Glenview Ave., Memphis 14, Tennessee 1961
Isham, Mrs. Mabelle B., 1610 West Highland Blvd., Battle Creek, Michigan 1958
Isleib, Peter M., R.D. 2, Jones Hollow Rd., Marlborough, Connecticut 1958
Ivie, Mrs. Kathryn R., 721 North Main St., Sandwich, Illinois 1957
Ivor, H. Roy, R.R. 1, Erindale, Ontario, Canada 1945

†Jaeger, Ellsworth, 470 Bird Ave., Buffalo 13, New York 1956
Jahn, Laurence Roy, 129 Juneau St., Horicon, Wisconsin 1950
James, Douglas Arthur, Dept. of Zoology, University of Arkansas, Fayetteville, Arkansas 1946
James, Pauline, Dept. of Biology, Pan American College, Edinburg, Texas 1952
James, P(ercival) H(enry), Dept. of Psychology, Queen's University, Kingston, Ontario, Canada 1958
James, William S(tuart), P.O. Box 495, Chapel Hill, North Carolina 1959
Janssen, Robert B., 1817 West 59th St., Minneapolis 19, Minnesota 1952
Janvrin, Edmund R(andolph) P(easlee), 38 East 85th St., New York 28, New York 1942
Jaques, Florence Page, 10 East Oaks Rd., North Oaks Farms, St. Paul 13, Minnesota 1950
†Jaques, F(rancis) L(ee), 10 East Oaks Rd., North Oaks Farms, St. Paul 13, Minnesota 1939
Jegla, Thomas Cyril, 345 Natural History, Urbana, Illinois 1959
†Jehl, Joseph R., Jr., 331 Lindberg Ave., Frederick, Maryland 1953
Jenkins, James H(obart), School of Forestry, University of Georgia, Athens, Georgia 1939
Jenkins, Mary Caroline, Box 715, Bryson City, North Carolina 1952
Jenner, William A., 306 Alma St., O'Fallon, Illinois 1933

Jenni, Donald A(lison), Dept. of Biology, University of Florida, Gainesville, Florida 1958
*Jennings, Mrs. B. Brewster, Glen Head, Long Island, New York 1959
†Jeter, Horace Hearne, 410 Green St., #3B, San Francisco 11, California 1950
Johnsgard, Paul A(ustin), Dept. of Conservation, Cornell University, Ithaca, New York 1959
Johnson, Albert George, Route 1, Box 166, Excelsior, Minnesota 1947
Johnson, DeWitt T(almadge), 118 North Glenwood St., El Paso, Texas 1960
Johnson, J(ohn) C(hristopher), Jr., Dept. of Biology, Kansas State College, Pittsburg, Kansas 1955
Johnson, Mabel Claire, 30 Westfield Rd., West Hartford, Connecticut 1946
Johnson, Robert A., R.D. 1, Bloomington, Indiana 1930
Johnston, Mrs. Bette Jane, 191 North Rose St., Mt. Clemens, Michigan 1953
Johnston, David Ware, 1955 Faculty Dr., Winston-Salem, North Carolina 1943
Johnston, Richard F., Museum of Natural History, University of Kansas, Lawrence, Kansas 1949
Jones, John C(ourts), 5810 Namakagan Rd., Washington 16, D.C. 1931
Jones, Vincent C(lements), 3125 Winnett Rd., Chevy Chase 15, Maryland 1951
†Jorae, Irene Frances, 32 Balboa Dr., Tempe, Arizona 1942
Jordan, John N., P.O. Box 29, Piedmont, Quebec, Canada 1951
Jubon, John M., P.O. Box 16, Millstone Rd., East Millstone, New Jersey 1951
Juhn, Mary, P.O. Box 225, Beltsville, Maryland 1954
Jung, Clarence (Schram), 6383 North Port Washington Rd., Milwaukee 17, Minnesota 1921
Jurica, E., St. Procopius College, Lisle, Illinois 1940

Kahl, M(arvin) Philip, Jr., Dept. of Zoology, University of Georgia, Athens, Georgia 1953
Kahn, Mrs. Reuben L., 8 Ruthven Pl., Ann Arbor, Michigan 1938
Kale, Herbert W(illiam) II, Dept. of Zoology, University of Georgia, Athens, Georgia 1957
Kalmbach, Edwin Richard, 1601 Mariposa Ave., Boulder, Colorado 1926
Kammeraad, Jack W., 1005 Moreland Ave., Grand Haven, Michigan 1962
Karns, Ronald R(aymond), 1059 Roche Ct. S., Columbus 24, Ohio 1955
Kasper, John L(oren), 5765 Lake Rd., Oshkosh, Wisconsin 1947
Kassoy, Irving, 235 South Fourth St., Columbus 15, Ohio 1958
Keck, Warren N., North Central College, Naperville, Illinois 1958
Keegan, Jack, 803 Madison, Dixon, Illinois 1961
Kecton, Luther F., 80 Eastland Dr., Memphis, Tennessee 1952
*Keil, Julius J., 33-47 14th St., Long Island City 6, New York 1959
†Keith, G. Stuart, 130 East End Ave., New York 28, New York 1960
*Kelker, George H., School of Forestry, Utah State Agricultural College, Logan, Utah 1938
Keller, Charles Edward, 3905 South Olney, Indianapolis 22, Indiana 1962
Kelly, Neil Thomas, 3681 Forest Hill Dr., Birmingham, Michigan 1951
Kelso, Leon H(ugh), 1601 Argonne Pl. N.W., Apt. 351, Washington 9, D.C. 1930
Kemnitzer, Allen E(dward), 969 Five Mile Line Rd., Webster, New York 1949
Kemper, Charles A., 1192 Bridge St., Chippewa Falls, Wisconsin 1959
Kemsies, Emerson, Dept. of Biological Sciences, Biology Bldg., University of Cincinnati, Cincinnati, Ohio 1948
Kenaga, Eugene E., 3309 Isabella Rd., Midland, Michigan 1949
Kendeigh, S(amuel) Charles, Vivarium Bldg., University of Illinois, Champaign, Illinois 1923
*Kennedy, Bruce H., 389 West Tenth Ave., Columbus 1, Ohio 1947
Kent, F. W., 302 Richards St., Iowa City, Iowa 1951
*Kent, Richard J(erome), 2921 Main St., Bethlehem, Pennsylvania 1960
Kenyon, Karl W(alton), U.S. Fish & Wildlife Service, Branch of Wildlife Research, N.A.S., Sand Point, Seattle 15, Washington 1948
†Kersting, Cecil Carl, Mobil Exploration Mediterranean Inc., PK 11, Bakanliklar, Ankara, Turkey 1950
Kessel, Brina, Dept. of Biological Sciences, University of Alaska, Box 211, College, Alaska 1946
Kibler, Lewis F(oster), 1343 North Main St., Jamestown, New York 1962
Kiblinger, Carrol E., 6160 St. Moritz, Dallas, Texas 1957
†Kicran, John, 25 Norwood Ave., Rockport, Massachusetts 1942

Kiff, Mrs. Maxine C., Box 157, Ona, West Virginia 1959
Kildow, T(homas) Monroe, Box 910, Tiffin, Ohio 1948
†Kilham, Lawrence, Dept of Microbiology, Dartmouth Medical School, Hanover, New Hampshire 1952
Killip, Thomas III, 525 East 68th St., New York 21, New York 1946
Killpack, Merlin L(eo), 1726 East 24th St., Ogden, Utah 1950
Kincaid, Edgar, Jr., 702 Park Pl., Austin 5, Texas 1951
King, John Arthur, Dept. of Zoology, Michigan State University, East Lansing, Michigan 1947
Kirk, Lester K(ing), 19520 Bretton Dr., Detroit 23, Michigan 1954
Kirkpatrick, Charles M., Dept. of Forestry, Purdue University, West Lafayette, Indiana 1948
†Klamm, William A(lden), 2140 Lewis Dr., Cleveland 7, Ohio 1957
Kleen, Richard L., St. Michaels, Maryland 1955
*Kletzly, Robert C(harles), Route 1, Box 125, Point Pleasant, West Virginia 1948
Klimstra, W(illard) D(avid), Cooperative Wildlife Research Lab., Southern Illinois University, Carbondale, Illinois 1958
Kloniek, Allan S., 111 Rowland Parkway, Rochester 10, New York 1941
Klotz, Roy P(aul), 3036 West 114th St., Chicago 55, Illinois 1960
Knight, Charles Harold, 20700 Gladstone Rd., Warrensville Heights, Cleveland 22, Ohio 1959
Knoblaugh, Mrs. Jean S., R.D. 3, Box 271, Tiffin, Ohio 1957
Knorr, Mrs. Betty, 58 Steamboat Landing Rd., South Amboy, New Jersey 1962
Knorr, Owen A(lbert), 730 Evergreen, Boulder, Colorado 1954
Koerker, Richard M(orton), 4103 Dyckman Rd., Midland, Michigan 1961
Kolb, C(harles) Haven, Jr., 5915 Meadow Rd., Baltimore 6, Maryland 1937
Kosaka, Ernest F(utoshi), Division of Fish & Game, P.O. Box 1761, Hilo, Hawaii 1961
Kossack, Charles W(alter), 715 South Division St., Barrington, Illinois 1945
Kramar, Nada, 927 15th St. N.W., Washington 5, D.C. 1947
Kramer, Theodore C(hristian), 1810 Waven Rd., Route 6, Ann Arbor, Michigan 1939
Kraus, Douglas L(awrence), Dept. of Chemistry, University of Rhode Island, Kingston, Rhode Island 1942
Krause, Herbert, 1811 1st Ave. South, Sioux Falls, South Dakota 1953
Krebs, Mrs. R. W., 98 Druid Hill Rd., Summit, New Jersey 1946
Krehbiel, Adolf J., P.O. Box 4008, Santa Fe, New Mexico 1955
Krug, Howard H(enry), Chesley, Ontario, Canada 1944
Kuhn, Kenneth H(erbert), 4503 North 64th St., Milwaukee 18, Wisconsin 1949
Kuitert, Louis Cornelius, Agricultural Experiment Station, University of Florida, Gainesville, Florida 1938
Kump, George F(rancis), Box 71, Westfield, Pennsylvania 1962
Kunkle, Donald E., Box 121, Port Norris, New Jersey 1956
Kuyava, Gary C(lement), 1611 North 7th Ave. East, Duluth 5, Minnesota 1959

Labisky, Ronald F., Sect. of Wildlife Research, Nat. Hist. Sur., Natural Resources Bldg., Urbana, Illinois 1956
Laitsch, Mrs. Nevada, MC 21, East Liverpool, Ohio 1961
Lamore, Donald Hart, 419 West Main St., Nevada, Missouri 1942
Lancaster, Christine, 90 Appian Way, Keene, New Hampshire 1959
Lancaster, Douglas A(lan), Dept. of Biological Sciences, Northwestern State College, Natchitoches, Louisiana 1949
Land, Hugh Colman, Dept. of Biology, Concord College, Athens, West Virginia 1950
Landing, James E., Dept. of Geography, I. C. Elston Jr. High, Michigan City, Indiana 1957
Lanyon, Wesley E(dwin), American Museum of Natural History, Central Park West at 79th St., New York 24, New York 1955
†Laskey, Mrs. Frederick Charles, 1521 Graybar Lane, Nashville 12, Tennessee 1928
Lawrence, Mrs. Louis de Kiriline, The Loghouse, Pimisi Bay, Rutherglen, Ontario, Canada 1946
*Lawson, Ralph, 42 Chestnut St., Salem, Massachusetts 1951
*Lea, Robert B(ashford), 1045 North Spring St., Elgin, Illinois 1940
Leavitt, Benjamin Burton, Dept. of Biology, University of Florida, Gainesville, Florida 1947
Leberman, Robert C(harles), R.D. 1, Saeger Hill, Meadville, Pennsylvania 1958

Leedy, Daniel L(ong), Fish & Wildlife Service, Branch of Wildlife Research, Washington 25, D.C. 1936
Lees-Smith, D(erer) T(hayer), 75 School Lane, Addlestone near Weybridge, Surrey, England 1958
LeFebvre, Mrs. Joyce, 3889 Bellaire Ave., White Bear Lake 10, Minnesota 1953
Lehmann, Margaret C., 6942 Jeffery Ave., Chicago 49, Illinois 1960
Lehrer, G. John, 3093 Lockport-Olcolt Rd., Newfane, New York 1961
Lengemann, Martha A., 360 Cedar St., Imlay City, Michigan 1946
Leopold, A(ldo) Starker, Museum of Vertebrate Zoology, University of California, Berkeley 4, California 1940
LeSassier, Mrs. Anne L., 1611 West Indiana, Midland, Texas 1957
Lesher, Frederick, 309 Decorah Ave., Decorah, Iowa 1958
Levi, Herbert W., Museum of Comparative Zoology, Harvard University, Cambridge 38, Massachusetts 1949
Levy, Alice K(lund), 2980 Edgewick Rd., Glendale 6, California 1941
Lewin, Mrs. B., 7390 Kildare Rd., Côte St. Luc, Montreal, Quebec, Canada 1962
Lewis, C. Bernard, The Science Museum, Institute of Jamaica, Kingston, Jamaica, British West Indies 1947
Lewis, Harrison F(lint), Sable River, Nova Scotia, Canada 1939
Lewis, Mary (Evelyn), 941 St. Philip St., New Orleans 16, Louisiana 1957
Lewis, Thomas J., Jr., 2712 Jersey Ridge Rd., Davenport, Iowa 1956
Lewis, William O(wen), Box 22, Ivy, Virginia 1953
Lien, Mrs. Boyd M., 5148 29th Ave. South, Minneapolis 17, Minnesota 1944
†Ligas, Frank J., 1500 S.W. 15th Ave., Fort Lauderdale, Florida 1951
Lincoln, Charles W., 392 Highland Ave., Upper Montclair, New Jersey 1953
†Lincoln, M(orris) Albert, 315 East Oak Ave., Moorestown, New Jersey 1941
Lindberg, Harold Lloyd, 311 Emery Ave., Peshtigo, Wisconsin 1962
Littlefield, Carroll Dwayne, Route 1, Friona, Texas 1960
Livingston, John A., 27 Nanton Ave., Toronto 5, Ontario, Canada 1958
Livingston, Philip A(tlee), 620 Manor Rd., Narberth, Pennsylvania 1953
Lloyd, C(lark) K., 11 North Elm St., Oxford, Ohio 1925
Lloyd, Hoyes, 582 Mariposa Ave., Rockcliffe Park, Ottawa, Ontario, Canada 1922
Lockwood, Robert Minturn, 2217 Glenwood Lane, Denton, Texas 1949
Loetscher, Frederick W(illiam), Jr., 507 West Main St., Danville, Kentucky 1946
Logan, W(illiam) Ronald, 2935 Glenview St., Philadelphia 49, Pennsylvania 1962
Longley, William H(oward), Box 532, Forest Lake, Minnesota 1943
Loomis, Mrs. Lester R., R.R. 2, Box 157–T, Hammond, Louisiana 1942
†Lory, Mrs. William T., Route 2, Box 41, Momence, Illinois 1944
Lovejoy, Thomas E(ugene) III, 116 East 63rd St., New York 21, New York 1960
Lovell, Mrs. C(harles) Edwin, 48 Christopher Dr., Box 186, Poland 14, Ohio 1958
†Lovell, Harvey B., 2424 Dundee Rd., Louisville 5, Kentucky 1936
Lowe, Mrs. Frank E., Box 65, Harrison, Maine 1958
Lowe, W. Ross, 256 Oak St., Sudbury, Ontario, Canada 1961
†Lowery, George H(ines), Museum of Zoology, Louisiana State University, Baton Rouge, Louisiana 1937
Lowther, James K., Dept. of Zoology, University of Toronto, Toronto 5, Ontario, Canada 1956
Luckenbach, Mrs. Bert A., 1548 Lehigh Parkway, S., Allentown, Pennsylvania 1956
†Ludwig, Frederick Edwin, 2864 Military St., Port Huron, Michigan 1941
Ludwig, James Pinson, 2864 Military St., Port Huron, Michigan 1962
Lueshen, Mrs. John (Willetta), Wisner, Nebraska 1952
Lumsden, H. G., Dept. of Lands & Forests, Southern Research Station, R.R. 2, Maple, Ontario, Canada 1961
Lunk, William A., 1807 Sunrise St., Ann Arbor, Michigan 1937
Luther, Mrs. Frederick, 4515 Marcy Lane, Apt. 239, Indianapolis 5, Indiana 1935
Luthy, Fred, Jr., 1310 North Institute, Peoria, Illinois 1937
†Lyman, Mrs. Clara Cross, Route 5, Box 590, Wayzata, Minnesota 1944
Lynn, Robert T., 1016 East Arkansas, Norman, Oklahoma 1957

Mabus, Mrs. Mildred M(axine), R.D. 1, Sesser, Illinois 1955
MacInnes, C. D., Dept. of Conservation, Fernow Hall, Cornell University, Ithaca, New York 1959

Maciula, Stanley J., 2 Springdale Ct., Clifton, New Jersey 1962
Mack, Charles B., R.R. 3, Box 41, Alexandria, Indiana 1961
*Mackenzie, Locke Litton, 829 Park Ave., New York 21, New York 1947
MacLaren, R. G., Hamilton General Hospital, Barton St., Hamilton, Ontario, Canada 1956
MacLean, John A., Jr., 330 Locust Rd., Winnetka, Illinois 1957
MacMillan, Robert L(aidlaw), 350 Inglewood Dr., Toronto 7, Ontario, Canada 1961
MacMullen, R(alph) Austin, 2205 Hopkins Ave., Lansing 12, Michigan 1940
Magner, J(ohn) Marshall, 516 Bacon Ave., Webster Groves 19, Missouri 1948
Mahan, Harold D., Dept. of Biology, Central Michigan University, Mt. Pleasant, Michigan 1953
Maher, William Joseph, Dept. of Biology, San Francisco State College, 1600 Holloway Ave., San Francisco 27, California 1951
Mahlburg, Milton William, 1109 Grant Ave., Rockford, Illinois 1949
Mainster, Raymond Waite, 3716 Criyson Rd., Baltimore 7, Maryland 1949
Malcomson, Richard O., Sterling College, Sterling, Kansas 1960
Malick, Donald L(eo), Route 1, Happy Canyon Rd., Castle Rock, Colorado 1958
*Maly, Mrs. Lucy Marie, 1870 North Fourth St., Apt. 5, Columbus 1, Ohio 1947
Manners, Edward Robert, 216 New Broadway, Brooklawn, New Jersey 1942
Manning, T. H., 37 Linden Terrace, Ottawa 1, Ontario, Canada 1950
Manville, Richard H(yde), Fish & Wildlife Service, U.S. National Museum, Washington 25, D.C. 1941
†Mark, Cyrus, 80 Wentworth Ave., Glencoe, Illinois 1960
†Mark, Mrs. Cyrus, 80 Wentworth Ave., Glencoe, Illinois 1960
Markgren, Gunnar, Boda Försöksstation, Enånger, Sweden 1960
Marks, Jack Loran, 1107 S.W. 4th Ave., Portland 4, Oregon 1949
Marriette, D(aryl) J(ames), R.R. 4, Dundas, Ontario, Canada 1962
Marsden, Halsey M(eans), Dept. of Zoology, University of Missouri, Columbia, Missouri 1957
Marshall, Terrell, 372 Skyline Dr., Park Hill, North Little Rock, Arkansas 1944
*Marshall, William H(ampton), 300 Coffey Hall, University of Minnesota, St. Paul 1, Minnesota 1942
Martin, Fant W., Patuxent Wildlife Research Center, Laurel, Maryland 1957
Martin, J. E., 1716 Dorchester Pl., Oklahoma City 16, Oklahoma 1955
*Martin, Joseph H., 1001 Peoples Building, Grand Rapids, Michigan 1959
Martin, Neil S(idney), 1110 Wilder, Helena, Montana 1961
*Marvel, Carl S(hipp), 2332 East 9th St., Tucson, Arizona 1949
†Maslowski, Karl H(erbert), 1034 Maycliff Pl., Cincinnati 30, Ohio 1934
Mason, C(harles) N(athan), 6432 31st St. N.W., Washington 15, D.C. 1947
Mason, Esther, 2541 Montgomery St., Louisville 12, Kentucky 1941
Mason, Mrs. James H., Box 251A, Route 1, West Terre Haute, Indiana 1960
Mattocks, Philip W(ard), Jr., 1900 Calion Rd., El Dorado, Arkansas 1960
Maxwell, George R. III, 337 East Lullwood Ave., San Antonio 12, Texas 1960
May, Aubrey, Box 715, Huntsville, Ontario, Canada 1961
May, Fred Hamilton, 211 Beall St., Lenoir, North Carolina 1959
Mayer, Charles C(ushing) B(ailey), Elm Grove, Colrain, Massachusetts 1958
Mayfield, G(eorge) R(adford), 414 Vanderbilt Pl., Nashville 12, Tennessee 1917
†Mayfield, Harold F(ord), River Rd., R.D., Waterville, Ohio 1940
†Mayr, Ernst, Museum of Comparative Zoology, Harvard University, Cambridge 38, Massachusetts 1933
†Mazzeo, Rosario, 114 The Fenway, Boston, Massachusetts 1947
McAlister, J(ames) Don, 1723 Cardiff Rd., Columbus 21, Ohio 1949
McAllister, Mrs. N. A., 501 Metcalfe, Ottawa 1, Ontario, Canada 1957
McAtee, Waldo Lee, 3 Darie Circle, Chapel Hill, North Carolina 1911
McBee, Mrs. Lena G(riffin), Wyatt, West Virginia 1957
McBride, David Newton, Box 85, Hillsboro, Ohio 1959
†McCabe, Robert A(lbert), 424 University Farm Pl., University of Wisconsin, Madison 6, Wisconsin 1942
McCleary, Ralph, 33 Lake Promenade, Toronto 14, Ontario, Canada 1962
*McClure, H(owe) Elliott, U.S.A. Medical Research Unit, Institute for Medical Research, Kuala Lumpur, Malaya 1942
McCormick, John M., 1827 Richards Rd., Toledo 7, Ohio 1951
McCosh, Gladys K., Dept. of Zoology, Wellesley College, Wellesley 81, Massachusetts 1957

McCrary, Mary, 1039 Clarksville St., Paris, Texas 1960
McCue, Earl Newlon, Box 104, Morgantown, West Virginia 1941
McCullagh, E(rnest) Perry, 2020 East 93rd St., Cleveland, Ohio 1937
McCullough, C(lyde) Robert, North Cheshire, Burton, Ohio 1953
McDonald, Malcolm E., Bear River Research Station, P.O. Box 603, Brigham City, Utah 1936
McEntee, Mrs. Howard G., 490 Fairfield Ave., Ridgewood, New Jersey 1948
McFarlane, Robert W(illiam), Dept. of Biology, University of Florida, Gainesville, Florida 1959
†McGaw, Mrs. G. Hampton, 18 Beech St., Woodsville, New Hampshire 1945
†McGeen, Daniel S., 707 Community National Bank Bldg., Pontiac, Michigan 1944
McKinley, Daniel L(awson), Dept. of Biology, Lake Erie College, Painesville, Ohio 1948
McKinley, George G(ael), P. O. Box 468, Glasgow, Kentucky 1945
*McKinney, Mrs. Walter A., 2511 South Boston Pl., Tulsa 14, Oklahoma 1945
McKnight, 5038 Park Pl., Washington 16, D.C. 1936
McLaughlin, Frank W., 790 Ewing Ave., Franklin Lakes, New Jersey 1953
McLean, David C(osten), 550 Wisteria Dr., Florence, South Carolina 1962
Meacham, Frank B., State Museum, Raleigh, North Carolina 1945
Mead, Frank Waldreth, State Plant Board of Florida, Gainesville, Florida 1948
†Meade, Gordon M(ontgomery), 3115 34th St. N.W., Washington, D.C. 1938
Meanley, Brooke, Patuxent Wildlife Research Center, Laurel, Maryland 1950
Medina, Don(ald) R(aul), Museum of Vertebrate Zoology, University of California, Berkeley 4, California 1955
Mehner, John F., Edinboro State College, Edinboro, Pennsylvania 1949
Mellinger, E(nos) O(ren), Savannah N.W. Refuge, Box 4008, Port Wentworth, Georgia 1939
†Melone, Theodora G(ardner), Geology Library, Pillsbury Hall, University of Minnesota, Minneapolis 14, Minnesota 1947
Meltvedt, Burton W., Paullina, Iowa 1930
†Meng, Karl, State Teachers College, New Paltz, New York 1943
†Mengel, Robert M(orrow), Museum of Natural History, University of Kansas, Lawrence, Kansas 1937
Menhennet, Mrs. William, 221 North Macdonald St., Mesa, Arizona 1961
Menninger, Phil B., 2521 Burnett Rd., Topeka, Kansas 1949
Merck, G(eorge) W(all), The Fields, Far Hills, New Jersey 1959
Meritt, James Kirkland, 809 Saratoga Tr., Whitman Square, Blackwood P.O., New Jersey 1944
Mers, W(illiam) H(enry), 1659 Marlowe Ave., Cincinnati 2, Ohio 1949
Mery, Mrs. Sophia C., 345 Boston Ave. S.E., Bartlesville, Oklahoma 1955
Messersmith, Donald Howard, 100 Monroe Tr., Radford, Virginia 1961
Metcalf, H(omer) N(oble), Dept. of Horticulture, Montana State College, Bozeman, Montana 1944
*Mewaldt, L(eonard) R(ichard), Dept. of Natural Science, San Jose State College, San Jose 14, California 1947
Meyer, Henry, Wisconsin State College, Whitewater, Wisconsin 1939
*Meyerriecks, Andrew J(oseph), Box 155, South Lincoln. Massachusetts 1948
†Meyers, Kenneth Lewis, 5441 Far Hills Ave., Dayton 59, Ohio 1949
Michaud, Howard H(enry), 301 East Stadium Ave., West Lafayette, Indiana 1938
Middleton, William R(obert), 109 South Jackson Ave., Wenonah, New Jersey 1953
†Mikkelson, Herbert G., Box 142, Minnetonka Beach, Minnesota 1948
Miles, John B., 656 King St. East, Hamilton, Ontario, Canada 1958
Miley, Theodore R., 18579 Edinborough, Detroit 19, Michigan 1960
Millar, John B., c/o Canada Wildlife Service, 900 Dominion Public Bldg., Winnipeg, Manitoba, Canada 1956
†Miller, Alden H(olmes), Museum of Vertebrate Zoology, University of California, Berkeley 4, California 1930
Miller, Mrs. Alice, 1150 Brewer Rd., Leonard, Michigan 1944
*Miller, Clark, Inwood, West Virginia 1953
†Miller, Douglas Scott, 122 Lawrence Ave. East, Toronto, Ontario, Canada 1939
Miller, Irene E., 5505 Scenic Dr., Little Rock, Arkansas 1955
†Miller, Loye H(olmes), 821 Cherry Lane, Davis, California 1939
Miller, Lyle (DeVerne), 5795 Mill Creek Blvd., Youngstown 12, Ohio 1947

Miller, Robert R(aymond), 1424 Liberty St., Allentown, Pennsylvania 1954
Miller, Mrs. William C., 4408 Fairfax, Dallas 5, Texas 1961
†Mills, Herbert H., Arrowhead Farms, R.F.D. 3, Bridgeton, New Jersey 1951
Milon, Philip, 4 Rue de la Pompe, Paris 16, France 1958
Minot, John Granville, 144 Gratte St., Cambridge, Massachusetts 1957
Miskimen, Mildred, Dept. of Biological Sciences, Douglas College—Rutgers University, New Brunswick, New Jersey 1950
†Mitchell, Harold Dies, 238 West Royal Pky., Williamsville 2, New York 1936
†Mitchell, Mrs. Osborne, c/o Canadian–Brazilian Services Ltd., 9/12 Cheapside, London, E.C. 2, England 1933
Mitchener, Alfred John, 127 Robinson St., Collingwood, Ontario, Canada 1961
Mockford, Edward (Lee), Dept. of Biological Sciences, Illinois State Normal University, Normal, Illinois 1946
Monk, Harry C(rawford), 406 Avoca St., Nashville 5, Tennessee 1920
†Monroe, Burt L(eavelle), Ridge Rd., Anchorage, Kentucky 1935
Monroe, Burt L(eavelle), Jr., Museum of Zoology, Louisiana State University, Baton Rouge, Louisiana 1946
Monroe, Mrs. Robert A., 1424 Tugaloo Dr., Knoxville 19, Tennessee 1960
Monson, Gale, 1003 Ninth Ave., Yuma, Arizona 1933
Moody, Frank B., 862 Spruce Ave., West Chester, Pennsylvania 1962
Moody, Marjorie J., 1380 Veteran Ave., Apt. 1, Los Angeles 24, California 1957
Moore, Betty Jean, 5944 Evanston Ave., Indianapolis 20, Indiana 1961
Moore, Robert B(yron), 1332 Knollwood Dr., Baton Rouge 8, Louisiana 1947
*Moran, James Vincent, Darnestown-Seneca Rd., Route 2, Germantown, Maryland 1943
Morgan, Allen H., 114 Cochiluate Rd., Wayland, Massachusetts 1958
Moriaty, Lester J., 914 1st St. N.W., Watertown, South Dakota 1957
Morrisette, Mrs. Mary Frances, Severn Point, Norfolk 5, Virginia 1960
Morrow, Mrs. John, Jr., 1320 North State St., Chicago 10, Illinois 1949
Morse, Douglas H., Star Route, Lisbon, Maine 1956
Morse, Margarette Elthea, 122 West South St., Virogua, Wisconsin 1921
Morton, Eugene Siller, 22676 Beechnut Lane, Rocky River 16, Ohio 1959
Mosby, Henry Sackett, 1300 Hillcrest Dr., Blacksburg, Virginia 1951
Mossman, H(arland) W(infield), 2902 Columbia Rd., Madison 5, Wisconsin 1948
*Mudge, Edmund W., Jr., 5926 Averill Way, Dallas, Texas 1939
*Mueller, Mrs. Florence N., 4408 Pine St., Omaha 5, Nebraska 1951
Mueller, Helmut Charles, Dept. of Zoology, Birge Hall, University of Wisconsin, Madison 6, Wisconsin 1949
Muhlbach, W(alt) L(auritz), 2013 Vine St., Berkeley 9, California 1951
Mumford, Russell E(ugene), Dept. of Forestry & Conservation, Purdue University, West Lafayette, Indiana 1949
Murie, Adolph, P.O. Box 672, Medford, Oregon 1932
Murie, O(laus) J(ohan), Moose, Wyoming 1934
Murphy, Paul C(harles), 935 Goodrich Ave., Apt. 10, St. Paul 5, Minnesota 1944
†Murray, Bertram George, Jr., Bird Division, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1954
Murray, J(oseph) J(ames), 6 Jordan St., Lexington, Virginia 1931
Musselman, T(homas) E(dgar), 124 South 24th St., Quincy, Illinois 1940

Nearing, C(harles) Turner, 1400 West Macon St., Decatur, Illinois 1962
Nearing, Mrs. C(harles) Turner, 1400 West Macon St., Decatur, Illinois 1962
Neel, Charles A(ndrews), Star Route, Sheffield, Pennsylvania 1960
Neff, Johnson Andrew, 3965 South Bannock St., Englewood, Colorado 1920
Neher, Harry T(rainer), 817 Radcliffe St., Bristol, Pennsylvania 1958
Nelms, Nancy Jane, 1506 Ardmore Pl., Kingsport, Tennessee 1960
Nelson, Mrs. Carl R., Jr., 409 Sunnycrest Ct. West, Urbana, Illinois 1959
*Nelson, Charles E(llsworth), Jr., Box 161, Route 1, Dousman, Wisconsin 1937
†Nelson, Theodora, 315 East 68th St., New York 21, New York 1928
Nero, Robert William, University of Saskatchewan, Regina Campus, Regina, Saskatchewan, Canada 1947
Nessle, James P., R.F.D. 1, Waterville, Ohio 1936
†Netting, M(orris) Graham, Carnegie Museum, Pittsburgh 13, Pennsylvania 1941
Nevius, Mrs. Richard, Route 3, Greenville, Tennessee 1940

New, John G., Dept. of Science, State University Teachers College, Oneonta, New York 1946
Newberry, A(ndrew) Todd, Hopkins Marine Station, Pacific Grove, California 1952
*Newman, Donald L., 14174 Superior Rd., Cleveland Heights 18, Ohio 1957
Newman, Robert J(ames), 655 Ursuline Dr., Baton Rouge, Louisiana 1950
Nice, L(eonard) B., 5725 Harper Ave., Chicago 37, Illinois 1932
†Nice, Mrs. Margaret Morse, 5725 Harper Ave., Chicago 37, Illinois 1921
Nicholas, Mrs. W. C., 79 Lawrence Ave., Highland Park, New Jersey 1959
*Nicholson, Donald J., 1224 Palmer St., Orlando, Florida 1945
Nicholson, Wendell W., Route 1, Box 350, La Porte, Indiana 1958
†Nickell, Walter Prine, Cranbrook Institute of Science, Bloomfield Hills, Michigan 1943
Nielsen, Mrs. B. W., Route 1, Box 808, Kauffman Ave., Red Bluff, California 1945
Nolan, Val, Jr., School of Law, Indiana University, Bloomington, Indiana 1940
Noland, Mrs. Hulbert V., 57 Indian Hills Trail, Louisville 7, Kentucky 1956
Norberg, Arthur H., 323 North Main St., Ada, Ohio 1960
Nordquist, Theodore C., 5006 46th Ave. N.E., Seattle 5, Washington 1941
*Nork, Theodore J., 7433 North Ridge, Chicago 45, Illinois 1947
Norman, Edward d'Aubigny, 181 Stage Harbor Rd., Chatham, Massachusetts 1951
Norman, James L(ee), 502 North 14th St., Muskogee, Oklahoma 1948
Norman, K. Duane, 103 16th St. N.W., Minot, North Dakota 1957
Norris, Robert Allen, Dept. of Zoology, University of Georgia, Athens, Georgia 1941
North, George W(ebster), 249 Charlton Ave. West, Hamilton, Ontario, Canada 1941
†Novaes, Fernando C., Museu Paraense Emilio Goeldi, Caixa Postal 399, Belem, Para, Brasil 1953
Novotny, Edwin, 921 Norman Ave., Ashtabula, Ohio 1959
†Nowland, Paul J., 700 Equitable Bldg., Wilmington, Delaware 1950
Nye, Frederick F., Jr., Box 632, Pharr, Texas 1943

Oberholser, Harry Church, 2933 Berkshire Rd., Cleveland Heights, Cleveland 18, Ohio 1894
O'Brien, Francis P., Ephrata Senior High School, Ephrata, Washington 1961
O'Callaghan, Terence C., Maromala R.D., Bay of Islands, Northland, New Zealand 1954
*Odum, Eugene P(leasants), Dept. of Zoology, University of Georgia, Athens, Georgia 1930
Ogden, John C(lifton), 2813 White Oak Dr., Nashville 12, Tennessee 1960
*Olsen, Richard E., 3325 Franklin Rd., Bloomfield Hills, Michigan 1938
Olson, Mrs. Frank, R.D. 2–147, Cherry Valley Rd., Princeton, New Jersey 1961
†Olson, Mrs. Gladys E., 33 Harvard Dr., Lake Worth, Florida 1959
Olson, James G., 2740 Elinor St., Eugene, Oregon 1960
Olson, Mrs. Monrad, Box 595, Waterford City, North Dakota 1946
Olson, Storrs L., 700 Stiles Ave., Tallahassee, Florida 1960
O'Neil, Norah Selby, 1311 Bonham St., Commerce, Texas 1949
O'Neill, John P(atton), 10723 Beinhorn Rd., Houston 24, Texas 1962
Osterhaus, Sister M. Benita, College of Saint Francis, Joliet, Illinois 1960
Overing, Robert, 119 Willow Lane, Decatur, Georgia 1930
Overmire, Thomas G(ordon), 3914 Burton Dr., Muncie, Michigan 1962
Owen, J(ames) B(unyan), 2722 Fairview St. N.E., Knoxville 17, Tennessee 1960
Owre, Oscar T., Dept. of Zoology, University of Miami, Coral Gables, Florida 1935

Packard, Gary C., Museum of Natural History, University of Kansas, Lawrence, Kansas 1960
Palmer, Ralph S(imon), New York State Museum, State Educational Bldg., Albany 1, New York 1934
Palmquist, Clarence O(scar), 834 Windsor Rd., Glenview, Illinois 1945
Pangborn, Mark W(hite), 25 East 56th St., Indianapolis, Indiana 1948
Parker, John A., 274 Airdrie Rd., Toronto 17, Ontario, Canada 1961
Parker, Kenneth W., Box 621, University Station, Shawnee, Oklahoma 1960
†Parkes, Kenneth Carroll, Carnegie Museum, Pittsburgh 13, Pennsylvania 1946
Parks, Richard Anthony, 2303 Pembrook Pl. N.E., Atlanta 5, Georgia 1942
Parmelee, David F(reeland), Dept. of Biology, Kansas State Teachers College, Emporia, Kansas 1949
Parmeter, B(enjamin) D(avid), Armstrong Woods Rd., Guerneville, California 1957
Partridge, William H., Belgrano 363, Caseros B.A., Argentina 1953

*Patten, Bradley M., 2126 Highland Rd., Ann Arbor, Michigan 1953
Paulson, Dennis R., 3834 La Playa Blvd., Coconut Grove, Florida 1957
Payne, Robert B(erkeley), Museum of Vertebrate Zoology, University of California, Berkeley 4, California 1960
Paynter, Raymond A(ndrew), Jr., Museum of Comparative Zoology, Harvard University, Cambridge 38, Massachusetts 1946
Pearson, Mrs. Carl E., 632 North Stone Ave., LaGrange Park, Illinois 1954
Peelle, Miles L., 1039 College St., Adrian, Michigan 1940
Peer, Mrs. George Sherman, 25 Canoe Hill, New Canaan, Connecticut 1960
Peffer, Mrs. Thomas A., 49 West Depot St., Hellertown, Pennsylvania 1954
Penner, Lawrence R., Dept. of Zoology & Entomology, University of Connecticut, Storrs, Connecticut 1940
Penney, Richard Lee, Dept. of Zoology, Birge Hall, University of Wisconsin, Madison 6, Wisconsin 1962
Pepper, William, 20 East Bells Mill Rd., Philadelphia 18, Pennsylvania 1957
Perkins, Mrs. Mary Loomis, 1305 South 52nd St., Omaha 6, Nebraska 1946
Peters, Harold S(eymour), 98 Querida St., Bridgeport 4, Connecticut 1924
Petersen, Arnold J(erome), Route 1, Northfield, Minnesota 1949
†Petersen, Peter C., Jr., 620 East 30th St., Davenport, Iowa 1951
Peterson, Alfred, Box 73, Brandt, South Dakota 1931
†Pettingill, Olin Sewall, Jr., Laboratory of Ornithology, Cornell University, Ithaca, New York 1930
Petts, Mrs. Thomas A., 16201 Beaverland, Detroit 19, Michigan 1957
†Phelps, William H(enry), Apartado 2009, Caracas, Venezuela 1940
†Phillips, Allan Robert, c/o Prof. Bernado Villa R., Privada de San Lucas No. 9, Coyoacan 21, D.F., Mexico 1934
*Phillips, Homer Wayne, Route 1, Converse, Texas 1947
Phillips, Richard S(tuart), 834 Liberty St., Findlay, Ohio 1944
Pierce, Fred J(ohn), Winthrop, Iowa 1947
Pierce, Robert Allen, Arkansas Game & Fish Commission, Game & Fish Bldg., Little Rock, Arkansas 1941
Pilling, Norman B(oden), 3 Cherry Lane, Westfield, New Jersey 1960
*Pirnie, Miles David, 103 Conservation Bldg., Michigan State University, East Lansing, Michigan 1928
Pittman, James Allen, Jr., 2770 Smyer Circle, Birmingham 16, Alabama 1945
Platt, Dwight R(ich), R.F.D. 2, Newton, Kansas 1959
Poole, Cecil A(very), 1764 Topeka Ave., San Jose 26, California 1942
Poole, Earl L., 509 Sunset Rd., West Reading, Pennsylvania 1960
Poole, Frederick P., 17 North Girard St., Woodbury, New Jersey 1959
Poor, Hustace Hubbard, 36 Baldwin St., Hudson, Ohio 1935
Porter, Eliot F(urness), Route 4, Box 33, Sante Fe, New Mexico 1947
Porter, Richard Dee, 130 South Prince, Whitewater, Wisconsin 1950
Porter, T(homas) Wayne, Dept. of Zoology, Michigan State University, East Lansing, Michigan 1938
Post, William, Jr., Box 582, Aiken, South Carolina 1957
Postupalsky, Sergej, 7283 Lozier, Warren, Michigan 1960
Potter, David M., Dept. of History, Stanford University, Stanford, California 1946
Potter, Julian K(ent), Box 464, Goshen, New Jersey 1915
Potter, N(athan) S. III, R.D. 5, Huntington, New York 1959
†Pough, Richard H(ooper), 33 Highbrook Ave., Pelham 65, New York 1938
*Powell, Leon W., Jr., 451 Southland Dr., Danville, Virginia 1960
Prager, Robert G., 716 South High St., Yellow Springs, Ohio 1961
Prather, Millard F(illmore), P.O. Box 599, Fairfield, Alabama 1940
Prescott, Kenneth Wade, Academy of Natural Sciences, 19th and Parkway, Philadelphia 3, Pennsylvania 1946
Prescott, Robert G., Jr., Wildlife Research Unit, Auburn University, Auburn, Alabama 1961
Preston, Frank W(illiam), Box 149, Butler, Pennsylvania 1948
Prior, Gertrude, Sweet Brier, Virginia 1956
Prosser, Albert L(aurence), Box H, 116 Main St., Springvale, Maine 1955
Pruitt, Mrs. William O., Jr., Box 282, College, Alaska 1948
Puett, May Wilson, 1811 East North St., P.O. Box 2183, Greenville, South Carolina 1959

Pugh, William H., 2703 Green Haze Ave., Racine, Wisconsin 1961
Puleston, Dennis, Brookhaven National Laboratory, Upton, New York 1955
Putman, Loren Smith, Dept. of Zoology, Ohio State University, Columbus 10, Ohio 1942
Putman, William L(loyd), Dominion Entomological Laboratory, Vineland Station, Ontario, Canada 1945

Quam, Mrs. Mary Battell, 102 Cedar Hollow Rd., Paoli, Pennsylvania 1944
Quay, Thomas L., Dept. of Zoology, North Carolina State College, Raleigh, North Carolina 1939
Quay, W(ilbur) B(rooks), Dept. of Zoology, University of California, Berkeley 3, California 1949
Quilliam, Mrs. H(elen) R(ose), R.D. 1, Kingston, Ontario, Canada 1953
Quimby, Don C., Dept. of Zoology & Entomology, Montana State College, Bozeman, Montana 1942

Radke, Mrs. Eleanor L., Box 138, R.D. 1, East Chatham, New York 1959
Ragusin, Anthony V(incent), P.O. Box 496, Biloxi, Mississippi 1937
Rahe, Carl W., 9005 Tioga Ave., Cleveland 5, Ohio 1931
Raible, Frank Roch, St. Fidelis Seminary, Herman, Pennsylvania 1958
Raitt, Ralph J., Dept. of Biology, New Mexico State University, University Park, New Mexico 1961
Ramisch, Marjorie (Viola), Box 424, Bass Lake Rd., Chardon 5, Ohio 1947
Rand, Austin L., Chicago Natural History Museum, Roosevelt Rd. & Lake Shore Dr., Chicago 5, Illinois 1950
Randall, Clarence B(elden), 30 West Monroe St., Chicago 3, Illinois 1949
Randall, Robert Neal, 928 16th St., Bismarck, North Dakota 1939
Randle, Worth S., 1534 Sutton Ave., Apt. 2, Cincinnati 30, Ohio 1949
Rankin, Henry Ashby, Jr., Box 893, Fayetteville, North Carolina 1960
†Rapp, William F(rederick), Jr., 430 Ivy Ave., Crete, Nebraska 1944
*Ray, Mrs. Grace Ernestine, 520 West Symmes, Norman, Oklahoma 1959
Rea, Gene, 251 Leland Ave., Columbus 14, Ohio 1948
Rea, Mrs. R. V., 856 Forest Ave., South Bend 16, Indiana 1958
†Read, Bayard W(hitney), Upper Dogwood Lane, Rye, New York 1949
Rebmann, G. Ruhland, Jr., 10 West Old Gulph Rd., Gladwyne, Pennsylvania 1941
Reed, Parker Crosby, 27 Hayes Ave., Lexington, Massachusetts 1949
Rees, Earl Douglas, Dept. of Medicine, University of Kentucky, Lexington, Kentucky 1946
Reese, C(arl) R(ichard), 266 East Dunedin Rd., Columbus 14, Ohio 1948
Reichert, Elsa, Mirakel Optical Company, 14 West First St., Mt. Vernon, New York 1950
Reilly, E(dgar) M(ilton), Box 21, Old Chatham, New York 1946
Reinelt, Mrs. Frank, 344 Arroyo Seco, Santa Cruz, California 1959
Renfrew, Mrs. Malcolm M., 1271 Walenta Dr., Moscow, Idaho 1956
Rett, Egmont Z(ackary), Museum of Natural History, Santa Barbara, California 1940
Reynard, George B., 105 Midway, Riverton, New Jersey 1950
*Rice, Dale Warren, U.S. Fish & Wildlife Service, Sand Point Naval Air Station Bldg. 192, Seattle 15, Washington 1946
Rice, Orville O(wen), 1663 West 28th St. Terrace, Topeka, Kansas 1953
Rich, Mrs. Eva, 149 West 79th St., New York 24, New York 1952
Richards, Tudor, Dublin, New Hampshire 1951
†Richardson, E(dgar) P(reston), Winterthur, Delaware 1954
Richardson, (William) John, 4380 Queen Elizabeth Highway, Burlington, Ontario, Canada 1962
Richter, Carl H., 703 Main St., Oconto, Wisconsin 1947
Richter, G(eorge) William, 251 Bradford Lane, Canfield, Ohio 1954
Ricker, W(illiam) E(dwin), Pacific Biological Station, Nanaimo, British Columbia, Canada 1943
Ricks, John T(homas), East Gate Rd., R.D. 3, Huntington, New York 1959
*Riesz, Richard P(arrish), Missionary Orientation Center, Crickettown Rd., Stony Point, New York 1955
Riggs, Carl D(aniel), Dept. of Zoology, University of Oklahoma, Norman, Oklahoma 1943
Riggs, Jennie, 2005 Capers Ave., Nashville 12, Tennessee 1952
Rimsky-Korsakoff, V(ladimir) N(icholas), 220 Middle Rd., Sayville, New York 1951
†Ripley, S(idney) Dillon II, Peabody Museum, New Haven 46, Connecticut 1946

Rising, Gerald R(ichard), Board of Education Offices, 105 Main St., Norwalk, Connecticut 1953
Rising, James D., 4406 Sunrise Dr., Kansas City, Missouri 1956
Ritchie, Robert C., Mansfield Farm, R.R. 2, King, Ontario, Canada 1942
†Robbins, Mrs. Chandler II, Eastern Point, Gloucester, Massachusetts 1958
†Robbins, Chandler S(eymour), Patuxent Wildlife Research Center, Laurel, Maryland 1941
Robbins, Eleanor C(ooley), Patuxent Wildlife Research Center, Laurel, Maryland 1936
Roberts, J(ohn) O(uvry) L(indfield), 62 Inglewood Dr., Toronto 7, Ontario, Canada 1960
Robertson, Mrs. Mary J., R.D. 2, Box 83C, Homestead, Florida 1954
Robins, C(harles) Richard, The Marine Laboratory, University of Miami, Virginia Key, Miami 49, Florida 1949
Robinson, Mrs. James C(arr), R.F.D., Brownsboro, Alabama 1959
Robinson, Peter J., 333 Crossman St., Jamestown, New York 1956
Robinson, Thane S., Dept. of Biology, Western Michigan University, Kalamazoo, Michigan 1952
Rochester, Mrs. R. William, 216 Highland Ave., Hamburg, New York 1961
†Roesler, Mrs. Carol S., June Rd., Cos Cob, Connecticut 1949
Roesler, M. Stuart, June Rd., Cos Cob, Connecticut 1949
†Rogers, Charles H(enry), Princeton Museum of Zoology, Box 704, Princeton, New Jersey 1903
†Rogers, Gerald T., WSS-O-S, Maxwell Air Force Base, Alabama 1956
Rogers, John P., Gaylord Memorial Laboratory, Puxico, Missouri 1956
Rogers, K(ay) T(rowbridge), Dept. of Zoology, University of California, Berkeley 4, California 1952
†Rogers, Mabel T., 436 North Beach St. West, Daytona Beach, Florida 1947
Romaine, Mrs. Lawrence B., Weathercock House, Middleboro, Massachusetts 1958
†Root, Oscar M(itchell), Brooks School, North Andover, Massachusetts 1940
Rorimer, Mrs. J. M., 6910 Point of Rocks Rd., Sarasota, Florida 1938
Rosche, Richard Carl, 48 Dartmouth Ave., Buffalo 15, New York 1953
†Rositzky, Simon, 1605 Ashland Blvd., St. Joseph, Missouri 1953
*Ross, C(harles) Chandler, 710 Wolcott Dr., Philadelphia 18, Pennsylvania 1937
Ross, Hollis T., 29 South 2nd St., Lewisburg, Pennsylvania 1956
†Ross, Mrs. Mary (Reeve) Spear, Route 1, Box 940, Marquette, Michigan 1953
Ross, R(aymond) Dudley, East Tennis Ave., Ambler, Pennsylvania 1959
†Rudd, Clayton G(lass), 315 Medical Arts Bldg., Minneapolis 2, Minnesota 1944
Ruder, Clare Louise, 520 Franklin St., Wausau, Wisconsin 1954
Russell, Stephen M(ims), Dept. of Biology, Louisiana State University, Lake Front, New Orleans 22, Louisiana 1952
Rustad, Orwin A., 1134 East Division St., Faribault, Minnesota 1957
Rutter, Russell James, Box 794, Huntsville, Ontario, Canada 1950
Ryder, Ronald A., College of Forestry, Colorado State University, Fort Collins, Colorado 1952
Ryel, Lawrence A(twell), U.S. 16 W., Box 195, Route 4, Lansing, Michigan 1951

Sabin, Walton B., 652 Kenwood Ave., Slingerlands, New York 1945
Sadler, Doug(las) (Campbell), R.D. 2, Ida, Ontario, Canada 1958
Salman, D(ominic) H(enry), 2765 St. Catherine Rd., Montreal 26, Quebec, Canada 1959
Sanborn, Alvah W., Pleasant Valley Sanctuary, Lenox, Massachusetts 1951
Sands, James L(ester), P.O. Box 1126, Silver City, New Mexico 1959
Sands, Mrs. Ora, 45 Buckingham Ave., Oshawa, Ontario, Canada 1962
Sather, Kenneth L., Round Lake, Minnesota 1959
Satter, John M., 7254 North Tuxedo St., Indianapolis 20, Indiana 1955
Sauer, Gordon C(henoweth), 425 East 63rd St., Kansas City 10, Missouri 1949
Saugstad, N(els) Stanley, Route 4, Minot, North Dakota 1939
Saunders, Aretas A(ndrew), P.O. Box 141, Canaan, Connecticut 1934
Saunders, George B(radford), Box 131, Gainesville, Florida 1926
Saunders, Walter Grier, 21 Andrews Rd., Malvern, Pennsylvania 1962
Sawyer, Dorothy, 419 Euclid Pl., Syracuse 8, New York 1937
Schaefer, Robert J(ames), 93 Dartmouth St., West Newton 65, Massachusetts 1958
Schaffer, Catherine, 1202 West Roscoe, Chicago 13, Illinois 1958
Schaffer, Elizabeth D., 8 Beechdale Rd., Baltimore 10, Maryland 1960

Scheider, Francis G., 6748 2nd St. N.W., Washington 12, D.C. 1960
Schell, Gary D(ean), 631 South Harlan Ave., Evansville 14, Indiana 1961
Schemnitz, Sanford David, School of Forestry, Forestry Bldg., The Pennsylvania State University, University Park, Pennsylvania 1961
Scherer, Lloyd E., Jr., Box 34, Lutsen, Minnesota 1958
Schlonga, A(ndrew) M(atthew), 1904 Main St., Kansas City 8, Missouri 1952
Schmid, John C., 24 Bowman Dr., Greenwich, Connecticut 1958
*Schmid, Mrs. A. W., 1060 Highmont Rd., Pittsburgh, Pennsylvania 1960
Schneider, Evelyn, 2207 Alta Ave., Louisville 5, Kentucky 1935
†Schnitzer, Albert, 155 Wild Hedge Lane, Mountainside, New Jersey 1953
†Schorger, A(rlie) W(illiam), 168 North Prospect Ave., Madison, Wisconsin 1927
Schramm, R. M., 606 San Miguel Ave., Berkeley 7, California 1960
Schreiber, (Edwin) Dan(iel), Jr., Dept. of Biology, Eastern Kentucky State College, Richmond, Kentucky 1961
†Schultz, Albert B(igelow), Jr., Penryn Park, Port Hope, Ontario, Canada 1954
Schüz, Ernst, Staatl. Museum für Naturkunde, (14a) Stuttgart-O, West Germany 1957
Schwartz, Charles Walsh, 131 Forest Hill, Jefferson City, Missouri 1950
†Schwartz, Paul (Alvin), Apartado 1766, Caracas, Venezuela 1952
Schwilling, Marvin D., Box 855, Burwell, Nebraska 1951
Sciple, George W., P.O. Box 279, Savannah Beach, Georgia 1951
Scotland, Minnie B(rink), 42 Continental Ave., Cohoes, New York 1938
*Scott, D. M., Dept. of Zoology, University of Western Ontario, London, Ontario, Canada 1950
*Scott, Frederic R(obert), 115 Kennondale Lane, Richmond 26, Virginia 1947
Scott, Peter, The New Grounds, Slimbridge, Gloucestershire, England 1947
†Scott, Thomas G(eorge), Wildlife Research, Illinois Natural History Survey, Urbana, Illinois 1936
Scott, W(alter) E(dwin), 1721 Hickory Dr., Madison 5, Wisconsin 1938
Seaman, George Albert, P.O. Box 474, Christiansted, St. Croix, Virgin Islands 1950
†Seeber, Edward L(incoln), 493 Norwood Ave., Buffalo 22, New York 1944
Sehl, Robert H., 1062 Welsh Rd., Philadelphia 15, Pennsylvania 1962
Seibert, Henri C., Ohio University, Athens, Ohio 1941
Seibert, Robert F(rederick), 17 Canoe Brook Rd., Short Hills, New Jersey 1954
Serbousek, Lillian, 1226 Second St., S.W., Cedar Rapids, Iowa 1935
Shaftesbury, Archie D., Dept. of Biology, Lenoir Rhyne College, Hickory, North Carolina 1930
Shannon, Mrs. Francis P., 3021 Eagle Pass, Louisville 17, Kentucky 1949
Sharp, Ward M., 206 Forestry Bldg., The Pennsylvania State University, University Park, Pennsylvania 1936
Shaub, Benjamin Martin, 159 Elm St., Northampton, Massachusetts 1948
Shaughnessy, Winslow M(orse), Pennsylvania State Museum, Harrisburg, Pennsylvania 1957
Shaver, Jesse M(ilton), 1706 Linden Ave., Nashville 12, Tennessee 1922
Shaw, Marilyn Leah, German House, Oberlin, Ohio 1961
Sheffield, O(ren) C(onway), 817 West Houston, Tyler, Texas 1954
†Sheffler, W(illiam) J(ames), 4731 Angeles Vista Blvd., Los Angeles 43, California 1954
Shellenberger, Emmett L(ee), Akron Museum of Natural History, 500 Edgewood Ave., Akron 7, Ohio 1954
Sheppard, Jay M., 51 Sherry Rd., Cincinnati 15, Ohio 1961
Shetler, Stanwyn G(erald), Dept. of Botany, University of Michigan, Ann Arbor, Michigan 1949
Shimanski, Walter, 115 Grove Ave., Woodbridge, New Jersey 1960
†Shires, James E., 544th Recon. Tech. Sq., Box 168, Offutt AFB, Nebraska 1951
Short, Lester L(eRoy), Jr., Dept. of Biology, Adelphi College, Garden City, New York 1953
Short, Wayne, 3034 Orange St., Miami 33, Florida 1941
Shuler, James B(ernard), Jr., 43 Kirkwood Lane, Greenville, South Carolina 1954
Sibley, Charles G(ald), Fernow Hall, Cornell University, Ithaca, New York 1942
Sibley, Fred C(harles), Miner Institute, Chazy, New York 1953
Sick, Helmut M., Museu Nacional, Quinta de Boa Vista, Rio de Janeiro, G.B., Brasil 1951
Sieh, James G(erald), Biology Station, Spirit Lake, Iowa 1948
*Simmons, Mrs. Amelia C., 2676 North Kale Dr., Milwaukee 11, Wisconsin 1943

†Simmons, Edward McIlhenny, Avery Island, Louisiana 1942
†Simmons, Grant Gilbert, Jr., Lake Ave., Greenwich, Connecticut 1949
Simmons, K(enneth) E(dwin) L(aurence), c/o C. & W. Ltd., Ascension A.A.F.B., P.A.A., P.O. Box 4187, Patrick A.F.B., Florida 1962
Simon, Stephen Wistar, Dept. of Biology, Ashland College, Ashland, Ohio 1947
Skutch, Alexander F(rank), San Isidro del General, Costa Rica 1944
Slack, Mabel, 1004 Everett Ave., Louisville 4, Kentucky 1934
Slavik, David J., 3426 Texas Dr., Dallas 11, Texas 1962
Sloan, Norman F(rederick), 17 North Butler, Madison 3, Wisconsin 1959
Slocum, Mrs. J. Fred, 29 Park St., Buffalo 1, New York 1959
Smart, Robert W(illiam), New Hampton School, New Hampton, New Hampshire 1957
Smith, Earl R(oy), Box 5271, New Orleans, Louisiana 1957
*Smith, Emily D., 19651 Glen Una Dr., Saratoga, California 1948
†Smith, Harry M(adison), 215 South White St., Macomb, Illinois 1936
Smith, Herman D., Box 123, Danforth, Illinois 1961
Smith, H(erman) Granville, 3920 Martindale Blvd., Columbus 14, Ohio 1960
Smith, Marion L(ucille), 429 South Willard St., Burlington, Vermont 1949
Smith, Neal Griffith, Fernow Hall, Cornell University, Ithaca, New York 1958
Smith, Robert L(eo), Division of Forestry, West Virginia University, Morgantown, West Virginia 1945
Smith, Wendell Phillips, 911 E Street, North Wilkesboro, North Carolina 1921
*Smithe, Frank B., F. L. Smithe Machine Co., Inc., 44th St. & 12th Ave., New York 36, New York 1960
Snapp, Mrs. R. R., 310 West Michigan, Urbana, Illinois 1940
Snow, Mrs. C. S., 2211 Chester Blvd., Richmond, Indiana 1950
Snow, Isabel W(heeler), 340 19th St., Brooklyn 26, New York 1961
Snyder, Dana Paul, Dept. of Zoology, University of Massachusetts, Amherst, Massachusetts 1949
*Snyder, Dorothy E(astman), 12 South St., Marblehead, Massachusetts 1951
Snyder, L(ester) L(ynne), Royal Ontario Museum of Zoology, Queen's Park at Bloor, Toronto 5, Ontario, Canada 1929
Sooter, Clarence Andrew, U.S. Public Health Service, N.I.H., D.R.G., R.F.R.D., Bethesda 14, Maryland 1940
†Sorrill, Mrs. Anna Marie, 2425 Third Pl., Yuma, Arizona 1950
Southern, William E., Dept. of Biological Sciences, Northern Illinois University, Dekalb, Illinois 1954
Spangler, Iva M., 128 East Foster Parkway, Fort Wayne, Indiana 1939
†Speirs, Mrs. Doris Huestis, "Cobble Hill," R.R. 2, Pickering, Ontario, Canada 1936
†Speirs, J(ohn) Murray, "Cobble Hill," R.R. 2, Pickering, Ontario, Canada 1931
†Spencer, Haven Hadley, 2645 Bedford Rd., Ann Arbor, Michigan 1946
Spencer, Michael, 33 Finchley Rd., Hampstead, Montreal 29, Quebec, Canada 1961
†Spencer, O(live) Ruth, 1030 25th Avenue Court, Moline, Illinois 1938
Sperry, Charles Carlisle, 1455 South Franklin St., Denver 10, Colorado 1931
Sperry, John A., Jr., 308 N.E. First St., Apt. 7, Gainesville, Florida 1957
†Spofford, Walter R(ichardson) II, Dept. of Anatomy, Medical College, State University of New York, Syracuse 10, New York 1942
Springer, Heinrich K., 18th Engineer Co., APO 731, Seattle, Washington 1962
Sprinkle, Mrs. Dorothy Scott, 1 Circle Dr., Momence, Illinois 1962
Squire, Paula D(iane), 2635 Hillgass #3, Berkeley 4, California 1957
Stabler, Robert M(iller), Colorado College, Colorado Springs, Colorado 1939
Staebler, Arthur E(ugene), Dept. of Biology, Fresno State College, Fresno, California 1937
Stamm, D(onald) D(aniel), U.S. Public Health Service, C. Dc., Atlanta 22, Georgia 1958
Stamm, Mrs. Frederick W., 9101 Spokane Way, Louisville 7, Kentucky 1947
Stanford, Jack A., 124 Boonville Rd., Jefferson City, Missouri 1962
Stark, Wilma R(uth), 1915 Kalorama Rd. N.W., Apt. 509, Washington 9, D.C. 1939
Starr, Robert R., 700 Leslie Ave., Glasgow, Kentucky 1956
Stasz, C(larence) E(mil), 179 Edgewood Ave., Audubon 6, New Jersey 1953
Stauffer, Ralph Stanley, 208 West Irwin Ave., Hagerstown, Maryland 1949
Stearns, Edwin I(ra), 206 Lynn Lane, Westfield, New Jersey 1945
Stein, Robert C., Laboratory of Ornithology, Cornell University, Ithaca, New York 1951

†Stettenheim, Peter, U.S.D.A. Poultry Research Laboratory, 3606 East Mt. Hope Rd., East Lansing, Michigan 1951
Stevens, Charles E(lmo), 615 Preston Pl., Charlottesville, Virginia 1947
Stevens, O. A., State University Station, Fargo, North Dakota 1926
Stevenson, Henry M(iller), Dept. of Biological Sciences, Florida State University, Tallahassee, Florida 1943
Stevenson, James O., Fish & Wildlife Service, Dept. of the Interior, Washington 25, D.C. 1933
Stewart, James R(ush), Jr., 2225 Meriwether Rd., Shreveport, Louisiana 1954
†Stewart, Mildred, 2579 Queenston Rd., Cleveland 18, Ohio 1949
Stewart, Paul A., Patuxent Wildlife Research Center, Laurel, Maryland 1925
Stewart, Robert Earl, 810 17th St. S.E., P.O. Box 1013, Jamestown, North Dakota 1939
Stickley, Allen R., Jr., 803 Elkton Rd., Newark, Delaware 1961
*Stine, Perna M., 1314 12th St., Zephyrhills, Florida 1931
†Stoddard, Herbert Lee, Sherwood Plantation, Route 3, Box 139, Thomasville, Georgia 1916
†Stokes, Allen W., Dept. of Wildlife Management, Utah State Agricultural College, Logan, Utah 1950
†Stoner, Mrs. Dayton, 399 State St., Albany 10, New York 1945
Stoner, Emerson A(ustin), 285 East L St., Benicia, California 1947
Stophlet, John J(ermain), 2612 Maplewood Ave., Toledo 10, Ohio 1934
Storer, Robert Winthrop, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1938
†Storer, Tracy I(rwin), Division of Zoology, University of California, Davis, California 1928
†Street, Phillips B(orden), Route 1, Chester Springs, Pennsylvania 1946
†Strehlow, Elmer William, Box 1443, Milwaukee 1, Wisconsin 1941
Strosnider, Ruth C., 4115 Wisconsin Ave. N.W., Washington 16, D.C. 1959
Stull, W(illiam) D(eMott), 5 Mason Ct., Delaware, Ohio 1952
Stupka, Arthur, Route 1, Gatlinburg, Tennessee 1935
†Sturgeon, Myron T., Dept. of Geography & Geology, Ohio University, Athens, Ohio 1934
Sturges, Franklin W., Southern Oregon College, Ashland, Oregon 1955
Stutesman, Philip, 1517 Pontiac St., Ann Arbor, Michigan 1962
Summers, Lawrence, Dept. of Chemistry, University of North Dakota, Grand Forks, North Dakota 1956
†Sundell, Robert A(rnold), 970 First Ave., Salt Lake City, Utah 1951
Suthard, James (Gregory), 1881 Raymond Ave., Long Beach 6, California 1936
Suthers, Roderick A(tkins), The Biological Laboratories, Harvard University, Cambridge 38, Massachusetts 1954
†Sutton, George Miksch, Dept. of Zoology, University of Oklahoma, Norman, Oklahoma 1920
Swedenborg, Ernie D(avid), 4905 Vincent Ave. S., Minneapolis 10, Minnesota 1929
†Swetland, David W., Daisy Hill, Chagrin Falls, Ohio 1953
Swinebroad, Jeff, Dept. of Botany & Zoology, Douglas College, Rutgers University, New Brunswick, New Jersey 1953
Swisher, John F., Jr., 117 North 10th East, Brigham City, Utah 1957
Sywalski, Robert J., 562 East Ave., Brockport, New York 1956

Tabor, Ava Rogers, 305 Canal Blvd., Thibodaux, Louisiana 1940
Tallman, William S(weet), Jr., 4 Linden Pl., Sewickley, Pennsylvania 1940
Talvila, Elmer, 1 Faukland Rd., Scarborough, Ontario, Canada 1954
Tanner, James Taylor, Dept. of Zoology, University of Tennessee, Knoxville 16, Tennessee 1937
Tate, James (Lery), Jr., 430 Best Ave., Dekalb, Illinois 1961
†Taylor, Arthur Chandler, 309 North Drew St., Appleton, Wisconsin 1929
Taylor, G(eorge) Thomas, Dept. of Zoology, University of North Carolina, Chapel Hill, North Carolina 1961
Taylor, J(ohn) Kenneth, 128 Charles St., New York 14, New York 1959
Taylor, Joseph William, 590 Allen's Creek Rd., Rochester 18, New York 1946
Taylor, R(obert) L(incoln), Inverness Dr., Flintridge, Pasadena 3, California 1947
Teale, Edwin Way, R.D. 2, Hampton, Connecticut 1948
Terres, John K(enneth), P.O. Box 571, Chapel Hill, North Carolina 1955
Terrill, Lewis McIver, Ulverton, R.D. 1, Melbourne, Quebec, Canada 1948

Thomas, Edward S(inclair), 319 Acton Rd., Columbus 14, Ohio	1921
Thomas, Jack Ward, Box 491, Llano, Texas	1957
Thomas, Landon B(aillie), 1006 Blaine St., Edgerton, Wisconsin	1947
Thomas, Mrs. Rowland, 410 East Green St., Morrillton, Arkansas	1937
Thompson, Daniel Q., Fernow Hall, Cornell University, Ithaca, New York	1945
Thompson, E. G., 586 Gulf Bldg. Extension, Houston 2, Texas	1957
Thompson, Katrina, 2039 Milford, Houston 6, Texas	1957
*Thompson, Marie E(vadne), 2717 Parkview Ave., Kalamazoo, Michigan	1953
Thompson, Max C., Box 385, Udall, Kansas	1956
Thompson, Milton D(ouhan), 26 Lambert Lane, Springfield, Illinois	1959
Thompson, Reynolds W(ardell), 1373 Redding Rd., Fairfield, Connecticut	1959
Thompson, William Lay, Dept. of Biology, Wayne State University, Detroit 2, Michigan	1952
Thoresen, Mrs. Frances, 720 Wagner Rd., Glenview, Illinois	1961
Thorne, Alvin L., University of Wisconsin, Milwaukee 11, Wisconsin	1949
Thorne, Mabel E., 4431 Wilmette Dr., Fort Wayne 5, Indiana	1962
†Thorne, Oakleigh II, Thorne Ecological Research Station, 1229 University Ave., Boulder, Colorado	1947
Thorpe, Heather G., 3435 Edgewood, Ann Arbor, Michigan	1959
Tillman, Clifford, 492 Park Pl., Natchez, Mississippi	1959
Tipton, Samuel R., Dept. of Zoology & Entomology, University of Tennessee, Knoxville, Tennessee	1959
†Todd, Mrs. Elizabeth D., Box 591, Kalamazoo, Michigan	1939
Todd, W(alter) E(dmond) Clyde, Carnegie Museum, Pittsburgh 13, Pennsylvania	1911
Tomer, John S(haffer), 4045 East 27th St., Tulsa, Oklahoma	1954
Tompkins, Ivan Rexford, 1231 East 50th St., Savannah, Georgia	1931
Tomlinson, Roy E(ugene), 3803 Headingly N.E., Albuquerque, New Mexico	1958
Tordoff, Harrison B(ruce), Museum of Zoology, University of Michigan, Ann Arbor, Michigan	1947
Tout Bird Club, Care of Mrs. Glenn Viehmeyer, Route 4, North Platte, Nebraska	1961
Townes, George F(ranklin), Masonic Temple, Greenville, South Carolina	1953
*Townsend, Elsie White, Dept. of Biology, Wayne State University, 4841 Cass Ave., Detroit 1, Michigan	1938
*Townsend, Mrs. Frank, 333 Sunset Rd., Pompton Plains, New Jersey	1958
Trainer, John E(zra), Dept. of Biology, Muhlenberg College, Allentown, Pennsylvania	1952
Transue, Barrett D(ecker), R.D., Mt. Bethel, Pennsylvania	1959
†Trautman, Milton B(ernard), Ohio State Museum, Columbus, Ohio	1932
Travis, Vaud A(neil), Jr., 531 North 13th St., Muskogee, Oklahoma	1955
*Traylor, Melvin Alvah, Jr., 759 Burr Ave., Winnetka, Illinois	1947
Trost, Charles H., Box 181, Flint Hall, University of Florida, Gainesville, Florida	1959
†Tucker, Mrs. Carll, Penwood, Mount Kisco, New York	1928
Turner, Mrs. M(ary) E(llis), Bryn Ayron, Ebensburg, Pennsylvania	1961
Turner, Robert H(arold), 27002 Lime City Rd., Perrysville, Ohio	1953
Twiest, Gilbert, 1401 A Spartan Village, East Lansing, Michigan	1962
Twomey, Arthur C(ornelius), Carnegie Museum, Pittsburgh 13, Pennsylvania	1936

Uhler, Francis Morey, Patuxent Wildlife Research Center, Laurel, Maryland	1931
Uhlig, Hans, P.O. Box 358, Fergus Falls, Minnesota	1961
Ulrich, Edward C., 193 LaSalle Ave., Buffalo 14, New York	1952
Ulrich, Mrs. Edward C., 193 LaSalle Ave., Buffalo 14, New York	1952
Underdown, Henry T., 8216 Manor Rd., Elkins Park, Philadelphia 17, Pennsylvania	1952
Urban, Emil K., Dept. of Zoology, University of Wisconsin, Madison 6, Wisconsin	1956
Ussher, Richard Davy, R.R. 1, Morpeth, Ontario, Canada	1947

Vaden, Virginia (Mozelle), 4325 Bowser Ave., Dallas 19, Texas	1959
Vaiden, M(eredith) G(ordon), Rosedale, Mississippi	1937
Valentine, Allen E., 32948 Slocum Dr., Farmington, Michigan	1957
*Van Blaricon, Robert P., 527 Lodge Lane, Route 1, Kalamazoo, Michigan	1958
*Van Cleve, G(eorge) Bernard, 323 South Fairmount St., Pittsburgh 32, Pennsylvania	1954
Van Coevering, Jack, 6150 Commerce Rd., R.F.D. 1, Orchard Lake, Michigan	1939

*Vanderbilt, Robert, Att. Miss Schreiber, 230 Park Ave., New York 17, New York 1961
Van Deusen, Hobart M(erritt), 13 Stonewood Parkway, Montclair, New Jersey 1941
Vane, Robert F(rank), 600 Dows Bldg., Cedar Rapids, Iowa 1946
Van Oosten, Jan Roger, 801 North Uakima, Tacoma, Washington 1961
van Tets, G(errard) F(rederick), Dept. of Zoology, University of British Columbia, Vancouver 8, British Columbia, Canada 1955
†Van Velzen, Willet T(heodore), Dept. of Zoology, University of Oklahoma, Norman, Oklahoma 1959
Van Winkle, William Mitchell, Jr., 31 Centre St., Rye, New York 1962
†Vaughan, William C(oleman), Locust Grove Farm, River Rd., Youngstown, New York 1941
Vaurie, Charles, c/o American Museum of Natural History, Central Park West at 79th St., New York 24, New York 1946
Vesey, Mrs. George W., 1654 Greenwood Dr., South Bend 14, Indiana 1962
Vincent, Alvin, National Life & Accident Insurance Co., National Bldg., Nashville 3, Tennessee 1961
von der Heydt, James A(rnold), P.O. Box 722, Juneau, Alaska 1947
Von Haartman, Baron Lars, Zoological Institute, University of Helsinki, Finland 1959
Vore, Marvin E(lmer), 1128 North 8th Ave., West Bend, Wisconsin 1947

Wachenfeld, Mrs. William A., 787 East Clarke Pl., Orange, New Jersey 1954
*Wade, Mrs. Emily V(anderbilt), 251 Old Billerica Rd., Bedford, Massachusetts 1959
Wagner, Mrs. C(ary) R., South Lane Farm, Utica, Ohio 1947
Wagner, Helmuth O., Ubersee Museum, Bremen, Germany 1945
Walding, Howard P(ayne), 606 East Main St., Madison, Ohio 1960
Walker, Charles F(rederic), Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1939
†Walker, Jayson A(lison), 89 Church St., Waterloo, New York 1949
†Walkinshaw, Lawrence Harvey, Wolverine-Federal Tower, Battle Creek, Michigan 1928
Wallace, George J(ohn), Dept. of Zoology, Michigan State University, East Lansing, Michigan 1937
Wallace, Roy, 63 DuPont St., Toronto 5, Ontario, Canada 1952
Walters, Cliff, Dutch Mountain Nursery, Route 1, Augusta, Michigan 1958
Walty, John B., 227 Wilfred Ave., Willowdale, Ontario, Canada 1961
*Wangensteen, Mrs. Owen H., 2832 River Rd. West, Minneapolis 6, Minnesota 1949
Ward, Gertrude L(uckhardt), Earlham College, Richmond, Indiana 1953
Warren, James R., 1471 Crestview Ave., Tallahassee, Florida 1959
Warter, Stuart L., Museum of Zoology, Louisiana State University, Baton Rouge 3, Louisiana 1956
*Washington, Mrs. Dorothy W., North Edgecomb, Maine 1959
Wasserfall, William, 22 Roycrest Ave., Willowdale, Ontario, Canada 1956
Watson, Frank Grahm, Old Hyde Rd., Weston, Connecticut 1937
Watson, George E. III, Peabody Museum, New Haven, Connecticut 1957
Watson, Robert J(ames), 1507 North Hancock St., Arlington 1, Virginia 1943
Weber, Louis M(arkus), 340 Crest Dr., Sherman, Missouri 1941
Webster, Clark G(ibbons), 160 Azalea Ave., Garden City, Georgia 1948
Webster, Conley, 347 Oldham Ave., Lexington, Kentucky 1961
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on 2–5 May

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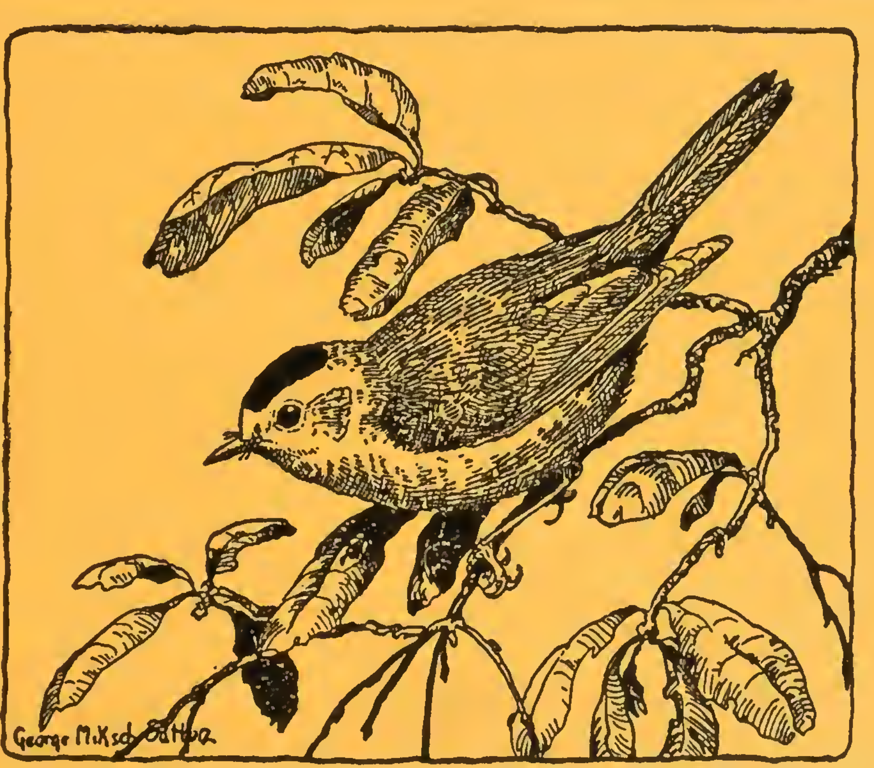

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CONTENTS

SPOTTED RAIL (*Pardirallus maculatus*)
From a tempera painting by Robert Verity Clem.

NOTES ON THE SPOTTED RAIL IN CUBA

George E. Watson

The Spotted Rail (*Pardirallus maculatus*) is exceedingly rare in Cuba outside the Zapata Swamp, and was thought to be limited to the three central provinces of the island (Bangs, 1913; Barbour, 1923; Bond, 1956; Greenway, 1958). It is therefore worth recording its presence and abundance in the westernmost province, Pinar del Rio. In addition, a few notes are included on molt, breeding season, available specimens, and habits of the population and taxonomy of the species.

The trip during which the specimens mentioned here were collected was partially supported by the Peabody Museum of Yale University. Notes on the collection made between August and December 1955 were published by Ripley and Watson (1956). I am grateful to Mr. and Mrs. W. W. Caswell, Jr., and to the late Mr. Dayton W. Hedges for hospitality during my stay in Cuba and to Srs. Jack Boyle, Gaston S. Villalba, and Jesus Carrillo for facilitating my travel and collecting. Without the services of these persons I would probably never have seen any Spotted Rails. For the loan of specimens I am indebted to R. A. Paynter, Jr., C. H. Blake, C. O'Brien, J. Bond, H. G. Deignan, and D. W. Warner and I also thank E. Stresemann, G. Mauersberger, and D. Goodwin for reporting on the Berlin and British Museum collections. J. Bond and P. S. Humphrey have given helpful criticism on the manuscript.

OCCURRENCE

I collected two female Spotted Rails, one laying, in wet rice fields at Finca Dayaniguas, south of Paso Real de San Diego, on 16 September 1955. The rice plantation lies in the flat natural savannah between the Los Palacios and San Diego rivers where cultivated and fallow irrigated fields, criss-crossed with shallow ditches, provide an extensive wet habitat of high grasses. Several other Spotted Rails flushed or called in this area so that I hardly regard the species as either a chance find or rare in Pinar del Rio. As Bond (1956) found in 1935, the species was also locally common around Santo Thomás (=Las Mercedes) in the Zapata Swamp during 1955 and I was able to collect three specimens there. The saw grass, rush, and *Myrica* bush habitat is probably ecologically very similar to the rice fields and wet savannahs in southern Pinar del Rio. The grunting and clucking voice of the Spotted Rail is distinctively different from the voices of other rails and gallinules one might find in similar habitat (*Rallus elegans ramsdeni, Porzana flaviventer gossi, P. carolina, Gallinula chloropus cerceris,* and *Porphyrula martinica*). I feel reasonably confident that I heard the species in the Lanier Swamp on the Isle of Pines, where the habitat. although less extensive, is much the same as in the Zapata Swamp. Schwartz (pers. comm.) saw what he has tentatively identified as a Spotted Rail west of Nueva Gerona in August 1958. The species has never been collected on the Isle of Pines.

MOLT

All five 1955 specimens of the Spotted Rail were in molt. Little has been published on rail molts and this small series contributes data on the sequence and timing of molt in the Cuban population of this species. A nonlaying hen from Pinar del Rio had enlarged gonads but no brood patch in mid-September. Numerous pinfeathers were present on all parts of the body and only the outer pair of rectrices had not been shed. I secured the bird alive and when it flapped its wings in an attempt to escape, several of the worn outer primaries dropped from each wing. Wing molt was probably just beginning. The other hen, which was laying, was in the process of renewing its alula quills, all of its remiges, greater wing coverts, and rectrices at once and graphically illustrates simultaneous molt of the main flight feathers which is a common occurrence in rails (Witherby et al., 1952). Much of the body plumage is fresh but some of the crown and rump feathers and smaller upper tail coverts are still in growth; the undertail coverts have all been dropped. This specimen was therefore about to complete a molt, probably prebasic, while laying. A male with enlarged gonads, which I collected in the Zapata Swamp on 17 October, has worn remiges and coverts but much of the body shows incoming feathers. Two other specimens from the Swamp also had enlarged gonads. A male collected on 23 October had newly replaced wing and tail feathers but was still molting on the crown, mantle, breast, sides, and flanks. A female was only replacing its upper tail coverts on 17 October; the rest of its plumage seems to be fresh.

Although the evidence is meager, the general sequence of prebasic molt in the Cuban Spotted Rail appears to be as follows: feather replacement begins on the body in several areas (nape, upper back, upper sides, flanks, breast, and throat). The crown starts to molt as the remiges, wing coverts, alula quills, and rectrices begin regrowth after having been shed simultaneously. The wings and tail complete growth quickly but a few areas of the body and head continue to show some feather renewal. The molt is complete when the upper tail coverts are fully regrown.

These five specimens also permit speculation on the timing and duration of the prebasic molt in the Cuban population. The two mid-September birds are about half-way through the molt; a mid-October bird has nearly completed molting, the other two October birds are less advanced. Molting, therefore, probably lasts from August into December in the population.

BREEDING SEASON

No young of this species were found either in Pinar del Rio or in the Zapata Swamp during September and October. The laying hen collected in September and the fact that all the other specimens had enlarged gonads indicate that the breeding season persisted into the early fall during 1955, when molt had already begun. Evidence from other rails collected in Cuba in the same year suggests that most species were nesting in the late summer and early fall (Ripley and Watson, 1956).

Soft part colors were recorded in the field: iris, reddish brown; bill, bright yellowish green with an orange red spot at the base of the lower mandible; and legs and feet, pinkish red. These colors, which were recorded while at least one specimen was breeding, are essentially the same as those noted on the labels of nonbreeding specimens from the island Trinidad and those recorded by Friedmann (1949) and Dickerman and Warner (1961) for Mexican specimens.

SPECIMENS

In an attempt to learn more about the Cuban Spotted Rail, I borrowed whatever Cuban material was available in the United States and made inquiries in an attempt to locate specimens in Europe. These and other known examples are listed in Table 1, which probably records most of the extant specimens of this population. The only specimens I was able to locate outside of the U.S. are in Cuba. Some are not sexed; none are accompanied by breeding data; all are in relatively fresh plumage; one may be molting. Males sexed at skinning average larger in all measurements. On this basis, unsexed specimens have been provisionally identified in Table 1.

The type, collected in February, shows one upper breast and one mantle feather in growth. Scattered molting feathers, however, are difficult to locate on dried skins. Evidence for a prealternate body molt in the Cuban population is thus doubtful. A series of eight skins of Spotted Rail from Trinidad, however, contains molting specimens from August, September, October, February, and May. One August specimen is apparently just completing regrowth of its primaries, September and October birds have fresh remiges but are renewing upper tail coverts and some body feathers. All these birds seem to be in prebasic molt. The February and May specimens are in body molt only but the remiges are somewhat worn. They are probably undergoing a partial prealternate body molt which Witherby et al. (1952) and Bent (1926) found in all British and United States rail species studied.

ECOLOGY AND HABITS

According to Gundlach (1875) the species was common in wet grassy ditches of Havana Province in his time and frequently appeared on sale in the Havana market. The striking dearth of material in museums and the difficulty Barbour (1923) had in locating living birds or specimens, led, however, to the subsequent opinion that this was a rare species in Cuba.

TABLE 1

KNOWN SPECIMENS OF CUBAN SPOTTED RAILS PRESERVED IN MUSEUM COLLECTIONS

Museum No.	Locality	Date	Sex	Wing (mm)	Tail (mm)	Tarsus (mm)	Culmen (mm)	Wt. (g)
MCZ* 61101 (type)	Jaruco, Havana	14 Feb. 1913	o = ♂	125	48	39	50.5	—
MCZ 61117	Havana Province	ca. 1870	o = ♀	105 worn	—	—	43	—
MCZ 158959	Santo Tomás Zapata Swamp	20 April 1935	♀	117	49.5	34	44	—
CNHM* 36598	Cuba	March 1892	o = ♂	121	47	37.2	47.5	—
CNHM 36599	Cuba	March 1892	o = ♂	122.5	54	38	50	—
AMNH* 45671	Cuba	——	o = ♂	120	52.5	37	49	—
USNM* 453185	Havana	Winter 1917	o = ♂	124	49.5	39	—	—
ANSP* 111893	Santo Tomás Zapata Swamp	4 Jan. 1931	♀	119	51	35.5	46	—
YPM* 33333	Las Mercedes Zapata Swamp	17 Oct. 1955	♀	116	48	36	46	153
YPM 33334	Finca Dayaniguas Pinar del Rio	16 Sept. 1955	♀	—	—	36.5	47	167
YPM 33335	Finca Dayaniguas Pinar del Rio	16 Sept. 1955	♀	—	—	37.5	48.5	190 laying
YPM 33336	Las Mercedes Zapata Swamp	23 Oct. 1955	♂	129	54	39	50	193
YPM 33337	Las Mercedes Zapata Swamp	17 Oct. 1955	♂	125.5	50	37.5	—	195
Gundlach Collection Havana, Cuba		No data available, seen in 1955						
Ramsden Collection Guantanamo, Cuba	Havana	No data available, not seen; mentioned by Barbour (1923).						

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* Museum of Comparative Zoology, Cambridge, Mass.; Chicago Natural History Museum, Chicago, Illinois; American Museum of Natural History, New York, N.Y.; United States National Museum, Washington, D.C.; Academy of Natural Sciences, Philadelphia, Penn.; Yale Peabody Museum, New Haven, Conn.

Mongoose (*Herpestes auropunctatus*) predation, which Bangs (1913) suggested would bring about extinction of the Spotted Rail, is probably insignificant at present in the wetlands of the southern swamps, but may have radically reduced the population in the drained agricultural lands near

Havana. Allen (1911) recounts some of the destruction to native wildlife by the mongoose in the West Indies and specifically mentions its great abundance near Havana. Simultaneous molt of most of the flight feathers must render the Spotted Rail extremely vulnerable to ground predation in drier areas, such as Havana Province, in which the mongoose and domestic cat are plentiful. In Jamaica, the first of the Greater Antilles to experience mongoose introduction, the Spotted Rail population disappeared before a single specimen was collected (Bond, 1956). In the heavy marshes of southern Cuba, fluctuating water levels and perhaps avian, reptilian, and piscine predation may limit Spotted Rail populations, but no natural mammalian predators live in the swamps and wet savannahs.

Little is known of the habits of this retiring species in Cuba, even in the Zapata Swamp where it has been observed most frequently. A nest has never been found in Cuba, although Gundlach (1875) mentions, without giving dates, two eggs taken from dead birds.

Friedmann (1949) records observations on a captive example in Mexico which suggest that this rail frequently climbs in vegetation using its wings for balance, but descends by flying. I found the Spotted Rail loath to fly in Cuba although one flushed just ahead of a moving rice combine. Most of my other observations have been of individuals skulking in heavy grasses or dashing from the cover of one bush to another in low open places. Only one other time did one flush when I cornered it in a low bush. Dickerman and Warner (1961) report flushing several birds but with difficulty. I was able to attract Spotted Rails by imitating their accelerating clucking and occasionally I was answered, but never did a bird leave its cover in response to my calling. I was told that one of the local Cuban names, "Gallinuela Escribano," refers to the dangling legs "writing" on the water surface in flight. The other local name I heard was "Gallinuela Color-Guineo" calling attention to the rail's similarity in plumage pattern to the introduced Guinea Fowl (*Numida meleagris*).

RANGE AND TAXONOMY

In addition to its occurrence in Cuba and formerly in Jamaica, the species ranges over Middle and eastern South America from Veracruz, Mexico, to northern Argentina. Few series of specimens have been collected from any one locality and only the nominate race is recognized for all South America and Central America north to Costa Rica (specimen in the British Museum identified by D. Goodwin). The apparent rarity of the species over all its range is probably best explained by its inaccessible habitat, wary habits, and its reluctance to flush.

Pardirallus maculatus inoptatus, of Cuba, was described from two specimens which were apparently compared with a single South American specimen and with the then unique type of *P. m. insolitus* (Bangs and Peck) from British Honduras. Bangs (1913) separated the Cuban specimens from South American *maculatus* on the basis of reduced spotting and consequent darker appearance, lack of white spotting on the rump, and black tips on the white under tail coverts; and from *insolitus* on the basis of its pure white throat and lighter brown upper parts. Using these characters I am unable to separate the thirteen available Cuban specimens from South American birds either individually or in series. I compared the Cuban series with eight Yale Peabody Museum specimens from the Caroni Swamp in Trinidad and twelve South American specimens from Venezuela south to Argentina in the American Museum of Natural History. The range of variation in size, color (even allowing for seasonal wear and foxing), amount of spotting, and relative width of black and white bars is the same in Cuban and Trinidad series. The Cuban birds do not appear darker and less spotted; in some Cuban specimens the spotting is reduced; in most, however, it is pronounced. Birds with the greatest amount of white on the nape also have the white markings on the innermost secondaries, their coverts, and the scapulars elongated into marginal streaking. Seven Cuban specimens have larger white spots on the rump than any of the birds from Trinidad, three of which almost lack rump spotting. The under tail coverts are faintly tipped with black in most specimens of both series, but in a few they are pure white. Some Cuban individuals are markedly white on the throat, others are flecked with grey, especially in worn plumage. In fact, all the characters mentioned in the description are highly variable in the Cuban population and vary to the same extent in the South American series. In short, *P. m. inoptatus* does not stand up as a valid subspecies on the basis of comparisons of series of specimens.

Dr. Warner has kindly sent me the three Veracruz specimens, collected by Dickerman, for comparison with the recently collected Cuban material and with the Trinidad and other South American birds. The main characters requiring comparison were the brown margination of the back feathers and wing coverts and the intensity of the dorsal spotting since all the other characters such as dark or light color of the underparts and the throat have proved to be individually variable in the species (Friedmann, 1949; Dickerman and Warner, 1961). The recently collected Mexican specimens are in fresh or slightly worn alternate (?) plumage but the brown feather margins are less pronounced and extend less far onto the mantle than in most of the Cuban and Trinidad specimens so that the total appearance of the birds is darker and much less brown. One of the Veracruz examples, however, is almost identical with a Cuban specimen in this regard. The shade of brown in each of the four Mexican specimens may be matched in a Cuban and a

Trinidad specimen, but is slightly darker than in the majority. During previous comparisons of specimens with the type of *insolitus* (which is worn) and with old Cuban specimens (the three in the MCZ), no allowance has apparently been made for foxing due to the difference in ages or wear of the material. Old and worn Cuban specimens, for instance, are lighter than freshly collected newly molted ones. The Mexican specimens are separable from South American ones, however, on the basis of dorsal spotting. The size of the individual white spots is less in the type of *insolitus,* in the two darker specimens from Veracruz, and in Friedmann's (1949) Chiapas bird (examined), so that the spotting in all four shows less tendency toward elongation and streaking than in the South American specimens. This is most marked on the inner secondaries, secondary coverts, and scapulars which are distinctly streaked in all South American specimens and either spotted or unmarked in Central American ones. Cuban specimens are variable in this character, three of the 11 tending toward spotting but the majority being streaked like South American birds. On the basis of the few available specimens, it seems that nigrescent individuals with reduced spotting and narrower brown feather margins are found in Central America from British Honduras north. Consequently, two populations may be recognized on the basis of quantitative characters in this highly variable species, nominate *maculatus* from South America north to Costa Rica and Cuba, and *insolitus* from northern Central America to Veracruz.

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PEABODY MUSEUM AND DEPARTMENT OF ZOOLOGY, YALE UNIVERSITY, NEW HAVEN, CONNECTICUT (PRESENT ADDRESS: U.S. NATIONAL MUSEUM, SMITHSONIAN INSTITUTION, WASHINGTON 25, D.C.), 19 APRIL 1962

NEW LIFE MEMBER

Mrs. Frederick C. Lyman, of Wayzata, Minnesota, is a new Life Member of the Wilson Ornithological Society. As an amateur in ornithology she is particularly interested in the history of the study of birds in the United States. In addition, she has spent a considerable amount of time observing present-day bird life from the decks of the "Tern," the Lymans' 39-foot yawl, while sailing along the Atlantic coast from the Bahamas to Maine and New Brunswick, and while sailing in European waters from Holland to Norway and Sweden. Mrs. Lyman, a graduate of the University of Minnesota, is a member also of the Minnesota Ornithologists' Union, National Audubon Society, Nature Conservancy, and Garden Clubs of America.

DOES THE BOBOLINK NAVIGATE?

WILLIAM J. HAMILTON III

RECENT discussions of celestial cues used by birds to tell direction have centered on the problem of whether these cues provide sufficient information for navigation (Sauer, 1957, 1961; Sauer and Sauer, 1960; Wallraff, 1960*a*, 1960*b*). Matthews demonstrated the navigational abilities of the pigeon (1953*a*) and the Manx Shearwater (Matthews, 1953*b*), and it has been shown that the experimental demonstration of navigational ability is at least partly dependent upon the sun (Matthews, 1953*a*, 1953*b*, 1955) and an internal clock (Hoffman, 1954; Schmidt-Koenig, 1960) compensating the apparent passage of this body. At night stars appear to be the significant celestial cues (Sauer, 1957) and unless Polaris is the essential cue a clock mechanism must also be implicated. But the question posed is not: Do these birds navigate? but: Can they navigate with celestial cues alone? Lest the reader be deceived it should be stated at the outset that this paper contains no definitive answer to either question.

I am especially indebted to Robert and Ann Gammell who captured and shipped the Bobolink reported on here from North Dakota. Dr. Franz Sauer, California Academy of Sciences, and Stephen L. Billeb read the manuscript and offered helpful suggestions. This research was supported by the United States Air Force through the Air Force Office of Scientific Research of the Air Research and Development Command, under Contract No. AF49(638)-825.

METHODS

The orientation testing method has been reported elsewhere (Hamilton, 1962). It consists of a circular apparatus with a vertical screen prohibiting view of all terrestrial landmarks. Since the apparatus is rotated hourly at least 180°, the bird can obtain consistent directional information only from celestial cues and pervasive geophysical forces. Twelve peripheral symmetrically arranged perches register the bird's restricted locomotion.

The experimental data reported here come from a single Bobolink taken 9 August 1959 near Kenmare, North Dakota, and air-shipped the next day to Berkeley, California. It was housed there under artificial lights on a light-dark schedule coinciding with the seasonal schedule for Kenmare, North Dakota.

RESULTS

Orientation following geographic displacement without time shift.—On 29 August at 1800 local standard time this bird was permanently removed from the holding shed and placed in the test apparatus situated atop the

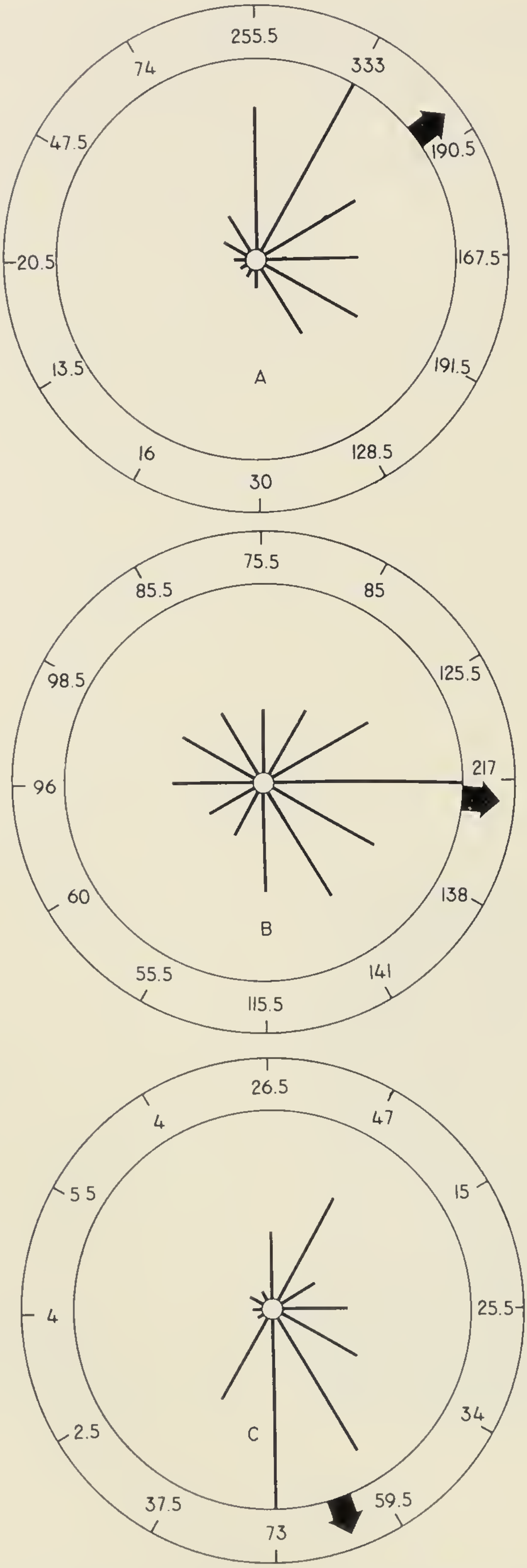

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FIG. 1. Preferred directional response of a North Dakota adult female Bobolink recently translocated from North Dakota to San Francisco, held on a time schedule in

Life Sciences Building on the Berkeley campus. This was her first exposure to the natural outdoor Berkeley sky since her capture in North Dakota three weeks earlier. Until this time the overt features of her lighting schedule, i.e., the beginning and end of the day, could have provided no clue permitting the detection of the geographic displacement.

On the assumption that her internal clock was unaffected by the shift, the new outdoor environment might reveal several things which would influence her directional preference. These include the relative duration of the light and dark periods, the temporal schedule of the light and dark periods, and the position of celestial features (i.e., sun, stars, etc.) with declinations temporally out of phase with the setting of the internal clock. The importance of any or all of these features depends on the nature of the orientation mechanism.

Figure 1A indicates the northeasterly response of this bird during the ensuing clear night from 2100 to 0430. The bird was left under the natural outdoor Berkeley sky during the following day, being removed briefly for maintenance of the apparatus. The response during the period 2100 to 0430 on the following night is indicated in Fig. 1B. On this night the response showed a wide scatter with the mode shifted nearly 40 degrees to the south.

The bird was again left in the apparatus except for the brief maintenance period in the middle of the day. That night, from 2100 on 31 August to 0430 on 1 September, she showed a somewhat weaker and bimodal response. The heaviest peak was to the southeast (Fig. 1C). The second mode to the northeast is atypical even of an ambivalent response since the northward trend is not the back azimuth of the southward tendency. No such variations in directional tendency from night to night have been noted for birds time-adjusted to local time (Hamilton, 1962). This result is probably based on the time sense and its relationship to direction. Since the time difference between the light-dark schedule under which the bird was maintained and local time differed by only 100 minutes we are left with a directional shift well in excess of the 15-degree-per-hour shift noted for other species of time-shifted birds responding during the day.

The comparatively wide scatter of the response on these three nights probably stems from her unfamiliarity with the test environment. A comparable scatter has been noted for other birds on the first nights that they were introduced to the apparatus (Hamilton, 1962). However, it may also be due to the conflicting information from the visual field and the internal

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phase with the natural light-dark schedule in North Dakota, and then exposed to the natural night sky in San Francisco. See text for conditions and subsequent data on this bird.

clock. This might provide the bird with less adequate information for making an appropriate directional choice.

In the early morning following the third experimental night the bird escaped as it was being removed from the apparatus.

DISCUSSION

It is important to point out here that navigation has been used with two quite different meanings, both appropriate in the dictionary sense. One is directional response based on geographic position, the Type III homing of Griffin (1952). The other is so-called one-direction navigation (Matthews, 1955), which corresponds to the performance of Mallards (Bellrose, 1958) and Common Terns (Griffin and Goldsmith, 1955).

Possible courses from San Francisco.—In experimenting with spontaneous migratory activity we are dealing either with fixed directional courses in which a directional tendency is taken which has no apparent geographic meaning, or with responses which must be interpreted in relation to an actual migratory pathway. In the case of the Bobolink, we are almost surely dealing with this latter case. For this reason, the experimental result should be interpreted in relation to geographic localities. The bulk of the experiments done to date have been performed in and around San Francisco, California—an area which is not included in the normal pathway of any population of Bobolinks. The experimental results must therefore be interpreted in terms of this geographic displacement. The bird may or may not correct for the displacement under these experimental conditions.

Later in the season all experiments were performed with birds time-adjusted to San Francisco. Subjected to this treatment, the North Dakota birds expressed a preference for the southeast (Hamilton, 1962) as indicated in Fig. 2, Arrow 1. If such a bird were released in San Francisco, what direction would it fly? The southeasterly course extended indefinitely from San Francisco leads through terrestrial areas to the tip of Baja California and then out to sea over vast stretches of ocean (Fig. 2, Arrow 4). Were the bird to actually take such a course it would surely perish. There is only one other possibility which might be in full accord with the experimental result and other available information. Such a bird, time-adjusted to San Francisco, might continue to follow this course as long as it is appropriate with respect to the terrain below (Fig. 2, Arrow 5).

Social stimulation appears to be a very significant factor in Bobolink migration. The night call notes, for example, have a strong stimulatory effect on the migratory behavior of experimental birds (Hamilton, MS). And like many other birds Bobolinks are reluctant to leave a land area to pass over open water alone (Stone, 1937).

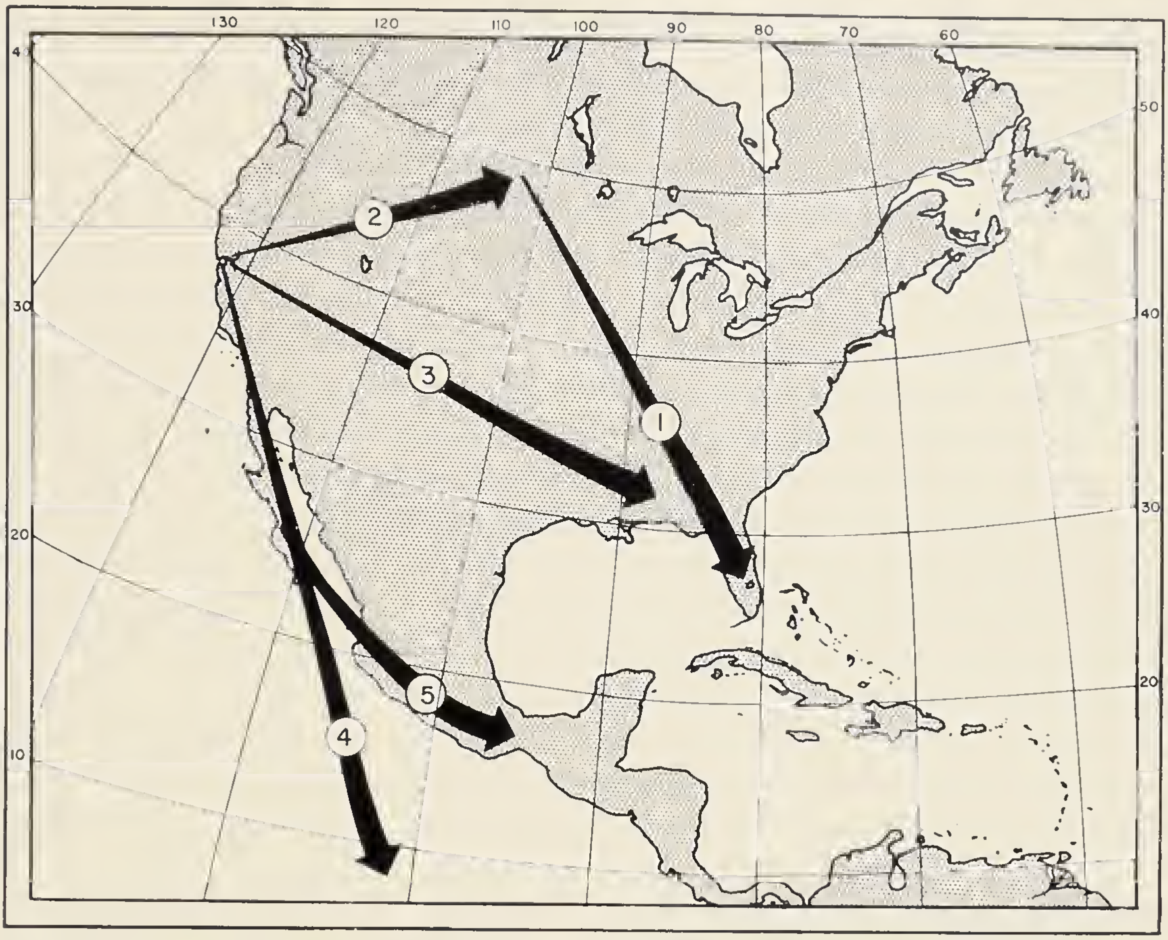

FIG 2. Possible courses of a Bobolink from the North Dakota breeding population upon release in San Francisco. The most probable route of migration is shown by Arrow 1. The bird might return to the home area (2), intersect the migratory route (3), fly a parallel course (4), or fly a parallel course as long as it covers overland areas (5). The map is an oblique conic conformal projection.

A Bobolink responding to the southeast in San Francisco in the experimental apparatus might, therefore, if given its freedom, follow such a course as long as it covered overland areas but shift when it intersected open water and fly as close as possible to such a course without leaving terrestrial areas. There is no reason to believe that the bird would stubbornly stick to a fixed direction unless it were satisfactory in relation to other aspects of the environment such as the relative positions of land and water masses, mountains, weather fronts, etc.

The experiment reported here for a bird held on the time schedule of its home area indicates that under these conditions a homing tendency may be witnessed. This bird took an almost absolutely correct homing course the first night it responded in the apparatus.

The directional shift to the southeastern sector in subsequent nights brought the vector of the response on the final night of testing into agreement with the performance of other North Dakota Bobolinks with internal clocks in phase with local San Francisco time. When thus time-shifted to San Francisco these displaced birds take a course in the apparatus paralleling the natural migratory route from North Dakota to Florida (Hamilton, 1962). It seems then that the performance of the bird reported on here, shifting direction drastically over a period of three nights, indicates that the internal clock shifts rapidly to local time. Such a relatively labile timing mechanism would be advantageous to birds which traverse great east-west distances such as the North Dakota Bobolinks and other more westerly populations in their move to Florida. If the internal clock did not shift, birds relying only on the innate directional information provided by the internal clock and the stars would encounter considerable difficulty in continuously maintaining a direct and accurate course. This would be true since in shifting to the east these birds no longer encounter the same stellar pattern 24 hours later but a stellar pattern out of phase by the degree of the geographic shift to the east and south. The labile timing mechanism would be disadvantageous in relation to homing, especially if homing were delayed for a considerable period of time. But probably the homing response of birds shifted from their home area is initiated almost at once, and the birds would not depend on a rigid internal clock mechanism and could at once be under way in a homeward direction or at least immediately determine the direction of home.

Subsequent travels of the experimental bird.—The North Dakota bird discussed here provided some exciting information relative to the previous discussion. As previously noted, this bird escaped while being removed from the experimental apparatus for routine cleaning and rotation of the apparatus following the third experimental night (Fig. 1C). The bird was marked with plastic bands. This was on 1 September 1959. On 1 June 1960, Mrs. Gammell phoned to say that she had taken a color-banded female Bobolink in the meadows south of Kenmare, North Dakota, where she had trapped the birds she shipped the previous fall. She took color photographs of the bird and its bands and forwarded them. Without question it was the bird which had escaped from my hand on the first day of September the previous fall! Where had this bird spent the intervening period and how had she found her way back to North Dakota after so great a displacement in a closed cage? She might have returned directly to North Dakota before initiating the fall migration (Fig. 2, Arrow 2). Based on her directional response the night before the escape it seems much more likely that she headed south through California and made her journey to the wintering grounds without returning to North Dakota. It is most improbable that she remained in the United States through the winter. Bobolinks are not known even as rare winter stragglers in the United States, and have never been reported at the time of the annual

Christmas Bird Count. She may have rejoined migratory flocks of Bobolinks anywhere along the migratory route between North Dakota and Florida (Fig. 2, Arrow 3) but her behavior in the experimental apparatus does not indicate this as a probable course.

The directional tendency of Bobolinks which are time-shifted and thus in phase with San Francisco time (Hamilton, 1962) indicates only a capacity to take a fixed direction. There is no indication in these experiments that the birds attempt to return home or to any part of the migratory course. While the birds obviously use the internal clock to maintain this heading, the course observed is a parallel one and suggests that the bird has no information indicating to it that it is displaced from the migratory route. A bird with an internal clock in phase with a displaced locality would not necessarily be unable to home, however. When exposed to the total stimulus of an unfamiliar environment, either upon release or under other experimental conditions, the bird might respond quite differently. All we can presently say is that under experimental conditions the bird gave no indication that it would do so.

The route following the extension of the directional tendency of the North Dakota population from San Francisco out to sea cannot have been pursued indefinitely since the bird obviously did not perish at sea. The most likely explanation seems to be that the bird followed the final course which it indicated in the experimental apparatus, just to the east of south and where this course left the coastline, the lone bird, reluctant to leave such a coastline alone, perhaps followed other birds or the coastline on south along the Central American isthmus to South America. At this point the track would come close to rejoining the natural migratory pathway. Since this bird had made the journey from North Dakota to the winter quarters in South America and back at least once before, the subsequent route of travel could have been based on landmarks. Also, if the directional response is based on a labile timing device, then clock resetting at the point where the coasting course (Fig. 2, Arrow 5) intersects the natural migratory route in South America would permit continued use of celestial cues throughout the rest of the migration.

It is interesting to consider the possible role of social phenomena in the homing and natural migration of these birds. Elsewhere (Hamilton, 1962) I pointed out that the call notes of the Bobolink probably play an important role in natural migration, serving both to stimulate grounded birds which are in migratory condition to fly up and join migrants aloft and perhaps also to maintain flock structure by closing the ranks of the travelers. Such flocking mechanisms are probably particularly important under overcast conditions when celestial patterns are not easily visible or are completely masked. It seems quite possible that the bird just discussed may have joined flocks of other passerines such as the Russet-backed Thrush which has a very similar call note and which follows the Central American peninsula to South America.

Does the Bobolink navigate?—Most bird species studied to date which show an oriented response under experimental conditions with familiar landmarks excluded can maintain this directional tendency only when the overhead sky is unobscured by overcast. In a number of animals the response is in a particular compass direction regardless of the direction of home. The Mallard is a good example of a bird taking a fixed direction in this manner. When Bellrose (1958) released Mallards in open fields away from the familiar migratory pathway the birds responded by taking a northerly course. This response persisted through the seasons, night and day, but scatter resulted under overcast conditions. Similarly the Common Tern (Griffin and Goldsmith, 1955), when released at inland points which in all likelihood the birds had never seen before, fly to the southeast. This course is taken regardless of the location of the release in relation to the home. In similar fashion an aquatic bug, *Velia* (Birukow, 1957) heads south when agitated in an experimental situation. While there has been some speculation, there is no adequate adaptive explanation of the directional feature of such responses.

On the other hand a number of species initiate homeward flight immediately when released in unfamiliar country. Matthews (1953*b*), for example, showed that Manx Shearwaters, released at various inland localities which these birds had surely never before visited, initiated homeward flight almost at once. This was true regardless of the direction of displacement. In a similar manner pigeons apparently initiate homeward flight immediately from unfamiliar areas regardless of the direction of displacement (Matthews, 1953*a*; Kramer, 1952). However, Matthews (1961) has recently pointed out that the homeward tendency may be partially masked by a north-flying tendency.

The very limited data for the bird not time-adjusted to local time but maintained on a photoperiod in phase with the home area suggests that under these circumstances the response can be quite different and, furthermore, that the response indicates the possibility of navigation under these circumstances. Many species of birds, and certain populations of Bobolinks in particular, have migrations traversing, in addition to the north-south spans, extensive east-west movements. Such movements to the east or west would present additional problems in orientation to a bird with a rigid internal clock not rapidly adjusting to local time. Especially for an inexperienced bird, using no other orienting information, a particularly difficult problem would be involved in maintaining a compass direction of any sort in relation to the internal clock if this clock were not in phase with local time. These considerations lend support to the hypothesis presented here that the circadian clock rapidly shifts into phase with local time.

The migratory route of the Bobolink in itself demonstrates conclusively that something more than a fixed compass direction is involved in the oriented movement between summer and winter quarters. For the North Dakota population the summer and winter quarters and points along the known migratory route lie approximately on a straight line. But this is not true of other populations such as those in the far west and in the northeast where a directional change must be made in Florida. Of course, we do not yet know whether these changes and subsequent orientation are made on the basis of celestial cues. However, experiments with birds time-adjusted to San Francisco show that the New York population probably heads in a direction approximately paralleling a course from New York to Florida (Hamilton, 1962). From Florida a difficult part of the migration lies ahead with vast stretches of water remaining to be crossed. A shift to topographic features at this point will not suffice and the celestial course taken by the New York population will be inappropriate for further celestial orientation. We might, therefore, anticipate direction shifts based on latitude in the Bobolink such as those noted by the Sauers for the *Sylvia* species. These shifts will not be based on the circadian clock mechanism. The information may be derived either from the latitude through interpretation of the declination of celestial bodies or be part of a programmed circannuan migratory schedule (Hamilton, 1962).

SUMMARY

On 1 September 1959, a captive adult female Bobolink escaped from captivity at Berkeley, California. This bird had been taken from its breeding locality in North Dakota on 9 August 1959 and shipped to Berkeley where it was held on a light-dark schedule coinciding with the natural photoperiod for its home locality in North Dakota. On the three nights prior to escape this bird was held in an experimental cage automatically registering the directional component of migratory activity at night. On the first of these nights the preferred direction almost coincided with the home direction while on the third the direction was parallel to the natural route of migration of the population from which this bird was derived. The direction on the second night was intermediate.

On the first day of June of the following year this same bird was recaptured at the location where it was originally trapped in Kenmare, North Dakota. Since the experimental site in California is not on a migratory pathway of Bobolinks, some navigation capacity permitting the eventual return seems to be implied. The orientation mechanism and the possible travels of this bird prior to recapture are discussed.

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CALIFORNIA ACADEMY OF SCIENCES, GOLDEN GATE PARK, SAN FRANCISCO 18, CALIFORNIA, 16 OCTOBER 1961

THE EFFECTIVENESS OF AIRCRAFT-TYPE (APS) RADAR IN DETECTING BIRDS

Richard R. Graber and Sylvia Sue Hassler

Radar has proven itself a useful tool in ornithological studies (Lack, 1959*a*, *b*; and 1960 *a*, *b*). Lack and others have used high-powered weather radar to detect birds, and this technique along with the lunar-observation and audio-observation methods holds great promise for solving problems relating to bird migration.

In the fall of 1959, Frank C. Bellrose, William W. Cochran, and Graber inaugurated a radar study of nocturnal migration of birds in Illinois, supported by the National Science Foundation and the State Natural History Survey. Most of our data on migration will be presented in subsequent papers. For the benefit of others who may wish to use aircraft-type radar in migration studies, the present paper deals with the method and its effectiveness.

Data for this particular study were collected at the University of Illinois airport, Champaign, Illinois.

METHODS

Aircraft radar (AN/APS series) are readily obtainable and though they are less powerful than the large, fixed base weather radars, we found it expedient for financial reasons to try detecting migrants with the smaller set.

An APS–31 radar was installed in a small building on the University of Illinois airport in an open area free from obstructions. The regular antenna for this set did not provide a 360° sweep and was replaced with an antenna from an APS–15 radar. With this antenna, a parabolic dish about 29 inches in diameter, the radar beam width was about 3 degrees to the half-power points.

The APS–31 radar has a wave length of 3 cm and utilizes about 9 amperes at 115 volts, 400 cycles and 40 amperes at about 28 volts dc. The transmitter-receiver frequency is 9,375 megacycles and the peak R-F output—52 kw. For the 5-mile range used in this study, the output pulse duration was 0.5 microsecond, 800 pulses per second. The antenna rotated at the rate of about 10 rpm.

The antenna was fixed on a pivot so that it could be set to sweep 360° either in a vertical plane—perpendicular to the horizon (Fig. 1), or on a horizontal plane (Fig. 2). For the migration study the antenna was usually set for horizontal sweep tilted 30° above the horizon.

The radar had two 5-inch diameter indicators (scopes), one for direct viewing and a second to which a 16-mm motion picture camera was mounted.

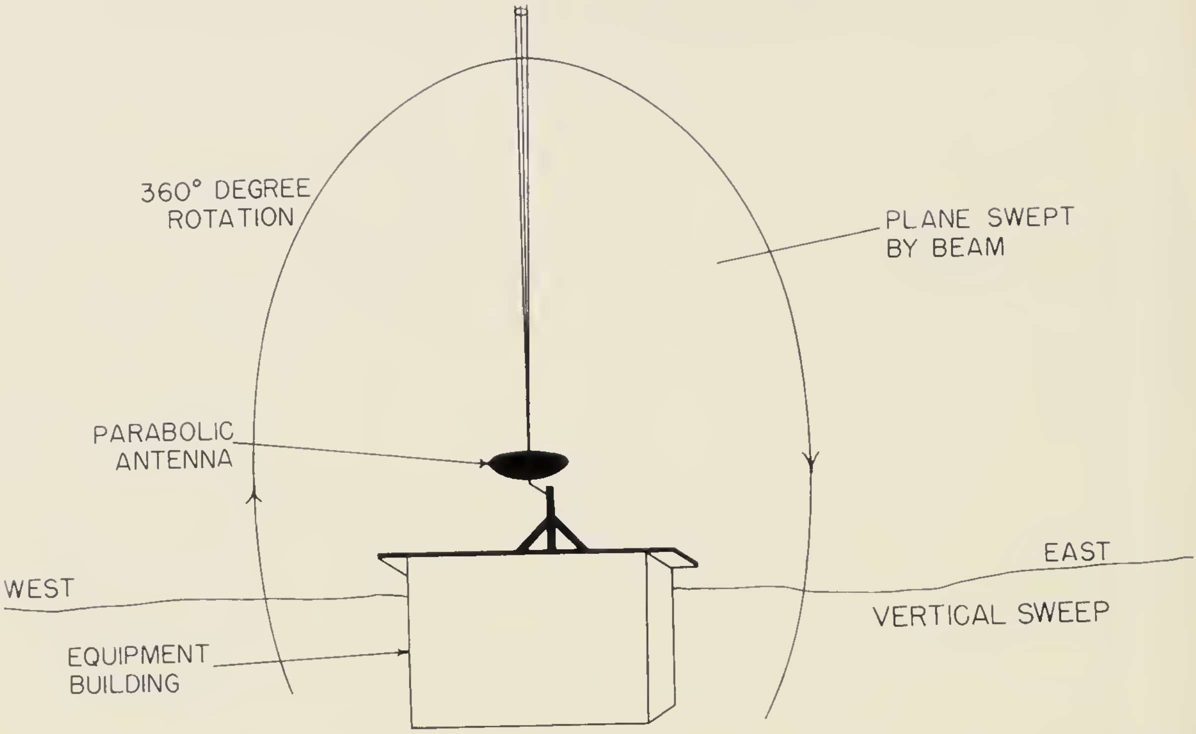

Fig. 1. Diagram showing 90° (vertical) scan of radar antenna. Radar beam rotates 360°, sweeping in an east-west plane. Beam width is approximately 3° to the half-power points.

The camera with single-frame action was modified so that the shutter remained open except when the film was advanced. It was triggered through a timing mechanism which advanced a single frame at regular intervals. The lengths of exposure could be varied and, in practice, we usually used exposures of one or two minutes.

In our migration study the radar was usually operated from just before sundown to sunup. On the night of 28–29 September 1960, beginning at 1830 CST, William Cochran and Graber attended the radar throughout the night, switching the antenna at roughly ½-hour intervals from 30° (horizontal) to 90° (vertical) scan until 0100 when the antenna was left on vertical. During the periods of vertical scanning we also observed migrants in the beam of a floodlight. The floodlight consisted of twelve 250-watt reflector lamps mounted in a line on a 6-foot board. This battery of lights was beamed directly upward to cover the same area as a portion of the vertical radar sweep. Using the lights and radar simultaneously, one observer manned the radar indicator to look for targets directly above the radar, while the other observer lay on his back with 7 × 50 binoculars looking up the light beam. Using comparative data from vertical versus horizontal scanning, and flood-

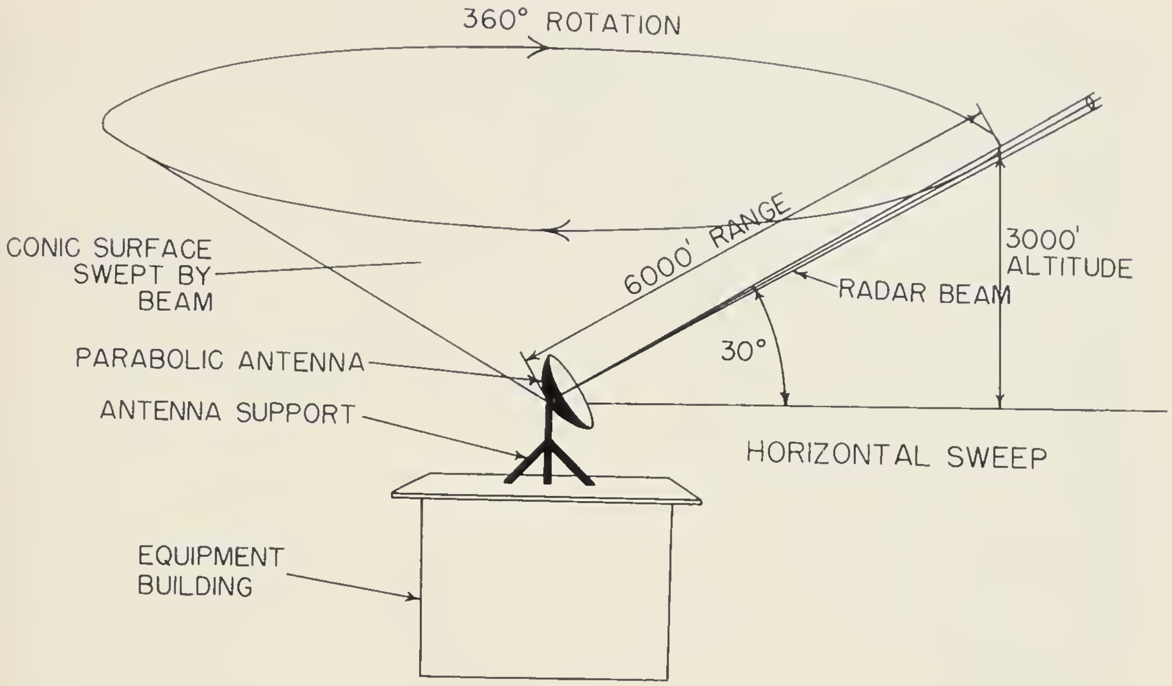

FIG. 2. Diagram showing 30° (above horizontal) scan of radar antenna. Radar beam reaches upward one foot of altitude for every 2 feet of range.

light observations, we were able to learn something of the characteristics and limitations of the radar in bird detection.

Most of the data reported represent the night of 28–29 September, but for the brief discussion of different types of targets we have selected photographs from our collection of radar film representing two years of data collecting.

The identification of targets in our photographs is based on direct identification with the use of lights as described above, and, in part, on aural identification and seasonal distribution of the targets during the two years of study. Characteristics of the echo track, such as shape and speed, are also helpful.

EFFECTIVENESS OF THE APS RADAR

The APS–31 may be considered typical of a whole series of airborne radars with peak output of about 40–50 kw. Because of its wave length and power characteristics, we expected it to be capable of detecting birds, but did not know how effective it would be in this task.

The night of 28–29 September brought one of the heaviest flights of migrants through the Champaign region recorded in 1960. On both vertical (Figs. 1 and 3) and horizontal scan (Figs. 2 and 4) numbers of targets were apparent on the scope, and from our radar film for this night we collected data on over 18,000 bird targets.

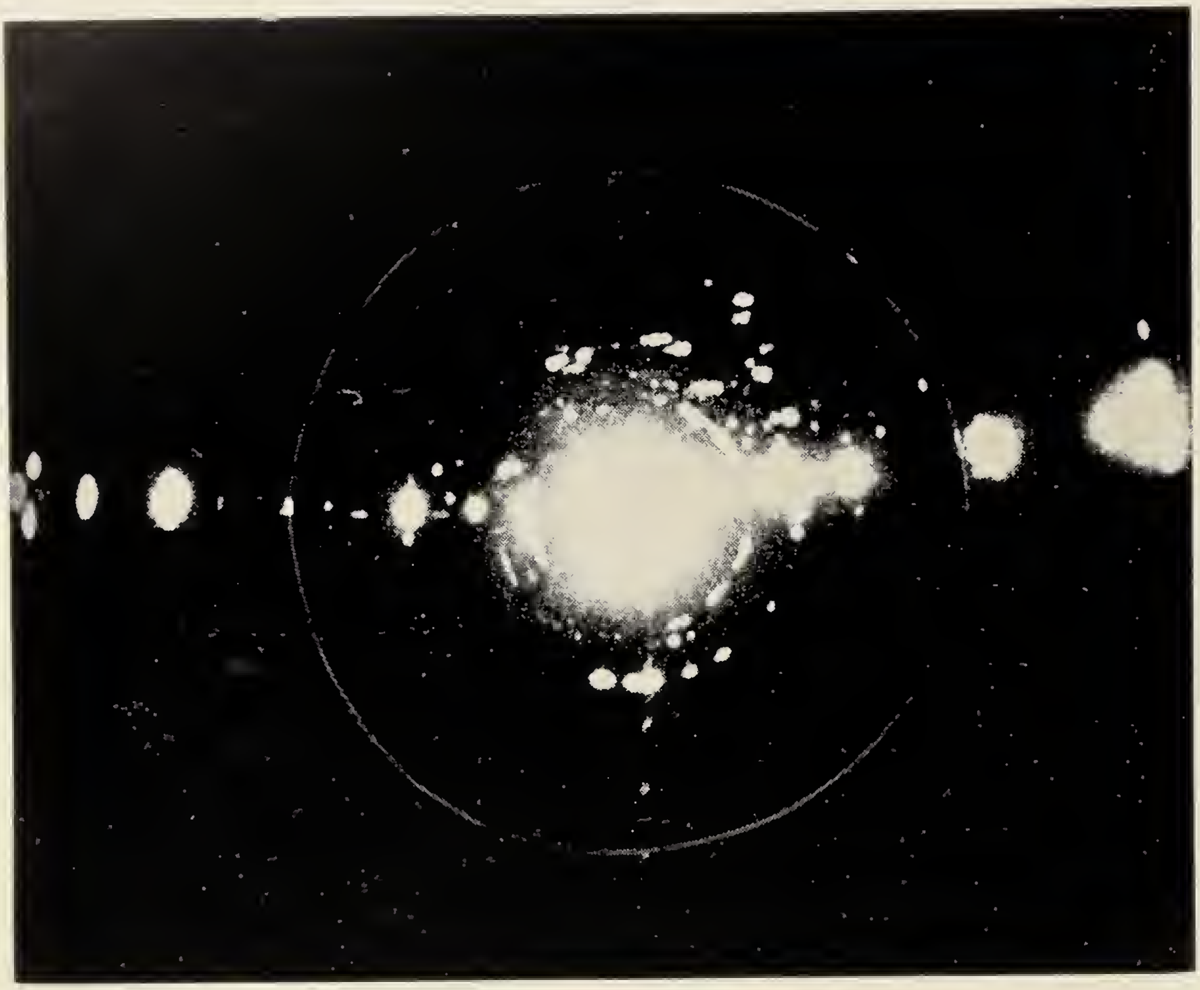

FIG. 3. Enlargement of a one-minute exposure of a 16-mm-radar-film frame showing presentation on radar indicator (scope) with antenna on 90° (vertical) scan. Circle indicates two nautical miles from radar antenna. Large white marks to left and right of center are ground targets showing actual horizon. White spots above horizon are passerine birds. White spots below horizon are ground targets from spurious radar beams deflected from roof of radar building.

When the antenna was scanning vertically, we could see occasional targets which appeared to be directly over the radar shack. With the floodlights on, we could see through binoculars that these radar targets were reflections from single passerine birds. In about one hour we saw 14 targets which appeared to be directly over the radar shack. Eleven of these were observed in the lights. According to the range markers on the radar scope these targets ranged in altitude from 4,500 to 9,000 feet, and even the highest was detectable in the lights. It was not possible to accurately identify the birds as to species. From the reflected light all appeared whitish below. There appeared to be two sizes of birds, but all that we saw were passerines. The fact that the birds were seen singly is in keeping with lunar observations, as recorded by Lowery (1951)

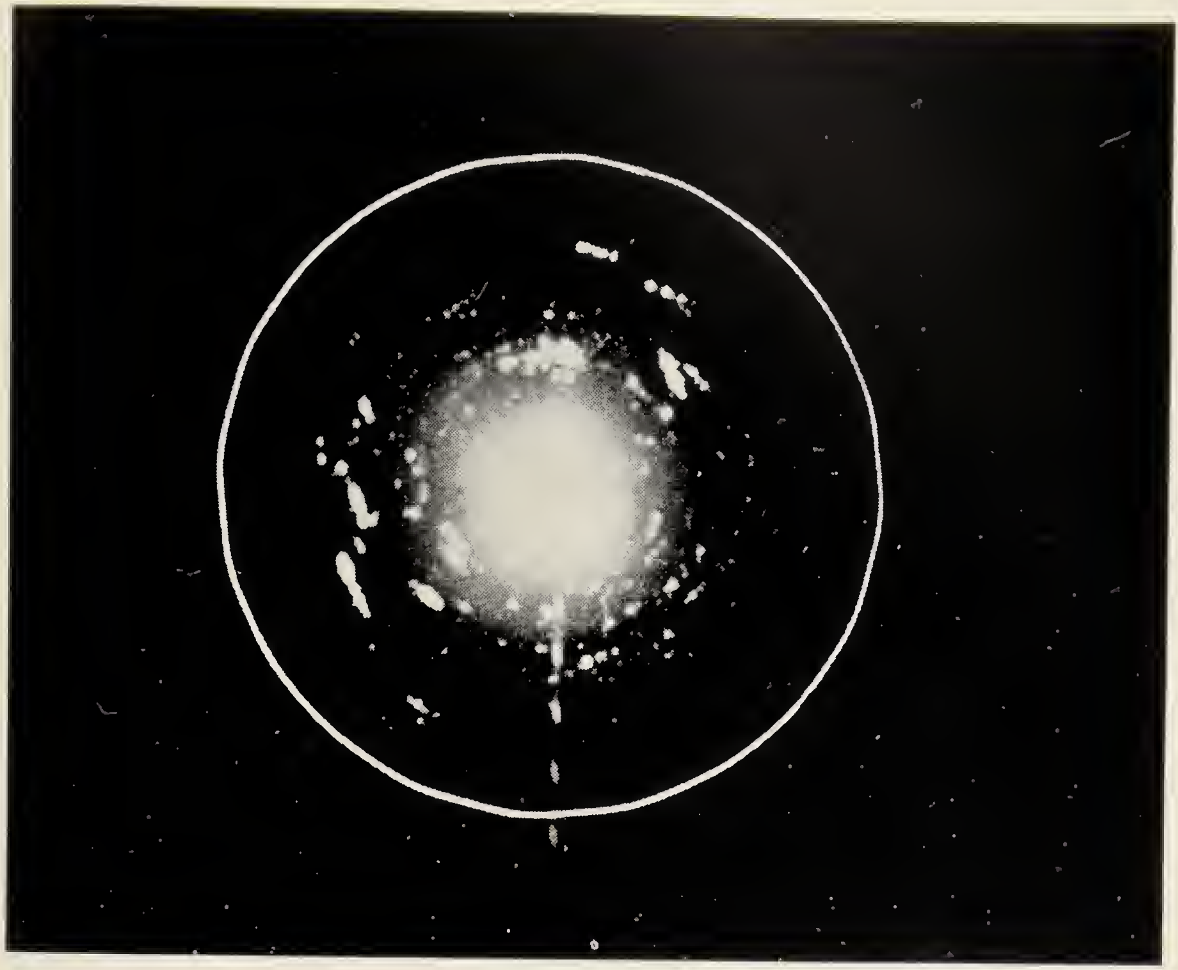

Fig. 4. Enlargement of a 16-mm-radar-film frame (1-minute exposure) showing presentation on radar indicator with antenna on 30° (above horizontal) scan. Circle indicates two nautical miles from radar. White center represents radar recovery time and some ground clutter. Distinct white spots and streaks out from center are typical echoes from passerine birds. Streaks show track of a bird flying tangential to the sweep, the bird having been intercepted by the radar beam in several rotations of the antenna. Single white spots are echoes from birds intercepted only once by the radar beam. Altitude of each target is ½ of the range.

and others, which show a uniform, not a flocked, distribution of migrants at night. The echoes observed on the radar indicators were distinct bright points of light the size of large pinheads.

On vertical scan such targets were usually picked up only in one sweep of the radar beam, but sometimes in two consecutive sweeps (Fig. 3). On 30° scan targets moving tangential to the sweep at constant altitude were picked up repeatedly by consecutive sweeps of the beam (Fig. 4). Echoes from the moving bird left a trace (a line or a series of points) on the scope which marked the progress of the bird showing direction of the movement and roughly the speed (Fig. 4).

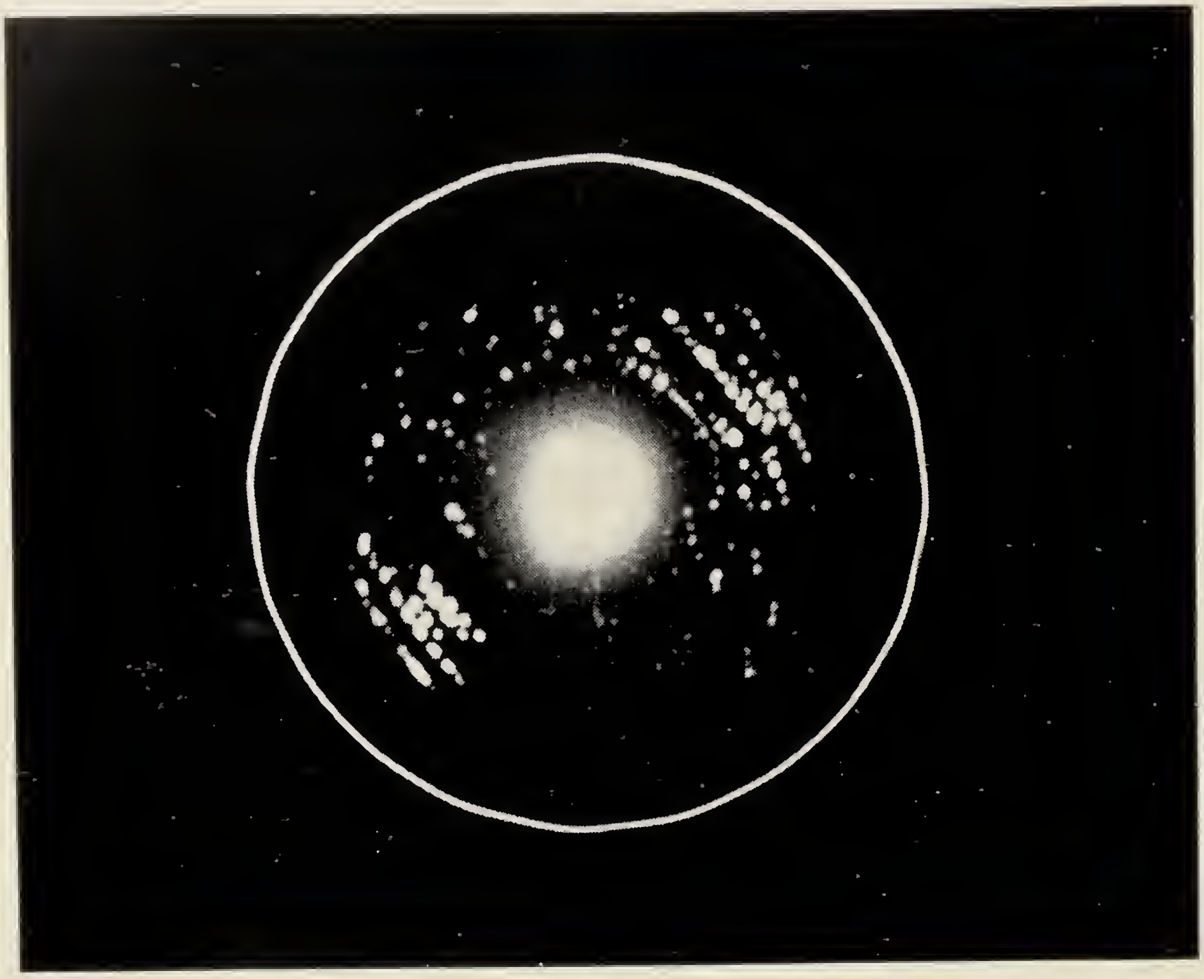

Fig. 5. Enlargement of a 16-mm-radar-film frame (2-minute exposure) showing presentation on radar indicator with antenna on 30° (above horizontal) scan. White center ring represents radar recovery time and some ground targets. Distinct white streaks and spots out from center are typical echoes from waterfowl. Rows of spots show tracks of a waterfowl flock intercepted repeatedly by radar beam in several rotations of the antenna. Single white spots are echoes from birds intercepted only once by radar beam. Altitude of each target is ½ of the range (22 October 1960, Champaign, Illinois).

The targets shown in Figs. 3 and 4 are typical of single passerine birds. Waterfowl (Fig. 5) are usually flocked in migration, but the difference in the size of the echo from a flock of large birds and that for a single small bird is not proportionate to the actual difference (see Figs. 4 and 5). Airplanes (Fig. 6) are more highly reflective even than waterfowl flocks, and, of course, have higher velocity. Approximate average speeds for the three types of targets figured are 40 mph, 80 mph, and 200 mph for, respectively, the passerine, waterfowl, and airplane targets. Precipitation targets—rain, snow, etc.—(Fig. 7) may cover up bird echoes, but the two types could not readily be confused. Heavy concentrations of insects are detectable by radar, and in the few

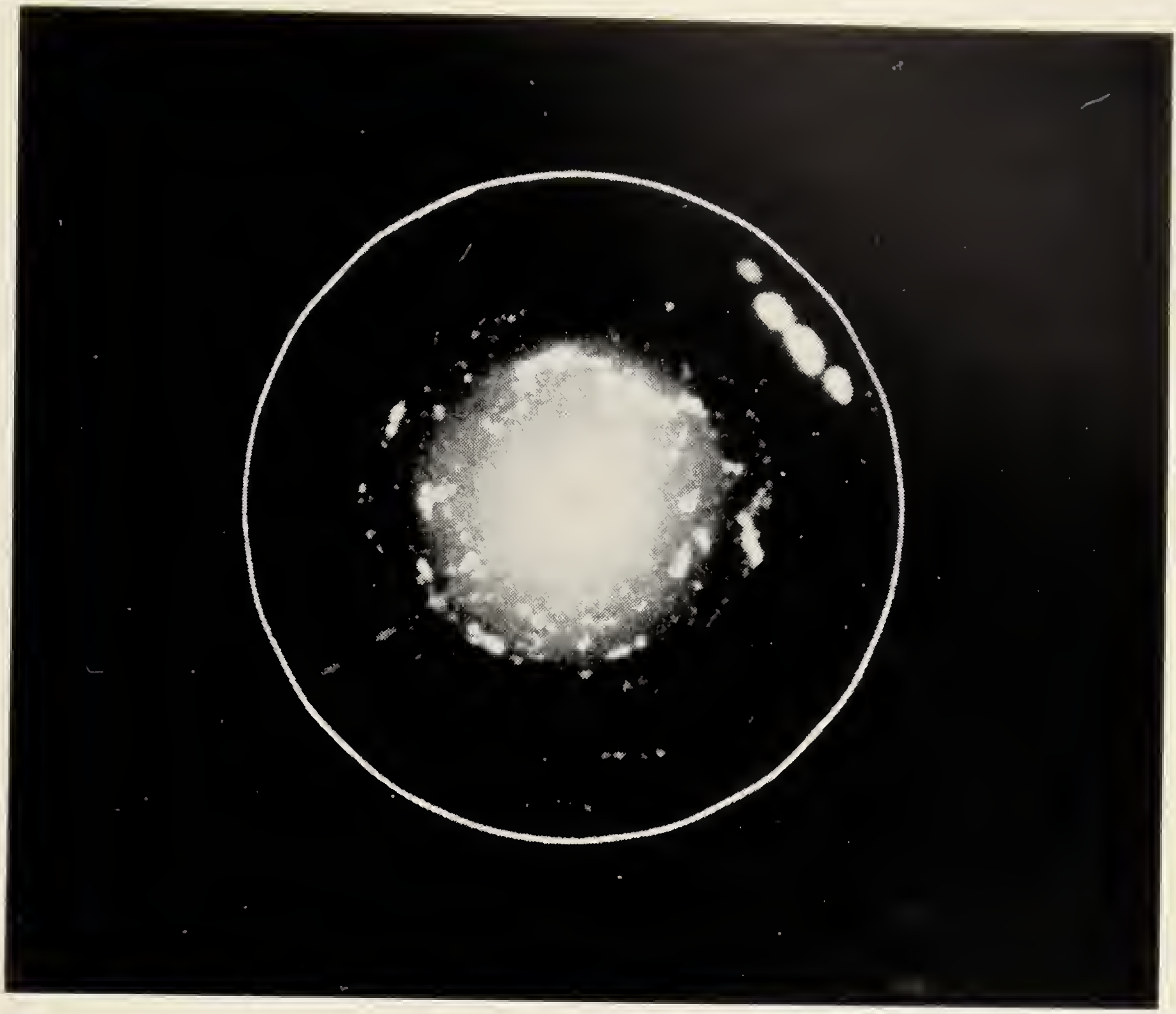

FIG. 6. Enlargement of 16-mm-radar-film frame (2-minute exposure) showing presentation on radar indicator with antenna on 30° (above horizontal) scan. Large white spots near range mark show track of airplane intercepted in four rotations of the radar beam.

instances when we have observed such phenomena the echo was most like precipitation.

Comparison of data from vertical and horizontal scan.—In the following discussion certain basic and inherent characteristics of the technique of observation should be borne in mind.

On 30° (horizontal) scan the center of the radar beam reaches an altitude of 1 mile for every 2 miles of range where range is the straight-line distance from radar antenna to target. On 90° (vertical) scan the altitude-range relationship of the beam varies from place to place in the scan, but at the zenith, 1 mile of range equals 1 mile of altitude.

Because the radar transmits roughly a 3° beam of energy, the area of coverage of the beam increases with range. Thus, the diameter of the beam

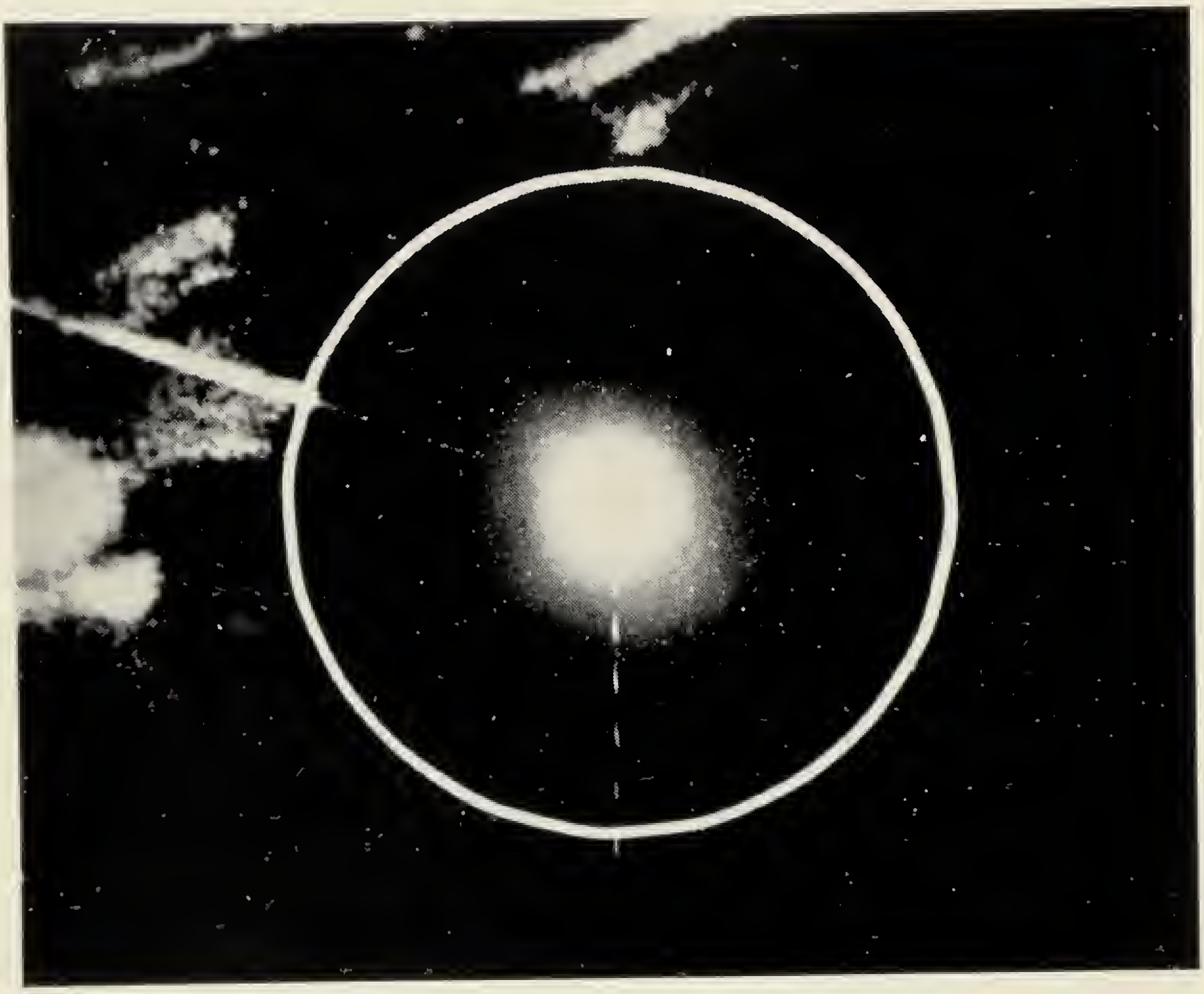

FIG. 7. Enlargement of 16-mm-radar-film frame (2-minute exposure) showing presentation on radar indicator with antenna on 30° (above horizontal) scan. Trace of radar beam may be seen to left of center, intercepting areas of rain at altitudes above 6,000 feet.

at a range of 2,000 feet would be about 105 feet while at range 6,000 feet the diameter would be about 314 feet. While the area of coverage increases with range, the radar energy is also diffused as the range increases. These two opposing factors affect the probability of detecting a given target at a given range.

The difference in results from the two types of scan is at once apparent (Fig. 8). Vertical scan showed a broader altitudinal distribution of birds than did 30° scan. Minimum and maximum altitudes recorded from the two points of view were, respectively: vertical—1,000 feet and 13,000 feet; 30° —1,400 and 8,000 feet. In the altitude range between 2,000 and 4,000 feet (actual range: 4,000–8,000 feet) horizontal sweep picked up about three to four times as many targets per unit of area as the vertical coverage, but above

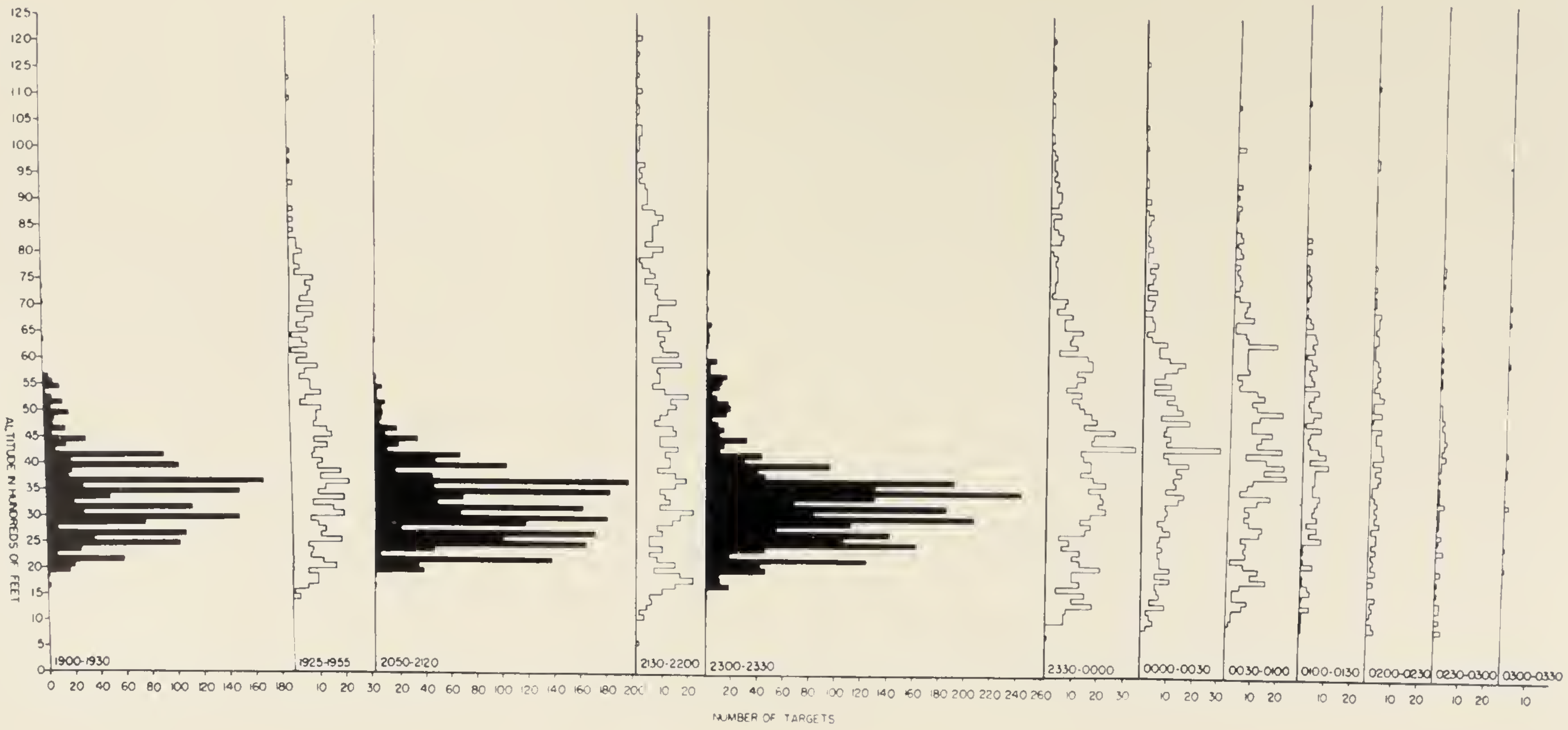

Fig. 8. Altitudinal distribution of migrants as observed on radar. The total number of bird targets at each 100-foot level is shown for periods of approximately ½-hour duration. Data representing periods of observation (1900–1930, 2050–2120, and 2300–2330 CST) with the radar antenna on horizontal (30°) scan are shaded. Unshaded portions of the graph represent observations made with the radar antenna scanning in a vertical plane.

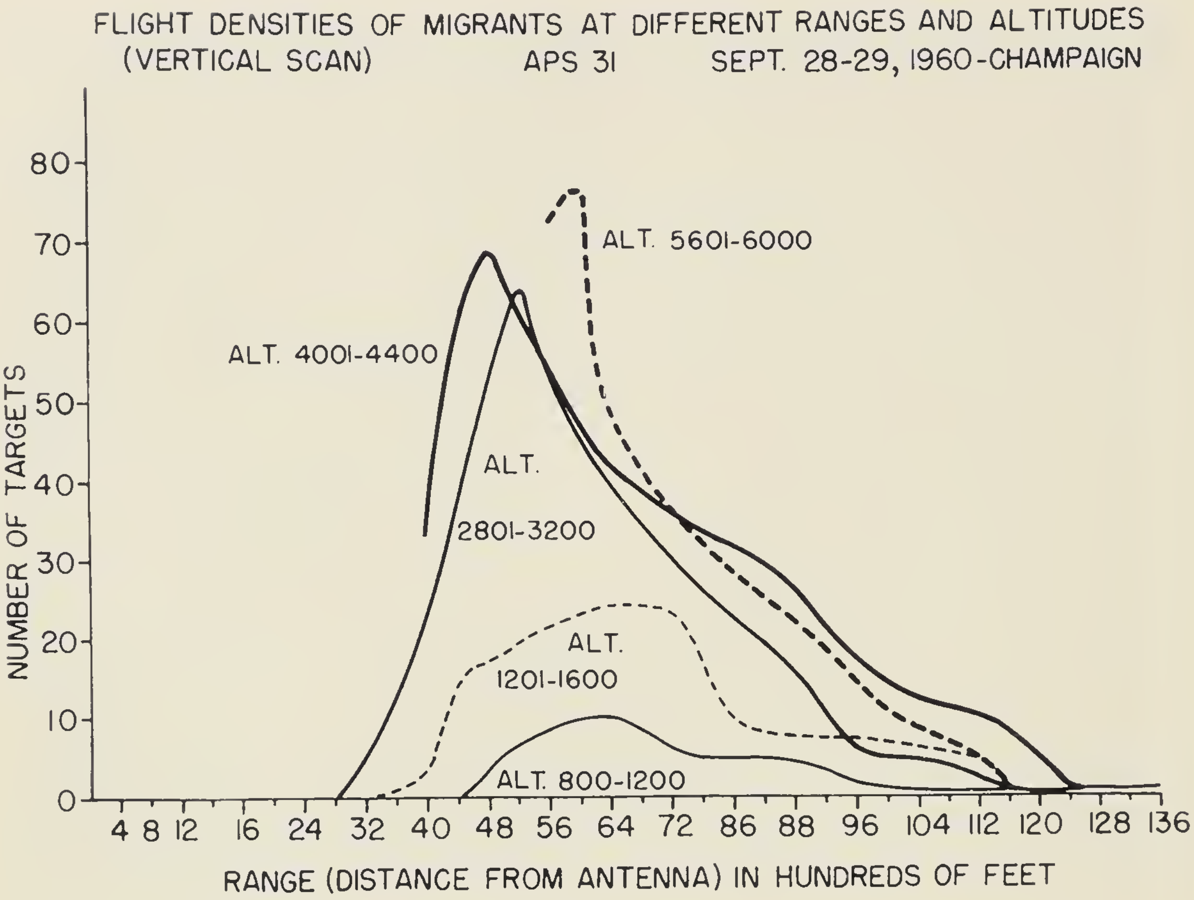

Fig. 9. Comparison of flight densities of migrants at different range and altitude levels. The maximum point of each curve is at the range where the radar is most effective in detecting birds. The range of peak effectiveness varies slightly with altitude but maximum effectiveness occurs at a range between 5,000 and 6,500 feet.

altitudes of 4,000 feet the number of targets detected on 30° scan fell off steeply despite the expanding (3°) beam width. Apparently, at a range above 4,000 feet and below 8,000 feet the transmitted energy becomes diffused to the extent of reducing the radar's effectiveness in detecting birds. Further analysis of vertical scan data, considering range versus altitude, indicates more precisely that the range above which effectiveness is reduced is about 6,400 feet (Fig. 9). This should be considered the range for solitary passerine birds, as our lighting observations showed this type of migration on the night of the experiment. We have recorded strong echoes from waterfowl at ranges up to nearly four nautical miles (24,000 feet) and on the night of our experiment some birds were detected on vertical scan at altitudes up to 13,000 feet. Obviously other factors than just range affect the picture. Birds near the center of the beam are more likely to be detected than those at the edge. What the difference in reflectivity might be for birds of different species or what factors affect this reflectivity we cannot say at present. The difference in results from the two types of scan is not surprising, and can be attributed to the innate limitations of the equipment and of the two methods. Vertical scan provides better altitudinal information at both the lower and higher extremes of coverage.

Because of the inherent recovery time of the radar, the radar receiver cannot detect targets in the first 1,000 feet of range (see opaque halo in Figs. 4 and 5). This range of "blind area" must be considered minimal as ground targets are most likely to be picked up close to the antenna and may cover up as much as an additional 500–1,000 feet of range. This means that with the antenna on 30° tilt, the first 750–1,000 feet of altitude are occluded. On vertical scan, however, objects at low altitude may be picked up at any range beyond 1,500 to 2,000 feet. More high-altitude targets were detected on vertical scan because in the region of the zenith, range and altitude are equal, while on 30° scan, altitude is always only half of the range.

In considering the greater number of targets detected on horizontal scan it should first be pointed out that half of the vertical sweep is lost when the rotating antenna is pointed toward the ground. In addition, horizontal sweep provided maximum coverage at the altitudes where flight densities of migrants were highest.

The temporal pattern.—Lowery (1951) presented lunar observation data which indicated that migrants did not usually fly throughout the night. The number of flying migrants increased progressively after sunset to a peak density between 2230 CST and midnight, falling off steeply after 0100 to virtually zero by 0230.

This is precisely the kind of pattern shown in our radar film for 28–29 September (Fig. 8), and it is the typical autumn pattern shown in most of the radar data collected at Champaign, Illinois, in the past two years. This pattern indicates that birds are landing, or at least descending, after midnight, yet there is no conspicuous increase at this time in the number of birds at lower altitudes (Fig. 8). The inherent "blindness" of the radar at short range, and low altitudes (because of recovery time and ground clutter) has already been pointed out, and accounts for this void in our observations.

Although radar is a very useful tool in migration studies, the inherent weaknesses of the technique must be recognized.

FLIGHT DENSITY DETERMINED BY RADAR

The most accurate available figures on flight densities of migrants are those obtained from lunar observations (Lowery, 1951, and others).

In further evaluating the radar technique, it is useful to compare flight density levels as determined from radar observations with published figures ascertained from moon watching.

As already noted, the flight of migrants on 28–29 September was extensive, and the peak density occurred around 2300 CST (see above). From 2300 to 2330 CST, 2,670 bird targets were detected with the radar on 30° scan. Direct observations of the indicators showed that most of these birds were holding south-southeast headings (150°–180°), but a large number were also moving 190°–210°.

For density determinations, vertical scan would appear to provide better basic data than horizontal scan, since vertical scan, in effect, resembles an east-west curtain of energy through which the migrants pass on their southerly headings.

This "curtain" is actually the sweep of a 3° beam, passing a given point every six seconds. There is a possibility, of course, that birds pass through the area covered by the beam without actually being intercepted by the energy. Within well-defined limits the possibility of a bird passing through the area of coverage undetected is better if it passes close to the antenna than if it passes at greater range. For instance, the diameter of the beam at a range of 1,000 feet is 52 feet, while at 6,200 feet range the diameter is 324 feet. At the shorter range a bird would have to be flying only 6 mph to cross the beam area undetected, while at the greater range the bird's speed would have to be better than 36 mph to pass undetected, even if the migrant's flight was timed perfectly to miss the sweep. Depending on this timing, the migrant's speed could be as much as 70 mph and it might still be "caught." On this particular night migrants were making ground speeds between 34 and 45 mph and it seems reasonable to assume that most migrants were probably intercepted by the vertically directed beam at ranges over 6,000 feet. There are other reasons for considering range in calculating flight densities.

It has already been pointed out that recovery time of the radar receiver and the presence of ground targets at short range reduce the effectiveness of the radar in detecting birds close to the antenna. It has also been shown that the effectiveness of the APS radar in detecting birds is reduced at ranges much above 6,400 feet. For the most accurate possible estimate of density it is advisable, therefore, to calculate flight densities at specific altitudes and ranges. Densities for the lower altitudes should be calculated for ranges distant from the antenna, but not exceeding 6,400 feet. Densities for the higher altitudes (above 6,400 feet) should be calculated at minimum range, i.e., where range equals altitude.

In an hour (2230–2300 and 2330–0000 CST) representing the peak of the night's migration, 177 bird targets were counted at all altitudes up to 6,500 feet in the 500-foot range sector from 6,000 to 6,500 feet. If our 500-foot sector is representative, the flight density to this altitude would be about 1,870 birds crossing a mile in one hour. To this should be added the densities for higher altitudes (6,500 feet and above). To calculate densities at these higher altitudes we have counted the number of migrants at each hundred-foot level within ¼ mile either side of the radar zenith. In this area range is very nearly equal to altitude. Within this sector 50 birds were counted during the peak hour of migration at altitudes above 6,400 feet. This is a flight density of 100 birds crossing a mile line per hour. This calculation does not take into account two factors: (1) that the diameter of the beam increases as the range increases, and (2) that the effectiveness of the radar in detecting birds is reduced to an unknown extent at ranges above 6,400 feet. The density figure for higher altitudes is, therefore, less reliable.

The estimated peak flight density for all altitudes on 28–29 September was 1,970 birds per mile per hour. Although we have no comparative data representing other techniques for this night, Lowery (1951) lists hourly densities for spring migrants as high as 2,700 birds per mile at midwestern localities.

ACKNOWLEDGMENTS

We are most indebted to William W. Cochran who engineered our migration project from the start, established the radar station, gave valuable advice throughout, and helped with the collection of data. It was he who suggested the present comparative study. Our project is also indebted to Glenn E. Stout, Donald W. Staggs, Eugene A. Mueller, Donald H. Summers, and Kenneth E. Wilk of the State Water Survey Meteorological Laboratory for technical advice and help with equipment as well as encouragement, and to members of the staff of the Coordinated Science Laboratory—especially Robert E. Potter and Earl E. Rumbaugh for the loan of radar equipment.

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ILLINOIS NATURAL HISTORY SURVEY DIVISION, URBANA, ILLINOIS, 7 OCTOBER 1961

Lieutenant Colonel Gerald T. Rogers, shown here in his present niche—that of jet pilot and chief of engineering for a satellite-tracking system—is a new Life Member of the WOS. He is a Life Member also of the AOU. An electrical-engineering graduate of MIT, Colonel Rogers is interested in bird flight, navigation, distribution, and migration. He has published several general notes in *The Auk* on rare bird specimens from Panama, Alabama, and North Carolina. Also, he has collected resident bird specimens in New Guinea.

SAMPLING PASSERINE BIRDS IN A WOODED SWAMP IN SOUTHEASTERN MASSACHUSETTS

Kathleen S. Anderson and Herbert K. Maxfield

During the summer of 1960, small passerine birds of the understory of a red maple-white cedar swamp in southeastern Massachusetts were sampled by means of Japanese mist nets. Results of the sampling provided data on a habitat not previously investigated in this manner. Blood samples were obtained from the netted birds as part of an ecologic study of eastern encephalitis. The investigation was part of a joint study sponsored by the Communicable Disease Center, United States Public Health Service, and the Division of Communicable Diseases, Massachusetts Department of Public Health; and was supported in part by research grant 4242–00–00(03) from the National Institute of Allergy and Infectious Diseases of the National Institutes of Health, Public Health Service, U.S. Department of Health, Education, and Welfare.

Pine Swamp is located in Raynham (Bristol County), Massachusetts, about 30 miles south of Boston on the northeast outskirts of the city of Taunton. The area is 55 feet above sea level and is drained by the Pine Swamp Brook that flows eastward across its northern portion to enter the Taunton River. The swamp is roughly oval in shape and contains 658 acres. The water level in the swamp fluctuates seasonally, inundating the area during the winter and spring. During the remainder of the year, the substratum is generally saturated with water. There has been no significant disturbance of the swamp's vegetation by man, either by cutting or burning, for many years.

Red maple (*Acer rubrum*) and white cedar (*Chamaecyparis thycides*) occupied the swamp as codominant species. The height of the overstory was about 30 feet. The understory was composed largely of species of the genus *Vaccinium*, predominantly highbush blueberry (*V. corymbosum*). Cinnamon fern (*Osmunda cinamonea*) was the dominant fern, and ground cover was club (*Lycopodium* spp.) and sphagnum (*Sphagnum* spp.) mosses.

METHODS

Two trails each 1,032 feet long were laid out by hand compass. One trail was oriented north and south, the other east and west, and intersected at their midpoints. Eight Japanese mist nets, each about 7 by 40 feet, were placed in cleared areas at 100-foot intervals on each trail (Low, 1957). This was a modification of the method used by Stamm et al. (1960). The netting area was at least 1,000 feet from the nearest edge of the swamp. There were 10 netting periods beginning 17 May and occurring every 14 days until 22 September 1960. A netting period consisted of two collecting days. The

TABLE 1
BIRDS CAPTURED WITHIN A MASSACHUSETTS FRESH-WATER SWAMP
17 MAY–22 SEPTEMBER 1960

Species	Individual birds taken	Repeats in subsequent* netting periods	Birds dying	Males		Females		Sex unknown		
				Adults	Immature	Adults	Immature	Adults	Immature	Unknown
Hairy Woodpecker	2	1		1			1			
Downy Woodpecker	4	1		1		2	1			
Blue Jay	6			1					6	
Black-capped Chickadee	35	15	6	1		7		6	6	15
Catbird	4								4	
Robin	34	1	1	6	3	5	1		18	1
Wood Thrush	17	1		2		2		3	6	4
Veery	23	3	2	6		4		4	7	2
Black-and-white Warbler	4			2		1			1	
Black-throated Green Warbler	1					1				
Ovenbird	11	2		1		2		1	7	
Northern Waterthrush	13	2	2	5		1		3	3	1
Yellowthroat	2				1				1	
Canada Warbler	7	2	1	4		2			3	
American Redstart	1				1					
Baltimore Oriole	1								1	
Common Grackle	11			5	2	1		1	2	
Rufous-sided Towhee	1								1	
Totals	177	28	12	35	7	28	3	18	66	23

* These figures do not include birds recaptured more than once in a single netting period. Therefore, the totals of columns 1 and 2 do not equal the actual number of birds captured.

first day began at noon and ended shortly after dark. Nets were left in place and the second day lasted from shortly before dawn until noon. Captured birds were banded and bled for serologic tests and then released.

RESULTS

A total of 176 individual birds was recorded in 2,280 net-hours. Repeat captures raised the total nettings to 218 for an average of nine birds per 100 net-hours.

The total captures of each species recorded by the study are shown in Table 1, as is the number of immature birds netted. Figure 1 shows that over 50 per cent of the captures in July and August were immature birds of the year. Post-juvenal molt caused some difficulty in age determination, especially with chickadees and waterthrushes.

SIGNIFICANCE AND LIMITATIONS OF STUDY

This is believed to be the first sampling of small passerine birds of a red maple–white cedar swamp in which the edge effects from surrounding habitats were negligible. Those species of birds living or traveling in the tree crowns were infrequently sampled. For example, Cooper's Hawk, Common Crow, Great Crested Flycatcher, Black-throated Green Warbler, and other species

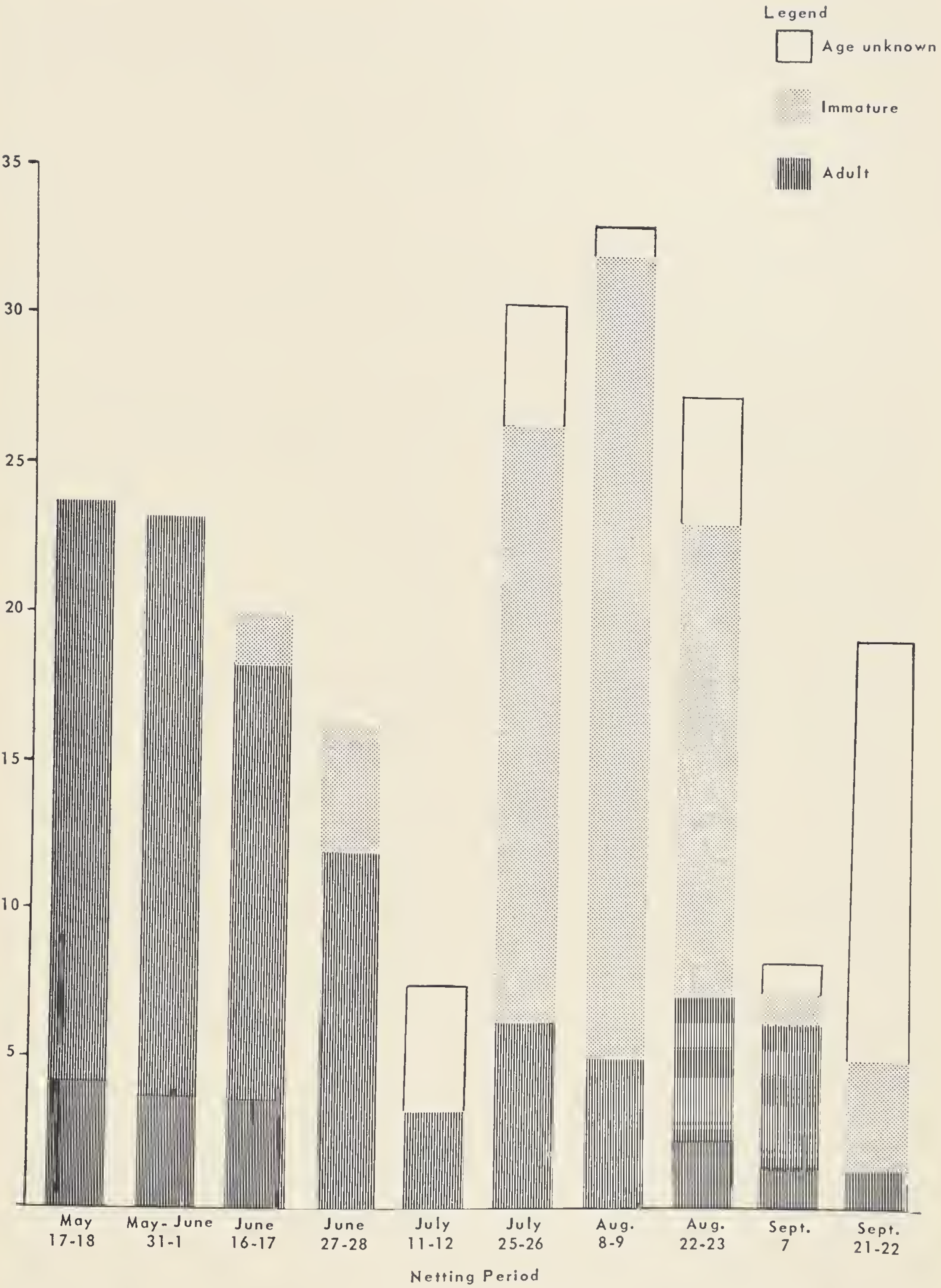

FIG. 1. Age distribution of wild birds captured per netting period within a red maple–white cedar swamp in southeastern Massachusetts during 1960.

were observed but were seldom snared in the nets. Some of the larger birds frequently bounced off the nets and escaped. Ruffed Grouse, Yellow-shafted Flickers, Common Grackles, Red-winged Blackbirds, and Blue Jays were seen to avoid capture in this manner. Blue Jays, Common Grackles, and Red-winged Blackbirds were often seen deliberately avoiding the nets. The number of these species collected did not seem to be indicative of the numbers present in the swamp.

It was not possible to assess any influence in the mist-net collections resulting from either recruitment or the development of net-shyness; in spite of the two-week interval between the relatively short netting periods, these phenomena may have occurred.

Based on captures, singing males, nests, and recently fledged young, the following species were determined to be breeding residents of the swamp: Ruffed Grouse, Hairy Woodpecker, Downy Woodpecker, Blue Jay, Black-capped Chickadee, Catbird, Robin, Wood Thrush, Veery, Black-and-white Warbler, Ovenbird, Northern Waterthrush, Yellowthroat, Canada Warbler, and Common Grackle. The American Redstart, Baltimore Oriole, and Rufous-sided Towhee were all immature birds taken in late summer and were probably wanderers into the swamp.

The data gathered contribute additions to the knowledge of the frequency and distribution of certain species. The summaries of the status of several species in 1925 (Forbush, 1929) and in 1955 (Griscom and Snyder, 1955) favor a theory of range extension over an explanation of the possible lack of field work. The Northern Waterthrush was recorded only once in the four counties of southeastern Massachusetts prior to 1925 (Forbush, 1929). It had become a common summer resident in western and northern Massachusetts in 1955 (Griscom and Snyder, 1955). The Northern Waterthrush probably was the commonest breeding warbler of this southeastern Massachusetts swamp in 1960. The Canada Warbler was listed as an occasional summer resident in eastern Massachusetts in 1925 (Forbush, 1929). Fifty miles north of the study area, an increase of this species was recorded in maple swamps, a new habitat, from 1928–1948 (Griscom, 1949). Many singing males plus seven netted birds indicated that Canada Warblers were present in numbers in this study area. The Ovenbird was last netted on 23 August. Such departure dates agree with statements of Forbush (1929).

The abundance of the Black-capped Chickadee netted was regarded as an indication of its abundance. As many as 11 per day were netted for a total of 35 individuals banded in this study. Forbush (1929) considered the chickadee to be an open woodland breeder. The present study in Pine Swamp indicated that chickadees were common to abundant in red maple–white cedar swamps.

The Robin owed its large number of nettings to an influx of immature birds during the fourth week of July, when the blueberries ripened. The five adult Robins taken prior to this invasion may have represented a more realistic picture of the population.

CONCLUSIONS AND SUMMARY

Birds of the understory of a red maple–white cedar swamp in southeastern Massachusetts were sampled by mist nets from 17 May to 22 September 1960. By arranging the mist nets along two 1,032-foot lines that bisected each other at right angles, a modification of a method developed by Stamm et al. (1960), 176 individual birds were netted for an average of nine birds per 100 net-hours. The netting was done at least 1,000 feet from the swamp's edge, so border habitat effect was minimized. There was evidence that the ranges of the Northern Waterthrush and Canada Warbler have extended to the study area and that the Black-capped Chickadee breeds in red maple–white cedar swamps.

ACKNOWLEDGMENTS

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WING MOVEMENTS, HUNTING, AND DISPLAYS OF THE NORTHERN SHRIKE

Tom J. Cade

The recent papers by Selander and Hunter (1960) and by Hailman (1960) on wing-flashing of the Mockingbird (*Mimus polyglottos*) have focused attention on the difficulties of interpreting this kind of behavior. On the one hand, the function of wing-flashing is debated in these two papers; on the other hand, there are important unsettled questions about the origin and the phylogeny of such behavior. Especially important in the latter regard is the degree to which special wing movements in other species may be homologous with the wing-flashing of Mockingbirds. Before these problems can be resolved it will be necessary to have more detailed information, not only on wing-flashing and other types of wing movements in the Mimidae, but also for other passerines with similar types of behavior. It should be particularly rewarding to examine the behavior of other birds that possess conspicuous wing patches like those of *Mimus polyglottos*, to see whether or not such similar morphological features function in analogous ways and to determine to what extent the movements involved in this kind of behavior are the same in the different species.

The Northern Shrike (*Lanius excubitor*) provides an instructive comparison because in several ways it is remarkably like the Mockingbird. The two species are about the same size, and the plumages of the two are similar in general coloration as well as in many details of pattern, including their conspicuous white wing patches. In the Northern Shrike, the white patch appears on the dorsal aspect of the wing distal to the tips of the primary coverts and extends from the first through the seventh primaries. The patch contrasts sharply with the rest of the dorsal surface of the wing. Ventrally the contrast is much less, and the outline of the patch can barely be distinguished. In the Mockingbird, the white patch also appears on the dorsal aspect of the wing distal to the primary coverts but extends from the first through the ninth primaries and also includes one secondary. The coverts of these remiges are also mostly white. The patch therefore covers a larger area of the wing than does the patch on the wing of a shrike. Furthermore, the patch is equally distinct on the ventral and on the dorsal surfaces of the wing of a Mockingbird. The most interesting similarity, however, lies in the fact that the Northern Shrike often uses special wing movements during its hunting forays in a manner which is like the wing-flashing of the Mockingbird.

The purpose of this paper, then, is to describe some wing movements of the Northern Shrike that appear to function in ways analogous to the wing-flashing of the Mockingbird, to compare these wing movements with others used by shrikes in different behavioral contexts, and finally to compare the wing movements of shrikes and Mockingbirds. These comparisons are made in an effort to discover whether or not homologies exist between the two species with respect to these wing movements and to add to the discussion on the phylogenetic origin of "wing-flashing" movements. Andrew's (1961) important paper on passerine displays provides a general background for the phylogenetic approach.

METHODS

Data on wing movements were obtained in two ways: (1) by observing wild shrikes around their nests in northern Alaska (Lake Peters; Colville River) and on their wintering ground in central New York, and (2) by studying closely the reactions of hand-reared and captive shrikes in various manipulated situations. Daily observations were made on the behavior of a pair of shrikes nesting at Lake Peters in 1960, and again in 1961, and less intensive observations were made on the actions of shrikes around 17 other nests at various localities north of the Brooks Range in the years 1958 to 1961. Many instances of special wing movements were recorded at these nests. Since 1959, 19 captive shrikes have been under study. Eleven of these were hand-reared nestlings, four of which were under observation for more than a year; and eight were trapped as adults or immatures in the winter around Syracuse, New York. One of the latter was also under observation for more than a year.

Most of the wing movements observed around nests were elicited under natural circumstances—consisting of reactions to potential nest predators, or to prey, and of social interactions between mates. A few tests were carried out in 1961 by placing stuffed shrikes and other dummies near nests. Wintering shrikes have been tested with dummies and by placing live, captive shrikes in their hunting areas.

The captives, on the other hand, were repeatedly subjected to experimentation. Primary consideration was given to testing the reactions of the shrikes to various kinds of live prey introduced into their cages and to testing their interactions with each other. But their responses to cats and dogs, stuffed hawks and owls, and to "strange objects" such as children's toys, have also afforded instances of special wing movements.

Finally, two hand-reared shrikes were trained by a slight modification of the techniques used in falconry to fly free out-of-doors, to hunt, and to return on call to a portable cage made of splintered bamboo. One of these birds was flown almost daily for more than a year and a half. These trained birds provided many instances of special wing movements while hunting or during hostile encounters with other species.

DESCRIPTION OF WING MOVEMENTS AND OBSERVATIONS

Special wing movements by shrikes occur in many different behavioral contexts, but these can be grouped into six categories for comparative purposes: (1) flight-intention movements, (2) food-begging by young, (3) courtship displays, (4) hunting tactics, (5) hostile reactions to enemies or to other, large species, and (6) stretching reflexes. The last-mentioned will not be considered in this paper, and food-begging is so similar to the familiar pattern observed in passerines that it need not be dealt with as a special topic.

FLIGHT-INTENTION MOVEMENTS

Description.—Flight-intention movements have been the subject of a good deal of ethological discussion (Daanje, 1950; Andrew, 1956), and the behavior is probably universal among flying birds; but the pattern of movements is not the same in all species. For instance, Andrew (1956) distinguishes four basic types of tail-flicks used by passerines in flight-intention.

Northern Shrikes indicate their intention to fly by stereotyped, readily recognizable patterns of behavior, one of the most characteristic components of which is a rapid flicking of the wings away from the body and back to it. Typically, these flicks are initiated from a normally folded position of the wings, and the movement, which is most conspicuous at the bend of the wing (carpus), appears to result mainly from rapid, partial extension and flexion of the forearm with simultaneous abduction and adduction of the humerus. Flipping the tail (down-up type) parallel with the median plane of the body often precedes the wing-flicks and, when executed alone, is the weakest expression of flight-intention given by shrikes. As the tendency to fly increases, the wing-flicks and tail-flips occur together, and the tail may also be spread and closed as it is flipped, particularly if aggressive tendencies are also present. These movements are performed in a more or less normal, upright sitting position with the plumage slightly sleeked. Ruffed plumage may occur if hostile tendencies are present. In its most intense expression, flight-intention also includes various bobbing and twisting movements of the body, which is oriented in the horizontal plane, with the tail being flipped rapidly down and up or rotated quickly from side to side in synchrony with the wing-flicks. The plumage is extremely sleeked, except when aggressive tendencies are present, giving the bird a long, thin appearance. Such extreme movements are most often performed during "conflict" situations—for instance, when a shrike encounters nest predators or strange animals, when it spots quarry that may present difficulties of capture (large rodent), or when it sees tempting prey but is not highly motivated to hunt. Sometimes a very striking display is produced with the white wing patches and the white parts of the tail feathers both "flashing" conspicuously.

Typical observations.—12 February 1961. Example of low intensity movements. An immature shrike was observed near Cicero, Onondaga County, New York, sitting in the top of an elm tree about 60 feet above the ground, which was covered with deep snow. I set a balchatri trap (see Cade, 1955; Berger and Mueller, 1958) baited with a live canary on the snow about 350 yards from the shrike. As soon as I withdrew to my car, 50 yards from the trap, the shrike flew toward the trap but stopped about 50 yards short and flew into a small willow tree, where it chased a Blue Jay (*Cyanocitta cristata*), which I had not previously seen. The jay flew away, and the shrike sat on a low branch of the tree about 5 feet above the ground intently watching the canary. The shrike apparently was not very hungry, because it sat in the same place for nearly 10 minutes watching the trap and occasionally flipping its tail down and up. Finally it flew toward the trap but alighted on the snow and hopped all around the trap instead of landing on top of it. Then the shrike jumped up into the air and hovered about a foot over the trap for several seconds before flying off to land in a small bush about 10 yards away from the trap. There it perched in a horizontal position facing the trap with the tail flipping and the wings flicking off and on for a minute or more. Then the shrike flew back to the trap and hovered over it again but did not land. Slight variations of this performance continued for about 10 minutes before the shrike finally lost interest and flew away.

15 January 1960. Example of high intensity movements. A captive, adult female shrike was taken into a living room where a full-grown house cat was sleeping on the hearth. This shrike was tame enough to sit quietly on my finger. I stood in the middle of the room holding the shrike on my finger about 5 feet above the floor. The cat was then awakened, and as soon as she began to stretch and move a little, the shrike immediately sleeked down her plumage to an extreme degree and assumed a rigid, upright posture. As the cat moved around the room, the shrike turned her head to follow but otherwise remained motionless. The cat did not stalk the strike or approach closely. Gradually the strike began to relax her plumage and appeared to become "alert" and "curious" about the actions of the cat. Soon her tail began flipping, followed shortly after by wing-flicks. I then called the cat to my feet, the shrike still being perched on my finger 5 feet above the floor. As the cat approached, the strike became active on my finger, constantly shifting the position of her feet. She moved into a horizontal position and started screaming a series of *jaa* calls, which wild shrikes use in the presence of mammalian predators at their nests. Occasionally an alarm whistle was also uttered, and the shrike began twisting and bobbing her body rapidly, at the same time quickly spreading and closing her tail and flicking her wings as she looked down at the cat below. The cat was then removed from the room, and the shrike soon quieted down, although she remained sleeked and alert for several minutes after.

COURTSHIP DISPLAYS

Description.—Quivering and fluttering movements of the wings are used by male and female shrikes in many of their social interactions during the breeding season. I have not yet observed the complete sequence of courtship displays in the wild, but captive pairs in large, indoor flight rooms have given a good many hints about what probably takes place. Only details pertinent to the present topic are presented here.

Most of the displays involving wing movements are concerned with some expression of the tendency to engage in courtship-feeding, which is the main interaction between male and female shrikes during the preincubation phase of the breeding cycle. The male, when presenting food to his mate, quivers or flutters his wings and utters a call note, which phonetically is *wuut.* The call sounds the same as the note which males and females use when they land on the rim of the nest with food for the young. The female, when soliciting for food from her mate, also quivers or flutters her wings and utters a whining note like *waik, waik* repeated over and over. This sound is much like the food-begging whine of the nestling or, especially, the fledgling shrike. A single captive male with developed gonads will often take a bite of meat in his beak and hop about over all the perches in his room, fluttering his wings (wing patches make conspicuous flashes) and uttering *wuut* sounds. These activities are usually interspersed with periods of singing. Likewise, a single captive female with developing gonads will often sit fluffed out on a branch in her room, quivering her wings and calling *waik.* This behavior is also interspersed with singing. Captive females readily learn to associate their keeper with food and will give this display when he enters the room with meat in his hand.

Males also quiver or flutter their wings quite often when they are singing, and there is a special, upright bill-raising display given by males and females —often during song—in which the wings are quivered, the tail is spread, and the bird's back is turned toward its mate. The function of this display is not yet clear. It is given most often when the mate of the reactant approaches closely, and it appears to be some form of appeasement display. Van Tyne and Berger (1959), Selander and Giller (1960), and Andrew (1961) discuss bill-raising as a component of different kinds of display among passerine species.

All these courtship displays have "degrees of expression," which are indicated in part by the intensity of the wing movements. At low intensities the wings are held with the tips slightly drooped to the sides below the level of the rump, against which they are usually folded in the resting position, and they are then quivered slightly. The movement is most conspicuous at the tips of the wings, in contrast to flight-intention movements, which are most obvious at the carpus. Vocalizations may not be given at all. As the tendency to engage in courtship-feeding increases, vocalizations are added, and the wings are held more loosely from the sides (slight extension of the forearms) and are quivered more conspicuously. In the extreme expression, the vocalizations are loud and constantly repeated, the forearms are extended from one-half to three-fourths their full reach, and the wings are fluttered by rapid strokes of the humeri. Although the hands never seem to be maximally extended during these extreme wing-flutters, the wing patches are quite visible and make conspicuous "flashes" as they pass through the arcs described by the moving wings.

Wing movements are not a part of the usual intraspecific agonistic displays of the Northern Shrike, but spreading of the tail and ruffing of the feathers on the dorsum are. Occasionally when a subordinate, caged bird is hard pressed by a dominant individual, it will assume a juvenile posture with the feathers fluffed out and its head sunk deep into the furcular region, whereupon it quivers its wings and utters the food-begging whine. This reaction probably is not normal but occurs only in confined places such as cages. The fact that wing movements are not usually a part of the intraspecific hostility of the Northern Shrike should be borne in mind when considering the descriptions of hostility toward other species.

Typical observations.—8 June 1959, 5:00 PM. The following observation was made at a nest in a stand of willows on an alluvial fan at the northeast corner of Lake Peters, Alaska. Six eggs were present. When first observed, the female, an immature bird, was perched atop a willow a few feet from the nest. She was singing a repetitious song phrase and occasionally fluttering her wings and giving voice to the *waik* food-begging whine. In a few seconds, the adult male flew to her from an undertermined point lower down on the fan and fed her a bit of meat. Both birds fluttered their wings during the feeding. The male then departed, and the female flew to the nest and soon sat on the eggs.

15 June 1959, 3:00 PM. This observation was made at a nest on the east side of Lake Peters. Eight recently hatched young were in the nest. The male was perched quietly in the top of a willow about 10 yards away from the nest, while the female was sitting on a branch about a foot from the rim of the nest. The female kept up a continual food-begging display for about five minutes, with frequent whining and the wings constantly quivering. Suddenly the male flew away about 30 yards downhill to a mouse carcass hung in a fork two feet above the ground. As he flew, the female turned on her perch, keeping her head pointed in his direction, her whines became louder and more rapidly repeated, and her wings were quivered more. The male stripped off a piece of meat from the carcass and then flew with it in his beak back to his first perch, where he looked down intently at the female or at the nest. The female's begging increased still more, as her wings were extended farther from her body and were fluttered through a wider arc than previously. In a few seconds, the male flew down from his perch, dropping low just over the ground to land in the lower branches of the nest tree. Then by jumping from branch to branch he worked his way up to the nest. He jumped right past the food-begging female to the rim of the nest, where he immediately fed one of the young. He remained on the rim of the nest, looking down at the young and poking his beak among them, apparently waiting for a fecal sac to be voided. During this time, the female was actively flitting about in the branches just above the nest, making a hollow *beek* sound and still quivering her wings. After a few more seconds, the female came to the nest and settled on the young while the male was still on the rim. The male then flew back to his original perch.

29 January 1961. Observation on the initial introduction of a captive, wild-caught adult female to a captive, hand-reared immature male. The male had been on a 20-hour photoperiod for 28 days and was sexually motivated; the female had been on an 8-hour

photoperiod for several months, but she too showed some behavioral signs of sexual recrudescence. At 8:15 PM the female was placed in the room where the male was kept. Bits of meat were present in the food dish. The female flew to the back of the room and landed on a high perch, where she sat looking around. She appeared neither frightened nor aggressive, but sat quietly in a normally relaxed posture. The male did not attack her or make any vocalizations, but he flew to a perch about 6 inches directly above her and sat looking down at her for a couple of minutes with his head lowered below the level of his feet and his tail pointing obliquely up into the air. The female did not move away or display aggressively; instead, she sat with her head pointed up at the male but sunk deeply into the furcular region. Soon the male flew several feet to the front of the room, where he sat looking at the female in a mildly hostile posture with his crown raised and the feathers on his back slightly ruffed. The female began looking down at the food dish, soon flew to it, and ate several bites while perched on the rim of the dish. Then she flew back to her previous perch, but almost immediately she dropped down again, this time to the water dish, where she drank. While she was at the water dish, the male suddenly swooped down over her uttering the aggressive, rattling *aak, aak* call, but the female continued to sit calmly on the dish without displaying. Then she hopped over to the food dish and ate some meat. Again the male dived over her screaming, but she continued eating as though he were not even in the room. Soon the female flew back up to her perch, where she wiped her beak, roused, and began preening her plumage. The male then hopped to a special perch where he sang a lot of the time (his chosen nest-site), assumed a sleeked upright posture with his beak pointing up and his tail fanned out, and quivered his wings violently, keeping his back to the female and uttering a series of *wuut* notes. The female continued to perch quietly. Then the male flew down to the food dish, picked up a bite of food in his beak, looked up at the female, quivered his wings and uttered *wuut*, and then flew straight up to her side, fluttering his wings and uttering *wuut* over and over. He offered the piece of meat to the female, who took it immediately without making a sound or moving her wings. This first feeding occurred 15 minutes after they had been introduced. In the next half-hour the male fed the female six more times. Each time his wings were quivered or fluttered, but no sound was made. The female did not move her wings or vocalize during these first encounters.

HUNTING TACTICS

General description.—The Northern Shrike hunts in two basic ways. Most commonly the shrike perches on some high vantage, usually the upper branches of the tallest tree in the area, from which it keeps a vigilant watch for suitable prey moving on the ground or in the air below. Once the quarry is chosen, the shrike suddenly drops straight down from its perch and flies just above the surface of the ground, often using concealing landforms to remain hidden from view of the quarry as it approaches. Thus, it apparently attempts to catch the prey by surprise. This method of hunting is quite reminiscent of the tactics used by accipiters (see Tinbergen, 1946, for details about *Accipiter nisus*).

Alternatively, the shrike may move actively about on the ground, through brush, or among the branches of trees in apparent attempts to flush quarry into flight. This type of hunting is more likely to take place after the shrike has failed to effect a capture by the first method, and the prey has sought cover.

Birds are sometimes pursued actively in flight, and occasionally they are caught in the air; but I believe aerial capture is exceptional and that birds are usually taken by surprise while perched on the ground or in bushes and in trees. The Northern Shrike catches birds in its feet, just as an accipiter does; but it kills them—and all other vertebrate prey—by biting into the neck and severing the cervical vertebrae, just as falcons do (see Cade, 1960). I have never seen an exception to this method of killing, and Thielcke (1956) also calls attention to the fact that this shrike always kills with its beak.

A shrike does not usually grab a rodent in its feet, because it is likely to be bitten if it does so. Instead, it jumps and dances erratically about the rodent, reaching in when the advantage is right to deliver a series of quick bites at the neck. A small mouse weighing 20 to 25 grams is easily killed in a few seconds, but larger rodents weighing 50 grams or more may take several minutes and many bites.

When hard pressed by a shrike, small birds always seek the protection of dense brush or thickly branched trees, in which they "freeze" and from which they are reluctant to leave. Once inside a bush or among the branches of a tree, small birds are relatively safe from a shrike, even if the predator plunges right among the branches with them, for a small bird like a chickadee or sparrow by hopping from branch to branch can easily avoid the shrike, which cannot maneuver so fast or so adroitly through the dense tangle of branches. Only if a "frozen" sparrow does not see the shrike approach, or if it essays to fly out of the tree across open terrain to an adjacent patch of cover, does the shrike have a possibility for effecting a capture.

I have seen one of my trained shrikes stalemated for half an hour in an isolated spruce tree with a flock of six to eight Black-capped Chickadees (*Parus atricapillus*), which were often perched only one or two feet away from their antagonist. The chickadees, constantly uttering the *chickadee-dee-dee* call, would work their way up to the top of the tree pursued from branch to branch by the shrike. When they finally reached the top and it seemed that the shrike would at last have a chance to pounce on one, instead of flying off to an adjacent tree, the chickadces one by one, dodged around the shrike and started working their way back down the tree, with the hapless shrike still in pursuit.

It was during these encounters with quarry holding to dense cover that I first became aware that shrikes use special wing movements under such circumstances in apparent attempts to flush the prey into a more vulnerable position. Under such circumstances, the hunting shrike often flits about through the branches with bobbing and twisting movements of the tail and with the wings quivering or fluttering. Some of these movements are quite clearly flight-intentions, but others are not. Often the wings are quivered only slightly, just as in low intensity courtship-feeding. The movements are exactly the same. In a more intense expression, the wings are extended from the sides and are fluttered up and down rapidly, during which the wing patches describe conspicuous flashing arcs. Again the actions are indistinguishable from high intensity food-begging movements. The tail is also spread and closed rapidly, a movement which is unlike the aggressive spreading of the tail, in which the tail is held in the spread position and is associated with ruffed plumage. In the most intense expression of this behavior, the wings are greatly extended from the body but are drooped so that the tips of the primaries are well below the axis of the body, and the tail is maximally spread. As the tail is spread, the wings are swept forward, during which there is a conspicuous extention of the hands, producing a maximum exposure of the white areas on the primaries. Then the wings are snapped back to a drooped, half-extended position, and the tail is closed. One complete cycle of these movements produces a conspicuous flash of the wing patches and of the white areas on the tail.

Similar movements are performed on the ground during attacks on large rodents. In these encounters the tips of the primaries may actually touch the ground as they are swept forward. The wings are never held high over the back of the shrike, although sometimes they are extended horizontally from the sides. Forward sweeping of the wings with extension of the hands is especially likely to occur when the shrike is attacking a rodent near the maximum size it can kill (80 to 100 grams). No vocalizations usually accompany these movements, except when aggressive tendencies are also present, as may be the case when a vigorous rat fights back. In that event, ruffing of the dorsal feathers also occurs.

Typical observations.—7 June 1959 at the south end of Lake Peters, Alaska. As I was walking along one of the channels of Carnivore Creek, a sudden commotion at the mouth of the creek 50 yards away caught my attention. An adult shrike was chasing a female Lapland Longspur (*Calcarius lapponicus*) along a zigzag course one to two feet above the ground. The shrike followed every twist and turn of the longspur, keeping just behind her tail. The birds flew upstream toward me. Then a male longspur descended from the air above and joined in the flight, uttering alarm notes and flitting about above the shrike. The latter did not take its attention away from the female longspur. When about 20 yards from me, the shrike struck at the female longspur—it was not possible to tell just how—and she fluttered down into some clumps of grass about one foot high on the bank of the creek. There were also some large rocks and mounds of dirt that afforded hiding places for the longspur. The shrike hovered over the spot where the longspur disappeared and then dropped to the ground. The shrike began hopping about in an excited manner from grass clump to grass clump, up onto rocks and mounds of dirt, clinging momentarily to stems of grass, back to the ground, maneuvering all through the area where the longspur had evidently hidden. Unfortunately, I did not pay close attention to the wing movements during this episode, but the wing patches and white markings on the tail were definitely flashing much of the time. All this while the male longspur kept flitting about, calling in the air above the shrike. In crossing the creek to approach closer, I was forced to divert my attention momentarily from the action of the birds, and when I was able to look up again, the shrike was flying heavily away with a longspur in its feet. It flew a straight course for a quarter of a mile to a small patch of willows on a lateral moraine along the east wall of the valley. While in flight the shrike was assailed by a Water Pipit (*Anthus spinoletta*). I marked the spot where the shrike landed, and in a few minutes I found the prey already decapitated and wedged into the forked branch of a decumbent willow, lying on the ground. It was a male longspur! Apparently, not being able to find the female, the shrike had turned suddenly on the pestering male and caught him instead.

21 August 1958 at Jago Lake, Brooks Range, Alaska. Three post-fledgling, juvenile shrikes—probably siblings of a late brood—had been hunting for a week about our camp at Jago Lake and in the willow brush growing on alluvial bars in the flood plain of the Jago River. These birds evidently had been attracted to the area by an unusual swarm of grasshoppers, which appeared in mid-August. The shrikes were observed repeatedly taking these insects from the tundra vegetation. On this date, one of the shrikes was observed perched in the top of a willow growing in the river bottom. Twenty yards across the river there was a steep slope with large boulders protruding from the tundra mat of mosses, dwarf willows, heaths, and other decumbent shrubs. Suddenly the shrike flew across the river and landed on top of a rock. Orienting itself horizontally, the shrike looked down intently at the ground and then simultaneously fluttered its wings and spread and closed its tail. This act was repeated several times in quick succession; then the shrike jumped to a spot on the ground about three feet away and snapped up a grasshopper in its beak. The shrike flew back up onto the rock and ate the insect there. Since the wing patches and the light markings on the tail of juvenile shrikes are not pure white, no striking flashes were produced by movement of the wings and tail on the rock, but the behavior was typical of movements which I was later to see executed many times by my tame shrikes, and it was followed, in this case, by the immediate capture of food.

24 June 1961 at Lake Peters, Alaska. Observation on three hand-reared young. These young shrikes had been removed from their nest at the age of 13 to 14 days and were 22 to 23 days old on this date. They were kept in a small tent with a floor space of 6 by 6 feet and a ceiling height of 6 feet at the apex. A willow bush was provided for perches. At this age the young were actively hopping about in the branches of the willow, but they could not make sustained flights of more than a few feet. Numerous blowflies and other small, flying insects became trapped inside the tent and spent their time crawling about on the walls and ceiling. One of the young shrikes was observed watching intently all the moves of a blowfly crawling on the tent about two feet away from the bird. This fly frequently buzzed around inside the tent. Whenever the fly came within 6 to 8 inches of the shrike, the bird sleeked its plumage, assumed a horizontal position facing the fly, and quivered its wings, as in low intensity food-begging. If the fly came close the shrike also snapped at it. On subsequent days, all three of the young shrikes were seen performing this kind of behavior many times, as they became more interested in stalking and catching these insects. Captures were frequently made.

2 September 1960 at the Manlius School, New York. Large flocks of Chipping Sparrows (*Spizella passerina*), Robins (*Turdus migratorius*), and Starlings (*Sturnus vulgaris*) were foraging on the athletic fields. I walked up close to a group of sparrows, carrying

one of the trained shrikes (Green, a female weighing 65 grams) in the portable cage. At a distance of 10 yards, I released the shrike, but she did not pursue the sparrows; instead, she returned immediately to the cage looking for food, putting many of the sparrows to flight as she did so. Finally, she flew out again and landed on some bleachers back of a baseball diamond. A dozen sparrows were feeding under the bleachers. On seeing the shrike, some of these sparrows flew up and landed a few feet away from her on the top of a bleacher. The shrike immediately sleeked her plumage and assumed a horizontal position with her head pointing toward the sparrows. Then she began quivering her wings and hopping toward the sparrows along the back of the bleacher. The sparrows did not act frightened and did not take flight until the shrike was less than a foot away and almost close enough to grab one. The sparrows then flew toward a stand of second-growth aspen, and the shrike chased after the birds but soon lost them in the dense brush.

20 September 1960 on a vacant lot in Manlius, New York. A flock of House Sparrows (*Passer domesticus*) was feeding on the ground in a vegetable garden. I approached slowly with a trained shrike (Red, a male weighing 75 grams) in the portable cage, but the sparrows became frightened, and one by one they started flying up into a nearby spruce tree. The shrike immediately sleeked his plumage, assumed a horizontal position on his perch inside the cage, and quivered his wings. I released the shrike 10 yards from the spruce tree. He flew straight up into the tree to a height of 15 feet and caught an immature sparrow sitting on an outside branch. I feel certain the sparrow did not see the shrike approaching. The shrike fluttered to the ground with his prey, and there holding the sparrow by its wings, he bit its neck several times until it was dead.

22 October 1960 in the backyard of my residence in Manlius, New York. Carrying Green in the portable cage, I approached a Black-capped Chickadee foraging in the lower branches of a leafless tree about 15 feet above the ground. At a distance of 20 feet, the shrike saw the chickadee and reacted with the characteristic sleeking of the plumage and assumption of a horizontal position on her perch. Her wings were then quivered several times in rapid succession. The chickadee paid no attention to our presence. I opened the cage door; the shrike dashed out and grabbed the chickadee before it had a chance to move off the branch. She carried the prey in her feet to the roof of a nearby garage, where she killed it by biting into its neck. Then she flew with the chickadee to an apple tree, where she hung it by the neck in the forks of a branch.

22 October 1960 at the Manlius School, New York. I took Red to the athletic field, where I released an adult male House Sparrow for him to chase. There was a long "tail-chase" all about the field, following a zigzag course of about 300 yards. Finally the sparrow escaped into a low hedge at the side of the gymnasium. The shrike perched in the branches of a tree about 10 feet above with his head pointed down below the level of his feet and his tail pointed diagonally upward. His tail and wings were repeatedly moved in flight-intentions. I ran up and put the sparrow out of the hedge several times. The shrike was very eager, but he missed the sparrow each time it was in the open. Finally the shrike flew into the hedge with the sparrow and hopped from branch to branch in pursuit, but the sparrow easily kept ahead of him to the end of the hedge at the corner of the building, where it flew quickly around the corner and disappeared from my line of sight with the shrike immediately after it.

I do not know what happened after that for several seconds, but the sparrow somehow slipped away from the shrike. About 50 yards up a hill from the gymnasium I contacted the shrike again. He was perched atop a dense thorny bush with three, excited Black-capped Chickadees flitting about in the lower branches. Periodically the shrike sleeked down his plumage, assumed a horizontal position, quivered his wings, and then jumped down among the branches where he hopped about after the chickadees. While pursuing the chickadees from branch to branch, the shrike often extended his wings from his sides and fluttered them, at the same time spreading and closing his tail. The chickadees were so reluctant to leave the cover that even when I crawled in under the bush and tried to shake them out they would not fly away. Often one of the chickadees was no more than a foot away from my face. My close presence seemed to spur the shrike to renew his attacks from above with increased vigor—especially the extent to which his wings were fluttered—but in more than 5 minutes of repeated attempts, he never got really close to one of the chickadees. Suddenly the shrike flew away. Squatting under the bush, I could not see where, but it was evidently a long distance, because the chickadees soon essayed to fly across an open weed field. I lost contact with the shrike for about 5 minutes.

When next encountered, the shrike was in some tall elms behind the gymnasium, attacking a Blue Jay. The jay, putting up surprisingly little defense, kept moving away from the shrike and uttering very metallic, ravenlike croaks as it flitted from branch to branch. Then two more jays appeared, and the shrike chased after them all with abandon, fluttering his wings whenever he approached one of the jays closely. The jays soon left. In the brush below the trees, there were several Robins, and the shrike next dived down and chased these birds out of the area. In the same patch of woods, there were also two Downy Woodpeckers (*Dendrocopos pubescens*) foraging on the trunks of the larger trees. After returning from the Robins, the shrike flitted up into the branches near the woodpeckers and started the characteristic bobbing antics with his wings quivering or fluttering. Then he flew at one of the woodpeckers, which avoided his attack by dodging around to the other side of the trunk. The shrike then sat on a branch bobbing up and down, quivering his wings, and spreading and closing his tail for several seconds before attacking again. The result was always the same: the woodpeckers easily avoided him by moving around on the tree trunks. Then another Robin flew by just over the tree tops, and the shrike left the woodpeckers to chase after the Robin. This flight ended about 300 yards away on a building, where the shrike landed on top of a tall smoke stack after losing the Robin in some shrubbery around one of the dormitories. I followed after and arrived just in time to see the shrike chase a feral pigeon around the building. The pigeon spiraled up high, easily leaving the shrike behind. Red returned to the top of a nearby spruce tree, and I finally called him back into the cage almost an hour after his initial release.

30 October 1960 on a vacant lot in Manlius, New York. After an unsuccessful attempt to catch a Black-capped Chickadee, Green perched 20 feet above the ground in the top of a leafless tree. Standing 20 yards away, I released an adult female House Sparrow, which started flying toward another tree about 50 yards away. The shrike immediately chased after the sparrow and soon caught up with it. Just as the sparrow was approaching the tree, the shrike made a determined but unsuccessful attempt to snatch the sparrow in flight. The sparrow fled into the central branches of the tree, where it sat cowering. Just as the sparrow was entering the tree, the shrike abruptly changed course and shot straight up to the topmost branch of the same tree. She sat motionless in an upright position with her head cocked down, obviously looking intently at the sparrow. I had the distinct impression that the sparrow did not see where the shrike had gone. At any rate, the sparrow continued to sit motionless on its branch in the central part of the tree. A few seconds later, the shrike suddenly plummeted straight down through the branches and grabbed the sparrow with her feet before the prey could move. The shrike sat right where it had caught the sparrow and began biting into its neck. The sparrow uttered a series of squeals (a typical reaction of House Sparrows when caught by a shrike), and almost at once three other House Sparrows and two Downy Woodpeckers flew into the

tree and started mobbing and scolding the shrike. When the shrike had first grabbed the sparrow, she also had caught hold of a spray of twigs in the same foot. During the mobbing, the captured sparrow managed to struggle loose, but the shrike continued holding onto the spray of twigs, struggling with it and trying to fly away with it, acting as though she still held onto the sparrow. In the meantime, the sparrow escaped with the other three, apparently before the shrike realized she no longer held her prey. The shrike then pursued the two pestering woodpeckers, which retreated into the upper branches of the tree. Again, these birds easily eluded the attacking shrike by dodging around on the trunks. The shrike kept up a series of short attacks from branch to branch, and between attacks while perched on a branch watching the woodpeckers, she fluttered her wings conspicuously and spread and closed her tail. The woodpeckers were just about as aggressive as the shrike and made short advances toward her, scolding and also fanning out their wings. The interaction between these birds continued for more than 10 minutes, before I was finally able to entice the shrike down to her cage for a bite of meat.

17 December 1960 in a large outdoor flight cage. An immature laboratory rat weighing 77 grams was placed in the cage with Red. The rat moved about normally exploring the floor of the cage. The shrike sat in an alert, horizontal position four feet above, looking intently down at the rat and following its every move by appropriate turns of his head. Then his tail began flipping down and up, followed by a number of flight-intention flicks of his wings. The flight-intention flicks were interspersed with brief periods of wing-quivering. Then the shrike dropped onto the ground and hopped rapidly up behind the moving rat. The rat stopped briefly in a corner, and the shrike jumped in close to deliver a quick bite at the neck, but the rat turned on the shrike, warding the bird off with its forelegs. The shrike jumped back a few inches and stood in an upright posture looking at the rat and uttering *jaa* calls. The rat began to move away; then the shrike started a series of quick jumps and flits around the rat, fluttering his wings repeatedly and giving the *jaa* call. Often, the shrike moved in close and struck toward the rat's neck with his beak, being careful always to jump back quickly. Between encounters, the shrike flew back up to a perch to watch the rat. There, looking down intently, the shrike quivered his wings and called. After several such attacks, the shrike flitted to the ground and hopped toward the rat, which was now cowering from several hard bites in the neck. As the shrike approached closely, he slowed down, assumed an erect posture with the feathers of his neck and crown ruffed out aggressively. His tail was spread and depressed toward the ground, and his wings were extended and drooped so that the tips of the primaries were near the ground. Then, as the shrike made quick hops at the rat, he swept his wings forward with maximal extension of the hands, producing a conspicuous flashing of the wing patches. As he flicked his wings back to a half-folded. drooped position, the shrike also jumped back away from the rat. These maneuvers were repeated several times. The rat did not move. Then the shrike hopped quickly to the rat again and bit into its neck with a long hold of several seconds. This bite caused the rat to drag itself away sluggishly, and the shrike quickly followed the struggling rat, delivering a series of hard bites to the neck. After 4 minutes and 50 seconds from the time of the shrike's first bite, the rat lay on its side, kicking its hindlegs spasmodically. The shrike sat quietly nearby, occasionally nibbling at one of the twitching feet of the rat. It took the shrike a total of 117 grabs at the neck to kill this vigorous rat.

HOSTILE REACTIONS TO LARGE ANIMALS

General description.—In this category I have grouped together the responses of shrikes to a variety of different species and under varying circumstances—potential nest predators, competitors for food, non-predator species too large to serve as prey, strange objects, stuffed hawks and owls. The one feature common to all these animals is that they are too large to be killed by shrikes. The wing movements used by shrikes in encounters with these species are exactly the same as those described previously in the section on hunting. While there is no absolute difference between the responses of a shrike to a large prey animal—for instance, an 80-gram rat—and a potential predator or competitor for food such as a Kestrel (*Falco sparverius*), there are average differences in the frequency with which the various kinds of wing movements occur in the two situations. When reacting against a species too large to kill, the shrike is more prone to employ the extreme "wing-flashing" movement, in which the wings are extended, drooped, and swept forward with maximal extension of the hands. Moreover, the aggressive *jaa* and *aak* calls are given frequently during these encounters, and the displays involving wing movements are often interposed by true hostile displays, such as are used in intraspecific aggressive encounters, which employ ruffing out of the feathers on the dorsal surfaces and extreme spreading of the tail. These aggressive, ruffed-out postures rarely occur during hunting attacks and then only when the quarry is very large and potentially dangerous (large rodent).

Typical observations.—6 July 1959 on a brush-covered island along the middle reach of the Colville River, Alaska. A recently abandoned shrike nest was found at the edge of a dense stand of willows averaging 15 feet in height. Both adults and three or four young were still present in the immediate area. The nest, which was situated about 8 feet above the ground, had been ripped apart. Most of the outer structure of sticks had been torn or shaken loose, and ptarmigan feathers from the inner, felted layers were strewn about on the ground under the nest over a radius of 6 feet or more. Although all the young present were fledged, the adults still protected the nest, following me to the site and sitting nearby scolding with the *jaa* call and ruffing out the feathers on their backs and crowns. While I was examining the nest, the adults suddenly turned their attention from me and flew 30 or 40 yards away through the brush, uttering loud and persistent *jaa* screams, which continued all through the subsequent action. I could see the shrikes diving from the willows toward some animal on the ground and then quickly darting back up into the branches. There they hesitated a few seconds, looking down, screaming, bobbing up and down, spreading and closing their tails, and fluttering their partly extended wings before attacking again. The wing-fluttering was interspersed with typical wing-flicks of flight-intention. The extreme "wing-flashing" movement was not seen. As the shrikes continued attacking, they moved in my direction toward the nest. Suddenly a Red Fox (*Vulpes fulva*) appeared in a clearing between two willows. The fox stopped about 10 yards away when it saw me; then it turned around and trotted off casually with both shrikes still diving over its back and screaming. It seems likely that this fox had visited the nest previously.

26 October 1960 in the Episcopal Church Cemetery, Manlius, New York. Following an unsuccessful flight after a House Sparrow, Red flew up into the main branches of a tall elm, where an adult Gray Squirrel (*Sciurus carolinensis*) sat husking a nut. The shrike showed immediate interest in the squirrel, which began to chatter when the bird

flew into the tree. The shrike sat several feet above the squirrel, intently looking down at it and flipping his tail down and up for several seconds. Then the shrike flew down and hovered just over the squirrel's head. The squirrel became agitated and started scolding. The shrike flitted back to a nearby branch and sat there in a horizontal position, spreading and closing his tail and fluttering his wings. No vocalizations were given. Then the shrike dived over the squirrel's head to another branch. The squirrel flattened out on its branch. The shrike next landed on the same branch with the squirrel and advanced toward it by a series of short hops. As he approached, the shrike extended his wings horizontally and fluttered them periodically. When the shrike was within two feet of the squirrel, he drooped his wings and swept them forward in conspicuous flashing movements. At the same time his tail was spread and closed. As soon as the squirrel moved a little, the shrike quickly flitted away to a close branch. Variations of this attack and retreat were repeated for about 5 minutes, until a sparrow flew by diverting the shrike's attention from the squirrel. Later, in the same area, the shrike also had a similar encounter with two subadult Red Squirrels (*Tamiasciurus hudsonicus*). The same wing movements were again very much in evidence. The shrike pushed his attack a little more vigorously with these smaller squirrels, actually striking one and causing it to fall several feet through the branches before it regained a hold. Both these squirrels finally escaped by running into hollows.

20 February 1961 in a large, indoor flight room. An adult, male laboratory rat weighing 300 grams was placed in the room with Red and an adult female shrike (Blue). Both birds immediately fixed their attention on the rat and followed its every move for more than 10 minutes. They uttered no vocalizations, and their plumages were sleeked at all times. The shrikes assumed a horizontally crouched posture with their heads slightly lower than their tails. Their heads were cocked downward with one eye always following the rat, which moved about actively on the floor below. In this posture, the shrikes hopped from branch to branch slowly following the rat, but not once did either bird attempt to dive at the rat or strike at it. There were, however, many typical flight-intention tail-flips and wing-flicks, and several times Red also quivered his wings slightly. Blue also quivered her wings once or twice, but she was less responsive to the rat than Red was, and at the end of 10 minutes Blue was no longer paying close attention to the movements of the rat; but Red's attention was still completely fixed on the rodent.

Then I removed the rat briefly, killed it by concussion, and threw it back on the floor of the room. The rat made a few convulsive kicks of its hindlegs for several seconds. Red's reaction was immediate. He hopped down to a perch just above the rat and gave many intention-movements to jump down by the rat, but he appeared reluctant to do so. During all the time the rat was lying on the floor, the shrike never approached closer than about 18 inches; but for 5 minutes he was in close attendance. During this period the shrike fluttered his wings many times whenever he approached the rat closely. Especially when he moved close to the rat, the fluttering changed into the more conspicuous "wing-flashing" movement previously described. Sometimes, after several flashes, the shrike stood erect and motionless with the wing nearest to the rat drooped and more extended than the opposite wing, and his tail was spread and canted to the same side. The shrike appeared definitely reluctant to touch the rat, and I had the distinct impression that the bird was "trying to test" the rat to see whether or not it would move. Blue did nothing but sit high above and watch. After 5 minutes, Red's interest in the rat began to wane, and he started flitting up to higher perches, then returning briefly to display near the rat, soon flitting up again to sit near Blue. For three more minutes he continued to show some interest in the rat, but the wing-fluttering became subdued and finally merged into the low intensity quivering.

After Red's response had subsided, I picked up the rat and hung it by its neck in the forks of a branch three feet off the floor, in the typical way a shrike "impales" its prey. Again, Red's response was immediate. Showing no signs of fear or reluctance to approach, Red jumped right up to the rat and at once bit into its neck several times. Then he started trying to strip the skin around the eyes of the rat—the usual way a shrike begins to dismember a carcass for feeding. This response was in marked contrast to his cautious and hesitant behavior toward the rat when it was lying on the floor.

4 March 1961 in the same room. I placed a stuffed male Kestrel, mounted in a normal sitting posture, on a slanting perch one foot off the floor in the room with Red and Blue. Blue remained quiet on a high perch, only looking down at the dummy, but Red at once assumed an aggressive ruffed-out plumage with his tail widely spread and commenced a series of loud, rapidly repeated *aak* notes. At first, he flitted about in the upper branches, scolding and keeping his eyes fixed on the Kestrel. Occasionally he gave flight-intention movements. After about two minutes, he jumped down onto some lower branches, still ruffed out and screaming. Now and then he assumed a brief upright position, during which he quivered his wings as he looked down at the dummy. Finally he jumped to the slanting perch on which the dummy had been placed and advanced by short hops down the perch toward the dummy. His wings were quivering slightly. The shrike's movements on the perch caused the dummy to fall over on its side on the floor. At first the shrike was startled and jumped back on the slanting perch; but he then immediately began advancing toward the dummy again, no longer ruffed out and no longer vocalizing. The approach became cautious. When the shrike was about one foot from the dummy, he fluttered his partly extended wings, bobbed up and down, spread and closed his tail several times. Then he jumped back from the dummy, only to begin approaching again. Variations of this approach-and-retreat sequence were repeated several times. Usually the wings were fluttered on close approaches, and several times they were also flashed. Finally, the shrike hopped down onto the floor by the Kestrel and fluttered and flashed his wings and tail around the dummy for a minute or more. In about 5 minutes, the shrike's response began to wane, and he finally returned to the upper branches, although still looking down frequently at the dummy, occasionally ruffing out a bit and even uttering the scolding *aak* note.

DISCUSSION

The accounts presented above have been selected from dozens of similar records in my notebooks since 1958 and are sufficient to show that quivering, fluttering, and "flashing" movements of the wings are often associated with the hunting activities of Northern Shrikes and with their reactions toward potential predators or other large species. It is not surprising that little has been reported about this kind of behavior by previous investigators; the Northern Shrike is not a commonly observed bird, and it remains one of our least-studied Holarctic species. Miller (1931) in his account of the natural history of North American shrikes makes no mention of this kind of behavior; nor does Thielcke (1956) in his excellent analysis of the hunting behavior of the nominate race in Germany refer to such habits. Of the works I have reviewed, only Zimmerman (1955:205) records similar behavior based on his observations of wild shrikes in Michigan in the winter: "Near Imlay City, Michigan, December 5, 1954, I watched a subadult Gray Shrike fly from its perch on a roadside wire to a tree near a chicken yard where numerous House Sparrows (*Passer domesticus*) were noisily feeding on the ground. Apparently attempting to startle the sparrows into flight, the shrike began excitedly jumping about—from branch to branch, from the tree to an adjacent wire fence or to low telephone wires and back to the tree again—all the while flopping its tail and repeatedly spreading its tail and wings. As I followed the rapid action (with difficulty) through the telescope I was continually reminded of a Mockingbird's (*Mimus polygottos*) 'wing-flashing.'" Zimmerman's comment on the difficulties involved in making his observation substantiates my own field experiences and confirms the usefulness of making observations on tame or trained birds under partly controlled and partly natural conditions.

Although it is possible to conclude from the data presented here that these special wing movements are definitely associated with hunting and with hostile reactions toward other species, the function and the biological significance of this kind of behavior are open to several possible interpretations, as previously discussed by Selander and Hunter (1960) and by Hailman (1960) for wing-flashing of the Mockingbird.

BIOLOGICAL SIGNIFICANCE OF THE WING MOVEMENTS

Even though I have only once seen wing-fluttering by a wild shrike followed by the immediate capture of food—an association which Hailman (1960) has been able to establish by statistical analysis for wing-flashing by the Mockingbird—the fact that these movements occur so frequently during hunting forays leads to the inference that they serve a useful biological function. Moreover, the specific situations in which the movements occur during hunting—that is, when the prey has taken a stand in dense cover—strongly suggests that the wing and tail movements produce a startling effect that sometimes flushes the prey into flight or into moving sufficiently to make itself more vulnerable to capture. This conclusion is the most reasonable one that can be drawn from the present observations.

Similarly, intimidation and distraction seem to be the functions of these wing movements when they are directed against a possible predator or other large species. To this extent, the wing movements of shrikes also appear to function in ways analogous to the hostile use of wing-flashing by Mockingbirds (Selander and Hunter, 1960), but there is no indication that they also function as social displays in intraspecific aggressive encounters, as these authors claim for the Mockingbird.

Selander and Hunter (1960) concurred with Sutton (1946) that wing-flashing by the Mockingbird indicates a state of wariness, suspicion, and distrust. These are frankly anthropomorphic adjectives that also apply in a descriptive sense to the motivational state of the Northern Shrike when it is engaged in wing movements. The behavior seems to indicate that the shrike is hesitant or unsure about what action to take, especially when it has been thwarted in attempts to capture prey, which has escaped into safe cover, or when confronted by some strange or unusual encounter with another animal (a rat too large to kill), or a predator which does not fly away (stuffed hawk). There may also be an element of exploration or testing involved. Rand (1941) expressed a similar view about the "snake-display" of the Curve-billed Thrasher (*Toxostoma curvirostre*). (Although Rand's description is not explicit, the "snake-display" may be a form of wing-flashing.) For the moment it is impossible to describe the internal factors precisely, nor does it seem more heuristic to resort to ethological conceptualizations of the possible internal motivations involved (see, for instance, Hinde and Tinbergen. 1958).

COMPARISON BETWEEN SHRIKE AND MOCKINGBIRD

Pattern of the wing movement.—Hailman (1960) presents the best available description of the form of wing-flashing by the Mockingbird. The bird is usually standing on the ground in a normal body position with its head forward when the wing movements are given. The two wings are opened simultaneously in a series of distinct motions or "hitches," which vary from one to five in number. The direction in which the wings are opened also varies from horizontal extension to nearly vertical over the back. As the wings are hitched open, the white patches are flashed; then the wings are brought back to the body in one, quick, uninterrupted motion. According to Hailman there are no movements of the wings intermediate between wing-flashing and other characteristic, special wing movements of the Mockingbird. Hailman makes no mention of movements of the tail, which is conspicuously marked with white on the outer feathers in a manner similar to the markings of the Northern Shrike. Selander and Hunter (1960), however. mention simultaneous fanning of the tail when a Mockingbird was wing-flashing in response to a stuffed Mockingbird placed in its territory, and a photograph accompanying their article shows a Mockingbird wing-flashing with spread tail near a stuffed Screech Owl (*Otus asio*).

Comparing this brief résumé of wing-flashing by the Mockingbird with the accounts given here of wing movements by the Northern Shrike, it is obvious that the movements used by the two species are not very much alike. The one component of movements by the Northern Shrike that is most comparable to wing-flashing by the Mockingbird is the extreme drooped and forward extension of the wings used against large prey or enemies. Sometimes the wings are extended horizontally during this behavior, but I have never seen the wings of a shrike "flashed" in any position between horizontal and vertical with respect to the body. This lower positioning of the wings may be associated with the fact that the wing patches of the shrike are only conspicuous from the dorsal surface of the wings, whereas the patches of a Mockingbird are equally conspicuous from the ventral or dorsal surfaces.

The shrike does not extend its wings by a series of hitches but usually by one complete outward and forward sweep of the wings. Sometimes the hands may be separately extended near the end of this sweep, producing a single hitchlike movement. The wings usually are not brought back to the body at the end of the shrike's "wing-flashing" before the next flash is given, but instead to a half-extended, drooped position. Moreover, there are definite intermediate wing actions, "wing-quivering" and "wing-fluttering," which are lower intensity expressions of the same tendency and which have a pattern of movements indistinguishable from the quivers and flutters used by shrikes in various mating contexts or in food-begging. The chief superficial resemblance between the wing movements of Northern Shrikes and of Mockingbirds is that the wing patches of both birds produce conspicuous flashing motions when the wings are in action.

Contexts of the wing movements.—There are more similarities between the behavioral contexts in which the two species employ wing-flashing than there are in the form of the movements. Both species frequently use such movements when foraging or hunting, and in both cases it seems likely that the startling effect of the flashing wing patches (and the white areas on the tail?) in some way aids in the capture of food. In addition, shrikes and Mockingbirds both use wing-flashing behavior in various encounters with potentially dangerous or theatening species. There is a suggestion in both cases that the birds are suspicious or distrustful of the animal toward which they are reacting. Thus, the movements of the two birds seem to be clearly analogous and convergent in several respects, but they are not homologous, if one follows a strictly "morphological" criterion of homology.

According to Selander and Hunter (1960) wing-flashing of the Mockingbird also functions as an aggressive, intraspecific social display, although Hailman (1960) seemed doubtful about this point, and the evidence presented by Selander and Hunter is only suggestive. The Northern Shrike does not use such wing movements in intraspecific hostile displays.

DERIVATION OF THE WING MOVEMENTS

General.—To work out homologies in phylogentically relevant patterns of behavior one faces essentially the same problems as in the field of morphological comparison (Lorenz, 1955). On the one hand there is the need to distinguish between similarities which are merely convergent or parellel and similarities which are homologous and derived from a common ancestry; on the other hand, there is the need to identify transformations that have occurred within a homologous series. As pointed out by Hinde and Tinbergen (1958), morphologists do have the advantage of the fossil record: otherwise, the problems of evolutionary interpretation are the same for the behaviorist as for the morphologist.

There are two fundamental behavioral modalities which seem to have contributed a great deal to the evolution of avian displays and in which special wing movements are conspicuous components. These two are: (1) flight-intention movements (Daanje, 1950; Andrew, 1956), and (2) the food-begging responses of young birds (Andrew, 1961). Both appear to be phylogenetically old characters, and most students of the evolution of bird behavior agree that they have provided many components of behavior which have subsequently been transformed and incorporated into other major modalities of behavior, such as courtship display and agonistic display.

Some significant differences exist between the components of flight-intention and food-begging. Tail-flipping in some form is nearly always associated with flight-intention movements in passerines (Andrew, 1956), but conspicuous movements of the tail are absent in food-begging. Furthermore, the motions of wing-flicking in flight-intention are quite distinct from those of wing-quivering and wing-fluttering used in food-begging, and they probably represent quite different neuromuscular coordinations and central nervous mechanisms.

Origin of wing-flashing by the Mockingbird.—Both the wing-quivering of food-begging (Sutton, 1946) and the wing-flicking of flight-intention (Selander and Hunter, 1960) have been suggested as the original behavioral component from which wing-flashing has been derived. Hailman (1960) points out, however, that the form of wing-flashing does not resemble closely either the wing vibrations of food-begging or the wing-flicks of flight-intention, nor does it resemble any of the other special wing movements in the repertoire of the Mockingbird closely enough to suggest common origin. If none of these pre-existing behavioral components is involved in wing-flashing, then one must conclude that wing-flashing represents the acquisition of an entirely new behavior. Such an assumption goes against the rule of parsimony, and it seems more likely to me that wing-flashing is a highly transformed (ritualized) pattern of behavior derived from previously existing components. which can no longer be identified with certainty. For the present, I am inclined to agree with Selander and Hunter (1960) that wing-flashing of the Mockingbird is probably a ritualized form of flight-intention movements. A more precise analysis of the exact movements used in wing-flashing and a study of their ontogeny in young Mockingbirds may clarify the problem.

Origin of wing movements of the Northern Shrike.—The wing-quivering and fluttering movements used by a hunting or by a mobbing shrike seem less ritualized than the wing-flashing of a Mockingbird, and for this reason it is easier to speculate about the origin of these movements in shrikes. It seems likely to me that these movements of the Northern Shrike have been derived from food-begging components of behavior. The low-intensity forms of these movements appear identical to the low-intensity forms of wing-quivering and fluttering associated with food-begging and courtship-feeding. Only at the highest intensity does a transformation of movement occur. Wing-quivering and wing-fluttering associated with the pursuit of prey first appear in young shrikes during the fledgling period when they are still partly dependent on their parents and are still begging for food from them. The wing movements used in hunting could, therefore, arise by easy transition or "emancipation" (Hinde and Tinbergen. 1958) from food-begging. Finally. tail-flipping, which is so intimately a part of flight-intention movements. never appears in the context under consideration. Had the lower intensity quivering and fluttering expressions of this behavior been lost in the course of its evolution, so that only the "flashing" movements were now manifested, then one would be faced with the same problem of determining origin as in the case of the Mockingbird.

In conclusion, the Northern Shrike and the Mockingbird provide an interesting example of convergent or parallel evolution of a similar morphological feature (white wing patch), which functions in virtually an identical way in foraging and in hostile behavior. Yet a close study of the form of the movements involved reveals differences which suggest these analogous wing movements in the two species represent transformations of basically unrelated behavioral components.

SUMMARY

The Northern Shrike has white wing patches which are similar to the wing patches used by the Mockingbird for wing-flashing. Field observations on 19 pairs of shrikes nesting in Northern Alaska and on individuals wintering in central New York, and close studies of captive and of free-flying, trained shrikes, revealed that shrikes also use special quivering, fluttering, and "flashing" movements of their wings during hunting forays and in hostile encounters with other species.

Shrikes use special wing movements in many different behavioral contexts: flight-intention, food-begging, courtship display, hunting, interspecific hostility, and in stretching. Like many passerines, shrikes indicate their intention to fly by tail-flipping (down-up type) and by wing-flicking. Typically the wing-flicks are initiated from a normally folded position of the wings, and the movement is most conspicuous at the bend of the wings. Observations of specific instances in which shrikes have shown flight-intention indicate that tail-flipping without wing movements is the lowest intensity of expression of this tendency and that as the tendency to fly increases the wing-flicking becomes more prominent and exaggerated.

The quivering and fluttering of the wings used by male and by female shrikes in the breeding season are concerned mainly with some expression of their tendency to engage in courtship-feeding. Again, specific observations reveal "degrees of expression" of this tendency. Slight quivering movements are the lowest expression; conspicuous fluttering of the partly extended wings accompanied by persistent food-begging whines, in the case of the female, is the strongest expression. When the wings are fluttered in food-begging, the white patches describe conspicuous flashing arcs.

Close observations of tame shrikes trained to hunt out-of-doors show that they often engage in special wing movements when their quarry escapes into dense brush or among the branches of a tree. The same kinds of wing movements are also used when shrikes mob potential predators or other large species of animals. Three degrees of these wing movements can be distinguished: low intensity quivering, medium intensity fluttering, and high intensity "flashing." The first two are indistinguishable from movements also used in food-begging by young or in courtship-feeding by adults. In the most extreme expression of this behavior, the wings are drooped so that the tips of the primaries are well below the axis of the body; then the wings are partially extended and swept forward, a motion which produces a maximum extension of the hands and a conspicuous exposure of the white areas on the primaries. At the same time, the tail is spread widely. Then the wings are snapped back to a drooped, half-extended position, and the tail is closed. A complete cycle of these movements produces a "flash" of the white wing patches and of the outer white areas of the tail.

Although one can conclude that these special wing movements of shrikes are definitely associated with hunting and with hostile reactions toward other species, the biological significance of this kind of behavior can be interpreted in various ways. The specific situations in which movements occur during hunting strongly suggest that the wing and tail movements produce a startling effect that sometimes causes the prey to move from a safe position. Intimidation and distraction seem to be the functions of these wing movements when they are directed against a potential enemy.

These wing movements of the Northern Shrike are not very similar in pattern to wing-flashing of the Mockingbird. Thus, while the movements of the two birds seem to be clearly analogous and convergent in function, they are not homologous on the basis of a strictly morphological criterion of homology. Wing-flashing of the Mockingbird may be a transformation or ritualization of the wing-flicking of flight-intention, whereas the wing movements of the Northern Shrike appear to be less transformed and show a very clear similarity, in the lower intensity expressions, to the quivering and fluttering movements of food-begging.

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DEPARTMENT OF ZOOLOGY, SYRACUSE UNIVERSITY, SYRACUSE 10, NEW YORK.

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NESTING OF THE BLACK SWIFT IN MONTANA

William F. Hunter and Paul H. Baldwin

In recent decades it has been fully realized that the Black Swift (*Cypseloides niger*) occurs regularly in mountainous northwestern Montana during the summer months. Saunders (1921) did not list this bird among those known for Montana as late as 1919, yet the Black Swift has been known since the 1940's at Avalanche Creek in Glacier National Park and in the Mission Mountains, about 90 miles to the south. During the latter period, the species was occasionally seen in summer at lower elevations, as at Coram, at Yellow Bay on Flathead Lake, and at the National Bison Range by several persons from the staffs of the Montana State University Biological Station and Glacier National Park. An adult specimen was collected at Coram, Flathead County, by P. L. Wright in July 1954.

Despite this information on its occurrence, no nests or breeding colonies of the Black Swift were on record from Montana. However, parties from the Biological Station on occasion had noticed birds flying into waterfalls in the southern part of the Mission Range, and this suggested the possibility that swifts could be found nesting there. In 1960, a brief effort was made, without success, to see Black Swifts around waterfalls of the high cliffs above Avalanche Lake in Glacier National Park; at that time plans were made for an investigation of the Mission Range the following summer. In 1961, Hunter, working at the Montana State University Biological Station, with the aid of National Science Foundation Grant Number 71,200, searched for colonies of Black Swifts in the southern part of the Mission Mountains, assisted by R. L. Anderson, who roped over the falls several times to visit a swift's nest and obtain and return the nestling, and by L. W. Mottus and P. T. Baldwin. Dr. P. L. Wright and Dr. R. B. Brunson told us of sightings of the Black Swift at waterfalls in the Mission Range.

The most complete description available of high-mountain nesting of the Black Swift is given by Knorr (1961), who visited numerous colonies in Colorado: the nestings in Montana reported below differ in certain particulars from those in Colorado.

Our field work began on 20 June, and three canyons were explored during the first week without encouraging results, but on 28 June, several Black Swifts were seen flying in the Mission Creek canyon east of St. Ignatius. By following the suggestions of Knorr (loc. cit.), we located a colony on 25 July 1961.

The colony was situated at a waterfall (Fig. 1) about four miles up the canyon. The falls was on a nameless tributary which plunged down a gorge in the sedimentary rock of the steep south wall and entered the main stream

Fig. 1. Enlarged view of waterfall showing sites of four nests of Black Swifts (30 July 1961).

immediately below Lower Mission Falls. The falls was at approximately 4,700 feet elevation; it had an interrupted fall of 200 feet and was 150 feet wide, including all rills and cascades. The part occupied by the swifts was 75 feet wide. The transition-zone vegetation on adjacent slopes was primarily lowland fir (*Abies grandis*) and Douglas fir (*Pseudotsuga menziesii*) but also included Engelmann spruce (*Picea engelmanni*), mountain maple (*Acer glabrum*), willow (*Salix* sp.), alder (*Alnus tenuifolia*), dogwood (*Cornus stolonifera*), and juniper (*Juniperus scopulorum*).

A moss (*Leptodictyum riparium*) grew luxuriantly on the rocks behind the falls and invaded the clefts and crannies containing swift nests or roosting sites. A grass grew on several ledges, and a fern (*Asplenium* sp.) occurred sparingly about the falls. Currant (*Ribes* sp.), blue aster (*Aster* sp.), saxifrage (*Saxifraga oppositifolia*), and bluebells (*Companula rotundifolia*) were also present on various niches of the falls.

Five active nests, each containing one downy young, were discovered in this colony along with what appeared to be three older nests, possibly used the previous year. Adult birds were observed entering crypts where other nests were probably present, which could not be seen or reached at this time; also, as many as 10 adults were counted leaving the waterfall. The five nests were on a southwestern exposure and secluded from the rays of the sun until late afternoon, at which time four of the nests came into direct sunshine.

Nest 1 was found on 25 July near the top of the falls beneath an overhang about 8 feet from the torrent. The nest was on a small mossy ledge just at the edge of rock wet by spray or trickles. The nest itself looked dry, and the materials composing it appeared from a distance like liverwort and other brownish materials. One young occupied the nest and from time to time would move around exposing its wing feathers, still sheathed. Adult birds had been observed the evening of 24 July entering this grotto. At 5:55 PM on 25 July, an adult perched on the outside of the nest, its body vertical. It bobbed its head frequently, apparently feeding the young while the latter held its mouth open. The two birds remained there quietly until 6:15 PM. when the adult left not to return at least before dark. We did not see either of these birds again, although the nest was still intact during all later observations.

Nest 2 also was found on 25 July and the downy young was seen on that date. The nest was reached on 30 July by roping over the top of the main falls to the triangular nesting cavity (21 inches long, 9 inches wide at its maximum point, and 7 inches high) 15 feet below. The cavity was covered with moss, except for the vertical rear wall, and it was completely moist from water rushing on both sides of the opening and trickles pouring over the entrance a mere 3 or 4 inches from the nest itself. It was necessary for birds entering or leaving to go through the water. The nest itself, composed of moss, stood up plainly above the floor near the center of the cranny, leaving enough room behind and on the sides for adult birds to perch. Swifts were observed doing this in both places, sometimes crouching in the moss slightly below the level of the nest so that one could not see them with a 20× spotting scope. Although the rim and body of the nest were of fresh green moss, scrapings from the bottom of the nest cup included one broken pine needle and several fibrous twigs. There was no other lining material. The outside diameter of the nest was 14.7 cm, the inside diameter, 9.1 cm, and the depth of the cup, 4.2 cm. The nest was marked with a piece of yellow plastic for identification in the future.

The nestling of Nest 2 was measured twice during the summer and banded. On 30 July it weighed 38 grams, had its eyes open, and was covered with dark slate-gray down feathers. Contour feathers of the spinal tract were breaking sheaths but had not yet emerged through the dense down which originated in the dorsal apteria. These white-tipped contour feathers of the pterylae were the first feathers of their follicles and were not preceded by neossoptiles. Above the bill a triangular area with its point extending back on the crown between the eyes was studded with tiny white pins of contour feathers, whereas gray down covered adjacent areas of the crown. The primaries were pins with brush tips, Primary 10 measuring 8 mm, Primary 9, 13 mm, and Primary 2, 14 mm. The rectrices were 6-mm pins; the tarsus was 12 mm. The young bird was sluggish in its actions, although it did try to crawl away while in the hand. Its claws were dull and the foot showed little grasping ability as compared to the sharp claws and strong toes of the nestling Vaux's Swift (*Chaetura vauxi*) of comparable developmental age (Baldwin and Hunter, MS). On 6 August, the nestling was obtained again and measured. Primary 10 had increased to 42 mm, Primary 9 to 45 mm. and Primary 2 to 36 mm; the rectrices had grown to 19 mm; the tarsus was 13 mm. Most of the inner primaries were edged with white. The front toes of each foot had been injured, as the terminal phalanx of each was bulbous, soft and bloody, and the claw missing. The cause of this was unknown. The hind toes showed normal development. It was estimated that this nestling was not more than one quarter through its nestling developmental period on 30 July, which would place the probable hatching date at about 16 to 19 July. Legg (1956) found the nestling period of the Black Swift to be 45 days, and on this basis the nest-departure date could be predicated as around 30 August to 2 September.

An adult was seen at Nest 2 on six out of seven days of observation between 25 July and 7 August. It seemed to spend most of its time either brooding on the nest or perching in the nest cavity, and once it probed and pecked at length at the moss beside the nest. Its absences from the nest were brief. On two evenings it left the nest and its return was not observed before dark. Delayed feeding of the young was witnessed on 25 July, after the adult had perched behind the nest for at least two hours. At 3:58 PM the adult moved up on top of the nest, whereupon, with its tail and wings sticking out through the water, it stuck its bill down the nestling's mouth, which was open and waiting. After three minutes of this the adult returned to its perch behind the nest, and the young disappeared in the nest bowl.

Nest 3 was located on 30 July, at 2:15 PM, when an adult entered a small ledge rimmed with grass and *Campanula rotundifolia*. The young bird became active immediately and pecked vigorously at the chin of the adult. Soon the adult settled next to the young. The sun reached Nest 3 by 5:30 PM: as the nestling warmed it became quite active. sunbathing and preening: also the wings were stretched and held out so that they were plainly visible through the spotting scope. This nestling showed more advanced growth of the primaries than the young of Nest 2, the vanes being broken out more and the primaries seeming to be about 10 mm longer; hence, the probable hatching date for Nest 3 would have been a few days earlier than for Nest 2, perhaps around 13 to 16 July, and nest departure might have been expected around 27 to 30 August.

Nest 4 was discovered on 30 July by watching an adult cling on the dry wall under a cascade for a moment before crawling onto a nest and settling down beside a downy young (4:30 PM). The nest site was a crypt, and the nest consisted of dried yellow-green moss. The adult moved frequently and would gape now and then, showing a pink lining to the wide mouth. A slight overhang of the roof of the crypt kept the sun from shining directly on the nest until 6:30. At 6:50, the adult leaned down over the nest rim, slid off, and swooped deep down the gorge into the main canyon; the nestling remained humped up in the nest. The sun left the nest at 7:10 PM. On 7 August, we found this nest gone—it had been constructed on a rounded part of the ledge and it must have slipped off, perhaps as a result of drying, jostling, or the weight of adults perching on its side.

Nest 5 was located on 7 August (6:45 PM) at a spot where two adult swifts had perched on the previous evening. While searching the area with a binocular, we saw a young bird in a nest on a ledge immediately under a small cascade, about 4 feet above Nest 4. A broken screen of water flowing in front of the nest made it difficult to see. The nest appeared to be in the grass with large basal leaves of *Campanula*, and with the top of the cascade serving as a roof. This nest would not have been observed without the illumination of sunshine on it. It was judged that the rays appeared on this nest for about 15 minutes daily. The nestling showed white-tipped body contour feathers along with its deep gray down and long primaries. An adult bird entered the niche at 7:00 PM, flapping its wings until it could get a hold on the side of the nest. It then mounted the nest and stretched out one wing.

DISCUSSION

Previous descriptions of nesting of the Black Swift (northern race) have concerned nests in California and Colorado. New nest records from Montana permit certain comparisons to be made.

The availability of several nesting dates from the three separate localities makes possible a preliminary examination and comparison of the timing of nesting in these localities. With the duration of the incubation period (24–27 days) and nestling period (45 days) being known (Murphy, 1951; Legg. 1956), approximate dates can be extrapolated for such events as start of incubation, hatching, and nest departure for nearly all the nests reported in the literature. The following summary of phenological relations is based on the inferred dates for start of incubation for 11 nests in California, 10 nests in Colorado, and 5 nests in Montana (Table 1). The earliest date for each locality is used. The basis for comparison of the dates among the three geographic areas is Hopkins' Bioclimatic Law, which describes a lag of four days for a given vital event with a progression of each 1° of latitude to the

TABLE 1

RETARDATION OF INCUBATION INITIATION OF THE BLACK SWIFT BASED ON HOPKINS' BIOCLIMATIC LAW

Area	Location	Early date for start of incubation	Days retardation	
			Actual	Expected
South-central California	37°N, 119°W (sea level)	23 May	–	–
Northwestern Montana	47°N, 114°W (4,700 feet)	15–18 June	23–26	48–62
Colorado	39°N, 107°W (9,300 feet)	8 July	48	36–46

north, with each 5° longitude to the east, and with each 400 feet of rise in altitude (Hopkins, 1938; also see Johnston, 1954, for a carefully worked-out example in the Song Sparrow, which conforms quite well to the law).

The base reference date of 23 May for coastal California is based on Dixon's (1935) earliest nest at Sequoia National Park, with hatching date approximately 2 July, corrected for elevation and longitude. This procedure necessitates the assumption that the Black Swift could arrive early enough from its winter home to breed by that date; indeed, Grinnell and Miller (1944:214) state that the Black Swift is a summer resident in California from May to October. If these assumptions and inferences are permitted for a preliminary comparison, then it may be noted further that nesting in the Montana colony started only 23–26 days later than the base reference date, although the expected delay would have been about 48–62 days. The Colorado nests, on the other hand, appear to have been started some 48 days after the base reference date, with an expectation of about 36–46 days.

It cannot be said from these preliminary indications that the geographic progression of an equivalent nesting event in the Black Swift follows closely the expected progression to be inferred from Hopkins' law. The Montana dates appear especially divergent. Again, the small sample size should be noted, as well as the need for firmer data for all localities.

The question as to just when the nestling Black Swift acquires its coat of down is not yet settled. Legg (1956) and Dixon (1935) reported that the just-hatched young was naked; Wetherbee (1961:87) suggested that the down described on two-week-old nestlings is "*not* natal down, but emerging teleoptiles." What is not apparent from previous accounts is that the down and the contour feathers arise from separate areas of the skin, at least as observed on dorsum and crown. It is remarkable that the downy teleoptiles grow abundantly and rapidly on the "apteria," while pins of the contour feathers form slowly in the pterylae. It appears that the down, once acquired, would function as an effective adaptation to the cool and moist nesting niche

(Legg, cited in Wetherbee, 1961). The downy coat developed in the apteria could be a primitive feature retained in this swift, or more likely, after loss of neossoptiles by cavity-dwelling ancestors, it was acquired as a secondary adaptation when the swift took up its unusual nesting niche.

The Black Swift in Montana nested in a situation which conformed to all of Knorr's (1961:168–169) physical ecological factors: water, high relief, inaccessibility, unobstructed flyways, and darkness. Yet our nests were in less darkness than is typical. Knorr states that he has never found an occupied nest upon which the sun shone, and other authors have stressed the darkness of the nest site (Michael, 1927:97) and avoidance of light by the young (Dixon, 1935). Four of the five active nests seen in the Mission Valley colony in Montana had sunshine directly on them during the late afternoon; in the fifth nest the sun reached the nest rim but did not actually enter the nest. One nest received sunlight for as much as an hour and a half a day in late July and early August. The nestlings did not seem distressed at the sunlight; in fact, they exercised, preened, and exposed feathers to the sun. Smith (1928) tells of the filtered sunlight shining into Black Swifts' nests in the early morning in California. Nevertheless, the Montana nests were in deep shade most of the day, and at the start of nesting they may have been in shade the entire day.

In California the nest sites ranged from sea level to 6,000 feet (Grinnell and Miller, 1944:215), in Montana the colony studied was at 4,700 feet, while in Colorado the lowest site found was 7,200 feet (Knorr, 1961). The difference between Montana and Colorado is probably due to the different base level of the mountain masses (Montana, 3,000 feet; Colorado, 5–7,000 feet) whose steep canyons provide suitable conditions for nesting.

In reviewing the existing accounts of nesting, one cannot avoid noting the rather large proportion of nesting failures. This seems strange for a nest in such an inaccessible place and containing only one egg; furthermore, the low reproductive rate would seem to suggest a high degree of success. The usual failure involves a mysterious disappearance of the young long before normal nest departure could have been expected: also, young have been found in the nest dead (Bent, 1940:261). In both the California and Colorado nest records quite a number of such vanishings are to be found; Knorr (1961:168) states that he observed at least one young fall out of the nest. In the Montana colony reported here, two of the five nests failed during the early nestling period: in Nest 1, the downy young simply vanished, and in Nest 4, both nest and nestling disappeared. Vertebrate predators have not been detected, and it has been felt by those who have commented on the matter that only winged predators could get to the nests; yet there are no observations of raptorial birds at the nest colonies, either elsewhere or in Montana.

SUMMARY

Nesting of the Black Swift in northwestern Montana was established with the finding of a colony in the Mission Valley of the Mission Range, where five active nests at a waterfall were studied. The presence of adults elsewhere in the Mission Range and in the Glacier Range strongly suggests that other colonies remain to be discovered.

The nestings studied in Montana were started earlier than those reported in Colorado, contrary to expectations based on Hopkins' Bioclimatic Law.

The downy covering developed early in the nestling period may represent a secondary adaptation to the semiexposed nesting niche.

Nestings in Montana differed from those in Colorado in their greater exposure to sunshine and lower elevation. Nesting failures appear to be common in the Black Swift.

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SYSTEMATIC AND ECOLOGIC NOTES ON THE OLIVE WARBLER

J. Dan Webster

SYSTEMATIC POSITION

The Olive Warbler (*Peucedramus taeniatus*) has been classified by almost everyone for the last 86 years as a monotypic genus, closely related to *Dendroica*. However, Griscom (1957) recommended that *Peucedramus* be merged with *Dendroica* and I (1958) agreed with him. On the contrary, William George (oral communication and papers read orally) and others have recently stated that the Olive Warbler is not a wood warbler (Parulidae) at all, but an Old World warbler of the family Sylviidae, or else a thrush of the family Turdidae. My own study was confined to the skin and skull.

Characters of the skin.—The following eight differential characters listed by Ridgway (1902) or Chapman (1907) are invalid as differentiations from *Dendroica*, because *Peucedramus* does not exceed the variation within the larger genus:

Character	My observations
(1) Bill more slender (subulate) than in *Dendroica*.	Less slender in *Peucedramus* than in *Dendroica dominica*.
(2) Bill more rounded than in *Dendroica*.	Less rounded in *Peucedramus taeniatus micrus* than in *Dendroica dominica*.
(3) Rictal bristles weak and fewer than in *Dendroica*.	Same in *Peucedramus* as in those several species of *Dendroica* with the longest bristles.
(4) White patch in secondaries.	Same in *Dendroica coerulescens*.
(5) Wing–tail difference greater than in *Dendroica*.	Wing–tail difference in *Peucedramus* less than that in *Dendroica striata*.
(6) Tarsus one-fourth length of wing; scutellae indistinct or fused.	Same in *Peucedramus* and in *Dendroica*.
(7) Middle toe with claw shorter than the tarsus; basal phalanx of middle toe united for slightly more than half its length to the outer toe and about half its length to the inner toe.	Same in *Peucedramus* and in *Dendroica*.
(8) Slight sexual dimorphism in juvenal plumage in *Peucedramus*, but sexual dimorphism in *Dendroica* acquired with first winter plumage or never.	No sexual variation distinguishable in 23 specimens in juvenal plumage of *Peucedramus*. Much foxing and geographic variation; the most important variable, though, is the amount of first winter plumage coming in, and this, of course, is sexually dimorphic.

The following three differential characters listed by Ridgway (1902) or

Chapman (1907) are valid distinctions from *Dendroica*. To my mind, however, they are not very striking:

Character	My observation
(1) Bill more decurved and notched than in *Dendroica*.	Very slightly more decurved and notched in *Peucedramus* than in any *Dendroica*; matches *Seiurus*.
(2) Tail distinctly emarginate.	More prominently emarginate in *Peucedramus* than in any *Dendroica*. However, three species of conifer-inhabiting *Dendroica*—*pinus*, *graciae*, and *discolor*—have an emarginate tail. Measured as the difference in length between the longest and shortest rectrices, the figures are: *Peucedramus*, 5.3 mm average; *D. discolor*, 3.8; other species of *Dendroica*, 3.5 to 1.0.
(3) Male requires 14 months to acquire adult pattern in *Peucedramus*; 3 months in *Dendroica*.	True in *Peucedramus* only in the northernmost race; the male adult plumage pattern acquired at about 3 months in many or most individuals of the Central American races.

One character of the skin is a valid family character. The tenth primary is extremely rudimentary in *Peucedramus*. (A long series of varied age and size examined.) In my opinion this is a more deep-seated taxonomic character than some characters of muscles or bones. If this is correct, *Peucedramus* cannot belong to any family except Parulidae or Thraupidae.

I studied four more plumage characters, looking especially for similarities between *Peucedramus* and other Oscine groups. These observations reinforce the position that *Peucedramus* belongs in Parulidae, with more distant relationships to Thraupidae and Fringillidae:

Character	My observation
(1) Plumage pattern and color of adult male.	Ochraceous color not matched in other Parulidae except for small markings, but some Thraupidae and Fringillidae come fairly close. Pattern matched closely in several other Parulidae; some tanagers fairly close.
(2 and 3) Plumage pattern and color of females and fall immatures.	Outside the Parulidae only the tanagers come close. Amongst the warblers, the similarity of three species of conifer-inhabiting *Dendroica* (*pinus*, *occidentalis*, and *townsendi*) to *Peucedramus* is remarkable. In fact, I was unable to pick out immatures of either sex of Olive Warblers from a tray of Hermit Warblers when placed

	dorsal side up, or from a tray of Townsend Warblers when placed laterally.
(4) Juvenal plumage.	The dull olive green of *Peucedramus*, with obscure longitudinal streaks and prominent white wing bars is typical for a warbler and not out of line for a tanager, an icterid, or an emberizine finch. But a streaked juvenal plumage is absent in any Sylviidae and I have found only one Turdidae (*Luscinia suecica*) which is streaked. The last is fairly close to the emberizine sparrow-type of juvenal plumage.

Characters of the skull.—Each of the following has been used as a familial characteristic by the recent authority cited (see Fig. 1):

Character	My observation on *Peucedramus* with comment
(1) Ectethmoid foramen (Beecher, 1953; Brodkorb, 1958).	Double. This puts the genus in either Parulidae or Turdidae according to Beecher's classification, and in Parulidae or Turdidae according to Brodkorb.
(2) Shape of ectethmoid plate and character of lacrimal (Beecher, 1953).	Ectethmoid plate truncate; lacrimal fused. This puts the genus in Sylviidae or Parulidae according to Beecher.
(3) Palatine process of premaxilla (Tordoff, 1954; Bock, 1960).	Visible, but mostly fused, in 2 of 5 specimens: completely fused in 3. This indicates Parulidae (Tordoff) or nothing (Bock).
(4) Basihyoid (George, in litt.).	Shape of Sylviidae.
(5) Maxillo-palatine (Brodkorb, 1958).	Hooked; median part pneumatic, swollen, and bearing an anterior spur. According to the classification of Brodkorb, this *Peucedramus* shape is probably either sylviid, vireonid, or parulid. According to my observations, vireo maxillo-palatines are very distinct from those of warblers (wider all along their length and very flat). But Parulidae grades into Sylviidae via *Dendroica townsendi*, which has a small anterior spur, *Peucedramus*, and *Sylvia hortensis*. The maxillo-palatine of the last is very similar to that of *Peucedramus*.

The following additional skull characters separate Parulidae, including *Peucedramus*, from Sylviidae:

(1) Shape of vomer posteriorly.	Split wider in Sylviidae and extending farther anteriorly (anterior to interpala-

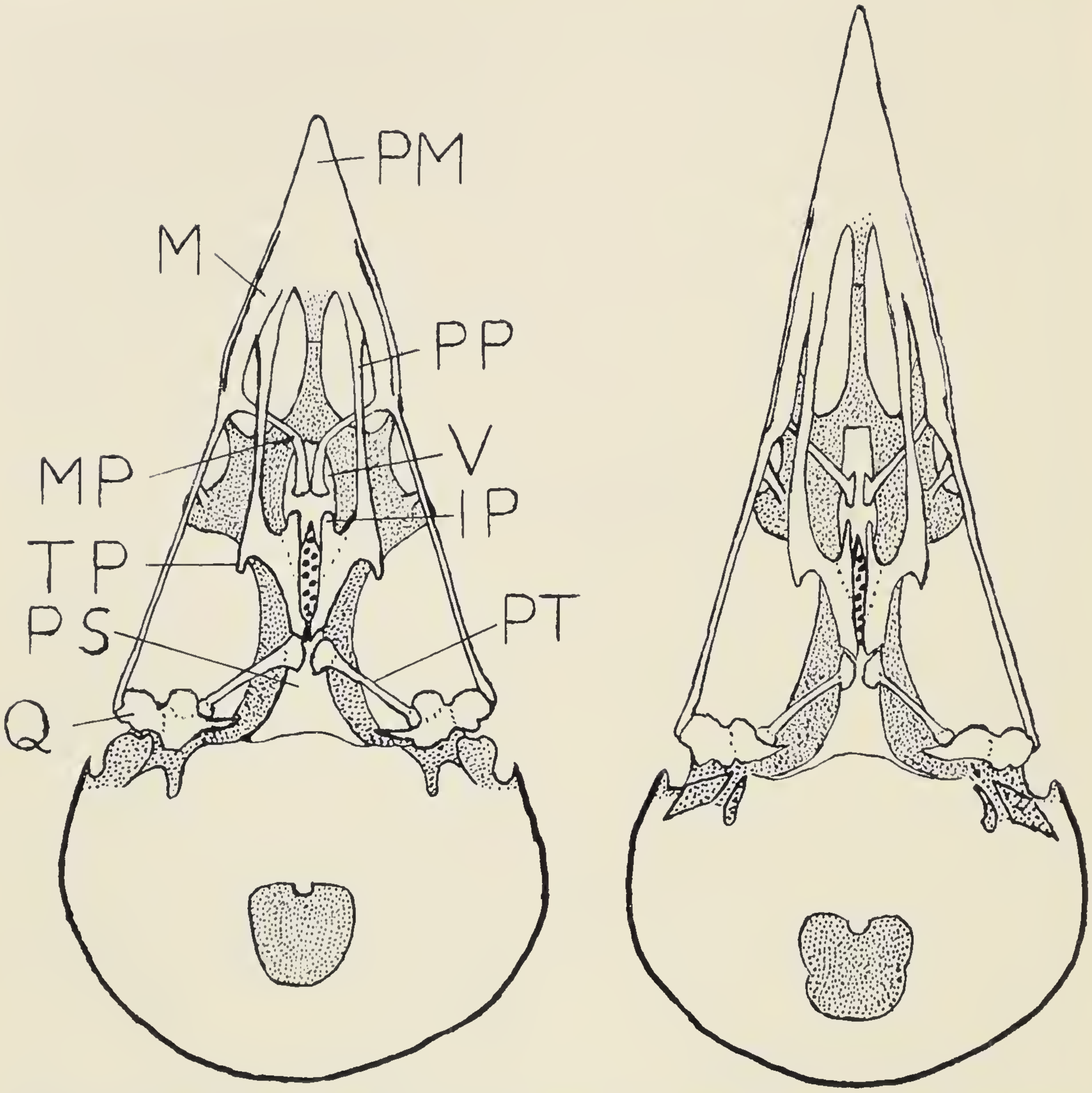

FIG. 1. Ventral view of skulls of two species of warblers drawn to the same scale. Left, *Dendroica auduboni*; right, *Peucedramus taeniatus*. The more dorsal structures are in fine stipple; the anterior part of the parasphenoid (parasphenoidal rostrum) is in coarse stipple. Key: PT—Pterygoid. IP—Interpalatine process. V—Vomer (prevomers). PP—Prepalatine bar. PM—Premaxilla. M—Maxilla. MP—Maxillopalatine. TP—Transpalatine process. PS—Parasphenoid. Q—Quadrate.

	tine process and end of parasphenoid); split narrower in Parulidae and extending not so far (rarely beyond the midpoint of the interpalatine process and not so far as the tip of the parasphenoid).
(2) Transpalatine process.	Absent, or else wide from whole width of palatine shelf in Sylviidae; always present but relatively narrow and from lateral edge, only, of palatine in Parulidae.
(3) Posterior palatine bone.	Narrower in Sylviidae; broader in Parulidae.

In the following skull characters the various warblers differ among themselves:

(1) Shape of interpalatine process.	*Peucedramus* long and rod-like, near *Chamaethlypis* and *Icteria.*
(2) Shape of transpalatine process.	*Peucedramus* long and rounded, near *Vermivora*, and *Dendroica.*
(3) Thickness of lateral process of nasal in lateral view.	*Peucedramus* broad and heavy, near *Icteria*, *Chamaethlypis*, and *Oporornis.*
(4) Naso-frontal hinge.	But slightly developed in *Peucedramus*, near *Seiurus.*
(5) General shape of skull in dorsal or ventral view.	Long and slender in *Peucedramus*, nearest *Dendroica.*

Characters of the skull, then, mostly indicate that *Peucedramus* is a legitimate genus of wood warblers, with affinities to *Dendroica*, *Icteria*, and *Chamaethlypis*. However, the hyoid apparatus is divergent in character. Characters of the skin, on the other hand, indicate that generic separation of *Peucedramus* from *Dendroica* is unwarranted. Studies of the rest of the skeleton, the other anatomical systems, and especially of behavior, are needed before the classification of the Olive Warbler can be regarded as settled.

GEOGRAPHIC VARIATION

The races of the Olive Warbler were revised by Miller and Griscom (1925) and, recently, by me (1958). The present notes constitute only a revision of my earlier paper, based on a restudy of much of the same material, plus 151 additional specimens. Of the last, most were in fresh plumage, including 49 which I collected in Mexico.

Variation in wing length can now be analyzed statistically (Table 1). Two observations are pertinent: (1) Bermann's Rule is applicable, despite the facts that there is little or no migration and that the climates inhabited in the various areas are not strikingly varied. (2) The only significant breaks occur between *giraudi* and *taeniatus* and between *taeniatus* and *micrus.*

Variation in tail length (Table 2) shows only one significant point—the short tail of the southernmost race, *micrus.*

Color variation, based only on fresh-plumaged specimens, clearly differentiates five subspecies. The following synopsis includes only an abbreviated color diagnosis of each race, plus conclusions new or different from those in my earlier (1958) report.

Peucedramus taeniatus arizonae (Miller and Griscom). Paler, grayer, and less green than all other races; adult males also duller ochraceous anteriorly than all other races; females and immature males also yellower, less orangish anteriorly and browner dorsally than all other races.

P. t. jaliscensis (Miller and Griscom). Paler generally than the three succeeding

TABLE 1
MEASUREMENTS IN MILLIMETERS OF THE WING OF MALE OLIVE WARBLERS IN ADULT PLUMAGE

Subspecies	Sample size	Population	Range	Mean	Standard deviation	Coefficient of variability
arizonae	51	Arizona, New Mexico	75–80	77.53	1.46	1.88
	7	Northwestern Coahuila	76–81	78.29	—	—
	29	Northwestern Chihuahua	74–78	75.93	1.18	1.56
jaliscensis	15	Durango, Zacatecas, southwestern Chihuahua	73–80	76.60	1.71	2.23
	13	Sierra Madre Oriental in San Luis Potosi, Nuevo Leon, Tamaulipas	73–79	76.08	1.58	2.07
	4	Sierra de Tamaulipas	69–75	73.00	—	—
	8	Nayarit, western Jalisco	75–79	77.00	1.51	1.97
giraudi	51	Vera Cruz, Est. de México, Morelos, Dist. Federal, Michoacan, north-central Jalisco	73–79	76.33	1.63	2.14
taeniatus	11	Oaxaca, Guerrero	68–75	72.27	1.91	2.65
	6	Chiapas	71–76	73.50	—	—
micrus	8	Honduras, El Salvador	66–71	68.50	1.50	2.19

races; less green dorsally and especially on the edgings of the remiges, rectrices, and scapulars than *giraudi*; females and immature males also duller, less orangish anteriorly than the three succeeding races; anterior ochraceous of adult males paler than *giraudi*, duller than *taeniatus* and *micrus*.

P. t. giraudi Zimmer. Greener than all other races; also paler dorsally than *taeniatus* and *micrus*; anterior ochraceous of adult males duller and darker than *taeniatus* and *micrus*; females and immature males less orangish anteriorly than *taeniatus* and *micrus*.

P. t. taeniatus (du Bus). Greener and browner, more olivaceous, dorsally and ventrally than *micrus*; anterior ochraceous of adult males also darker and duller than *micrus*.

P. t. micrus (Miller and Griscom). Generally more blackish, less green, than all other races; females and immature males more orangish anteriorly than all other races; anterior ochraceous of adult males paler, brighter and more orange than in all other races (slightly on the Tawny side of Orange); rump of adult males blackish or leaden gray, concolor with the back, rather than more or less greenish as in all other races.

Neither Miller and Griscom (1925) nor I (1958) gave a correct color diagnosis of *micrus*, for lack of fresh-plumaged material. The bill of *micrus* is smaller and wider than in the more northern races, as both revisions noted.

In summary, the five races of the Olive Warbler recognized by previous revisers are upheld. Of these, the race *jaliscensis* is the weakest; it is distinguishable about 90 per cent from 90 per cent of all specimens or 95 per cent from 95 per cent for adults in fresh plumage. The race *micrus* is the most distinct—100 per cent from 100 per cent in the sample examined.

TABLE 2
MEASUREMENTS IN MILLIMETERS OF THE TAIL OF MALE OLIVE WARBLERS IN ADULT PLUMAGE

Subspecies	Sample size	Population	Range	Mean	Standard deviation	Coefficient of variability
arizonae	51	Arizona, New Mexico	47–54	50.45	1.81	3.59
	7	Northwestern Coahuila	49–54	51.86	—	—
	29	Northwestern Chihuahua	48–53	50.07	1.37	2.74
jaliscensis	14	Durango, Zacatecas, southwestern Chihuahua	46–54	50.29	2.08	4.14
	13	Sierra Madre Oriental in San Luis Potosi, Nuevo Leon, Tamaulipas	46–54	50.23	2.08	4.14
	4	Sierra de Tamaulipas	46–50	47.75	—	—
	8	Nayarit, western Jalisco	46–52	49.12	—	—
giraudi	49	Vera Cruz, Est. de México, Morelos, Dist. Federal, Michoacan, north-central Jalisco	47–54	50.43	1.89	3.78
taeniatus	16	Oaxaca, Guerrero, Chiapas	47–54	49.19	1.74	3.53
micrus	8	Honduras, El Salvador	53–51	46.25	—	—

Two populations, those of the Sierra de Tamaulipas and of the state of Chiapas plus Guatemala, show enough differentiation to be mentioned as "almost" subspecies. The latter was once named "*aurantiacus*" by Ridgway (1896).

Additional specimens examined.—These skins were studied, in addition to those listed in my previous report: *P. t. arizonae*—Southeastern Arizona, 5; northwestern Coahuila, 1; Northern Chihuahua, 22. *P. t. jaliscensis*—Southern Coahuila, 1; Nuevo Leon, 11; San Luis Potosi, 20; Durango, 6; Zacatecas, 1; Nayarit, 1; Jalisco, 3. *P. t. giraudi*—Michoacan, 15; estado de México, 29; Distrito Federal, 5; Morelos, 6; Vera Cruz, 2. *P. t. taeniatus*—Oaxaca, 10; Chiapas, 2; Guatemala, 1. *P. t. micrus*—El Salvador, 2; Honduras, 8.

ECOLOGICAL REMARKS

The Olive Warbler inhabits pine forests from southeastern Arizona to Nicaragua. In several parts of the range (for instance, Zacatecas) the more arid fasciations of the pine forest are inhabited, but in other areas (for instance, Oaxaca) only humid, high elevation pine forests are utilized.

The ranges of the Olive Warbler and of Grace's Warbler (*Dendroica graciae*) make an interesting ecological and geographical comparison. The two species appear to occupy very similar ecological niches. Grace's Warbler, too, inhabits pine forests from the southwestern United States to Nicaragua. (See range maps, Webster, 1958 and 1961.)

Comparing the ranges of the two species, I note these differences: (1) The only large area inhabited by Grace's Warbler but not by the Olive Warbler is in the United States—northern Arizona, northern and eastern New Mexico, and the southern edges of Utah and Colorado. (2) The only large area inhabited by the Olive but not by Grace's is eastern Mexico—from isolated peaks in Coahuila south through the Sierra Madre Oriental and the eastern part of the Trans Volcanic Range to eastern Oaxaca. (3) In Arizona, Durango, and Jalisco the two species are coresident in some pine forests, but the Olive extends to considerably higher elevations. (4) In Central America and north along the Pacific Coast to southern Sinaloa Grace's Warbler inhabits low and middle elevation pine forests, whereas the Olive Warbler is found in high elevation pines.

On neither Grace's nor the Olive Warbler have detailed behavior studies been reported. Foraging behavior is similar, although Grace's abandons foliage gleaning a little more often to fly out for a flying insect, and tends to forage farther out on the tips of the branches. (The Olive is about one-fifth again the larger.) In fall and winter the Olive is usually in flocks of 4 to 15 birds, whereas Grace's is ordinarily single or in pairs.

Grace's Warbler is apparently dependent on a nearby source of surface water, for I have never found one more than a few hundred yards from a permanent stream. On the other hand, the Olive Warbler, in Nuevo Leon, Durango, and Zacatecas, at any rate, is often found miles from any surface water—especially in June, before the rains have soaked the soil and started the creeks.

ACKNOWLEDGMENTS

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CALIFORNIA ACADEMY OF SCIENCES, SAN FRANCISCO, AND HANOVER COLLEGE, HANOVER, INDIANA, 3 JANUARY 1962

ORNITHOLOGICAL NEWS

The 1963 Annual Meeting of the Wilson Ornithological Society will be held at Charleston, South Carolina, on 2–5 May.

It is a real pleasure to express here sincere appreciation to the members of the Editorial Advisory Board and to the Ornithological Literature Editor for their invaluable service: George A. Bartholomew, Andrew J. Berger, William C. Dilger, William W. H. Gunn, William A. Lunk, Robert A. Norris, Kenneth C. Parkes, Raymond A. Paynter, Jr., and Olin Sewall Pettingill, Jr.

Credit belongs to them for things you the reader may like about the *Bulletin.*—HLB

LOUIS AGASSIZ FUERTES RESEARCH GRANT

This grant, established in 1947, is 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 some $600. The Council of the Wilson Ornithological Society has added funds as necessary to provide at least one $100 grant annually.

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 17 persons, many of whom have continued their research work. The recipients are listed below.

1948—Leonard R. Mewaldt, Life history of Clark's Nutcracker.
1949—Stephen W. Eaton, A comparative study of the genus *Seiurus.*
1950—Henry E. Childs, Population dynamics and life history of the Brown Towhee.
  Byron E. Harrell, Ecology of the Rancho del Cielo, Tamaulipas, Mexico.
  Arnold J. Petersen, Reproductive cycle in the Bank Swallow.
  Harrison B. Tordoff, Comparative osteology of the subfamilies of the Fringillidae.
1951—Howard L. Cogswell, Territory size and its relation to vegetation, structure and density among birds of the chaparral.
1952—Robert W. Nero, Territorial and sexual behavior in the Red-wing.
1953—no award.
1954—William C. Dilger, The isolating mechanisms and relationships of the thrush genus *Hylocichla.*
1955—Robert G. Wolk, Analysis of reproductive behavior in the Black Skimmer.
1956—John B. Millar, An investigation of possible factors involved in the initiation of migration.
  Lester L. Short, Jr., Hybridization and isolating mechanisms in North American flickers.
1957—Millicent (Mrs. Robert L.) Ficken, Comparative study of the behavior of the Canada Warbler and the American Redstart.
1958—Harold D. Mahan, Studies of growth and temperature regulation in the Red-wing.
1959—no award.

1960—Robert T. Lynn, The comparative behavior of the Carolina Wren and Bewick's Wren.

1961—Frances (Mrs. Douglas A.) James, Compilation on the distribution and abundance of Arkansas birds.

1962—Donald Heintzelman, Life history of the Sparrow Hawk, *Falco s. sparverius* Linnaeus.

Application forms may be obtained from Harvey I. Fisher, Southern Illinois University, Carbondale, Illinois. Completed applications must be received by 1 March 1963.

Andrew J. Berger has been awarded a Guggenheim Fellowship for next year in order to continue his work on the avian muscular system.

FROM THE AOU

At its annual meeting in Salt Lake City, Utah, on 20 August 1962, the AOU elected the following officers:

Austin L. Rand, President
Roger Tory Peterson, First Vice-President
Robert W. Storer, Second Vice-President
Lawrence H. Walkinshaw, Secretary
Robert J. Newman, Treasurer
Robert M. Mengel, Editor

REQUEST FOR ASSISTANCE

Extensive evidence indicates that wild birds are involved in the life cycle of many arthropod-borne viruses and are the source of infection for arthropods that infect man and domestic animals. The natural history of these viruses and the epidemiology of the diseases they produce are so complex that only a coordinated effort by specialists on all facets of ornithology, ecology, and virology can produce the information needed.

The American Committee on Arthropod-borne Viruses (ACAV) has been attacking the virological aspects of these problems for several years, but greater participation by ornithologists is required. A meeting of ornithologists, virologists, ecologists, and entomologists was organized in Atlanta, Georgia, 16–17 February 1962, to discuss information at hand, current investigations, and the need for more research and communication.

A subcommittee of the ACAV was formed to serve as a channel of information exchange, a focus for consultation, and to stimulate development of new tools and ideas.

The proceedings of the meeting and a list of references have been prepared and the subcommittee desires to distribute them as widely as possible. Interested persons may obtain copies from Donald D. Stamm, Chairman, USPHS, Communicable Disease Center, Atlanta 22, Georgia, who will place their names on a mailing list for future communications.

THE JOSSELYN VAN TYNE MEMORIAL LIBRARY

BOOKS: List B–6

Following is the sixth supplementary list of books acquired by our library, these being new since publication of List B-5 in March 1961 (*Wilson Bulletin*, 73: 93–95). Members wishing reprints of this and earlier book lists may write to the Josselyn Van Tyne Memorial Library (Wilson Ornithological Society), Museum of Zoology, The University of Michigan, Ann Arbor, Michigan.

This list includes, in particular, numerous titles in recent increments of the personal library of the late Josselyn Van Tyne, being progressively incorporated into the Society's permanent holdings through the generosity of Mrs. Van Tyne.

Also included are gifts from a number of other members; contributions from Houghton Mifflin Co.; and significant purchases made from the New Book Fund, substantially augmented of late by donations and by sale of duplicate books and separates.

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The following gifts have been recently received. From:

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ORNITHOLOGICAL LITERATURE

ALABAMA BIRDS. By Thomas A. Imhof. University of Alabama Press, University, Alabama, 1962: 7¼ × 10 in., xxx + 591 pp., 103 maps, 61 photos., 43 plates (mostly in color). $7.50.

The introductory portion of this book occupies about 73 pages and contains the following sections: 1. Foreword. 2. Preface. 3. Tables of contents, with separate listings of (a) major sections of the text, (b) plates, (c) photographs, and (d) maps. 4. Glossary. 5. "Bird Study," under which appear six sub-headings.

The portion entitled "Species Accounts" begins with some general comments, including valuable definitions of terms used to describe relative abundance (pp. 44–56), and is followed by the systematic account of species (pp. 59–576). After this section are a bibliography (pp. 577–586) and an index (pp. 587–591).

Much of the introductory portion may be passed over without comment, but reference should be made to certain parts. A concept of the glossary may be gained by listing the first several terms: above, abundant, accidental, adult, albino, amphipod. The inclusion of "above," along with the synonymous term "dorsal," seems superfluous, aside from the fact that its meaning is obvious. The definition of "adult" as "a full-grown plant or animal" could prove confusing to a beginner at bird watching.

The heading "Bird Study" proves to be a catch-all wherein several distantly related topics are discussed in the informal, but informative, style which characterizes this work: 1. Introduction (pp. 1–10)—general public interest in birds, bird-watching equipment and references, ornithological organizations and their journals, and much other information useful to beginners; 2. Ornithology in Alabama (pp. 11–14)—a brief historical account; 3. Physiography of Alabama (pp. 14–25)—including topography, climate, and "plantlife"; 4. Birds and the Law (pp. 25–28); 5. Migration (pp. 28–38); and 6. Banding (pp. 38–43).

The bibliography appears reasonably complete, but certain omissions are puzzling in the absence of stated criteria for inclusion of articles. (Very few articles or books are referred to in the text.) Both common and colloquial names of birds, but *no scientific names*, appear in the index.

It is in the species accounts that work of this sort must make its distinctive contribution, and a single comparison points up the value of this volume. Whereas its predecessor (Howell's "Birds of Alabama," 1924) listed 274 species, Imhof's book credits the state with 352 species. After establishing residence near Birmingham in 1946, the author carried on extensive field work in 64 of the state's 67 counties. He also solicited, evaluated, and used the data of all other observers considered reliable; examined specimens in ten collections of museum skins; and received lists of Alabama specimens from four other museums. The resulting mass of information was diligently and conscientiously reviewed in the preparation of this book.

In the account of each species the first two or three paragraphs are usually concerned with identification marks, habits, and habitat, but the treatment is not entirely uniform from one species to another. Following these paragraphs come sections on nesting, food, and distribution, the last stating the total known summer and winter ranges. The advisability of including nesting data for species which do not breed in Alabama is doubtful.

Seldom should a reader be more strongly cautioned to "read the fine print" than in this work, for its very *raison d'être* appears in reduced type under the heading "Occurrence in Alabama." (Two additional paragraphs, "Time of Breeding" and "Banding," are included whenever pertinent data are available.) In this section the extreme migration dates and highest one-day counts are presented under each of six natural divisions of the state (Tennessee Valley, Mountain Region, Piedmont, Upper Coastal Plain, Lower Coastal Plain, and Gulf Coast). The locality, year, and name of the observer are cited for each record. The inclusion of quantitative data, even though not in highly refined form, is laudable. In view of the importance of this section, it is deplorable that succinctness prevented discussion and evaluation of unusual records, leaving the reader to wonder about their validity. An added disadvantage is that the method does not lend itself to the historical approach which could develop trends of increasing or decreasing abundance. The greatest drawback, however, is that there is no provision for including more detailed information on distribution *within* each region of the state, except for those species represented by range maps. Even in the smallest of these regions (Gulf Coast) the north–south extent is more than 50 miles, and the limits of dozens of species terminate therein, but rarely are they delineated.

The book features no separate Hypothetical List, but the names of species whose status "is not completely acceptable" are enclosed in brackets. Among these are recently extirpated forms properly accredited to the state earlier, such as the Ivory-billed Woodpecker and the Ruffed Grouse (the latter re-introduced in 1958), and birds examined in the hand not preserved. Evidently these rules were applied rigidly to all species, so that none is admitted to the list on insufficient evidence. The danger in such a disposition of doubtfully recorded species, however, is that the neophyte may not realize the significance of the brackets. The necessity for specimen support should not, of course, apply only to species doubtfully recorded in the state, else the addition of a species to a state list might be followed by a rash of irresponsible records. Even though all eastern species of *Empidonax* have been collected in Alabama, additional records of silent birds caught in mist nets and released should not be given the same weight as museum specimens.

Although some mildly objectionable features of this book may be accepted as a means of gaining popular appeal, the almost complete omission of any reference to subspecies appears too great a sacrifice to make in this effort. Exceptions are made in a few cases, such as the Palm and Yellow-throated Warblers.

A few errors are almost inevitable when such a large mass of records is handled, but the per cent in this volume seems quite low. The "last authentic record" of the Ivory-billed Woodpecker in Florida was more recent than "March 3, 1950" (p. 340). Among the reviewer's records which are partly in error are the year of the Buff-breasted Sandpiper at Tuscaloosa (p. 258; 1938 rather than 1948), and the localities for records of the following species in the Gulf Coast region: Cedar Waxwing at *Foley* (p. 419), Prairie Warbler at Foley rather than Gulf Shores (p. 476), and Dickcissel at Fort Morgan rather than Robertsdale (p. 531). Nor have I heard the song of the Yellow-bellied Flycatcher *anywhere* (p. 352). One could also take issue with the interpretation of a few records, but for the most part it is sound and conservative.

Grammatical errors are very few, and both the author and his technical editor, James E. Keeler, may be proud of the nearly complete absence of typographical errors.

Another of the fine features of this book is the abundance of range maps depicting the distribution of about 50 species in Alabama. Occasionally these show the distribution of the bird by a bounding line, but in all cases the locations of various types of records are shown by symbols. When as many as seven symbols are used (e.g., for the Swainson's Warbler), some confusion results. The symbol indicating definite breeding was inadvertently omitted for the Whip-poor-will (p. 317).

Most of the remaining maps show banding points in North America for birds recovered in Alabama, or less frequently recovery points for those banded in Alabama. It is obvious that such pictorial representation of migratory trends in individual birds is of great value. Readers who are interested in either set of maps would be greatly aided if the two kinds were differentiated in the table of contents.

One of the most remarkable features of this book is that so many illustrations, mostly in color, could be included without raising its price excessively. Almost every species on the list, whether or not supported by a specimen, is illustrated. (The only exception noted, the Golden-crowned Sparrow, is represented by only a single sight record.) The majority of the paintings are the enviable work of Richard A. Parks. Though some may object to the crowding of so many birds on each plate, as in a field guide, my impression is that they are both accurate and attractive. Possibly through no fault of the artist, most of the thrushes (Plate 29) are too pale, and the Veery too dull. On Plate 25 the Great Crested and Ash-throated Flycatchers are *much* too pale. The artist's name is cut off the bottom of Plate 34. One may only conjecture why so many birds, females as well as males, are pictured with the bill open. Seven of the eight warblers on Plate 35 have the bill agape. The water birds (through ducks) are illustrated by David C. Hulse. Although some (e.g., diving ducks on Plate 11) are quite meritorious, these plates generally do not maintain the high standard set by Parks or by the frontispiece of a Turkey (Walter A. Weber). The Sandhill Crane (included with ibises and the Roseate Spoonbill on Plate 6) is grossly disproportionate, and the Wood Ibis is only a slight improvement. The only leg shown in the picture of the White-faced Ibis is as dark as those of the Glossy Ibis, rather than reddish.

The contributions of several photographers complete the copious illustrations. These depict adults, young, or nests and eggs of various species, particularly those of the lower orders (only 11 of 61 show passeriforms). These are generally of good caliber, although the eggs of the Red-Shouldered Hawk (p. 181) are out of focus.

A given book may be assessed either according to how well its author carries out his objectives in writing it, or in the light of what the reviewer thinks its objectives should have been. If I correctly infer the unstated objectives, Imhof has succeeded extremely well in preparing a book for readers of diverse backgrounds and interests. If any group has been slighted, it is those of a more scientific bent. In any case, weighing the book's merits against its cost, one would have to search far and wide to find a better bargain in a state bird book.—HENRY M. STEVENSON.

BIRD. By Lois and Louis Darling. Houghton Mifflin Company, Boston, 1962: 6½ × 9½ in., xiii + 261 pp. Numerous illustrations by the authors. $5.00.

"Bird" is a delightfully illustrated, chattily written account of the behavior and structure of birds. Unfortunately, the reader must accustom himself to the rambling sentence structure and the stylistic gaucheries which he meets, particularly in the first half of the book, before he can appreciate, or benefit from, the authors' effort. While it is true that the use of "human" as a noun has become commonplace, reference to birds as being "born" is still offensive to many people. Except in children's tales, birds should be written of as "it," or "which," rather than as "he," or "whom." The reviewer would not call attention to these errors, were it not for the recurring "and/or," a usage which may be appropriate in legal descriptions, but which brings the continuity of thought, and of communication from authors to readers, to an abrupt halt. That the first half of the book gives the impression of being a first draft, unedited, imposes an unnecessary burden on the reader.

There are numerous oversimplifications throughout the book. One, only, will be cited.

"Although migration is synchronized with the breeding cycle, the basic cause for it is food." This statement is not true. Food is not the basic cause of anything. Lack of food can produce hunger, so if we impute our own sensations and interpretations to birds we can say that the lack of food may produce activity tending to reduction of unpleasant sensations. Unfortunately, as the sentence stands, it suggests to the unwary reader that birds somehow "know," during the highly food-productive late summer and early autumn months, that edible material is soon to become scarce, and that if they fly in a certain direction they will reach (and recognize) a place where such food materials will *not* be scarce in the near future.

To call food the basic cause of migration is also to raise the question of the cause of northward spring migration, from regions *not* about to become short of edible material (unless the birds "know" that they are going to raise a number of young birds, and consequently require a greater amount of food). Northward migration, based on need for food, means departure from an area which has, and will continue to have, available food. Thus two different causal mechanisms must be postulated for the two seasonal directions of migration, one operative in the spring and the other operative in the fall. There are many such oversimplifications in the book, which the reader should be warned to recognize.

Counteracting (but not counterbalancing) this criticism are the illustrations (all drawings), and the excellence of several of the chapters. Indeed, the book is as strong, textually, in its second half as it is weak in its first half. There is much of real value in "Bird" that is not to be found in any of the other available books on ornithology. This value results mainly from the marginal illustrations, which achieve the desirable but seldom attained effect of pointing up the facts as presented in the text in such a way as to make them memorable. For example, who could look at the delightful sketch of an awkward and startled *Archaeopteryx* just as it begins to fall clumsily into muddy prehistoric Bavarian waters, and not forever remember the living creature which became our oldest known fossil bird?

The second half of "Bird" is devoted to anatomy, with a nod to physiology. This part is excellent. The authors, regardless of their stated aims, appear to have kept the interested and intelligent layman, rather than the biologist or the child, in mind. They know that a large portion of their audience might find an operating room or an anatomy laboratory distasteful, and perhaps even offensive. Here the power of the illustrations is most pronounced. It would be difficult to be upset by the drawing of a plucked bird that heads the chapter, "Skin and Feathers," so the reader is led to pay careful attention to the accurate descriptions and illustrations that explain the structure, growth, and development of feathers. Bones and important muscles are well treated by the same method.

The five-page chapter on circulation is devoted primarily to the heart. Its appropriate introductory illustration is of two chickadees on the snow, in a cold-looking forest. Introducing the chapter on the urogenital system is a charming portrayal of a rooster chasing a hen. The rooster's expression is eager and intent, while the hen's head is just off the page, leaving the reader to his own imagination. An extension of this type of humor leads to the chapter on the nervous system being entitled, "The Bird Brain."

There are chapters on hormones, sense organs, and flight. The last is usually a difficult subject to explain or to understand. The Darlings have produced, in 19 well-illustrated pages, one of the best popular accounts yet written.

The book concludes with a weak epilogue which implies that practice of conservation and of respect for life are natural products of a mature humanity. They are, but the Darlings state that we have attained such maturity, and they deplore that we do not act as though we had. Here they are criticising symptoms after making a faulty diagnosis.

"Bird" is a book which cannot be given unequivocal recommendation. It is marred by stylistic weaknesses and oversimplifications. On the other hand, it undoubtedly fills one of the few gaps left in popular ornithological literature. A revised, carefully edited edition would be a valuable addition to private and public libraries throughout the country.—ORMSBY ANNAN.

INDEX TO VOLUME 74, 1962

This index includes, in addition to names of genera, species, and authors, references to the following topics: anatomy, behavior, distribution, food habits, measurements, migration, molts and plumages, nesting, parasitism, physiology, populations, predation, taxonomy, voice, and weights. Also included are references of biological significance to mammals.

This issue of *The Wilson Bulletin* was published on 31 December 1962.

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the AOU Check-list (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited; otherwise, follow the "Style Manual for Biological Journals" (1960. AIBS). Photographs for illustrations should be sharp, have good contrast, and be on gloss paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A WORD TO MEMBERS

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

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4th	1916	Chicago, Illinois
5th	1917	Pittsburgh, Pennsylvania
6th	1919	St. Louis, Missouri
7th	1920	Chicago, Illinois
8th	1921	Chicago, Illinois
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11th	1924	Nashville, Tennessee
12th	1925	Kansas City, Missouri
13th	1926	Chicago, Illinois
14th	1927	Nashville, Tennessee
15th	1928	Ann Arbor, Michigan
16th	1929	Des Moines, Iowa
17th	1930	Cleveland, Ohio
18th	1931	New Orleans, Louisiana
19th	1932	Columbus, Ohio
20th	1934	Pittsburgh, Pennsylvania
21st	1935	St. Louis, Missouri
22nd	1936	Chicago, Illinois
23rd	1937	Indianapolis, Indiana
24th	1938	Ann Arbor, Michigan
25th	1939	Louisville, Kentucky
26th	1940	Minneapolis, Minnesota
27th	1941	Urbana, Illinois
28th	1946	Omaha, Nebraska
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30th	1949	Madison, Wisconsin
31st	1950	Jackson's Mill, West Virginia
32nd	1951	Davenport, Iowa
33rd	1952	Gatlinburg, Tennessee
34th	1953	Cheboygan, Michigan
35th	1954	Cape May, New Jersey
36th	1955	Stillwater, Oklahoma
37th	1956	Buffalo, New York
38th	1957	Duluth, Minnesota
39th	1958	Wheeling, West Virginia
40th	1959	Rockland, Maine
41st	1960	Gatlinburg, Tennessee
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