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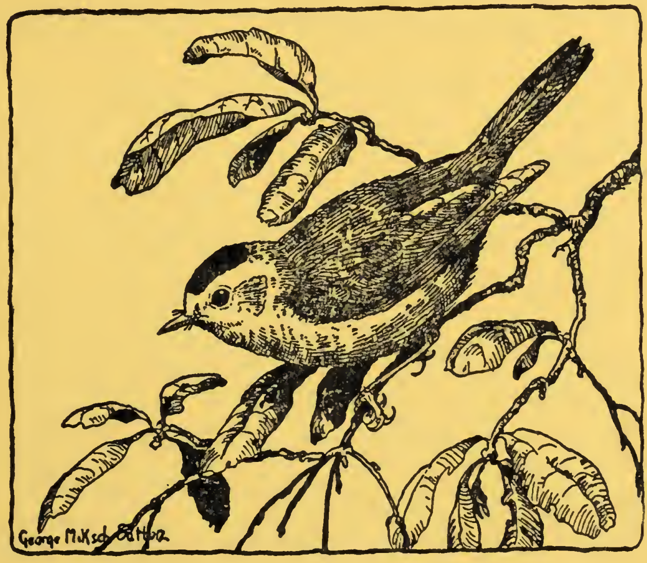

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MOURNING WARBLER (*Oporornis philadelphia*).
Male at nest with young. Photographed by Hal H. Harrison.

A LIFE HISTORY OF THE MOURNING WARBLER

BY GEORGE W. COX

During the summers of 1956 and 1957 I studied the breeding biology of the Mourning Warbler (*Oporornis philadelphia*) at the University of Minnesota Forestry and Biological Station in Itasca State Park, Minnesota. Here, in contrast to much of the breeding range of the species, the Mourning Warbler is one of the commoner nesting warblers. During the spring of 1957 I made observations on migrating Mourning Warblers at Urbana, Illinois. In February, March, and April, 1959, I made scattered observations of the species in its winter range in the Panama Canal Zone. Since no comprehensive life history study of this species has been published, an attempt is made here to summarize available information related to the aspects of the breeding biology investigated in the present study.

Acknowledgments

This paper is based on a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at the University of Illinois, Urbana, Illinois.

I express appreciation to S. Charles Kendeigh, who directed the study, and to John T. Emlen, Jr., and Wilbur Mayhew who offered valuable suggestions during the course of it. William Marshall and T. Shantz-Hansen kindly made facilities of the University of Minnesota Forestry and Biological Station available to me, and M. Moynihan and Richard Brewer offered valuable suggestions regarding the manuscript. Finally, sincere thanks are extended to W. D. Stull for guidance both during the course of the study and during the writing of the paper.

Methods

During the summer of 1956 three nests (#1, #2, #3, 1956) were studied from blinds situated close to the nests. In 1957 two additional nests (#1, #2, 1957) were studied, one with the aid of an itograph, a device for automatically recording visits to the nest by the parents. This itograph was a modification of the type used by Hann (1937), and consisted of a hardware-cloth cage fitted over the nest, and a battery-run recorder located in a nearby blind. The cage over the nest had a single opening through which the parents entered and left. The record obtained, however, did not distinguish between birds entering or leaving. Because of this, difficulties of interpretation were encountered. During incubation these difficulties were greatly reduced by the observer frequently visiting the blind and marking on the record whether the female was on the nest or not, thus providing reference points for interpreting adjacent records of entrance or departure of the parents. After the young had hatched and both parents were actively feeding the young, as well as the female brooding for longer periods of time, interpretation was more difficult. For this reason data from this period are more approximate, and have been summarized separately from data obtained from direct nest observation.

During both summers observations were also made on the behavior and ecology of the pairs with nests under observation and of other territorial pairs throughout the park.

Range and Migration

The breeding range of the Mourning Warbler extends, in the north, from west-central Alberta eastward through central Saskachewan and Manitoba, northern Ontario, and central Quebec to Newfoundland and Nova Scotia, and in the south, from northeastern North Dakota eastward through the northern parts of Minnesota, Wisconsin, and Michigan to northern Pennsylvania and southern New York, with a southward extension in the mountains to West Virginia (for detailed account, see A.O.U., 1957). In the southern extension of the range the species breeds only at higher elevations. In Massachusetts it occurs mostly above 1600 feet, although occasionally as low as 940–960 feet (Eliot, 1941). In western Pennsylvania the lower limit is about 1100 feet (Todd, 1940). In West Virginia (Brooks, 1940) and Maryland (Stewart and Robbins, 1947) the 3000-foot contour is the lower limit of the species.

The winter range, although poorly known, seems to extend from southern Nicaragua to Colombia, western Venezuela, and northern Ecuador (A.O.U., 1957). In the Panama Canal Zone, from February to April, 1959, I found the species to be a not uncommon winter resident in the lowland areas from sea level to about 500 feet. During this period the species was observed five times in edge areas with dense brush or tall rank grass. Miller (1947) reports that in the Magdalena Valley of Colombia they frequented low tangles and understory vegetation in damp woodlands. In Costa Rica Skutch (in Bent, 1953) states that low dense thickets and fields overgrown with tall weeds and rank grass are favorite habitats. He states that he has observed them mainly in the lowlands up to 4000 feet, but that they are still one of the commoner wintering warblers at 3000 feet.

The migration route of the species is primarily through Central America (Stevenson, 1957). In general it is one of the later migrants, leaving the winter range in March and April (Bent, 1953) and arriving at the latitude of Champaign, Illinois, and central and northern Ohio about May 11 or 12 (Smith, 1930; Jones, 1914; Borror, 1950). Observations of Soper (1949) and Peters and Burleigh (1951) at the extremities of the breeding range indicate that the species has reached most of this area by the last week in May.

At Urbana, Illinois, during the spring of 1957, 48 individuals of this species were observed between May 10 and May 25. The majority were observed in brushy edges, thickets and understory vegetation in open woods. When first noted, 90 per cent of the birds were in vegetation less than 5 feet in height.

In fall, migration begins early, with immature birds often appearing far south of the breeding range in early August, as, for instance, in Texas on August 4 (Baumgartner, 1951). At Chicago the average fall arrival is about August 25 (Clark and Nice, 1950), and in central Ohio the first birds appear about September 5 (Borror, 1950). Arrival in the winter range occurs during the last half of September and the first half of October (Bent, 1953).

Breeding Habitat

The Mourning Warbler is found in a variety of habitats, including brushy woodland clearings (Gromme, 1938; Saunders, 1938; Forbush, 1929; Peters and Burleigh, 1951), forest edges, brushy edges of marshes and bogs (Roberts, 1932), and dense second growth (Roberts, 1932; Todd, 1940; Brooks, 1940). In the present study area, Hickey (1956) found the species strongly associated with clearings, while Kendeigh (1956) noted it most strongly associated with aspen-birch stands.

During the summer of 1957 I obtained data on the general habitat of the species by spot-checks of areas occupied by singing males throughout the park. Males were found in all the major vegetation types, from almost pure stands of red, white, or jack pine to stands of maple-basswood, spruce-fir, aspen and aspen-birch. In most cases these males were associated with edge conditions such as road edges, logging trails, bog borders, clearings, or areas of open woods. Occasionally, however, they were noted where well defined edge conditions seemed to be absent.

The vegetational characteristics of four territories were determined by quantitative measurements of tree density, degree of canopy closure, and type of ground cover. Canopy closure and ground cover were measured by walking parallel line transects 50 feet apart through each territory and counting the number of paces through each condition (open or closed canopy, herbs, shrubs or bare ground). Data on tree density were obtained by a method of stratified random sampling, using 30- by 30-foot quadrats laid out in a manner described by Oosting (1956:50). In these quadrats all trees more than two inches dbh were identified and measured. From these data the number of stems per acre, and the average diameter and the average basal area for each species and each territory were computed.

Canopy closure in these territories varied from 48 to 77 per cent (Table 1). Ground coverage by herbs varied from 41 to 81 per cent and by shrubs from 18 to 59 per cent. These results and a consideration of the features common

TABLE 1

CHARACTERISTICS OF FOUR MOURNING WARBLER TERRITORIES AT ITASCA STATE PARK

	1	2	3	4
Territory size (acres)	1.7	2.2	1.8	1.6
Herb coverage (per cent)	65	43	41	81
Shrub coverage (per cent)	34	53	59	18
Bare ground (per cent)	1	4	0	1
Canopy closure (per cent)	77	48	71	69
Trees per acre	334	211	281	358
Average tree dbh (inches)	7.5	6.3	7.3	8.4
Basal area per acre (ft.^{2})	111.6	51.6	111.7	159.2
Per cent basal area of deciduous species	68	98	18	7
Per cent basal area of coniferous species	32	2	82	93

to the various other locations in which the Mourning Warbler was noted in the park, and to other habitats from which it has been reported, suggest requirements for a partially open canopy and the presence of both herb and shrub cover on the ground. If these requirements are satisfied the species may occur in a wide range of plant communities ranging from almost pure coniferous (Territories 3 and 4, Table 1) to pure deciduous (Territories 1 and 2) and even in relatively dense coniferous forests, provided there are scattered openings.

COMPETITION WITH ASSOCIATED SPECIES

On the biological station grounds at Itasca Park, where five territories of the Mourning Warbler were under close observation during the summer of 1957, 11 other species of warblers held territories which overlapped with those of Mourning Warblers. These were the Blackburnian (*Dendroica fusca*), Black-throated Green (*Dendroica virens*), Parula (*Parula americana*), Chestnut-sided (*Dendroica pensylvanica*), Black-and-white (*Mniotilta varia*), Nashville (*Vermivora ruficapilla*), Myrtle (*Dendroica coronata*), and Golden-winged (*Vermivora chrysoptera*) Warblers, American Redstart (*Setophaga ruticilla*), Yellowthroat (*Geothlypis trichas*), and Ovenbird (*Seiurus aurocapillus*). Interspecific aggressive behavior was noted with only two of these, the Yellowthroat and the Chestnut-sided Warbler.

On four occasions (one in migration at Urbana, Illinois) encounters were noted between male Mourning Warblers and Yellowthroats (both sexes). These encounters involved mutual wing-flipping and tail-flipping displays, usually accompanied by *tshrip* notes (see section on vocalizations), and occasionally chases. The aggressive behavior on the part of the male Mourning Warbler was similar to that shown in encounters with other Mourning Warblers.

Several authors have pointed out the similarity of the habitats of the Mourning Warbler and the Yellowthroat (Roberts, 1932; Todd, 1940). On the biological station grounds at Lake Itasca, Yellowthroat territories overlapped all five of the Mourning Warbler territories studied there, and two of the Yellowthroat nests were known to be located inside Mourning Warbler territories. There was no evidence of mutual exclusiveness of territories.

One example of aggressive behavior was noted between the Mourning Warbler and the Chestnut-sided Warbler. On June 19, 1957, in an area where territories of the two species overlapped, the male Mourning was observed to chase the male Chestnut-sided briefly. In the same area, these same two birds were observed singing in a clump of shubbery where the nest of the Chestnut-sided was located. At this time the male Mourning Warbler gave a series of soft, gurgling phrases rather than the typical territorial song. There was no evidence of mutual exclusiveness of territories between these two species either, and on the biological station grounds the territory of one pair of Mourning Warblers almost completely overlapped that of a pair of Chestnut-sided Warblers.

Food Habits

Few food habits data are available for this species. In eight stomachs of adult Mourning Warblers from the vicinity of Lake Nipagon, Ontario, Kendeigh (1947) found that spiders, various beetles, and Lepidoptera constituted over 50 per cent of the contents. Other insects typical of the ground and low vegetation were present in smaller amounts. Saunders (1938) and Roberts (1932) report that nestlings are fed mainly on Lepidoptera larvae. This item was commonly brought to the young in the present study, but numbers of other small insects were fed as well.

Relation to Predators

Two of the nests under observation during 1956 fell victim to predators. One, from which eggs were taken, was in an area frequented by two ground squirrels (*Citellus tridecemlineatus* and *C. franklini*), the eastern chipmunk (*Tamias striatus*), the least chipmunk (*Eutamias minimus*), and the red squirrel (*Sciurus hudsonicus*) by day and the racoon (*Procyon lotor*) by night. The nest itself was little disturbed and it seemed likely that one of the smaller mammals was responsible. The second nest, from which nestlings were taken, was located in an area frequented by red squirrels and least chipmunks. This nest was also little disturbed, suggesting the action of one of these small mammals.

On one occasion, where Mourning Warblers had young just out of the nest, the parents, several Blue Jays (*Cyanocitta cristata*), and several Red-eyed Vireos (*Vireo olivaceus*) were found scolding a large hawk or owl. The Mourning Warblers remained in the dense underbrush and gave loud *tshrip* notes.

Two types of distraction displays were given by the adults in response to the observer approaching the nest or the young birds after they had left the nest. When a nest containing eggs or young was approached the female usually remained on until the observer was quite close. She would then dive quickly over the edge and run away quickly through the ground vegetation, not taking flight until reaching a distance of 20–25 feet from the nest. This escape was very mouse-like, and often a peculiar gait seemed to be used. This behavior may well function as a distraction display based on the resemblance of the female to a mouse scurrying through the leaves, since the action, *per se,* is conspicuous, but the identity of the female as a bird may not be evident. This type of behavior has also been noted by Forbush (1929) and Gromme (1934).

A typical "broken wing" display was also given by the adults, especially during the period just after the young had left the nest. The initial part of the display was most intense. The adults would dash and flop through the ground vegetation, flipping the wings outward from the body, and often holding them out in a dragging position for short periods. During this display *tsip* notes were usually given. This behavior became weaker as the young birds grew older, but was noted for about two weeks after the young had left the nest. In the present study this behavior was noted occasionally during the period when the young were still in the nest. Gromme (1934) recorded this display during incubation, also.

The Mourning Warbler is not uncommonly a victim of the Brown-headed Cowbird (*Molothrus ater*). During the present study one nest was parasitized, containing one egg of the parasite and three of the host. Twelve other instances of parasitism have been reported in the literature, including five (Pitelka, 1939; Roberts, 1932; Lloyd, 1949; Chambers, 1947; Hickey, *et al.*, 1955) not included in summaries by Friedmann (1929, 1931, 1938, 1949).

VOCALIZATION

In the following discussion the term "song" is applied to the more complex vocalizations and the terms "call notes" or "notes" to the less complex. These should be understood as simply convenient names for these vocalizations and not as interpretations of function or motivation. Likewise, the term "territorial song" refers to the complex male vocalization which may be similar in function and motivation to the advertising songs of other species.

The territorial song of the Mourning Warbler is loud and ringing, with a somewhat throaty quality. It consists of 3–7 two-parted phrases, with the accent on the first syllable of each phrase. Typically, the last 1–3 phrases are given on a lower pitch. The length of the song varies approximately from 1–1¾ seconds (Gunn and Borror in Griscom and Sprunt, 1957). A typical song of the males in the present study area could be paraphrased *whee-o whee-o whee-o, whoo-e whoo-e.* Other common song patterns are given by Gunn and Borror (*op. cit.*). Variations I noted consisted of differences in number of phrases, omission of the changed ending, and differences in pitch and quality.

Only the male sang. He showed definite attentive and inattentive song periods, the latter being devoted mainly to feeding. Attentive periods were long, often over an hour in length, but within these the rate of singing varied. The rate of singing varied from 1–8 songs per minute, averaging about 3.6, giving an interval of about 15 seconds between songs. At times feeding and singing were carried out together in the underbrush, and during these times the rate of song was low (1–2 per minute). High intensity singing (6–8 per minute) was usually noted after territorial encounters.

The height in the vegetation at which territorial song was given varied from near ground level to about 40 feet high in trees. The stratum with the most records (37 per cent of 1200 records) of singing birds was that of low underbrush less than 5 feet in height. The stratum of second highest number of records was that between 20 and 25 feet (22 per cent). At this level the males often perched for long periods and sang rather steadily. The heights of those perches at which males remained and sang steadily for at least 10 songs ("singing perches"), were most frequently between 20 and 25 feet. Kendeigh (1947) found nearly the same distribution of song in relation to height in the vegetation in Ontario, where he noted the average height to be 26 feet, with some as high as 60 feet. Roberts (1932) and Forbush (1929) have also noted the tendency of the males to sit motionless at certain perches, singing steadily for long periods. When disturbed from these perches the males usually flew quickly into the underbrush, frequently to continue singing there.

A definite pattern of movement was followed during the attentive periods of song. At the beginning the male would fly up to a low branch, give a few songs, fly to a higher perch nearby, give a few more songs, and continue this process until reaching a perch 20–30 feet high, from which he would sing steadily for a long time (often 40–50 songs). From here occasional flights would be made to adjacent trees, or back down into the underbrush, in which case the performance would often be repeated. Trautman (1940) has described this behavior in Ohio in migration.

In the present study singing was less frequent in the afternoon hours. In New Hampshire, Wright (1913) stated that song began about 37 minutes before sunrise. Trautman (1940), however, states that males in migration at Buckeye Lake, Ohio, remained silent during the early morning warbler chorus.

Song declined near the end of the nesting cycle, but did not cease until some time after the young were out of the nest. Roberts (1932) found young awing in late July with the parents still in full song. Saunders (1948*a*) found the average date of song cessation to be July 16 in Allegany Park, New York. He also noted a revival of song, frequently the flight song, between August 5 and 16 (Saunders, 1948*b*).

At Urbana, Illinois, in the spring of 1957, migrating males were frequently heard singing. One male was observed to maintain a nearly constant rate of 3–4 songs per minute for almost an hour. Trautman (1940) on one occasion observed 25 males singing at one time in migration in Ohio. Song is rare during fall migration.

The male also possesses a flight song, which is given as the bird flies upward, and ceases when a certain height is reached (Saunders, 1954). At Itasca Park the entire performance was never seen, but was heard on many occasions. Although hard to describe because of its rapidity, the song apparently begins with a series of chipping notes, followed by a rapid version of the territorial song, and ends with a few more chipping notes. A paraphrase of this song might be given as: *chi-chi-chi-chip-chip-cheery-cheery-chorry-chorry-chi-chip.* This song was heard once in mid-afternoon in migration at Urbana, Illinois. At Itasca Park it was heard between June 21 and July 13, but was most common during the first part of July when most pairs were in the latter stages of nesting. It was given at various times throughout the day. On one occasion it occurred at the beginning of a period of territorial song. In the territory of one of the pairs whose nests were under observation the flight song was heard on three occasions during the period when this pair had nestlings or fledgings. The sex of the bird giving this song was noted only twice; it was the male.

A third type of song pattern was heard once in early June. A male gave a soft, patternless series of muttering notes, interspersed with notes resembling soft *tschrip* notes. The significance of this song was not determined.

Two call notes were given by the adults. One was a *tshrip*, loud and rather harsh in quality. It was heard commonly interspersed with the territorial song of the male, and was also frequently noted in both male and female when disturbed by an observer away from the nest area. It was heard commonly from migrating birds. It may have had some signal function between the male and female, since during the period of incubation, when the male occasionally fed the female, it was noted in association with this behavior (see section on incubation).

The second note, a *tsip*, less harsh, and higher in pitch, was heard commonly when I approached a nest containing eggs or young, or when the young fledglings were approached. It was also given during a territorial encounter between two females.

TERRITORIES AND TERRITORIAL DEFENSE

The sizes of ten territories were measured during the summer of 1957. The boundaries of these territories in early June were determined by marking the locations of singing males in the field. At least four hours of observation were spent with each pair, divided among at least three trips. Lines connecting the outermost points, thus giving the maximum enclosed area, were measured with a steel tape, and the direction of these lines noted with a compass. These measurements were then transferred to a map, and the enclosed area measured by dividing the areas into triangles and calculating their sizes.

The ten territories ranged in size from 1.6 to 2.4 acres, averaging 1.9 acres. Near Lake Nipagon, Ontario, Kendeigh (1947) found that during a spruce-budworm outbreak two territories were 0.9 and 1.5 acres in size. Kendeigh (pers. comm.) has suggested that these measurements were probably not as detailed as those of the present study, rather than representing a response to the spruce-budworm outbreak. In New Hampshire the foraging area of a pair was about 1.5 acres (Wallace, 1949).

The territories observed at Itasca Park included the nest site, and were used as foraging areas by the parents.

Two males, studied closely in 1957, defended the entire territory by territorial song early in the nesting cycle, but in the later stages their singing was confined to a smaller portion of the territory. In the period between June 20 and 25 the male of a nest containing nestlings confined his singing to two small areas near the nest, while a second, during the same period, sang regularly only in a small area at the opposite end of the territory from its nest, which contained eggs. Although singing seemed to be confined chiefly to these small areas, territorial encounters were noted in other parts of the territory, suggesting that the entire area was defended against other birds if they were noticed.

In 1957, when the nest sites of only two pairs were known, the males did not sing in the immediate vicinity of the nest. The closest the two males sang to their nests was 30 feet and 85 feet.

In addition to song, other more aggressive displays were used to defend the territory against intruding Mourning Warblers. Good observations on these encounters were made on only three occasions. One encounter, in June, 1956, took place between two males in thick underbrush. The males hopped rapidly from perch to perch, bobbing their bodies violently. At the same time they rapidly flipped their wings outward and rapidly opened and closed their tails. Frequent *tschrip* notes were given. Occasionally short winding chases through the brush were made. During this encounter, the female of one pair appeared and began begging from the male by fluttering her wings and gaping. After a few minutes the males separated, one beginning to sing rapidly, the other continuing to give *tshrip* notes. After a few more minutes the second male also began to sing. During late June, 1957, a similar encounter was noted between two other males. During July, 1957, an encounter taking place mainly between two females was seen. At this time both pairs had fledglings, and the encounter was probably caused by the movement of one group into the territory of the second. When first seen, both females were in a small tree, and were both giving *tsip* and *tshrip* notes. Bobbing and wing- and tail-flipping similar to that seen in encounters between males were also performed. The two birds gradually hopped higher in the tree, then flew quickly down into the underbrush and engaged in a short, winding chase. Following this they returned to the same tree and repeated the posturing behavior. Both males remained nearby in the undergrowth, giving *tshrip* notes. This encounter continued for over an hour.

Territorial behavior was evident in some migrant birds at Urbana, Illinois. Between May 16 and 24, 1957, a male Mourning Warbler was found daily in a brushy area adjacent to a small stream. On the basis of song pattern I judged this to be the same bird each day. This bird sang regularly in an area about an acre in size. No encounters with other males were noted.

TIME OF NESTING

Five nests were found during the course of the present study. The following summary indicates the general course of events at these nests:

No. 1, 1956. Found on June 14, 1956, containing three eggs. A fourth added the next morning. Eggs removed by a predator late in incubation.

No. 2, 1956. Found on June 21, 1956, with three eggs of the owner and one of the Brown-headed Cowbird (latter I removed). Two of the eggs hatched on July 3 (other infertile) but the young later died when they fell from the poorly constructed nest (Cox, 1958).

No. 3, 1956. Found on July 1, 1956, with three eggs which hatched on July 6. The young were later removed by a predator.

No. 1, 1957. Found on June 12, 1957, containing five eggs, one of which disappeared during incubation. The young hatched on June 20 and left the nest on June 28.

No. 2, 1957. Found on July 5, 1957, with four well developed young which left the nest before noon of the following day.

Data on time of nesting in this species are scant. The earliest observed date of a nest with eggs is May 31 (Macoun and Macoun, 1909) in southern Ontario, and the latest is July 15 in Minnesota (Roberts, 1932). The earliest observed date of a nest with young is apparently June 20 in Minnesota (present study), and the latest, July 17 in Minnesota (Chambers, 1947).

NEST SITE

Nests of the Mourning Warbler are usually placed on or close to the ground. In the present study, four of the nests rested on the ground surface and one was supported on fallen branches 5½ inches above the ground. Records in the literature are mostly of nests on the ground or a few inches above it. The highest record is of a nest 30 inches off the ground (Roberts, 1932).

The nests are concealed in dense herbaceous or shrubby vegetation in most cases. In the present study, three nests were hidden in dense low herbs of the forest floor, one in dense tall grass in a small forest opening, and one in a dense growth of raspberry (*Rubus* sp.) at the edge of an area covered with this plant. The nests are usually supported laterally by stems of the concealing vegetation.

In the literature nests are usually reported from edge areas such as woodland edges or clearings, logging trails, or edges of bogs and marshes. Tree density and coverage of herbs and shrubs were measured in the vicinity (40-foot radius) of the five nests located in the present study. At these sites the average basal area and the number of stems per acre of trees were noticeably lower than in the previous analysis of the territories as a whole (Table 2). This suggests that at least in an area where the territories of the species are located in woodland which is fairly well developed the nests are placed in a more open part of the territory.

NEST STRUCTURE AND COMPOSITION

Nests of this species are rather bulky. Measurements for the five nests in the present study, together with five others reported in the literature (Roberts, 1932; Todd, 1940; Davison, 1891; Bent, 1953) gave average figures of 89 mm. (range 70–102 mm.) for outside height, 130 mm. (range 90–229 mm.)

for outside diameter, 47 mm. (range 38–57 mm.) for inside depth, and 54 mm. (range 44–64 mm.) for inside diameter.

Nests vary widely in composition, depending on the nature of available materials, but are usually described as consisting of leaves, weed stalks, pieces of bark, grasses and sedges, with a lining of fine rootlets, grasses or hair. In the nests I studied leaves were always present, usually as the outer shell of the nest, and varied according to the type available in the vicinity of the nest. Grasses, weed stems, and fibrous tree bark were used to bind the wall together. Linings were of fine weed stems, fine rootlets, grasses, and fine strips of bark.

Weights of four of the nests which had been air-dried for at least two weeks were 11.6, 20.2, 22.6, and 28.0 grams; a nest found by Walkinshaw (1956) weighed 12.2 grams.

TABLE 2

COMPARISON OF TERRITORIES AND NEST SITES* WITH RESPECT TO TREE DENSITY AND GROUND COVER

	Basal area per acre	Stems per acre	Per cent shrub coverage	Per cent herb coverage	Per cent bare
Territories (4)	108.5 ft.^{2}	296	41	58	1
Nest sites (5)	76.5 ft.^{2}	219	42	55	3

*40-foot radius of nest

EGGS AND EGG LAYING

Clutch sizes in the present study were 3, 3 (parasitized by cowbird), 4, 4 (brood size), and 5. The average size for these and for 31 other clutch sizes taken from the literature was 3.7, with a variation from 2–5.

In a single observation of the time of laying, the last egg of nest # 1, 1956, was laid between 3:15 and 6:15 a.m.

INCUBATION

Hofslund (1954) recorded the length of the incubation period of one pair of Mourning Warblers as 12 days, with the same probable time for a second nest. In the present study, nest # 2, 1956, was found on June 21, and contained a full clutch of three eggs at that time. On July 3, 12 days after the nest was found, the young hatched, indicating a minimum period of 12 days for this nest.

The female may begin incubation before the clutch is complete. At nest # 1, 1956, which was found with an incomplete clutch, the female was observed on the nest three of the four times it was visited on the day before laying of the last egg.

The female usually approached and left the nest by hopping through the ground vegetation for 10–30 feet, and was never observed to fly directly to the nest. Definite routes of approach to and departure from the nest were used, especially in the immediate vicinity of the nest. On arriving at the nest the female usually paused on the rim and looked into the nest cavity for a few seconds, after which she entered the cavity and settled with a side-to-side rocking motion, spreading the feathers on either side of the brood patch as she did so.

While on the nest the female engaged in various activities such as resettling, preening, particularly around the brood patch, pecking at materials in the nest bottom, and moving the eggs. Occasionally she would "yawn," briefly close her eyes, or tuck her bill under her wing for a few seconds. During hot periods of the day, or when direct sunlight fell on the nest, she would sit with the bill agape, "panting" almost constantly.

Little or no response was shown to loud calling of other birds at distances over 50 feet from the nest. When other birds or small mammals passed through the vegetation within 5 or 6 feet of the nest, the female usually elevated her head and looked in the direction of the disturbance.

During incubation the female is fed by the male both at and away from the nest. On June 14, 1956, the female of nest # 1 was seen to fly up from the vicinity of the nest to a perch about 5 feet off the ground in a small spruce. The male appeared and the female begged by gaping, fluttering her wings, and uttering soft, throaty, musical sounds barely audible to the observer 50 feet away. The male fed her and flew down to the ground, *tshrip*-ping vigorously. He then flew back up and fed the female twice more. Following this he gave *tshrip* notes from several perches and flew away. The female flew down into the ground vegetation and returned to the nest.

Several times while the observer was watching the incubating female of this same nest from a blind, the male came near the nest and began giving *tschrip* notes. In several instances the female responded by giving similar notes from the nest but did not leave. This response occured on the average 7.4 minutes after the beginning of an attentive period of brooding by the female (attentive periods averaged 28.2 minutes for this bird). On four occasions when the male appeared and gave *tschrip* notes near the nest the female responded by giving similar notes from the nest and then leaving the nest in less than a minute. The attentive periods terminated by this behavior averaged 13.5 minutes in length, seeming to indicate that these periods were shortened by the appearance of the male and that possibly they also represented times when the male fed the female away from the nest. It is suggested that the relative strength of the incubation drive (higher when occurring shortly after the beginning of an attentive period, lower later) to the drive activated by the appearance of the male was the controlling factor in whether the female left the nest or not.

The male also fed the female on the nest. This was difficult to observe because of the extreme shyness of the male. When approaching the nest the male occasionally gave low *tshrip* notes, but often appeared silently. The food item brought was most frequently a large green larva. When the male appeared the female either remained in the nest cavity or backed off to the opposite edge of the nest and begged by gaping, spreading her wings slightly and giving soft musical notes. After feeding the male usually remained on the edge of the nest for a few seconds. Sometimes the male apparently followed the female to the nest at the end of an inattentive period to feed her, but this was never seen in entirety. In one instance the female hopped to the edge of the nest with her bill agape, making soft musical sounds. The male was heard giving soft *tshrip* calls in the nearby vegetation, but was apparently frightened by the observer and left.

The function of this behavior may be partly that of anticipatory food bringing as described by Nolan (1958), but since the female was also fed away from the nest, an additional function, perhaps related to the pair bond, is probably involved.

Toward the end of attentive periods of incubation, the female exhibited what might be termed incubation restlessness. From seven to eight minutes before the end of the period the female would begin to shift position and resettle more frequently. From one to four minutes before leaving she would begin to show nervous turning and tilting movements of the head. This behavior became more and more frequent until she left the nest.

The length of the attentive periods in the three nests studied averaged 35.8 minutes, and ranged from 2–93 minutes (Table 3). In respect to the individual females the average lengths were 60.5, 28.2, and 38.4 minutes.

Inattentive periods averaged 9.6 minutes for all three birds together, and 17.8, 8.7, and 9.2 minutes for the three individual females. In these three birds longer average length of attentive periods was correlated with longer average length of inattentive periods.

Length of attentive and inattentive periods also varied with time of day, probably due to daily changes in temperature. Attentive periods averaged longer in the early morning and evening than in mid-day (Table 4). Data on the length of inattentive periods were less conclusive in this regard, but the longest inattentive periods occurred in the afternoon hours.

Overall attentiveness averaged 77.4 per cent and varied only from 76.4 to 81.9 per cent for the individual birds (Table 3). In relation to time of day,

TABLE 3

ATTENTIVE AND INATTENTIVE PERIODS AND OVERALL ATTENTIVENESS DURING INCUBATION FOR THREE MOURNING WARBLERS AT ITASCA STATE PARK

	# 1, 1956	# 2, 1956	# 1, 1957	Total
Attentive periods				
Number	10	45	38	93
Average length (minutes)	60.5	28.2	38.4	35.8
Range (minutes)	18–93	2–52	14–65	2–93
Inattentive periods				
Number	10	45	39	94
Average length (minutes)	17.8	8.7	9.2	9.6
Range (minutes)	9–29	2–17	3–24	2–29
Overall attentiveness				
Time (minutes)	1081	1844	3251	6176
Time in incubation (minutes)	885	1408	2486	4779
Attentiveness (per cent)	81.9	76.4	76.5	77.4

overall attentiveness was highest in the early morning hours and in the evening, and lowest at mid-day (Table 4).

The length of inattentive periods was found to be correlated with the length of the attentive periods immediately preceding them. Longer attentive periods resulted in longer inattentive periods immediately following them (Table 5), probably due to the build-up of a stronger feeding drive. The reverse relation showed no correlation.

TABLE 4

ATTENTIVE BEHAVIOR DURING INCUBATION IN RELATION TO TIME OF DAY*

	4–8 a.m.	8–12 a.m.	12–4 p.m.	4–8 p.m.
No. attentive periods	9	54	13	10
Average length (minutes)	42.6	32.8	37.5	47.7
No. inattentive periods	11	53	14	6
Average length (minutes)	11.1	9.6	12.6	8.5
Total observed time	856	2925	1301	1094
Attentiveness (per cent)	82.9	76.8	74.0	78.6

*# 1, # 2, 1956; # 1, 1957 (see text)

Itograph records from the nest of pair # 1, 1957, during incubation and early feeding of the young gave information on the time of beginning and ending of daily activity by the female. Between June 14 and 26, the female returned to the nest for the night an average of about 14 minutes before sundown (eight records), with a range of 54 minutes before to 15 minutes after. Two records of departure in the morning were 23 minutes before and 15 minutes after sunrise.

On one occasion the female was seen when returning to the nest immediately after the hatching of one young. When she reached the nest she paused on the rim and pecked in the nest bottom for over a minute, then picked up the broken parts of the egg shell, worked them around with a chewing motion for several minutes, and finally swallowed them.

Table 5

Length of Inattentive Periods of Incubation in Relation to Length of Preceding Attentive Periods*

Length of attentive period (minutes)	Number of observations	Average length of following inattentive periods (minutes)
Less than 20	10	6.0
21–30	20	8.4
31–40	23	10.6
41–50	13	12.7
Over 50	9	13.9

*# 1, # 2, 1956; # 1, 1957 (see text)

Nestling Period

Hofslund (1954) recorded the nestling period in two Minnesota nests as 8–9 days. Cottrille (1958) found that the young left the nest after eight days in one Michigan nest. The young successfully fledged at a known age in only one nest in the present study. In nest # 1, 1957, the first young hatched between 2:10 and 2:25 p.m. on June 20, and the remaining young hatched before 7:30 a.m. on the following day. On the afternoon of June 28 the young left the nest, at an age of between seven and eight days. These young survived and the family group was observed until the young achieved independence.

During this period the adults approach the nest silently. The external stimulus causing the young to gape is therefore tactile and/or visual. Before and shortly after the eyes of the young were open they gaped in response to movement of the nest by the observer. Gaping was seen at irregular intervals when the parents were absent, possibly in response to movements of the other young or to slight movement of the nest by wind. Occasionally the young failed to gape when the parent appeared. In these cases the adult would hop around the edge of the nest, or back and forth between the nest and an adjacent perch until the young gaped.

After feeding, the adults paused on the edge of the nest for a few seconds. Fecal sacs were expelled by the young during this period. Only the young which had been fed were observed to produce fecal sacs. During the first part of the nestling period the fecal sacs were eaten by the parents. On the seventh day after hatching a fecal sac was carried away from nest # 1, 1957, suggesting that this may be the pattern during the later stages of the nestling period. Production of fecal sacs was lowest in the early morning (Table 7).

The appearance of the male with food while the female was brooding often seemed to result in the female's leaving the nest. In 15 of 27 observations, the female left within two minutes of the arrival of the male. When the female did not leave, she generally would rise and back off to the edge of the nest, often showing begging behavior by gaping in the direction of the male and fluttering her wings. In most cases the male fed the young directly, but he often responded to the female by giving her at least part of the food. On these occasions both would then feed the young.

Sometimes the female did not rise off the nest when the male appeared. When this happened the male usually gave the food to the female who then rose and fed the young. Once, however, the male hopped around the edge of the nest, and when the female rose slightly, fed the young beneath her. Another time, the male fed two young, but still had some food left. The female begged, the male gave the food to her, and she ate it. The female occasionally begged after the male had fed the young and had no food left.

When the food item was large, and the young had difficulty swallowing it, the parents frequently removed the object and reinserted it in the same or a different mouth.

Behavior of the female on the nest during brooding was similar to that shown during incubation. When direct sunlight fell on the nest the female spent much time standing over the young with her wings spread slightly, usually panting.

In direct observations on feeding behavior, the average rate was 2.5 feeding visits per nest per hour during the first four days after the young had hatched. This value ranged from 2.2 to 4.3 per nest per hour in the three nests studied (Table 6). Feeding rate varied with the time of day, the lowest rate being observed in the early morning hours (Table 7). Factors related to this low rate may be high brooding attentiveness in the female, and possibly more active territorial defense by the male at this time.

A fairly complete record of nest activity was obtained with the itograph for the nestling period of nest # 1, 1957. In this record two jogs close together indicated a bird leaving the nest soon after arriving, and were assumed (sup-

TABLE 6

RATE OF FEEDING OF YOUNG IN THREE NESTS OF MOURNING WARBLERS DURING FIRST FOUR DAYS OF NESTLING PERIOD*

	# 2, 1956	# 3, 1956	# 1, 1957	Total
Time observed (minutes)	1172	240	180	1592
Feeding visits by male	26	10	5	41
Feeding visits by female	17	1	8	26
Total feeding visits	43	11	13	67
Feeding visits/nest/hour	2.2	2.8	4.3	2.5
Feeding visits/young/hour	1.2	0.9	1.1	1.1

*Direct nest observations only

ported by observations from the blind while the itograph was recording) to represent a feeding visit. These are summarized in Table 9 as "apparent feeding visits." However, since the female sometimes brought food at the beginning of an attentive period of brooding (represented by a single jog), the total number of feedings could not be determined. Since brooding visits (summarized in Table 9 as "apparent female brooding visits") became less frequent toward the end of the nestling period, the number of "apparent

TABLE 7

BROODING ATTENTIVENESS, RATE OF FEEDING OF YOUNG, AND RATE OF FECAL SAC PRODUCTION DURING FIRST FOUR DAYS OF NESTLING PERIOD IN RELATION TO TIME OF DAY*

	4–8 a.m.	8–12 a.m.	12–4 p.m.	4–8 p.m.
Brooding attentiveness				
Attentive periods	6	26	26	31
Average length (minutes)	20.5	20.5	19.5	14.0
Inattentive periods	6	28	27	34
Average length (minutes)	8.7	8.6	8.0	6.7
Observation time (minutes)	205	805	743	747
Attentiveness (per cent)	71.2	69.4	72.0	63.7
Feeding rate and rate of fecal sac production				
Observation time (minutes)	137	672	627	235
Total feeding visits	2	23	32	10
Feedings/nest/hour	0.9	2.0	3.1	2.6
Feedings/young/hour	0.5	1.2	1.0	1.1
Fecal sacs/young/hour	0.2	0.8	0.7	0.7

*# 2, # 3, 1956; # 1, 1957 (see text)

TABLE 8

BROODING ATTENTIVENESS IN RELATION TO AGE OF YOUNG*

Age (days)	Attentiveness: Observation time (minutes)	Attentiveness: Brooding (per cent)	Duration of attentive periods: Number	Duration of attentive periods: Average length (minutes)	Duration of inattentive periods: Number	Duration of inattentive periods: Average length (minutes)
0	361	68.4	14	17.9	14	7.8
1	1081	63.7	44	15.3	47	8.0
2	690	78.7	24	20.4	26	5.8
3						
4	785	33.1	10	24.2	11	18.2
5	542	37.1	17	11.4	16	16.6
6	308	25.3	7	11.1	7	26.7
7	371	12.1	6	7.7	7	47.1
8	429	3.3	3	4.7	3	135+

*# 2, # 3, 1956; # 1, 1957 (see text)

feeding visits" approximates the true feeding rate more closely at this time. Thus the six-fold increase in the rate of "apparent feeding visits" between the first and eighth days probably represents an increase in the true feeding rate of about four times.

TABLE 9

RATE OF FEEDING OF YOUNG AS RECORDED BY ITOGRAPH FOR NEST #1, 1957, IN RELATION TO AGE OF YOUNG

Age (days)	Time recorded (minutes)	Apparent feeding visits*	Apparent female brooding visits*	Apparent feeding visits/nest/hour	Apparent feeding visits/young/hour
0	405	4	13	0.6	0.2
1	605	17	30	1.7	0.4
2					
3					
4	489	35	4	4.3	1.1
5	226	13	7	3.4	0.9
6	308	30	8	5.8	1.5
7	371	57	7	9.2	2.3
8	429	79	3	11.0	2.8

*See text

Brooding tended to remain high during the first three to four days after hatching, but declined rapidly after this. The length of attentive periods varied between about 15 and 25 minutes during the first four days but decreased rapidly after this (Table 8). Inattentive periods remained short during the first few days after hatching, and then increased rapidly in length. Overall attentiveness was 63.7 to 78.7 per cent during the first few days and declined to 3.3 per cent on the last day.

FLEDGLING PERIOD

Observations of the activity of the young after they had left the nest were difficult because their movements were confined to thick underbrush. In addition, the adults usually showed alarm reactions when the family group was approached.

The family group of nest # 1, 1957, was followed for three weeks after it had left the nest on June 28. Although the birds were not marked, confusion with other groups was improbable, since the fledglings from the only close neighbor were of a much different age.

During this three-week period the family group remained within the general area of the territory of that pair, with most of the observations of the group being within 150 feet of the nest site.

When the young left the nest, they were unable to fly, and showed very little development of the tail feathers, By July 4, the tail feathers still showed little development, but the young could fly about 30 feet with a fluttering, uneven flight. On July 12 they were able to fly well and were heard giving weak *tshrip* notes. On July 18, the last day they were seen, they were completely feathered out and were foraging independently, although still accompanied by the adults.

The postnuptial molt of the adults apparently began at about this time. On July 18, two males (one the male from nest # 1, 1957) which were still in company with young birds were just beginning to molt. On July 25, 1957, two females were seen, one in light and one in heavy molt. Dwight (1900) stated that the postnuptial molt occurs in August, but observations of Saunders (1948*a*), with which those of the present study agree, suggest that it begins as early as mid-July.

SUMMARY

The breeding biology of the Mourning Warbler was studied in Itasca State Park, Minnesota, during the summers of 1956 and 1957. Observations on migrants were made at Urbana, Illinois, during the spring of 1957, and on wintering birds in the Panama Canal Zone during the early part of 1959.

In both breeding and winter ranges and in migration the species is a typical inhabitant of forest edge communities. Breeding territories were found in a wide variety of plant communities, where requirements of a partially open canopy and a mixture of herbaceous and shrubby ground cover were satisfied.

Aggressive encounters were noted with Yellowthroats and Chestnut-sided

Warblers, suggesting interspecific competition. Territories of these two commonly overlapped with those of the Mourning Warbler, however.

Vocalizations of the species include a male territorial song, a male flight song, and two call notes in both sexes.

Breeding territories are established and are defended by male song and aggressive displays by both sexes. The average size of the territory is 1.9 acres. The territorial song is given most frequently from low underbrush and from definite song perches 20–25 feet high. The rate of song varies from one to eight songs per minute. It is most frequent in the morning. Song declines during the nesting cycle but does not end until sometime after the young have left the nest. After nesting is well underway the size of the area regularly defended by singing is apparently decreased. Singing was not heard in the vicinity of the nest. A temporary territory was apparently established by a male in migration at Urbana, Illinois.

Nesting was begun mostly in June at Itasca Park. Nests were hidden in thick vegetation on or a few inches above the ground in a more open part of the territory. Leaves, grasses, weed stems, and fibrous bark were the principal items used in nest construction, with fine plant materials used as a lining. Clutch size averaged 3.7 eggs, ranging from two to five. The eggs are probably laid in the early morning. Nest parasitism by the Brown-headed Cowbird is not uncommon. Two nests in the present study were lost to predators, probably small mammals. Two types of distraction displays were shown by the adults when the nests were approached, one possibly based on the resemblance of the female leaving the nest to a small mammal scurrying through the leaves, and the second based on the resemblance of the actions of the adults to those of wounded birds.

Incubation lasts about 12 days, is carried on entirely by the female, and may begin before the clutch is complete. Attentive and inattentive periods averaged 35.8 minutes and 9.6 minutes, respectively, with overall attentiveness averaging 77.4 per cent. Attentiveness was highest in the early morning and evening. The male feeds the female at and away from the nest during incubation. Once the female was observed to eat the egg shell when the young hatched.

The nestling period lasts seven to nine days and the young are fed by both parents. The rate of feeding increases about four times during the period. The rate is lowest in the early morning. Fecal sacs are eaten by the adults at first, but may be carried away later. Brooding by the female is high for the first few days, but decreases rapidly later. The young are unable to fly when they leave the nest, and the family group remains together in the vicinity of the nest for a period of about 2–3 weeks, until the young have achieved independence.

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DEPARTMENT OF ZOOLOGY, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS, OCTOBER 6, 1959

NEW LIFE MEMBER

S. Dillon Ripley, a member of the Wilson Ornithological Society since 1946, is Director of the Peabody Museum, New Haven, Connecticut. Dr. Ripley received his baccalaureate degree from Yale University, and his doctorate from Harvard University. He is especially interested in avian speciation and ecology, and in waterfowl conservation. From these interests his researches have resulted in the publication of 150 technical papers and bulletins and three books: "Trail of the Money Bird," "Search for the Spring Babbler," and "A Paddling of Ducks." In addition, he is President of the International Council for Bird Preservation, a Fellow of the A. O. U., and a member of Sigma Xi, A. A. A. S., Zoological Society of India, B. O. U., French Ornithological Society, S. African Ornithological Society, etc. The photograph shows Dr. Ripley with an Andean Goose on a private preserve in Litchfield, Connecticut, where he rears waterfowl and other birds.

MASSED WATERFOWL FLIGHTS IN THE MISSISSIPPI FLYWAY, 1956 AND 1957

FRANK C. BELLROSE AND JAMES G. SIEH

Almost every year in the Mississippi Flyway there is one waterfowl flight that is greater in scope and magnitude than all others. Some refer to it as the "grand passage" of waterfowl. This great movement usually occurs during the first week of November, but it may be earlier or later. In 1957, this spectacular duck migration occurred from October 23–25; in 1956, it occurred from November 6–8; in 1955, it occurred from October 31 to November 3.

The 1955 grand passage of waterfowl was discussed in an earlier paper (Bellrose, 1957). The present paper largely concerns the grand passage of waterfowl in 1956 and 1957. Although the 1956 and 1957 flights were not so large as the one in 1955, they were still of unusual scope and magnitude in the Mississippi Flyway. They are discussed here not so much because of their size, but primarily because of the unique complementary observations made in Iowa and in Illinois.

The 1955 massed waterfowl flight was well documented on its passage from Canada to Louisiana (Bellrose, 1957). Therefore, in discussing the 1956 and 1957 grand passages of waterfowl we have attempted to provide only a sketchy documentation of the over-all flights in favor of more detailed descriptions of the movement through Iowa and Illinois.

Studies of waterfowl movements are productive of information on three aspects of migration: (1) the mechanics of migration including routes, speed, altitude, and flock behavior; (2) the problem of navigation; and (3) the weather conditions responsible for initiating migratory movements.

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GRAND PASSAGE OF 1956

Extensive Observations.—The prelude to the 1956 grand passage began late in the afternoon of November 5, when at Bismarck, North Dakota, C. H. Schroeder (letter, July 29, 1957) of the Game and Fish Department reported scattered flocks of ducks flying southward. Before sunrise on November 6, Schroeder heard ducks flying overhead, and at daylight he observed a "sky full of ducks," moving southeast. Most of the ducks were Mallards (*Anas platyrhynchos*), but flocks of Pintails (*A. acuta*), Gadwalls (*A. strepera*), Green-winged Teals (*A. carolinensis*), Shovelers (*Spatula clypeata*), Lesser Scaups (*Aythya affinis*), Canvasbacks (*A. valisineria*), Ring-necked Ducks (*A. collaris*), Redheads (*A. americana*), Buffleheads (*Bucephala albeola*), and Ruddy Ducks (*Oxyura jamaicensis*) also were observed.

W. G. Leitch of Ducks Unlimited telegraphed that on the morning of November 6, 1956, there was an appreciable movement of ducks through and out of southern Manitoba.

At Fergus Falls, Minnesota, Joseph Hopkins (letter, March 11, 1957), U. S. Game Management Agent, reported a mass migration of ducks, which appeared about 11:00 a.m. (C.S.T.) on November 6. The flight was still in progress at sunset. Late in the afternoon many Mallards dropped out of the passing throng to alight on local lakes. On the morning of November 7, Hopkins observed numerous high flying flocks of ducks heading south-southeast whenever there was a break in the low overcast. Several flocks of Whistling Swans (*Olor columbianus*) were observed migrating at a high altitude. The waterfowl flight continued through the afternoon and was still in progress at dark.

There was no indication of the mass migration in the area of Minneapolis, Minnesota, until 9:00 a.m. (C.S.T.) on November 7. At that time, J. D. Smith (letter, August 15, 1957) and others of the U. S. Fish and Wildlife Service noticed long strings of Mallards passing over that city, heading in a southeasterly direction. The flight continued until between 3:30 and 4:00 p.m. In the morning and early afternoon, duck flocks were observed at 3- to 5-minute intervals. Later in the afternoon, however, flocks passed by at intervals of 10 to 15 minutes. Most of the duck flight occurred at about 2000 feet, but during the afternoon the flight dropped progressively lower until by 3:30 p.m. the flocks were at 800 to 1000 feet.

Similar observations were made at Swan Lake, near New Ulm, Minnesota, 60 miles southwest of Minneapolis. There, W. G. Hoerr, local duck hunter, reported (letter to A. H. Hochbaum, January 21, 1957) that ducks showed up from the northwest about 9:00 a.m. on November 7. From that time until 3:30 p.m., when the flight ceased, Mr. Hoerr could see large flocks of ducks through breaks in the clouds and/or when the snow abated. The flight consisted mostly of Mallards and Lesser Scaups. About 10 per cent of the observed ducks dropped into Swan Lake, and the others continued in a southeasterly direction.

R. A. McCabe (letter, March 18, 1958), of the University of Wisconsin, reported this duck flight as follows:

> "On the morning of November 7, 1956, I hunted at Mud Lake, between Lake Waubesa and Kegnosa, 5 miles south of Madison, Wisconsin. On this particular body of water the shootable duck flight was mediocre but about 9 o'clock that morning, and for at least 1 hour, there was a phenomenal movement of birds in a northwest-southeasterly direction. I would say there were about 75 per cent divers and 25 per cent dabblers and that they were about 1.500 feet more or less, in the air."

At the Fountain Grove Wildlife Area in north-central Missouri, C. T. Shanks (letter, August 27, 1957) noted the first migrating flock at 11:00 a.m. on November 7. His account of the flight follows:

> "Another group of birds came by about 10 minutes later. Both of these flocks were relatively low when I saw them, about 500 feet . . . . By the time I reached the blind at about 12:30, these low flying flocks were passing overhead about every 3 minutes. Upon reaching the blind I noticed for the first time a large migration of birds which was occurring at a much higher altitude. These high flyers were just under the clouds and were about constant, one flock directly behind the other. I estimated this flight at about 3,000 feet. They were moving out of the northwest and continuing on in a southeasterly direction.
>
> "At about this same time flocks of gadwalls began coming in to land 100 to 150 yards out from my blind, drinking, and immediately taking to the air. According to my counts there were, on the average, 75 gadwalls landing in this area every 2 minutes. However, since they were departing so quickly there were never more than 200–300 birds on the water at any one time. It is interesting to note that they all landed exactly in the same spot. This gadwall flight continued in this manner for approximately 2 hours, which, figuring 75 every 2 minutes, calculates to 4,500 birds landing during this 2 hour period.
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> "During this same period, there were just as many low flying flights which passed on without stopping so that I feel it is safe to say that 9,000–10,000 gadwalls came by this particular spot between 12:30 and 2:30 p.m. This gadwall flight seemed to stop as suddenly as it started, and was replaced by an even heavier flight of mallards. The mallard flight continued for the remainder of the afternoon. By nightfall the Fountain Grove Area, which was devoid of ducks that morning, was covered with mallards."

The vanguard of the flight arrived in Tennessee, according to P. B. Smith (letter, July 19, 1957), formerly of the Tennessee Game and Fish Commission, late in the afternoon and evening of November 7. The main flight occurred all through the day of November 8, when it was reported from numerous places throughout the state.

Smith reported that he had never seen so many ducks arrive in Tennessee in so short a time. Illustrating the magnitude of the flight, he cited the two-day kill of ducks on the West Sandy hunting area: On opening day, November 7, 400 hunters averaged 0.12 ducks per man; on November 8, hunters averaged 2.1 ducks per man.

In Arkansas, the flight was first noticed at the Big Lake National Wildlife Refuge in the northeast corner of the state about 3:30 p.m. on November 7. According to D. M. Donaldson (letter, July 24, 1957) of the Arkansas Game and Fish Commission, the flight continued until dark and through most of the following day, November 8. Upon conducting an aerial survey, Donaldson found 15,000 Mallards on the Big Lake Refuge on November 8, where only a few Mallards had occurred before. Near Weiner, Arkansas he observed the duck flight coming in from the north at altitudes from 2000 to 2500 feet. The flight was made up almost entirely of Mallards.

The vanguard of this great duck flight arrived in Louisiana at noon on November 7, 1956, according to R. K. Yancey (letter, August 5, 1957) of the Louisiana Wildlife and Fisheries Commission. The flight was detected throughout the state by a great number of observers. Yancey was in northeastern Louisiana on November 7 and observed ducks migrating at 300 to 400 feet all across that section of the state. However, he noted that the largest movements occurred along river courses. At Lake Pontchartrain in southeast Louisiana, John Newsom, Federal Aid Coordinator with the Commission, saw large numbers of ducks arrive during the afternoon of November 7.

The flight into Louisiana continued over the next two days and brought at least 1,200,000 ducks into the state, including the first major arrivals of Mallards and diving ducks. Green-winged Teals, Gadwalls, and Pintails also arrived in large numbers. As these northern ducks moved in, the bulk of the Blue-winged Teal (*Anas discors*) population which had been present departed from the state.

Iowa-Illinois Observations.—The earliest indication of a waterfowl flight in Iowa was reported by F. A. Heidelbauer (pers. comm.) of the Iowa Conservation Commission. Late in the morning of November 6, he was flying from Des Moines to Sioux City, Iowa, when two flocks of Mallards were encountered flying southeast at 1500 feet. During an afternoon aerial reconnaissance he observed a flock near Sioux City, which also was flying southeast at 1500 feet.

At 9:30 a.m. on November 7, Heidelbauer began to see migrating ducks as soon as he left the Sioux City airport. Over the Missouri River ducks were seen in an unending stream from a few hundred feet to 5000 feet above the river. Later it was learned that the flight first appeared at Onawa, Iowa, about 8:00 a.m. Migrating flocks were made up largely of Mallards, Lesser Scaups, and Redheads. The flight continued throughout the day, but by the morning of November 8 it was over.

At Spirit Lake, Iowa, Sieh first noted a few flocks of migrating Mallards at 9:00 a.m., November 7. By 9:30 a.m. the number of passing flocks had increased until ducks were constantly in view. The flight direction was to the south-southeast, and virtually all ducks passed over without stopping at local lakes.

Seth Shepard (pers. comm.) made counts of duck flocks he could see from a window of the Biology Station at Spirit Lake. In one hour, between 9:30

and 10:30 a.m., he counted 45 flocks averaging 67 ducks per flock, for a total of 3083 birds. At nearby Pleasant Lake during a 2-hour period (1:30 to 3:30 p.m.) Thomas Moen and Seth Shepard counted 90 flocks averaging 92 ducks per flock for a total of 8,311 ducks, or 4,155 per hour. The count was made of all waterfowl crossing an imaginary vertical plane, with the observers facing to the east.

At Trumbull Lake, 20 miles southeast of Spirit Lake, William Basler (pers. comm.) similarly counted 86 flocks, totaling 5,160 ducks, passing over in an hour (1:30 to 2:30 p.m.). The flight began to taper off by 3:00 p.m. in northwestern Iowa, and by 4:00 p.m. it was practically over.

Sieh obtained a "cross-section" of this flight through northern Iowa by driving east from Spirit Lake on state route No. 9 to Osage, a distance of 128 miles. The trip was made from 12:55 to 3:40 p.m. During this 2¾-hour period, 11,925 ducks in 193 flocks (4155 birds per hour) were observed crossing the highway in front of the car. The flocks were moving largely in a south-southeast direction as far east as Thompson, but farther east, between Thompson and Osage, the flight was largely to the southeast.

Table 1 shows the distribution of the waterfowl flight between Spirit Lake and Osage. The route taken across northern Iowa crossed the upper reaches of several rivers which flow to the southeast, but little relationship between the rivers of northern Iowa (Fig. 1) and the magnitude of the flight is indicated. For the most part the flight of waterfowl was passing over the fields of northern Iowa in an evenly distributed pattern. However, eastward from Lakota to Osage, the magnitude of the flight was somewhat reduced.

Accompanied by Norman White, pilot, Bellrose had been aviating up the Mississippi River Valley for five hours before sighting the first migrating duck flocks at 2:00 p.m. on November 7 near Wapello, Iowa. By 2:15 p.m., when Muscatine, Iowa, was reached, the duck flight was appreciably greater.

At Muscatine, flocks of Mallards were observed arriving at the Mississippi River from the north and northwest. Several flocks arriving from the northwest were observed to alter course 30 to 40 degrees to move southward down the bluff of the Mississippi River Valley, some 3 to 4 miles east of the river channel. A smaller number of flocks continued on a southeast course, over the fields of Illinois, apparently bound for the Illinois River Valley.

The airplane was flown northwest from Muscatine into the stream of migrating ducks. A zigzag course was pursued; each leg of the course was about 25 miles in length and centered on the Cedar River.

On the three legs of the course, each bisected by the Cedar River, counts of flocks revealed one per minute within a belt of 5 miles on each side of the river valley as opposed to one flock per two minutes farther away from the valley.

TABLE 1

NUMBERS OF DUCKS SEEN CROSSING ROUTE 9 BETWEEN SPIRIT LAKE AND OSAGE, IOWA, ON NOVEMBER 7, 1956

City	Time P.M.	Miles Travelled	Number of Ducks	Ducks per Minute	Ducks per Mile
Spirit Lake	12:55				
Superior	1:03	6	1100	138	183
Estherville	1:15	8	575	48	72
Armstrong	1:37	18	3007	137	167
Swea City	1:46	9	1310	146	146
Lakota	2:00	12	1369	86	114
Thompson	2:22	18	1690	77	94
Forest City	2:35	14	495	38	35
Hanlontown	2:54	14	1077	57	77
Manly	3:05	9	790	72	88
Osage	3:40	20	510	15	26
Total	2¾ hours	125	11.923		
Average				71	94

At Iowa City the airplane was headed south via Mt. Pleasant to Argyle, Iowa. For 11 miles, from Iowa City to Riverside, the course was adjacent and parallel to the Iowa River. In that stretch flocks of ducks were cutting across the Iowa River Valley at an angle of 40 degrees as they pursued their southeast direction of flight.

South of Riverside the magnitude of the flight began to lessen (Table 2). Also, the flight direction of the migrating birds gradually but steadily shifted from southeast at Riverside, to generally east-southeast from there to Mt. Pleasant, and to generally east from there to Argyle. Near Argyle, two flocks of ducks were observed flying southeast down the Des Moines River Valley.

At Argyle, Iowa, the airplane's course was once again altered, this time to east-southeast toward Havana, Illinois. At the Mississippi River numerous flocks of ducks were seen descending to the river, joining rapidly-forming rafts of birds which had not been present several hours earlier.

Between the Mississippi River and Havana flocks of ducks were observed at intervals flying largely either south or southeast. The magnitude of the flight was considerably less than it was in Iowa (Table 2).

The altitude of each flock of ducks was recorded on the entire aerial trip. Over the Mississippi River Channel south of Muscatine, flocks of Mallards and Ring-necked Ducks were observed at from 400 to 600 feet. Over land during mid-afternoon flocks were observed at altitudes from 2100 to 3500 feet; the bulk of the birds, however, were flying at 2400 to 2800 feet. Most of the flight was 700 to 1100 feet below the continuous cloud layer; a few

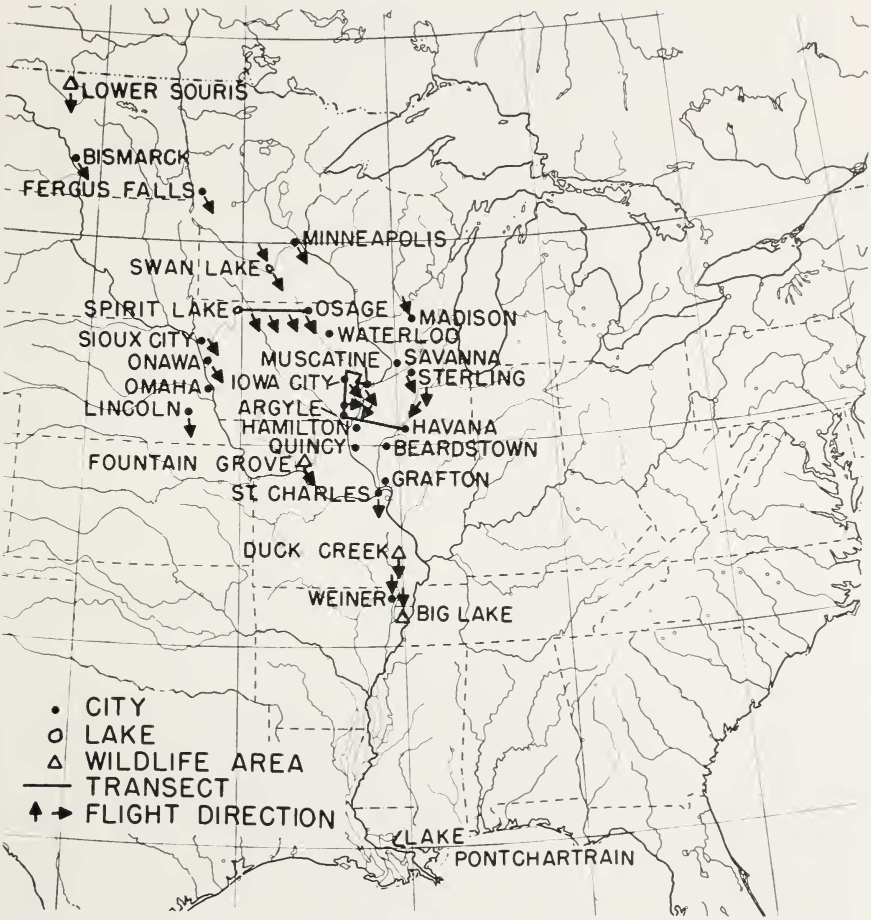

Fig. 1. Places of observation and direction of movement of two waterfowl flights, November 6–8, 1956 and October 23–25, 1957. Car and aerial transects were made of the 1956 flight in Iowa and Illinois.

flocks were observed from time to time disappearing momentarily into the base of low clouds.

As the afternoon waned, it was apparent that the flight of waterfowl descended to lower altitudes (Table 2). The last flocks, at dark, were only 500 feet above the ground.

Observations made elsewhere in Illinois aid in further delineating the November 7, 1956, duck flight. At the Spring Lake National Wildlife Refuge, near Savanna, R. V. Wade (oral comm.) noted that the flight arrived

TABLE 2

NUMBERS AND FLIGHT ALTITUDES OF DUCKS SEEN FROM AN AIRPLANE IN EAST-CENTRAL AND SOUTHEASTERN IOWA AND WEST-CENTRAL ILLINOIS ON NOVEMBER 7, 1956

City	Time P.M.	Miles Travelled	Number of Ducks	Ducks per Minute	Ducks per Mile	Average Altitude
Willow Jct.	2:45					
West Liberty	2:55	14	540	54	39	2800
Bennett	3:05	19	600	60	32	2300
Iowa City*	3:25	32	1140	57	36	2400
Riverside	3:52	11	360	51	33	2200
Ainsworth	4:00	13	300	38	23	2100
Olds	4:07	11	240	34	22	2400
Mt. Pleasant	4:15	13	180	23	14	2700
St. Paul	4:23	13	180	23	14	2300
Argyle	4:33	16	180	18	11	2000
Ferris**	4:41	13	240	30	19	1800
Colchester**	4:53	19	240	20	13	1600
Table Grove**	5:05	20	120	10	6	1100
Havana**	5:20	20	180	12	9	500
Total	2 hrs. 15 min.	214	4500			
Average				33	21	

*Landed at Iowa City airport for 20 minutes
**Cities in Illinois, others in Iowa

there about 1:30 p.m. Most of the ducks came from the northwest, but some came from the north, following the Mississippi River Valley. The bulk of the ducks continued to the southeast. It is probable that this line of flight was observed late in the afternoon of November 7, by Charles Wheat at Sterling, Illinois, about 25 miles southeast of Spring Lake. He reported (letter, June 11, 1957) that for one and one-half hours during late afternoon he saw flock after flock of Mallards passing over, heading between southeast and south-southeast, which would take these birds to the big bend of the Illinois River at Bureau, where the principal duck habitat of that famous waterfowl area begins.

The waterfowl flight was not evident on November 7 south of central Illinois. At the mouth of the Illinois River, Edward Davis (oral comm.) of the U. S. Fish and Wildlife Service did not see any migrating waterfowl until the morning of November 8, when a spectacular flight was observed. The flight continued there until early afternoon. Slightly over 100 miles farther down the Mississippi River Valley, George Arthur (oral comm.) of the Illinois Department of Conservation observed the duck flight moving down the Mississippi River Valley all day on November 8.

On the morning of November 8, White and Bellrose left the Havana, Illinois, airport at 8:00 a.m. Immediately, migrating flocks of ducks were visible on a course 1 to 5 miles east of the Illinois River Valley. An occasional flock detached itself from the south-moving stream of birds to fly west into a strong wind. Upon reaching one of the numerous lakes or marshes the flock descended to join others already at rest on the water.

By the time the aerial observers reached Meredosia, 45 miles south-southwest of Havana, the flight stream of ducks had practically disappeared, as the bulk of the migrating birds had steadily descended to the intervening waters. Inasmuch as local observers reported a large movement of ducks into the Illinois River Valley all through November 8, it was apparent that the bulk of the birds arriving at the Illinois River during the period had temporarily ceased migrating southward.

At Meredosia the airplane was turned away from the Illinois River Valley and headed west for the Mississippi River at Quincy, Illinois. During the 45-mile flight over land, three flocks of Mallards, aggregating 280 birds, were observed flying east at altitudes of 700 to 1000 feet.

Once more White and Bellrose headed their plane up the Mississippi River Valley. A moderate flight of Mallards and diving ducks was encountered (Table 3) up to Hamilton, Illinois. From that city northward in the Mississippi River Valley, only small and scattered flocks were observed flying south. Two flocks, aggregating 130 Mallards were observed flying north, in the opposite direction to the rest of the flight.

TABLE 3

NUMBERS AND FLIGHT ALTITUDES OF DUCKS MOVING DOWN THE MISSISSIPPI RIVER VALLEY AS SEEN FROM AN AIRPLANE ON NOVEMBER 8, 1956

City	Time A.M.	Miles Travelled	Number of Ducks	Ducks per Mile	Average Altitude
Quincy	10:10				
Hamilton	10:40	35	1000	29.0	1100
Burlington	11:15	40	145	3.6	900
Muscatine	11:45	50	245	4.9	900
Rock Island	12:00	25	50	2.0	1500

GRAND PASSAGE OF 1957

Extensive Observations.—The 1957 grand passage of waterfowl began in western Saskatchewan on October 22. In an unpublished report, J. L. Nelson of the Saskatchewan Wildlife Branch and Alex Dzubin of the Canadian Wildlife Service state that at Kindersley, Saskatchewan, flocks of 25 to 300 Mallards, with some Pintails and Lesser Scaups, were observed flying southward. The migration occurred under extremely poor visibility as a result of blizzard conditions which caused the birds to fly only 100 to 200 feet above the ground.

In the western part of Saskatchewan the peak of the duck and goose exodus occurred from mid-day on October 22 to mid-day on October 23; in the eastern part of the province it occurred largely during the afternoon of October 23. An aerial survey on October 27, 28, and 29, disclosed that waterfowl north of the snow belt (north of Saskatoon, Saskatchewan) were present in their former numbers, whereas in the snow belt south of Saskatoon only a relatively few ducks were found, the bulk having departed. Freezing temperatures were common in all areas, so Nelson and Dzubin believed that snow was the factor primarily responsible for the exodus of waterfowl from southern Saskatchewan.

At Delta, Manitoba, Frank McKinney of the Delta Waterfowl Research Station reported (telegram, October 24) that there was a mass migration through the Delta Marshes on October 24, with the local ducks departing that evening, under a clearing sky.

In North Dakota at the Lower Souris National Wildlife Refuge, Merrill Hammond, refuge biologist, reported (telephone conversation, 12:00 Noon, October 24) that the mass migration began there at 7:30 a.m., October 24. The flight continued strong until 10:00 a.m. with an intensity equal to or greater than the spectacular flight on November 1, 1955. He observed a few flocks of Pintails in the flight, but the bulk of the flight was composed of Mallards. The birds passed at the rate of 2000 to 3000 per minute. The flight was headed due south at the Lower Souris Refuge.

Previous to the mass flight of ducks, Hammond reported that Gadwalls left the refuge in the evening of October 23; they left Whitewater Lake, Manitoba in the evening of October 22.

The mass flight arrived at Swan Lake, New Ulm, Minnesota, at 8:00 a.m., October 24, according to W. G. Hoerr (letter to A. H. Hochbaum, October 25, 1957). The flight continued until 2:30 p.m., and during that time Mr. Hoerr reported that everywhere one looked in the sky there were large flocks of ducks and geese, almost all of which passed over without stopping. This was the largest flight he had ever seen so early in the autumn. Although most of the duck flocks were Mallards, there was an intermingling of Pintails, Lesser Scaups, Redheads, and Canvasbacks; the geese were Canada Geese (*Branta canadensis*) and Snow Geese (*Chen hyperborea*).

On the previous day, October 23, Hoerr reported a small flight of ducks at Swan Lake, commencing about 11:30 a.m. and continuing through the day, with flocks arriving at 30- and 60-minute intervals. On October 25, the day after the mass flight, there were only a few flocks of migrating ducks, which appeared in the afternoon.

Although Lincoln, Nebraska, lies 40 miles west of the Mississippi Flyway in the Central Flyway, its proximity suggests that observations made there reflect the waterfowl flight down the western side of the Mississippi Flyway.

George Schildman (letter. April 25, 1958) of the Nebraska Game, Forestation and Parks Commission provided some observations. After hearing geese passing over the Wildlife Building in Lincoln during the morning of October 24, Clarence Newton and he spent the afternoon observing the migration from a hilltop, 5 miles north of Lincoln. Schildman's graphic description of the flight follows:

> "Strong northerly winds, and heavy overcast skies with occasional light drizzle characterized the weather. When we first arrived we started to keep a record of the strings of moving birds. In about 10 minutes we had 9 of geese and 13 of ducks. At this point by using binoculars, we could see about 10 separate bunches of birds at one time, and one which I called geese turned out to be gulls on the second look. From then on we stopped counting because of the difficulty in identifying the more distant flocks, and the rapidity in which groups of birds were moving in and out of view. It is impossible to even guess at the number of flocks we observed that afternoon. In addition to the ducks and geese, many flocks of gulls, small groups of shorebirds, and eagles and hawks passed —all going south. Several times I scanned the horizon and counted in excess of 10 flocks of moving birds.
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> "At 4 o'clock the flight was over. I checked my watch at 4:07 when it dawned on me that we had seen little in the last few minutes. We stayed until sundown (about 5:20) and observed only 6 or 8 flocks in the last hour and a quarter. A light streak appeared in the overcast on the western horizon about 4 o'clock.
>
> "I went back the next morning about sunrise, and observed only one large bunch of ducks and another small group of eight. The weather had cleared during the night, and, with it, we had our first hard freeze of the year."

In southeast Missouri at the Duck Creek Wildlife Area, George Brakhage (oral comm.) of the Missouri Conservation Commission observed the start of the waterfowl flight at 9:00 a.m., October 25. The flight continued through the rest of the day, but only a few flocks were observed the following day. About 90 per cent of the southward flying flocks passed by without stopping. Some 6000 Mallards did stop at Duck Creek, and 8000 at the adjacent Mingo National Wildlife Refuge.

Seventy-five miles south of Duck Creek, David Donaldson of the Arkansas Game and Fish Commission (letter, December 16, 1957) reported that the duck flight arrived at the Big Lake National Wildlife Refuge at 11:00 a.m. on October 25. He considered it to be only a small flight of waterfowl.

A flight of 500,000 ducks arrived in Louisiana on the night of October 24 and during the day and night of October 25, according to M. M. Smith (letter, March 10, 1958) of the Louisiana Wildlife and Fisheries Commission. The flight was made up of large numbers of divers and smaller numbers of most species of dabbling ducks.

Iowa–Illinois Observations.—The earliest observation of the 1957 spectacular waterfowl flight in Iowa was made by Conservation Officer Gerald Jauron, who reported (pers. comm.) that a sizeable duck flight was starting at 12:20 p.m. on October 23 along the Missouri River north of Council Bluffs. On October 24, in the same area, he witnessed the largest day-long waterfowl migration he had ever seen. The flight continued there on October 25 but in reduced volume. The ducks came from the north, flying south down the Missouri River Valley.

At Spirit Lake, Iowa, Sieh first observed the migration at 9:10 a.m., October 24, when a flock of 50 Mallards appeared. From that time until dark, flocks of ducks passed by the Biology Station, but they were much less numerous than on November 7, 1956. An all-day count yielded 131 duck flocks and 17 goose flocks, totaling 2962 ducks and 976 geese. Ducks passed at the rate of 37.8 birds per hour, with the flight twice as large in the afternoon as in the morning. The duck flight was to the south-southeast, but the goose flight was largely to the southwest.

Twenty miles southeast of Waterloo, Iowa, along the Cedar River, P. D. Kline (letter, October 29, 1957) of the Iowa Conservation Commission made counts of migrating ducks and geese for an hour in early afternoon on October 24, and again for an hour later in the afternoon. The count from 12:45 to 1:45 p.m. amounted to 1810 ducks in 15 flocks; and from 4:09 to 5:09 p.m., 340 ducks in 8 flocks. All of the ducks were migrating in a southeasterly direction; some goose flocks were also headed southeast, but other geese were flying to the south and southwest.

In central Illinois the flight arrived at the Chautauqua National Wildlife Refuge at 1:00 p.m., October 24. From that time until 4:00 p.m., 34 flocks of Mallards, 2 flocks of Blue (*Chen caerulescens*) and Snow Geese, and 1 flock of Canada Geese were observed alighting in the lake.

At 4:45 p.m. the refuge manager, Arthur Hughlett, and Bellrose climbed the refuge's 99-foot observation tower. A census revealed that there were about 5000 newly-arrived Mallards on the lake. Other flocks of Mallards were observed swinging into the lake from the northeast, steadily increasing the size of the rafts of birds resting on the water. At first, flocks were dropping into the lake at the rate of one per minute, but as darkness approached the tempo increased and flocks of ducks were alighting at the rate of one every 10 seconds.

As great as was the number of waterfowl which stopped at Lake Chautauqua that evening, it represented only a part of the flight south. Many flocks could be seen streaming by from ½ to 2 miles east of the Illinois River Valley. A large part of this flight, however, is believed to have taken place above the almost solid overcast, for in looking south through rifts in the cloud layer, more ducks could be seen in a limited area above the clouds than below. At one time, through a break in the overcast, four large flocks of migrating waterfowl were visible in the binocular field. Over 200 flocks containing about 25,000 ducks were observed flying past the observation tower from 4:45 to 5:30 p.m.

By dark it was estimated that 30,000 Mallards, plus several thousand Lesser Scaup, Ring-necked Ducks, and Canvasbacks had alighted on Lake Chautauqua. Two additional flocks of Blue and Snow Geese had also dropped into the lake.

On the Mississippi River at Dallas City, Illinois, Harry Canfield, a lifelong duck guide, reported (oral comm.) that the waterfowl flight arrived there late in the afternoon of October 24, continued apparently into the night, and ended at 2:00 p.m. on October 25. He considered the flight to be larger than that of November 7, 1956, but not so large as the November 2, 1955, duck flight.

Canfield noted on October 25 that several dozen flocks of ducks were flying north at extremely high altitude, at a time when the bulk of the flight was moving south down the Mississippi River Valley.

On October 25, with Norman White as pilot, Bellrose aviated down the Illinois River Valley from Havana to Grafton, Illinois, and up the Mississippi River Valley from Grafton to Rock Island, Illinois. During the aerial survey, it was noted that from Havana to Beardstown migrating waterfowl flocks (Table 4) were east of the Illinois River Valley at altitudes of 1500 to 1800 feet, with the cloud layer at 1800 to 2000 feet. Between Beardstown and Grafton waterfowl flocks were in the eastern part of the valley, but they appeared to be following it. Above Beardstown, three flocks were observed flying north against the wind at 1500 feet.

Table 4

Numbers of Ducks Moving South in the Illinois and Mississippi River Valleys as Seen from an Airplane on October 24, 1957

City	Miles Travelled	Number of Ducks	Ducks per Mile
Havana	—	—	—
Beardstown	30	600	20
Meredosia	15	180	12
Grafton	60	900	15
Clarksville	55	1200	22
Quincy	50	3000	60
Hamilton	35	1200	34
Burlington	40	800	20
Muscatine	50	600	12

TABLE 5

A 2-DAY CHANGE IN WATERFOWL POPULATIONS OF THE LOWER ILLINOIS AND MISSISSIPPI RIVER VALLEYS FROM GRAFTON, ILLINOIS, TO MUSCATINE, IOWA, IN 1956

Species	November 7	November 8	Per Cent of Change
Mallard	257,000	704,000	+63.5
Black Duck	1,500	6,400	+76.6
Gadwall	900	1,600	+43.8
Pintail	29,000	4,500	–84.5
Green-winged Teal	10,800	4,400	–59.3
American Widgeon	8,600	4,400	–48.9
Shoveler	400	400	00.0
Ring-necked Duck	4,700	83,000	+94.3
Canvasback	520	3,000	+82.7
Lesser Scaup	13,500	127,000	+89.4
Ruddy Duck	150	30	–80.0
Total	327,070	938,730	+65.2

Near St. Charles, Missouri, three flocks of geese and two flocks of ducks were observed leaving the Mississippi River where it bends to the east. The waterfowl flocks were pursued a short distance on their southward line of flight until it was ascertained that their course was to the west of St. Louis.

The intensity of the waterfowl flight in the Mississippi River Valley on October 25 (Table 4), the second day of the 1957 grand passage, was greater than it was on November 8 (Table 3), the second day of the 1956 grand passage. On the second day of the 1956 and 1957 aerial surveys, the waterfowl flight declined in magnitude above Hamilton, Illinois.

A measure of the magnitude of the massed waterfowl flights which arrived in Illinois on November 2, 1955, November 7, 1956, and October 24, 1957, is shown in Fig. 2. The figures were obtained by Bellrose from periodic aerial surveys of waterfowl populations in Illinois.

The 1955 grand passage resulted in an increase of 775,000 ducks in the Illinois River Valley; the 1956 grand passage resulted in an increase of 600,000; and the 1957 grand passage in an increase of 225,000. The species composition of the 1956 and 1957 flights is indicated by Tables 5 and 6. As in 1955, Mallards made up the bulk of the flight population, but, unlike the 1955 flight, the largest proportionate increases in local population as a result of the 1956 and 1957 massed flights occurred in Lesser Scaups, Ring-necked Ducks, and Canvasbacks.

Population figures reveal that there was a pronounced exodus of ducks from the Illinois and Mississippi River valleys concurrent with the arrival of the northern birds. In 1956, the principal species departing were the Pin-

TABLE 6

WATERFOWL POPULATION CHANGES ON LAKES IN THE ILLINOIS RIVER VALLEY FROM PEKIN TO HAVANA, ILLINOIS, ON THREE DAYS IN 1957

Species	October 22	October 24	October 25	Per Cent of Change
Mallard	6,900	19,100	111,500	+ 82.9
Black Duck	380	655	675	+ 3.0
Gadwall	45	85	1,100	+ 92.3
Pintail	500	1,500	500	- 66.6
Green-winged Teal	1,800	1,250	650	- 48.0
American Widgeon	3.650	1,010	2,800	+ 63.1
Shoveler	70	60	50	- 16.7
Ring-necked Duck	0	0	10,000	+100.0
Canvasback	0	0	500	+100.0
Lesser Scaup	0	0	6,500	+100.0
Total	13,345	23,660	134,275	+ 82.4

tail, Green-winged Teal and American Widgeon (*Mareca americana*) (Table 5). In 1957, the Pintail and Green-winged Teal departed in large numbers (Table 6) .

MECHANICS OF MIGRATION

The piecing together of visual records of the directions taken by migrating waterfowl supplement information on flyway routes provided by band-recovery data. Band recoveries do not fix as finitely as visual records, specific routes of passage in any geographic area.

An analysis of the flight directions reported for November 1–3, 1955 (Bellrose, 1957:20), and those of November 6–8, 1956, and October 23–25, 1957 (Fig. 1), adds materially to the available knowledge on routes taken by waterfowl in the Mississippi Flyway.

From the plains of Saskatchewan and Manitoba to Illinois the general direction of flight was between south-southeast and southeast. In the area between northern (latitude 42°30') and south central Illinois (latitude 39°), there was a great wheeling movement as the bulk of the flight turned from a southeasterly direction to a southerly one. It appeared as if the Mississippi River played a major role in changing the course of the migrants, with the Illinois River playing a secondary role and other bodies of water, such as the Chain-of-Lakes in northeastern Illinois, tertiary roles. In other states, significant bodies of water might serve in a similar fashion.

The key role that certain water areas may serve in altering direction of flight was illustrated by the fact that duck flocks changed their course from southeast to south when they arrived at the Mississippi River near Muscatine, Iowa. Although other duck flocks continued in flight to the southeast, observations made of the November 2, 1957, flight and other flights indicated that they changed to a more southerly direction at the Illinois River. On the basis of observation on past flights, such migrating flocks as those observed by McCabe in Wisconsin are thought to have shifted to a southerly direction in the Chain-of-Lakes region in northeastern Illinois.

There was a strong flight of waterfowl down and adjacent to the Missouri River Valley in Iowa. Because the bulk of the movement did not turn east at Kansas City, Missouri, to follow the Missouri River, the plausible conclusion was that the flight continued in a south-southeasterly direction over the Ozark Mountains to wintering grounds in Arkansas and Louisiana.

Sieh did not observe any tendency for migrating waterfowl to follow rivers when he crossed northern Iowa on November 7, 1956. Duck flocks were dispersed all across the northern part of the state (Table 1). Farther down the flight lines, where the streams were larger, Bellrose's observations indicated that migrating waterfowl were more abundant within 5 miles of the Iowa and Cedar Rivers, which flow from northwest to southeast; however, he found ducks migrating across all of southeastern Iowa (Table 2). It appeared that as the rivers became larger, there was a tendency for the ducks to use them as guide lines, but only when river courses paralleled the lines of flight. Migrating waterfowl appeared to depart from river guide lines whenever they were inconvenient to follow, as exemplified by flocks leaving the Mississippi River above St. Louis to fly straight south.

The migrating flocks observed flying southward between the Mississippi and Illinois rivers (Fig. 1) may well have turned south at some point on the Mississippi River directly north of the place where they were observed. At three different latitudes duck flocks were observed heading directly east from the Mississippi River toward the Illinois River; again these birds may have used some point on the Mississippi to alter their line of flight.

Flocks observed flying north at the same altitude as the stream of southbound migrants are thought to be ducks which arrived at the Mississippi River at a point south of the desired one. These ducks would appear to have recognized their displacement from land marks, and used them as a means of returning to their haunts of other years.

In aviating inland from the Mississippi River between Iowa City and Argyle, Iowa, on November 7, 1956, it was obvious that the direction of duck flight changed from southeast to east by the time Mt. Pleasant was reached. Apparently most flocks headed directly toward the Mississippi River as darkness approached. From an altitude of 2500 feet the river was barely discernible 20 to 30 miles away, and apparently as the birds saw it, they swung east toward it. Most ducks appeared to be halting their flight for part or all of the night when they reached the river.

The waterfowl passage on November 7, 1956, was on a front of at least 250 miles. The first migrants formed a line which at 9:00 a.m. was farthest south near Omaha, Nebraska, and slanted abruptly to the north-northeast, extending at least as far as Minneapolis, Minnesota. The location of the front line of migrants is derived from observations of the first ducks which appeared in the Missouri River Valley at Onawa, Iowa, at 8:00 a.m., at Spirit Lake, Iowa, at 9:00 a.m.; at Swan Lake near New Ulm, Minnesota, at 9:00 a.m.; and at Minneapolis, Minnesota, at 9:00 a.m. (Fig. 1). Thus the western terminus of the flight line in the Mississippi Flyway was about 200 miles south of the eastern segment of the flight line at Minneapolis.

The apparently greater progress southward in the west segment of the flight over the segments farther east no doubt stems from the fact that these mass waterfowl migrations often start from the western plains of Canada ahead of those from the eastern plains. This was recorded on the October 31–November 3, 1955, flight (Bellrose, 1957:19), and on the October 22–25, 1957, flight. In 1957, the passage peaked between the noons of October 22–23 in western Saskatchewan, and during the afternoons of October 23 in eastern Saskatchewan and October 24 farther east at Delta, Manitoba.

Counts made in Iowa at Spirit Lake, across northern Iowa from Spirit Lake to Osage (Table 1), and in eastern Iowa (Table 2) on November 7, 1956, indicate that that flight was much greater in the western part than in the eastern part of the Mississippi Flyway. Even though observations were made from fixed points, from a car, and from a plane the results were roughly comparable because all counts were made at an approximate right angle to the line of flight. Thus a moving observer would not tend to expand or compress the magnitude of the flight as long as observations formed a cross-section; his zone of observation would remain of comparable size.

Rate of Movement.—During the 1956 grand passage certain observers were in a position to notice the first major wave of migrating ducks reaching their locality. They also reported the flight directions which made it possible to project probable lines of flight.

A comparison of the arrival of ducks at selected points, 250 to 270 miles apart and along projected lines of flight, makes it possible to roughly compute the speed of the 1956 mass migration through the Midwest.

Ducks observed passing over Swan Lake near New Ulm, Minnesota, at 9:00 a.m., on November 7, and moving in the direction of Muscatine, Iowa, were probably representative of the birds which reached that area at 2:15 p.m. It is about 260 miles from Swan Lake to Muscatine, and the ducks appeared to cover this distance in 5¼ hours for an average flight speed of 50 mph. The flight which passed Minneapolis, Minnesota, probably represented the same section of the migration which reached Savanna, Illinois, 5½ hours later and some 250 miles to the southeast for a speed of 45 mph. The Mallards that reached Sumner, Missouri, at 2:30 p.m. were probably in the section of flight which passed Spirit Lake, Iowa, at 9:00 a.m. These ducks probably travelled 270 miles in 5½ hours, for a speed of 49 mph.

Amazing though it seems, it is probable that ducks which left central Saskatchewan during the day on October 23, were the ones which arrived in Louisiana the night of October 24. This indicates a continuous flight for about 36 hours covering some 1500 miles (±200 miles) for an average speed of 40 mph.

Both the 1956 and 1957 grand passages of waterfowl arrived in Louisiana at almost the same time as in Illinois, even though central Louisiana is some 600 miles south of central Illinois. The fact that ducks did not appear in eastern Arkansas until the following day, strongly suggests that the early arrivals in Louisiana flew 150–200 miles west of the Mississippi River, on a south-southeast course. Probably these flights crossed western Iowa during the afternoon and night. The flocks Heidelbauer observed in migration on the afternoon of November 6, 1956, in western Iowa probably represented this pulse of the flight. Apparently Jauron saw the start of this segment of the 1957 flight at 12:20 p.m. on October 23, when it began to pass down the Missouri River Valley near Onawa, Iowa. The segment of the grand passage observed at Bismarck, North Dakota, and Fergus Falls, Minnesota, on the morning of November 6, 1956, may represent part of this passage which reached Louisiana on November 8.

Altitude.—Under high overcast skies on November 7, 1956, ducks were found migrating from 2100 to 2800 feet over the farm lands of Iowa (Table 2). As darkness approached, the ducks dropped lower and lower until at dark they were only 500 feet above the ground. A similar decline in altitude with the waning of the day was also observed near Minneapolis, Minnesota. There Donald Smith estimated that flocks of waterfowl descended from 2000 feet in mid-day to 800–1000 feet late in the afternoon.

On November 8, 1956, migrating flocks were found from 900 to 1500 feet above the Mississippi River (Table 3), and in the same area on October 24, 1957, they were found at altitudes varying from 1100 to 1700 feet. Over Arkansas, they were recorded at 2000 to 2500 feet. In western Iowa, several flocks were recorded at 1500 feet on November 6, 1956.

Weather Conditions.—Weather conditions associated with the November 6–7, 1956, waterfowl flight from the northern Great Plains region were under the influence of a moderate low which, on November 5, moved north-north-

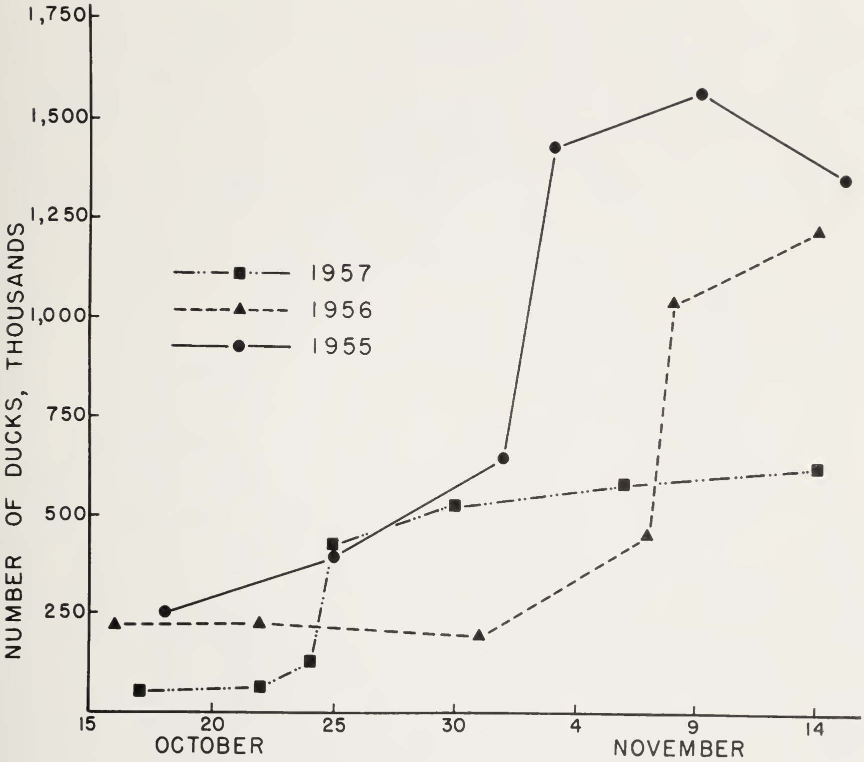

FIG. 2. Changes in the waterfowl population of the Illinois River Valley resulting from a mass migration in each of the three years, 1955–1957.

west from western Iowa to center in southwestern Manitoba by 12:30 a.m. on November 6.

Apparently as the low pressure area passed through North Dakota, it, or the weather associated with it (Fig. 3), induced some movement of ducks out of that state, beginning late in the afternoon of November 5. By the morning of November 6, much larger numbers of ducks were reported moving through central North Dakota, western Minnesota, and southern Manitoba.

The weather map for 12:30 a.m. (C.S.T.) on November 7 (Fig. 4) shows that the low pressure area had deepened slightly and had become extended to form a trough from southeastern Ontario to James Bay. Weather associated with this low consisted of falling temperature; overcast skies through eastern Ontario, Manitoba, eastern Saskatchewan, and south through Minnesota, North and South Dakota; falling snow in a belt from eastern Ontario, through

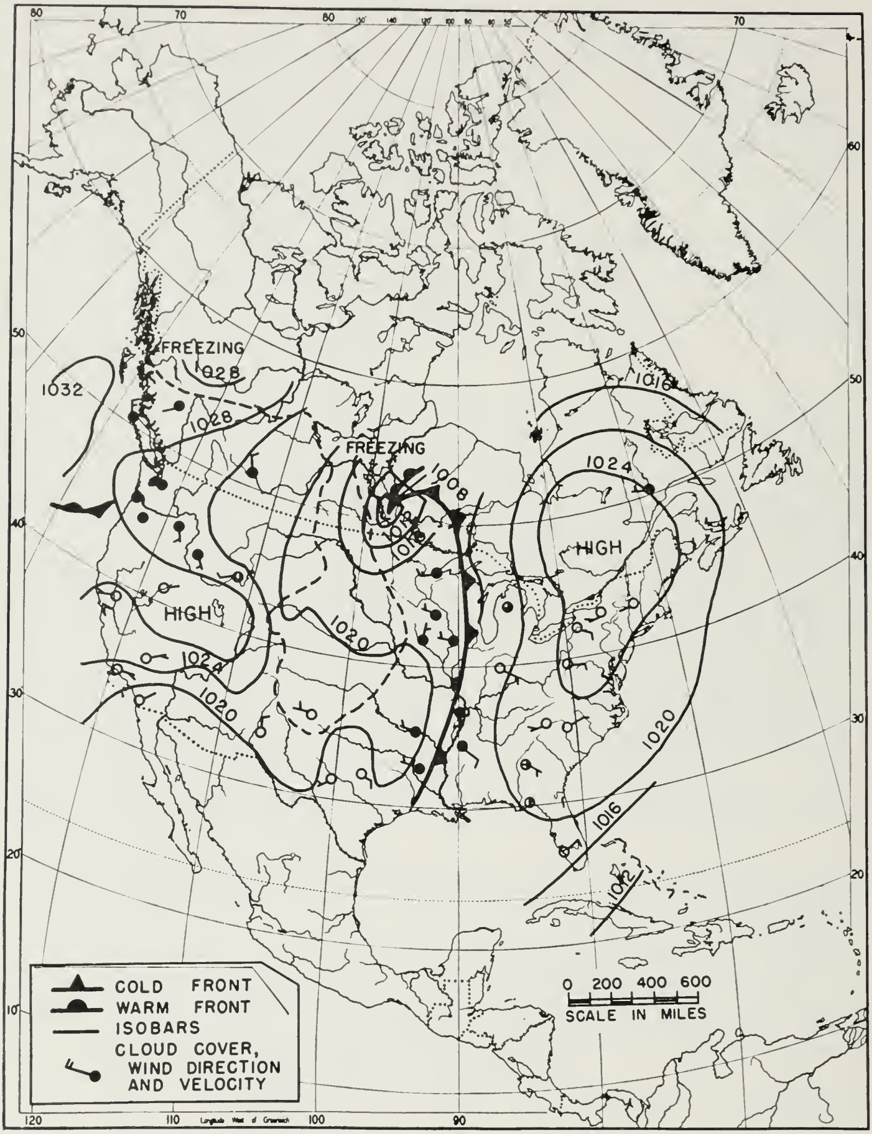

Fig. 3. Weather conditions as of 1:00 a.m. (C.S.T.), November 6, 1956, according to the United States Weather Bureau.

southern Manitoba to central Saskatchewan; and winds from the northwest in the northern Great Plains region.

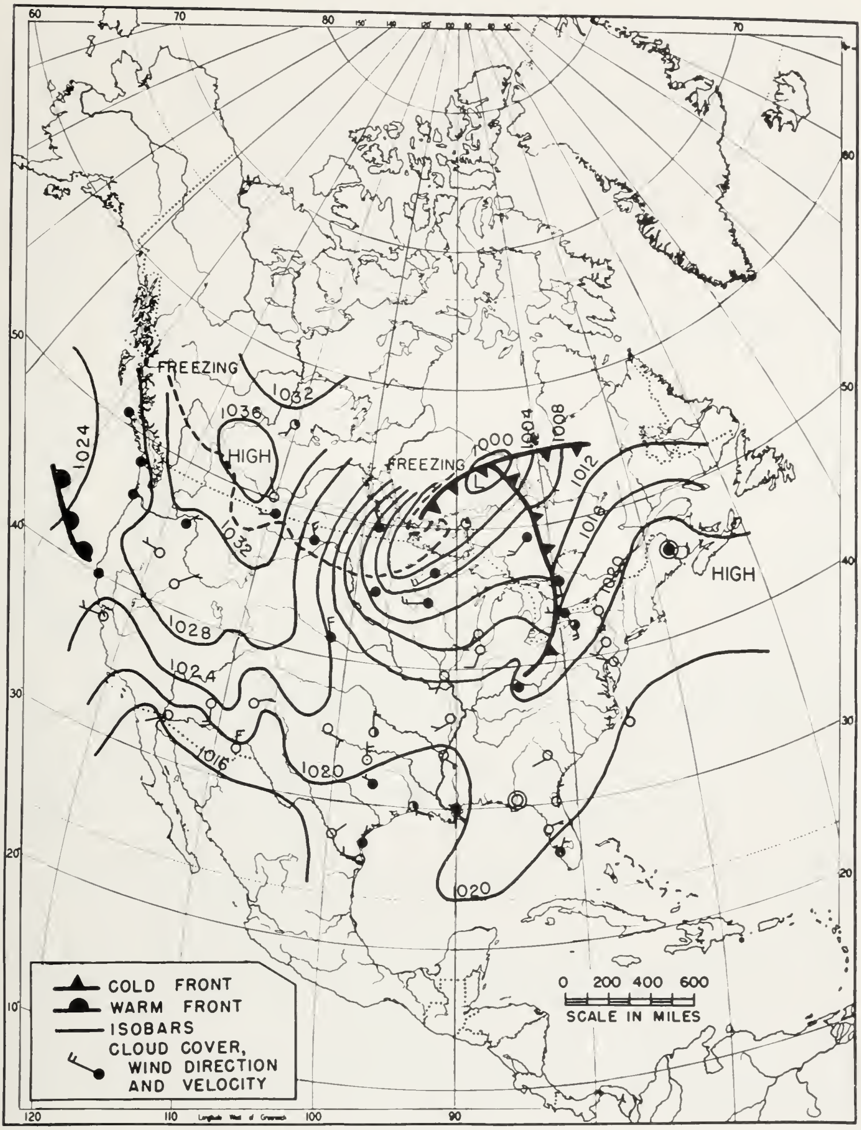

Fig. 4. Weather conditions as of 1:00 a.m. (C.S.T.), November 7, 1956, according to the United States Weather Bureau.

Daily weather records at Winnipeg, Manitoba, show (Fig. 5) that on November 5, 1956, the minimum temperature rose slightly but fell 6 degrees

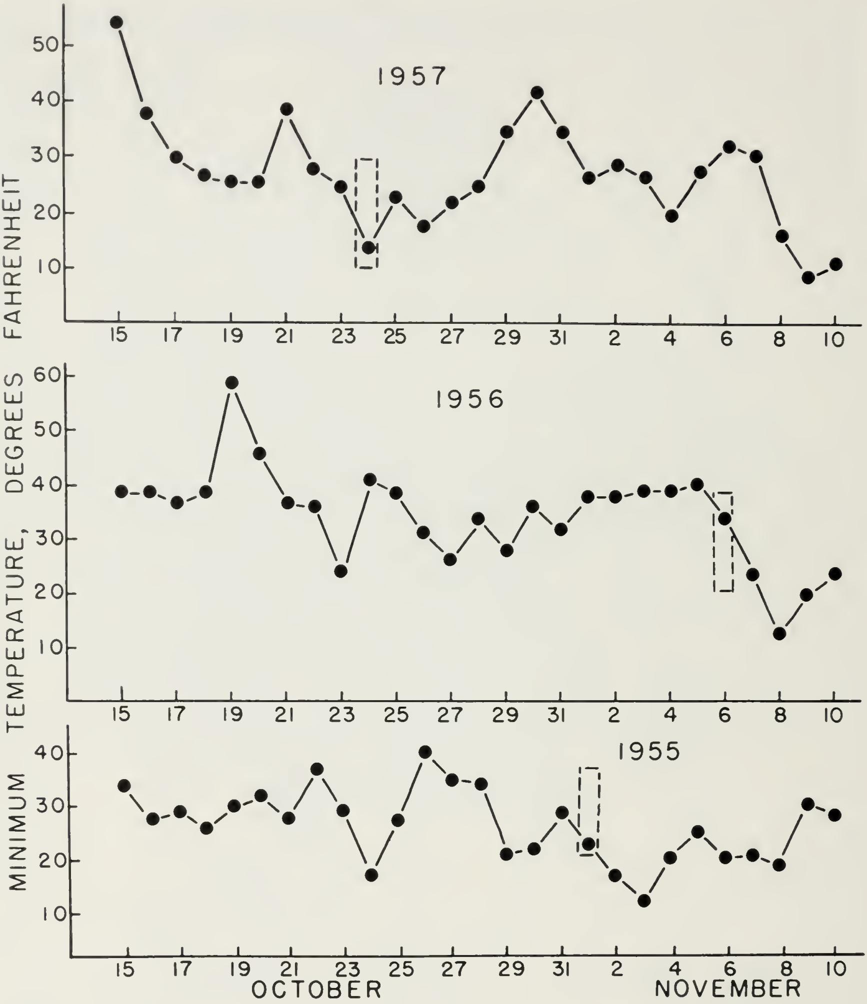

Fig. 5. The minimum daily temperature from October 15 through November 10, 1955–1957, at Winnipeg, Manitoba, Canada. Vertical bar designates day flight started from southern Manitoba.

on November 6, 8 degrees on November 7, and 11 degrees on November 8. when a low temperature of 13 degrees was reached. Daily weather records of Saskatoon, Saskatchewan, 450 miles northwest of Winnipeg, show (Fig. 6) that temperatures as low as 4 degrees above zero occurred there as early as October 29, followed by a slight warming trend on October 31, near zero on

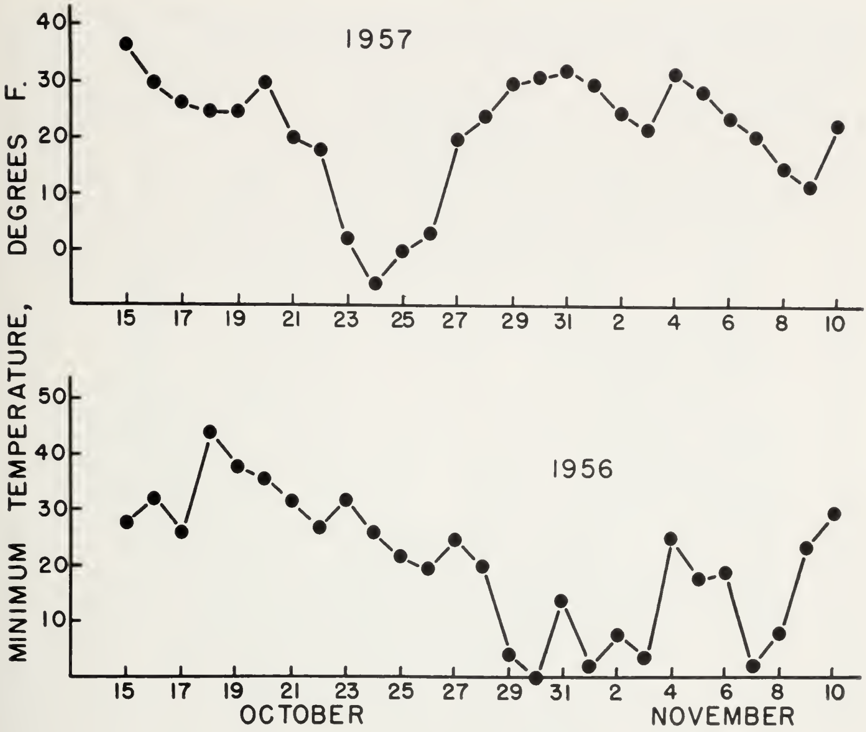

Fig. 6. The minimum daily temperatures from October 15 through November 10, 1956 and 1957, at Saskatoon, Saskatchewan, Canada.

November 1 and 2, a strong warming trend on November 4, 5, and 6, followed by a return of cold air on November 7.

Moderate flights of ducks which arrived in Illinois on October 31 and November 3 (not indicated by population data because of departure of other ducks, Fig. 2) were probably triggered by the cold air which penetrated the Saskatoon, Saskatchewan, area on October 29 and November 1. Because this cold air did not extend as far southeast as Winnipeg (Fig. 5), the bulk of the ducks which may have departed from the Saskatoon area at that time probably halted their migration north of the border.

They were then in position to become affected by the weather (produced by the low pressure area moving north from Iowa) which brought storm conditions to southern Manitoba and Saskatchewan on November 6 and 7. As indicated by temperature and wind changes at Winnipeg (Table 7), the flight probably started from this region about midnight on November 6, when

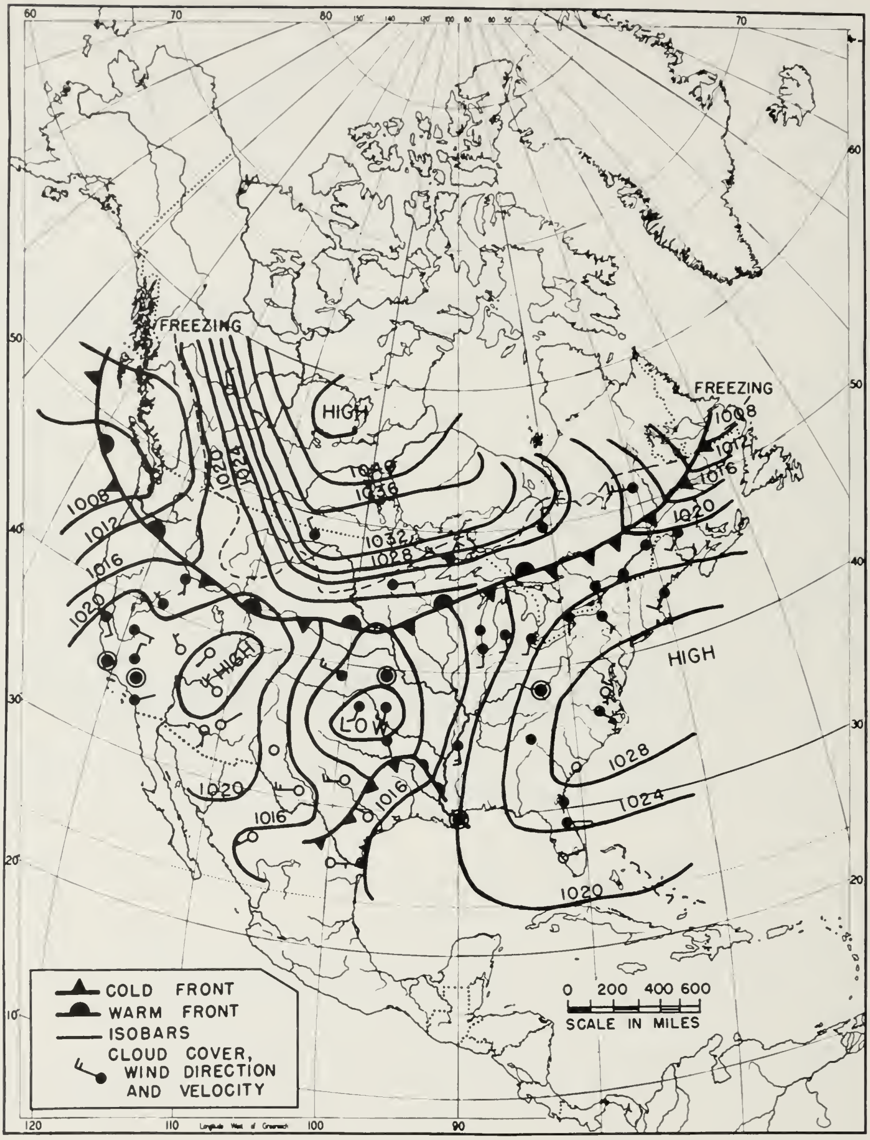

Fig. 7. Weather conditions as of 1:00 a.m. (C.S.T.), October 23, 1957, according to the United States Weather Bureau.

the wind shifted from north to northwest and increased in velocity. Temperatures fell slowly but steadily, reaching a low of 13 degrees at Winnipeg on November 7.

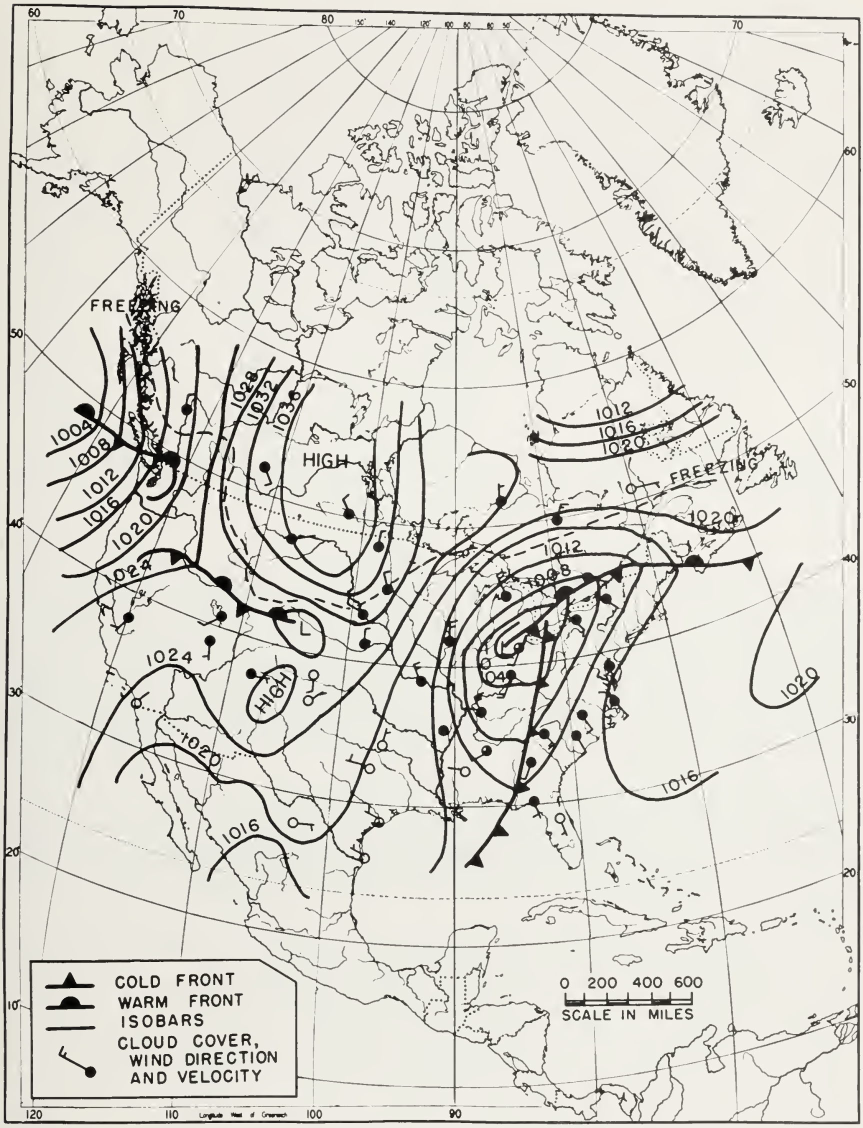

Fig. 8. Weather conditions as of 1:00 a.m. (C.S.T.), October 24, 1957, according to the United States Weather Bureau.

The 1957 grand passage started in western Saskatchewan about mid-day on October 22, in eastern Saskatchewan during the afternoon of October 23, and in Manitoba probably about midnight, October 23.

TABLE 7

WEATHER CONDITIONS[1] AT WINNIPEG, MANITOBA, NOVEMBER 6–7, 1956, AND OCTOBER 23–24, 1957

Hour of Day	1956				1957			
	November 6		November 7		October 23		October 24	
	Temp.	Wind	Temp.	Wind	Temp.	Wind	Temp.	Wind
1	38	S 26	31	NW27	28	NE18	25	NW17
3	37	S 25	28	NW25	27	NE17	26	NW 8
6	37	S 20	25	NW27	26	NE16	25	NW14
9	36	S 19	25	NW26	27	NE15	29	NW20
12	36	S 9	26	NW27	31	NE19	32	NW21
15	36	SW 7	27	NW25	27	NE19	36	NW19
18	36	N 8	26	NW24	26	NE17	30	NW14
21	35	N 16	25	NW13	27	NE16	26	NW14
24	33	NW24	17	W10	25	NE17	24	NW16

[1] Temperature in degrees Fahrenheit; wind direction; and velocity in mph.

This flight of ducks from Canada started when a very large and strong high pressure area moved southeast from the Yukon Territory of Canada to northern Alberta, where it was centered at 6:00 a.m. (C.S.T.) on October 22. By 6:00 a.m. on October 23 (Fig. 7) the high pressure area had moved farther southeast to central Saskatchewan, and from there it moved slowly southward on October 24 (Fig. 8), reaching the United States–Canadian border by 6:00 a.m. on October 25.

A cold front moving south through Wyoming, South Dakota, Minnesota, and Wisconsin on October 22 stalled and partially disappeared on October 23, when a moderate low moved northeastward to Missouri, and on to Lake Ontario by October 24 (Fig. 8).

On October 22, snow fell most of the day in Alberta, southern Saskatchewan, southern Manitoba, and Montana; and rain fell in the northern plains states and in the Midwest. The entire northern Great Plains was under obscured or overcast skies. In that region winds were largely from the northeast and east at 15–25 mph.

Snow continued to fall through the morning of October 23 in southern Alberta, southern Saskatchewan, the southwest corner of Manitoba, and northern Montana. Snow showers occurred in North Dakota and rain fell through much of the Midwest. Skies were obscured or overcast through most of the northern Great Plains and the Midwest. In the Great Plains and north-central United States winds were mainly from the northeast at 15–25 mph, shifting to the north as the day progressed.

During the morning of October 24, snow continued to fall in North Dakota and scattered snow storms occurred in Minnesota and South Dakota. Skies became clear in the prairie provinces, and as the day progressed the clearing extended southward through North Dakota and Minnesota. Skies were largely overcast in the Midwest during the morning, and the overcasting increased as the day progressed. In Manitoba and Saskatchewan winds were largely westerly early in the day, shifting to northwest later in the day as the high pressure moved farther south in Saskatchewan.

The high pressure area, with its clockwise flow of air, began bringing continental arctic air into Alberta on October 21. This cold air mass moved into Saskatchewan and northern Montana on October 22, and into North Dakota during the afternoon of October 23. On October 24, the cold air mass moved to South Dakota and thence eastward to Wisconsin.

This cold air mass produced a similar sequence in temperature decline at both Saskatoon, Saskatchewan, and Winnipeg, Manitoba (Figs. 5 and 6). However, as might be expected, the temperature decline during the period of October 21–24 was more severe at Saskatoon than at Winnipeg. The –6°F. reported at Saskatoon was an unusually low temperature for the season.

Calculating the time of the waterfowl flight on October 24 from its apperance in the Midwest suggests that ducks may have started migrating from southern Manitoba about 1:00 a.m. on that date. About that time the wind shifted from northeast to northwest (Table 7). The temperature which had dropped 6 degrees since noon, remained at or near 25°F. through the early morning hours.

Effect of Weather on Mass Flights.—An analysis of weather conditions occurring at the time of the massed waterfowl flights on October 31–November 3, 1955 (Bellrose, 1957:21–24), November 6–8, 1956, and October 23–25, 1957, points to several similar and dissimilar weather conditions in association with the three flights.

Barometric Pressure.—Two massed waterfowl flights (1955 and 1956) occurred as a result of weather conditions associated with low pressure areas, and one massed flight (1957) was initiated by weather conditions produced by a high pressure area. It is difficult to assess the role of barometric pressure alone as a factor in triggering waterfowl flights. The low center passing through North Dakota on November 5, 1956, may have resulted in some ducks migrating in advance of storm conditions. Certainly, the peaks of the 1955 and 1956 massed flights were more directly associated with weather conditions than with low pressure, and the 1957 flight was definitely not the result of low pressure.

Atmospheric Conditions.—The massed flights in all three years were associated with overcast skies which prevailed over almost the entire northern Great Plains and south through the Midwest. In the Midwest we observed massed flights in the daytime only under overcast skies.

For example, November 7. 1956, began as a clear day in Illinois. By 1:30 p.m., a solid overcast moved in from the northwest along the Mississippi River.

At 2:30 p.m., the front line of migrating ducks appeared, as previously described. at Muscatine, Iowa. Both the duck flight and overcast skies persisted until darkness. On other occasions we have observed duck flights to end shortly before or after the overcast passed regardless of the time of day.

All three flights originated when snow was falling extensively on the plains of Canada. Usually the snow had been falling for several hours, or longer, before the first migrating waterfowl were observed. The importance of snow as a factor in large scale waterfowl migrations is apparent in Nelson's and Dzubin's October, 1957, observations of the almost complete exodus of ducks from the snow belt south of Saskatoon, Saskatchewan, as opposed to ducks remaining in customary numbers north of there.

Observations made on the Pink-footed Goose (*Anser brachyrhynchus*) in central Iceland by Jones and Gillmor (1955:163) led them to conclude that snow was the most important factor in their fall departure. They stated: "The two departures in the two snows were forced departures. . . . The geese which left in the second snow were actually leaving on their migration to Britain. Some arrived the same day as they left, others the next day. . . . Temperature alone seems to have very little effect on geese."

Wind.—In the three massed duck flights studied, the wind was never unfavorable on the northern Great Plains when the migrations started. At the time of the November 1, 1955, flight winds were largely westerly through southern Manitoba and North Dakota (Bellrose, 1957: 15, 22); they were more northerly to the north and west of there. Although farther south in the Mississippi Flyway wind direction was flanking or adverse, winds in Manitoba and Saskatchewan, where a large part of the migration originated, were partially to fully favorable.

Early migrants on the November 6–8, 1956, movement experienced flanking winds for the most part. However, winds became exceedingly favorable by November 7, and it seems evident that the bulk of the flight developed with the shift in wind to the northwest (Table 7), which would provide a tail wind.

Again on the October 22–24, 1957, mass movement from the plains, winds were flanking in the early stages of the migration, but the winds shifted more and more to a favorable northwest direction as the day of October 24 progressed. The bulk of the flight appears to have developed from Manitoba about the time the wind shifted from northeast to northwest (Table 7).

Wind apparently was a factor in reducing the magnitude of a waterfowl flight on October 24, 1955. About equally low temperatures prevailed on that same day in 1955 and 1957 (Fig. 3). Although there was a flight from the northern plains on October 24, 1955, it was much below the proportions of the one on October 24, 1957. One difference in the weather conditions was the wind, which on October 24, 1955, at Winnipeg, Manitoba, was light and from the west, southwest and south.

Temperature.—All three of the waterfowl flights under discussion occurred when temperatures were in the process of dropping to lows of 17° on November 2, 1955; 17° on November 7, 1956; and 24° on October 24, 1957, at Winnipeg, Manitoba (Fig. 5 and Table 7). Data recorded on weather maps indicate that temperatures on the southern plains of Saskatchewan dropped to similar minimums 12 to 24 hours ahead of Winnipeg on the occasion of all three duck flights. In 1956, temperatures dropped to seasonal lows at Saskatoon, Saskatchewan, several days ahead of the change at Winnipeg, but in the 1957 period temperature changes were similar in chronology at both cities.

Analysis of Weather Factors and Mass Migration.—Three spectacular waterfowl flights in as many years resulted from storm conditions on the northern Great Plains. The elements responsible for the storms were created by low pressure areas in two years and a high pressure area in one year.

The weather elements which appeared to contribute to these massed flights were: extensive overcast skies, falling snow, fairly strong winds which were partially or entirely favorable in the areas where the flights originated, and falling temperatures which in southern Manitoba declined at least to the low 20's. A cold front was involved in the 1955 massed flight, but not in those of 1956 and 1957.

SUMMARY

1. Spectacular waterfowl flights, sometimes referred to as "grand passages," occurred in the Mississippi Flyway on October 31–November 3, 1955; November 6–8, 1956; and October 23–25, 1957.
2. The massed waterfowl flight of 1955 was discussed in detail in an earlier paper; the present paper discusses the flights of 1956 and 1957, with particular emphasis on their passages through Iowa and Illinois.
3. Observers at numerous places from southern Manitoba to Louisiana reported the movements of waterfowl. The 1956 massed flight was first noted passing through southern Manitoba and in the vicinity of Bismarck, North Dakota, and Fergus Falls, Minnesota, during the morning of November 6.
4. The "leading edge" of one pulse of the flight reached Onawa, Iowa, on the Missouri River at 8:00 a.m., November 7, 1956, and Spirit Lake, Iowa, New Ulm and Minneapolis, Minnesota, at 9:00 a.m. Migrant flocks continued en masse

over these points until the flight slackened appreciably at each location about 3:30 p.m.

5. Counts of flocks migrating in the region of Spirit Lake, Iowa, indicated a passage of 3083 ducks per hour from 9:30 to 10:30 a.m., and 4155 ducks per hour from 1:30 to 3:30 p.m.
6. A "cross section" of the waterfowl passage on November 7, 1956, through northern Iowa was obtained by driving eastward from Spirit Lake to Osage, a distance of 128 miles. Ducks crossed this line of observation at the rate of 4260 birds per hour from 12:55–3:40 p.m.
7. A cross section of the waterfowl passage through east-central Iowa was obtained from a light airplane. At the Mississippi River near Muscatine, Iowa, the "leading edge" of the flight appeared at 2:15 p.m., November 7, 1956. The waterfowl flight was observed as the plane took a zigzag course to Iowa City and thence south parallel to the Mississippi River to Argyle, Iowa, and eastward to Havana, Illinois. Ducks crossed the line of flight in Iowa at the rate of 2520 ducks per hour, and in Illinois at the rate of 996 ducks per hour.
8. The vanguard of this massed flight arrived in Louisiana at noon on November 7, 1956, and continued for two days, bringing at least 1,200,000 ducks into that state.
9. The 1957 grand passage of waterfowl began in western Saskatchewan on October 22, where it peaked that afternoon and the following morning; in eastern Saskatchewan the flight occurred largely during the afternoon of October 23; and at Delta, Manitoba, it took place largely on October 24.
10. In North Dakota at the Lower Souris National Wildlife Refuge mass migration commenced at 7:30 a.m. on October 24, 1957, and continued strong until 10:00 a.m. It appeared at Swan Lake, Minnesota, at 8:00 a.m. and continued there to 2:30 p.m.
11. A segment of the grand passage appeared on the Missouri River in western Iowa at 12:20 p.m. on October 23, 1957. However, farther east in Iowa the flight did not appear until October 24, reaching Spirit Lake at 9:10 a.m. It continued through the day, but the rate of flight was only 378 ducks per hour, about one-sixth of the magnitude of the 1956 flight.
12. Although a few migrating ducks appeared in central Illinois at 1:00 p.m., October 24, 1957, the main body of migrants arrived at 4:45 p.m. and continued into the night. During the period it was estimated that 25,000 ducks passed the Chatauqua National Wildlife Refuge and a slightly larger number dropped into the lake.
13. The 1955 grand passage of waterfowl resulted in an increase of 775,000 ducks in the Illinois River Valley; the 1956 grand passage resulted in an increase of 600,000 ducks; and the 1957 massed flight in an increase of 225,000 ducks in that area.
14. A half-million ducks were estimated to have arrived in Louisiana on the night of October 24, and the day and night of October 25, 1957.
15. Flight directions recorded during the spectacular flights of 1955, 1956, and 1957 were generally between south-southeast and southeast from the plains of Saskatchewan and Manitoba to Illinois. Certain water areas may serve a key role in altering direction of flight as indicated by flocks shifting from southeast to south when they arrived at the Mississippi River Valley.
16. The waterfowl passage on November 7, 1956, was on a front more than 250 miles in length, extending from near Omaha, Nebraska, north-northeastwardly to Minneapolis, Minnesota, and probably in both directions beyond those points.

17. The mass migration of October 31–November 3, 1955, and October 23–October 25, 1957, progressed southward in the west ahead of the east in the Mississippi Flyway probably because migrations started from the western plains of Canada ahead of those from the eastern plains corresponding with weather impetus. Counts on November 7, 1956, indicate that the flight was much greater in the western segment than in the eastern segment of the Mississippi Flyway.
18. A series of observations during the grand passage of 1956 indicate a ground speed from 45–50 mph. Ducks leaving central Saskatchewan on the day of October 23, 1957, suggest a continuous flight to Louisiana, a distance of 1500 (±200) miles for an average speed of 40 mph.
19. Arrivals in 1956 reached Illinois and Louisiana within a few hours of each other, strongly suggesting that the early arrivals in Louisiana flew 150–200 miles west of the Mississippi River, and were ahead of flight segments migrating farther east before they turned south.
20. The altitude of migrating ducks over the fields of Iowa and Illinois varied from 1500 to 2800 feet during the day. As darkness approached, flocks of ducks dropped lower to a minimum of 500 feet.
21. The weather responsible for the three massed duck flights was created by low pressure areas in two years and a high pressure area in one year. The weather elements associated with the flights were: extensive overcast skies, falling snow, fairly strong winds which were partially or entirely favorable in areas where the flights originated, and falling temperatures which in southern Manitoba declined to the low 20's.

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ILLINOIS NATURAL HISTORY SURVEY, HAVANA, ILLINOIS; AND IOWA CONSERVATION COMMISSION, DES MOINES, IOWA, JULY 24, 1959

SOME ANATOMICAL CHARACTERS OF THE CUCULIDAE AND THE MUSOPHAGIDAE

BY ANDREW J. BERGER[1]

MOST authors have placed the African touracos ("plantain-eaters") and the cosmopolitan cuckoos in a single order, the Cuculiformes or Cuculi (e.g., Mayr and Amadon, 1951, Wetmore, 1951). Bannerman (1933), Moreau (1938, 1958), Lowe (1943), and Verheyen (1956*a*, 1956*b*), however, believed that the touracos deserve ordinal rank, the Musophagiformes. I agree with these authors but not for some of the reasons they cite.

I have been interested in the anatomy and relationships of these two groups of birds for over a decade, but it now seems unlikely that it will be feasible to continue this work. Consequently, I have decided to publish certain information which, although still very incomplete, may prove useful to other investigators. The complete appendicular myology of a touraco apparently has never been described. My plan, therefore, is to describe this musculature for *Tauraco leucotis donaldsoni* ("*Turacus donaldsoni*") and then to compare the myology, osteology, and pterylosis of this touraco with that of the cuckoos. Such a comparison can not be made properly without also analyzing differences in morphology within the family Cuculidae.

This paper is based on the dissection of one or more specimens of the following genera and species of cuckoos: *Carpococcyx radiceus, Centropus bengalensis, C. superciliosus, Ceuthmochares aereus, Chrysococcyx cupreus, Ch.* ("*Lampromorpha*") *klaas* and *caprius, Ch.* ("*Chalcites*") *basalis, Clamator jacobinus, Coccyzus americanus, C. erythropthalmus, Coua serriana, C. reynaudii, C. ruficeps, C. cristata, C. caerulea, Crotophaga sulcirostris, Cuculus canorus* and sp., *Dromococcyx pavoninus, Geococcyx californianus, Guira guira, Morococcyx erythropygus, Piaya cayana, Phaenicophaeus pyrrhocephalus, Saurothera merlini, Surniculus lugubris, Tapera naevia.* These 18 genera represent less than half of the 38 genera recognized by Peters (1940), although several of his genera have been suppressed by later workers (e.g., Mayr, 1944; Delacour and Mayr, 1945; Delacour, 1946; Berger, 1955*b*). Consequently, it must be borne in mind that conclusions and generalizations presented here may have to be altered when data become available on the remaining genera of cuckoos. As a matter of convenience for other workers, I have, by and large, used Peters' genera and species of cuckoos. I do this in part because I do not agree with those who propose that it is not necessary to examine the internal anatomy of a given species merely because an earlier genus has been suppressed and its contained species have been placed in some other genus. Evidence presented here certainly casts doubt on the wisdom of

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[1] I dedicate this paper to Erwin Stresemann on the occasion of his 70th birthday.

synonymizing some genera of cuckoos, as has been done on the basis of external characters alone.

Over the years I have received alcoholic specimens from several generous cooperators: Dean Amadon, Jacques Berlioz, Ernest P. Edwards, Herbert Friedmann, Mrs. Richard R. Graber, Theodore Miller, Renaud Paulian, Helmut Sick, George M. Sutton, P. B. Uzzell, and John G. Williams.

Some of the material from museums had been collected many years ago. In a few specimens, an incision through skin and muscle had been made from chin to vent. It is difficult (and sometimes impossible) to determine accurately the details of the ventral feather tracts in such birds. In two specimens, the articulations of the sternal ribs had been cut bilaterally and the viscera were held in place by strings tied around the body. When the strings were cut, the sternum fell out of the body! Shot damage to the specimen of *Dromococcyx* was so great that I could not study some important anatomical details. I made a plea several years ago (1955*a*) for better anatomical material. For the benefit of all students of pterylosis, myology, etc., I repeat that plea here. One often feels that it is better to have no representative of a species or genus than to have a specimen so mutilated by shot damage or by incisions that one can obtain only a portion of the information that one needs.

Anatomists sometimes are criticized for publishing information based on the dissection of only one or two specimens of a species. To be sure, the anatomist would be delighted to have a dozen or more specimens of each form that he is studying, but he is rarely so fortunate. In order to obtain the specimens that form the basis for this paper, I wrote well over a hundred letters to all parts of the world during a 12-year period. Perhaps this is the best example that I could cite to emphasize the continuing great need for well-preserved anatomical material.

Wing Muscles of *Tauraco leucotis donaldsoni*

M. latissimus dorsi.—Pars anterior arises from the neural spines of the last two cervical and the first dorsal vertebrae. It inserts fleshily over an area 7 mm. long beginning 9 mm. from the proximal end of the head of the humerus. *Pars posterior* arises from the neural spines of the five dorsal vertebrae. It inserts by a flat tendon (2 mm. wide) immediately posterior to the proximal end of the insertion of pars anterior. *Pars metapatagialis*, the dermal component, is a very small band of fleshy fibers about 1 mm. in width. It arises from the superficial surface of pars posterior at the level of the spine of dorsal vertebra number 4; it inserts into the skin at the posterior margin of the humeral feather tract adjacent to the insertion of M. serratus metapatagialis.

M. rhomboideus superficialis arises by an aponeurosis from the neural spines of the last three cervical and the first two dorsal vertebrae. The fleshy fibers pass outward and forward to insert on the anterior 36 mm. of the scapula.

M. rhomboideus profundus arises by an aponeurosis from the neural spines of the last two cervical and the first two dorsal vertebrae. The muscle inserts on the posterior 28 mm. of the scapula.

M. cucullaris, pars propatagialis.—I did not find any tendon of this muscle inserting on the tendon of the tensor patagii longus.

M. serratus profundus has a typical origin from the posterior cervical vertebrae and from the cervicodorsal ribs. The several fasciculi pass backward to insert on the medial surface of the scapula.

M. serratus anterior arises by a superficial and a deep band of fibers. The larger and more superficial slip arises from the lateral surface of the first true rib, ventral to the uncinate process. The deeper slip arises from the ventral portion of the last cervicodorsal rib. The two slips fuse and give rise to a strong aponeurosis (6 mm. wide), which passes upward between the two heads of M. subscapularis to insert on the ventral edge of the scapula just caudal to the glenoid fossa.

M. serratus posterior arises by fleshy fasciculi primarily from the uncinate processes of true ribs numbers 1, 2, and 3. The complex is an extensive, but thin, sheet of fleshy fibers that inserts on the apex of the scapula (by fleshy fibers) and on the ventral edge of that bone (by an aponeurosis) as far craniad as the insertion of M. serratus anterior. *Pars metapatagialis*, the dermal component, has a typical origin. The belly, about twice as large as pars metapatagialis of M. latissimus dorsi, passes upward to insert into the skin at the posterior margin of the humeral feather tract.

M. proscapulohumeralis is a thin strap of fleshy fibers 4 mm. wide at its origin from the scapula immediately posterior to the glenoid lip and the origin of M. scapulotriceps. The belly is about 13 mm. in length. It has a typical insertion on the humerus between the two heads of origin of M. humerotriceps.

M. dorsalis scapulae arises from the lateral surface of the scapula in its posterior 33 mm. It inserts on the anconal surface of the bicipital crest of the humerus.

M. subscapularis has the usual two heads.—*Pars externa* arises for a distance of 8 mm. from the ventrolateral edge of the scapula, beginning a short distance caudal to the glenoid fossa. *Pars interna* arises from an area about 20 mm. long on the medial surface of the scapula. The two heads fuse and insert by a short stout tendon on the internal tuberosity of the humerus, adjacent to the insertion of M. subcoracoideus.

M. subcoracoideus arises by two heads, a clavicular head and a coracoidal head. The clavicular head is unusually well developed. It has an extensive origin from an area 17 mm. long on the medial surface of the superior end of the clavicle and from the acromion of the scapula. The coracoidal head arises from the basal 10 mm. of the posterior face of the coracoid and from the adjacent coracoclavicular membrane. The two heads fuse and insert in common on the internal tuberosity of the humerus.

M. coracobrachialis anterior is a well-developed muscle, although it does not cover the anterior surface of the head of the humerus. It arises from the head of the coracoid (and adjacent ligaments) immediately dorsal to the origin of M. biceps brachii. The belly (about 13 mm. long and 5 mm. in maximum width) passes outward, closely applied to the capsule of the shoulder joint, to insert on the proximal end of the humerus.

M. coracobrachialis posterior has a typical origin and insertion.

M. supracoracoideus has a typical origin from the sternum and the coracoclavicular membrane. A very large tendon of insertion is formed; the fleshy fibers continue through the triosseal canal (see p. 82) with the tendon and cover it almost to the point of insertion on the humerus.

M. sternocoracoideus has a typical origin and insertion.

M. pectoralis.—*Pars thoracicus* is very well developed; it has a typical origin and insertion. *Pars propatagialis longus et brevis* is a large fleshy fasciculus arising from the ventral surface of pars thoracicus. The fleshy bundle fuses with the distal end of the belly of M. tensor patagii longus, but it also gives rise to a flat bandlike tendon which appears to form the bulk of the tendon of M. tensor patagii brevis. The belly of the latter muscle appears to insert into the tendon formed from pars propatagialis. Near its formation, the tendon of pectoralis pars propatagialis has a tendinous anchor to the anterior edge of the deltoid crest of the humerus.

M. deltoideus major has a total length of belly (from the scapular origin) of about 44 mm.;the terminal tendinous insertion reaches to within 12 mm. of the distal end of the humerus. The longer head arises from the acromion of the scapula and by a strong aponeurosis from the ventral edge of that process, as in *Coua caerulea.* The much smaller anterior head arises from the very large os humeroscapulare; it inserts by fleshy fibers on the anconal surface of the deltoid crest.

M. deltoideus minor is, relatively, a fairly well-developed muscle in the touraco. It is a flat band of fleshy fibers 3 mm. wide and 14 mm. long. Unlike the origin in *Coua*, it arises from the acromion and from the coracoscapular and acromioclavicular ligaments. It has a typical insertion at the junction of the articular head and the deltoid crest of the humerus. The belly, which passes anterior to the os humeroscapulare and overlies the subjacent tendon of M. supracoracoideus, is visible anterior to M. deltoideus major after removal of Mm. tensores patagii longus et brevis.

Mm. tensores patagii longus et brevis are represented by a common belly which arises from the dorsal and medial surfaces of the apex of the clavicle and the tip of the acromion; posteriorly, the origin is shared with the posterior head of M. deltoideus major. The origin of this complex in *Tauraco leucotis* is like that found in the cuckoos and not like that illustrated for *Tauraco corythaix* by Lowe (1943). The insertion of the tensor patagii brevis seems to be similar in the two species, and I suspect that Lowe's separation of the tendon into two discrete slips in *corythaix* may have been an artifact. At any rate, in *leucotis* the tendon of the brevis is a single sheet (about 1.5 mm. wide) which inserts primarily into the belly of M. extensor metacarpi radialis, but an extension of this tendon-sheet proximally passes posteriorly over the forearm muscles to fuse with the antebrachial fascia, which is closely adherent to the bases of the proximal secondaries.

M. biceps brachii has a typical double origin from the coracoid and from the bicipital crest of the humerus. The belly, 37 mm. in length, extends to the distal end of the humerus. The tendon bifurcates to insert 2 mm. and 3 mm., respectively, from the proximal ends of radius and ulna. A biceps slip is not present.

M. triceps brachii exhibits about the same development as in the cuckoos. The scapulotriceps portion has a somewhat two-headed fleshy and tendinous origin: one head from the lateral surface of the scapula, dorsal to the glenoid fossa; the other head from the ventrolateral edge of the scapula just caudal to the glenoid lip. There is no humeral anchor. The humerotriceps can be divided into two heads only proximally, where the two heads arise on either side of the insertion of M. proscapulohumeralis. There is a typical insertion on the olecranon and the adjacent area on the proximal end of the ulna.

M. expansor secundariorum is similar in structure to that previously described for several cuckoos in that there is both a humeral and a scapular origin. The two tendons of origin give rise to fleshy fibers that insert on several of the proximal secondaries. The short tendon arises from the distal end of the humerus. The long tendon extends proximad through the metapatagial skin fold to the axilla where the tendon bifurcates. The dorsal branch attaches to the medial surface of the scapula, deep to the origin of M. subcoracoideus and at about the line of separation between this muscle and M. subscapularis (pars interna). The ventral branch attaches to the coracoid in relation to the origin of M. coracobrachialis posterior; this attachment I have not found in the cuckoos (see p. 77).

M. anconaeus coracoideus.—I did not find this muscle in the specimen I dissected.

M. brachialis is typical in origin and insertion.

M. pronator superficialis is a well-developed muscle (belly 35 mm. long) which extends to within 10 mm. of the distal end of the radius.

M. pronator profundus, with a belly 32 mm. long, extends distad almost as far as M. pronator superficialis. The origin of both muscles is typical.

M. flexor digitorum superficialis has a typical origin from the distal end of the humerus. The tendon of origin expands into a broad aponeurosis (the humerocarpal band) which extends the entire length of the ulna and fuses with the fascia around the bases of the secondaries; near the distal end of the ulna, the humerocarpal band gives rise to fleshy fibers (essentially a second belly for the muscle), which fuse with the main belly just before the tendon of insertion is formed. The main belly (30 mm. long) arises from the deep surface of the humerocarpal band, beginning 12 mm. from its humeral attachment. The muscle inserts on the base of the proximal phalanx of digit II.

M. flexor digitorum profundus arises by a single head from the ulna, posterior to the area of insertion of M. brachialis. The belly is about 33 mm. in length; it extends to the distal end of the ulna. The main tendon of insertion passes around the pisiform process of the carpometacarpus and then passes distad superficial to the tendon of the flexor digitorum superficialis to insert on an extensive area of the distal phalanx of digit II. A very unusual feature is the presence of a second tendon given off the main tendon opposite the base of the pollex; this tendon inserts on the palmar surface of the pollex.

M. flexor carpi ulnaris is a well-developed muscle, whose belly (37 mm. long) extends nearly the entire length of the forearm. The origin and insertion are typical, but fleshy fibers do not insert on the bases of the secondaries as they do in *Coua caerulea.*

M. extensor metacarpi radialis has a typical origin from the lateral epicondyle of the humerus. The belly is about 34 mm. long. The tendon of the tensor patagii brevis muscle inserts into the belly and its enveloping fascia about 10 mm. distal to the humerus. The tendon of M. extensor metacarpi radialis inserts on the extensor process of the carpometacarpus. M. abductor pollicis arises from the tendon a short distance before its insertion.

M. flexor metacarpi radialis arises by a tendon attached to the lateral epicondyle of the humerus. The belly is about 28 mm. long, and the fleshy fibers begin about 10 mm. from the humeral origin of the tendon. A fascial extension of the tendon of origin fuses with the fascia surrounding the bases of the proximal secondaries. The tendon inserts on metacarpal II, about 6 mm. from the proximal end of that bone at the proximal limit of the intermetacarpal space.

M. extensor digitorum communis arises by a tendon from the lateral epicondyle of the humerus. The fleshy fibers of the 33 mm.-long belly begin almost at the humeral origin of the tendon. Two tendons are formed near the base of the carpometacarpus. The shorter tendon inserts on the base of the pollex. The longer tendon runs in a groove on the dorsal surface of metacarpal II; near the distal end of that bone, the tendon turns abruptly around a bony tubercle to insert on the base of the proximal phalanx of digit II.

M. anconeus has a typical origin from the humerus. The belly (39 mm. long) extends nearly the entire length of the ulna.

M. supinator has a typical origin from the humerus. The belly is short (about 18 mm.), extending less than half the length of the radius, on which bone it inserts.

M. extensor indicis longus is a long (26 mm.), thin muscle arising from the radius only. Its tendon inserts on the base of the distal phalanx of digit II.

M. flexor metacarpi brevis is absent bilaterally.

M. flexor carpi ulnaris brevis is a short muscle, with a belly 13 mm. long, arising from the ventral surface of the distal third of the ulna. The tendon has a typical insertion on the dorsal surface of the base of the carpometacarpus.

M. extensor pollicis longus is a well-developed muscle with two heads of origin; the over-all length of the belly is 34 mm. The smaller head (24 mm. long) arises from the middle half of the radius. The larger head (30 mm. long) arises from the ulna, beginning at the level of insertion of M. biceps brachii. The tendon inserts on the extensor process of the carpometacarpus deep to the tendon of M. extensor metacarpi radialis.

M. extensor pollicis brevis is a triangular muscle with two heads of origin and with a total length of about 6 mm. The larger head arises from the base of the carpometacarpus. The smaller head arises from the base of the extensor process and from the tendon of insertion of M. extensor pollicis longus.

M. abductor pollicis, with a single belly 6 mm. long, has a typical origin from the tendon of insertion of M. extensor metacarpi radialis. It inserts by fleshy fibers on the pollex.

M. adductor pollicis arises fleshily from the anterior surface of the carpometacarpus near the base of the extensor process. It inserts by fleshy fibers on the posterior face of the pollex.

M. flexor pollicis is a very small band, less than 1 mm. in width, which arises from the carpometacarpus; it inserts on the base of the pollex, posterior and adjacent to the insertion of M. abductor pollicis.

M. abductor indicis is a well-developed muscle, arising from an extensive area on the base of the carpometacarpus, both anterior and posterior to the pisiform process, and from nearly the entire length of the anterior surface of metacarpal II. The muscle inserts by a stout tendon on the anterior surface of the proximal phalanx of digit II.

M. flexor metacarpi posterior has a typical origin by a strong flat tendon from the distal end of the ulna. The well-developed belly inserts on the posterior surface of about the proximal half of metacarpal III, and it also sends fleshy fasciculi into the bases of the proximal five or six primaries.

M. flexor digiti III arises along a narrow line from most of the palmar surface of metacarpal III, beginning at the proximal limit of the intermetacarpal space, and from the posterior surface of that same bone distal to the insertion of M. flexor metacarpi posterior. The muscle inserts by a tendon on the base of digit III and by fleshy fibers on the entire anconal surface of that digit.

Mm. interossei dorsalis et palmaris have typical origins from the facing surfaces of metacarpals II and III. M. interosseus dorsalis inserts by a tendon on the base of the distal phalanx of digit II. M. interosseus palmaris inserts by a tendon a little beyond mid-length of the distal phalanx of digit II.

"Leg" Muscles of *Tauraco leucotis donaldsoni*

M. sartorius arises from the anterodorsal end of the ilium only, i.e., it has no origin from the neural spine of the last dorsal vertebra. It inserts on the anteromedial corner of the head of the tibiotarsus.

M. iliotibialis is a very extensive muscle, covering all other muscles on the lateral aspect of the thigh except for parts of Mm. sartorius and semitendinosus. The central part of the complex is aponeurotic in its distal three-fifths. The muscle arises from the anterior iliac process and from the entire length of the anterior and posterior iliac crests. Most of the origin is by an aponeurosis (including that from the anterior iliac process), but the origin posteriorly is by fleshy fibers. Anteriorly, the origin is inseparably fused with the origin of M. sartorius. Distally, the tendon contributes to the formation of the patellar ligament, inserts on the tibiotarsus, and fuses with the deep fascia of the crus, particularly that covering M. peroneus longus.

M. iliotrochantericus posterior is well developed and has a considerable bulk of its fibers arising dorsal to the acetabulum. The muscle arises from the anterior iliac process and from all of the anterior iliac fossa. It inserts on the femur by a strong flat tendon, beginning 1 mm. distal to the trochanter.

M. iliotrochantericus anterior also is well developed. It arises from the posterior surface of the anterior iliac process and from the ventrolateral edge of the ilium. It inserts by a strong tendon (2 mm. wide) on the lateral surface of the femur, beginning 7 mm. distal to the proximal end of that bone.

M. iliotrochantericus medius is absent bilaterally.

M. gluteus medius et minimus is conspicuously developed, especially the long tendon of insertion, which passes superficial to the tendon of M. iliotrochantericus posterior to insert on the posterolateral edge of the femur about 7 mm. from the proximal end of that bone between the areas of insertion of Mm. iliotrochantericus anterior and ischiofemoralis. The fleshy belly is 5 mm. long; it arises from the most posterior part of the anterior iliac crest.

M. femorotibialis externus arises by fleshy and semitendinous bands (especially distally) from most of the lateral surface of the femur. The origin begins just distal to the level of insertion of M. iliotrochantericus anterior.

M. femorotibialis medius arises by tendinous and fleshy fibers from the trochanteric ridge and the femoral shaft distal to it. The belly is fused with that of M. femorotibialis externus. Both muscles contribute to the patellar ligament; their configuration is like that illustrated for *Coua caerulea* (Berger, 1953*a*: Fig. 6).

M. femorotibialis internus is a long thin muscle that arises from the medial surface of the femur, beginning 14 mm. inferior to the neck of that bone; the belly increases in size distally. It inserts by a single tendon on the anteromedial surface of the head of the tibiotarsus.

M. biceps femoris arises by two heads which fuse at about mid-thigh level. The anterior head is somewhat larger; it arises by an aponeurosis from the caudal portion of the anterior iliac crest and by fleshy fibers from the anterior 3 mm. of the posterior iliac crest. The more rounded posterior head arises by tendinous and fleshy fibers from a pronounced tubercle on the lateral surface of the ilium about 3 mm. ventral to the projecting posterior iliac crest. The muscle inserts by a stout, rounded tendon on the fibula about 16 mm. inferior to the head of that bone.

M. ischiofemoralis has a typical origin from the lateral surface of the ischium, dorsal to the origins of Mm. semimembranosus and adductor longus et brevis. It inserts by a strong tendinous band (2.5 mm. wide) beginning 5 mm. inferior to the trochanter and immediately posterior to the insertion of M. gluteus medius et minimus.

M. piriformis.—Both parts of this complex are well developed. *Pars caudofemoralis* arises from the base of the pygostyle by a wide (8 mm.) tendinous band and by fleshy fibers from the superficial surface of this band. The maximum width of the belly, inferior to the posterior iliac crest, is 10 mm. *Pars iliofemoralis* arises by fleshy fibers from the lateral surface of the ilium, ventral to the origin of Mm. semitendinosus and biceps femoris. The belly passes downward and forward, superficial to pars caudofemoralis, to insert on the posterolateral edge of the femur for a distance of 7 mm., beginning 10 mm. inferior to the trochanter. Pars caudofemoralis inserts by a tendon-sheet (4.5 mm. wide), beginning 12 mm. inferior to the trochanter and immediately medial to and in contact with the insertion of pars iliofemoralis.

Mm. semitendinosus and *accessorius semitendinosi.*—The bulky semitendinosus muscle arises from the ventral surface of the projecting posterior iliac crest in its posterior 8 mm.; there is no origin from the free caudal vertebrae. The raphe which separates this muscle from the accessory semitendinosus muscle behind the knee broadens into a 2 mm.-wide tendon, which inserts on the medial surface of the tibiotarsus 2 mm. posterior to the insertion of M. semimembranosus. The accessorius muscle inserts by fleshy fibers on the posterolateral edge of the femur in its distal 13 mm.

M. semimembranosus arises by an aponeurosis (shared in part with M. adductor longus et brevis, pars externa) attached to the lateral surface of the ischium a few millimeters dorsal to the ischiopubic fenestra. Most of the thin sheetlike belly of the semimembranosus muscle is concealed by the overlying semitendinosus muscle. M. semimembranosus inserts along a curved line (6 mm. long) on the anteromedial edge of the tibiotarsus, beginning 7 mm. inferior to the proximal end of that bone.

M. iliacus.—I found no evidence of this muscle in either leg.

M. ambiens is a thin strap of muscle, 30 mm. in length; it has a maximum width of 5 mm. near its origin from the pectineal process. It arises mostly by fleshy fibers. The tendon of insertion, like that in *Coua caerulea*, enters the patellar ligament and passes diagonally downward and laterad around the front of the knee. Below the knee the tendon fans out into an aponeurosis which gives origin to parts of Mm. flexores perforati digiti II, III, and IV.

M. obturator internus is a well-developed triangular-shaped muscle arising from the medial surface of the ischium and pubis; it also has a large portion arising in the renal depression, as in *Coua* and several other unrelated birds. The large tendon passes out of the obturator foramen and inserts on the lateral surface of the femur, proximal to the insertion of M. ischiofemoralis and beginning about 3 mm. inferior to the trochanter. The tendon of M. gluteus medius et minimus passes superficial to the tendons of insertion of Mm. obturator internus and externus.

M. obturator externus is a small band of fleshy fibers arising from the dorsal margin of the obturator foramen. A flat tendon forms and fuses with the proximal side of the tendon of M. obturator internus.

M. adductor longus et brevis is composed of two distinct parts. *Pars externa* arises by an aponeurosis (8.5 mm. wide) from the lateral surface of the ischium, beginning about 2 mm. caudal to the obturator foramen and 4 mm. dorsal to the ischiopubic fenestra. Pars externa inserts on the femur medial to M. piriformis and beginning at the inferior limit of the tendon of pars caudofemoralis and extending distad about 23 mm. *Pars interna* arises by a dense aponeurosis 10 mm. wide, beginning at the posterior margin of the obturator foramen and passing caudad along the dorsal margin of the ischiopubic fenestra. Fleshy fibers form at once in the anterior fifth, but posteriorly the aponeurosis extends distad about 15 mm. before fleshy fibers arise. Pars interna inserts on the femur mostly by an aponeurosis (by fleshy fibers superiorly), medial to the insertion of pars externa and extending for a distance of 33 mm.

M. tibialis anterior, as in other birds, has both a femoral and a tibial head. The femoral head arises by a stout tendon from the anterodistal end of the external femoral condyle. The tibial head arises in common with, but deep to, M. peroneus longus. The two heads fuse about a third the way down the crus. The over-all length of the belly is 60 mm., and it extends distad as far as the ligamentum transversum. A very large tendon of insertion is formed; it passes deep to the ligamentum transversum and inserts 7 mm. inferior to the proximal end of the tarsometatarsus. Just before the area of insertion, the tendon gives off a fascial band that fuses with the fascia covering the muscles of the anterior surface of the tarsometatarsus.

M. extensor digitorum longus arises by fleshy fibers from the proximal third of the anterior surface of the tibiotarsus and from the inner and outer cnemial crests of that bone. The belly extends for a distance of 60 mm., but the muscle is very small in its distal half. The tendon passes deep to the ligamentum transversum and then under a bony bridge on the anterior surface of the tibiotarsus. Continuing distad, the tendon is held in place by a strong ligament (and not by a bony bridge) on the proximal end of the tarsometatarsus. The tendon trifurcates in the distal third of the tarsometatarsus to supply digits II, III, and IV. The tendon complex to digit III (the largest digit) is unusually well developed; the small single tendon to digit II exhibits the poorest development. Attachments of the tendons are made to each of the phalanges of the respective digits.

M. peroneus longus arises by semitendinous bands, in common with the underlying muscles, from the outer and inner cnemial crests and the rotular crest of the head of the tibiotarsus. The belly is about 50 mm. long, and, although it covers all of the other muscles on the anterolateral surface of the proximal five-sevenths of the crus, it is a relatively thin sheet of muscle which does not extend around to the medial surface of the crus (as this muscle does in *Coua*). The tendon bifurcates near the distal end of the tibiotarsus. The shorter of the two tendons inserts on the tibial cartilage and associated ligaments. The longer tendon passes downward to insert on the tendon of M. flexor perforatus digiti III a short distance inferior to the proximal end of the tarsometatarsus.

M. peroneus brevis arises from the fibula and the tibiotarsus for a distance of about 45 mm., beginning at the level of insertion of M. biceps femoris. It inserts on the posterolateral corner of the proximal end of the tarsometatarsus at the base of the hypotarsus.

M. gastrocnemius has the typical three heads. *Pars externa* arises primarily by a flat aponeurotic band fused to the lateral surface of the distal arm of the biceps loop. *Pars media* arises from the posterior surface of the distal end of the femur, immediately distal to the area of insertion of M. accessorius. *Pars interna* arises from the entire medial surface of the inner cnemial crest of the tibiotarsus and from the fascia covering the anterior and medial aspects of the knee joint, where this head has an intimate relationship to the fleshy insertion of M. sartorius. None of pars interna covers the anterior or lateral portion of the crus, as it does in *Coua caerulea.* Pars media and pars interna are separated by the tendon of insertion of M. semimembranosus. There is also a strong fascial band extending from M. semitendinosus to both pars media and pars interna. The very strong common tendon of M. gastrocnemius inserts on the back of the hypotarsus and the posterior ridges of the tarsometatarsus throughout most of its length.

M. plantaris has a typical origin from the proximal end of the tibiotarsus. The belly is about 18 mm. in length. The small tendon of insertion expands distally and inserts on most of the proximal end of the tibial cartilage.

M. popliteus is a reasonably well-developed muscle, about 3 mm. wide and 6 mm. long. Both the origin and the insertion are semitendinous. It arises from the head of the fibula. The fleshy fibers pass downward and mesiad to the insertion on the tibiotarsus.

M. flexor perforatus digiti II is a small muscle with a belly 35 mm. long but only 3 mm. wide. It arises from the continuation of the ambiens tendon and from the deep surface of M. flexor perforatus digiti III. The tendon passes through the deep aspect of the lateral side of the tibial cartilage. The tendon of insertion is perforated by both of the deep flexor tendons to digit II (flexor digitorum longus and flexor perforans et perforatus digiti II) and then inserts on both sides of the proximal phalanx of digit II.

M. flexor perforatus digiti III arises from the femur (in common with Mm. flexor perforatus digiti IV and flexor hallucis longus) and from a broad aponeurosis which is a continuation of the ambiens tendon. The belly is 50 mm. in length. The long tendon of

M. peroneus longus inserts on the tendon about 8 mm. inferior to the proximal end of the tarsometatarsus. Near the distal end of the tarsometatarsus, the tendon is united by a vinculum ("V") with the tendon of M. flexor perforans et perforatus digiti III, which lies deep to the tendon of M. flexor perforatus digiti III. The vinculum arises from the deep surface of the latter tendon and then passes deep to the subjacent tendon of flexor perforans et perforatus digiti III, so that the vinculum fuses with the deep side of the latter tendon. The very large tendon of insertion of M. flexor perforatus digiti III is perforated by both of the deep flexor tendons to digit III and then inserts on both sides of the proximal phalanx and on the base of the second phalanx of digit III.

M. flexor perforatus digiti IV arises from the femur (in common with Mm. flexor perforatus digiti III and flexor hallucis longus) and from the ambiens tendon. The belly is 40 mm. in length. At the base of digit IV, the tendon of flexor perforatus digiti IV expands into a large mass, which ensheathes the tendon to that digit of M. flexor digitorum longus. The tendon then sends slips to attach to the proximal ends of phalanges 2, 3, and 4 of digit IV.

M. flexor perforans et perforatus digiti II appears to arise exclusively from the lateral femorofibular ligament (i.e., there is no direct origin from bone), immediately distal to the attachment of the distal arm of the biceps loop. The belly is 22 mm. long. The tendon inserts on both sides (the medial slip being the stronger) of the bones at the interphalangeal joint between phalanges 1 and 2 of digit II.

M. flexor perforans et perforatus digiti III arises by fleshy and tendinous fibers from the outer cnemial crest, the third arm of the biceps loop, and from adjacent ligaments on the anterolateral aspect of the knee, including the patellar ligament. The belly is about 40 mm. long. The tendon perforates the tendon of M. flexor perforatus digiti III and is itself perforated by the tendon of M. flexor digitorum longus. It inserts on both sides of the distal end of phalanx 2, digit III.

M. flexor digitorum longus arises by two distinct heads from the proximal end of the tibiotarsus, most of M. popliteus being visible between the two heads. The belly (55 mm. long) extends to within 15 mm. of the distal end of the tibiotarsus, so that this muscle is very well developed as compared with M. flexor hallucis longus. The tendon of M. flexor digitorum longus is the only one that passes through a bony canal in the hypotarsus. Inferior to that process, the tendon of the flexor hallucis longus passes diagonally downward and superficial to the tendon. The two tendons are connected by a small vinculum in the distal fourth of the tarsometatarsus. The tendon of the flexor digitorum longus muscle trifurcates. The primary insertion of each branch is on the ungual phalanx of digits II, III, and IV. Vinculae pass from the deep surface of the tendons to other phalanges of these digits.

M. flexor hallucis longus is, compared with the flexor digitorum longus, a weakly-developed muscle with an over-all belly-length of about 30 mm. It arises by two distinct but short heads from the distal end of the femur; both heads lie medial to the tendon of M. biceps femoris. The more lateral (anterior of Hudson, 1937:49) and fleshy head arises from the posterior face of the external condyle. The larger medial head arises by tendinous fibers from the intercondyloid area of the femur; this origin is shared with Mm. flexores perforati digiti III and IV. The tendon of insertion *does not* pass through a bony canal in the hypotarsus, but passes along the lateral surface of that process, where it is held in place by a fascial band. The tendon inserts on the ungual phalanx of the hallux.

M. flexor hallucis brevis is a bulky muscle whose belly (15 mm. long) is limited to the proximal third of the tarsometatarsus. The tendon expands to ensheath the tendon of M.

flexor hallucis longus and then inserts on both sides of the base of the proximal phalanx of the hallux.

M. extensor hallucis longus arises by two heads, one on each side of the tendon of insertion of M. tibialis anterior. The medial head is the larger of the two. The origin begins at the proximal end of the tarsometatarsus. The over-all length of the belly is 15 mm. The tendon is held in place by fibrous bands at the distal end of the tarsometatarsus. The single tendon inserts on the base of the ungual phalanx of the hallux.

M. extensor proprius digiti III is a long, thin and weakly-developed muscle, whose belly begins at the proximal end of the tarsometatarsus between M. extensor brevis digiti IV and the tendon of M. tibialis anterior. The tendon forms at the junction of the proximal and middle thirds of the tarsometatarsus. Fleshy fibers insert on this tendon to the level of the trochlea for digit III, so that the over-all length of the fleshy belly is 35 mm. The tendon expands to insert on most of the dorsal surface of the proximal phalanx of digit III.

M. extensor brevis digiti IV is another long, thin muscle, whose origin begins at the proximal end of the tarsometatarsus and extends distad about 32 mm. The tendon passes around the trochlea for digit IV and inserts on the medial side of the base of the proximal phalanx of that digit.

M. abductor digiti II is a fairly stout muscle, 10 mm. long, which arises from the distal end of the tarsometatarsus. It inserts by a tendon on the dorsomedial corner of the base of the proximal phalanx of digit II. The tendon is visible throughout its course.

M. lumbricalis is vestigial. A few fleshy fibers (about 7 mm. in length) arise from the deep side of the tendon of M. flexor digitorum longus near the distal end of the tarsometatarsus.

M. abductor digiti IV has a small belly 10 mm. long, which is limited to the proximal end of the tarsometatarsus. The long tendon is held in place by a ligament at the distal end of that bone. The tendon inserts on the ventrolateral corner of the base of the proximal phalanx.

Comparative Myology

My reasoning in the analysis that follows may be clearer if prefaced by some general remarks. If we assume with Hudson (1937:77) that the generalized condition is represented in those birds that possess the full complement of formulae and other muscles (as in the Galliformes), it follows that the absence of muscles represents a specialized condition. We assume also that, by and large, closely related birds will have lost the same muscles, and that either the hypertrophy or the loss of leg muscles must in general be correlated with locomotor habits or feeding habits (as in the birds of prey, with their very large flexor digitorum longus and flexor hallucis longus muscles). Further, we recognize that the age of a genus (and/or its geographical isolation and related factors) may be such that differences in locomotor pattern within the genus may not yet be accompanied by extensive myological changes. Finally, we assume that what we refer to as a "vestigial muscle" is a muscle that is in the process of being lost phylogenetically, that the degree of degeneration of such a muscle may vary among individual specimens of a genus or a species, and that one might expect some individual variation in the presence or absence of such a vestigial muscle.

Lowe (1943:512–514) made a considerable issue out of the alleged difference in development of M. iliotibialis between *Tauraco corythaix* and *Cuculus canorus.* I have been puzzled by the fact that I could not in any sense corroborate Lowe's description and illustration of M. iliotibialis in *Cuculus.* Actually, there is little resemblance between Lowe's figure of this muscle in *Cuculus* and what I found in the specimens available for dissection. Except for the fact that the central portion of this muscle is not aponeurotic from origin to insertion, M. iliotibialis in *Cuculus* is very similar to that muscle in *Chrysococcyx* ("*Lampromorpha*") *caprius* (Berger, 1955*b*: Fig. 71), and it is almost identical to the muscle in *Ch. cupreus* (Fig. 1).

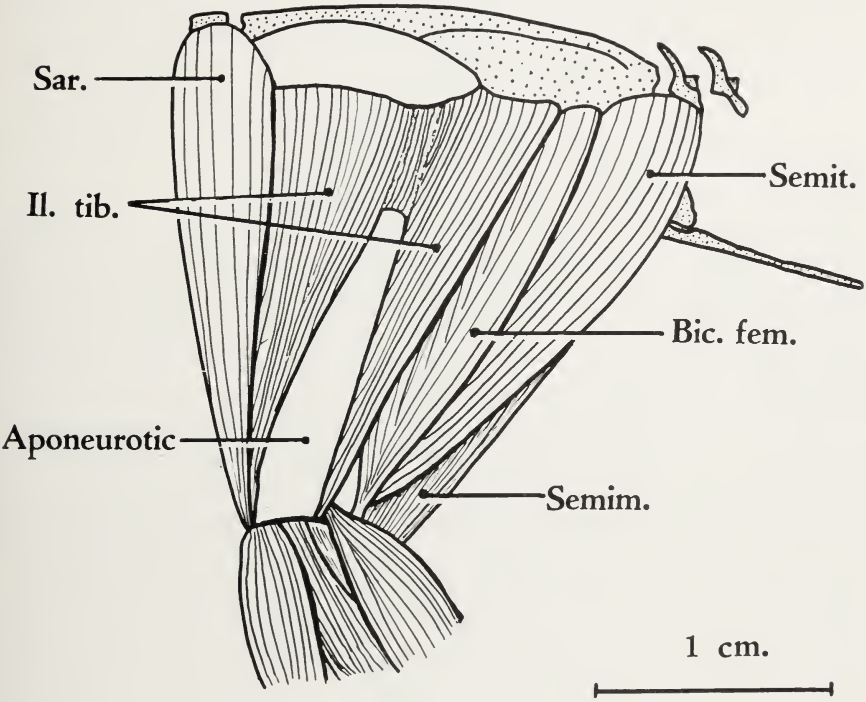

FIG. 1. Lateral view of thigh of *Chrysococcyx cupreus* to illustrate the relative weak development of M. iliotibialis. Bic. fem., biceps femoris; Il. tib., iliotibialis; Sar., sartorius; Semim., semimembranosus; Semit., semitendinosus.

In *Cuculus,* M. iliotibialis arises by fleshy fibers from the tip of the anterior iliac process and by an aponeurosis from the anterior iliac crest and the cephalic half of the posterior iliac crest. The caudal part of this aponeurosis overlies the origin of the anterior portion of M. biceps femoris (as in other cuculine genera), but the iliotibialis muscle has no direct attachment to the belly of the biceps muscle (as illustrated by Lowe). The posterior segment (the gluteus posterior of Gadow) of the iliotibialis muscle is poorly developed so that it does not conceal any part of Mm. semitendinosus or semimembranosus, and it conceals only a small proximal and anterior part of M. biceps femoris. The central portion of the iliotibialis muscle is aponeurotic in about its distal half, and few, if any, of the fleshy fibers of the relatively small anterior and posterior fleshy parts of the complex extend distad as far as the knee. Relative to other cuckoos, M. iliotibialis is poorly developed in *Cuculus* and in *Chrysococcyx*. In many cuckoos, however, the development of M. iliotibialis is equal to that found in *Tauraco*. Hence, this muscle does not offer any clues concerning the relationship between the touracos and the cuckoos. It might be well to add that, anatomically, *Cuculus* is perhaps the least "typical" genus of the family, and, therefore, that it is a poor genus to use as a basis for comparison with genera of other families. Although much information is needed on the habits of other parasitic cuckoos, it would appear that *Cuculus* is the most highly specialized genus in the family.

Hudson (1937:14) reported that among American genera of birds, M. iliacus is "present in all forms examined and is one of the most uniformly developed thigh muscles in birds." This muscle is present in some genera of cuckoos, absent in other (Old World) genera: *Carpococcyx, Centropus, Coua, Chrysococcyx,* and *Cuculus*. Moreover, I did not find this muscle in the specimen of *Tauraco leucotis* that I dissected.

M. iliacus is a small muscle at best (with a maximum width of about 1 mm. in most cuckoos examined), and it might easily be destroyed by shot or be torn away in dissecting. Except for *Carpococcyx*, however, I dissected two or more specimens of each of the other genera of cuckoos mentioned above and found no evidence of the muscle; it was absent in each of five species of *Coua*. Shot damage to both femora of the single specimen of *Dromococcyx* available for dissection made it impossible to determine whether or not M. iliacus is present in that genus. Because this muscle has been found in all other genera of American cuckoos examined, I assume tentatively that it is present in *Dromococcyx*. Relative to other muscles in the thigh, M. iliacus might well be considered vestigial or rudimentary (with a very weak action) in many birds. It is highly desirable for someone to conduct a study directed to determine whether or not the absence of this muscle within a genus or species is a matter of individual variation. Gadow and Selenka (1891:145) reported that M. iliacus was absent as an individual variation in *Bucorvus* and *Platycercus*.

Nevertheless, I have proposed (1959) that M. iliacus be included in leg-muscle formulae and that its presence be indicated by adding the letter "E" to such formulae. I would be among the first to agree that muscle formulae must be used with caution and that they often are misused. I think that this is especially the case when contemporary writers ignore data presented by Hudson and others and include only the symbols proposed many years ago by Garrod. Thus, if we use only Garrod's symbols, the muscle formula for *Tauraco leucotis* is ABXYAm; that for cuckoos is either ABXYAm or AXYAm. This is misleading because it does not tell the whole story; the myology of the hind limb is not that similar in the two groups of birds. This can be demonstrated by using Hudson's expanded muscle formula, with or without the addition of "E." The formula for *Tauraco* then becomes ABDXYAmV. For cuckoos the formulae are:

AXYAm—*Cuculus, Chrysococcyx*
AEXYAm—*Coccyzus, Piaya, Saurothera, Tapera, Clamator, Surniculus*
ABXYAm—*Coua, Carpococcyx, Centropus*
ABEXYAm—*Geococcyx, Morococcyx, Dromococcyx* (E?), *Crotophaga, Guira, Ceuthmochares, Phaenicophaeus*

It is my opinion that the presence of M. gluteus medius et minimus (D) and of the vinculum (V; between the tendons of Mm. flexor perforatus digiti III and flexor perforans et perforatus digiti III) in *Tauraco* and the absence of these structures in the cuckoos constitute a significant difference in their pelvic musculature. Another interesting difference is that in the cuckoos the two deep plantar tendons (the tendons of Mm. flexor digitorum longus and flexor hallucis longus) pass through separate bony canals in the hypotarsus, whereas in *Tauraco* there is a single bony canal that transmits only the tendon of M. flexor digitorum longus. M. flexor hallucis longus in *Tauraco* arises from the femur by two separate heads, both of which lie medial to the tendon of M. biceps femoris; in the cuckoos (but apparently not in *Centropus*) the muscle arises by a single head from the intercondyloid area of the femur.

Beddard (1898*a*:45) said that W. A. Forbes found the flexor hallucis longus muscle to be "totally absent" in *Centropus* (see also Verheyen, 1956*a*: 8), but I found it in both species examined. Beddard (1898*b*:276) further stated that the deep plantar tendons of *Centropus* are peculiar in that "no branch is sent to the hallux." and I found this to be true. M. flexor digitorum longus in *Centropus* is at least twice as bulky as M. flexor hallucis longus, although the latter muscle extends distad about half the length of the tibiotarsus. The tendons of both muscles pass through bony canals in the hypotarsus, below which the tendon of M. flexor hallucis longus fuses completely with the tendon of M. flexor digitorum longus. The resulting common tendon trifurcates to send branches to insert on digits II, III, and IV; *no branch is sent to the hallux*. There exists, however, a most unusual condition that I have not seen in any other genus. There is a very large automatic flexor of the hallux (Berger, 1953*a*:75). From its attachment to the trochlea and the fibrocartilaginous pulley for digit IV, the automatic flexor passes mesiad to the base of the hallux and then runs distad (held close to the bone by a vaginal sheath) to insert on the entire *plantar* surface of the base of the distal phalanx of the hallux. Consequently, the relationships of the automatic flexor to the phalanges in *Centropus* are identical to those of the flexor hallucis longus tendon when it is present as in the other cuckoos. The absence of the tendon of M. flexor hallucis longus to the hallux in *Centropus* is compensated for, in part, because M. extensor hallucis longus not only has a typical insertion on the dorsal surface of the distal phalanx but it also sends a strong slip to insert on the medial and plantar edge of the proximal phalanx of the hallux (for other examples of this double insertion, see Hudson, 1937:52).

The absence of pars iliofemoralis (B) of M. piriformis (=M. caudofemoralis) in some of the cuckoos raises interesting questions. The muscle is absent in the more arboreal members of the group; it is present in the more terrestrial members (but also in *Eudynamis*). In locomotor habits, *Guira* and *Crotophaga* are intermediate between the cursorial *Geococcyx* and the arboreal *Coccyzus*. Both *Guira* and *Crotophaga* possess the full cuculine complement of leg muscles, and they also share similar social nesting habits. In this instance, therefore, the similarity in development of leg muscles would seem to indicate closeness of relationship rather than locomotor pattern. I assume that the primitive cuckoos possessed both parts of the piriformis complex and that the loss of pars iliofemoralis in certain modern cuckoos is a secondary condition correlated with locomotor habits, in this instance with perching and arboreal habits (often also with parasitic breeding habits). One disadvantage of muscle formulae, however, is that they indicate nothing about the relative development of the muscles concerned. It is interesting to note, for example, that in *Ceuthmochares* (unlike any of the other genera possessing the muscle) pars iliofemoralis is vestigial; it is a minute band of fleshy fibers about 1 mm. in width. One might expect this muscle to be absent, either unilaterally or bilaterally, in some specimens of *Ceuthmochares*. As a possible similar example, I have pointed out elsewhere (1956:436) that pars caudofemoralis of the piriformis complex may be considered to be vestigial in the Sandhill Crane (*Grus canadensis tabida*), and Fisher and Goodman (1955:86) reported that pars caudofemoralis was absent in one of three specimens of the Whooping Crane (*G. americana*). In the cuckoos, pars caudofemoralis is relatively well developed in all species examined, although it is more strongly developed in the arboreal species. (For a discussion of the function of pars caudofemoralis, see Fisher, 1957.)

The relative development of Mm. peroneus longus and peroneus brevis in birds has been discussed by Mitchell and by Hudson (1937). Mitchell (1913: 1068) said: "I find it extremely difficult to associate the conditions of the peroneal muscles with differences in habit that point directly to functional adaptation," and that, with very few exceptions, "there is a close conformity between the condition of the peroneals and what appears to be the most securely founded systematic divisions. Birds seem to have this or that type of peroneal muscle, not because they are arboreal or terrestrial, swimmers or waders, scratchers, predatory or vegetarian, but because it is the type occurring in this or that systematic division."

One might agree in essence with such a generalization, but an analysis of these two muscles as found in the cuckoos may give one an insight into the difficulties involved as one attempts to determine which myological characters indicate closeness of relationship and which are a reflection of locomotor or other habits. These two factors are, of course, undoubtedly interrelated.

We may ignore for present purposes the fact that either of the peroneal muscles may be absent in a few non-cuculine genera. Among the cuckoos, then, we may say that M. peroneus longus exhibits its two extremes of development. At its highest degree of development, M. peroneus longus arises from the proximal end of the tibiotarsus, and its belly (or aponeurosis of origin) conceals all but the most distal parts of Mm. tibialis anterior and peroneus brevis (Berger, 1953*a*: Figs. 5, 8). This situation is found, in general, in terrestrial cuckoos (*Geococcyx, Morococcyx, Centropus, Carpococcyx, Coua, Crotophaga, Guira, Tapera,* and (?) *Dromococcyx*), but also in *Tauraco*. In a second group of primarily arboreal cuckoos, M. peroneus longus is a long, thin, and deeply situated muscle, concealing no part of M. tibialis anterior (Berger, 1952: Pl. II). This condition is found in *Coccyzus, Piaya, Saurothera, Ceuthmochares, Clamator, Chrysococcyx, Cuculus, Surniculus,* and *Phaenicophaeus*. With one exception (*Tapera*), the fully-developed peroneus longus muscle is found in those genera that possess both parts (AB) of M. piriformis. These genera either are essentially cursorial and terrestrial birds or they are well-defined genera whose distribution or breeding behavior appear to set them apart from the remaining cuckoos. Among the cuculine genera considered in this paper, we may conclude that the relative development of M. peroneus longus coincides reasonably well both with locomotor habits and with the two major subgroups of the family. The relative development of this muscle, however, is of no value in determining the relationship between the cuckoos and the touracos (as Lowe proposed, 1943:514).

The relative development of M. extensor proprius digiti III seems to be correlated with locomotor habits. In the more arboreal cuckoos (and in *Tauraco*) this muscle arises just distal (just proximal in *Tauraco*) to the insertion of M. tibialis anterior, and the belly extends to the distal end of the tarsometatarsus: *Coccyzus, Piaya, Saurothera, Crotophaga, Guira, Ceuthmochares, Surniculus, Clamator, Phaenicophaeus, Chrysococcyx, Cuculus.* In a second group, the entire muscle is limited to the distal half or less of the tarsometatarsus: *Geococcyx, Morococcyx, Dromococcyx, Tapera, Carpococcyx, Coua, Centropus.*

M. adductor digiti II is the smallest muscle of the pelvic limb in cuckoos. It seems proper to refer to it as a vestigial muscle in this group; it was, however, present (or absent) constantly in all specimens of the several genera examined. I did not find this muscle at all in *Cuculus, Chrysococcyx, Ceuthmochares, Surniculus, Phaenicophaeus, Centropus, Piaya,* or in *Tauraco.*

Certain tendon relationships in the foot appear to be correlated, in part, with zygodactylism, but there are curious exceptions. For example, the tendon of M. flexor perforatus digiti IV does not ensheathe the tendon of M. flexor digitorum longus in 16 of the genera studied, but it does ensheathe the longus tendon in *Dromococcyx* and in *Phaenicophaeus,* as well as in the semizygodactylous (see Moreau, 1938:666) *Tauraco. Phaenicophaeus* presents an intermediate condition in that about 95 per cent of the tendon inserts on the lateral side of the basal phalanx of digit IV, whereas the remainder of the tendon inserts on the medial side of the same phalanx. The tendon of M. flexor hallucis brevis forms a complete sheath around the tendon of M. flexor hallucis longus in all of the cuculine genera (as well as in *Tauraco* and many other birds) except *Centropus,* in which genus the flexor hallucis longus muscle does not insert on the hallux (see p. 73).

Another curious difference is found in the structure of M. femorotibialis internus in *Cuculus* and *Coua,* two distantly related cuckoos. In these two genera alone, M. femorotibialis internus has two independent heads, each of which inserts by its own tendon on the head of the tibiotarsus. The muscle is single in the other genera, including *Tauraco.*

Turning our attention now to the muscles of the wing, we find that Mm. tensores patagii longus et brevis in cuckoos (as in *Tauraco*) tend to be represented by a single muscle mass that gives rise to two tendons distally. There is a single fleshy origin from the dorsomedial surface of the furculum, also from the adjacent acromion of the scapula in some genera. In *Chrysococcyx* two bellies are discrete distally but the complex does not differ significantly from that in other cuckoos. The primary insertion of M. tensor patagii brevis in all cuculine genera (despite Lowe's statement and illustration) is on the tendinous surface of M. extensor metacarpi radialis, and part of the brevis tendon fans out posteriorly over the forearm muscles to fuse with the antebrachial fascia; the pattern is the same in *Tauraco* (see page 63, and Garrod, 1881, Pl. 22). There are secondary attachments of the brevis tendon-complex as follows: (1) to the lateral supracondylar ridge of the humerus—

Geococcyx; (2) to the lateral epicondyle (ectepicondylar process) of the humerus, superficial or proximal to the origin of M. extensor metacarpi radialis—*Coccyzus*; (3) to the tendon of origin of M. extensor digitorum communis—*Coccyzus, Morococcyx, Dromococcyx, Tapera, Chrysococcyx.* One must conclude that these secondary attachments are not important taxonomically.

M. expansor secundariorum has both a humeral and a scapular tendon of origin in all of the cuckoos. At the elbow there may be two independent bellies (as in *Coua, Geococcyx, Guira,* etc.) or a single muscle mass with two fleshy tongues directed proximally (as in *Crotophaga, Dromococcyx, Surniculus, Phaenicophaeus*) to the two primary (humeral and scapular) tendons of origin. This muscle is similar in *Tauraco,* but the axillary tendon bifurcates, the two resulting branches attaching respectively on the scapula and on the coracoid, i.e., the pattern of attachment is "ciconine" rather than "cuculine" (Garrod, Beddard). It seems likely that this is a significant difference between *Tauraco* and the cuckoos.

M. flexor metacarpi brevis is a small muscle, arising from the base of the carpometacarpus or from the os radiale and associated ligaments, and inserting on the tendon of insertion of M. extensor indicis longus. M. flexor metacarpi brevis is absent in *Coua, Carpococcyx, Geococcyx,* and *Morococcyx* (as well as in *Tauraco*); it is present in all other cuckoos examined. It should be noted that this muscle is present in all parasitic cuckoos and in all of those that lack pars iliofemoralis of the piriformis muscle. It is present also in *Crotophaga, Guira,* and in *Ceuthmochares* (in which genus pars iliofemoralis is vestigial); it is present but very much reduced in size in *Phaenicophaeus.*

Only in *Geococcyx, Morococcyx,* and *Coua* is M. coracobrachialis anterior a very large muscle, extending upward around the anterior edge of the humerus and to the dorsal surface of that bone. In the other genera, M. coracobrachialis anterior is a small muscle on the ventral surface of the humerus where it is closely applied to the capsule of the shoulder joint.

M. pectoralis propatagialis longus et brevis may be entirely tendinous (*Morococcyx, Dromococcyx, Tapera, Guira, Ceuthmochares, Centropus, Cuculus, Piaya*), or it may arise from M. pectoralis as a fleshy bundle (*Geococcyx, Crotophaga, Coccyzus, Saurothera, Coua, Carpococcyx, Clamator, Chrysococcyx, Surniculus, Phaenicophaeus*).

M. deltoideus minor apparently is absent only in *Coccyzus* and *Centropus.*

Three patterns in the relative development of Mm. pronator superficialis and pronator profundus are seen in the cuckoos: (1) the two muscles are about equal in length and both are relatively short—*Coccyzus, Dromococcyx, Chrysococcyx, Surniculus*; (2) they are about the same length and they extend nearly to the distal end of the radius—*Morococcyx, Guira. Centropus, Ceuth-*

mochares, Phaenicophaeus; (3) the profundus is longer than the superficialis —*Coua, Geococcyx, Crotophaga, Tapera, Piaya, Saurothera, Carpococcyx, Clamator, Cuculus.*

Cuculus and *Chrysococcyx* appear to differ from all other genera in that they possess an accessory flexor muscle of the pollex, which arises from the tendon of insertion of M. tensor patagii longus (Berger, 1955*b*: Fig. 70). In these two genera and in *Surniculus* and *Phaenicophaeus*, M. flexor digitorum profundus arises on both sides of the insertion of M. brachialis, rather than only posterior to it as in the other cuckoos.

The relative development of M. flexor carpi ulnaris brevis appears to be correlated with locomotor habits. The muscle is very short in *Geococcyx, Morococcyx, Dromococcyx, Tapera, Crotophaga, Coua, Carpococcyx, Centropus, Phaenicophaeus,* and *Ceuthmochares.* It is relatively long in *Coccyzus, Piaya, Saurothera, Guira, Clamator, Cuculus, Chrysococcyx,* and *Surniculus.*

Throughout the discussion above, I have used qualifying terms (e.g., primarily, in general, more arboreal) when referring to cuckoos as being arboreal or terrestrial. A review of the general habits and the myology of the couas may be instructive in this regard. The genus *Coua* contains a well-defined group of cuckoos that is restricted to Madagascar. Several years ago I (1953*a*: 53–54) quoted from a letter that Dr. A. L. Rand had written to me about this genus. He wrote, in part: "The three arboreal species *caerulea, cristata,* and *verreauxi* are geographical replacements. The terrestrial rain-forest species, *reynaudii* and *serriana*, have different food, one insects, one fallen fruit. In the dry forests and brush are four species, one rather wide-spread (*ruficeps*), but the other three are more restricted. *C. coquereli* and *cursor* are geographical representatives, and the much larger *C. gigas* co-exists with *C. coquereli* but overlaps the range of *C. cursor.*

"The group is, to my mind, a terrestrial type. The terrestrial species are at home, agile and graceful on the ground, swift of foot, and may prefer to escape danger on foot rather than by flying or seeking concealment. The arboreal species, and this includes *C. caerulea*, have carried over as much of this as possible into their arboreal life.

"The various modifications in range, habitat, and habits seem to be the result of an intra-group pressure and competition with little competition, in island isolation, from other groups. They have modified these without modification in structure. Thus, to use *C. caerulea* as an example of an arboreal cuckoo is a mistake. It is a terrestrial type that has taken to living in trees! Hence, its resemblance in leg proportions to *Geococcyx* is what I would expect."

Dr. Reynaud Paulian wrote (letter, January 16, 1956) that "*Coua ruficeps* walks along branches, just as the African *Musophaga* do, moving one leg after the other in alternating movements. Only when excited will it run by a series of sharp jumps on the ground. The *Coua* walks along the ground if not afraid, but it will take to the jumping run if at all disturbed."

In view of these statements made by two men who have observed the couas in the field, it is interesting to report that I found only one difference (not correlated to size difference) in the myology of five species of *Coua*, and there is a possibility of individual variation in this feature. In *C. serriana* and *C. reynaudii*, M. extensor pollicis brevis arises by two separate heads: one from the tendon of insertion of M. extensor pollicis longus; the other, from the base of the carpometacarpus adjacent to the insertion of the tendon of M. flexor carpi ulnaris brevis. M. extensor pollicis brevis has a single head in *caerulea*, *cristata*, and *ruficeps*. The remaining wing muscles and the leg muscles exhibit an identical pattern of development in the five species. We can, indeed, agree with Dr. Rand that the couas have modified their habits without extensive modification in myology. This suggests that myological data can be used with some degree of confidence for determining closeness of relationship, providing, of course, that other factors are taken into consideration. One does not find, however, a similar uniformity in the relative lengths of the bones of the appendages within the genus *Coua*. Milne-Edwards and Grandidier (1879: 170) commented on differences in development of the leg in various species of this genus. The following is a free translation of a portion of their comments: One does not perceive any relation between the habits of the birds and the dimensions of the tarsus; thus, the tarsi are long in *Coua caerulea*, which is arboreal, and in *C. gigas* and *C. ruficeps*, which are terrestrial; they are, on the contrary, short in *C. reynaudii* and in *C. cursor*, whose habits are very different, the first being a climber, and the second a runner. The chief difference in the leg muscles of the couas is in the increased length of the tendons in the long-legged forms.

Another example of difference in habit without elaborate modification in myology may be provided by the genera *Geococcyx* and *Morococcyx*. These two presumably closely related genera exhibit essentially an identical pattern in the myology of both limbs. The well-known Roadrunner (*Geococcyx*) is a terrestrial bird that has a running speed estimated at 10 to 15 mph. *Morococcyx* also is a "Ground-Cuckoo," but little seems to be known about its life history or habits. However, Dr. Ernest P. Edwards wrote (letter, January 23, 1953) that *Morococcyx* "*walks* along branches somewhat as a dove would walk along them." Perhaps *Morococcyx*, also, is a ground-cuckoo that has taken to living in trees.

A number of other cuckoos are intermediate in locomotor habits. For example, Delacour (1947:120) characterized the species of *Phaenicophaeus* (in which genus he included all the species of nine of Peters' genera) as being poor fliers, living among vines and bushes.

The correct interpretation of differences in myology within the family Cuculidae is complicated because some genera are parasitic and others are not. If one attempts to use myological formulae as well as breeding behavior in determining relationships among cuckoos, one is confronted with some puzzling situations, even if one excludes "E" from the muscle formulae. Among New World cuckoos, for example, *Tapera* is known to be parasitic, and the meager information available indicates that *Dromococcyx*, also, is parasitic (Giai, 1949; Neunteufel, 1951). *Tapera*, like all of the Old World parasitic cuckoos except *Eudynamis* and *Scythrops*, lacks pars iliofemoralis of the piriformis muscle, whereas *Dromococcyx*, *Eudynamis*, and *Scythrops* are, apparently, the only parasitic cuckoos that have what is traditionally considered the full cuculine muscle formula of ABXYAm. Hence, it would appear that one must discount either myological data or breeding behavior in deciding the relationships among the cuckoos. It must be emphasized, however, that we are handicapped seriously because so little is known about the life histories of the Neotropical (as well as many other) cuckoos.

Friedmann (1933) suggested that the parasitic habit is "of great antiquity" in the cuckoos and that *Tapera* developed its parasitism independently of the Old World cuckoos. I would suggest that the parasitic habit did not develop independently in *Tapera* and *Dromococcyx* but that "the ancestral Cuculine stock that reached the Americas brought with it a tendency towards parasitism (if not an actually developed parasitic habit) which has fructified in *Tapera*" (Friedmann, 1933:533) and in *Dromococcyx*. There are parasitic cuckoos in both hemispheres that possess the two basic types of cuculine muscle formulae: (1) AXYAm: Old World—*Cuculus*, *Chrysococcyx*, *Clamator*, *Surniculus*, etc.; New World—*Tapera*. (2) ABXYAm: Old World—*Eudynamis*, *Scythrops*; New World—*Dromococcyx*. Thus, if we are to place any value on morphological characters, we must assume either that parasitism has developed independently as many as four times in this one family (which seems highly unlikely) or that the parasitic habit (or tendency for it) developed in the primitive cuckoos (all ABXYAm) while still in the Old World ancestral home of the family.

COMPARATIVE OSTEOLOGY

Moreau recently called attention to the considerable difference of opinion expressed by the several classifications of the touracos that have been proposed during the past 34 years. I am in no sense prepared to comment on the classification of the touracos, but I can add some pertinent remarks on the osteology of the group. Several years ago, I examined the skeletons of 14 touracos, representing four of Moreau's (1958:75) five genera and eight of his

18 species: *Corythaeola cristata*; *Crinifer piscator*; *Corythaixoides concolor* and *personata*; *Tauraco corythaix* (including *persa* and *persa buffoni*), *macrorhynchus*, and *leucotis donaldsoni*.

Verheyen (1956*a*, 1956*b*) analyzed the skeletons of touracos and cuckoos in some detail, and from this and other information taken from the literature proposed systems of classification for both the touracos and the cuckoos. With regard to the touracos, Moreau (1958:77) commented: "I understand from Verheyen (*in litt.*) that his sub-families are not based on osteological characters except for the Corytheolinae (which have 20 pre-synsacrals and five dorso-sacra, compared with nineteen and four respectively in all the other Musophagidae). The separation of *Corytheola* in this way might perhaps be justifiable, but the allocation of the remaining Musophagidae into three subfamilies can hardly be accepted."

The separation of *Corythaeola* from the other musophagids on the basis of the number of cervical or presynsacral vertebrae is not justifiable. I studied two skeletons of *Corythaeola cristata*: one had 14 cervical and 5 dorsal vertebrae, or 19 presynsacral vertebrae as in the other musophagids; the other specimen had 15 cervical and 5 dorsal vertebrae, or 20 presynsacrals, as in the single specimen examined by Verheyen. This is surely another example of individual variation in the number of cervical vertebrae within a species; in my opinion, it has no taxonomic significance. I had for study only one specimen of *Corythaixoides* (= *Gymnoschizorhis*) *personata*, but it, too, had 20 presynsacral vertebrae. Each of two specimens of *Tauraco corythaix persa* (see Moreau, 1958) had 14 cervical vertebrae, but one had 5 dorsal vertebrae, the other only 4. Hence, one specimen had the typical musophagid number of 19 presynsacral vertebrae, whereas the other had only 18. Despite these few examples of individual variation, it seems likely that the typical number of presynsacral vertebrae in the musophagids is 19: 14 cervical and 5 dorsal vertebrae.

Among the specimens studied by Verheyen, the number of free caudal vertebrae varied from 6 to 8; among my specimens, from 5 to 7.

The number of ribs that articulate directly with the sternum varies, among the several genera and within a species, from 3 to 5, with 4 being the usual number. In one specimen of *Corythaixoides concolor*, five ribs articulated with the sternum on the right side, but only four did so on the left.

If we now turn our attention to the Cuculidae, we find that the typical number of presynsacral vertebrae in most genera is 18: 14 cervical and 4 dorsal vertebrae. However, I found that each of 30 specimens of the genus *Coccyzus* had only 13 cervical and 4 dorsal vertebrae, or a total of 17 presynsacral vertebrae; one additional specimen had 14 cervical and 4 dorsal vertebrae. According to Shufeldt, *Clamator glandarius* has only 13 cervical vertebrae; Verheyen (1956*a*:17) indicated that he examined four specimens of *C. levaillantii* and found 13 cervical vertebrae in this species; I found 13 cervical vertebrae in my single specimen of *C. jacobinus*. Apparently there are no reliable published data to indicate that any other cuculine genus has 13 cervical vertebrae. Fürbringer (1888:779), for example, is in error when he lists 13 cervical vertebrae for *Crotophaga*, except, of course, as a matter of individual variation; the genus typically has 14 cervical vertebrae. However, I found only 13 cervical and 4 dorsal vertebrae in single specimens of *Piaya* and *Saurothera*. One specimen of *Guira* had 14 cervical and 4 dorsal vertebrae, whereas a second specimen had 13 cervical and 5 dorsal vertebrae, certainly an abnormal number for cuckoos. The number of cervical and dorsal vertebrae within a genus appears to be relatively constant in the cuckoos (Berger, 1956:437), and it seems likely that the usual pattern in *Guira* is 14 cervical and 4 dorsal vertebrae. The osteology of only one genus (*Coccyzus*) can be considered to have been studied in sufficient numbers to justify much confidence in numerical data, however, so that much additional information is needed on the osteology of the cuckoos before the full significance of the data can be appreciated. Nevertheless, it is interesting to note that, apparently, *Coccyzus*, *Piaya*, *Saurothera*, and *Clamator*, each have 13 cervical vertebrae, and each genus has the same muscle formula of AEXYAm.

In my single specimen of *Carpococcyx* (United States National Museum No. 223,970), there were 15 cervical and only 3 dorsal vertebrae. There was, however, a well-developed thoracic rib (which, by definition, articulates dorsally with the synsacrum and not with a dorsal vertebra), and this rib had a direct articulation with the sternum, so that 4 ribs (3 true ribs and 1 thoracic rib) articulated with the sternum bilaterally. This represents a very unusual condition, at least among cuckoos. I suspect that it is an anomaly in this one specimen, and that *Carpococcyx*, like most other cuckoos, typically has 14 cervical and 4 dorsal vertebrae.

We may summarize some of the pertinent differences in the osteology of the two groups of birds. Touracos typically have 19 presynsacral vertebrae; most cuckoos have 18 presynsacral vertebrae, but a few have only 17. Touracos have a notched atlas; cuckoos, a perforated atlas. Touracos have a single bony canal in the hypotarsus; cuckoos have two bony canals. The sternum is double-notched in the touracos; the sternum is either single-notched or double-notched in cuckoos, sometimes (in older individuals?) it is merely fenestrate. In the touracos (all?) the clavicles are not fused ventrally to form a furcula, but the inferior ends are united by a ligament; a furcula is present in the cuckoos. As pointed out by Pycraft (1903:279) and Verheyen (1956*a*), the two dorsal processes of the coracoid are fused to form a bony canal in the touracos; the two processes do not fuse in the cuckoos. In the touracos, the tendon of M. supracoracoideus passes through the canal in the coracoid and then through the foramen triosseum, which is bounded only by coracoid and scapula. Lowe (1943) described and illustrated differences in the structure of the ectethmoid plate and the lacrimal bone between *Tauraco* and *Cuculus*. Some cuckoos (e.g., *Centropus*) are somewhat intermediate between *Cuculus* and *Tauraco* in the development of these characters, but the over-all pattern probably is distinctive for the two families (Fig. 2).

Fig. 2. Lateral view of part of skull of *Crinifer piscator* to emphasize the lacrimal bone.

Comparative Pterylosis

Forbes (1885:212) remarked that the pterylosis of the Musophagidae "is peculiar, and gives no aid in determining their affinities." Nitzsch (1867: Pl. 6) illustrated the dorsal and ventral feather tracts of *Tauraco erythrolophus* ("*Musophaga paulina*"), and Lowe (1943) illustrated these tracts for *Musophaga violacea*. I found the feather tracts of *Tauraco leucotis donaldsoni* to be essentially the same as those shown in Lowe's figures.

Beddard (1885 and later) placed considerable emphasis on the value of the ventral feather tracts in determining relationships among the cuckoos, but the entire matter is in need of a thorough re-investigation. I have pointed out elsewhere (1953*a*, 1955*b*) that two of Beddard's assumptions were wrong. It has been demonstrated, however, that there are several patterns of feather tracts among the Cuculidae. In one group (*Cuculus*, *Cacomantis*, *Surniculus*, *Ceuthmochares*, *Clamator*, *Piaya*, *Coccyzus*, *Saurothera*) there is a single ventral abdominal tract on each side. In a second group (*Chrysococcyx*, *Scythrops*, *Carpococcyx*, *Centropus*, *Eudynamis*, *Phaenicophaeus*, *Geococcyx*, *Crotophaga*, *Guira*, *Morococcyx*), the ventral abdominal tracts are paired bilaterally. Furthermore, the ventral cervical tract may bifurcate in the region of the chin (*Piaya*, *Saurothera*, *Coccyzus*, *Phaenicophaeus*), about midway down the neck (*Cuculus*, *Clamator*, *Tapera*, *Crotophaga*, *Guira*, *Carpococcyx*, *Geococcyx*, *Morococcyx*), or at the base of the neck (*Centropus*, *Ceuthmochares*, and probably *Surniculus*). Beddard (1898*b*:280) separated certain Old World cuckoos from certain New World cuckoos because the ventral cervical tract in the New World cuckoos is "double at [its] commencement." This latter group is the one for which I have stated that the ventral cervical tract bifurcates in the region of the chin. There is some minor variation in these tracts among the four genera that I have listed above, and this character is perhaps most striking in the Old World genus *Phaenicophaeus*. In *Phaenicophaeus* there are two interramal feather tracts, separated by a median apterium, and each tract is bounded laterally by a pronounced marginal apterium.

Similarly, there are differences in the pattern of the dorsal feather tracts. In *Cuculus canorus*, for example, the dorsal cervical tract is continuous with the interscapular tract, and there is a large median apterium in the latter tract (Lowe, 1943: Fig. 6). In *Coua*, *Geococcyx*, *Morococcyx*, *Carpococcyx*, *Guira*, and *Centropus*, however, the dorsal cervical tract ends abruptly at the base of the neck, and the interscapular tract begins as two independent, anteriorly-directed tracts, which fuse posteriorly to form a single median pelvic tract. There are some differences among these genera and it seems pertinent to describe both the dorsal and ventral tracts of *Carpococcyx*. I have already described these tracts in *Coua caerulea* and *C. ruficeps* (1953*b*, 1954); Shufeldt (1886) illustrated the pterylosis of *Geococcyx*; and Beddard (1885) illustrated feather tracts of *Centropus*, *Eudynamis*, *Piaya*, and *Cacomantis*. Shelford (1900) described and illustrated the pterylosis of the embryo and nestling of *Centropus sinensis*, and Hartley (in Beebe *et al.*, 1917) illustrated the feather tracts in both the embryo and adult of *Crotophaga ani*.

A median frontal apterium is wanting and the feathers of the capital feather tract are a little more sparse in *Carpococcyx radiceus* than they are in *Coua*. A large lateral apterium surrounds the orbit. The spinal cervical tract ends abruptly at the junction of the neck and thorax, and there is a relatively wide

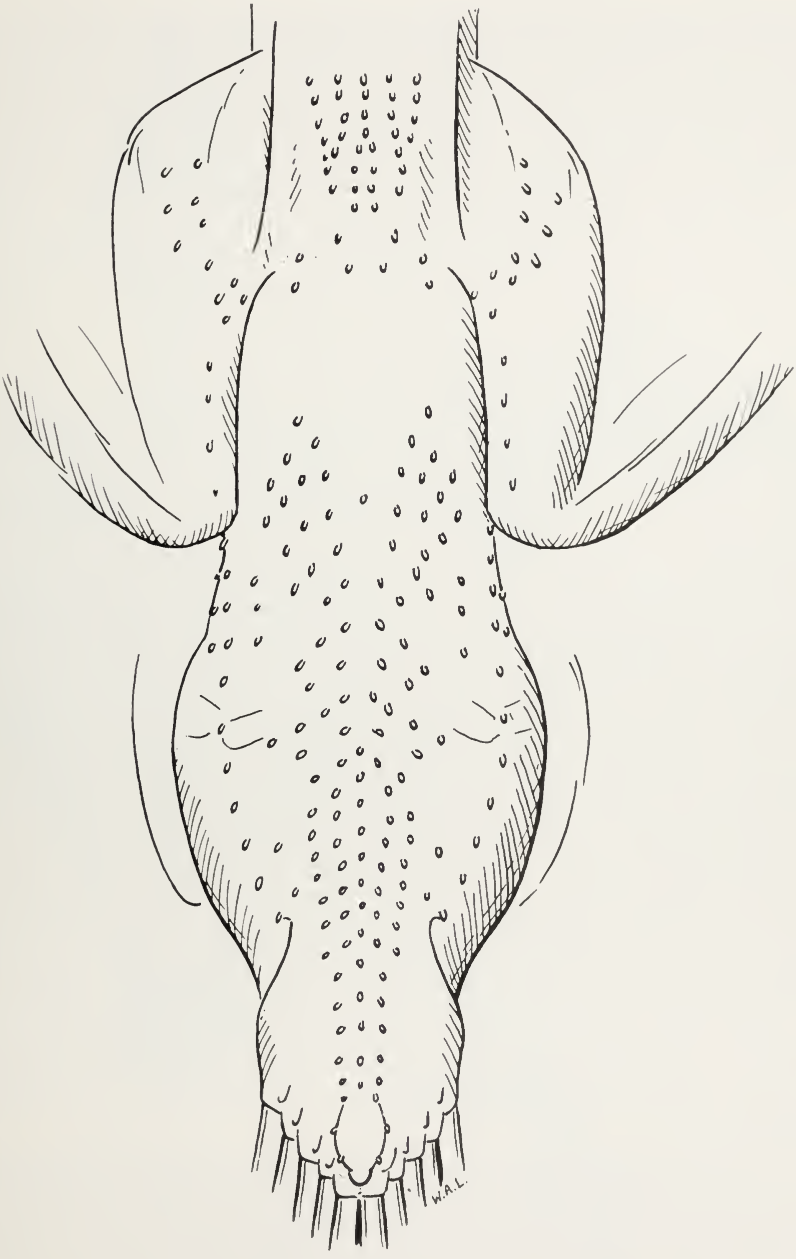

FIG. 3. Dorsal feather tracts of *Carpococcyx radiceus.*

(20 mm.) apterium between this tract and the interscapular tracts. These tracts (Fig. 3) differ from those found in other cuckoos thus far studied, as pointed out by Beddard (1901:201) but not precisely in the way that he stated. There does appear to be a short, narrow, V-shaped median apterium between the two interscapular tracts anteriorly, although in shape and extent it is unlike that in *Coua* (Fig. 4). The two interscapular tracts are continuous posteriorly with the dorsal spinal tracts, which join to form a single, median pelvic tract. In addition, lateral dorsal tracts, essentially single-rowed, pass caudally from the anterolateral edge of the dorsal spinal tracts to the area over the posterior iliac crests. There is an almost featherless area between these bilateral tracts and the median pelvic tract.

Turning now to the ventral feather tracts of *Carpococcyx*, we note first that the marginal apteria are very small, if present at all (an incision had been made along the mandible, thus making this determination somewhat unreliable). The presence or absence of the marginal apteria on either side of the interramal feather tract was one of the diagnostic features used by Beddard (1898*b*:281): (1) ventral tract occupying the entire space between the mandibles; or (2) ventral tract occupying only the median region between the mandibles, that is, the interramal tract is bounded by marginal apteria. Judging from what I have seen to date, I would say that Beddard's criteria for separating the Old World *Centropus* (= "*Pyrrhocentor*") and *Coua* from the New World *Geococcyx*, *Crotophaga*, and *Guira* are untenable. The pattern in *Cuculus* certainly is not precisely like that illustrated by Lowe (1943) in that there are definite small apteria on either side of the interramal tract; nor, in this character, is there such a close similarity between *Cuculus* and *Musophaga* as Lowe illustrated. The marginal apteria in *Centropus* are like those in *Coua caerulea* and *C. ruficeps*. It seems to me that we are dealing here with the degree to which the marginal apteria are developed. The narrowest interramal tract, and therefore the widest marginal apteria, seems to be found in *Crotophaga*. Thus between *Crotophaga* and *Cuculus* or *Centropus* there is a marked difference in the development of the marginal apteria, but *Tapera* (Figs. 5 and 6), *Guira*, *Geococcyx*, and *Morococcyx* are intermediate between the two extremes, And, as pointed out above, *Phaenicophaeus* and certain other genera have two interramal tracts, each of which is bounded laterally by a marginal apterium.

The ventral cervical tract of *Carpococcyx* bifurcates at about the midlength of the neck. Opposite the head of the furcula, two rows of feathers pass dorsocaudad to join the humeral feather tract. The ventral tract bifurcates at about the level of the anterior end of the sternum, forming an inner and an outer ventral abdominal tract bilaterally. The inner tract is composed of a double row of feathers anteriorly, but of a single row in the posterior half of

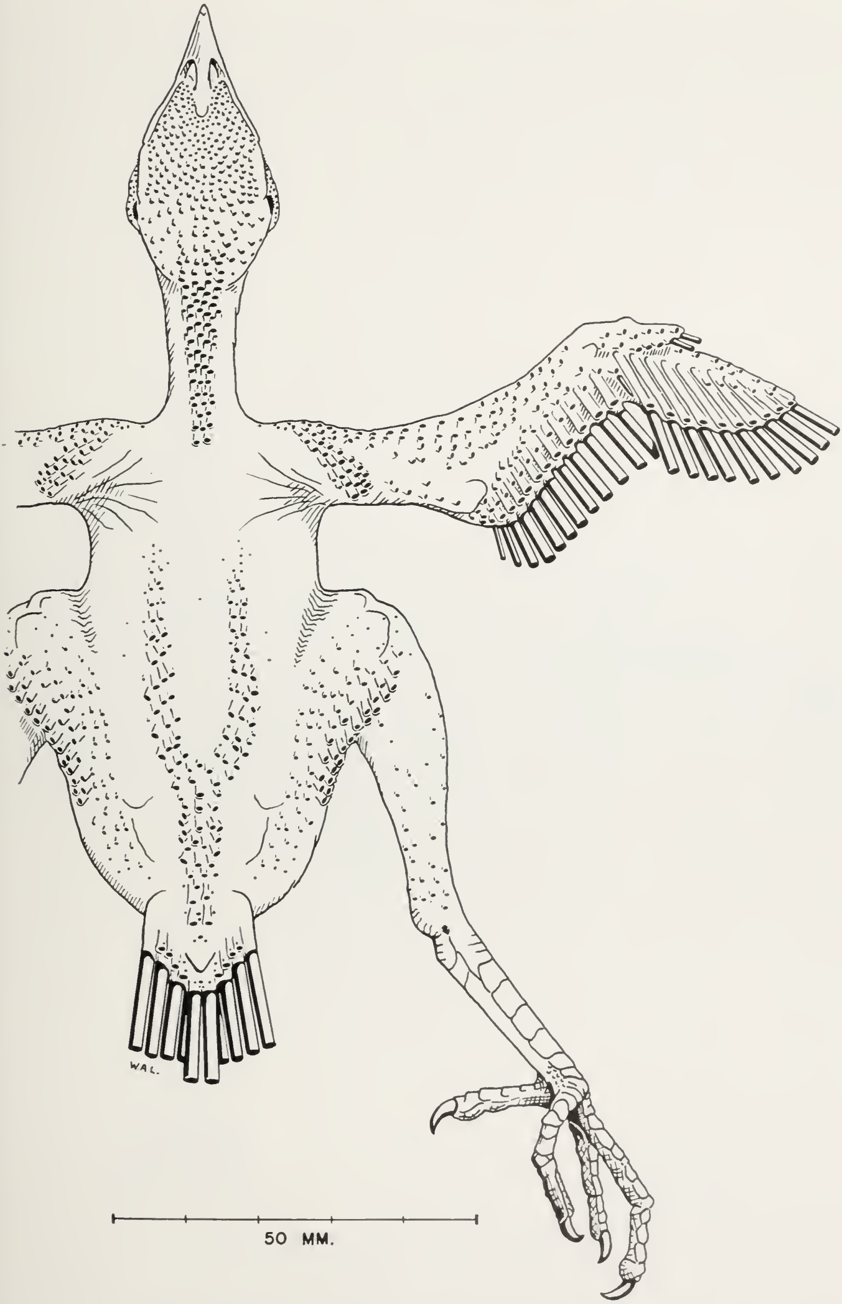

FIG. 4. Dorsal feather tracts of nestling *Coua ruficeps.*

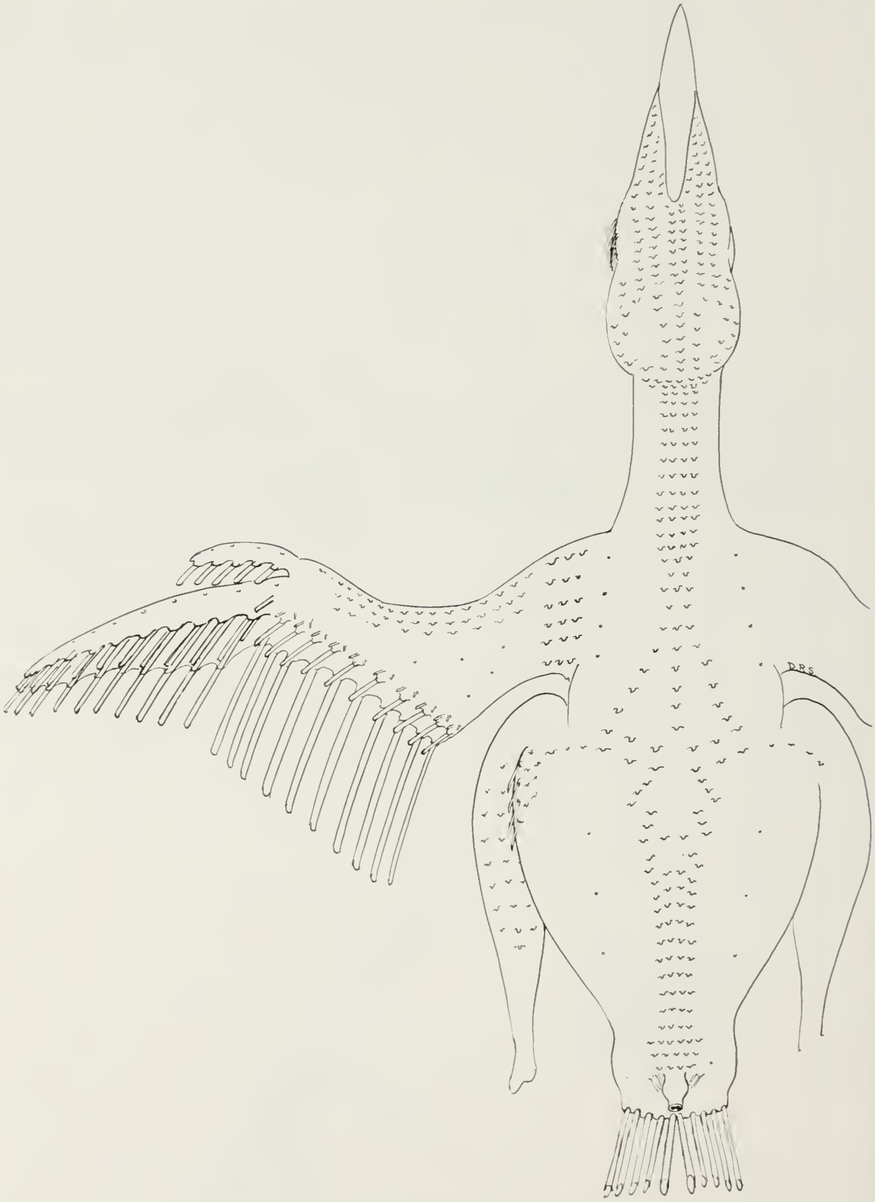

FIG. 5. Dorsal feather tracts of *Tapera naevia*.

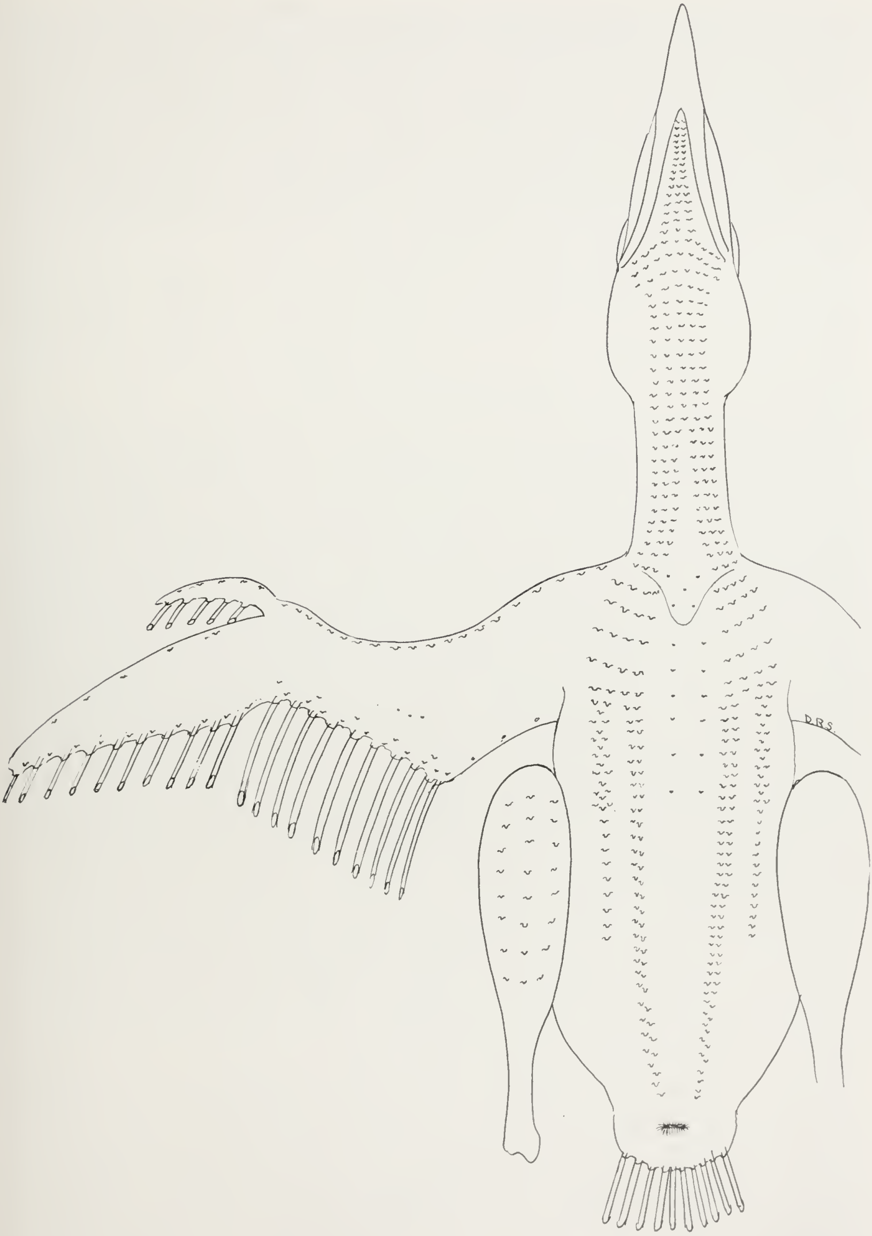

Fig. 6. Ventral feather tracts of *Tapera naevia*.

its extent; this tract terminates a short distance (about 6 mm.) in front, and a little anterolateral, of the vent. The outer abdominal tract anteriorly is composed of three rows of four feathers each, but throughout most of its extent it is composed of a single row of feathers. This row ends about midway between the posterior margin of the sternum and the vent; it does not turn inward to meet the inner abdominal tract. From the lateral margin of the anterior part of the outer abdominal tract, a single row of feathers passes dorsolaterad to the posteoventral surface of the arm (humerus).

There are 10 primaries in *Carpococcyx*. The wing is eutaxic. There are apparently 11 secondaries; the outer eight have large quills, whereas the inner three are progressively smaller and are more like coverts in size, but they are in direct line with the outer secondaries. Beddard considered only the distal eight feathers to be secondaries. There are five alula quills; the molt was in progress when the specimen was collected so that it was not possible to determine the relative lengths of the alula feathers. A relatively well-developed (40 mm. long) carpal remex was found bilaterally, but no evidence of the carpal covert. There are 10 rectrices and 10 upper tail coverts. The femoral tract laterally is developed as in *Coua ruficeps*; medially, the thigh is almost devoid of feathers. The crural tract is best developed anteriorly, where there is a triple row of feathers proximally (somewhat irregular in pattern) and a single row distally; there are three rows of widely-spaced feathers on the lateral side of the crus; medially, there are a few scattered feathers; and posteriorly, there is a single row of small feathers. The crural tracts do not extend downward on to the tarsometatarsus, as they do in *Cuculus*, *Chrysococcyx*, and *Clamator*. Sharpe (1873:579) spoke of *Cuculus*, *Chrysococcyx*, and *Clamator* as having "accipitrine thigh-feathers," and he reported that the rim around the external naris is swollen in these genera; *Surniculus lugubris* also exhibits both of these characters.

Apparently all cuckoos have 10 primaries. Most cuckoos have either 9 or 10 secondaries; *Scythrops* is said to have 13; *Carpococcyx* and *Centropus* appear to have 11; and the nestling *Coua ruficeps* seems to have 12 (see, however, the discussion by Berger and Lunk, 1954). *Guira* and *Crotophaga* have 8 rectrices; all other cuckoos are said to have 10.

Despite the variation in pattern of both the dorsal and the ventral feather tracts among the cuckoos, no cuckoo yet studied has feather tracts (particularly dorsally) like those of the touracos. The oil gland is tufted in touracos; it is nude in cuckoos. An aftershaft is present in touracos; it is absent or vestigial in cuckoos (Miller, 1924). Well-developed "eyelashes" are characteristic of cuckoos. The eyelashes may be featherlike, as in *Cuculus*, *Chrysococcyx*, *Clamator*, and *Surniculus*, or they may be "hairlike," as in *Coua*, *Geococcyx*, *Morococcyx*, *Dromococcyx*, *Tapera*, *Guira*, *Crotophaga*, *Piaya*, *Saurothera, Ceuthmochares, Centropus,* and *Phaenicophaeus.* The small, black, hairlike eyelashes are least conspicuous in *Phaenicophaeus pyrrhocephalus*; those of *Dasylophus* (= *Phaenicophaeus*?) *superciliosus* are said to be large and scarlet. Eyelashes are absent in *Tauraco leucotis donaldsoni,* and both eyelids are covered by fleshy caruncles which are especially prominent dorsal to the upper eyelid. There appear to be seven alula quills attached to the pollex in *Tauraco*; these increase in length from proximal to distal: No. 1 is 23 mm. long; No. 2, 28 mm.; No. 3, 33 mm.; No. 4, 36 mm.; No. 5, 44 mm.; No. 6, 50 mm; No. 7, 52 mm. Cuckoos apparently have either four or five alula quills. The innermost, the outermost, or one of the intermediate feathers may be the longest in the series.

THE CUCULINE SYRINX

There are few anatomical structures throughout the families of birds that need study as badly as the syrinx. Except for a very few isolated instances, our knowledge of both the passerine and the nonpasserine syrinx is based largely on work published during the last century (e.g., Müller, 1878). Such pioneers as Müller, Garrod, Forbes, Fürbringer, and Gadow were remarkably astute scholars of the old school and any thorough anatomical study must begin with a careful analysis of their papers. Nevertheless, the work of the past needs to be corroborated and extended, using both gross and microscopic techniques. We need detailed comparative studies of the syrinx interpreted in terms of modern concepts of anatomy and of systematics. For such studies, one needs a number of specimens of each species in order to work out all relationships carefully. The intrinsic syringeal muscles usually are very small and they often are poorly preserved in alcoholic specimens. In addition to gross descriptions, microscopic analyses and embryological studies of developmental stages of the syrinx *in both sexes* would undoubtedly add much to our understanding of the significance of the adult configuration of the syrinx and its relation to muscles and to the tracheobronchial tree.

I can do little more here than verify statements in the literature and summarize present knowledge of the cuculine syrinx. The following cuckoos are known to have a bronchial syrinx: *Centropus, Carpococcyx, Coua, Geococcyx, Morococcyx, Dromococcyx, Crotophaga,* and *Guira.* Within this group, however, there is a considerable difference as to the location of the syrinx within the bronchi, as pointed out by Beddard (1885:170–174). Beddard reported (1901:202) that "the syrinx of *Carpococcyx* . . . is the most purely bronchial syrinx that exists among the Cuculidae; it is even more exaggerated than that of *Crotophaga*," and he added that the syringes of *Centropus* and *Geococcyx* "present us with an intermediate stage between the typical tracheo-bronchial syrinx of the Phoenicophainae and the extraordinarily specialized bronchial syrinx of *Crotophaga* and of *Carpococcyx*." The syrinx of *Centropus superciliosus* (Fig. 11), however, approaches the "exaggerated" condition found in *Carpococcyx* (Beddard, 1901:203), and it appears to be different from the syrinx of *Centropus ateralbus* (Beddard, 1885:172). This suggests that a comparative study of the syrinx among the many species of *Centropus* would be a fruitful project.

All other cuckoos studied, including *Tapera*, have a tracheobronchial syrinx. Beddard remarked (1902:605–606) that the syrinx of *Rhamphococcyx* (= *Phaenicophaeus* according to some writers) exhibits "a hint of a development into the bronchial syrinx of the Centropine Cuckoos." Hence, as with other anatomical information, we seem to know just enough about the anatomy of the cuculine syrinx to suggest many intriguing problems for further study and not enough to understand completely the significance of the data that are available. My material was not suitable for microscopic study, and I present here figures (Figs. 7–11) illustrating the gross differences in the syrinx of one series of cuckoos. A knowledge of the finer structure of the cuculine syrinx would undoubtedly be instructive. It should be noted that M. sternotrachealis inserts very near the tracheal bifurcation in *Centropus*, whereas it inserts some distance from the bifurcation in the other genera. Only in the syrinx of *Crotophaga* (a female) did I find two pairs of intrinsic syringeal muscles; there is a single pair of intrinsic muscles in the other genera.

Discussion

There has been a tendency by some contemporary writers to state flatly that certain anatomical features in birds are so stable in an evolutionary sense that similarities in these characters "prove" relationship among the birds concerned. One may make such a basic assumption about a single character and then proceed to "prove" all sorts of inter-relationships that then permit the construction of an elaborate phylogenetic tree, which the author may state or imply is to be accepted without qualification or question. Most often such authors base their conclusions on a smattering of information about a particular anatomical character. When, for example, an author purports to "explain" the course of evolution in all oscine passeriform birds on the basis of a single bone of the skull and on the size of the birds, I believe that we have reached the ultimate in this type of systematic approach, one which might aptly be termed "the pseudo-anatomical approach." Other examples could be cited. The naive confidence in, and the exaggerated positive interpretation of, inadequate data expressed by such authors does a great disservice to anatomical studies and to the application of anatomical information to avian taxonomy.

I doubt that we know enough about avian anatomy or about the interrelationships between structure and function—and all of the related problems

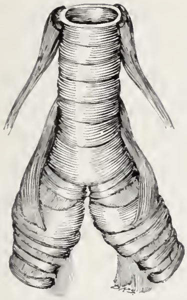

FIG. 7

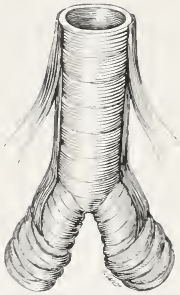

FIG. 8

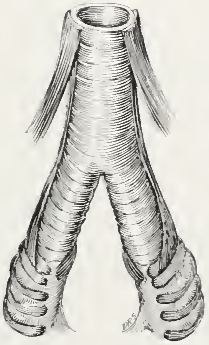

FIG. 10

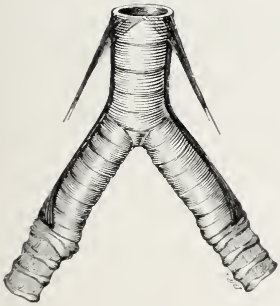

FIG. 9

FIG. 11

FIG. 7. Tracheobronchial syrinx of *Piaya cayana*.
FIG. 8. Bronchial syrinx of *Guira guira*.
FIG. 9. Bronchial syrinx of *Morococcyx erythropygus*.
FIG. 10. Bronchial syrinx of *Crotophaga sulcirostris*.
FIG. 11. Bronchial syrinx of *Centropus superciliosus*.

of convergence and divergence among birds—to justify such confidence. Miller (1937:58–59), Rinker, and others have discussed this problem and that of the inequality of values to be assigned to anatomical features in the study of both birds and mammals. Thus, Rinker (1954:117), in speaking of rodents, wrote: "Even the segregation of characters into adaptive and nonadaptive categories, or a classification based on current survival value, is, in my opinion, a highly subjective approach. I do not believe that the present state of knowledge will allow this approach to be used with any appreciable degree of certainty. It appears to me that success in such an attempt would require much greater insight into the relationships of structure and function, into the basis of habitat preferences (or restrictions), and into many more phenomena than is possible at present." It does not seem to me to be an exaggeration to make a similar statement about birds, particularly when it seems that we know less about the significance of anatomical characters in birds than in mammals. Moreover, we can agree wholeheartedly with Enlow and Brown (1958:221) when they caution: "The projection of preconceived concepts and prejudices of evolutionary mechanics into the interpretation of observations is a consideration that must consciously, and continually, be recognized and evaluated. It is a constant temptation to look for, and thereby find, a logical, uni-linear assemblage of structural changes that conform with and confirm some preexisting idea on how things should be happening."

Before summarizing the data presented in this paper, it will be instructive to consider Peters' (1940) classification of the cuckoos. There seems to be general agreement that Peters' classification is unsatisfactory. He had little published information on cuculine anatomy to rely on, and I suspect that his system was based primarily on two factors: parasitism and geographical distribution. An analysis of his subfamilies will give further insight into some of the problems involved and will reveal where further work is needed.

Peters' subfamily Cuculinae is composed of Old World cuckoos that have parasitic breeding habits. For most of the included genera the muscle formula is AXYAm, but for *Eudynamis* and *Scythrops* it is ABXYAm. *Clamator* has 13 cervical vertebrae; so far as is known, the other genera have 14. There is a single ventral abdominal feather tract on each side in *Cuculus*, *Cacomantis*, *Clamator*, and *Surniculus*; these tracts are paired bilaterally in *Chrysococcyx*, *Scythrops*, and *Eudynamis*. Baker (1927) erected the subfamily Eudynaminae for the single genus *Eudynamis*.

An analysis of Peters' subfamily Phaenicophaeinae—which he admitted was a "catch-all" group—is even more interesting. He included in this subfamily three nonparasitic American genera and nine nonparasitic Old World genera. Each of the American genera (*Coccyzus*, *Piaya*, *Saurothera*) has a muscle formula of AEXYAm, a single ventral abdominal feather tract bilaterally, and, apparently, 13 cervical vertebrae. Six of the nine Old World genera are known to have the muscle formula of ABXYAm. Of the two genera studied for this paper, *Ceuthmochares* has a single ventral abdominal feather tract bilaterally, whereas *Phaenicophaeus* has paired tracts bilaterally. Both genera have 14 cervical vertebrae and a muscle formula of ABEXYAm. It should be pointed out that Delacour and Mayr (1945) did not recognize eight of the nine Old World genera (including *Ceuthmochares*) listed by Peters, and, therefore, placed all of the species in the genus *Phaenicophaeus.* Bannerman (1933), on the other hand, placed *Ceuthmochares* in his subfamily Centropodinae.

The Crotophaginae (*Crotophaga* and *Guira*) are New World cuckoos that have eight rectrices, a muscle formula of ABEXYAm, and social nesting habits.

Peters' subfamily Neomorphinae contains one Old World genus (*Carpococcyx*) and five New World genera. All except *Tapera* (AXYAm) have a muscle formula of ABXYAm. *Tapera* and *Dromococcyx* are parasitic; so far as is known, the other genera are not parasitic, although Makatsch (1955:34) suggested that *Neomorphus* might have parasitic nesting habits (but see, Sick, 1949). Shelley (1891:423) placed *Tapera* (= "*Diplopterus*") and *Dromococcyx* in the subfamily Diplopterinae (= Taperinae), whereas Gadow and Selenka (1893:214) put *Tapera* in their subfamily Cuculinae (parasitic, AXYAm, syrinx tracheobronchial).

The subfamily Couinae presumably was established because the single genus is restricted to Madagascar. There is little in the internal anatomy to separate *Coua* from *Geococcyx* or *Morococcyx.*

Peters' last subfamily, the Centropodinae, contains the single Old World genus *Centropus* with some 27 species and 55 subspecies. These are widespread (from Australia, the Philippines, and China to Africa and Madagascar), nonparasitic cuckoos that have a very long, straight and sharp claw on the hallux (of many, but not all, of the species), thus the name of Lark-heeled Cuckoos. The coucals build a bulky globular nest that has a side entrance (Delacour, 1947; Loke, 1953), but I suspect that most authors have erected the subfamily primarily on the basis of the long claw on the hallux.

Both Beddard (1898*b*) and Pycraft (1903) adopted several anatomical features—leg-muscle formulae, patterns of the feather tracts, skeletal characters, and the structure of the syrinx—in an attempt to determine cuculine relationships, but, as in the present paper, each author had information from less than half of all the genera. Beddard placed primary emphasis on the syrinx and the leg-muscle formulae (and omitted skeletal characters) in assigning cuckoos to three subfamilies. Pycraft omitted consideration of feather tracts and used skeletal characters (sternum and pectineal process) and the syrinx in arranging the genera. The divergence in the placement of genera between these two systems was considerable.

The difficulty of deciding relationships among the genera of cuckoos seems to result largely from the fact that anatomical characters often presumed to be very stable in an evolutionary sense exhibit several patterns among the cuckoos. Thus, the muscle formula may be AXYAm or ABXYAm; the syrinx may be bronchial or tracheobronchial; the sternum may be single-notched or double-notched; there may or may not be an apterium between the dorsal cervical and the interscapular feather tracts; and the ventral abdominal feather tracts may be either single or double bilaterally. Similarly, parasitic breeding habits have developed in genera possessing both types of muscle formula, both types of syrinx, both types of sternum, both types of ventral feather tracts, and, perhaps, both types of dorsal feather pattern. Moreover, genera with a bronchial or a tracheobronchial syrinx, those with a single-notched or a double-notched sternum, etc., are found in both the Old World and the New World. These points may be illustrated by constructing a key using such anatomical features rather than using only parasitic breeding habits, geographical distribution, or the appearance of the study skin as a basis for classification. It is obvious that an author can focus the reader's attention on certain relationships by the relative weight placed on anatomical characters in constructing such keys. To demonstrate this point, I present three different keys (Tables 1–3), which embody anatomical features used by Beddard and Pycraft, as well as other features discussed in this paper; by using information reported by Beddard, I have added a few genera not examined for this paper. It is obvious, also, that the data in the tables can be arranged in several other ways.

If we consider only Table 1 for the moment, we can say, in addition, that the genera in Group I have a well-developed peroneus longus muscle; the genera in Group II, except for *Tapera*, have a weakly-developed peroneus longus muscle. M. iliacus ("E") is absent in the Old World genera of Group I. All the genera in Group I have a bronchial syrinx, bilaterally paired ventral abdominal feather tracts, and 14 cervical vertebrae; most of the genera are nonparasitic, but two have developed social nesting habits. Sick (1953*a*, 1953*b*) reported that *Tapera* and *Dromococcyx* are similar in certain external features and in general habits, but the two genera are unlike in internal characters. One would conclude that the superficial similarities in appearance are the result of convergence.

I mentioned above (p. 90) that four genera (*Cuculus*, *Chrysococcyx*, *Clamator*, and *Surniculus*) have "accipitrine" thigh feathers and raised narial rims, but these genera differ considerably in other morphological features. All four genera have parasitic nesting habits.

After examining the tables, one can see why it would be much easier to classify the cuckoos on the basis of breeding habits or on geographical distribution rather than on the basis of internal anatomical characters.

Still other anatomical features of the cuckoos need to be studied: the morphology of the head, particularly the jaw muscles and nerves (see, for example, Barnikol, 1953, and Starck, 1959); a comparative study of the viscera, the vascular system, and the brachial and lumbosacral plexuses.

SUMMARY

As a result of this introduction to an anatomical study of cuckoos and touracos, I agree with those who have proposed that the touracos (Musophagidae) deserve ordinal rank, the Musophagiformes. Table 4 presents comparative data on the cuckoos and on *Tauraco leucotis donaldsoni.* Because they are present in all genera studied for this paper, I have not placed emphasis on two muscles that I recently (1959) proposed be added to muscle formulae: "F," M. plantaris; "G," M. popliteus. They are included in Table 4.

The following wing muscles are absent in *Tauraco leucotis donaldsoni*: cucullaris, pars propatagialis; biceps slip; anconaeus coracoideus; entepicondyloulnaris; flexor metacarpi brevis. The following leg muscles are absent in *Tauraco*: iliotrochantericus medius ("C"); iliacus ("E"); extensor brevis digiti III; adductor digiti II; adductor digiti IV.

The relatively large assemblage of zygodactyl birds that have been grouped together as cuckoos contains genera exhibiting a considerable diversity in internal morphology. It is an old group, first reported from the Oligocene Epoch. One might speculate that the ancestral cuckoos had a more complete complex of thigh muscles than do the modern forms, that they had a tracheobronchial syrinx, and that they had a propensity for developing parasitic nesting habits. Two lines of specialization might then be proposed. One group, with primarily terrestrial habits, tended to retain the thigh muscles but developed a bronchial syrinx. The other, more arboreal, group retained the tracheobronchial syrinx, tended to lose certain thigh muscles, and tended to develop parasitic breeding habits. However, there seems to be little correlation between the type of sternum and the other anatomical characters studied. Some of the cursorial genera (e.g., *Geococcyx*) have a double-notched sternum, whereas others (e.g., *Carpococcyx*) have a single-notched sternum. Similarly, both types of sternum are found among the more arboreal cuckoos. In view of the presumed occurrence of the bronchial type of syrinx in some, but not all, owls (as well as in a few other birds), one might question the significance of the bronchial syrinx, especially because of the several patterns found among the cuckoos.

Data presented in this paper reveal some of the pitfalls encountered when

TABLE 1

ANATOMICAL RELATIONS OF CUCKOOS

- Group I. Bronchial syrinx; ABE(±)XYAm; ventral abdominal feather tracts double bilaterally; 14 cervical vertebrae.
  - 1. Sternum double-notched; dorsal cervical and interscapular feather tracts separated by an apterium; M. flexor hallucis longus inserts on hallux.
    - a. M. flexor metacarpi brevis absent: *Coua* (E absent), *Geococcyx. Morococcyx, Neomorphus?*
    - b. M. flexor metacarpi brevis present; parasitic; E?; dorsal feather tracts?: *Dromococcyx*
  - 2. Sternum single-notched
    - a. M. flexor hallucis longus inserts on hallux
      - 1) dorsal cervical tract is continuous with interscapular tract; social nesting habits: *Crotophaga*
      - 2) dorsal cervical tract separated from interscapular tract by an apterium
        - a) M. flexor metacarpi brevis present; social nesting habits: *Guira*
        - b) M. flexor metacarpi brevis absent; E absent; nonparasitic: *Carpococcyx*
    - b. M. flexor hallucis longus does not insert on hallux; E absent; nonparasitic: *Centropus*
- Group II. Tracheobronchial syrinx; dorsal cervical feather tract is continuous with interscapular tract.
  - 1. ABE(±?)XYAm
    - a. Sternum double-notched; nonparasitic; E present.
      - 1) ventral abdominal tracts double bilaterally: *Phaenicophaeus*
      - 2) ventral abdominal tracts single bilaterally: *Ceuthmochares*
    - b. Sternum single-notched; parasitic; ventral abdominal feather tracts double bilaterally (from Beddard): *Scythrops, Eudynamis*
  - 2. AEXYAm; sternum double-notched; ventral abdominal tracts single.
    - a. 14 cervical vertebrae; parasitic: *Tapera, Surniculus*
    - b. 13 cervical vertebrae
      - 1) parasitic: *Clamator*
      - 2) nonparasitic: *Coccyzus, Saurothera, Piaya*
  - 3. AXYAm; parasitic
    - a. Sternum double-notched; ventral abdominal tracts double: *Chrysococcyx*
    - b. Sternum single-notched; ventral abdominal tracts single: *Cuculus, Pachycoccyx*

TABLE 2

ANATOMICAL RELATIONS OF CUCKOOS

Group I. ABXYAm.	
1. Bronchial syrinx; ventral abdominal feather tracts double; 14 cervical vertebrae.	
a. Dorsal cervical and interscapular feather tracts are separated by an apterium.	
1) M. flexor hallucis longus does not insert on hallux; sternum single-notched; M. flexor metacarpi brevis present; nonparasitic:	*Centropus*
2) M. flexor hallucis longus inserts on hallux.	
a) Sternum double-notched	
1—M. flexor metacarpi brevis absent; nonparasitic:	*Coua, Geococcyx, Morococcyx, Neomorphus?*
2—M. flexor metacarpi brevis present; parasitic; dorsal feather tracts ?:	*Dromococcyx*
b) Sternum single-notched	
1—M. flexor metacarpi brevis absent; nonparasitic:	*Carpococcyx*
2—M. flexor metacarpi brevis present; social nesting habits:	*Guira*
b. Dorsal cervical tract continuous with interscapular feather tract; sternum single-notched; social nesting habits:	*Crotophaga*
2. Tracheobronchial syrinx; dorsal cervical tract is continuous with interscapular feather tract.	
a. Sternum single-notched; parasitic; ventral abdominal feather tracts double:	*Scythrops, Eudynamis*
b. Sternum double-notched; nonparasitic	
1) ventral abdominal tracts double:	*Phaenicophaeus*
2) ventral abdominal tracts single:	*Ceuthmochares*
Group II. AXYAm; tracheobronchial syrinx; dorsal cervical tract continuous with interscapular feather tract.	
1. Sternum double-notched	
a. Ventral abdominal tracts single bilaterally	
1) 14 cervical vertebrae; parasitic:	*Tapera, Surniculus*
2) 13 cervical vertebrae	
a) nonparasitic:	*Coccyzus, Saurothera, Piaya*
b) parasitic:	*Clamator*
b. Ventral abdominal tracts double; parasitic:	*Chrysococcyx*
2. Sternum single-notched; ventral abdominal tracts single; parasitic:	*Cuculus*

TABLE 3

ANATOMICAL RELATIONS OF CUCKOOS

Group I.	Sternum double-notched.	
	1. Bronchial syrinx; ABE(±)XYAm	
	a. M. flexor metacarpi brevis absent; nonparasitic:	*Coua, Geococcyx, Morococcyx, Neomorphus?*
	b. M. flexor metacarpi brevis present; parasitic:	*Dromococcyx*
	2. Tracheobronchial syrinx	
	a. ABEXYAm; nonparasitic	
	1) Ventral abdominal tracts double:	*Phaenicophaeus*
	2) Ventral abdominal tracts single:	*Ceuthmochares*
	b. AEXYAm; ventral abdominal tracts single	
	1) 14 cervical vertebrae; parasitic:	*Tapera, Surniculus*
	2) 13 cervical vertebrae	
	a) parasitic:	*Clamator*
	b) nonparasitic:	*Coccyzus, Saurothera, Piaya*
	c. AXYAm; ventral tracts double; parasitic:	*Chrysococcyx*
Group II.	Sternum single-notched.	
	1. Bronchial syrinx	
	a. M. flexor hallucis longus inserts on hallux	
	1) Dorsal cervical tract continuous with interscapular tract; social nesting habits:	*Crotophaga*
	2) Dorsal cervical tract separated from interscapular tract by an apterium.	
	a) Flexor metacarpi brevis present; social nesting habits:	*Guira*
	b) M. flexor metacarpi brevis absent; E absent; nonparasitic:	*Carpococcyx*
	b. M. flexor hallucis longus does not insert on hallux; E. absent; nonparasitic:	*Centropus*
	2. Tracheobronchial syrinx; parasitic	
	a. ABXYAm; ventral abdominal tracts double:	*Scythrops, Eudynamis*
	b. AXYAm; ventral abdominal tracts single:	*Cuculus, Pachycoccyx*

one compares only a few anatomical characters in single representatives of two or more families of birds. To illustrate that it is unwise to draw broad conclusions on relationships after dissecting only one or two representatives of each of several families, we may cite as examples the relative development of M. iliotibialis in *Tauraco* and in *Cuculus* and the intergeneric differences in relative development of M. peroneus longus or M. pronator superficialis and M. pronator profundus among the cuckoos.

TABLE 4

ANATOMICAL CHARACTERS OF CUCKOOS AND TOURACOS

Cuculidae	**Tauraco leucotis**
1. AFGXYAm, AEFGXYAm, ABFGXY Am, ABEFGXYAm	1. ABDFGXYAmV
2. Expansor secundariorum is cuculine	2. Expansor secundariorum is ciconine
3. 2 bony canals in hypotarsus	3. 1 bony canal in hypotarsus
4. 17 or 18 presynsacral vertebrae; 4 dorsal vertebrae typical	4. 19 presynsacral vertebrae; 5 dorsal vertebrae typical
5. Perforated atlas	5. Notched atlas
6. Typical furcula present	6. Furcula absent
7. No bony canal formed by coracoid	7. Bony canal is formed by the dorsal processes of the coracoid
8. Lacrimal bone is "cuculine"	8. Lacrimal bone is "musophagine"
9. Oil gland is nude	9. Oil gland is tufted
10. Aftershaft is absent or vestigial	10. Aftershaft is present
11. Eyelashes are characteristic	11. Eyelashes are absent
12. Pattern of dorsal feather tracts is dissimilar	

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UNIVERSITY OF MICHIGAN MEDICAL SCHOOL, ANN ARBOR, MICHIGAN, MAY 9, 1959

NEW LIFE MEMBER

James M. Hartshorne is a graduate student at Cornell University undertaking a doctoral research program involving a study of the development of vocalization in the Eastern Bluebird. Also, he has studied zoology at the University of Lausanne, Switzerland, and has received his MS degree from Cornell. His interest in bird vocalizations has not confined him to the study of his hand-raised bluebirds in their special sound isolation chambers in a laboratory. He has also made voice recordings in the field under various conditions, for example (as the photograph shows), of Trumpeter Swans at Red Rock Lakes Refuge, Montana, in March when the area was still completely snowbound. The snow plane shown in the photograph was a necessary addition to his recording equipment. Mr. Hartshorne, in addition to being married and the father of two boys and a girl, is a ham radio operator, a photographer, and a member of the A. O. U., the Cooper Ornithological Society, B. O. U., Ecological Society of America, etc.

GENERAL NOTES

Red-crowned Ant-Tanagers, Tawny-crowned Greenlets, and forest flocks.—While studying Red-crowned and Red-throated Ant-Tanagers (*Habia rubica and H. gutturalis*) in 1957 at Gallon Jug, British Honduras, I took occasional notes on their association with the flocks of small insectivorous birds that, like the chickadee-titmouse flocks of the United States, wander through the forest searching for their randomly dispersed food. Red-crowned Ant-Tanagers were more often members of the wandering flocks than were Red-throated Ant-Tanagers, partly because the latter species spent much time with the birds that followed army ants.

The following list gives the most frequent companions of *H. rubica* in the flocks from March 3 to July 1 (except as noted); it is abbreviated from a list of 67 species in a thesis (1958. "The Foraging Behavior of Ant-Tanagers in British Honduras") in the Louisiana State University Library. Each record represents a period of five minutes or more when a species foraged alongside ant-tanagers.

Species	Records	Individuals
Hylophilus ochraceiceps	166	322
Xiphorhynchus flavigaster	58	69
Xenops minutus	42	54
Myiobius sulphureipygius	41	41
Microrhopias quixensis	38	89
Ramphocaenus rufiventris	37	44
Henicorhina leucosticta	36	63
Thryothorus maculipectus	33	41
Helmitheros vermivorus (to April 10)	22	23
Sittasomus griseicapillus	22	22
Mniotilta varia (to April 15)	21	22
Oncostoma cinereigulare	20	22

Tawny-crowned Greenlets (*Hylophilus ochraceiceps*) were so often companions of ant-tanagers that I learned, when the latter stopped calling and consequently became very difficult to follow, to listen for the plaintive calls of the greenlets. Several of the above 166 records represent one to three hours of continuous association between the two species. On several occasions when ant-tanagers darted off to a territorial dispute the greenlets that had been accompanying them called *d'd'd'dzee-errr* and *jwai jwai jwai* rapidly, flitted their wings, and darted rapidly around. The greenlets looked everywhere until apparently the distant song of the ant-tanager dispute became audible, when they hurried off toward the commotion. Often while two male ant-tanagers warbled and chattered during a territorial dispute the lisping, nasal notes of a greenlet territorial dispute came from the nearby undergrowth. Frequently the greenlets foraged high when the ant-tanagers foraged high, and descended when the ant-tanagers did. The two species occasionally bathed and preened together, too.

Though the wandering flocks were largest in late February and late July, they were larger and more frequent during the intervening main nesting period than are chickadee-titmouse flocks of northern latitudes during nesting. Several factors might cause such a difference. Many flock members in the tropics have large territories, which would allow individuals to follow one another for long distances before one came to the edge of its territory and had to turn back. Moreover, many pairs could join each other at one spot in the tropical forest because many species are present. It is likely that many tropical birds seldom interrupt flock-following to visit their nests. Certainly ant-tanagers of both species made few visits to their nests per hour (2 or 3 while feeding young), and it is well known that the size of tropical broods is generally smaller than that of northern broods (e.g., Lack, 1947. *Ibis*, 89:302–352). There may also be more nonterritorial species, more nonbreeding vagrants, and more nonbreeding immatures in tropical than in temperate forests. Some ant-tanager pairs were accompanied by one to three first-year birds, some greenlet territorial groups were trios rather than pairs, and many Dot-winged Antwren (*Microrhopias quixensis*) groups were larger than three birds.

Red-crowned Ant-Tanagers occasionally left a flock, visited their nests or engaged in territorial disputes or other activities for varying lengths of time, and later returned. At times one ant-tanager pair was replaced by a second after a territorial dispute when the flock crossed the ant-tanagers' territorial boundary. A wandering flock containing such birds as ant-tanagers must constantly vary in its composition.

I wish to thank the Belize Estates and Produce Company for their help at their Gallon Jug Camp, the National Science Foundation for fellowships supporting my studies, R. J. Newman of the Museum of Zoology at Louisiana State University for critical review of the manuscript, and G. H. Lowery, Jr., of that Museum, for directing the study.—Edwin Willis, *Museum of Zoology, Louisiana State University, Baton Rouge, Louisiana, May 6, 1959.*

Encounters between Barn Swallows and a Mockingbird.—On two occasions during June, 1958, I observed repeated attacks by Barn Swallows (*Hirundo rustica*) upon a Mockingbird (*Mimus polyglottos*). My home in Bethesda, Maryland, backs on a large golf course where Barn Swallows fly back and forth catching food, and where Mockingbirds nest in the bordering shrubs. (I know of no nesting site of the Barn Swallow within a half mile.) It is only when it is raining that the two species meet, for the swallows sit out the rain preening on a telephone wire which is within the territory of a nesting pair of Mockingbirds.

On June 25 my attention was drawn to several swallows which were making repeated dives on a lone Mockingbird sitting on the wire. I do not know which species arrived first. The Mockingbird attempted to thwart the attacks by directing a head-forward thrust at each diving swallow, and by snapping its bill violently. This action continued for several minutes, during which it appeared that the swallows never actually hit the mocker in their dives.

A similar encounter took place the following day. On this occasion swallows were sitting together on the same wire when a Mockingbird flew to a spot about 5 feet farther along, a place which it had used as a song post throughout the breeding season. The swallows left the wire, chattering, and began diving at the larger bird as before. This time the attack was well-coordinated, the seven swallows diving alternately, one from the east side of the wire, the next from the west. This forced the Mockingbird to turn completely around after each dive in order to thwart the next. Its defense was the same as before, and after several minutes of attacking, the swallows left to join others on a wire about 100 feet away. On other occasions I have observed Barn Swallows peacefully sharing the same telephone line with various species, at least seven in all, without the slightest sign of conflict.

These events bear a striking similarity to those described by Cross (1950. *Wilson Bull.*, 62:39). He observed five Barn Swallows making repeated diving attacks on a Loggerhead Shrike (*Lanius ludovicianus*) perched on a wire. Since it was well past nesting period, he suggested that the swallows recognized the shrike as a predator (either by instinct or experience or a combination of both), and therefore attacked it. If the Barn Swallow recognized the shrike by obvious "sign stimuli" (e.g., dark body, white wing patches, white outer tail feathers, sitting alone on a wire in the open), could it be that the swallows reported above "mistook" the Mockingbird for the similarly-patterned shrike, and therefore attacked it?—JACK P. HAILMAN, *4401 Gladwyne Drive, Bethesda, Maryland, March 17, 1959.*

Common Grackle heavily infested with Mallophaga.— The number of Mallophaga (chewing lice) harbored by individual birds varies considerably even within the same host species. Of many factors limiting population size of the lice, preening by the host is undoubtedly instrumental in removing many lice and their eggs. A female Common Grackle (*Quiscalus quiscula*) (No. 55–A, KSCP), collected January 18, 1959, in Cherokee County, Kansas, was found to be carrying the unusually high number of 323 lice (*Menacanthus*). The bird appears to be normal except for a markedly malformed bill. The upper portion of the distal half of the lower mandible is lacking; the upper mandible is twisted, with irregular tomia and with an elongate horny growth at the tip. A V-shaped gap, 5mm. wide distally, separates the two mandibles for about half their length. When the bird was collected, a great number of mallophagan eggs still adhered to barbs of the under-wing coverts.

Our search for Mallophaga on 130 birds (representing 7 orders, 20 families, 44 species) collected in southeast Kansas during several winter months has revealed that many individual hosts are louse-free. Of those infested, most harbored less than 20 lice and only three were infested with more than 100 lice. Heavy lice infestation in the instance mentioned herein may be due primarily to the inability of the host to preen itself efficiently.—J. C. JOHNSON, JR. AND CHARLES A. LONG, *Department of Biological Science, Kansas State College, Pittsburg, Kansas, April 25, 1959.*

ORNITHOLOGICAL NEWS

Anyone writing to the Wilson Ornithological Society in general, or to any of its officers specifically, is urged not to address the University of Kansas, as is too frequently done, but to refer to the proper address as listed on the inside front and back covers of the *Bulletin.*

The Wilson Ornithological Society's new Endowment Committee Chairman is Dr. Richard Zusi, Coburn Hall, Department of Zoology, University of Maine, Orono, Maine. He replaces Dr. Olin Sewall Pettingill, Jr., who recently resigned the chairmanship.

The A. O. U. Council at the 1959 meetings in Regina authorized issuance of the first grants for research from the income of the Josselyn Van Tyne Memorial Fund. A sum of approximately $600 will become available at the end of the fiscal year, July 31, 1960. The Council assigned to the Research Committee of the A. O. U. the administering of these grants and it is hoped that the first recipient or recipients may be announced at the next A. O. U. meeting in Ann Arbor in August.

Any student of birds who has a special need for equipment, travel, assistance, or materials to further his research is invited to submit an application (10 duplicate copies) for a portion or all of the money available. This application should give a full description of the proposed research, the type of help that is required, when the money should be made available, the background and training of the applicant, and other pertinent information. The applications will be evaluated and rated by the Research Committee to determine how the funds will be allotted.

All applications for grants must be in the hands of the chairman not later than June 1, 1960. Send them to Dr. S. C. Kendeigh, Chairman, Vivarium Building, University of Illinois, Wright and Healey Streets, Champaign, Illinois.

JOSSELYN VAN TYNE MEMORIAL LIBRARY

The following gifts have been recently received . From:

H. Lewis Batts, Jr.—1 pamphlet
Charles T. Black—1 reprint
William H. Burt—1 reprint
Robert S. Butsch—1 book
F. G. Cooch—1 reprint
W. P. and B. D. Cottrille—11 journals
Kai Curry-Lindahl—2 books, 14 reprints
Jack P. Hailman— 4 reprints
Karl W. Haller—2 books, 1 pamphlet
Fr. Haverschmidt—3 reprints
Leon Kelso—2 translations
William Lunk—1 book
University of Michigan Museum of Zoology —1 occasional paper
D. F. Owen—1 pamphlet, 6 reprints
William H. Phelps and William H. Phelps, Jr.—1 pamphlet, 3 reprints
Allan R. Phillips—4 reprints
Robert Leo Smith—5 reprints
Peter Stettenheim—2 books, 2 reprints, 1 translation
Robert W. Storer—1 reprint
Harrison B. Tordoff—1 journal
University of Utah Dept. of Zoology and Entomology—3 reprints, 1 pamphlet
Mrs. Josselyn Van Tyne—110 books
David K. Wetherbee—2 reprints
Harriet B. Woolfenden—1 book, 23 colored prints of bird paintings by Fenwick Lansdowne

ORNITHOLOGICAL LITERATURE

COMPLETE FIELD GUIDE TO AMERICAN WILDLIFE/EAST, CENTRAL AND NORTH/COVERING ALL SPECIES OF BIRDS, MAMMALS, REPTILES, AMPHIBIANS, FOOD AND GAME FISHES, SEASHELLS, AND THE PRINCIPAL MARINE INVERTEBRATES OCCURRING ANNUALLY IN NORTH AMERICA EAST OF THE ROCKIES AND NORTH OF THE 37TH PARALLEL. By Henry Hill Collins, Jr. Illustrated by Russell Francis Peterson, Nina L. Williams, and John Cameron Yrizarry. Harper & Brothers, New York, 1959: 7½x4½ in., xx+683 pp., maps, 200 figs., 48 color plates. $6.95 (de luxe edition, $7.95).

The title of this book, like an insurance policy, must be read in its entirety to be comprehended, and even then it leaves some doubt as to the book's scope. This work is, in truth, a field guide, with suitably small dimensions and strong binding, but its completeness is a matter of opinion, and its coverage is actually limited to selected groups of animals in eastern United States and Canada, west to and including the Black Hills and other eastern foothills of the Rockies, south to the borders of the Carolinas and Oklahoma, and north to and including the delta of the Mackenzie River and western Greenland. In all, 1439 animal species (author's count) are covered: first the birds, 454 species in 252 pages, well over a third of the book; then the mammals, 192 species in 88 pages; reptiles, 98 species in 70 pages; amphibians, 76 in 40 pages; fishes, 342 in 109 pages; and marine invertebrates, 277 in 99 pages.

Though four people, serving as an Editorial Advisory Board, "helped guide the plan of the work" and "read the manuscript in their respective fields," Mr. Collins wrote the book himself. How successful he has been in compiling his material, only the book's field use will tell. What interests us here are the organization and contents of the section on birds.

The introduction to this contains general information on the biology, history, ecology, and classification of birds and on some of the techniques of bird watching. All in all the information is appropriate, although the author has sometimes overstated matters (for example: "Being warm-bodied, birds can fly across the North Pole" (p. 4); bird watching is "a hobby of many millions of persons" (p. 5)), or has given misleading interpretations ("the food a bird eats is determined by the kind of a bill it has" (p. 7); species are arranged "in the presumed order of evolution" (p. 11)). Toward the end of the introduction he has outlined at length some of the activities and methods among bird watchers. Unfortunately, his treatment is so superficial as to make some of the aspects of bird watching seem foolish.

The bulk of the bird section comprises accounts of the species. Each adheres to a set pattern. After its title, consisting of common and scientific names, comes an introductory our-only-bird statement, a means to quick identification employed with discretion by Allan D. Cruickshank in his "Pocket Guide to the Birds" but used here as often as possible and at times carelessly. On page 22, the Gannet is said to be "our only large white sea bird with broad black wingtips" while on the same page, showing black on the tips of the wings, is a drawing of the White Pelican, a large white bird which frequents sea coasts. Again, on page 152, the Northern Three-toed Woodpecker is "Our only woodpecker with *a barred back and barred sides*," a statement that is hard to reconcile with a drawing on the same page of a Ladder-backed Woodpecker demonstrating very distinct barrings on the back and sides. Too many of the statements are loosely worded. The Western Kingbird (p. 154) does not have "*white outer tail feathers*" but outermost tail feathers edged with white; the Starling (p. 190) should have been referred to as a black bird instead of "blackbird."

Following the introductory statement comes information under subtitles, thus: Description, Habitat, Habits, Voice, Food, Nest, Eggs. The material is these categories is necessarily brief and, in the case of the first (Description), frequently marred by undefined terminology. Nowhere are "wing bars" and "eye rings" described or explained, nor are they shown on the drawing of the parts (topography) of the bird (Fig. 2); yet both terms are commonly used. In the accounts of the vireos, eye rings are used interchangeably with "spectacles" without any indication as to whether or not the terms are synonymous.

Toward the end of many species accounts is a subtitle, Age, under which is given the known maximum age. There are no additional figures to indicate *range* of known ages, or *number* of known ages. We are merely informed, for instance, that the Red-necked Grebe (p. 16) lives to 4 years and the Canada Goose (p. 33) to 22, the Arctic Tern (p. 127) to 22 years and the Roseate Tern (p. 128) to 10, the Robin (p. 180) to 10 years and the Eastern Bluebird (p. 183) to 4. While interesting, the figures can be misleading to the uncritical reader by giving him the idea that the Canada Goose usually lives five times longer than the Red-necked Grebe, and that there is a marked discrepancy in the ages of such closely related birds as the Arctic and Roseate Terns, or Robin and Eastern Bluebird, when we are actually not at all certain just how long these birds ordinarily live. Such data should either be qualified or left out entirely.

Each species account is concluded in a varied manner, sometimes with quotations from poets and naturalists, sometimes with comments on the habits of the species or its history. When a species' common name includes the name of a person, the conclusion is invariably devoted to identifying the person. In a field guide, whose text should be boiled down to bare essentials, the value of such extraneous material is questionable.

Greatly enhancing the species accounts are the range maps, one, sometimes two, to a species, worked out by Richard Ryan. They are carefully done, though one can find a few slips. The Horned Grebe is shown erroneously (p. 16) as breeding in northern New England, but this mistake is not as serious as the one in the accompanying text (same page) about the Horned Grebe "leaving for its Arctic breeding grounds." The map shows correctly that the species does not breed in the Arctic.

The bird illustrations comprise the drawings and silhouettes grouped in 51 figures and paintings in 28 color plates. All have been done by Russell Francis Peterson. It takes only a few moments for a person such as myself, who has regularly used Roger Tory Peterson's "A Field Guide to the Birds" (Second Edition, 1947), to discover that some of the drawings and silhouettes are, beyond a shadow of a doubt, copied from Peterson's work. Compare, for example, Figure 7 with the silhouettes on page 10 in Peterson, or the silhouette of the Turkey Vulture in Figure 26 with the silhouette of the same species on page 67. Here and there the artist has simply rearranged the subjects and made other minor alterations. A case in point is Figure 45, of the seven swallows on a sagging wire. In Peterson, page 162, there are six swallows in a different order from left to right, but posed in the same way, on a taut wire. Comparing the wash drawings of flying ducks in Figures 14, 15, 19, and 20 with similar wash drawings of the same birds in Peterson, one can readily surmise where the artist has obtained his ideas and some of his source material. He has taken pains to have all the ducks fly in the opposite direction.

The illustrations in color are amateurish in the extreme. If I felt that they represented a conscientious endeavor on the part of the artist to interpret birds as he has seen them in life or from specimems, I might say that he has mild promise; but I find too much evidence that he has relied to a large extent on other art work. It is hardly coincidence that his paintings on Plate 6 of the Great Blue Heron, American Bittern, and Green

Heron should show almost the same body attitudes and views as those depicted on Plates 14 and 15 by Don Eckelberry in Richard H. Pough's "Audubon Water Bird Guide." Interestingly, his painting of the male American Redstart with wings extended (Pl. 18) shows no orange-red on the bird's side (where the color should be), but on the bend of the wing where the color of the side often *appears to be* in paintings of the bird with wings folded.

When a new field guide to identification is published, we hopefully look for improvements that will more quickly point out distinctions. The bird section of this book has only one—a series of charts, by John Cameron Yrizarry, comparing closely related species. Otherwise we see what we have seen before in other guides, notably in the Peterson Field Guide Series—the same page makeup, the same use of boldface and italic type, range maps at the bottom of the pages as in Peterson-Mountfort-Hollom's "Field Guide to the Birds of Britain and Europe." Most of the drawings repeat the subjects depicted in other guides. As in Peterson's "A Field Guide to the Birds," there are drawings to show differences in the bills of three loons and two eiders, in the tails of the three jaegers and the four longspurs, and in the heads of two ptarmigan, and there are two color plates of fall warblers. The illustrations have one original feature—with most of the species are pictured their eggs.

Originality has not been the author's paramount objective. What he has strived to do, it seems to me, is to pull together between two covers as much material as possible from currently successful guides in the hope that his book will supplant all of them. In this effort he has overreached, at least insofar as the bird section is concerned, by assembling more material than can be handled consistently and conveniently in the space available. He has brought in and treated extensively a few Old World species (e.g., Ruff and Curlew Sandpiper) that occasionally show up in this country and many species that barely come within the established western limits of this book. He has omitted much-needed illustrations of such common species as the Acadian and Traill's Flycatchers. The Townsend's Warbler is illustrated, but the text account is omitted. Species are woefully jammed on the color plates, and the presence of their eggs makes the crowding seem even worse. Some surprising species are grouped together on the color plates. On Plate 27, which is captioned "BIRDS ONLY FOUND IN THE EAST," are the Greater Prairie Chicken, Ruff, Dickcissel, and Painted Bunting.

It is disturbing that a work with these shortcomings in its ornithological section should reach publication. But it has, and the fact that it has been brought out by a major publishing house will probably assure its wide promotion. If it should come into such wide demand as to require reprinting, I trust that the author and publisher will, in addition to correcting the factual matter in the text, give credit for the art work where credit is due.—Olin Sewall Pettingill, Jr.

Songs of Warblers of Eastern North America. Volume IV of the "Sounds of Nature" Series. Recorded by Donald J. Borror and William W. H. Gunn: narration by Thom Benson. Federation of Ontario Naturalists, 187 Highbourne Road, Toronto. $5.95.

Reproduced on this long-playing (33⅓ r.p.m.) record are 170 songs of 38 warbler species "known to breed regularly" in eastern North America. The species are grouped according to certain similarities of their songs, thus providing easier means of comparing them. In the case of all species at least two or three examples of songs (in the Magnolia Warbler, as many as 10) are given from different individuals, usually in widely separated parts of the species' range. This serves to point up the very considerable variation normally occurring within species, while at the same time enabling the listener to attain greater familiarity with the vocal abilities of each species. Despite the many songs (more than 400) on the record, one may easily find the songs he wants to play by referring to the back of the album where there is a list of species and the number of the bands which have their songs.—OLIN SEWALL PETTINGILL, JR.

A BIBLIOGRAPHY OF BIRDS. With Special Reference to Anatomy, Behavior, Biochemistry, Embryology, Pathology, Physiology, Genetics, Ecology, Aviculture, Economic Ornithology, Poultry Culture, Evolution, and Related Subjects. By Reuben Myron Strong. Publications of Field Museum of Natural History [now Chicago Natural History Museum], Zoological Series, Vol. 25, Part 4, pp. 1–85, 1959 (Finding Index). $2.75.

Parts 1 and 2 (Author Index) of Dr. Strong's widely used "Bibliography" were published in 1939 and Part 3 (Subject Index) in 1946. (For a review of all three volumes, see *The Wilson Bulletin* for 1947, vol. 59, pp. 49–50.) This, the fourth and final part (Finding Index), is a tool to assist in cross referencing. And a most welcome one it is!

From now on, almost anyone who uses the Bibliography will first consult the Finding Index, which consists of a "continuous alphabetically arranged list" of topics and names of bird species and groups of species occurring in the Subject Index. He will then go to the Subject Index which will in turn refer him to the Author Index. The vast majority of topics included in the Finding Index are anatomical, physiological, and geographical. Although many of them (for example, the eye) are already carried by special sections in the Subject Index, the Finding Index refers to these same topics in still other sections (in the case of the eye, 45 other sections). On looking through the Finding Index I was impressed with the large number of references to various bird species and groups of species, and also to geographical areas. I counted over 600 references to *Anas*, and 75 more references to 20 different species in the same genus. Geographical areas that I noted include all the continents (for example, Africa, to which there are 43 references) and many islands (Galapagos Islands, 10), as well as nations (France, 19), states (California, 22) and even cities (Chicago, 3).

The year 1926 marks the limit of literature covered by the Bibliography, but some references were added as late as 1938. To the modern investigator in ornithology, the Bibliography with its new Finding Index will be of invaluable assistance by facilitating a more thorough coverage of the earlier (and sometimes easily overlooked) books and papers.—OLIN SEWALL PETTINGILL, JR.

This issue of *The Wilson Bulletin* was published on April 1, 1960.

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A.O.U. Check-list (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. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. 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.

1960 ANNUAL MEETING

The 1960 meeting of the Wilson Society will be held from Thursday to Sunday, May 5–8, at Gatlinburg, Tennessee. The host organization for this meeting will be the Knoxville Chapter of the Tennessee Ornithological Society, whose President, Mr. David Highbaugh, has written to the Secretary as follows:

> "Mrs. Robert A. Monroe (1424 Tugaloo Drive, Knoxville 19, Tenn.) is our Local Chairman. Paul Pardue, President of the Tennessee Ornithological Society, and I are co-chairmen with Mrs. Monroe. The whole Knoxville Chapter makes up the balance of the committee. We are at your service."

Advance questions regarding details of the meeting (*other than accommodations*) should be addressed to Mrs. Monroe. Correspondence regarding *accommodations* should be addressed to: Mr. Tom Woods, Mgr., The Mountain View Hotel, Gatlinburg, Tenn. This will be the "headquarters" hotel, and its auditorium, the Huff House, will be used for papers sessions, etc. Mr. Woods suggests that members avail themselves of the hotel's European Plan rates (*without meals*), which range from $6.00 to $8.00 for a single room, and from $8.00 to $12.00 for a double room. Information on other accommodations is also available from Mr. Woods.

Program plans, so far, include a symposium on bird weights, to be led by Dr. Eugene Odum, who has suggested the tentative title: "The Ecological Significance of Bird Weights." The Secretary hopes that many ornithologists from the Southeast will plan to present papers at the meeting.

Those who have experienced a Wilson meeting at Gatlinburg, in Tennessee's Great Smoky Mountains, will need no urging to make immediate plans for attending the May 5–8, 1960, meeting there. Those who have not had that privilege should realize that it is difficult to visualize a more beautiful setting for a meeting—or a more delightful season for one—among hosts, moreover, who are anxious to show us their mountains, their birds, and their kindly hospitality.—A. M. B.

June 1960

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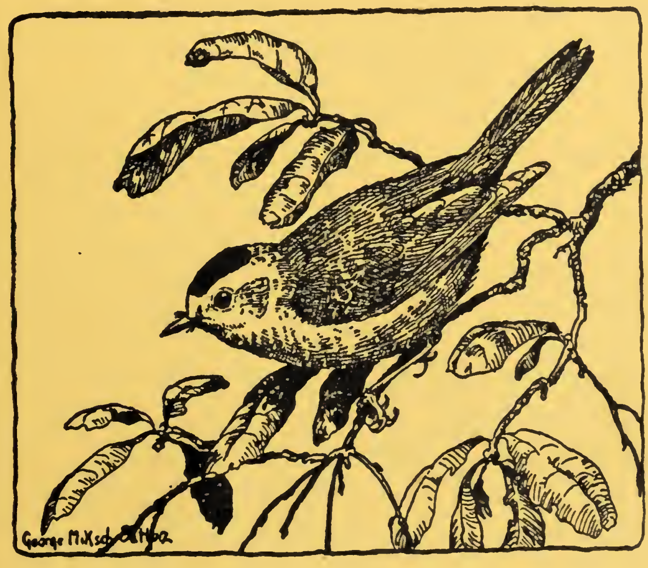
The Wilson Bulletin



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THE WILSON ORNITHOLOGICAL SOCIETY

Founded December 3, 1888

Named after ALEXANDER WILSON, the first American ornithologist.

President—Harold F. Mayfield, River Road R.F.D., Waterville, Ohio.

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

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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 contributions, thus making available to all Society members the more important new books on ornithology and related subjects. The fund will be administered by the Library Committee, which will be happy to receive suggestions on the choice of new books to be added to the Library. William A. Lunk, University Museums, University of Michigan, is Chairman of the Committee. The Library currently receives 65 periodicals as gifts and in exchange for *The Wilson Bulletin.* With the usual exception of rare books, any item in the Library may be borrowed by members of the Society and will be sent prepaid (by the University of Michigan) to any address in the United States, its possessions, or Canada. Return postage is paid by the borrower. Inquiries and requests by borrowers, as well as gifts of books, pamphlets, reprints, and magazines, should be addressed to "The 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.

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All articles and communications for publications, books and publications for review 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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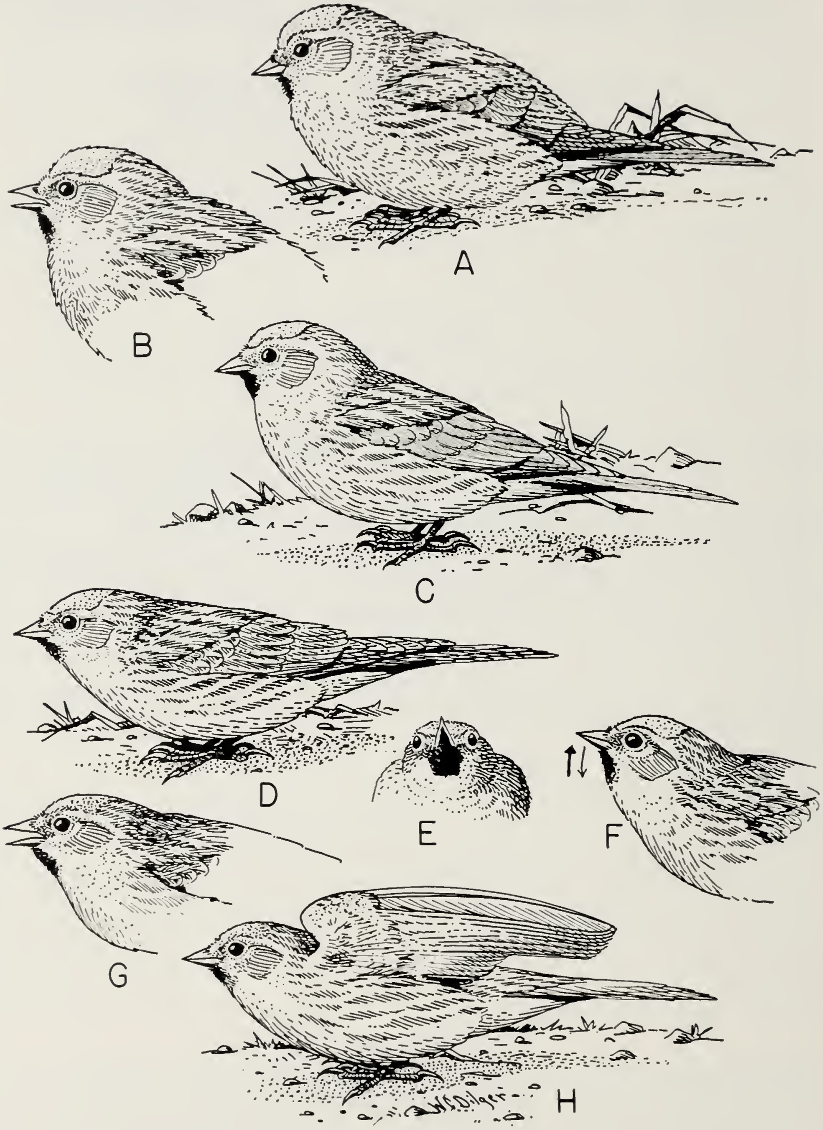


Postures of Redpolls: (A) Submissive display, (B) Defensive Threat, (C) normal relaxed posture, (D) basic Head Forward Threat display, (E) Head Forward Threat with Chin-lifting (front), (F) Head Forward Threat with Chin-lifting (side), (G) Head Forward Threat with Gaping, and (H) Head Forward Threat with Wings-raised (high intensity).

AGONISTIC AND SOCIAL BEHAVIOR OF CAPTIVE REDPOLLS

BY WILLIAM C. DILGER

The birds used in this study were trapped on the campus of St. Lawrence University, Canton, New York, during February and March of 1956. A simple droptrap operated manually by means of a long cord was used, and a mixture of canary and rape seed served as bait. After two or three birds were caught and placed in a small cage next to the trap little difficulty was experienced in quickly obtaining others. Deep snow throughout the trapping period seemed to facilitate the trapping, as food was presumably difficult to procure elsewhere.

The objectives of this study were as follows: (1) to describe and evaluate the agonistic (attack-escape) behavior; (2) to describe and evaluate any social hierarchy that might be established; and (3) to obtain information on the changes in behavior associated with the gradual onset of reproductive condition during the spring.

Thirty-one Common Redpolls (*Acanthis flammea*) were used as a source of observational data, but only eight of these were studied intensively. The others provided subsidiary data as did the wild ones which remained in the vicinity. All captives were color-banded to facilitate the ready recognition of individuals. The group of eight was placed in a semi-box type cage measuring 3 feet by 2 feet by 2 feet high. The back, sides, and bottom were fashioned of plywood. The top was covered with ½-inch mesh screening and the front was constructed of glass in order to increase visibility into the interior. A sliding metal tray on the bottom facilitated cleaning the cage. The substrate consisted of paper over which a thin layer of coarse quartz sand was spread. Two perches running from front to back were fastened to the back of the cage about 6 inches from the floor and about 18 inches apart. A third perch, running parallel to the cage front, was fastened to the cage sides about 18 inches from the bottom and about a foot from the back.

Food consisted of a standard canary mixture (three parts canary and one part rape seed). In addition, small amounts of parakeet conditioning food were supplied. This consisted of a mixture of small seeds and a mash made up of milk proteins, dried egg yolk, ground oyster shells, vitamin supplements, etc. Fresh water and cuttle bone were continually available. Food and water were placed in steep-sided glass dishes about 4 inches in diameter and 1½ inches deep.

Close observation was made easier by the quickness with which they became habituated (a learning process characterized by a waning of a response despite repeated stimulation but not associated with any reinforcement . . . see Thorpe (1951) for a thorough discussion) to the cages and to human presence. As a matter of fact, it was not unusual for freshly caught birds to feed in the gathering cages as they were being carried from the trap to the laboratory! Once established in the observation cages they soon permitted observations to be made at a distance of 3 or 4 feet without the slightest apparent alarm.

The methods used to determine the function ("meaning" to other individual(s)) and stimulus strength of each of the displays discussed are those ordinarily used by ethologists and frequently discussed in the literature; for instance, Moynihan (1955*a*) and Hinde (1955–56). In brief, four types of evidence are utilized: (1) the circumstance in which the display occurs; (2) the behavior demonstrated by both participants immediately before and after the display is given; (3) the behavior accompanying the display; and (4) the components of the display.

As might be expected, these birds proved to be highly social and their various activities tended to be performed in concert. This included eating, drinking, bathing, preening, stretching, etc. Periods of such activities alternated throughout the day with periods of resting. No sexual behavior was noted during the first weeks after capture, nor in the wild birds which remained in the vicinity. The captives were subjected to normal day lengths.

AGONISTIC BEHAVIOR

Agonistic behavior in redpolls, as in other animals, consists in part of a number of displays which serve to reduce the attack tendency and/or to increase the escape tendency of opponents or potential opponents (see Hinde, 1956, for a discussion of the use of the term "tendency"). As in other types of displays, these agonistic displays were most pronounced when the tendencies were in greatest conflict. In the case of agonistic displays the conflicting tendencies were usually the attack and escape tendencies. Sometimes other tendencies were also present and contributed additional variables.

It is thought, as a result of the findings of many investigators working with many kinds of animals, that the attack and escape tendencies are usually, if not always, simultaneously present in any animal demonstrating agonistic behavior (Moynihan, 1955*a* and *b*). Either may be so preponderant that the animal either simply flees (escape) or attempts to supplant or fight (attack) the opponent. Commonly, however, the two tendencies are in some degree of conflict resulting in various displays depending upon the actual and relative strengths of the conflicting tendencies. In such displays, it is usually possible to recognize the presence of both tendencies by the expression of motor elements associated with the attack and the escape behavior. The relative proportion of these motor patterns may be, but are not necessarily, associated with the relative strengths of the two conflicting tendencies. Thus, between the acts of simply fleeing and of simply attacking, there is a rather elaborate series of displays expressing varying proportions of actual and relative strengths of attack and escape tendencies. The type of display forthcoming is dependent both upon the internal state of the animal (specific action potential) and upon the nature of the external stimulus(i).

There are obviously an infinite number of actual and relative strengths of both the attack and escape tendencies between simple fleeing and simple attack. It is equally obvious that there are not an infinite number of displays which occur between these two extremes. Ordinarily only a few such displays exist, which means that each display functions within a rather broad spectrum of actual and relative strengths of tendency conflicts. This stabilization of display types within a certain amount of variability of tendency strengths has been termed "typical intensity." Morris (1957) presents a thorough discussion of this phenomenon. It might be mentioned here that the establishment of a typical intensity for a display is the result of conflicting selective pressures acting in a manner to insure maximum "understanding" of what the displayer may do next while at the same time minimizing any possible ambiguity.

It may be of value to mention here the fact that the amount of attack or escape valence cannot always be determined by the proportion of attack and escape motor elements incorporated in a given agonistic display. Once such a display has evolved and become at least partly ritualized (see Blest, in press) its threshold of response may have become shifted somewhat from its original source. Hence, a display made up of (and originally caused by) a preponderance of escape tendency may have its threshold of response shifted, through selective pressures operating until the display comes to have a high attack valence. The Spread Display of the Wood Thrush (*Hylocichla mustelina*) (Dilger, 1956) for instance, seems to have incorporated a great amount of escape motor patterns (much plumage fluffing and ruffling) but the display itself has a high attack valence. Thresholds, of course, can shift the other way and motor patterns originally associated with attack can come to have a greater escape valence. It must be remembered that any shifts in the form and/or "meaning" of displays must be coincident with the innate and/or learned "understanding" of the recipients.

Motor patterns associated with the attack tendency in redpolls consist of orientation toward another individual, locomotion toward another individual, and/or associated intention movements (see Daanje, 1950, for a discussion of intention movements). The acts of pecking, biting, holding, etc., are also, of course, associated with the attack tendency.

Motor patterns associated with the escape tendency in redpolls are orienting away, or moving away, from other individuals as well as the intention movements for doing so.

The various plumage adjustments such as sleeking, ruffling, and fluffing, which are incorporated are all probably intention movements to locomote and/or temperature adjustment mechanisms. The discussion by Morris (1956) of these phenomena is useful in this regard. The fluffing of the plumage associated with the escape tendency (submissive display) serves an appeasement function (Front. A). This posture is similar in many ways to the posture adopted by sick, cold, or resting birds. Its use as an appeasement signal may have been facilitated by its previous association with an inactive and therefore non-aggressive state, as well as by its difference from the Head Forward Threat (Hinde, 1955–56).

Visual Displays.—The displays dependent upon conflicts caused by the presence of attack and escape tendencies are mostly variants of the Head Forward Threat posture (Front. D). This posture is characterized by the bird's crouching slightly by bending its legs at the hip, knee, and "heel"; the plumage is sleeked to varying degrees (these are all probably originally intention movements to fly); and the head is carried in line with the body and pointed toward the opponent. When the escape tendency is relatively strong the feathers of the crown are somewhat fluffed. The various fluffings associated with the escape tendency occur in situations where the escape tendency is thwarted either by an incompatible tendency such as attack (intrinsic thwarting) or by a combination of intrinsic thwarting and some external prevention of overt escape such as being confined in a cage or the near presence of a number of dominant individuals (extrinsic thwarting). If the escape tendency is not strongly thwarted the bird may merely orient away from the external source of escape stimulation or locomote away in various speeds and manners depending upon the strength of its actual or relative escape tendency. In situations characterized by strong extrinsic escape thwarting, but subjected to persistent attack by an opponent, the bird may exhibit strong fluffing of the entire plumage as well as strong "defensive threatening" (Front. B). The same sort of motor patterns may be evinced also by birds prevented from overt fleeing because of strong intrinsic thwarting (such as a strong incubation tendency, etc.) while subjected to persistent attack.

"Defensive Threat" in redpolls consists of the bird's fluffing the entire plumage, retracting the neck (both manifestations of escape) and at the same time orienting toward, and gaping at, the opponent (both manifestations of attack).

In the opposite situation (where strong attack is thwarted either intrinsically or extrinsically) there seems to be no particular associated display but merely ambivalent intention movements, expressed alternately, characteristic of the two incompatible tendencies which have been simultaneously activated. For instance, a dominant bird with a strong tendency to feed may be approached by another individual. The dominant bird, although obviously exhibiting a very aggressive tendency and also very "hungry," often does not adopt a display but alternately demonstrates intention movements to eat and to attack.

The fact that thwarted escape is more often associated with a display than is thwarted attack probably is indicative of the fact that it is more of an advantage to an animal with thwarted escape to make its position clear to an opponent. The animal with thwarted escape is essentially indicating fear but a willingness to attack if further molested. An animal not able to flee is quite likely to avoid further attack if such information is communicated to an aggressor; hence, considerable biological advantage is gained. On the other hand, an animal with a thwarted attack usually has little if anything to lose if the actual attack has to be put off temporarily; hence, there probably is not as much selective pressure brought to bear which would tend to cause the evolution of a display in these circumstances.

Aside from the above special cases of thwarting of strong escape or attack tendencies there are several displays given by redpolls which are indicative of varying readiness to attack. Progressing from a simple orientation of the head toward the opponent (lowest indication of attack) we next find the Head Forward Threat (Front. D). This basic threat posture has been described above. Ordinarily the whole bird is oriented toward the opponent, but at low intensities only the head may be so oriented. In general, the head in any case makes the finer adjustments; the body sometimes being only roughly oriented. For instance, if the opponent is above the displaying bird, the body will remain roughly horizontal but the head will be pointed directly at the opponent. The same is true if the opponent is below the displaying bird but here the head would be lowered toward the opponent rather than raised. If it is possible for the whole bird to be oriented toward the opponent but only the head is so oriented, then the attack tendency is actually and/or relatively weak. The display with the next highest attack valence is the Head Forward with Chin-lifting (Front. E and F). Here the head is lifted in a quick perfunctory manner, sometimes several times. This action exposes the black chin and the pattern of the gonys to the opponent's view. The movement is repeated if the opponent does not, by its actions, signal some change in its mood. Other black-chinned carduelines such as the Hawfinch (*Coccothraustes coccothraustes*) and the Bullfinch (*Pyrrhula pyrrhula*) adopt a similar course of action (Hinde, 1955–56).

If the actual or relative strengths of the attack tendency continue to rise, then the Head Forward Threat is associated with Gaping (Front. G). The plumage is also more sleeked here than with the Chin-lifting, and even more so than with simple Head Forward Threat. Gaping is quite likely to have been derived from the intention movement for biting. Sometimes Gaping and Chin-lifting occur together, but this is not as common as either is alone. Apparently the exact relative and/or actual strength limits of the attack and escape tendencies responsible for Chin-lifting plus Gaping are more restricted than they are for either of these patterns alone.

Further rise in the actual and/or relative attack tendency is characterized by various strengths of intention movements to fly at the opponent. The display here is still essentially a Head Forward Threat but the plumage is very sleeked and the wings are raised to varying extents but remain closed. The wings may merely be raised a bit from their supporting feathers, thus exposing the carpal joints or they may, in extreme cases, be raised over the back (Front. H). Raised-wing displays, particularly the higher intensity forms, are not particularly common in the redpoll, and most attacks are either effective somewhere short of Wing-raising or they become supplanting attacks in which case the Wing-raising is such a quick transitory action that it can scarcely be perceived. In extreme cases the attacker may actually peck at or bite the opponent but this is rare even in captivity where escape is difficult. I have never seen it among individuals in the wild.

Auditory Displays.—Bill Snapping, presumably another intention movement to bite, which incorporates an auditory component, was not observed in these birds although it is common in many other passerines including some other carduelines (Hinde, 1955–56).

Redpolls, however, use vocal signals in agonistic situations. The commonest is a rather harsh, sharp *cheh, cheh, cheh* sound and seems to serve an intimidatory function. It was heard usually while the birds were in the higher attack displays and was uttered by dominant individuals as a warning. A similar utterance, only higher pitched, more musical, and slower in cadence, seemed to serve as a location call among members of the flock. Interspersed among bouts of these latter vocalizations are frequent utterances of a *sweeeeeeeeee* note. This is very similar to a vocalization heard from American Goldfinches (*Spinus tristis*) and Pine Siskins (*S. pinus*). It has a rising inflection, is rather high in pitch, and is quite musical.

There were some color differences among the males, chiefly in the amount of pinkish suffusion on the breast and the presence or absence of this suffusion on the cheeks. There was no correlation between color and social position. The most dominant male (The Green ♂) was less highly colored than the least dominant male (The Red ♂). The females also exhibited some variation and one, the Green ♀, had a very faint pinkish tinge to the sides of her breast, but she was the least dominant female (sex confirmed by autopsy).

SOCIAL HIERARCHY AND SEXUAL BEHAVIOR

As an outcome of rather intense agonistic activity from the time of capture, these birds soon established a very rigid social hierarchy. This hierarchy remained with no change until certain shiftings gradually took place coincident with the slow development of sexual activities later in the season. The hierarchy was established as far as I could determine, within three days from the time the birds were placed together. The establishment of such a rigid social order implies, of course, that the facility for individual recognition is well developed.

About 600 encounters were recorded and evaluated. An encounter was recorded whenever one individual avoided another as a result of an oriented action. Actual physical contact was very rare. Hereafter, individuals are designated by their band color and sex.

The males were all dominant over the females in the non-reproductive hierarchy. Moreover, the hierarchy was a linear one running from the most dominant male, through the males to the most dominant female, and thence to the least dominant female. Very few reversals of expected outcomes of encounters were noted, and most of these were clearly "mistakes" on the part of the birds involved. In most of these cases a dominant bird would be approached rapidly and from the rear by a less dominant individual which apparently did not "recognize" the individual it was approaching (most of the individual recognition features seemed to be associated with the head). The dominant bird would flee from this "pseudo attack," evidently before it recognized the identity of the "attacker."

The order which was established, starting with the most dominant bird, was as follows: Green ♂, Yellow ♂, Blue ♂, Red ♂, Blue ♀, Yellow ♀, Red ♀, and Green ♀. A graphic representation of this hierarchy can be seen in Fig. 1A. The circles represent the individual birds. The widths of the solid bars and lines are proportional to the number of "wins" over the bird to which they are connected on the right. The shaded bars and broken lines represent "reversals" in the straight-line hierarchy. Again, the widths are proportional to the number of encounters. This method of graphically representing data was adapted from one utilized by Baerends *et al.* (1955) for demonstrating the interrelationships of sexual behavior patterns in Guppies (*Lebistes reticulatus*).

Redirected Aggression.—It can be noted that birds adjacent in the hierarchy tended to be involved in more encounters with each other than with those which were not adjacent. This is to be expected, as such birds are more nearly alike in dominance value. When it became apparent that the Red ♂ was being particularly aggressive toward females, I suspected redirection on his part. A careful note was then made of what the Red ♂ did immediately after each losing encounter with another male, and in almost every case he immediately attacked a female, thus clearly demonstrating the redirectional nature of these attacks. Not only did he typically redirect to the females but these attacks were especially vigorous and commonly involved feather-pulling and other physical contact. For a discussion of the phenomenon of redirection see Moynihan (1955*b*). The other three males were never observed to indulge in redirectional activities of this sort but each of them, during the normal course of events, found themselves defeating other males. Not being able to defeat a male seems to be a source of rather strong thwarting in a male.

The relationship between position in the hierarchy and aggression is not clear. For instance, the Green ♂, the dominant bird, was not particularly aggressive in the sense that he most often initiated encounters which he won. On the contrary, encounters involving him were commonly initiated by other birds which violated his individual distance. If we think of this hierarchy as a straight line from the most dominant bird to the least dominant bird, it is more accurate perhaps to say that the hierarchy is due to an increasing tendency to recognize dominance rather than a decrease of aggressiveness through the same series.

There are many possible reasons why one bird should be more or less dominant than another. Possible factors tending to permit animals to be successful in agonistic encounters include such things as: physical superiority because of size, agility, good health, etc.; "psychological" superiority because of having won initial encounters; and being on some sort of territory or even in a more familiar location as opposed to the opponent. All of these could work in varying combinations to cause one individual to be more dominant than another. The reverse of the above conditions, on the other hand, tends to cause animals to be less dominant.

It must be remembered that the attack and escape tendencies have not evolved as a means to an end nearly to the extent other tendencies have, such as the sexual, feeding, and drinking tendencies, for instance. Attack and escape are almost always associated with gaining some advantage relative to other tendencies, and as such may be thought of as "service tendencies." Their expression allows an animal to gain food, water, space, mates, and escape from enemies or other undesirable or dangerous features of the environment. The use of attack and escape tendencies may, upon occasion, even be somewhat interchangeable. For instance, a bird may learn that it can approach a more dominant individual more closely if it adopts a submissive posture than it could otherwise. This might well allow this individual to feed, drink, or bathe in situations where it otherwise could not. In a case like this, the animal has profited by learned use of the escape motor patterns whereas it might have employed motor patterns associated with aggression in the presence of a less dominant individual.

A less dominant individual near a more dominant one conducts itself in such a way as to minimize the possibility of provoking an attack. The greater the disparity between the social positions involved, the greater the care taken by the less dominant bird not to provoke an attack. Less dominant birds do not move quickly in the presence of dominant individuals. They do not approach directly and from the front, but approach indirectly and from the rear or obliquely. They avoid orienting the head toward a superior, and frequently have the plumage fluffed to some degree indicating their submissive tendency. The Green ♀, the lowest bird in the hierarchy, was almost perpetually in the Fluffed Submissive posture.

Less dominant birds in general behave as if they had a very keen awareness of the presence of superior individuals. Dominant individuals, on the other hand, essentially behave as if their inferiors existed hardly at all.

"Unprovoked" attacks were made only by the Red ♂ and then only on females to which he was redirecting. These attacks were unprovoked in the sense that the recipient did nothing to warrant them. Such attacks are provoked, however, in the sense that these females were the only available individuals to which the redirecting Red ♂ could find a safe outlet for his otherwise thwarted aggression. These females had apparently learned to leave him alone even when they became aggressive with the onset of the reproductive season.

Straight line hierarchies were also found in Red Crossbills (*Loxia curvirostra*) (Tordoff, 1954) and in the Chaffinch (*Fringilla coelebs*) (Marler, 1955). No mention of redirection being evinced by the least dominant male is made by either of these two authors. However, Tordoff does mention that the least dominant male crossbills were particularly aggressive toward females and that this "provides an outlet for aggressive drives in the males ranked low in the male peck order." Marler does not emphasize any particularly great amount of aggression of low ranking males toward females, but both of his tables on page 111 indicate that in each case the low ranking male was involved in an inordinately great number of encounters with females. This seems to be enough evidence to suggest that low-ranking male Red Crossbills and Chaffinches may also redirect to females.

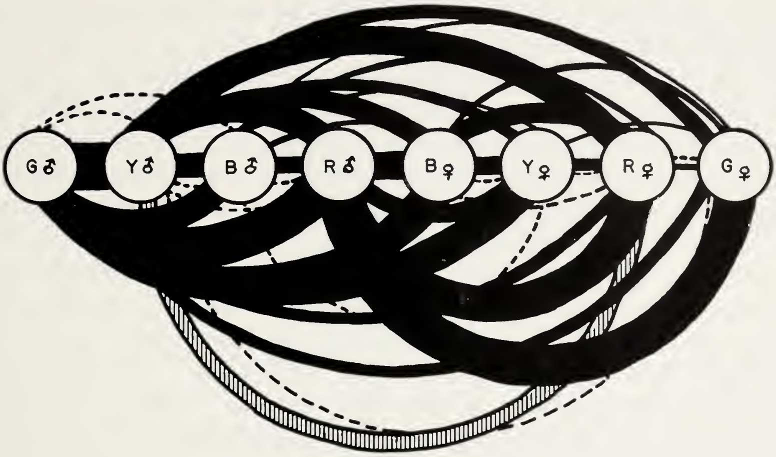
Marler (1957) came to the conclusion that Chaffinches have no innate, spontaneous appetitive behavior for fighting when in non-reproductive condition. This conclusion is in accord with my findings with redpolls. Fighting (usually only displays) only occurred in response to some external situation. This was ordinarily a situation where the attacker had to violate individual distance in order to feed, perch, bathe, drink, etc. Marler expresses his findings in this regard thusly: "When they seek fights, it can be related either to an aggressive mood aroused by external stimuli in the immediate past, or to a learned association between fighting and other activities."

After the hierarchy had been established for a few days the amount of overt aggression was markedly reduced. It was as if each bird had learned its place and the slightest reminder was all that was necessary to maintain the order. A dominant bird would merely have briefly to orient its head toward a lower ranking individual in order to cause it to retreat or stop. Often relatively very dominant birds would continue whatever activity they were engaged in at the time (husking seeds, preening, stretching, etc.) while orienting the head briefly at the opponent—with complete effect. Most of the displays occurred between individuals close in the rank order. This is to be expected as these individuals were closest in dominance and thus the attack and escape tendencies typically involved in each case tended to be closest in strengths.

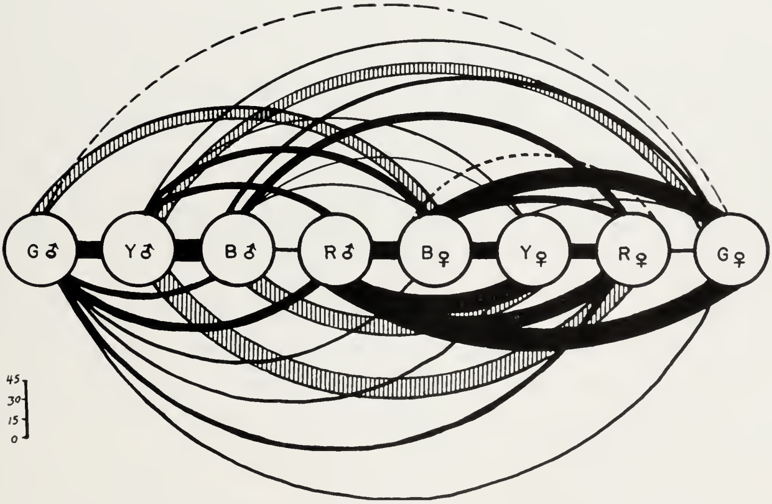
Reversal of Dominance.—As the birds demonstrated gradually increasing tendencies to behave sexually, the females gradually assumed an increasing amount of aggressiveness directed toward the males. Fig. 1A shows the Red ♀, the first to demonstrate this, having increasing success against the Yellow ♂. Fig. 1B was computed from data accumulated immediately after those for Fig. 1A and shows the reversal of dominance at a further stage. It is curious to note that the females did not become dominant over the males in general but that each female tended to select a particular male upon which to bestow her attentions. The male thus singled out behaved gradually less aggressively to "his" female as well as to other females. The Red ♂, however, continued his disproportionate aggressions against females and hence was not "chosen" by any of them as the recipient of their attentions. This, in effect, made the flock one male short and both the Red ♀ and the Green ♀ concentrated on the Yellow ♂. Aggression between these two females did not increase, however.

Hinde (1955) found the same shift in dominance in several other cardueline species, for example: Canary (*Serinus canarius*), Greenfinch (*Chloris chloris*), Bullfinch, Hawfinch, and the European Goldfinch (*Carduelis carduelis*). This situation is also found in the Chaffinch (Marler, 1955). These data and those of Hinde, Marler, etc., show that males, when in non-sexual condition, are dominant over females.

The suggestion is made that if this mechanism of female avoidance of the least dominant male, because of his redirected aggression, is working in the wild then it might serve to reduce the possibility of such "weak" males from contributing to the gene pool. There is at present no evidence from the



A



B

Fig. 1. Diagrams of encounters among individuals: (A) April 9 to April 22 (28 hours of observation), (B) April 23 to May 11 (38 hours of observation). Black bars and continuous lines should be read from left to right, shaded bars and dotted lines from right to left. The thickness of the bands are proportional to the number of encounters which the individual at the beginning of the bar won over the one connected to it at the end.

wild to indicate this. For a number of reasons it would seem unlikely, although the possibility remains.

The Green, Yellow and Blue males also began to sing more often and finally established territories in the small cage. Each chose a spot as far from the others as possible. The Red ♂ did not choose a territory and although he sang upon occasion, he maintained his dominance over females to the end of the investigations in early May. Actual encounters between males decreased during this early reproductive period. The songs apparently served to discourage encroachment upon the tiny territories. The males continued to feed, drink, and bathe side by side with no indication of increasing aggression among them. The fall in the amount of aggression among the males is probably due to the fact that they spent so much more time "on territory" that violations of individual distances decreased in frequency. An ordinary amount of aggression continued at feeding and watering places.

A new vocalization, other than advertising song, became apparent with the onset of this reproductive period. This was a harsh, rather high-pitched dry buzz with a speeded up ending; somewhat like the sound made by tearing a piece of coarse cloth. The function of this was not determined. This was largely because it was usually impossible to ascertain which bird uttered it at any given time. What little information I could gather seemed to indicate that it was indicative of a thwarted sexual tendency. Males were heard to give this vocalization if a female refused to be fed or if one moved away from this or other advances by the male. The advertising song, like the advertising song of many cardueIines, was mainly composed of a conglomeration of the usual social and agonistic vocalizations.

The Green ♀, the lowest ranking bird, kept herself in almost perpetual fluffed posture during the non-reproductive period but changed greatly later on, during the reproductive phase, and became quite active, especially in showing aggression to the Yellow ♂. As the reproductive season progressed the females began to spend more and more time in the company of the male to which they displayed most of their aggression. The birds in the cage were now most commonly seen sitting in pairs although considerable social coherence in the entire flock was still apparent.

Another manifestation of increasing reproductive condition in these birds was the advent of "courtship feeding." This normally consisted of the male passing food to the female. The food itself was always partly digested and never whole seeds. The tendency to courtship-feed gradually increased over a period of weeks. The increase in tendency was manifested by an increase in the completeness of the motor patterns involved until finally the complete act was typically performed. This act may either be initiated by the male or by the female. The male may gently peck at the corner of the female's mouth and she, if so inclined, will then open her mouth. The female may initiate courtship feeding by soliciting with open mouth. During courtship feeding the male stands rather erect and high on his legs, and then reaches down with his bill toward the squatting and somewhat fluffed female. Associated with the actual regurgitation of food by the male is a small amplitude, laterally-rolling vibration of the head which lasts for about a half second for each regurgitation. If the female, amenable to being fed, does not proffer her bill promptly when the male is ready with a beakful, he rapidly vibrates his mandible and tongue up and down with the bill slightly opened. This usually suffices to induce the female to permit a feeding contact. If it does not suffice, the male will then gently peck at the corner of the female's mouth. Feeding contacts ordinarily last for several seconds and sometimes as long as a minute or two. The food is rapidly pushed into the female's mouth with quick piston-like motions of the male's tongue. A bout of bill wiping by both individuals immediately follows the feeding bout. Sometimes the bills become rather generously daubed with the pasty white food.

Indications of courtship feeding began in early April. At first these were little more than repetitive gentle pecking by the males at the sides of the bills of the females. The postures of the two birds were always as described above even though the tendency to perform the feeding act was typically very low. A little later the motor patterns of the actual food regurgitation and transfer appeared but no food was actually passed. The complete act was ordinarily performed by a little past the middle of April. The frequency of occurrence of "normal" courtship feeding increased until the end of April. At this time the tendency for the males to perform this act waned markedly. The females, however, retained a strong tendency for being fed. After the first week in May courtship feeding remained a common activity but usually involved two females. It seems likely that this condition was an artifact of the conditions of captivity. It may be that because the birds were not able to perform the normal reproductive cycle, including the holding of adequate territories with the associated privacy of the pairs, the males were caused to cease their courtship feeding activities abnormally early, thus causing the females to resolve their still strong courtship feeding tendencies among themselves.

This "pseudomale" behavior on the part of the females which fed other females might be expected to be performed by females relatively higher in the dominance order than those being fed (see the excellent review paper by Morris (1955) on this subject). This was typically not the case. All of the females participated in this behavior but in the vast majority of cases the Yellow ♀ was the recipient and the Red ♀ the one assuming the "pseudomale" behavior. There were but four cases observed involving a dominant female feeding a less dominant one, (Blue ♀ feeding Yellow ♀). The Red ♀ was observed to feed the Yellow ♀ 35 times. The reason for this is not clear to me. It may be tied up with the fact that females are normally dominant to males during the sexual phase of their behavior and/or it may be because the Yellow ♀ had an abnormally low threshold for being fed. Even when the males were feeding the females, the Yellow ♀ was the commonest recipient of food. Even though the Yellow ♀ was the usual partner it was the Blue ♂ with which she finally paired, but he was never seen to feed her! The Blue ♂ did not feed any female very much although he sang more persistently than did any of the other males. The Red ♀ was seen to be fed by males only twice; once by the Green ♂ and once by the Blue ♂. A very fleeting feeding contact was once observed in which the Red ♀ fed the Yellow ♂ (the only case of a female feeding a male observed). The Yellow ♂ was once seen briefly to feed the Red ♂ (the only male-male feeding observed). In this latter case the male demonstrating the "pseudofemale" behavior was the less dominant individual.

Unfortunately, I was forced to terminate my observations on these birds early in May and was unable to follow this behavior any further. Cursory observations past early May were enough to reveal the fact that the females finally became totally dominant over their males and that Red ♂ never gave up his redirected attacks.

The following spring at Cornell University I liberated two pairs of these birds into a large (16 feet by 22 feet by 8 feet high) outside flight cage adjacent to my office. The remainder of the original birds had been liberated with the exception of a few kept in cages in the laboratory. The flight cage was densely planted in places with *Viburnum* bushes or small hemlocks. Nevertheless, the birds never successfully nested, although further sexual behavior was observed. This included further male sexual displays, copulations, and low intensity nest building.

The male displays mentioned above consisted of a posture oriented at the female and looking very much like a Wings-raised Horizontal Threat, except that the wings (held out horizontally from the body) were spread and quivered. This would be shown for many seconds at a time. The head was often tipped up slightly and the mouth held open. Males in this posture would make tiny, quick hops along a perch or on the ground toward the female. No associated vocalizations were noted although they may have been very faint. The males also performed another display which seemed to be derived from inhibited mounting of the female. This consisted of a "moth-flight" (rapid wing beats of small amplitude) while hovering just above a perched female. If the female responded by crouching, slightly spreading and quivering her wings, and raising her head and tail, the male would immediately land on her back and attempt copulation. The duration of copulations were usually about three seconds. The female would immediately afterward ruffle and shake her plumage and engage in a bout of preening. The male usually flew off some distance and began advertising song from one of his song perches. Males also occasionally were seen to preen after copulations.

The low intensity nest building observed consisted of females gathering fine pieces of grass, rootlets, etc., and carrying one or more bits of the material about the aviary for some time. Her male would ordinarily follow her about while she was so engaged and, more frequently, would engage in both the Head Forward Threat type display or the "moth flight" display.

Experiments on the Effects of Starvation and Proximity

Shortly after the 31 redpolls were captured, experiments were conducted to investigate the effects of starvation and proximity on agonistic behavior. All birds were in the non-reproductive condition during the course of these studies.

Since food and water were continually available, hunger and/or thirst had little or no effect on the social order. Most of the encounters, as mentioned above were caused by violations of individual distances. The only effect of hunger shown by birds that were equally deprived of food for a short period (three or four hours) and then presented with food, was to prompt less dominant birds to be more "reckless" about violating the individual distances of more dominant birds. This, of course, increased the number of encounters but their outcomes did not even temporarily upset the established hierarchy. The effects of differential starving on dominance have not as yet been studied. The starvation experiments were repeated a number of times and longer periods of starvation prompted greater numbers of encounters than did shorter ones.

I have noticed that during the winter ordinarily inferior Tree Sparrows (*Spizella arborea*) in possession of a food source became temporarily higher in dominance until their tendency to eat had markedly waned. These birds dug little pits in the snow in order to expose seeds which had been placed out for them. Such birds would often dig themselves nearly out of sight. Less dominant birds would vigorously defend their pits against ordinarily more dominant birds and would be successful until they had eaten for some time; after which they could be driven off by these dominant individuals. The relationships among hunger, thirst, aggression, and dominance are not at all clear as the evidence so far is somewhat conflicting. Marler (1955) studied the effects of starvation on the social order of Chaffinches and had results similar to mine for redpolls, and the same may be said in regard to Andrew's (1957) study on *Emberiza*.

In order to study the relationship between proximity and aggression in redpolls I constructed two identical food hoppers which were placed side by side and fashioned in a manner which allowed them to be slid along a horizontal rod calibrated in centimeters. The feeding apertures of the hopper could thus be placed at various distances from one another. This set-up was essentially similar to one used by Marler (1955) in order to investigate the same phenomena in Chaffinches. His results were similar to mine. Unfortunately, I was obliged to discontinue the investigations before an adequate amount of quantitative data became available. The females tolerated each other at much closer distances than did the males. The distances involved were about 4 cm. between females and about 10 cm. between males. Heterosexual combinations were intermediate at about 7 cm. The equivalent distances for Chaffinches (Marler, 1955) were 7 to 12 cm. for females, 18 to 25 cm. for males, and 8 to 12 cm. for heterosexual combinations. Marler found that there were some differences among various flocks in this regard. Some individuals were also more tolerant than others regardless of their positions in the hierarchy. Thus the most dominant male was not necessarily the least tolerant individual. These findings were also in agreement with my observations on redpolls except I had no measure of flock differences since I worked mostly with but one flock.

The distance measurements stated are indicative of a zone, rather than an abrupt threshold distance. This zone is measured as the distance at which approximately half of the time individuals would be tolerated and half of the time not tolerated. Birds showing some indication of submissive behavior (plumage fluffing) were tolerated at closer distances than those demonstrating some intensity of aggression. Again these findings agree with those of Marler (1955).

The initial vigor demonstrated by the various birds of the flock in their agonistic encounters may have played a role in the eventual determination of the social hierarchy. All birds were placed together at the same time so that prior residence did not have a bearing on social position. It may have been that at least some of these birds "knew" each other in the wild and this may have had a bearing on the eventual social structure in the cage.

I am indebted to the R. T. French Company of Rochester, New York, for financial aid enabling me to pursue this study, and also to Dr. Edward Warner of St. Lawrence University for his friendly cooperation and for making the facilities of the Department of Biology available.

SUMMARY

Thirty-one captive redpolls were studied in the laboratory but only eight of them (four males and four females) were studied intensively. Their agonistic behavior was described and evaluated, and the Head Forward

Threat display and its variants were found to be the chief displays indicative of varying readiness to attack. They have the usual passerine fluffed submissive posture and employ a defensive-threat display involving simultaneous submissive patterns and attack patterns.

This flock of eight birds quickly developed a linear hierarchy beginning with the most dominant male and running to the least dominant female. This is similar to hierarchies found in captive Red Crossbills and Chaffinches. The least dominant male showed an unusual amount of aggression to females and this was demonstrated to be caused by redirection.

Each female eventually, as the birds gradually began to behave sexually, became dominant over a particular male. This reversal of sexual dominance is known for several other species. The least dominant male was never "chosen" by a female, presumably because of his continuing history of redirected aggression.

Mild starvation of a few hours increased the number of encounters but did not affect the social hierarchy. It was found that females tolerate each other at smaller distances than males tolerate each other. Heterosexual combinations were intermediate in this regard.

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LABORATORY OF ORNITHOLOGY, CORNELL UNIVERSITY, ITHACA, NEW YORK, APRIL 9, 1959

NEW LIFE MEMBER

Mrs. G. Hampton (Elizabeth Taylor) McGaw, a graduate of Mount Holyoke College (B.A.), has been interested in birds for many years, strictly as an amateur. Forty years ago Mrs. McGaw taught bird and other nature study to her Camp Fire Girls, then began speaking before women's clubs and granges on the economic value of birds, and now is an active and generous supporter of conservation organizations. She is a life member of the American Forestry Association, the New Hampshire Audubon Society, and is becoming a life member of the A. O. U.

A QUANTITATIVE STUDY OF SEXUAL BEHAVIOR OF MALLARDS AND BLACK DUCKS

BY PAUL A. JOHNSGARD

In recent years an increased interest in the use of behavioral characteristics in evolutionary studies has developed, and this is particularly true in the case of waterfowl. The classical studies of Heinroth (1911), who was one of the first to apply knowledge of waterfowl behavior to systematics, have been elaborated on by Lorenz (1941; 1951–1953) in his important contribution toward the understanding of relationships in the Anatinae. These, and other, studies have stressed the qualitative behavioral differences occurring among different species as providing possible isolating mechanisms through their presumed function of conveying species-specific recognition signals. To the present, no extensive quantitative studies of the behavior of very closely related forms of waterfowl have been undertaken, although Dr. D. F. McKinney's still uncompleted studies on the races of the Common Eider (*Somateria mollissima*) will provide an important contribution in this field. By studying the reproductive behavior of such closely related forms the evolution of isolating mechanisms can be fruitfully studied in their early stages and thus provide an insight into the general process of speciation.

As part of a more general study (Johnsgard, 1959) concerning the evolutionary relationships between the Mallard (*Anas platyrhynchos*), the Black Duck (*Anas rubripes*), and other closely related forms, behavorial characteristics were utilized as taxonomic characters. The results of this general study, which will be published later, indicate that the Black Duck is much more closely related to the Mallard than is generally supposed and that the two forms should probably be considered to be only subspecifically distinct. The purpose of the present paper is to summarize the quantitative aspects of the behavioral studies and to discuss their probable significance in terms of (1) the evolution of behavioral isolating mechanisms; (2) the relative importance of display and plumage in species-recognition signals of these birds; and (3) the concepts of response specificity and response thresholds, or "drive."

METHODS AND OBJECTIVES

Observations were made over a two-year period on flocks of Mallards and Black Ducks in the Cayuga Lake region of New York. Mallard observations were carried out in large part at Stewart Park, Ithaca, where a semi-tame flock of approximately 200 birds is present the year around. Wild Black Ducks were observed primarily at the Howland's Island Game Management Area, near Port Byron, New York, where large numbers (1000 to 2000) of these birds winter with the waterfowl breeding stock of the New York State Department of Conservation. Wild Mallards also winter at Howland's Island, and supplementary observations on this form were made there. Most observations were made with the aid of a 20-power spotting scope, and approximately 1000 feet of 16 mm. motion picture film were exposed and analyzed for critical comparisons between the two forms.

For the use of camera and projection equipment I extend my sincere thanks to Dr. W. C. Dilger. I especially express my deepest appreciation to my graduate committee chairman, Dr. C. G. Sibley. Dr. L. C. Cole suggested certain statistical analyses. The study was financed in part by fellowships from the Cornell University Graduate School and the National Science Foundation.

Although the sexual displays of the Mallard are well known (e.g., Lorenz, 1951–1953; Weidmann, 1956; Ramsay, 1956), very few observations on the corresponding displays of the Black Duck have been published. The few which have been published, such as those of Trautman (1947) and Wright (1954), have dealt for the most part with copulatory behavior or aerial chases. According to Ramsay (1956) and Delacour (1956), Black Ducks differ in their sexual behavior from the Mallard only in that the "Head-up-tail-up" and "Nod-swimming" displays are independent in the former, but are linked in the latter. (Names given displays are those of Lorenz, 1951–1953, and detailed descriptions of them can be found in that paper or in those by Ramsay, 1956, or Delacour, 1956.) Cursory observations of Mallard and Black Duck displays soon made it clearly apparent that courtship patterns of the two forms are extremely similar, and motion picture analysis failed to establish any qualitative differences between them. However, it was believed that possible differences might be present which could take the form of (1) differences in frequencies of the various male displays, (2) differences in seasonal periodicity of displays, or (3) differences in the contextual occurrence of the various displays in the two forms.

With this in mind, it was decided to record the male responses which were usually elicited by unmated females and which could conceivably act as potential isolating mechanisms by providing specific recognition signals. There are three such responses, those called by Lorenz (1951) the "Grunt-whistle," the "Head-up-tail-up" with associated "Nod-swimming," and the "Down-up." Other male responses, such as "Mock Preening" and copulatory behavior, either occur very rarely or are of uniform nature throughout a wide range of species and thus probably could not function effectively in species recognition. The total number of each of the three mentioned male displays observed during each "bout" of display was tallied. A "bout" could range from a single male display to five or more males displaying simultaneously with the same or different movements toward a single female. The accurate recording of such combined displays involving several drakes has an obvious limit, depending upon the experience of the observer and the limitations of human perceptive powers. This limit, in my case, is approximately five birds. Fortunately, displays involving more than five birds displaying simultaneously were relatively rare. For the present purposes, "simultaneous" means that no noticeable temporal break occurred between the end of the first male display and the beginning of the last display. Each display in a bout involves a different male, since no male was ever observed to perform two displays during a single bout (the Head-up-tail-up and Nod-swimming are considered as a single display unit). A total of over 3000 Mallard and over 1300 Black Duck displays were recorded in this manner from September, 1958 through April, 1959, and form the primary basis for the following results and discussion.

Results

Seasonal Periodicity.—No definite differences in seasonal periodicity of displays were found. Mallards were observed displaying sexually as early as September 13, and Black Duck sexual displays were observed on the first trip to Howland's Island on October 11. The frequency of Black Duck displays observed at that time, however, indicated that they had begun considerably earlier. In Table 1 is presented the frequency of displays observed for Mallards and Black Ducks on a unit-time basis for the period September through April, and some idea of seasonal periodicity can be derived from these data. However, total numbers of birds under observation varied considerably, both between the two forms and at different times for a single form, and this makes close comparisons impossible. In addition, cold temperatures, wind, and disturbance had strong depressing effects on display frequency during any time period, and these factors also complicate the picture. Disturbance was a particularly important factor in the case of Black Ducks, which were a hunted population, and this single factor accounts in large part for the considerably lower overall frequency of courtship activity observed in that form.

Taking all of these factors into account, it was apparent that the largest numbers of birds were displaying sexually during November and December (Fig. 1). Sexual displays tapered off during the cold weather of January, and increased again in February and March. Displays were seen, sporadically, until the end of June, although females began laying early in April. However, the great majority of displays being observed from February onward was accounted for by the relatively small percentage of males not already mated, and the actual major period of sexual display appears to occur in

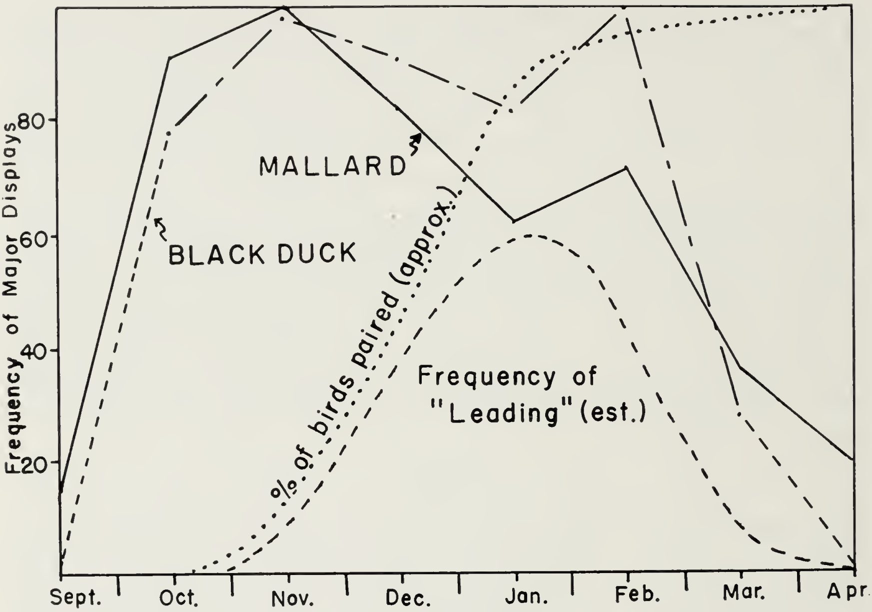

FIG. 1. Relation of approximate period of pair formation in Mallards and Black Ducks to relative frequencies of major male displays and "Leading" display.

November and December in both the Mallard and the Black Duck. These figures agree fairly well with those presented by Ramsay (1956), who found (in Maryland) a peak display frequency in December and January. The period of time required for individual pair formation in both Mallards and Black Ducks is probably much longer than is generally appreciated, and although some evidence of pairing was observed as early as late October, such pairs often appeared to be temporary. The period of pair formation does not seem clearly correlated with either the frequency of copulation (which was highest in October and November) or with the gonad cycle (Höhn, 1947), since the testes do not begin to recrudesce until the lengthening photoperiod provides a mechanism for gonadal stimulation. Stotts (1958) found a gradual increase in the percentage of paired Black Ducks from about 10 per cent in late September to about 60 per cent by April, and then rising sharply to nearly 90 per cent by early May. My own estimates of the period of major pair formation are indicated in Fig. 1, and are rather earlier than Stotts' estimates. I agree with Höhn (1947), who believed that the primary function of sexual display is in the formation of pairs, and that fall and winter copulations may serve to strengthen the bond between incipient pairs. It cannot be doubted, however, that a great many copulations occur between non-mated birds, and that therefore copulation *per se* appears to be relatively unimportant in pair formation. The apparent means by which pair formation is effected in Mallards has been discussed by Weidmann (1956), and my observations bear out his conclusions. In short, it may be stated that female Mallards (and Black Ducks) actively "select" potential mates by "Inciting" (Lorenz, 1951) them against other birds. The male response to such Inciting may be to attack the indicated individual (usually another male) or, more often in preliminary stages of pair formation at least, to respond with a special display I have termed "Leading" (Johnsgard, 1959). This display involves an orientation of the back of the male's head toward the Inciting female while swimming rapidly ahead of her. Which factors of display and/or plumage result in the selection of a specific drake by a female are still uncertain, but a few observations on this point will be discussed later.

Individual Display Responses.—In Lorenz's studies of the Mallard (1951), he concluded that the three major male displays were "of equal value," and whichever one was performed by a male was largely a "matter of chance." However, Lorenz's student Weidmann (1956) investigated this point and concluded that this is not the case. Weidmann's opinion was that the Grunt-whistle display indicates a low intensity courtship whereas the Down-up and the Head-up-tail-up displays are indicative of high intensity courtship situations. Thus, of a total of 1074 individual male displays of these types he recorded, he found that the Grunt-whistle was usually performed when a single male displayed toward a female. During displays where many males reacted simultaneously, the Head-up-tail-up or Down-up displays were usually performed. As shown in Table 1, my observations support Weidmann's conclusion that the displays are not of random occurrence or of equal probability of elicitation, since there are distinct differences in frequency of the three displays during the same time period, and of individual displays during the course of the entire pair formation period. In both the Mallard and the Black Duck the Grunt-whistle tended to be the most frequent display during the first few months of pair formation, and the Down-up tended to be least frequent. As time progressed, however, the Down-up became more frequent and comprised about half of the total male displays during peak pairing activity. This increase of Down-up displays was achieved primarily by the reduction in frequency of the Grunt-whistle in the Black Duck and the Head-up-tail-up in the Mallard. These figures thus corroborate Weidmann's opinion that the display performed most frequently during low intensity courtship situations early (and very late) in the season is the Grunt-whistle. However, in the present case the data also point to the conclusion that the Head-up-tail-up and Down-up are not equivalent either, but that the Down-up represents

TABLE 1

SEASONAL FREQUENCIES OF MAJOR MALE DISPLAYS

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total
Grunt-whistle									
Mallard	40(42%)	279(45%)	379(46%)	170(38%)	59(35%)	150(35%)	102(42%)	74(41%)	1250
Black Duck	—	66(41%)	148(30%)	34(26%)	62(27%)	43(15%)	5(19%)	—	358
Head-up-tail-up									
Mallard	35(37%)	185(29%)	202(25%)	95(21%)	19(11%)	71(16%)	41(17%)	46(26%)	694
Black Duck	—	64(40%)	200(41%)	36(28%)	81(35%)	108(38%)	8(31%)	—	497
Down-up									
Mallard	20(21%)	163(26%)	239(29%)	187(41%)	90(54%)	212(49%)	101(41%)	49(33%)	1071
Black Duck	—	30(19%)	144(29%)	60(46%)	86(37%)	133(47%)	13(50%)	—	468
Total Displays									
Mallard	95	627	820	452	168	436	244	179	3018
Black Duck	—	160	492	130	229	284	26	—	1321
Total Bouts									
Mallard	52	464	467	303	104	234	151	122	1897
Black Duck	—	76	237	74	132	144	10	—	673
Displays/Bout									
Mallard	1.8	1.3	1.8	1.5	1.6	1.9	1.6	1.4	1.6
Black Duck	—	2.1	2.1	1.8	1.7	2.0	2.6	—	2.0
Frequency of Display*									
Mallard	.13	.91	1.0	.82	.61	.71	.35	.20	—
Black Duck	—	.78	.98	.91	.81	1.0	.27	—	—

*Per unit of time, relative to month having highest frequency.

the highest intensity display since it occurs most frequently during the period of very intensive display.

It is of interest that the Head-up-tail-up, the most spectacular and complicated of the three displays, is apparently a lower intensity reaction than is the Down-up, which is a relatively simple display. However, it may be significant that, of the three displays, the Down-up has the narrowest range of interspecific occurrence, being restricted as such to the Mallard group and, in rather modified form, to the Gadwall (*Anas strepera*) (Lorenz, 1951–1953). The Grunt-whistle is of much wider distribution, occurring in the Mallard group, the Gadwall, the Green-winged Teal group (*Anas crecca, A. flavirostris,* etc.), the Pintail group (*Anas acuta, A. georgica,* etc.), and others. The Head-up-tail-up display also occurs in most of the species which possess the Grunt-whistle display. Thus the Down-up may be the most important of the three displays from the standpoint of recognition in Mallards, even though it is not the most complex.

To test the hypothesis that the three displays represent a hierarchy of reaction intensities, it must be hypothesized that the lowest intensity display would, since it results from low intensity stimulation, tend to occur most frequently as isolated displays. Conversely, when the female's behavior provides a strong stimulus, it would be expected that larger numbers of males would tend to respond simultaneously with one of the higher intensity displays. By determining the frequency with which a given display is performed by a single male, two males, etc., to the maximum number of males observed to perform a display simultaneously (i.e., during a single bout), this hypothesis can be tested. In Figs. 2 and 3 are presented such data for Mallards and Black Ducks. It will be noted that in both forms the Grunt-whistle occurs more frequently as a single display than does either the Head-up-tail-up or the Down-up. This latter display is more frequently performed simultaneously by several drakes than is either of the other two. These data thus correlate well with the supposition that the Grunt-whistle is the lowest intensity reaction and the Down-up represents the highest intensity reaction, with the Head-up-tail-up being intermediate.

At this point the assumption is that multiple simultaneous displays of a single kind are the result of a specific stimulus from a female and not simply the result of a contagious or mimetic effect resulting from several males "imitating" the display performed by the first male to respond. Although this possibility is almost impossible to test experimentally, it can nevertheless be tested statistically. That is, if the males are reacting completely independently of one another the frequency distribution patterns shown in Figs. 2 and 3 should follow a Poisson distribution, whereas if any contagious effect is present such a distribution will not obtain. A typical Poisson dis-

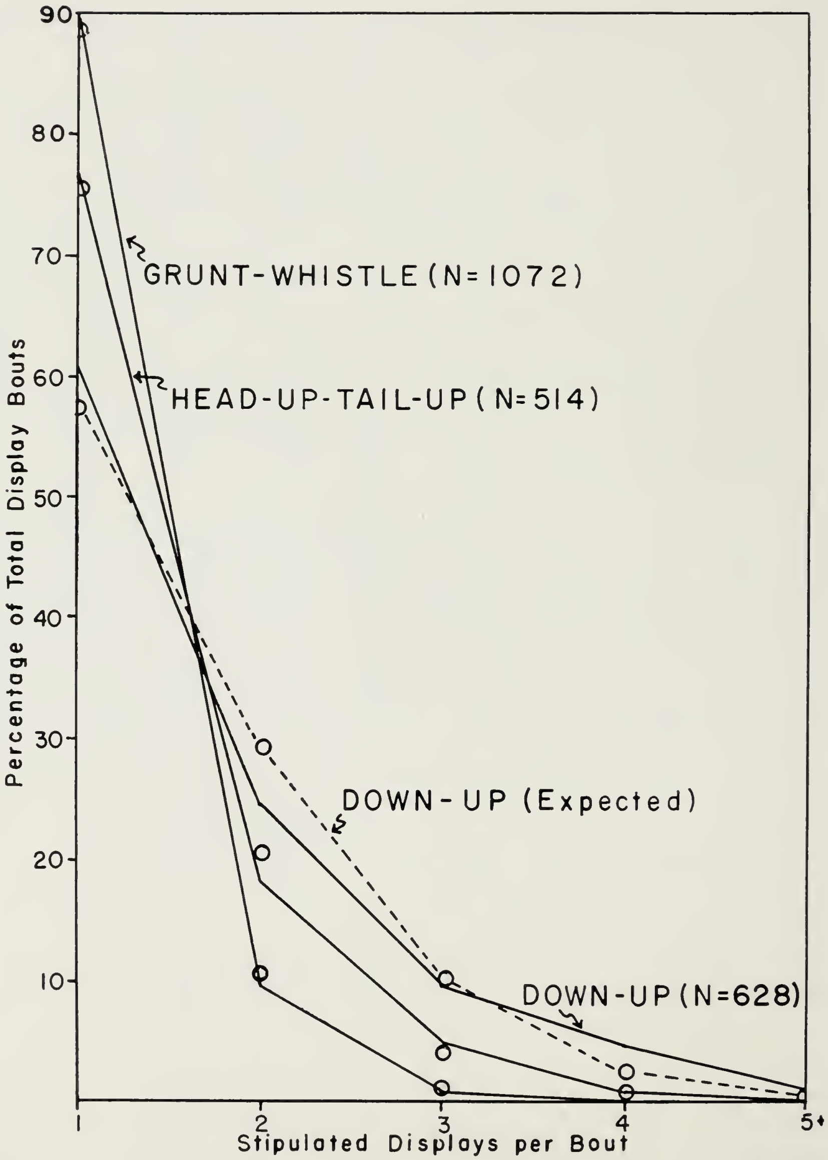

Fig. 2. Frequency distribution patterns of displays per bout observed in male Mallards. Solid lines connect observed frequencies; open circles (connected by dotted line in the case of Down-up) indicate calculated frequencies based in Poisson distributions. "N" equals number of bouts involving each of the indicated displays.

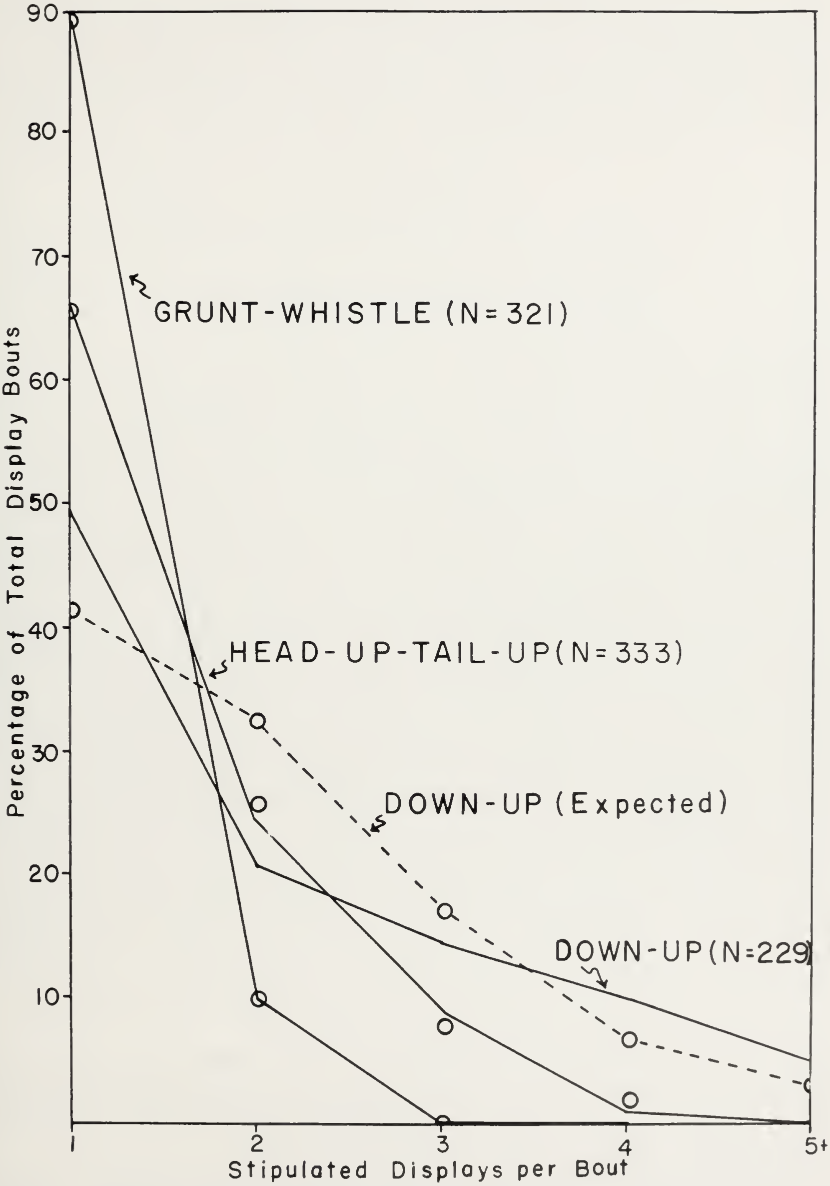

FIG. 3. Frequency distribution patterns of displays per bout observed in male Black Ducks. See Fig. 2 for explanation of symbols.

tribution contains a "O" frequency category, which in the present instance is unmeasurable since one obviously cannot tally the number of times no males displayed toward a female. However, this unmeasureable category can be accounted for (van Rest, 1937), and a mean Poisson value obtained by the general formula: $\bar{X} = \frac{m}{1 - e^{-m}}$. In this case $\bar{X}$ equals the observed, and m the actual, mean. After obtaining this value, the distribution in question can be tested to determine if it can be described by a Poisson distribution having the same mean as the calculated mean. This tended to be the case (see Figs. 2 and 3), for in both the Mallard and the Black Duck the Grunt-whistle and the Head-up-tail-up distributions could be explained ($p = .05$) by Poisson distributions having various means. For the Mallard these means were 0.23 and 0.54 for the Grunt-whistle and Head-up-tail-up, respectively, and for the Black Duck the corresponding values were 0.23 and 0.79 displays per bout. In the case of the Down-up, the observed distributions deviated sufficiently from the calculated ones to be rejected at the 5 per cent level, mainly because of too many observations in the categories of four displays or more per bout. The calculated mean Poisson figures for the Down-up were 1.03 and 1.59 displays per bout for the Mallard and Black Duck respectively. In the case of both the Head-up-tail-up and the Down-up, the Black Duck had a significantly higher ($p = .01$) number of displays per bout. Thus it may be said that the Black Duck has a lower threshold to perform the Head-up-tail-up and the Down-up than has the Mallard, as indicated by the larger average number of males performing these displays simultaneously. This may also be concluded from Table 1, in which it may be seen that the average number of total males displaying per bout is significantly higher ($p = .01$) in the Black Duck (2.0) than in the Mallard (1.6). If the relative frequency of total male displays per bout is plotted graphically (Fig. 4), this difference becomes even more apparent, and it will at once be seen that in the Black Duck multiple simultaneous displays are considerably more frequent than in the Mallard (difference significant at .01 level). The possible biological significance of these differences will be discussed later in the paper.

Finally, it may be said on the basis of the fit obtained using the Poisson distribution that males tend to react independently of one another when displaying (except possibly in the case of the Down-up), and thus presumably are reacting to a mutual specific stimulus (the female).

Combined Display Responses.—Simultaneous displays involving two or more males are frequently "mixed," rather than "pure," and may at times involve all three of the male display patterns. This is indicated in Figs. 5 and 6, in which the percentage composition of the three displays is indicated for all display bouts recorded involving from one to five or more males.

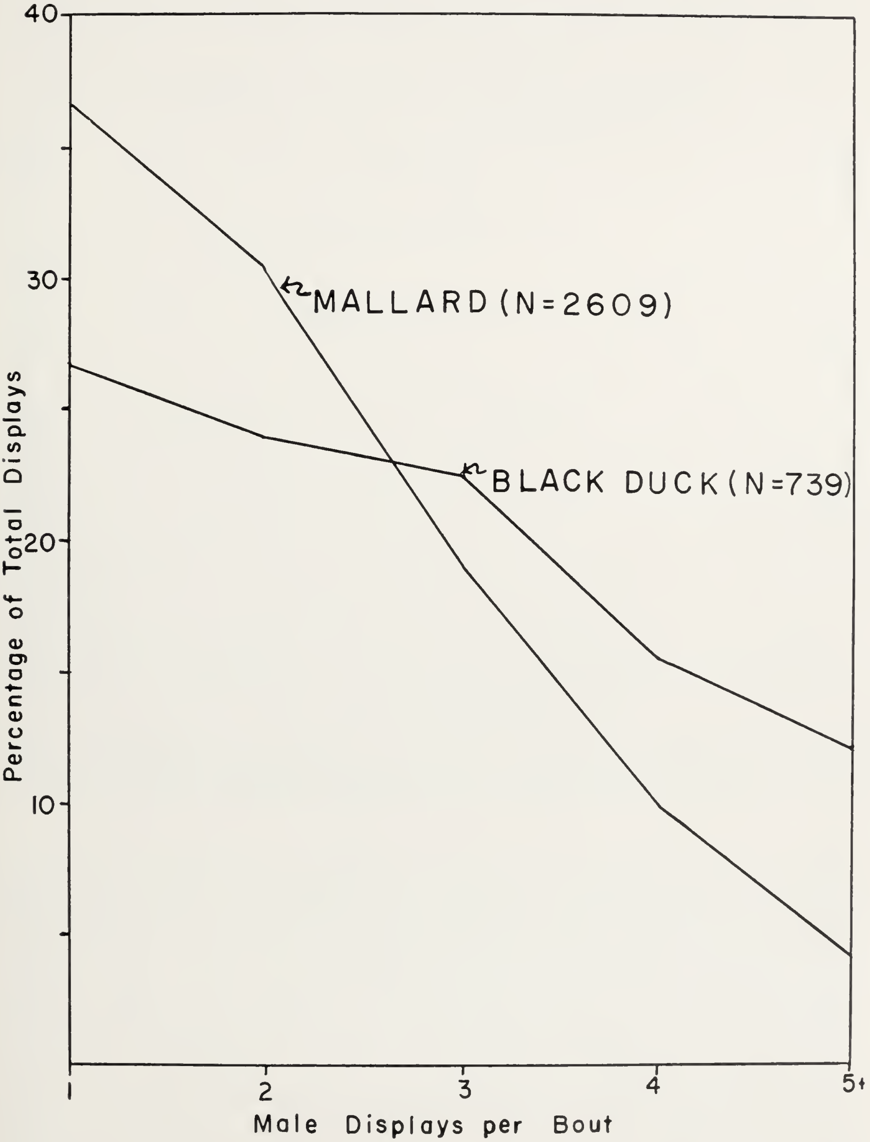

FIG. 4. Total male displays per bout observed for male Mallards and Black Ducks. "N" equals total number of displays included in sample.

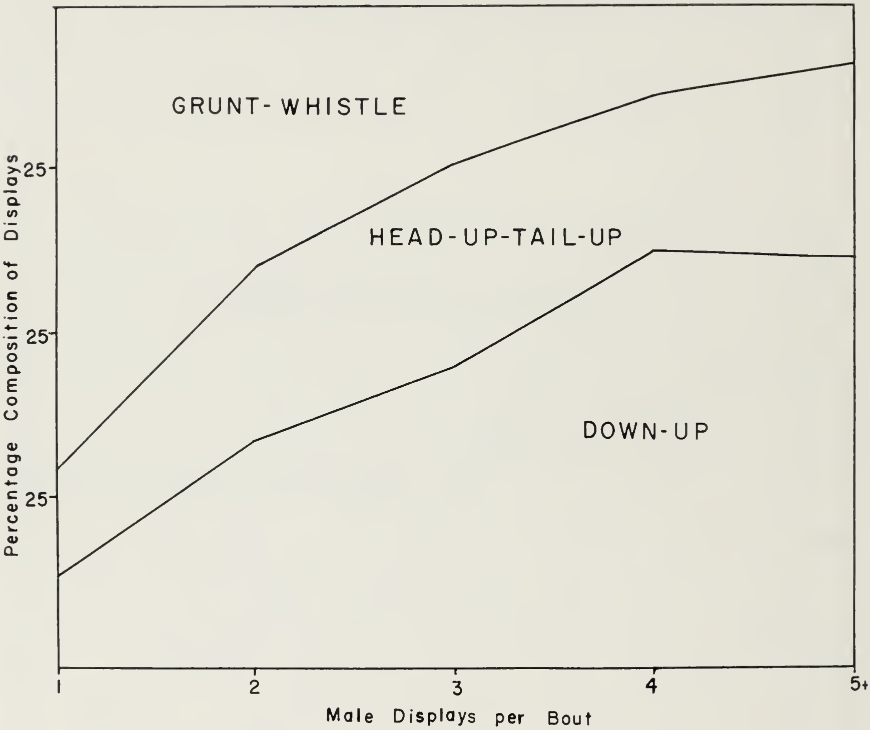

FIG. 5. Percentage composition of major Mallard displays relative to the number of total male displays per bout. Based on 2609 total male displays.

These graphs clearly point out the fact that Grunt-whistles predominate when a single male displays, that Down-ups predominate in bouts where four or more males display, and that Head-up-tail-ups tend to occur most frequently in intermediate situations involving two or three birds. Thus, of all the Grunt-whistles recorded, 58.0 per cent of the total occurred as lone displays in the Mallard and 45.6 per cent as such in the Black Duck. Of all Head-up-tail-ups, 60.3 per cent in the Mallard and 65.2 per cent in the Black Duck were performed when two or three birds displayed simultaneously. Finally, of all the Down-ups recorded, 26.4 per cent in the Mallard and 56.8 per cent in the Black Duck occurred when four or more birds displayed simultaneously. This relatively low per cent of Down-ups in the case of the Mallard suggests that Mallard males are less specific in their response to strong stimulation than are Black Duck males. More will be said of this later.

Field observations indicated that these three displays actually tend to represent graded responses to three increasing strengths of female stimuli.

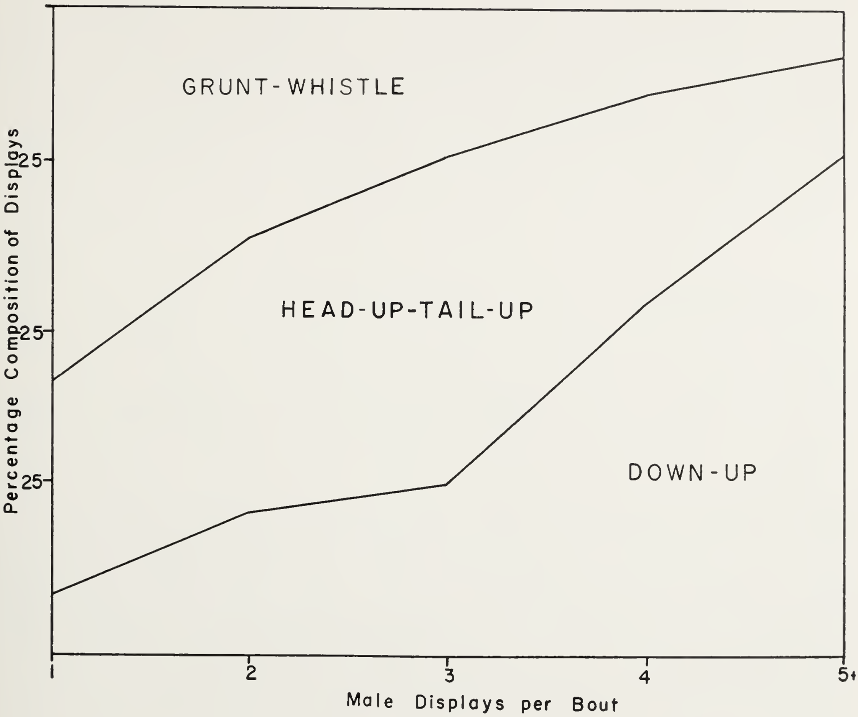

FIG. 6. Percentage composition of major Black Duck displays relative to the number of total male displays per bout. Based on 739 total male displays.

Thus, an Inciting female corresponds roughly in stimulus valence to a male Grunt-whistle response, Nod-swimming parallel to or away from a male corresponds approximately to the Head-up-tail-up response, and Nod-swimming toward a male (the strongest female stimulus) almost always results in the Down-up response. However, an unvarying one-to-one stimulus-response (or "sign stimulus"-"fixed action pattern" in ethological terms) cannot be supported by these data, since the percentage of Down-up displays varied greatly as the season progressed, but the number of male displays per bout remained relatively constant (see Table 1). Thus, a female stimulus which is sufficient to elicit a Down-up response later in the season would, in September or October, for example, most likely result in a Grunt-whistle or Head-up-tail-up. Nod-swimming by females tends to decrease later in the season (Ramsay, 1956), although it was observed as late as April in both forms. Inciting is much more common during this later period, and the male responses tend to shift from the three major swim displays to the Leading display described earlier, with several males often competing for the Leading position in front of the Inciting female. This Leading display may thus be thought of as possibly representing the highest intensity male response, and it seems very likely that it may have the greatest importance in mate selection of all the male displays. With the beginning of the male Leading displays in late October, courting groups became much more mobile and animated, and male competition became very evident. In their attempts to attain the Leading position, trailing males often made short flights (probably equivalent to the "Jump Flights" of Lebret, 1957) and landed a short distance in front of the Inciting female. Leading was most evident during December and January (when it was usually observed 20 to 30 times per hour) and tapered off in late February and March, and thus was most frequent during the period of apparent formation of pairs. It was, however, observed until the end of April in greatly reduced intensity.

This variable intensity of male displays, associated with constant or even decreasing female stimuli, seems explainable by hypothesizing a varying male response threshold to sexual stimuli. This may be the result of sex hormone level changes associated with testis growth, but no data on seasonal changes in Mallard androgen levels are available for testing this possibility. However, merely saying that the males have an increased sexual "drive" or "tendency" seems to avoid the basic question and does not contribute to its solution.

A crude measurement of this seasonal change in male response thresholds can be obtained by comparing the monthly percentage frequencies of the Down-up display, the highest intensity response of the three displays. These data suggest that the lowest male Mallard display thresholds occur in January and February. Data for the Black Duck, which are much less reliable, indicate low thresholds from December through March. Therefore, this period of low response thresholds does not fit well with the gonad cycle, since the testes do not begin to recrudesce until day-length begins to increase, and males remain sterile until mid-February (Höhn, 1947). In addition, display intensity tapers off in April, although gonad size is at a maximum during this time. Presumably, male hormone levels are closely related to gonad volume or size, which varies immensely in these birds, and this casts doubt on a close connection between male response thresholds and male hormone levels.

Specificity of Response.—Weidmann (1956) believed that simultaneous group displays involving Down-ups and Head-up-tail-ups tended to show a higher frequency of "pure" displays than one would expect to result from chance which, since mimesis is apparently not important, implies that the males tend to respond specifically to female stimuli. Weidmann's conclusions appeared, judging from his tabular data, to be based on 78 bouts of display. This conclusion seemed important enough to warrant further investigation, so the frequencies of all recorded combinations of these two displays have been determined for the Mallard (927 bouts) and Black Duck (456 bouts), and are presented in Tables 2 and 3. Inclusion of Grunt-whistles, which would have necessitated the construction of a three dimensional table, did not seem justified because they form a very minor component of multiple displays (see Figs. 2 and 3).

As a measure of the randomness of response, the expected frequencies of each of the possible combinations of these two displays can be calculated for each sample of bouts involving a given total number of males perfoming the two displays. That is, if the male responses are random in nature, they should "segregate" according to the random probability frequencies for each combination class. Such expected frequencies have been calculated, and are placed in parentheses below the observed frequencies of each combination class. An index to the relative "purity" of male response is obtained by comparing the number of observed "mixed" display bouts to the expected number. Thus in the Mallard 141 bouts of "mixed" displays were observed, whereas 224 would have been expected on the basis of random response (62.9 per cent of the expected). In the Black Duck 90 out of a calculated 158 expected bouts were recorded, or 57.0 per cent of the expected. In both cases the differences are highly significant (p less than .01), and it may be concluded that male Mallards and Black Ducks do tend to respond specifically to female stimuli. That such a response specificity exists should not be surprising, and the above technique seems to provide a useful measure of the degree of response specificity.

Individual Variation in Response.—Sources of individual variation are presumably of two types, namely variations in intensity of performance of the various displays by a single individual as a result of variations in its internal state or the strength of the external stimulus and, secondly, genetic variation among different individuals in the population. Since only unmarked birds were studied it was not possible to completely separate these two variables, but some pertinent observations might be mentioned here.

According to Delacour (1956) and Ramsay (1956), Mallards differ from Black Ducks in that the Head-up-tail-up display is linked to the subsequent Nod-swimming in the Mallard, whereas in the Black Duck the two displays are independent. Of 665 Mallard Head-up-tail-up displays I recorded, 625 (94.3 per cent) were followed by Nod-swimming, whereas in the Black Duck 479 out of 490 (97.7 per cent) were followed by Nod-swimming. Thus the two displays are actually strongly linked in both forms, and the statements of Delacour and Ramsay to the opposite effect are not supported by my

TABLE 2

RECORDED BOUTS OF MALLARD DISPLAY COMBINATIONS

		Males Performing Head-up-tail-up Display					
		0	1	2	3	4	5
Males Performing Down-up Display	0		258 (258)	65 (60)	17 (15)	1 (2)	1 (0)
	1	258 (258)	70 (120)	16 (30)	4 (9)	2 (2)	
	2	104 (60)	30 (30)	5 (14)	2 (4)		
	3	57 (15)	8 (9)	2 (4)			
	4	20 (2)	2 (2)				
	5	5 (0)					

data. In the small percentage of cases where Nod-swimming did not follow the Head-up-tail-up the apparent reasons were that (1) the male was unfavorably orientated with respect to the "courted" female (e.g., she was swimming away from him), (2) the male was still partially in juvenal or "eclipse" plumage and thus probably had a high response threshold, or rarely, (3) the male was physically prevented from Nod-swimming by the presence of several other birds directly in front of him.

Variations in display intensity were evident in all of the displays. For example, low intensity performances of all three major displays often lacked the whistle that normally is associated with all of them. This was particularly true during the first few weeks of display when many birds were still molting into nuptial plumage and also during the last weeks of display in April. Of the three major displays, the Down-up appears to be the most variable in intensity, judging from inspection of motion picture film. That is, the "Down" phase varied from only a very slight downward body inclination to one in which the whole forepart of the body was submerged. Variations in the length of time required to complete a display did not appear to be great, with the notable exception of Nod-swimming, in which the female's orientation had a profound effect on this display's length.

All of the above examples of variation seem explainable by quantitative

TABLE 3

RECORDED BOUTS OF BLACK DUCK DISPLAY COMBINATIONS

		Males Performing Head-up-tail-up Display					
		0	1	2	3	4	5
Males Performing Down-up Display	0		152 (107)	59 (30)	23 (8)	1 (2)	1 (0)
	1	61 (107)	35 (60)	10 (24)	4 (9)	1 (3)	
	2	27 (30)	14 (24)	5 (14)	0 (6)		
	2	17 (8)	11 (9)	5 (6)			
	4	17 (12)	5 (3)				
	5	8 (0)					

variations in stimuli strength and response thresholds of individual birds. Evidence for genetic variation within the total population was possibly indicated by the small percentage of abnormal displays seen. For example, although the display which Lorenz (1951) termed "Bridling" normally occurs in the male Mallard only after copulation, it was observed to be intercalated between the Head-up-tail-up and Nod-swimming on three occasions out of the total 625 Head-up-tail-up and Nod-swimming combinations recorded. In the Black Duck this variation was recorded twice out of the 479 such combinations. In addition, an independent Bridling followed by Nod-swimming was observed twice in the Mallard and not once in the Black Duck. Finally, an isolated Bridling movement was observed once in the Mallard. It is of interest that Bridling normally occurs in these same display combinations in a few closely related species such as *Anas castanea* (Lorenz, 1951–1953), which suggests that this might be an ancestral mallard condition which is occasionally expressed in certain genetic recombinations or mutant individuals.

Hybrid Behavior and Mallard-Black Duck Interaction.—Wild hybrids between Mallards and Black Ducks are relatively common in the Ithaca area, and repeated counts of wild Black Duck flocks suggest that roughly 3 per cent of the males exhibit rather obvious hybrid ancestry. Hybrid incidence is considerably higher toward the western edge of the Black Duck's range (Johnsgard, 1959), but they occurred in sufficient numbers in the area of study to allow certain observations of behavior.

Since no qualitative differences were observed in the behavior of the parental forms, it is not surprising that hybrids exhibited no noticeable deviations in their sexual displays. Hybrids also exhibited no greater or lesser frequency of display, although I do not have sufficient data to demonstrate this statistically. In short, hybrids displayed among courting groups of both parental forms, but those which showed a predominance of Mallard or Black Duck characteristics usually were to be found displaying with that form. All of the male displays observed in Mallards and Black Ducks were seen in hybrids and under the same conditions.

Display interaction between Mallards and Black Ducks is an important consideration when trying to determine the degree to which speciation has progressed and isolating mechanisms have evolved. Such interaction did occasionally occur in wild flocks, although courting groups were usually composed entirely of one form or the other. A few observations of Black Duck males displaying with Mallards were obtained, and since they have a bearing on the question of whether male Mallards and Black Ducks are responding to the same female stimuli when they perform the same displays, they will be mentioned here. For example, in the four instances where Black Duck males were observed to perform Down-ups simultaneously with male Mallard displays, these Mallard displays included two Grunt-whistles, three Head-up-tail-ups, and four Down-ups. Although the records are admittedly scanty they do suggest that male Mallards and Black Ducks are responding to the same stimuli when they perform the same displays, and that a female Mallard provides no less of a stimulus than does a female Black Duck under the same conditions, since the Black Duck displays were of equal or higher intensity than the male Mallard displays which were performed simultaneously.

Relationship of Plumage Pattern to Mating Success.—If Darwin's ideas concerning the importance of sexual selection in mating success are correct, it follows that the sexually dimorphic plumage of the male Mallard must be related to its chances of obtaining a mate. It should also be true that males with abnormal or subdued coloration would have less chance of obtaining a mate. Thus, hybrids or Black Duck males presumably would be selected against in a competition for female Mallard mates. Although no information relative to this possibility was obtained on wild birds, some observations bearing on this problem were obtained on the semi-tame ducks at Stewart Park. Here, in addition to the approximately 100 normally plumaged drakes, there were five birds which deviated markedly from the typical male Mallard plumage pattern. These deviations are rather commonly found mutations in domesticated Mallard flocks, such as birds lacking the chestnut breast, having reddish flanks, etc. To test the possibility that such males are less likely to obtain mates because of these aberrations in their plumage signal characters, records were kept on the frequency with which these males displayed relative to the normal "wild type" males. These observations were begun in February, after most birds were already paired and the remaining unattached males were competing for the relatively few unpaired females. The results of these counts are presented in Table 4. It will be seen that the small percentage of drakes possessing abnormal coloration contributed a relatively large percentage of the total male displays recorded during the period of observation, and that they, therefore, were being forced to compete more strongly for mates than were the wild type males. This was most marked during February and March, before mated pairs had begun to break away from the main flock to begin nesting activities. However, by April most pairs had dispersed, leaving only the excess males and a very few females. During that month the aberrant males contributed approximately the expected percentage of displays, since nearly all the other remaining males were also still unpaired. So far as

TABLE 4

FREQUENCY OF DISPLAYS IN WILD-TYPE AND ABERRANT MALE MALLARDS

	Feb.	Mar.	Apr.	Total
Grunt-whistles				
by wild-type males	69	79	60	208
by aberrant males	17	23	14	54
Total displays	86	102	74	262
Head-up-tail-ups				
by wild-type males	40	31	33	104
by aberrant males	6	10	13	29
Total displays	46	41	46	133
Down-ups				
by wild-type males	117	82	50	249
by aberrant males	21	19	9	49
Total displays	138	101	59	298
Combined displays				
by wild-type males	226	192	143	561
by aberrant males	44	52	36	132
Total displays	270	244	179	693
Per cent by aberrant males	16.3	21.3	20.0	19.0
Total wild-type males present	95	76	22	64 (Ave.)
Total aberrant males present	5	5	5	5
Per cent of males aberrant	5.0	6.2	18.5	7.2
Per cent excess aberrant male displays	11.3*	15.1*	1.5	12.8*

*Significant at .01 level.

could be determined, none of these abnormally plumaged males obtained mates. It may be concluded therefore that females are indeed "selecting" normal plumaged birds in preference to these mutants, and that selection for the typical Mallard-type male plumage pattern is probably in operation.

Discussion

The data presented above have pointed out two distinct differences in the displays of the Mallard and the Black Duck. These are (1) the markedly lower male response threshold in Black Ducks in comparison with Mallards, as indicated by the mean number of males responding simultaneously (see Table 1 and Fig. 4), and (2) the somewhat more specific responses of male Black Ducks over Mallards during simultaneous, multiple male displays, especially in those involving five or more birds (see Figs. 5 and 6).

Although these differences are not nearly so great as one might expect to find in two distinct species, they are nevertheless significant from both a statistical and an evolutionary standpoint. It seems entirely reasonable to assume that the Black Duck has been forced to evolve a more specific and sensitive species-recognition system in the form of displays than has the Mallard, as a result of the former's lack of special male plumage characters. Such male plumage patterns as are found in the Mallard would presumably render less necessary a precise behavioral species-recognition system, since these distinctive patterns would probably carry the major burden of signal specificity. In areas where selection for species recognition is reduced (as on oceanic islands where only a single species of *Anas* occurs), male plumage dimorphism is rapidly lost, since selection for concealing coloration is apparently greater than are any pressures for retaining male dimorphism through sexual selection alone. No detailed behavioral studies of any of these isolated populations such as the Hawaiian Mallard (*Anas platyrhynchos wyvilliana*) or the Laysan Mallard (*A. p. laysanensis*) have yet been undertaken, but it would be most interesting to determine whether the behavioral specificity of these forms has undergone a deterioration similar to that of the male plumage patterns because of the absence of a need for a precise species-recognition system.*

In theory, assuming a mixed population of male Mallards and Black Ducks competing for a limited number of female mates, sexual selection would seem to favor the Mallard because of the strong visual stimulus provided by its elaborate plumage, which might possibly provide a kind of "super-normal stimulus" to female Black Ducks. However, this advantage might be counteracted by the male Black Duck's lower, and apparently more specific display threshold, which would provide a potentially more sensitive and effective

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* Recent observations at the Wildfowl Trust on these and other island races indicate that this supposition is true.

signal system to females. Such a mechanism might explain the occurrence of male Black Ducks found paired with female Mallards in the wild (Johnsgard, 1959). I have recorded or have been informed of only six such pairs and only three pairs of the male Mallard and female Black Duck type. Additional comments on the possible importance of male plumage patterns, male displays, and female "Releasing Mechanisms" in species-recognition systems are presented by Dilger and Johnsgard (1959).

The behavioral differences encountered between the Mallard and the Black Duck might also be of significance in the general question of the evolution of behavioral isolating mechanisms. It seems to be a general truth that, in the genus *Anas* at least, behavioral differences among distinct but closely related species tend to be relatively minor although male plumage patterns may vary markedly. This also appears to be true in other avian groups (Hinde, 1959). Thus, although several species of *Anas* possess the Grunt-whistle, the optical and auditory stimuli produced by its performance vary greatly in different species as a result of differences imposed by plumage patterns, vocalizations, and variations in body size and form. In addition, variations undoubtedly also occur in the relative frequency of performance of this display and the female stimulus required to elicit it. It might be possible that one of the first stages in speciation is the evolution of threshold differences (or "tendency" differences, see Hinde, 1959) determining the performance of different male displays in isolated populations. Concommitant with these male variations, the females must simultaneously evolve variations in stimulus thresholds so that the male and female stimulus-response systems remain in synchrony (Dilger and Johnsgard, 1959). Conceivably, two such isolated populations might have gradually evolved such quantitative (or even qualitative) differences in these stimulus-response systems that by the time they acheive secondary contact the differences in the two systems are of such a magnitude that a stimulus presented by the females (or males) of one form invariably results in the incorrect response by individuals of the opposite sex in the other form. In such a way behavioral isolating mechanisms might be evolved, which could be strengthened by the evolution of male plumage differences or other morphological (and ecological) variations through selection of random mutations or by reinforcement of morphological, behavioral, and other differences through selection against disadvantageous hybridization (Sibley, 1957).

CONCLUSIONS

1. Male Mallards and Black Ducks tend to react independently and rather specifically to female stimuli.
2. Thresholds of male Mallard and Black Duck display responses vary seasonally, as apparently also do female stimulus thresholds.

3. The three major male sexual displays studied have the same hierarchy of reaction intensities in both the Mallard and the Black Duck.

4. No qualitative differences between male Mallard and male Black Duck displays were found.

5. Male Black Ducks have a distinctly lower threshold of display response, and apparently a somewhat more specific response, than do male Mallards.

6. These last two quantitative differences in two forms are believed to be related to the lack of male plumage dimorphism in the Black Duck, which probably must be compensated for by a more sensitive and specific sexual- and species-recognition mechanism than is needed by the Mallard, where male plumage characteristics alone can effect sexual and species recognition.

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DEPARTMENT OF CONSERVATION, CORNELL UNIVERSITY, ITHACA, N. Y., JULY 8, 1959

REQUESTS FOR INFORMATION

The reproductive biology of Cardinals has been under study in this area for six years. I wish now to compare local data with data from elsewhere in the species' range. For this purpose I am soliciting information on extreme dates of nesting, frequency of nests in different months, clutch-size with dates, nesting sites, and extent of cover available for first nests. Details of the study will be supplied to anyone interested in assisting me.—*D. M. Scott, Department of Zoology, University of Western Ontario, London, Ontario, Canada.*

As part of the preparation for a monograph on the Carolina Parakeet, I plan to make a census of extant specimens. I shall write to larger museums, but would greatly appreciate information on specimens of whatever nature in private hands or small collections.—*Daniel McKinley, Salem College, Winston-Salem, N. C.*

FOREST BIRD COMMUNITIES IN THE APOSTLE ISLANDS OF WISCONSIN

BY EDWARD BEALS

In the past few years more ecologists have become aware that the description of plant and animal communities as discrete ecological units is an oversimplification of community relationships. Among botanists, Gleason (1926) has proposed that, inasmuch as each plant species has environmental requirements different from those of every other species, the classification of plant communities into separate and distinct associations is inadequate. Following this individualistic concept, many phytosociologists have developed vegetational gradients based either on measurement of environmental factors (e.g., Ramensky, 1930; Whittaker, 1956) or on a direct analysis of the vegetation itself (e.g., Curtis and McIntosh, 1951; Brown and Curtis, 1952; Goodall, 1954; Horikawa and Okutomi, 1955; Bray and Curtis, 1957). Animal ecologists have also used community gradients in studies of insects (Whittaker, 1952; Kato *et al.*, 1955), copepods (Whittaker and Fairbanks, 1958), and birds (Bond, 1957).

Because different bird species seldom if ever coincide in their ecological distributions, no discrete communities can be clearly defined except where there are sharp changes of environment. Therefore the present paper describes the bird populations within the forests of the Apostle Islands in Lake Superior in terms of a community gradient, relating these bird communities to their environmental framework. Scientific names of plants follow Gleason (1952).

Acknowledgments

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Description of the Region

The Apostle Islands are situated in Lake Superior at the northernmost tip of Wisconsin. There are 22 islands in the group, most of which are low, rising no more than 50 to 75 feet above the lake level. Oak Island is an exception, rising nearly 500 feet. In size they range from a few acres to over 20 square miles. The largest, Madeline, has been most subjected to human disturbance, and it is the only island that supports a year-round human population. Several others have summer cabins.

The summer climate is remarkably cool, with a mean July temperature of 65°F. It is characterized by a high proportion of rainy days.

The islands lie in the hemlock–white pine–northern hardwoods region of Braun (1950). Extensive trembling aspen (*Populus tremuloides*) and white birch (*Betula papyrifera*) forests occur on some of the islands, where fire or logging has destroyed the original vegetation. Only a few forests of red, white, and jack pines (*Pinus resinosa, P. strobus*, and *P. banksiana*) occur on the islands. Red oak (*Quercus rubra*) forests may occur on higher locations. The predominant undisturbed vegetation consists of one or more of the following tree species: sugar maple (*Acer saccharum*), yellow birch (*Betula lutea*), white cedar (*Thuja occidentalis*), and hemlock (*Tsuga canadensis*). Dense populations of white-tailed deer (*Odocoileus virginianus*) have had a profound effect on the vegetation on some islands; elsewhere deer do not occur at all. Fields have been cleared on Madeline and Sand islands, and open bogs occur spottily, but the bird populations of these particular vegetation types were not studied in detail. For a general descriptive account of the birds of this region in all habitats see Beals (1958*a*).

Field Methods

In comparing communities it is desirable to study as many of them as possible in order to obtain more adequate information regarding the differences among communities. Therefore a rapid sample count method was used to census the birds in this study, somewhat similar to the methods used by Dambach and Good (1940) and by Bond (1957).

The sites were selected on the basis of previous studies of the vegetation (Beals, 1958*b*). Since much of the forested land is continuous on the islands, distinct stands of vegetation were seldom found. Areas of 20 to 40 acres, homogeneous in their vegetation at least for the dominant trees (Beals, 1958*b*), were selected for the vegetational survey. These stands had indistinct boundaries, except when bordering the lake, a bog, or a clearing.

The bird poplations of 24 stands were sampled in late June and early July of 1957 and in late June of 1958. The breeding season apparently reaches a peak around the end of June. Stands were usually sampled between five and eight o'clock in the morning, but on chilly mornings birds were active until nine or later.

A sample count was made by entering a given stand for about 100 yards, standing at a point for five minutes, recording the number and kinds of birds heard or seen, and then proceeding to another point within the stand 150 paces away (125 to 135 yards) and standing for another five minutes. This was repeated until ten points in the stand had been sampled. Birds seen flying high overhead, such as ducks and gulls, were not counted; those flying close to the canopy if not in it, including Chimney Swifts, Blue Jays, Common Ravens, Common Crows, and Cedar Waxwings, were included.

For each species, frequency (the number of points at which the species was observed) and density (the total number of individuals observed) were recorded in all the stands sampled. For loud-voiced birds or wanderers the same individual may have been observed at more than one point, so that frequency could have a higher value than density. An attempt was made not to count the same individual twice in the recording of density.

A method similar to this one has been checked for its accuracy in southern Wisconsin by Bond (1957), and he considered it a reasonable estimate of the relative values of bird populations. In this study one stand was sampled three times within one week, and the lowest similarity between any two of the samples was 84.9 per cent. (The method of calculating this similarity is described later.) This suggests that results from the sample count method are fairly constant. If one assumes that individuals of a given species of bird act similarly in different stands, in respect to their singing behavior and motor activity, the sampling method used here appears to be valid for a comparative study such as this one.

The sampling of a stand by this method took between one and one and one-half hours, so that if stands were close together, two could be sampled in a morning. However, most stands were rather far apart, and the mode of transportation (by foot or by boat) was slow, so that usually only one stand was sampled in a day.

STATISTICAL METHODS

Data from the field include two values for each species in each stand—the frequency and the density described above. These data are considered comparable for a given species between stands, assuming that the species does not differ appreciably in its conspicuousness from stand to stand. But comparisons between species within a given stand were made very cautiously, since species do differ markedly in their conspicuousness. Proportion of time spent singing, loudness of song or call notes, and amount of motor activity, all affect the observations recorded by the sample-count method. The density figure obtained by this sampling method might be distinguished from absolute and relative density figures as an "audiovisual" density index, which is presumed to bear some relationship to the absolute density for each species. Colquhoun (1941) developed coefficients of relative conspicuousness for various European species, which could theoretically be used in estimates of actual density. However, no valid estimate of the number of birds per fixed unit area is possible in this study, since no such "conspicuousness" coefficients are known and since the area of each sample is indeterminate. I have assumed that an estimate of absolute density is not necessary for comparisons of communities in the manner described below.

A single quantitative value for each species was desired in order to make comparisons between stands, and yet both frequency and density were considered necessary in determining the importance of the species in the community. Several birds observed at one point are considered less important, for example, than the same number of birds scattered throughout the community. The measure of such "importance" used by Bond (1957) was the sum of relative frequency and relative density. However, reducing frequency and density to relative values is not entirely satisfactory since direct comparisons were desired between stands for each species.

An index was obtained by multiplying the density of a species by the square root of its frequency, the product being called a "prominence value." It is to be distinguished from the "importance value," a term which has been used by plant and animal ecologists (Curtis and McIntosh, 1951; Brown and Curtis, 1952; Bond, 1957; and Beals, 1958*b*) to refer to a summation of relative figures, giving a constant value for the sum of all importance values in a stand. The term was first used by Curtis and McIntosh (1951) to denote the sum of relative frequency, relative density, and relative dominance of a tree species.

In determining the prominence value the number of individuals of a species in a stand is the most important figure, while the frequency, a measure of the distribution through the woods, is used to modify the density figure. The square root of the frequency is considered a sufficient modification, so that ten birds found all at one point are about one third as "prominent" as one bird found at each of ten points. By this method also, one bird observed at one point is half as "prominent" as one bird observed at four points. The index admittedly is arbitrary, but it is considered a reasonable quantitative method for describing the prominence of a species in a community.

A two-dimensional ordination of communities was constructed in a manner similar to that described by Bray and Curtis (1957) for plants. The method is based on a coefficient of similarity, calculated as $C = \frac{2\,w}{a+b}$, where a is the sum of quantitative values (in this case prominence values) of all species in one stand, b is the sum of quantitative values in another stand, and w is the sum of quantitative values the two stands have in common for each species.

To give a simple, hypothetical case, two stands have three species of birds: Stand A has prominence values for species X of 10, for species Y of 63, for species Z of 1; stand B has prominence values for species X of 1, for species Y of 33, for species Z of 36. To find w, the lowest values between two stands for each species are summed: $w = 1 + 33 + 1 = 35$. Therefore $C = \frac{2 \times 35}{74 + 70} = .486$; Stands A and B have a similarity of 48.6 per cent. The index ranges from zero, if the stands have no species in common, to 1.00 if they are by chance identical—exactly the same species in exactly the same amounts.

Birds with a high prominence value were more important in determining the coefficient of similarity than birds of low prominence. This procedure does involve the weighting of species within a stand; however, this weighting of prominence values no longer implies a comparison of density of birds within the stand. Prominence values were not reduced to relative figures (with a constant sum of 100 per cent) since this might obscure differences between stands for a given species, if the sum of prominence values was very different for the two stands.

A matrix was constructed showing coefficients of similarity for each of the stands with the 23 other stands. The coefficients were totaled for each stand, and the stand with the lowest sum could be considered the stand most different from all the others. It was used as one end of the first or x axis of the ordination. The other end stand of this axis was the stand having the least in common with the first.

Since this ordination attempts to arrange the stands according to their relative dissimilarity, inverse values of the coefficients of similarity were used, subtracting the coefficient from .85. This value was chosen rather than 1.00 because in sampling one stand three times, the coefficients of similarity between the samples were .849, .863, and .907. In other words, two stands with a similarity of .85 or higher should probably be considered essentially identical. Two stands with nothing in common would be 85 units apart (multiplying the inverse by 100). Expressed in these units, the distances between stands will be called *dissimilarity* values.

The length of the axis of an ordination is equal to the dissimilarity of the two reference stands. Each of the other stands is located by drawing arcs representing the dissimilarities from the two ends (Fig. 1). These arcs intersect each other above and below a line drawn between the two reference stands, and the arc intersection is projected onto this axis (Bray and Curtis, 1957). In practice the values of stands along an axis were calculated from a formula derived as follows. Two triangles can be found in Fig. 1, with sides exD_a and $e(L-x)D_b$, respectively. The hypotenuses are known (dissimilarities from the end stands, D_a and D_b); one side is equal in both triangles (the distance from the axis line to the arc intersection, e); and the sum of the third sides of the two triangles is known (the length of the axis, L). The triangles have the fol-

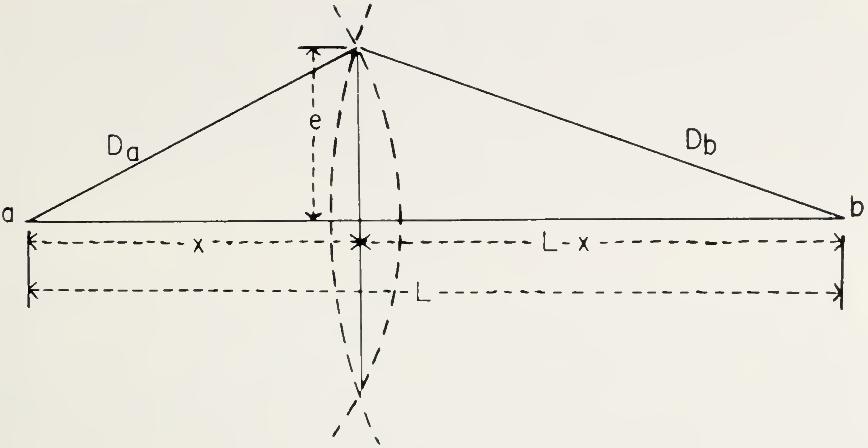

FIG. 1. Demonstration of stand location along an axis of the ordination, by projection of the point of arc intersection; a and b are reference stands, L is the dissimilarity value between the reference stands (the length of the axis), D_a and D_b are dissimilarity values of a given stand from the two reference stands, and x is the location of that stand along the axis.

lowing equations according to the Pythagorean theorem:

$$e^2 + x^2 = D_a{}^2$$

$$e^2 + (L-x)^2 = D_b{}^2$$

Subtracting one equation from the other, to eliminate e^2, and solving for x (the value along the axis from Stand A), the working formula results:

$$x = \frac{L^2 + D_a{}^2 - D_b{}^2}{2\,L}$$

Calculation is simplified somewhat by the fact that L is constant for all stands along a given axis.

When all the stands are located along the x axis, there are stands placed close together which in reality are quite dissimilar. Therefore a second or y axis was constructed to separate these. The first reference stand on the y axis was selected on the basis of the highest e value along the x axis (the stand of poorest fit along the first axis). The value of e is calculated as follows: $e^2 = D_a{}^2 - x^2$. The other end stand is the most dissimilar one to the first end within a distance from the latter, along the x axis, of less than 10 per cent of the total length of the x axis. In this way the second axis approximates a perpendicular relationship to the first. When the two ends were selected and placed the proper distance apart according to their dissimilarity, the other stands were located along the y axis as they were for the x axis. The stands were then plotted on a two-dimensional graph.

Distances between stands on the ordination were calculated as $d_x^2 + d_y^2$, where d_x is the difference between the two stands along the x axis, and d_y is the difference along the y axis. Correlation between these distances and the respective coefficients of similarity for a random sample of 50 interstand distances was remarkably high ($r = -.922$), indicating that the method yields a close approximation of the relationship of stands to one another based on the coefficients of similarity as calculated above.

RESULTS

Table 1 gives a summary of data for the 60 species recorded. Presence is the number of stands out of 24 in which the species occurred. There are two ubiquitous birds, the Red-eyed Vireo and the Ovenbird. The Black-throated Green Warbler and the American Redstart also show high presence. On the other hand, 15 species (one fourth of the total) were found in only one stand each.

Stand abundance is used here as the average audiovisual density of a species for all stands in which that species actually occurred. It is an indication of the densities commonly reached in the habitat of the species. Highest values are achieved by the Ovenbird and Black-throated Green Warbler; among other widespread species, the Hairy Woodpecker, American Redstart, and Solitary Vireo show low stand abundance. Birds reaching highest audiovisual densities in any stand are the Black-throated Green Warbler, Ovenbird, Red-eyed Vireo, White-throated Sparrow, and Least Flycatcher.

The forest types in Table 1 are rough groupings of the stands studied. The pine "type" includes three stands, one dominated by jack pine, one by red pine, and one by white pine. Because these pine forests are so different from one another, the values in the table are followed by letters indicating in which of the three pine stands the species were found. There were four aspen stands, two almost pure trembling aspen, one trembling aspen mixed with much balsam fir (*Abies balsamea*) and white spruce (*Picea glauca*), and another dominated by big-toothed aspen (*Populus grandidentata*). There were three white birch–red oak stands. The white birch–yellow birch–white cedar type includes six stands, which contain some of all three species, generally with two of the species dominant. There were three hemlock–yellow birch stands. Of the five sugar maple–yellow birch stands two were almost pure maple.

The distribution of stands within the ordination, each identified as to island, is pictured in Fig. 2; they are clustered toward the lower central portion of the graph, with a few scattered stands to the left, the upper left, and the upper right of this concentration. Fig. 3 shows the distribution of 24 bird species within the ordination, and Fig. 4 shows the distribution of certain tree groups and other vegetational characteristics.

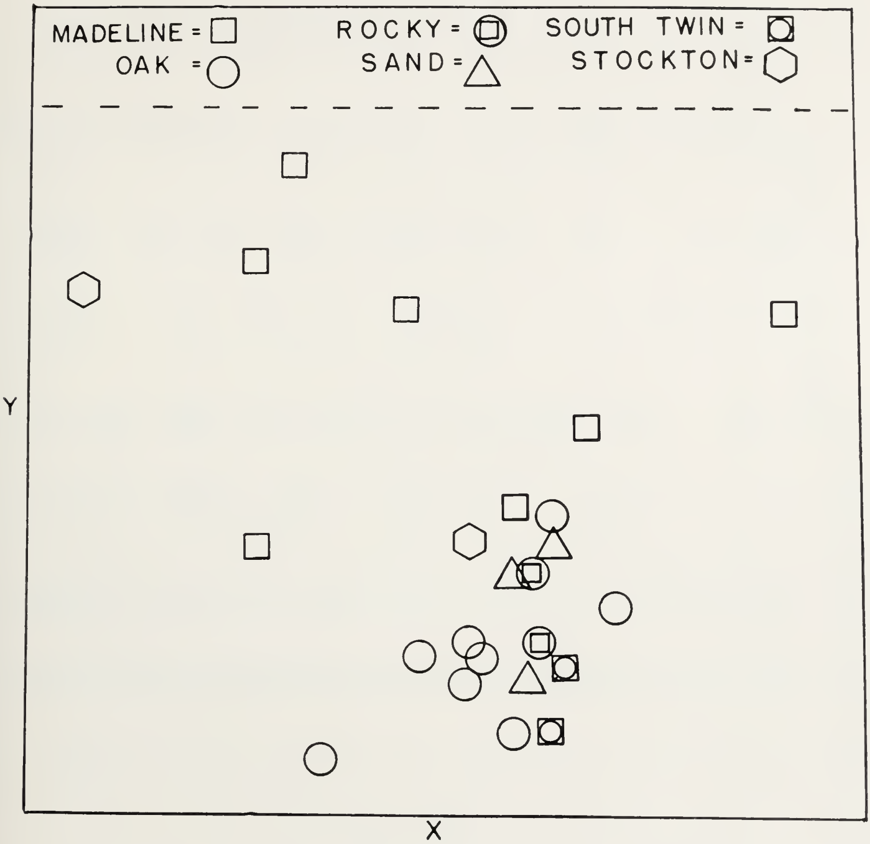

Fig. 2. The distribution of stands within the ordination according to island.

Ecological Distribution of Species

The following observations regarding the ecological requirements or preferences of birds were made. The species are divided into four general groups: those occurring mostly with the Black-throated Green Warbler, those occurring mostly with the White-throated Sparrow, those occurring with both, and those occurring with neither. These two reference species are found in high densities in their respective habitats, and yet their prominence values are negatively correlated with each other, significant at the 5 per cent level. Such a division into groups is quite arbitrary; the divisions were made by simple inspection and not in quantitative terms, but the result is a reasonable grouping of species often found together.

TABLE 1

SUMMARY DATA FOR ALL BIRD SPECIES RECORDED

Species	Stand Presence	Stand Abundance	Maximum Density	Average density for six forest types					
				Pines*	Aspens	W. Birch–R. Oak	W. Birch–Y. Birch–W. Cedar	Hemlock–Y. Birch	S. Maple–Y. Birch
Goshawk (*Accipiter gentilis*)	1	2.0	2					0.7	
Sharp-shinned Hawk (*Accipiter striatus*)	1	1.0	1			0.3			
Bald Eagle (*Haliaeetus leucocephalus*)	1	2.0	2						0.4
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	1	1.0	1		0.3				
Long-eared Owl (*Asio otus*)	2	1.0	1	0.3^{r}				0.3	
Chimney Swift (*Chaetura pelagica*)	8	2.5	7	0.3^{r}			2.0	1.0	2.0
Yellow-shafted Flicker (*Colaptes auratus*)	8	2.0	5		2.0	1.3			0.2
Pileated Woodpecker (*Dryocopus pileatus*)	3	1.7	3		0.3		0.2		
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	5	2.2	5					3.0	0.4
Hairy Woodpecker (*Dendrocopos villosus*)	13	1.8	5		2.0	0.3	0.8	3.7	0.4
Downy Woodpecker (*Dendrocopos pubescens*)	1	1.0	1		0.3				
Black-backed Three-toed Woodpecker (*Picoïdes arcticus*)	1	1.0	1			0.3			
Great Crested Flycatcher (*Myiarchus crinitus*)	5	1.4	3		0.3	0.3	0.5	0.7	
Yellow-bellied Flycatcher (*Empidonax flaviventris*)	2	3.5	5					2.3	
Traill's Flycatcher (*Empidonax traillii*)	1	3.0	3		0.8				
Least Flycatcher (*Empidonax minimus*)	5	11.6	27		4.5			13.0	0.4
Eastern Wood Pewee (*Contopus virens*)	14	6.9	16	4.3^{rw}	4.0	0.8	2.2	6.3	5.8
Blue Jay (*Cyanocitta cristata*)	15	2.9	8	3.0^{jw}	2.8		1.8	1.0	2.4
Common Raven (*Corvus corax*)	5	1.8	3	0.7^{r}	0.8				0.8
Common Crow (*Corvus brachyrhynchos*)	5	2.8	4	0.7^{w}			0.7		0.4
Black-capped Chickadee (*Parus atricapillus*)	9	3.2	6	0.3^{w}	0.8		1.5	3.3	0.8
White-breasted Nuthatch (*Sitta carolinensis*)	4	3.0	5	1.7^{w}	0.8			1.3	
Red-breasted Nuthatch (*Sitta canadensis*)	4	2.3	4	2.0^{rw}	0.3			0.7	
Brown Creeper (*Certhia familiaris*)	3	1.0	1				0.2	0.3	0.2
House Wren (*Troglodytes aedon*)	2	4.0	5		2.0				
Robin (*Turdus migratorius*)	8	2.4	4	1.3^{jw}	2.0	1.0	0.5	0.3	
Hermit Thrush (*Hylocichla guttata*)	5	3.6	9	3.0^{r}	1.0	1.0	0.2		0.2
Swainson's Thrush (*Hylocichla ustulata*)	15	4.7	10	2.0^{r}	1.8	3.0	4.8	1.3	3.7
Veery (*Hylocichla fuscescens*)	12	3.3	18	0.3^{j}	2.5	9.0		0.3	

* j = jack pine stand, r = red pine stand, w = white pine stand.

TABLE 1 (continued)

Species	Stand Presence	Stand Abundance	Maximum Density	Average density for six forest types					
				Pines*	Aspens	W. Birch–R. Oak	W. Birch–Y. Birch–W. Cedar	Hemlock–Y. Birch	S. Maple–Y. Birch
Golden-crowned Kinglet (*Regulus satrapa*)	4	1.3	2	1.0^{Jw}	0.3			0.8	
Cedar Waxwing (*Bombycilla cedrorum*)	4	3.8	10				1.8	1.3	
Solitary Vireo (*Vireo solitarius*)	16	2.8	10	4.0^{rw}	1.2	1.3	1.0	2.7	2.0
Red-eyed Vireo (*Vireo olivaceus*)	24	17.7	34	10.7^{Jrw}	12.8	23.3	23.8	7.3	21.2
Warbling Vireo (*Vireo gilvus*)	1	2.0	2					0.7	
Black-and-white Warbler (*Mniotilta varia*)	14	4.6	10		2.3	6.3	2.7	0.7	3.8
Tennessee Warbler (*Vermivora peregrina*)	1	1.0	1			0.3			
Nashville Warbler (*Vermivora ruficapilla*)	5	2.6	8	4.0^{rw}			0.2		0.4
Parula Warbler (*Parula americana*)	9	3.4	5				3.0	1.3	1.8
Magnolia Warbler (*Dendroica magnolia*)	2	4.0	6		0.5				1.2
Black-throated Blue Warbler (*Dendroica caerulescens*)	4	2.5	4				0.7	0.7	0.8
Black-throated Green Warbler (*Dendroica virens*)	22	21.8	43	16.3^{Jrw}	7.8	11.7	29.5	13.3	20.7
Blackburnian Warbler (*Dendroica fusca*)	7	3.7	7	3.3^{rw}			1.3	1.3	0.4
Chestnut-sided Warbler (*Dendroica pensylvanica*)	7	2.6	5		0.3	1.7	1.0		1.5
Pine Warbler (*Dendroica pinus*)	1	4.0	4	1.3^{r}					
Ovenbird (*Seiurus aurocapillus*)	24	23.6	41	24.0^{Jrw}	18.8	33.3	19.7	18.3	29.2
Connecticut Warbler (*Oporornis agilis*)	1	1.0	1		0.3				
Mourning Warbler (*Oporornis philadelphia*)	2	12.0	16		6.0				
Yellowthroat (*Geothlypis trichas*)	3	1.7	3		1.0			0.3	
Canada Warbler (*Wilsonia canadensis*)	7	6.1	13			6.0	1.3	4.3	0.8
American Redstart (*Setophaga ruticilla*)	18	2.7	6	3.7^{Jrw}	0.5	3.3	2.2	0.3	1.8
Baltimore Oriole (*Icterus galbula*)	2	1.0	1	0.3^{r}	0.3				
Brown-headed Cowbird (*Molothrus ater*)	4	2.3	3		1.3	1.0		0.3	
Scarlet Tanager (*Piranga olivacea*)	6	2.3	4	0.7^{J}		3.0	0.3	1.0	
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	4	1.5	2		0.5		0.2	0.3	0.4
Indigo Bunting (*Passerina cyanea*)	1	1.0	1		0.3				
Purple Finch (*Carpodacus purpureus*)	5	1.8	5	0.3^{r}	0.3		0.8	0.3	0.2
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	1	1.0	1		0.3				
Chipping Sparrow (*Spizella passerina*)	1	2.0	2	0.7^{r}					
White-throated Sparrow (*Zonotrichia albicollis*)	5	15.8	29	1.0^{r}	18.8		0.2		
Song Sparrow (*Melospiza melodia*)	4	6.8	11	1.3^{r}	5.8				

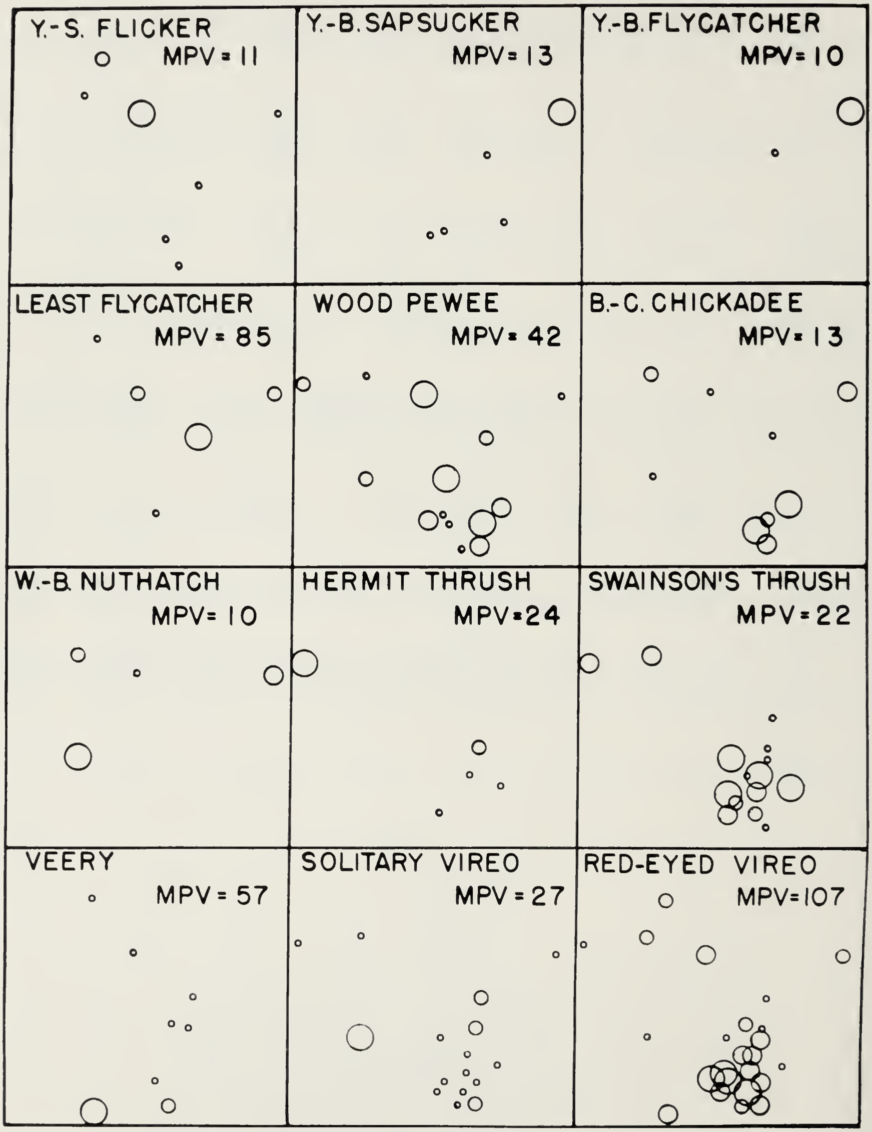

FIG. 3. The distribution of 24 bird species within the ordination. Sizes of circles represent four equal segments of the range of prominence values, based on the maximum prominence value (MPV), of each species.

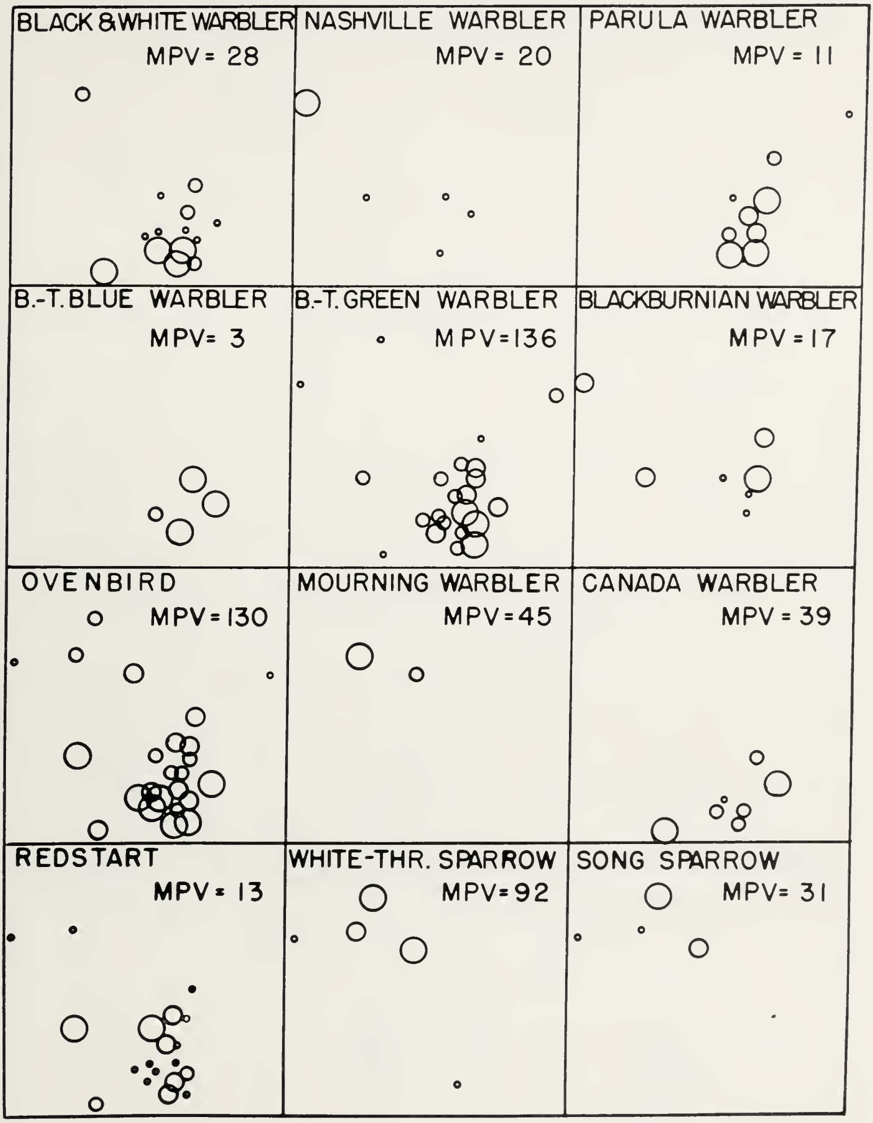

Fig. 3. (Continued)

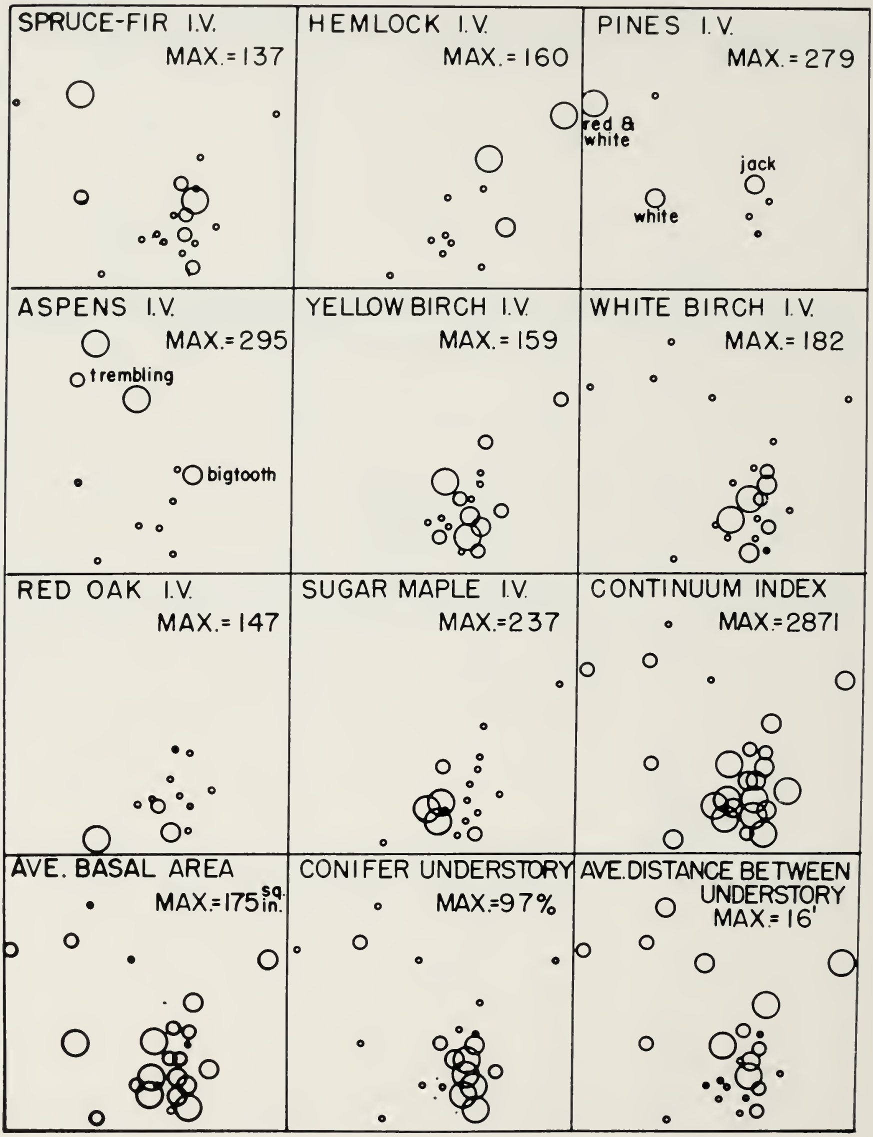

FIG. 4. Distribution of tree species and other vegetational factors within the ordination. Sizes of circles correspond to four equal segments of the range of quantitative values used, based on the maximum value as indicated (I.V. = importance value). For stands where aspens or pines are dominant, the more important species of aspen or pine are named. The dots in the conifer understory block indicate stands with no conifer understory.

Regression was tested in some cases between the species and certain environmental factors. However, most birds respond to a complex of factors, and it seldom happens that a significant value is obtained from an isolated factor. Otherwise the data only suggest trends in the distributions of species. Factors studied were taken from Beals (1958*b*) and included the following: importance values of pines, hemlock, sugar maple, aspens, spruce–fir, white birch, yellow birch, red oak, white cedar, etc.: average basal area of trees, trees per acre, trees at least 10 inches dbh per acre, trees at least 20 inches dbh per acre, total basal area per acre; average distance between stems of woody understory (1 to 7 feet high); relative amount of conifer and understory, etc. One vegetational factor referred to is the continuum index, described for this region by Brown and Curtis (1952). This is based on the importance of trees ranked according to their association with sugar maple at one end and jack pine at the other. A low value (minimum possible, 300) indicates a pioneer forest, and a very high value (maximum possible, 3000) indicates climax vegetation. The values for stands in this study ranged from 614 (aspens) to 2871 (sugar maple forest). See Brown and Curtis (1952) for the method used. This index was tested by correlation coefficient since it is not itself a controlling factor but only an expression of many possible controlling factors.

Birds whose distributions are pictured in Fig. 3 are marked with an asterisk (*) in paragraphs that follow. Those species which occurred in only one or a few stands are mostly just listed, and the reader may refer to Table 1 for vegetational data on them.

Species associated largely with White-throated Sparrow.—The Yellow-shafted Flicker* was widely distributed in small numbers but reached greatest prominence among aspens. This association with aspen coincides with Kendeigh's findings (1948) in lower Michigan and those of Adams (1909) on Isle Royale in northern Lake Superior. Elsewhere it is usually found in relatively pioneer forests also (Odum, 1950; Kendeigh, 1946; Bond, 1957).

House Wrens and Mourning Warblers* were confined to aspen stands, and Yellowthroats were nearly as restricted. Song Sparrows* and White-throated Sparrows* both showed highly significant positive regression with aspen importance values, and a highly significant negative correlation with the continuum index. In other words, these birds all seem to prefer pioneer forests of aspen and to some extent pine. Other studies confirm this preference for pioneer vegetation (Kendeigh, 1946, for Song Sparrow, House Wren, and Yellowthroat; Kendeigh, 1948, for Mourning Warbler and White-throated Sparrow; Stewart and Aldrich, 1949, for Mourning Warbler; and Odum, 1950, for Song Sparrow).

The Veery* was found in greatest numbers in both aspen and red oak forests, especially where understory was densest. In other studies Veeries have been found to be partial to deciduous forest (Kendeigh, 1948; Stewart and Aldrich, 1949). Kendeigh (1945, 1946) reported a preference for late shrub or early tree stages of succession in New York, and McCreary (1909) considered it characteristic of birch–aspen forests on Isle Royale. On the other hand, Odum (1950) found it most abundant in mature oak forest on the highlands of North Carolina. From the present data, both habitats are apparently used in northern Wisconsin.

Additional but uncommon species in this group are the Black-billed Cuckoo, Downy Woodpecker, Traill's Flycatcher, Connecticut Warbler, Indigo Bunting, and Rufous-sided Towhee.

Species associated largely with Black-throated Green Warbler.—The Chimney Swift occurred widely but seemed to prefer forests with many large trees, and with a high continuum index. The Pileated Woodpecker shows some partiality to white cedar. Other workers (Kendeigh, 1946, 1948; Stewart and Aldrich, 1949) have recorded it in mature conifer–hardwoods, and Kendeigh (1948) recorded it also in cedar–fir forest in Michigan. Blackwelder (1909), working in northwest Michigan, reported a preference by this species for edges between fir–cedar swamps and hardwood–hemlock forests. On the other hand, the Yellow-bellied Sapsucker* is found where hemlocks grow, as is the Yellow-bellied Flycatcher.*

Widely distributed in small numbers are the following: the Great Crested Flycatcher, especially where trees are close together; Common Crow; Black-capped Chickadee,* which shows some affinity for yellow birch stands; Solitary Vireo,* which prefers forests with larger trees apparently; and American Redstart,* which reached high densities in two pine stands and one birch–maple stand. The Scarlet Tanager is usually found in fairly dense forests.

The Red-breasted Nuthatch is restricted mostly to pine (except one hemlock stand), and the White-breasted Nuthatch* is also most common in pine and hemlock, with smaller numbers in fir and aspen stands. In Kendeigh's Michigan study (1948) the Redbreast was more common in cedar–fir than in pine, while in New York (Kendeigh, 1946) the Whitebreast showed some preference for mixed forests dominated by hemlock. The Golden-crowned Kinglet was found in stands containing hemlock, fir, and pine. Observations in this study agree with Bent's experience (1949) that this species prefers more open forests with scattered second-growth spruce (or fir) trees.

The Parula Warbler* is found in forests with a rather high continuum index —possibly because more beard moss (*Usnea*), with which it usually constructs its nest, is available in these undisturbed forests, although this lichen is nowhere abundant. This species' association with climax stands was also found by Stewart and Aldrich (1949) in West Virginia and by Odum (1950) in North Carolina, while Kendeigh (1948) found the Parula associated with cedar in lower Michigan.

The Black-throated Blue Warbler* occurred sparsely in hemlock, yellow birch, and sugar maple stands. Odum (1950) and Kendeigh (1946) found this bird most common in stands dominated by hemlock. Others (Griscom *et al.*, 1957) reported that it prefers deciduous trees. No preference one way or the other could be determined from the data of this study. Its usual occurrence where yew (*Taxus canadensis*) forms a part of the understory coincides with the reports of Chapman (1907) and Brewster (1938).

In spite of its rather high prominence in sugar maple stands, the Chestnut-sided Warbler shows a tendency to increase where the size of trees is small or the total basal area per acre is low. Where it does occur with maple, the forests are rather open, with a dense understory (due to selective cutting many years ago of red oak in the stands). It reaches highest densities in stands with large amounts of white birch. Stewart and Aldrich (1949), Kendeigh (1946), and Odum (1950) found it had a strong preference for young deciduous growth, and Odum also found it in mature oak stands opened up by chestnut blight.

The Blackburnian Warbler* increases with the increasing importance of conifers in a forest. This agrees with other reports of this species, except that of Brooks (1936), who said that in West Virginia they are quite at home in deciduous second-growth timber. It is more associated with pine in this study than other observers have found.

The Canada Warbler* shows a definite trend to increase as woody understory also increases, with best development in a red oak woods and in a hemlock stand with much fallen timber. While Kendeigh (1946), Stewart and Aldrich (1949), and Odum (1950) reported it in the more climax vegetation, Brooks (1936) said that it is well adapted to deciduous second-growth in his study area in West Virginia, and Stewart and Aldrich (1952) found it most characteristic of cedar–tamarack–ash bogs in Maine.

The Black-throated Green Warbler* is one of the most common species of the forests, and it shows a positive regression with the importance value of yellow birch, significant at the 5 per cent level. The total importance value of spruce, fir, cedar, and hemlock (all the conifers except pines) also tends to correlate with the prominence of this species. There is a lack of preference for pines, quite contrary to observations in New England (Bent, 1953). Allin (in Griscom *et al.*, 1957) observed a similar scarcity in pines north of Lake Superior. In this study, however, it did occur in moderate numbers where pines were mixed with white cedar or fir. This species shows a strong preference for stands with high conifer composition in most other studies (Kendeigh, 1946, 1948; Stewart and Aldrich, 1949), but Brooks (1940) found it well distributed in northern hardwoods and oak–hickory forests. In the spruce–fir forests on Isle Royale, McCreary (1909) reported this warbler most common where there were many white birch trees among the conifers. In the present study it inhabited areas lacking conifers, but was more common when at least a few conifers (other than pines) were present.

Other species in stands with high values of the Black-throated Green Warbler were the Goshawk, Sharp-shinned Hawk, Bald Eagle, Black-backed Three-toed Woodpecker, Brown Creeper, Cedar Waxwing, Warbling Vireo, Tennessee Warbler, Magnolia Warbler, and Rose-breasted Grosbeak.

Species associated with both reference species.—These included the ubiquitous species and a few others whose environmental requirements, though narrow, apparently cut across those of the two reference species. For instance, the Long-eared Owl was found in a pine stand and a hemlock stand, both of which had some large coniferous trees.

Hairy Woodpeckers were found most prominently in both aspen and hemlock stands but were widely distributed in small numbers, except in the most xeric forests (pine and red oak). In southern Wisconsin Bond (1957) found this woodpecker more common in mesic stands, with sugar maple dominant, than in xeric and intermediate stands, where oaks were dominant. Kendeigh (1948) in Michigan found it in cedar, fir, and aspen types, and other studies (Sutton, 1928; Kendeigh, 1946; Stewart and Aldrich, 1949; Odum, 1950) show it distributed in mesic to wet forests whether pioneer or climax.

The Least Flycatcher* also inhabited aspen and hemlock forests. Two environmental factors were common to the four stands occupied by this bird: very poorly drained soil and mostly deciduous understory. Kendeigh (1948) recorded it in aspen–red maple, cedar–fir, and especially beech–maple–pine woodland.

Wood Pewees* were widely distributed and show little pattern on the ordination. Bond (1957) found a similar lack of patterning in southern Wisconsin for the pewee. With the exception of one aspen stand in which the prominence of this species was high, the size of trees seemed to influence the density of pewees, areas of larger trees being preferred. Kendeigh (1948) in his Michigan studies showed two peaks of population density, one in pine–aspen and one in beech–maple–pine, which correspond somewhat to the results of this study.

Blue Jays and Common Ravens are both scattered over the ordination, and no vegetational characteristics could be pinpointed. Since their territories are rather large, they undoubtedly cover more than one type of habitat.

The Robin is found in aspen, fir, and jack pine forest types, and shows some preference for areas of smaller trees. In Michigan Kendeigh (1948) found it most abundant in pine–aspen, and rather common also in cedar–aspen, cedar–

fir, and aspen–red maple types. Stewart and Aldrich (1949) reported it most common in a young spruce stand. Most observers agree that relatively pioneer vegetation is preferred.

The Hermit Thrush* reached its maximum density in a pine stand, but otherwise was scattered in small numbers in several types of vegetation. Kendeigh's data (1948) indicate that this bird is most common in pine–aspen forest in lower Michigan, with smaller numbers in aspen–red maple.

Swainson's Thrush* is more widely distributed and shows some trend to increase with increasing continuum index values. Stewart and Aldrich (1949) also found this species best developed in climax (virgin spruce–hardwood) forest. The abundance of this species in the Apostle Islands coincides with McCreary's observations (1906) for the near-by Porcupine Mountains in Michigan.

The Black-and-white Warbler* shows preference for the pure sugar maple forests generally. However, its density apparently increases with increasing density of woody understory and with increasing amount of deciduous understory in particular, both of which were characteristic of some of the maple forests studied. In New York Kendeigh (1946) recorded it in all of his three vegetation types, but in Michigan (1948) he found it most common in cedar–aspen and cedar–fir.

The Red-eyed Vireo* and Ovenbird* are two ubiquitous species. The former tends to increase with increasing importance of white birch. Peet (1909) reported that the Red-eyed Vireo prefers white birch forests on Isle Royale. Bond (1957) found Red-eyed Vireo populations densest in the most mesic stands of his xeric to mesic gradient, and in the Apostle Islands white birch occurs most commonly in mesic to wet-mesic stands. The prominence of the Ovenbird shows significant (5 per cent level) regression with the density of the understory, in contrast to Bent's statement (1953) that it usually nests where underbrush is scanty. Stenger (1958) reported that territory size decreased as density of ground vegetation increased in her studies in Ontario. The several nests found in this study were not located in open situations as generally reported (Bent, 1953), but at the base of a tree seedling or among the low branches of a shrub. It was suggested by Stenger (1958) that the understory density is positively correlated with the food supply, which controls, at least in part, population density.

The Baltimore Oriole, Brown-headed Cowbird, and Purple Finch were not very common and showed little pattern within the ordination.

Species not associated with either reference species.—The Nashville Warbler* was most prominent in two of the pine stands, especially the red pine woodland. It also occurred in a cedar stand (as in Kendeigh's findings, 1948) and in two maple–birch stands, one of which contained cedar. Other species found in stands with low densities of the reference species were the Pine Warbler and Chipping Sparrow.

Discussion

Most plants respond to the same group of environmental factors (light, water, mineral nutrients, etc.), though each species responds in a different way from other species. But one animal species may respond to quite different factors from another species. The ground-feeding insectivorous bird is affected greatly by the insects on the forest floor, but it is little affected by the foliage insects; an insectivorous bird of the canopy is affected quite oppositely. Bark-feeders are probably independent of either of these factors, and seed-eaters will be distributed, at least in part, according to still another group of factors.

However, these different factors are all directly or indirectly related to one another. The autotrophic plants form the base of the food pyramid and often furnish nesting sites and materials. These plants, as mentioned before, respond generally to the same environmental factors, each in its own way, and are therefore distributed in some sort of pattern. Thus the animals must also be distributed in a pattern, although it may be more complex and less evident. For an example of interrelation of factors, Stenger (1958) stated that territory size of the Ovenbird increases as canopy density increases. She suggested that density and composition of the canopy influence the density of ground vegetation and the quality and quantity of humus, which in turn determine the abundance of invertebrates in the soil. The Ovenbird feeds upon the invertebrates. Apparently, then, the density of Ovenbirds is determined in part by the indirect influence of the canopy.

Most non-biotic factors, such as water and temperature, influence all animals and therefore also contribute to the patterning. The interaction between and within species must also be considered in the environmental complex. The ordination is constructed to represent this complex of environmental factors, and, if the birds are distributed according to an environmental complex, the more or less distinct patterns formed by most species of birds supports the validity of this representation.

Several species of birds, such as the Chimney Swift, Wood Pewee, Swainson's Thrush, Solitary Vireo, and Magnolia Warbler, do not follow distinct patterns in the two-dimensional ordination, indicating that the environmental complex represented by the ordination is not influencing the distribution of these species markedly. Species of low presence, such as the Magnolia Warbler, may exhibit broad tolerance to the environment expressed in the ordination but have very narrow tolerance to certain environmental characteristics unimportant to the bird populations as a whole. If the species has high presence, as do most of those without distinct distribution patterns, the lack of pattern may reflect a general broad tolerance to environmental variation.

It is important to realize that this ordination gives just one approximation of stand similarities according to the information in the matrix of coefficients of similarity, and that other approximations might be constructed by different criteria and techniques, which would be just as valid, or possibly even more valid. Yet the distances in this ordination and the coefficients of similarity from the matrix do show remarkably high negative correlation (r = –.922, for a random sample of 50 interpoint distances out of a total of 276). It would be expected that distances from the four reference stands would be correlated with the respective coefficients; however, most of the 50 sample distances were between stands not used in constructing the ordination. If the coefficients of similarity originally used were valid, and if differences in species composition between stands is an index of environmental differences, the number and importance of environmental factors not included in some way in the framework of this ordination is probably very small.

Certain environmental factors form excellent patterns within the ordination (Fig. 4), suggesting that these are important factors in the distribution of the birds. The distinctive patterns of hemlock, pines, aspens, red oak, sugar maple, and per cent of conifer understory in Fig. 4 give evidence that these factors make important contributions to the habitat. The average size of trees forms a less discernible pattern, but there appear to be areas of large trees and areas of small trees on the ordination, which suggest that tree size is an important modifying factor within the larger environmental framework. The lack of pattern for spruce and fir may reflect the important differences of associated tree species. One of the two stands of high spruce–fir importance had trembling aspen and white pine as codominants, the other had white birch and red maple.

To examine further the ecology of these bird populations, a second ordination of the 24 stands was run based on the vegetation itself. The method was exactly the same, except that the coefficients of similarity were derived from the vegetational data (trees, shrubs, and herbs) rather than from the birds. The coefficients had already been calculated for the report on the vegetation of the region (Beals, 1958*b*). A comparison of the ordination by birds and that by plants is shown in Fig. 5. Groups of stands together in both ordinations were outlined, and each group was labeled by the tree species which was common to the entire group in greatest importance. The similarities are striking, and the differences are enlightening. In the plant ordination the hemlock group is set between the sugar maple and yellow birch groups, indicating that the hemlock stands share many plants in common with the other two groups. Note, however, that the bird populations distinguish the hemlock group as quite different so that it is pushed to one side of this ordination. The special distinctiveness of pine and aspen forests is confirmed by this comparison, since these two groups are much more segregated from the other groups by bird composition than they are by plant composition. The differences between the two ordinations, however, are minor compared with their remarkable similarities, which are good indications of the close relationship between birds and the vegetation.

Furthermore, the general concurrence of the results of this study with those of other investigators in various regions, in regard to vegetation preferences, points up the relatively constant nature of the habitat requirements of most species over their breeding range.

Another biotic factor considered was the effect of deer populations. In spite of the influence of deer on the understory vegetation (Beals, 1958*b*), however, no correlations could be found between the deer pressure (as determined by me) and bird populations.

Geographic factors should also be considered. In Fig. 2 the relation of the islands to the ordination shows definite patterns. In examination of the plant ordination such patterning does not occur, so that vegetation cannot be the cause of the island patterns in Fig. 2. (One exception is Oak Island, the stands on which had a similar grouping on both ordinations. In the plant ordination (Fig. 5) the Oak Island stands include all but one of the sugar maple group, all the red oak group, and the uppermost stand each in the hemlock and fir groups. Their vegetational similarity is probably due to the unique topography of that island, with well-drained, deep soil.)

The Stockton Island maple stand in the bird ordination is pushed toward the Stockton pine stand (Fig. 2), while in regard to vegetation it was quite unrelated, located on the right side of the sugar maple group in Fig. 5, with the pine stand at the extreme left. Also, within the bird ordination the Oak Island hemlock and aspen stands are closer to most of the other Oak Island stands than they are to the other hemlock and aspen stands respectively, although obviously there are indeed great differences in bird populations.

Putting this phenomenon on a quantitative basis, the average coefficient of similarity according to the vegetation was about the same for stands on different islands as it was for stands on the same island (.325 for between-island average, .297 for same-island average), while based on birds the average coefficients for stands on the same islands were higher than the average for stands on different islands (.546 compared with .448). To test the difference, the median test described by Mood (1950) was applied. A distribution-free method was used since the distribution of coefficient values was highly skewed. All coefficients were ranked and the median value found. The number of intra-island values higher and lower than the median, and those for the inter-island values, were set up in a 2 × 2 contingency table. Chi-square was calculated and was significant at the 5 per cent level. Therefore, local geo-

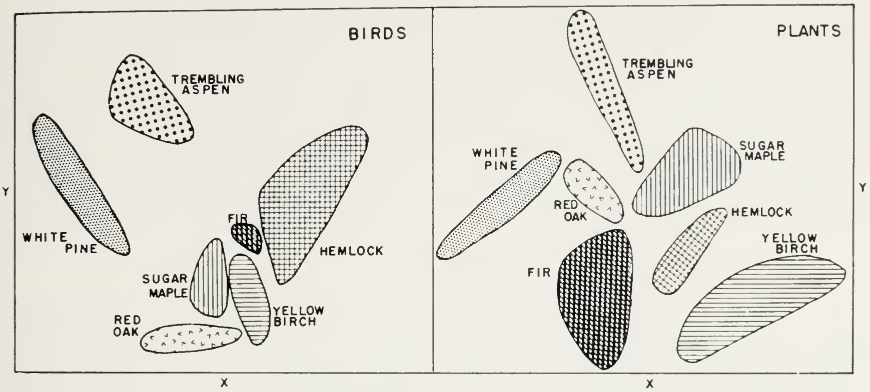

Fig. 5. Comparison of ordination by vegetation and by bird populations. Stands which are grouped together on both ordinations are encircled and are labeled by the tree species which was common to the entire group in greatest importance.

graphic influences apparently do play a role in bird distributions on the Apostle Islands.

The size of islands may have some effect. Fig. 6 shows the relationship of size to the ordination. The two largest islands (Madeline with 13,200 acres and Stockton with 8300) are grouped together. A definite planar gradient can be seen from the smallest island (South Twin, 350 acres) to the next in size (Rocky, 750 acres), to Sand (2900 acres), to Oak (4500 acres), to Stockton and Madeline. Van Tyne (in Hatt *et al.*, 1948) noted that the avifauna on Lake Michigan islands decreased in number of species with decreasing size of the islands, and Lack (1942) reported a similar impoverishment of the bird fauna on small islands around Great Britain. Lack attributes the phenomenon to limitation of habitats, the liability of very small populations of a species to extinction, and the inhibition of migration from other areas by the water. A number of birds in the Apostles were restricted to larger islands (Beals, 1958*a*), such as the birds of prey, Ruby-throated Hummingbird, Yellow-bellied Sapsucker, Yellow-shafted Flicker, Yellow-bellied Flycatcher, Veery, and Baltimore Oriole. Diversity of the bird communities (= diversity of habitats?) is definitely correlated with size of islands: the largest island, Madeline, has the lowest average coefficient of similarity between stands (.402), while each progressively smaller island has increasing average similarity (Stockton, .455; Oak, .621; Sand, .704; Rocky, .773; and South Twin, .849). Furthermore, the larger islands tend to have a greater number of species per individual stand (Madeline, 9–26 species per stand; Stockton, 13–21 species; Oak, 9–20 species) than the smaller islands (Sand, 8–17 species; Rocky, 13–16 species; South Twin, 12–15 species), indicating possible avifaunal limitations

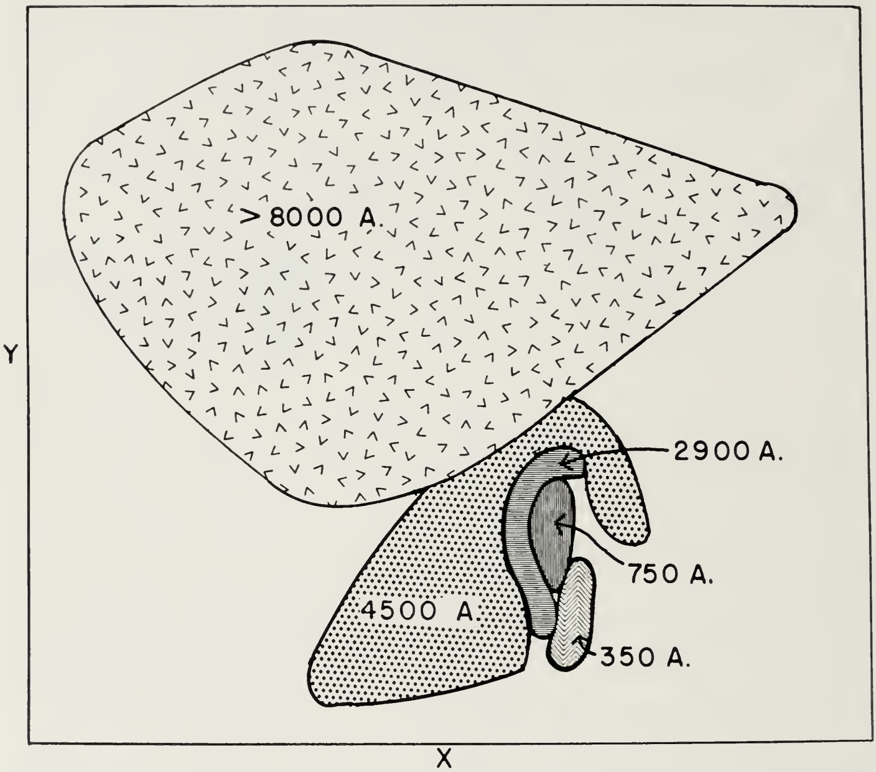

FIG. 6. The pattern of islands in the ordination according to size. Lines surround the stands of an island with the indicated size in acres.

other than lack of habitat variability alone, if one assumes habitat homogeneity in individual stands.

Another geographic influence which may cause added similarity of stands on the same island is related to the behavior of the birds. On the mainland, as population pressure disperses a species into suboptimal environment, individuals may wander considerably until they find suitable habitat, whereas in the island environment large stretches of water (1 to 3 miles or more) may tend to discourage the excess from leaving an island even if all the ideal habitat is occupied. (Unless the birds had some way of knowing that better environment was available beyond the totally unsuitable aquatic habitat, there would probably be little incentive to move out across the water.) Furthermore, the insular topography may accentuate orientation toward the previous breeding or fledging grounds of a bird. This hypothesis would explain the Nashville Warbler's singing in the middle of a birch–maple forest on Stockton, since several hundred yards away was the red pine stand where this species reached its greatest prominence. And the surprising number of Swainson's Thrushes in that pine stand might itself have been an overflow from the near-by woods of more appropriate habitat. Lack (1942) records several instances of modification of habitat on British islands, which were preceded by increased density in the normal breeding habitat. Additional, more subtle associations of populations with islands—perhaps none of which by itself would be considered significant—may combine to give the increased similarity between stands on an island.

SUMMARY

The bird populations of 24 stands of forest vegetation on the Apostle Islands of Lake Superior were censused by a sample count method. A two-dimensional ordination of the stands was constructed, based on the avifaunal similarities between stands. The ordination represents an environmental complex, within which many bird species are distributed in definite patterns. Certain vegetational characteristics of the stands also show well-developed patterns within the ordination, indicating that they may play an important role in the environmental complex. Aspens, pines, hemlocks, maples, and the relative amount of coniferous understory show excellent patterns. The species of birds observed in the study are discussed in relation to their apparent environmental preferences. Two species found in every stand, the Ovenbird and the Red-eyed Vireo, have broad environmental tolerances. Two others found in at least three fourths of the stands, the Black-throated Green Warbler and the American Redstart, are partial to mature forests, the former especially to birch–hemlock, and the latter to pine as well. In pioneer aspen growth, White-throated Sparrows and Mourning Warblers are most abundant. There are greater similarities between stands on the same island than would be expected from the vegetational variation. The possible influences of island size and of the behavior of birds in relation to island topography are discussed.

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DEPARTMENT OF BOTANY, UNIVERSITY OF WISCONSIN, MADISON 6, WISCONSIN, MAY 27, 1959

MALLOPHAGA FROM BIRDS OF NORTH AMERICA

BY RICHARD O. MALCOMSON

Sixty years have elapsed since a list of Mallophaga with their hosts was made (Kellogg, 1899. Smithsonian Institution Bull. XII:39–100). During this time many new species have been described and new genera have been erected.

The purpose of this paper is to stimulate interest among biologists, including the bird banders, to study the parasites of birds. Almost all birds have parasites, and the bander has a good opportunity to take these without killing the birds, as was done in the past. I would suggest that the bander obtain official sanction (on his banding permit) to carry on this work. He can take these parasites by a very simple delousing process as follows:

Procure an insecticidal powder, pyrethrum for example, a few sheets of white paper and a paper carton. After the bird has been banded, thoroughly dust some of the powder through the feathers, but be careful not to get any powder into the eyes of the birds. Now place the bird on a sheet of white paper and invert the paper carton over it. Allow the bird to flutter around in this enclosure for about five minutes. In the meantime the parasites will have crawled to the tips of the feathers and dropped to the paper. Some of the lice will show movement, but all can be picked up by a small camel hair brush and transferred to a piece of medicinal cotton.

If the bander is not interested in collecting and identifying these parasites for himself, he may record on a slip of paper, the name of the bird, date, place taken and his name as collector. The piece of cotton containing label and specimens may be dropped into an envelope and mailed to some mallophagologist.

The cotton method is the most convenient way to send specimens by mail. On the other hand, if the bander is interested in collecting and identifying his own material, he should put the specimens taken from each bird into separate small vials containing 70 per cent alcohol, to preserve them for some future time. A small slip of paper containing the collector's name, name of the bird, date and place taken should be inserted in the vial. Labels printed with soft lead pencil will be legible indefinitely in 70 per cent alcohol.

To identify the material collected requires a definite process of mounting on microscope slides. Good results may be obtained by the following method:

1. Transfer contents of each vial to a vial of 20 per cent potassium hydroxide for a period of 24 to 48 hours, depending upon the degree of scleritization of the lice.
2. Wash in distilled water 30 minutes.
3. Dehydrate with 35 per cent alcohol for 10 minutes.
4. Place in 50 per cent alcohol for 10 minutes.
5. Place in 70 per cent alcohol for 10 minutes.

6. Place in 85 per cent alcohol plus 15 per cent benzol for 10 minutes.
7. Place in 95 per cent alcohol plus 50 per cent benzol for 10 minutes.
8. Place in absolute alcohol plus 75 per cent benzol for 10 minutes.
9. Place in 100 per cent benzol for 5 minutes.
10. Mount in euparal or a medium with benzol base.
11. Mount in center of slide and cover with 18 mm. round cover slip.

There are more than 2600 recorded species of living Mallophaga, and this paper lists 800 of these species and about 500 species of birds from which they are recorded. I have not recorded any subspecies of Mallophaga. This list of about 800 species probably represents about one fourth of the species yet to be described.

In this paper the birds are listed phylogenetically. Under each bird is listed the scientific names of the Mallophaga known to infest it, as described in the literature of Systematic Entomology. I have followed very closely the classification of Hopkins and Clay in, "A Check List of the Genera and Species of Mallophaga" (1952. British Museum, London).

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HOST LIST WITH PARASITES

Great Tinamou, *Tinamus major*
  Kelloggia brevipes
  Heptapsogaster minutus
  H. parvulus
  Megaginus quadrithorax
  Menacanthus laticephalus
  Ornicolax alienus
  O. mexicanus
  O. robustus
  Pseudolipeurus tinami
  Pterocotes aberrans
  Rhopaloceras simplex
  Strongylocotes pellucidifrons
Little Tinamou, *Crypturellus soui*
  Heptapsogaster costaricensis
  H. tapicollae
  Megaginus laticlypeus
  Pectenosoma meserythra
  Physconella kelloggi
  Rhopaloceras rudimentarius
Slaty-breasted Tinamou, *Crypturellus boucardi*
  Austrokelloggia boucardi
  Discocorpus furculus
  Heptapsogaster boucardi
  H. modestae
  H. tuxtlae
  Megapeostus multiplex
  Pectenosoma boucardi
  Pseudolipeurus similis
  Rhopaloceras heterogenitalis
  Strongylocotes boucardi
Rufescent Tinamou, *Crypturellus cinnamomeus*
  Heptapsogaster acutiventris
  Heterogoniodes araeceps
  Megapeostus secundus
  Pectenosoma cinnamomea
  Strongylocotes fimbriatus
  S. interruptus
Bonaparte's Tinamou, *Nothocercus bonapartei*
  Nothocotus distinctus
  N. parvithorax

Common Loon, *Gavia immer*
  Craspedonirmus bisetosus
Arctic Loon, *Gavia arctica*
  Craspedonirmus atricolor
  C. colymbinus
  C. frontatus
Red-throated Loon, *Gavia stellata*
  Craspedonirmus colymbinus
  C. frontatus
Horned Grebe, *Podiceps auritus*
  Aquanirmus colymbinus
Eared Grebe, *Podiceps caspicus*
  Aquanirmus americanus
  Incidifrons fulicae
  Laemobothrion simili
  Pseudomenopon insolens
Western Grebe, *Aechmophorus occidentalis*
  Pseudomenopon par
Pied-billed Grebe, *Podilymbus podiceps*
  Aquanirmus americanus
Short-tailed Albatross, *Diomedea albatrus*
  Docophoroides brevis
  D. pacificus
  Harrisoniella densa
  Perineus concinnus
  P. giganticola
  Procellariphaga navigans
  P. pinquis
Black-footed Albatross, *Diomedea nigripes*
  Docophoroides ferrisi
  Episbates machilhennyi
  Perineus confidens
Black-browed Albatross, *Diomedea melanophris*
  Docophoroides harrisoni
  D. murphyi
  D. simplex
White-capped Albatross, *Diomedea cauta*
  Docophoroides brevis
Yellow-nosed Albatross, *Diomedea chlororhynchos*
  Docophoroides murphyi
Cape Petrel, *Daption capensis*
  Ancistrona procellariae
  Naubates testaceus
  Procellariphaga daptionis
  Pseudonirmus gurlti
Fulmar, *Fulmarus glacialis*
  Ancistrona vagelli
  Perineus nigrolimbatus
  Austromenopon brevifimbriata
  Saemundssonia occidentalis
Black-tailed Shearwater, *Adamastor cinereus*
  Halipeurus agusticeps
Cory's Shearwater, *Puffinus diomedea*
  Saemundssonia peusi
Pink-footed Shearwater, *Puffinus creatopus*
  Naubates major
Greater Shearwater, *Puffinus gravis*
  Halipeurus abnormis
  Naubates harrisoni
Wedge-tailed Shearwater, *Puffinus pacificus*
  Clypedon pacificus
  Longimenopon puffinus
Sooty Shearwater, *Puffinus griseus*
  Halipeurus diversus
  Procellariphaga paulula
Manx Shearwater, *Puffinus puffinus*
  Naubates major
  Saemundssonia valida
  Trabeculus aviator
  T. miriabilis
Audubon's Shearwater, *Puffinus lherminieri*
  Clypedon pacificus
  Procellariphaga narboroughi
Fork-tailed Petrel, *Oceanodroma furcata*
  Philoceanus annuliventris
Leach's Petrel, *Oceanodroma leucorhoa*
  Acidoproctus kelloggi
  Halipeurus subangusticeps
  Saemundssonia incisa
Guadalupe Petrel, *Oceanodroma macrodactyla*
  Longimenopon dominicanum
Red-billed Tropic-bird, *Phaëthon aethereus*
  Austromenopon becki
  Saemundssonia breviantennata
  S. phaetona
Red-tailed Tropic-bird, *Phaëthon rubricauda*
  Saemundssonia hexagona
White Pelican, *Pelecanus erythrorhynchos*
  Colpocephalum unciferum
  Piagetiella peralis
Brown Pelican, *Pelecanus occidentalis*
  Colpocephalum unciferum
  Pectinopygus occidentalis

Piagetiella bursaepelecani
Blue-faced Booby, *Sula dactylatra*
Pectinopygus jamaicensis
Blue-footed Booby, *Sula nebouxii*
Pectinopygus minor
Brown Booby, *Sula leucogaster*
Pectinopygus annulatus
P. garbei
Red-footed Booby, *Sula sula*
Pectinopygus sularum
Gannet, *Morus bassanus*
Eidmanniella pustulosa
Pectinopygus bassani
Great Cormorant, *Phalacrocorax carbo*
Eidmanniella brevipalpis
Pectinopygus gyricornis
Double-crested Cormorant, *Phalacrocorax auritus*
Eidmanniella kuwani
Pectinopygus gyricornis
Piagetiella incomposita
Olivaceous Cormorant, *Phalacrocorax olivaceus*
Eidmanniella eurygaster
Pectinopygus faralloni
P. gyroceras
Piagetiella vigua
Brandt's Cormorant, *Phalacrocorax penicillatus*
Eidmanniella kuwani
Piagetiella incomposita
Anhinga, *Anhinga anhinga*
Pectinopygus anhinge
Magnificent Frigate-bird, *Fregata magnificens*
Pectinopygus crenatus
Gray Heron, *Ardea cinerea*
Ardeicola ciconiae
A. ardeae
Ciconiphilus decimfasciatus
Common Egret, *Casmerodius albus*
Ardeicola albulus
Ciconiphilus obscurus
Little Egret, *Egretta garzetta*
Ardeicola expallidus
Black-crowned Night Heron, *Nycticorax nycticorax*
Ciconiphilus nyctardis
Least Bittern, *Ixobrychus exilis*
Ardeicola stellaris
American Bittern, *Botaurus lentiginosus*
Ardeicola stellaris
Wood Ibis, *Mycteria americana*
Ardeicola loculater
Ciconiphilus maculipes
C. femoratus
Colpocephalum scalariforme
Neophilopterus heteropygus
Glossy Ibis, *Plegadis falcinellus*
Ardeicola rhaphidius
Ciconiphilus blagoweschenskii
Colpocephalum leptopygos
Ibidoecus bisignatus
I. robustus
Plegadiphilus plegadis
White Ibis, *Eudocimus albus*
Colpocephalum fusconigrum
Ibidoecus bimaculatus
Scarlet Ibis, *Eudocimus ruber*
Ardeicola gracilentus
Ibidoecus hians
White Spoonbill, *Platalea leucorodia*
Eucolpocephalum femorale
Ibidoecus plataleae
Roseate Spoonbill, *Ajaia ajaja*
Colpocephalum ajajae
Ibidoecus iberoamericanus
American Flamingo, *Phoenicopterus ruber*
Anaticola candidus
Mute Swan, *Cygnus olor*
Ornithobius cygni
Whooper Swan, *Olor cygnus*
Anatoecus musicus
Whistling Swan, *Olor columbianus*
Ornithobius cygni
Canada Goose, *Branta canadensis*
Ornithobius goniopleurus
Trinoton anserium
Brant, *Branta bernicla*
Anaticola crassicornis
Anatoecus dentatus
Barnacle Goose, *Branta leucopsis*
Anatoecus brunneopygus
Ornithobius hexopthalmus
White-fronted Goose, *Anser albifrons*
Anaticola brevimaculatus
A. serratus
Trinoton squalidum

Domestic Goose, *Anser a. domesticus*
  Anaticola anseris
  Anatoecus adustus
  Ciconiphilus parvus
  C. pectiniventris
  Ornithobius mathisi
  Trinoton anserium
  T. squalidum
Black-bellied Tree Duck, *Dendrocygna autumnalis*
  Acidoproctus hopkinsi
Fulvous Tree Duck, *Dendrocygna bicolor*
  Anaticola chaetodens
West Indian Tree Duck, *Dendrocygna arborea*
  Acidoproctus maximus
White-faced Whistling Duck, *Dendrocygna viduata*
  Acidoproctus rostratus
Sheld-Duck, *Tadorna tadorna*
  Anaticola tadornae
  Colpocephalum quadriseriatum
Mallard, *Anas platyrhynchos*
  Anaticola crassicornis
  A. parviceps
  A. zukeri
  Anatoecus adustus
  Holomenopon transvaalense
  Trinoton querquedulae
Black Duck, *Anas rubripes*
  Anaticola crassicornis
  Anatoecus dentatus
  Trinoton lituratum
  T. querquedulae
Gadwall, *Anas strepera*
  Anaticola depurcatus
  Anatoecus dentatus
  Trinoton querquedulae
Pintail, *Anas acuta*
  Holomenopon clypeilargum
  Trinoton luridum
Common Teal, *Anas crecca*
  Anaticola sordidus
  Holomenopon leucoxanthum
Green-winged Teal, *Anas carolinensis*
  Anatoecus dentatus
Blue-winged Teal, *Anas discors*
  Anatoecus dentatus
European Widgeon, *Mareca penelope*
  Anaticola penelopes
  Holomenopon marecae
  Trinoton spinosum
American Widgeon, *Mareca americana*
  Anaticola crassicornis
  Trinoton luridum
  T. querquedulae
Shoveler, *Spatula clypeata*
  Anaticola hopkinsi
  Anatoecus ferrugineus
  Holomenopon steigerum
  Trinoton squalidum
Wood Duck, *Aix sponsa*
  Anaticola lepidotus
  Anatoecus dentatus
Redhead, *Aythya americana*
  Anatoecus dentatus
Common Pochard, *Aythya ferina*
  Anatoecus difficilis
Canvasback, *Aythya valisineria*
  Acidoproctus kelloggi
Greater Scaup, *Aythya marila*
  Anatoecus dentatus
Lesser Scaup, *Aythya affinis*
  Anaticola cornicephalus
  Anatoecus dentatus
  Trinoton querquedulae
Tufted Duck, *Aythya fuligula*
  Anatoecus obtusus
Barrow's Goldeneye, *Bucephala islandica*
  Anaticola clangulae
Bufflehead, *Bucephala albeola*
  Anaticola crassicornis
  Anatoecus dentatus
Oldsquaw, *Clangula hyemalis*
  Anaticola crassicornis
  Anatoecus clangulus
  A. natatorum
Common Eider, *Somateria mollissima*
  Anaticola rubromaculatus
King Eider, *Somateria spectabilis*
  Anatoecus dentatus
  A. obtusus
Muscovy Duck, *Cairina moschata*
  Anaticola cairinensis
  A. zunkeri
  Holomenopon cairinae
  H. transvaalensis
Velvet Scoter, *Melanitta fusca*

Anaticola punctulatus
Anatoecus natatorum
Anaticus roesleri
White-winged Scoter, *Melanitta deglandi*
Anaticola constrictus
Holomenopon loomisi
Surf Scoter, *Melanittta perspicillata*
Anaticola constrictus
Common Scoter, *Oidemia nigra*
Anaticola augustolimbatus
Holomenopon lunarium
Trinoton minus
Ruddy Duck, *Oxyura jamaicensis*
Anaticola crassicornis
Hooded Merganser, *Lophodytes cucullatus*
Anatoecus dentatus
Common Merganser, *Mergus merganser*
Anaticola crassicornis
Anatoecus dentatus
A. ferrugineus
Trinoton querquedulae
Red-breasted Merganser, *Mergus serrator*
Anaticola crassicornis
A. mergiserrati
Anatoecus icterodes
Trinoton mergi
T. querquedulae
Turkey Vulture, *Cathartes aura*
Laemobothrion canalense
Colpocephalum kelloggi
Cuculiphilus alternatus
Falcolipeurus marginalis
Black Vulture, *Coragyps atratus*
Falcolipeurus marginalis
King Vulture, *Sarcoramphus papa*
Colpocephalum megalops
Cuculiphilus cathartaepapae
Falcolipeurus ternatus
Laemobothrion glutinans
White-tailed Kite, *Elanus leucurus*
Colpocephalum osborni
Hook-billed Kite, *Chondrohierax uncinatus*
Kurodaia keopeckei
Laemobothrion condrohieracis
Everglade Kite, *Rostrhamus sociabilis*
Craspedorrhynchus obscurus
Falcolipeurus quadriguttatus
Goshawk, *Accipiter gentilis*
Degeeriella secondaria
D. temporalis
Bicolored Hawk, *Accipiter bicolor*
Degeeriella epustulata
Cooper's Hawk, *Accipiter cooperii*
Craspedorrhynchus dilatatus
Degeeriella fusca
Red-tailed Hawk, *Buteo jamaicensis*
Colpocephalum napiforme
Craspedorrhynchus dilatatus
Laemobothrion loomisi
Red-shouldered Hawk, *Buteo lineatus*
Craspedorrhynchus buteonis
Broad-winged Hawk, *Buteo platypterus*
Kurodaia macrocybe
Swainson's Hawk, *Buteo swainsoni*
Colpocephalum costaricense
Laemobothrion buteonivorum
Rough-legged Hawk, *Buteo lagopus*
Craspedorrhynchus dilatatus
White Hawk, *Leucopternis albicollis*
Craspedorrhynchus candidus
Golden Eagle, *Aquila chrysaëtos*
Colpocephalum impressum
Craspedorrhynchus aquilinus
Degeeriella fulva
Falcolipeurus auturalis
Gray Sea Eagle, *Haliaeetus albicilla*
Colpocephalum flavescens
Craspedorrhynchus macrocephalus
Degeeriella discocephalus
Falcolipeurus sulcifrons
Bald Eagle, *Haliaeetus leucocephalus*
Craspedorrhynchus halieti
Degeeriella amblys
Marsh Hawk, *Circus cyaneus*
Degeeriella fusca
Osprey, *Pandion haliaetus*
Kurodaia haliaeti
Small Forest Hawk, *Micrastur ruficollis*
Craspedorrhynchus ultimus
C. transversifrons
Caracara, *Caracara cheriway*
Cuculicola splendidus
Guadalupe Caracara, *Caracara lutosus*
Degeeriella caracarensis
Gyrfalcon, *Falco rusticolus*
Degeeriella fasciata
Peregrine Falcon, *Falco peregrinus*
Degeeriella fusca

D. temporalis

Pigeon Hawk, *Falco columbarius*
  Degeeriella temporalis

Kestrel, *Falco tinnunculus*
  Degeeriella rufa
  Laemobothrion tinnunculi
  Rediella pediculoides

Sparrow Hawk, *Falco sparverius*
  Degeeriella carruthi
  D. castanea
  D. giebeli
  D. secondaria
  Laemobothrion intermedium
  L. loomisi

Curassow, *Crax rubra*
  Oxylipeurus globicerus
  Amyrsidea rubra

Crested Guan, *Penelope purpurascens*
  Amyrsidea purpurascens
  Oxylipeurus penelope

Chachalaca, *Ortalis vetula*
  Amyrsidea spicula
  Oxylipeurus vetulae

Dusky-headed Chachalaca, *Ortalis garrula*
  Menacanthus ortalidis
  Oxylipeurus costaricensis
  O. postmarginatus

Black Chachalaca, *Penelopina nigra*
  Chelopistes rotundus

Horned Guan, *Oreophasis derbianus*
  Colpocephalum hoffmanni

Blue Grouse, *Dendragapus obscurus*
  Goniodes simoni
  G. merriamanus
  Lagopoecus obscurus

Spruce Grouse, *Canachites canadensis*
  Goniodes corpulentus

Ruffed Grouse, *Bonasa umbellus*
  Goniodes bonasus
  Lagopoecus umbellus

Willow Ptarmigan, *Lagopus lagopus*
  Goniodes lagopi
  Amyrsidea lagopi
  A. striata
  Lagopoecus affinis

Rock Ptarmigan, *Lagopus mutus*
  Lagopoecus affinis

White-tailed Ptarmigan, *Lagopus leucurus*
  Goniodes leucurus

Greater Prairie Chicken, *Tympanuchus cupido*
  Goniodes cupido

Sharp-tailed Grouse, *Pedioecetes phasianellus*
  Goniodes nebraskensis
  Lagopoecus perplexus

Sage Grouse, *Centrocercus urophasianus*
  Goniodes centrocerci
  Lagopoecus gibsoni

Bobwhite, *Colinus virginianus*
  Cuclotogaster maculipes
  Goniodes ortygis
  Lagopoecus numidianus
  Lipeurus dovei
  Oxylipeurus clavatus
  O. cubanus

Black-throated Quail, *Colinus nigrogularis*
  Oxylipeurus yucatensis

Scaled Quail, *Callipepla squamata*
  Goniodes squamatus
  Lagopoecus pallidus
  Oxylipeurus callipeplus

California Quail, *Lophortyx californicus*
  Goniodes mammilatus
  G. ovoidalis
  Lagopoecus docophoroids

Gambel's Quail, *Lophortyx gambelii*
  Lagopoecus gambeli

Mountain Quail, *Oreortyx pictus*
  Goniodes pictus
  Lagopoecus californicus

Harlequin Quail, *Cyrtonyx montezumae*
  Goniodes submamillatus
  Lagopoecus mearnsi
  Oxylipeurus montezumae

Ring-necked Pheasant, *Phasianus colchicus*
  Amyrsidea megalosoma
  Cuclotogaster heterographus
  Goniocotes chrysocephalus
  Goniodes capitatus
  G. colchici
  Lagopoecus colchicus
  Lipeurus maculosus
  Oxylipeurus colchicus

Gray Partridge, *Perdix perdix*
  Amyrsidea megalosoma
  A. perdicis
  Cuclotogaster heterogrammicus

Goniocotes microthorax
G. simillimus
Goniodes dispar
Menopon pallens
Black-eared Wood-quail, *Odontophorus erythrops*
Chelopistes elongatus
C. heterurus
Oxylipeurus melanotus
Marbled Wood-quail, *Odontophorus gujanensis*
Oxylipeurus repandus
Spotted Wood-quail, *Odontophorus guttatus*
Oxylipeurus guttatus
White-throated Wood-quail, *Odontophorus leucolaemus*
Menacanthus meridionalis
Long-tailed Partridge, *Dendrortyx macroura*
Chelopistes simillis
Highland Partridge, *Dendrortyx leucophrys*
Chelopistes dendrortyx
Peacock, *Pavo cristatus*
Amyrsidea phaeostoma
Goniocotes parviceps
G. rectangulatus
Goniodes meinertzhageni
G. pavonis
Lipeurus pavo
Hen, *Gallus domesticus*
Cuclotogaster heterogaphus
Goniocotes gallinae
Goniodes assimilis
G. gigas
Lipeurus caponis
Menacanthus stramineus
Menapon gallinae
M. pallens
Guinea Hen, *Numida meleagris*
Goniocotes gallinae
Goniodes gigas
G. numidae
Lipeurus numidae
Menacanthus numidae
Menapon gallinae
Turkey, *Meleagris gallopavo*
Chelopistes meleagridis
Menacanthus stramineus
Oxylipeurus corpulentus
O. polytrapezius
Ocellated Turkey, *Agriocharis ocellata*
Oxylipeurus agriocharis
Whooping Crane, *Grus americana*
Heleonomus assimilis
Sandhill Crane, *Grus canadensis*
Gruimenopom canadense
Esthiopterum brevicephalus
Limpkin, *Aramus guarauna*
Ibidoecus scolopaceus
Laemobothrion cubense
Clapper Rail, *Rallus longirostris*
Rallicola californicus
Virginia Rail, *Rallus limicola*
Fulicoffula cumstocki
Incidifrons monachus
Rallicola californicus
Water Rail, *Rallus aquaticus*
Fulicoffula rallina
Incidifrons ralli
Pseudomenopon scopulacorne
Rallicola cuspidatus
Spotted Crake, *Porzana porzana*
Rallicola mystax
Yellow Rail, *Coturnicops noveboracensis*
Rallicola porzanae
Wood Rail, *Aramides cajanea*
Fulicoffula volsella
Rallicola ewingi
Mexican Crake, *Laterallus albigularis*
Fulicoffula obstinata
Pseudomenopon costaricense
Corn Crake, *Crex crex*
Rallicola ortygometrae
Purple Gallinule, *Porphyrula martinica*
Rallicola elliotti
Common Gallinule, *Gallinula chloropus*
Fulicoffula gallinula
Incidifrons gallinula
Laemobothrion chloropodis
European Coot, *Fulica atra*
Fulicoffula lurida
Incidifrons fulicae
Laemobothrion atrum
Pseudomenopon pilosum
Rallicola fulicae
American Coot, *Fulica americana*
Fulicoffula longipila
Incidifrons transpositus
Pseudomenopon pacificum

- *Rallicola fulicae*

Sun Grebe, *Heliornis fulica*
- *Fulicoffula heliornis*

Jacana, *Jacana spinosa*
- *Rallicola exiguifrons*

European Oystercatcher, *Haematopus ostralegus*
- *Actornithophilus grandiceps*
- *Austromenopon haemantopi*
- *Saemundssonia haemantopi*

American Oystercatcher, *Haematopus palliatus*
- *Lunaceps haemantopi*
- *Quadraceps auratus*

Lapwing, *Vanellus vanellus*
- *Actornithophilus svobodae*
- *Lunaceps holophaeus*
- *Saemundssonia temporalis*

Ringed Plover, *Charadrius hiaticula*
- *Quadraceps fissus*
- *Quadraceps hiaticulae*
- *Saemundssonia platygaster*

Semipalmated Plover, *Charadrius semipalmatus*
- *Quadraceps major*
- *Q. opacus*
- *Saemundssonia platygaster*

Killdeer, *Charadrius vociferus*
- *Austromenopon aegialitidis*
- *Quadraceps boephilus*

Dotterel, *Eudromias morinellus*
- *Saemundssonia semivittata*

American Golden Plover, *Pluvialis dominica*
- *Actornithophilus timidus*
- *Quadraceps orarius*
- *Saemundssonia hawaiiensis*

Black-bellied Plover, *Squatarola squatarola*
- *Actornithophilus flavipes*
- *Austromenopon squatarolae*
- *Lunaceps incoenis*
- *Quadraceps hospes*
- *Saemundssonia naumanni*

Ruddy Turnstone, *Arenaria interpres*
- *Rediellia pediculoides*
- *Actornithophilus bicolor*
- *Quadraceps strepsilaris*

Black Turnstone, *Arenaria melanocephala*
- *Actornithophilus tigrus*

American Woodcock, *Philohela minor*
- *Rhynonirmus infuscatus*

European Woodcock, *Scolopax rusticola*
- *Austromenopon icterum*
- *Cummingsiella aurea*
- *Rhynonirmus helvolus*

Common Snipe, *Capella gallinago*
- *Austromenopon durisetosum*
- *Cummingsiella ambigua*
- *Rhynonirmus scolopacis*
- *Actornithophilus stictus*
- *Rhynonirmus magnocephalus*

European Jacksnipe, *Lymnocryptes minimus*
- *Actornithophilus multisetosus*

Long-billed Curlew, *Numenius americanus*
- *Cummingsiella longirostricola*
- *C. ovalis*

Eurasian Curlew, *Numenius arquata*
- *Actornithophilus patellatus*
- *Austromenopon crocatum*
- *Cummingsiella ovalis*
- *Lunaceps numenii*
- *Saemundssonia humeralis*
- *S. viridiscola*

Whimbrel, *Numenius phaeopus*
- *Actornithophilus ocellatus*
- *Austromenopon phaeopodis*
- *Lunaceps phaeopi*
- *Saemundssonia scolopacisphaeopodis*
- *S. viridicola*

Bristle-thighed Curlew, *Numenius tahitiensis*
- *Lunaceps hopkinsi*

Eskimo Curlew, *Numenius borealis*
- *Lunaceps rileyi*

Upland Plover, *Bartramia longicauda*
- *Rhynonirmus infuscatus*

Spotted Sandpiper, *Actitis macularia*
- *Quadraceps ravus*

Solitary Sandpiper, *Tringa solitaria*
- *Quadraceps waterstoni*

Wood Sandpiper, *Tringa glareola*
- *Quadraceps obscurus*

Wandering Tattler, *Heteroscelus incanum*
- *Actornithophilus kilauensis*
- *Saemundssonia hawaiiensis*

Polynesian Tattler, *Heteroscelus brevipes*
- *Quadraceps impar*

Willet, *Catoptrophorus semipalmatus*

Austromenopon sachtlebeni
Quadraceps carrikeri
Greater Yellowlegs, *Totanus melanoleucus*
Quadraceps austini
Lesser Yellowlegs, *Totanus flavipes*
Quadraceps falcigerus
Knot, *Calidris canutus*
Lunaceps drosti
Saemundssonia canuti
S. islandica
Purple Sandpiper, *Erolia maritima*
Lunaceps nereis
Pectoral Sandpiper, *Erolia melanotos*
Actornithophilus morsitans
Least Sandpiper, *Erolia minutilla*
Actornithophilus morsitans
A. trilobatus
Carduiceps zonarius
Saemundssonia fusiformis
Dunlin, *Erolia alpina*
Austromenopon alpinum
Carduiceps meinertzhageni
C. zonarius
Short-billed Dowitcher, *Limnodromus griseus*
Actornithophilus albus
Long-billed Dowitcher, *Limnodromus scolopaceus*
Quadraceps klatti
Semipalmated Sandpiper, *Ereunetes pusillus*
Actornithophilus hirsutus
Western Sandpiper, *Ereunetes mauri*
Lunaceps cabanisi
Marbled Godwit, *Limosa fedoa*
Carduiceps clayae
Lunaceps clayae
L. lucidus
Rotundiceps cordatus
Bar-tailed Godwit, *Limosa lapponica*
Austromenopon meyeri
Carduiceps clayae
Saemundssonia limosae
Hudsonian Godwit, *Limosa haemastica*
Lunaceps paschalis
Rotundaceps cordatus
Black-tailed Godwit, *Limosa limosa*
Actornithophilus spimulosus
Austromenopon limosae
Carduiceps cingulatus
Saemundssonia tompsoni
Ruff, *Philomachus pugnax*
Actornithophilus pustulosus
Austromenopon lutescens
Carduiceps fulvofasciatus
Lunaceps holophaeus
Sanderling, *Crocethia alba*
Actornithophilus albus
Carduiceps complexivus
Lunaceps actophilus
American Avocet, *Recurvirostra americana*
Actornithophilus uniformis
Austromenopon indistinctum
Cirrophthirius recurvirostrae
C. testudinarius
Cummingsiella inexpectata
Quadraceps zephyra
Black-necked Stilt, *Himantopus mexicanus*
Actornithophilus mexicanus
Quadraceps mexicanus
Red Phalarope, *Phalaropus fulicarius*
Austromenopon corporosum
Quadraceps phalaropi
Wilson's Phalarope, *Steganopus tricolor*
Quadraceps fimbriatus
Northern Phalarope, *Lobipes lobatus*
Carduiceps subscalaris
Quadracepts connexus
Mexican Thick-knee, *Burhinus bistriatus*
Quadraceps acuticeps
Pomarine Jaeger, *Stercorarius pomarinus*
Actornithophilus brachycephalus
Austromenopon circinatum
A. fuscofasciatum
Perineus grandis
Perineus laculatus
Quadraceps stellaepolaris
Parasitic Jaeger, *Stercorarius parasiticus*
Quadraceps normifer
Saemundssonia cephalus
Long-tailed Jaeger, *Stercorarius longicaudus*
Quadraceps parvapallidus
Skua, *Catharacta skua*
Perineus piratae
Saemundssonia stresemanni
Glaucous Gull, *Larus hyperboreus*
Quadraceps striolatus
Saemundssonia lari
Glaucous-winged Gull, *Larus glaucescens*

- *Actornithophilus funebris*
- *Austromenopon infrequens*

Great Black-backed Gull, *Larus marinus*
- *Saemundssonia gonothorax*
- *Actornithophilus lari*

Herring Gull, *Larus argentatus*
- *Qudraceps ornatus*

Ring-billed Gull, *Larus delawarensis*
- *Quadraceps sublingulatus*

Mew Gull, *Larus canus*
- *Quadraceps ornatus*
- *Saemundssonia congener*

Black-headed Gull, *Larus ridibundus*
- *Austromenopon ridibundus*
- *Quadraceps punctatus*

Laughing Gull, *Larus atricilla*
- *Saemundssonia gonothorax*

Bonaparte's Gull, *Larus philadelphia*
- *Actornithophilus funebris*

Heermann's Gull, *Larus heermanni*
- *Quadraceps felix*
- *Saemundssonia meinertzhageni*

Ivory Gull, *Pagophila eburnea*
- *Saemundssonia pagophilae*

Black-legged Kittiwake, *Rissa tridactyla*
- *Austromenopon transversum*
- *Quadraceps lineolatus*
- *Q. paulschulzei*
- *Saemundssonia tridactylae*

Ross' Gull, *Rhodostethia rosea*
- *Quadraceps bryki*

Sabine's Gull, *Xema sabini*
- *Quadraceps lineatus*

Forster's Tern, *Sterna forsteri*
- *Saemundssonia parvigenetalis*

Common Tern, *Sterna hirundo*
- *Austromenopon pachypus*
- *Quadraceps sellatus*
- *Saemundssonia sternae*

Arctic Tern, *Sterna paradisaea*
- *Quadraceps houri*

Roseate Tern, *Sterna dougallii*
- *Quadraceps giebeli*

Sooty Tern, *Sterna fuscata*
- *Quadraceps birostris*
- *Q. lepidus*
- *Q. obtusus*
- *Saemundssonia peristicta*
- *S. petersi*

Bridled Tern, *Sterna anaethetus*
- *Saemundssonia meridiana*

Royal Tern, *Thalasseus maximus*
- *Quadraceps praestans*

Sandwich Tern, *Thalasseus sandvicensis*
- *Actornithophilus piceus*
- *Saemundssonia laticaudata*

Caspian Tern, *Hydroprogne caspia*
- *Quadraceps caspius*
- *Q. griseus*

Black Tern, *Chlidonias niger*
- *Actornithophilus maurus*

Noddy Tern, *Anoüs stolidus*
- *Actornithophilus epiphanes*
- *A. milleri*
- *Clypedon incisus*
- *Saemundssonia remota*

Razorbill, *Alca torda*
- *Austramenopon nigropleurum*
- *Quadraceps alcae*
- *Saemundssonia celidoxa*

Common Murre, *Uria aalge*
- *Austromenopon uriae*
- *Quadraceps obliquus*
- *Saemundssonia calva*

Dovekie, *Plautus alle*
- *Austromenopon merguli*
- *Quadraceps klatti*
- *Saemundssonia merguli*

Black Guillemot, *Cepphus grylle*
- *Saemundssonia grylle*

Pigeon Guillemot, *Cepphus columba*
- *Quadraceps pacificus*
- *Saemundssonia procax*

Marbled Murrelet, *Brachyramphus marmoratum*
- *Saemundssonia montereyi*

Ancient Murrelet, *Synthliboramphus antiquum*
- *Quadraceps maritimus*
- *Saemundssonia montereyi*

Cassin's Auklet, *Ptychoramphus aleutica*
- *Quadraceps maritimus*
- *Saemundssonia isolita*
- *S. montereyi*

Crested Auklet, *Aethia cristatella*
- *Saemundssonia wumisuzume*

Least Auklet, *Aethia pusilla*
- *Quadraceps aethereus*

Rhinoceros Auklet, *Cerorhinca monocerata*
  Quadraceps maritimus
  Saemundssonia acutipecta
Common Puffin, *Fratercula arctica*
  Austromenopon fraterculae
  Saemundssonia fraterculae
Tufted Puffin, *Lunda cirrhata*
  Actornithophilus perplanus
  Quadraceps pacificus
Rock Dove, *Columba livia*
  Campanulotes compar
  Coloceras fahrenholzi
  C. piageti
  Colpocephalum turbinatum
  Columbicola columbae
  Horostiella lata
Mourning Dove, *Zenaidura macroura*
  Columbicola baculoides
  C. macrourae
  Physconelloides zenaidurae
Passenger Pigeon, *Ectopistes migratorius*
  Columbicola extinctus
Ground Dove, *Columbigallina passerina*
  Columbicola passerinae
Mexican Parrotlet, *Forpus cyanopygius*
  Paragoniocotes illustris
  Psittacobrosus forpi
Red-and-Green Macaw, *Ara chloroptera*
  Heteromenopon sincipitalis
  Paragoniocotes mirabilis
  Psittacomenopon acuticeps
Scarlet Macaw, *Ara macao*
  Neopsittaconirmus trinoton
  Paragoniocotes nanus
Green Macaw, *Ara militaris*
  Epiara dimorpha
Yellow-billed Cuckoo, *Coccyzus americanus*
  Cuculoecus coccygii
  C. latifrons
  Cuculiphilus decoratus
Black-billed Cuckoo, *Coccyzus erythropthalmus*
  Cuculiphilus fasciatus
Squirrel Cuckoo, *Piaya cayana*
  Cuculicola atopus
Smooth-billed Ani, *Crotophaga ani*
  Osborniella crotophagae
  Vernoniella guimaraesi
Groove-billed Ani, *Crotophaga sulcirostris*
  Vernoniella macgregori
Barn Owl, *Tyto alba*
  Kurodaia subpachygaster
Screech Owl, *Otus asio*
  Kurodaia painei
  Strigiphilus ceblebrachys
Great Horned Owl, *Bubo virginianus*
  Strigiphilus oculatus
Snowy Owl, *Nyctea scandiaca*
  Kurodaia menoponoides
  Strigiphilus ceblebrachys
  S. barbatus
Burrowing Owl, *Speotyto cunicularia*
  Kurodaia pectinata
  Strigiphilus speotyti
Great Gray Owl, *Strix nebulosa*
  Strigiphilus remotus
  S. syrnii
Long-eared Owl, *Asio otus*
  Strigiphilus cursor
  S. barbatus
Short-eared Owl, *Asio flammeus*
  Strigiphilus cursor
  S. nudipes
Squamulated Owl, *Ciccaba virgata*
  Strigiphilus viridicus
Common Nighthawk, *Chordeiles minor*
  Mulcticola macrocephalus
Chimney Swift, *Chaetura pelagica*
  Dennyus dubius
  Eureum ewingi
Vaux's Swift, *Chaetura vauxi*
  Dennyus richmondi
Chestnut-collared Swift, *Chaetura rutila*
  Dennyus brunneitorques
Spiny-tailed Swift, *Chaetura spinicauda*
  Dennyus limbus
White-throated Swift, *Aëronautes saxatalis*
  Dennyus bruneri
Smoky Swift, *Cypseloides fumigatus*
  Dennyus spininotus
Black Swift, *Cypseloides niger*
  Dennyus spiniger
Ruby-throated Hummingbird, *Archilochus colubris*
  Ricinus lineatus
Costa's Hummingbird, *Calypte costae*
  Trochiloecetes prominens
Anna's Hummingbird, *Calypte anna*

Bruelia eustigma
Rufous Hummingbird, *Selasphorus rufus*
Picicola snodgrassi
Trochiloecetes ochoterenal
Lesser Broad-tailed Hummingbird, *Selasphorus flammula*
Ricinus doratophorum
Rieffer's Hummingbird, *Amazilia tzacatl*
Ricinus jiminezi
Coppery-tailed Trogon, *Trogon elegans*
Trogonirmus eleganus
Large-tailed Trogon, *Trogon melanurus*
Trogonirmus melanurus
Violaceous Trogon, *Trogon violaceus*
Trogonirmus hastiformis
T. laticephalis
Belted Kingfisher, *Megaceryle alcyon*
Actornithophilus subpustulatus
Rufous-crowned Motmot, *Momotus mexicanus*
Philopterus dennyi
Blue-crowned Motmot, *Momotus momota*
Bruelia marginella
Emerald Toucanet, *Aulacorhynchus prasinus*
Austrophilopterus minutus
Collared Aracari, *Pteroglossus torquatus*
Austrophilopterus torquatus
Keel-billed Toucan, *Ramphastos sulfuratus*
Austrophilopterus subsimilis
Yellow-shafted Flicker, *Colaptes auratus*
Philopterus alienus
Picicola mississippiensis
Menacanthus colaptis
Penenirmus jugens
Pileated Woodpecker, *Dryocopus pileatus*
Picicola marginatulus
Gray-breasted Woodpecker, *Centurus hypopolius*
Menacanthus praecursor
Acorn Woodpecker, *Melanerpes formicivorus*
Penenirmus californiensis
Yellow-bellied Sapsucker, *Sphyrapicus varius*
Penenirmus californicus
P. varius
Hairy Woodpecker, *Dendrocopos villosus*
Penenirmus californiensis
Downy Woodpecker, *Dendrocopos pubescens*
Menopon hirsutum
Myrsidea funerea
Penenirmus evagens
Nuttall's Woodpecker, *Dendrocopos nuttallii*
Philopterus singularis
Black-backed Three-toed Woodpecker, *Picoïdes arcticus*
Menacanthus picicola
Northern Three-toed Woodpecker, *Picoïdes tridactylus*
Menacanthus picicola
Barred Antshrike, *Thamnophilus doliatus*
Machaerilaemus laticorpus
Masked Tityra, *Tityra semifasciata*
Machaerilaemus tityrus
White-collared Manakin, *Manacus candei*
Philopterus bruneri
Eastern Kingbird, *Tyrannus tyrannus*
Penenirmus tyrannus
Ricinus angulatus
Western Kingbird, *Tyrannus verticalis*
Picicola foedus
Cassin's Kingbird, *Tyrannus vociferans*
Ricinus arcuatus
Ash-throated Flycatcher, *Myiarchus cinerascens*
Menacanthus distinctus
Philopterus rufus
Picicola foedus
Say's Phoebe, *Sayornis saya*
Picicola foedus
Costa Rican Flycatcher, *Empidonax atriceps*
Myrsidea stenodesma
Western Flycatcher, *Empidonax difficilis*
Ricinus sucinaceus
Bruelia ductilis
Eastern Wood Pewee, *Contopus virens*
Philopterus fuscoventralis
Vermilion Flycatcher, *Pyrocephalus rubinus*
Philopterus insulicola
Skylark, *Alauda arvensis*
Menacanthus alaudae
Horned Lark, *Eremophila alpestris*
Ricinus serratus
Tree Swallow, *Iridoprocne bicolor*
Bruelia longa
Philopterus major

Bank Swallow, *Riparia riparia*
  Bruelia tenuis
  Myrsidea latifrons
Rough-winged Swallow, *Stelgidopteryx ruficollis*
  Myrsidea pallorus
Barn Swallow, *Hirundo rustica*
  Bruelia domestica
  Machaerilaemus malleus
  Myrsidea rustica
  M. straminea
Purple Martin, *Progne subis*
  Bruelia brevipes
  Machaerilaemus americanus
  Myrsidea dissimilis
  Philopterus domesticus
Gray-breasted Martin, *Progne chalybea*
  Dennyus similis
Blue Jay, *Cyanocitta cristata*
  Philopterus cristata
White-tipped Brown Jay, *Psilorhinus mexicanus*
  Philopterus underwoodi
Scrub Jay, *Aphelocoma coerulescens*
  Menacanthus persignatus
Black-billed Magpie, *Pica pica*
  Bruelia biocellata
  Philopterus picae
Common Raven, *Corvus corax*
  Bruelia argula
  Menacanthus gonophaeus
  Philopterus corvi
Common Crow, *Corvus brachyrhynchos*
  Bruelia rotundata
  Myrsidea interrupta
  Philopterus corvi
Rook, *Corvus frugilegus*
  Menacanthus laticeps
  Philopterus atratus
Hooded Crow, *Corvus cornix*
  Bruelia uncinosa
Piñon Jay, *Gymnorhinus cyanocephala*
  Philopterus phillipi
Clark's Nutcracker, *Nucifraga columbiana*
  Myrsidea brunea
Black-capped Chickadee, *Parus atricapillus*
  Philopterus rutteri
Carolina Chickadee, *Parus carolinensis*
  Bruelia vulgata
Verdin, *Auriparus flaviceps*
  Bruelia audax
Common Bushtit, *Psaltriparus minimus*
  Menacanthus robustus
Brown Creeper, *Certhia familiaris*
  Penenirmus trimarginis
Dipper, *Cinclus mexicanus*
  Menacanthus aleskensis
  Philopterus americanus
Winter Wren, *Troglodytes troglodytes*
  Penenirmus albiventris
Bewick's Wren, *Thryomanes bewickii*
  Philopterus mirus
Cactus Wren, *Campylorhynchus brunneicapillum*
  Menacanthus distinctus
Catbird, *Dumetella carolinensis*
  Picicola orpheus
Red-wing, *Turdus musicus*
  Bruelia iliaci
  B. inornata
  Myrsidea iliaci
Blackbird, *Turdus merula*
  Bruelia ansel
  B. jacobi
  B. merulensis
  Philopterus merulae
  Ricinus ernstlangi
Clay-colored Robin, *Turdus grayi*
  Penenirmus caligineus
Robin, *Turdus migratorius*
  Bruelia vulgata
  Ricinus merulae
  Sturnidoecus simplex
Fieldfare, *Turdus pilaris*
  Bruelia antimarginalis
  Philopterus bischoffi
Wood Thrush, *Hylocichla mustelina*
  Myrsidea incerta
Hermit Thrush, *Hylocichla guttata*
  Myrsidea incerta
Swainson's Thrush, *Hylocichla ustulata*
  Myrsidea incerta
Gray-cheeked Thrush, *Hylocichla minima*
  Myrsidea incerta
Veery, *Hylocichla fuscescens*
  Myrsidea fuscomarginata
Eastern Bluebird, *Sialia sialis*
  Philopterus sialii

Golden-crowned Kinglet, *Regulus satrapa*
  Ricinus frenatus
White Wagtail, *Motacilla alba*
  Menacanthus pusillus
  Philopterus passerinus
  Sturnidoecus aeneas
Yellow Wagtail, *Motacilla flava*
  Philopterus passerinus
Water Pipit, *Anthus spinoletta*
  Ricinus japonicus
Meadow Pipit, *Anthus pratensis*
  Bruelia cordyalla
Bohemian Waxwing, *Bombycilla garrula*
  Bruelia brachythorax
  Philopterus garrulae
  Ricinus bombycillae
Cedar Waxwing, *Bombycilla cedrorum*
  Bruelia cedrorum
Phainopepla, *Phainopepla nitens*
  Bruelia peninsularis
  Picicola foedus
Northern Shrike, *Lanius excubitor*
  Bruelia imponderabilica
  Menacanthus camelinus
Starling, *Sturnus vulgaris*
  Bruelia nebulosa
  Menacanthus mutabilis
  Myrsidea cucularis
  Sturnidoecus sturni
Crested Myna, *Acridotheres cristatellus*
  Myrsidea invadens
Prothonotary Warbler, *Protonotaria critrea*
  Ricinus pallens
Blue-winged Warbler, *Vermivora pinus*
  Ricinus picturatus
Orange-crowned Warbler, *Vermivora celata*
  Ricinus picturatus
Yellow Warbler, *Dendroica petechia*
  Myrsidea ridulosa
Yellow-breasted Chat, *Icteria virens*
  Picicola foedus
House Sparrow, *Passer domesticus*
  Bruelia obligata
  B. subtilis
  B. vulgata
  Menacanthus annulatus
  Philopterus fringillae
European Tree Sparrow, *Passer montanus*
  Bruelia cyclothorax
  B. subtilus
Wagler Oropendola, *Zarhynchus wagleri*
  Bizarrifrons francisi
  Myrsidea luoris
  M. miriabilis
Bobolink, *Dolichonyx oryzivorus*
  Menacanthus expansus
Eastern Meadowlark, *Sturnella magna*
  Bruelia abrupta
  B. picturata
Yellow-headed Blackbird, *Xanthocephalus xanthocephalus*
  Bruelia xanthocephali
Redwinged Blackbird, *Agelaius phoeniceus*
  Bruelia ornatissima
  Philopterus agelaii
Scarlet-headed Oriole, *Icterus pustulatus*
  Machaerilaemus icterus
Boat-tailed Grackle, *Cassidix mexicanus*
  Bizarrifrons meinertzhageni
Common Grackle, *Quiscalus quiscula*
  Philopterus quiscali
Brown-headed Cowbird, *Molothrus ater*
  Bruelia ornatissima
Swainson Tanager, *Piranga bidentata*
  Bruelia melanococa
Cardinal, *Richmondena cardinalis*
  Menacanthus spinosus
Rose-breasted Grosbeak, *Pheucticus ludovicianus*
  Bruelia pallidula
Varied Bunting, *Passerina versicolor*
  Ricinus australis
Dickcissel, *Spiza americana*
  Myrsidea incerta
Brambling, *Fringilla montifringilla*
  Bruelia cyclothorax
Evening Grosbeak, *Hesperiphona vespertina*
  Bruelia pallidula
Purple Finch, *Carpodacus purpureus*
  Bruelia vulgata
House Finch, *Carpodacus mexicanus*
  Bruelia vulgata
  Myrsidea conspicua
Pine Grosbeak, *Pinicola enucleator*
  Menacanthus alaskensis
Chestnut-capped Atlapetes, *Atlapetes brunnei-nucha*
  Menacanthus difficilis

European Goldfinch, *Carduelis carduelis*
  Bruelia densilimba
  Menacanthus carduelis
American Goldfinch, *Spinus tristis*
  Myrsidea incerta
Red Crossbill, *Loxia curvirostra*
  Bruelia limbata
  Myrsidea quadrimaculata
  Philopterus curvirostrae
Rufous-sided Towhee, *Pipilo erythrophthalmus*
  Bruelia vulgata
  Myrsidea melanorum
  Ricinus subhastatus
Brown Towhee, *Pipilo fuscus*
  Bruelia vulgata
Savannah Sparrow, *Passerculus sandwichensis*
  Ricinus diffusus
Lark Sparrow, *Chondestes grammacus*
  Bruelia augustifrons
Sage Sparrow, *Amphispiza belli*
  Bruelia lautiuscula
White-winged Junco, *Junco aikeni*
  Ricinus hastatus
  R. pallidus
Slate-colored Junco, *Junco hyemalis*
  Bruelia vulgata
  Ricinus pallidus
Oregon Junco, *Junco oreganus*
  Penenirmus mirinotatus
  Ricinus hastatus
  R. pallidus
Tree Sparrow, *Spizella arborea*
  Bruelia vulgata
Field Sparrow, *Spizella pusilla*
  Machaerilaemus complexus
White-crowned Sparrow, *Zonotrichia leucophrys*
  Bruelia vulgata
Golden-crowned Sparrow, *Zonotrichia atricapilla*
  Bruelia vulgata
Fox Sparrow, *Passerella iliaca*
  Ricinus angulatus
Song Sparrow, *Melospiza melodia*
  Ricinus melospizae
  Machaerilaemus maestus
  M. melospizae
  Menacanthus chrysophaeus
Lapland Longspur, *Calcarius lapponicus*
  Bruelia infrequens
  Menacanthus meniscus
Snow Bunting, *Plectrophenax nivalis*
  Bruelia nivalis
  Myrsidea major
  Philopterus hamatus
  Ricinus angulatus

DEPARTMENT OF BIOLOGY, CENTRAL MICHIGAN UNIVERSITY, MT. PLEASANT, MICHIGAN, OCTOBER 3, 1959

GENERAL NOTES

Flight distance in the Great Blue Heron.—Flight distance, as defined by Hediger (1950. "Wild Animals in Captivity," p. 32), is that distance at which an animal will take flight when approached by a supposed enemy. Flushing distance means the same. While Hediger recognizes variation between species, within species, and among individuals of a species, he maintains that a definite, specific flight distance exists within fixed limits.

Measurement of flight distance depends on two basic factors: (1) it must be possible to see the animal at distances greater than the outer limit and (2) reasonable evidence must exist to indicate that the animal is aware of the approaching object before the outer limit is reached. The Great Blue Heron (*Ardea herodias*) is a species which is large enough to be seen from considerable distances, and it usually exhibits head movements which give evidence of an awareness of approach. For example, birds which are fishing will have the head tilted downward; when disturbed the head is moved to a more horizontal position, after which the flight reaction occurs if approach is continued.

Observations were made on flight distance of the Great Blue Herons at Lake Itasca, Minnesota, during the period June 25 to July 12, 1957. The principal aim of the study was to determine the limits of flight distance for this species. Another objective was to determine whether variation of flight distance within the limits could be related to such factors as speed of approach and elevation of birds with reference to water level.

Observations were made from a rowboat equipped with an outboard motor. Herons at the shore line were located from open water with the aid of binoculars. An approach run was made on each bird by steering directly toward it on a line perpendicular to the shore line. During the last part of each run a rangefinder was used to determine boat-to-bird distance at the moment of flight.

Most of the approach runs were made using oars. Rowing was held to a constant speed and every attempt was made to limit unnecessary motion. Other runs were made with the 12-horsepower motor set at slow, medium or fast speed. The majority of birds approached were standing in or near the water and were apparently feeding, but some were perched on trees at heights up to 40 feet. Whenever it was possible to see the new location of a bird after flushing, the boat was returned to open water and another approach was made. This procedure was repeated on each bird as often as possible in order to collect data on the flight distance of specific individuals.

Flight distances ranged from 13 to 166 yards, indicating a considerable amount of variability. In fact, it seemed doubtful that flight distance had any promise as a quantitative basis for the study of behavior of the Great Blue Heron if these observations were a valid representation of the fixed limits for the species. However, it was apparent that some observations were of doubtful validity. Flight distances greater than 140 yards were more than three standard deviations from the mean, which may indicate that some birds were exhibiting the flight reaction in relation to factors other than the approach of the boat. Even the smallest values may have occasionally been in error, since preoccupation with other factors might have permitted closer than normal approach. One heron, which was being harrassed by two Redwinged Blackbirds (*Agelaius phoeniceus*), did not fly until the boat was within 10 yards. That the detection of the approach was late seemed supported by the fact that the heron was in an awkward position and did not successfully initiate flight on the first attempt because of inadequate preparatory motions.

An increase of flight distance was indicated by mean values obtained on four successive sampling dates. Table 1 contains this information, with data confined to approaches made at rowing speed toward birds less than 10 feet above the water. It was impossible to guess whether the increase, if real, was related to seasonal factors or to repeated testing. There was no way of knowing whether the same birds were being observed on the different dates.

Speed of approach made no apparent difference in mean flight distance of birds near water level. However, an increase did occur in relation to birds at positions 10 or more feet above water. At every speed except rowing, increased height was related to greater mean values for flight distance, and apparently was effective in aiding birds to detect increased speed. From this it would appear that increased confidence did not accompany movement to greater heights, but that height did increase perception, possibly in connection with advantage of angle.

All comparisons of mean flight distance were considered tenuous because possible differences were cancelled out by variance within each sampling condition. Unless variability could be assigned to some factor or combination of factors, the use of flight distance as a quantitative basis for further investigation of the behavior of this species did not seem valid.

An indication of one source of variability was obtained from those measurements made by successive approaches on the same subject. During the study period, 25 subjects were approached at least twice in succession. Some estimate of the nature of variability for individuals was possible from the fact that the average range for flight distance was 40 feet. Seven of the 25 birds did not vary at all from one approach to the next. A standard analysis of variance indicated that differences between individuals were significant (1 per cent level). This could be taken as evidence that variation of flight distance for individuals was less than first thought, and further that much of the variability noted during the study was due to differences between individuals. It follows that any future work should be confined to birds individually marked for recognition.

These observations were made while the authors were attending the Lake Itasca Forestry and Biological Field Station with the support of the National Science Foundation.
—Howard D. Orr, *St. Olaf College,* and Theodore W. Sudia, *University of Minnesota, March 27, 1959.*

TABLE 1

FLIGHT DISTANCE IN YARDS UNDER VARIOUS CONDITIONS

Date	Boat Speed	Elevation of Bird	Number of Observations	Mean Distance	Distance Range	S.D.
June 25	rowing	0	5	24	23– 33	5.5
June 26	rowing	0	14	35	23– 66	17.5
June 29	rowing	0	47	44	16– 66	15.9
July 12	rowing	0	5	63	25–166	22.9
	rowing	low*	79	42	16–166	21.9
		high*	48	40	13–100	19.9
	slow motor	low	28	47	20–100	24.0
		high	20	62	15–133	37.3
	medium motor	low	2	41	30– 50	—
		high	11	73	41–100	23.6
	fast motor	low	6	47	33– 60	20.2
		high	2	58	33– 83	—

*low is less than 3 yards; high is 3 or more yards.

Polygyny and other notes on the Redwinged Blackbird.—These observations were made on a one-acre cattail marsh at Itasca State Park, Minnesota, from June 19 to July 16, 1958, in connection with my studies at the University of Minnesota Biological Station. The somewhat isolated marsh is located in the southeast corner of the crossroads of Route 92 and the north boundary road of the park. Dr. John T. Emlen, Jr. found four Redwinged Blackbird (*Agelaius phoeniceus*) nests on June 19. Nests A, B and C contained young birds and Nest D was almost completed. Nests A, C and D were in a triangle almost in the center of the marsh and about 25 feet from each other. Nest B was almost 100 feet south of the southernmost nest in the triangle. I observed the nests 27 times with each visit lasting from ½ to 3½ hours and distributed through the day from 4:30 a.m. to 10:00 p.m.

In his studies of the Redwinged Blackbird in Wisconsin, Nero (1956. *Wilson Bull.*, 68: 35) states that "polygyny was common, but no more than three females were ever observed with one male; two was average." The population of unbanded adults in the area which I studied consisted of a single male with a bald white spot on his forehead and four females, one with an unusually light face, two with almost identical markings, and a fourth with half of her tail feathers much shorter than the others. I found, as did Nero, that the females were "out of phase" in their breeding cycles; the young left the nests on June 23, 27, 30, and July 15, at Nests A, B, C, and D, respectively.

I observed that the adults fed and gathered food for the young only outside the nesting area, usually in the marsh across the north boundary road. The male did not help feed the young; each female fed her own brood until the young from Nest C were destroyed two days after fledging. During the next 10 days on 12 occasions I saw both Females B and C feeding the two fledglings from Nest B, and this entire group left the marsh on the same day.

The resident male defended his territory by "song spread," "bill tilting," and attack, when necessary, from male Redwinged Blackbirds (apparently unmated and immature birds who sometimes entered the area) as well as from a pair of Baltimore Orioles (*Icterus galbula*) nesting nearby. When one of these intruders entered the territory, the resident male first gave a warning call, which sent the females into the willow trees to the south of the nests, and then he chased away the intruder. On one occasion when two males (one immature) were being chased away, one of the females flew into view and perched on a cattail. Immediately the resident male abandoned his pursuit of the intruders and chased her back to the willows. The area was not defended against other nesting species including a Ruby-throated Hummingbird (*Archilochus colubris*) and two Yellowthroats (*Geothylpis trichas*). Once when a Red-tailed Hawk (*Buteo jamaicensis*) circled high over the area the male displayed, gave an alarmed call, exposed his epaulets, and flew over the territory. Nero (*op. cit.*: 125–130) found that "nearly all Redwings on the marsh sat quietly on their perches with concealed epaulets when hawks were soaring overhead." Each female defended a small area around her nest, particularly against other females. On three occasions I saw the females band together and chase an immature male from the territory.

With three exceptions the observations of this brief study corresponded closely with those of Nero. A single male appeared to have a harem of four females, all with nests from which young fledged. On at least 12 occasions over a ten-day period two unbanded but easily identified females fed the fledglings from a single nest after one of these females had just lost her entire fledged brood. When a Red-tailed Hawk appeared over the area, the male made himself conspicuous.—Ruth Strosnider, *Woodrow Wilson High School, Washington, D. C., April 27, 1959.*

A record of swimming in Bobwhites.—Twenty-eight Bobwhites (*Colinus virginianus*) were observed to swim between 600–700 feet, approximately one-half the distance across the main axis of the west portion of 3300-acre Lake Carl Blackwell, Payne County, Oklahoma on October 13, 1958. The birds were seen about 7 a.m. slightly south of a point mid-distance from either shore where a north-south transect across the lake measured almost 500 yards. The quail were scattered in an area 10x40 feet swimming toward the south shore. The water was glassy calm, otherwise the birds probably would have gone unnoticed.

The head, neck and upper third of the body were all that protruded above the water as the Bobwhites "paddled" slowly along until 18 reached the south shore line. These individuals appeared completely exhausted. The remaining 10 birds, one of which was only 2 feet from shore, floated quietly just holding their heads above water. These floating birds offered no resistance when picked up by hand and placed in the grass at the shoreline. Two quail were so fatigued that they could not stand, but fell on their side when placed in the grass.

Two days later one dead bird was found intact where it had been placed in the grass, and the remains of two others had been partially eaten by some predator.

It is possible that these birds were attempting to fly across the lake, although the 500 yards is not an extreme distance for quail to fly. The birds could have been flushed some distance from the shore line and then become exhausted attempting to fly across the lake. This seems unlikely since the quail were able to swim the 600- to 700-foot distance and should have been able to fly the same distance more easily. Although there was no fog in the area where the Bobwhites were first seen, approximately 20 minutes earlier in another portion of the lake a light fog rising from the water surface was evident. With a light fog and perfectly calm water, the birds could have alighted in the lake by accident.

A weekly news report of the Oklahoma Wildlife Conservation Department dated November 7, 1958, gave another account of six quail being rescued from Ft. Gibson Reservoir in Northeastern Oklahoma. Population pressures may have some bearing on these unusual incidents. High Bobwhite populations in Oklahoma during the fall of 1958 produced many unusual behavior and distribution patterns. Coveys of quail were reported in downtown areas in several cities and quail were seen regularly in residential sections from late summer throughout the fall period.—William R. Heard, *Department of Zoology*, (Contribution No. 288) *Oklahoma State University, May 18, 1959.*

Ground nest of Florida Red-shouldered Hawk.—On Saturday, March 7, 1959, I visited the area of the Kissimmee Prairie between Lake Jackson and Lake Kissimmee, Florida. Having visited this area many times since 1950 I knew where several birds usually nested. For this reason a search was made through a small cabbage palm hammock on the west side of Lake Jackson, in Osceola County, for a nest of a Red-shouldered Hawk (*Buteo lineatus*). A single bird was seen on the outside, and upon entering this hammock a nest was found that had been blown to the ground by the recent high winds. Some 40 yards away another such nest was found. Both of these nests were composed of Spanish moss, oak sticks, shreds of airplant, and a few pieces of oak twigs with green leaves still attached.

After walking another few yards, possibly 20, I heard a scream from a bird flying overhead through the treetops. I immediately started looking closely in the trees for the new nest, as the parent bird remained close by and continued to call. Soon a nest with two warm eggs was found on the ground about 9 feet from the base of an oak and entirely unconcealed.

The nest was composed of Spanish moss, a branch of oak twig with green leaves, two pieces of coarse brown fiber from the cabbage palm and a piece of green plant commonly known as "dog fennel." This nest resembled the lining portion of most tree nests, but lacked the sticks and twigs.

The parent bird made several passes overhead and uttered the usual scream as she did so.

Some eight years previous a frail nest with two broken eggs was found in this same hammock. An investigation revealed this nest had been built on a horizontal palm frond, some 7 feet above the ground, and had blown off the night before.

This appears to be the only record of ground nesting of the Red-shouldered Hawk.—Charles E. Carter, *1339 30th Street, Orlando, Florida, June 8, 1959.*

ORNITHOLOGICAL NEWS

In accordance with a decision of the 13th International Congress of Zoology, 1948, public notice is hereby given of the possible use by the International Commission on Zoological Nomenclature of its plenary powers in connection with the following case, full details of which will be found in *Bulletin of Zoological Nomenclature*, Vol. 17, Parts 6/8, to be published on April 8, 1960:

Suppression of the generic name *Drepanis* Brisson, 1760 (Class Aves). Z. N. (S)901.

Anyone who wishes to comment on this change should do so in writing, and in duplicate, as soon as possible, and in any case before October 8, 1960. Each comment should bear the reference number. Comments received early enough will be published in the *Bulletin of Zoological Nomenclature*. Those received too late for publication will, if received before October 8, 1960, be brought to the attention of the Commission at the time of commencement of voting.

Communications should be addressed as follows:

The Secretary,
International Commission on Zoological Nomenclature,
c/o British Museum (Natural History),
Cromwell Road,
London, S.W. 7.,
England.

The American Museum of Natural History, New York 24, New York, announces that a post-doctoral Fellowship for one year will be available in its Department of Birds, beginning on October 1, 1960. Inquiries may be directed to the Chairman, Department of Birds.

In "Water Birds of Penobscot Bay," distributed at the Rockland meeting of the Wilson Ornithological Society in June, 1959, appears on page 14 the statement under Eider that "over 100 well-grown young and over 300 nests were observed." Actually, we found over 100 nests and saw over 300 well-grown young. Unfortunately the transposition of the figures was not caught in the proofreading.—*Frederick V. Hebard.*

Mrs. Harriet Buchheister, wife of Carl W. Buchheister, President of the National Audubon Society, has an appeal that she hopes will bring help from readers of *The Wilson Bulletin.* For several years she has been working with crippled or blind and otherwise handicapped children and has been bringing joy and instruction into their lives by letting them learn birds by handling bird skins and mounted specimens. Unfortunately, the specimens wear out and need to be renewed occasionally. Will all those who collect and have extra specimens—either prepared skins or mounted ones—please send them to Mrs. Buchheister at 1239 Madison Avenue, New York City, New York. If new fresh skins or mounts are made, she asks you to please use borax instead of arsenic in their preparation and indicate same.—*John K. Terres.*

ORNITHOLOGICAL LITERATURE

The Birds. By Oskar Heinroth and Katharina Heinroth. Translated by Michael Cullen. University of Michigan Press, Ann Arbor, 1958: 5¼x88½ in., 181 pp., 91 figs. $5.00. (First published in 1955 as Aus dem Leben der Vogel, second enlarged edition, by Springer-Verlag, Berlin-Goettingen-Heidelberg.)

A conventional review of this unusual book would be an injustice. To be sure there is a table of contents listing titles of the 22 chapters, and there is an index. But the chapter titles are inconsistent in style and their meaning is not always clear. They range from "The Nest" (Chapter 2) and "Color and Pigment" (15) to "Keeping Clean" (16) and "Getting About" (20). There is little or no balance among subject matter in the chapters, while certain specific subjects (for example, eggs) are discussed in widely scattered sections of the book. The length of the chapters varies greatly. Chapter 9, which is peculiarly titled "Is the Size of a Bird Related to the Size of Its Egg?" has the total length of one printed page. The index is limited to only the common names of species and groups of species, followed by their scientific names in parentheses and by page numbers.

These comments about an ordinary book would constitute a major criticism, but this is not an ordinary book. What, then has it? The first and truly intriguing aspect is the series of illustrations, each of which has a real purpose. Although they are small, their clarity of reproduction is exceptional. A few are line drawings, but most are photographs of nests, eggs, young, and adults, some showing special anatomical details. The purpose of all of the illustrations has been excellently achieved. They show us what birds really look like and, in many instances, why they behave as they do. An outstanding example are the neatly posed side and front views of a featherless Vasa Parrot which perfectly demonstrate the actual shape of a bird's body.

The illustrations serve to stimulate an interest in the text, which proves to be readable, smoothly flowing, and informative. It would be incorrect to say that this book is a complete work on ornithology, but it is nonetheless a complete story in itself, one that the reader may not easily leave unfinished. There is in it that rare quality of sensitivity to special details about living birds and that personal touch of the gifted authors, Dr. and Mrs. Heinroth. Dr. Heinroth was an ornithologist who knew birds so well that he could write of them as distinct personalities. We are fortunate to have their book made available to us in this very fine translation.—Dwain W. Warner.

Birds of Martha's Vineyard with an Annotated Check List. By Ludlow Griscom and Guy Emerson. Privately printed, 1959: 5½x8¼ in., xiv+164 pp., 1 map. $4.50. (For sale at National Audubon Society, 1130 Fifth Ave., New York 28, N. Y.; Massachusetts Audubon Society, 155 Newbury St., Boston 16, Mass.; and Avery's, Edgartown, Martha's Vineyard, Mass.)

This attractive, handsomely printed little volume resulted from the collaboration of at least ten persons. The senior author, the late Ludlow Griscom, originally prepared the annotated list of bird species; Mrs. Ruth P. Emery revised and brought it up to date to include records as recently as 1957. The final list of 342 species comprises the bulk of the book. Annotations on each species usually consist of a statement of status, followed by dates when reported, sometimes localities where seen, and the last names (no initials) of observers. For full names of observers the reader may consult a list in the back pages of the book. In a few instances, where there is more than one observer with the same last name, the reader has no way of knowing to which observer he is being referred. The annotations rarely include data on ecology (or even habitats), nests, and breeding habits. An excellent feature of the book is a summary or digest of the annotated list. This consists of six so-called Seasonal Lists to one of which each of the 342 species is assigned. On the line beside the name of the species is a brief designation of status. Altogether the lists provide a convenient device for quick reference.

What could have been a very useful feature of the book, "Where to Find Birds in Martha's Vineyard," is most disappointing. Despite the large, tipped-in, folding map, adequately detailed as to places and routes, the accompanying text of two pages is so imprecise as to be useless. Though it mentions some of the places on the map, it fails to state exactly how one reaches them and what he may expect when he gets there.

The book is concluded by a list of references to literature and a good index to bird species by both common and technical names.—OLIN SEWALL PETTINGILL, JR.

LEAD POISONING AS A MORTALITY FACTOR IN WATERFOWL POPULATIONS. By Frank C. Bellrose. Illinois Natural History Survey Bulletin, Vol. 27, Article 3, May, 1959: pp. 235–288; 31 tables, 9 figs. (2 charts, 7 photos), frontis. photo.

This paper reports extensive field and laboratory analysis of the incidence and effects of lead poisoning in waterfowl, between 1938 and 1955. Principal emphasis is on the Mallard and the Mississippi Flyway, but 23 species and all flyways are considered and compared. A complete review of reported die-offs is followed by detailed sections on the availability of lead, ingested lead shot in migrating fall and winter ducks, and effects of lead in wild Mallards dosed and released. Four pages of critical discussions and three pages of concise summary make the voluminous and important information in this bulletin readily available. Bellrose estimates the annual loss due to lead poisoning at 4 per cent for Mallards in the Mississippi Flyway and between 2 and 3 per cent for the total waterfowl population in North America, but thinks that the damage is not yet severe enough to warrant drastic regulations. The incidence of poisoning and the numbers of waterfowl hunters are both currently on the increase, posing a new management problem for the not-distant future.—T. L. QUAY.

FOOD HABITS OF MIGRATING DUCKS IN ILLINOIS. By Harry G. Anderson. Illinois Natural History Survey Bulletin, Vol. 27, Article 4, August, 1959: pp. 289–344; 43 tables, 18 figs. (15 photos, 2 charts, 1 map), frontis. photo.

The long and excellent series of research papers on waterfowl biology from the Illinois Natural History Survey is continued in the present bulletin. A total of 4977 duck gizzards of 17 species was collected in the autumns of 1938, 1939, and 1940 from hunters along the Illinois (90.5 per cent) and Mississippi rivers. The food contents were identified and calculated in minute detail, by the percentage volume method. The sample by species was roughly proportional to the estimated numbers in the fall flight, the seven commonest species and number of gizzards being: Mallard—2825, Pintail—881, Lesser Scaup—220, Blue-winged Teal—129, Green-winged Teal—393, Baldpate—160, and Ring-necked Duck—120. The foods and feeding habits of each species, including seasonal changes between October 16 and December 15, are presented in separate tables and discussions. The plant food items are listed in the tables by species only. Generic totals would have facilitated comparative understanding, since the genus is commonly used as the significant level in food habits literature. The ecology, availability, and use of each of the 19 most important plant species are discussed, and 12 of them figured. Animal foods amounted to only 5.52 per cent of the total organic contents, and the percentage volumes of many of the items in the tables carried to the rather meaningless level of four decimal places. The summary is too short to do full justice to the included data. Anderson is to be congratulated for publishing at this time this useful information which he collected 20 years ago, rather than leaving it in the files forever.—T. L. QUAY.

THE BIRDS OF THE SASKATCHEWAN RIVER, CARLTON TO CUMBERLAND. By C. Stuart Houston and Maurice G. Street. Special Pub. No. 2, Saskatchewan Natural History Society, Regina, Saskatchewan, 1959: paper covered, 5½x8½ in., 205 pp., 4 maps, illus. $1.50.

This volume is an excellent example of the valuable contributions which amateurs can make to scientific ornithology. The senior author is a physician, as were so many outstanding naturalists of an earlier period. Undoubtedly the precise training for such a profession imbues an individual with the idea that accuracy of observing and reporting is essential. This is not always realized by many amateurs. That a professional education is not essential, however, is illustrated by the work of the junior author whose education was limited to that taught in the local schools. Not only are his observations accurate but they are remarkable in the fact that he commenced his diary of bird migration at the age of 12.

The book deals with a narrow area in the eastern half of Saskatchewan, along the rivers of the same name, from Carlton, 200 miles northeast to Cumberland House. Here the parkland of the Transition Zone merges with evergreen forests of the Canadian Zone. The region is too far north to attract a number of prairie forms. Black Ducks and Wood Ducks have occasionally occurred. The Eastern Kingbird is a common summer resident, but the Western Kingbird has been reported but twice.

Nipawin and Prince Albert may be strange names but every taxonomist and student of nomenclature will be familiar with Carlton and Cumberland House. The latter, established by Samuel Hearne in 1774, is the oldest community in Saskatchewan. The senior author has written brief sketches of these four regions and biographies of Hearne (1745–1792), John Richardson (1787–1867) and Thomas Drummond (1790–1835) who served under Sir John Franklin, Blakeston (1832–1891), Eugene Bourgeau (1815–1887) and R. R. MacFarlane (1833–1920), as well as those of his contemporaries. A bibliography of 144 titles will prove invaluable to future students of this area.

Based upon these earlier records and the observations of the authors, Houston has collected records for 259 species and seven considered hypothetical. For each he reviews the historical status and adds an ample account of their present status in the region concerned. Among these are five species for which the area is the type locality: Forster's Tern, Olive-sided Flycatcher, Gray-crowned Rosy Finch, Clay-colored Sparrow and Smith's Longspur. From an obscure botanical article, he discovered that Forster's Tern was actually collected by Drummond "some 10 to 50 miles upriver from Cumberland House" and not downstream, possibly in Manitoba, as suggested in the 5th edition of the A. O. U. Check-list. We learn that "Carlton specimens constitute the first known records to science of Swainson's Hawk" and that Nipawin is possibly the site where Henry Kelsey on July 24, 1691, shot three Passenger Pigeons, the earliest records for Western Canada.

A casual reader might assume that the work of the senior author overshadowed that of his associate. This is far from true. To appreciate the contribution of Street, one must have worked in the Canadian Zone to realize the difficulties he encountered in his studies of the status of the breeding birds. He has found or checked the nests of 131 species, and the flightless young of 10 more, in a 20-mile radius of Nipawin. Can such a record be equalled? His findings include 33 nests of the Gray Jay, 20 of the Red-breasted Nuthatch, and the parasitization of 29 species by the Brown-headed Cowbird! Breeding ranges given in the 5th A. O. U. Check-list are extended by his nesting records for the Goshawk, Northern Three-toed Woodpecker, Gray Jay, House Wren, Catbird, Swainson's Thrush, Veery, Mountain Bluebird, Solitary, Philadelphia and Warbling Vireos and the Orange-crowned Warbler.

The authors are to be congratulated for the excellency of this volume which is remarkably free from errors. The Saskatchewan Natural History Society should be commended for making the information available at such a moderate price.—A. E. Allin.

Wildlife Conservation. By Ira N. Gabrielson. Second edition. The Macmillan Company, New York, 1959: 5½x8½ in., 244 pp., 23 maps and diagrams, 32 black and white plates. $5.50.

The first half of this book is an elementary treatment of the interrelations of natural resources; succeeding chapters on Grassland Conservation, Migratory Birds, Refuges, and Surmounting the Obstacles to Conservation, though brief, will interest more advanced students. The 16-page Grasslands chapter is the most dynamic one in the book, especially in its treatment of the pronghorn antelope. More discussion of the effects of present government agricultural policy would have made it unique as a brief statement of the major problem we face in bringing sound management to an area equal to two-fifths of the land area of the United States.

As one would expect of its author, there are many valuable insights into the problems discussed. On page 117, Dr. Gabrielson transcends his profession by stating flatly that the task we face is one of repairing the damage caused by past abuses, to "put natural constructive processes back to work." And in a brief discussion of crop-destruction by birds, he reminds us that it is the effect of this damage on the "margin of profit," rather than the proportion of the total crop affected, that makes this problem so difficult.

But the attempt to separate all topics according to popular interest in them results in chapters that mention nearly everything but almost never in such juxtaposition as to stimulate interest or excite concern. Conservation, as a doctrine, was born of conflict of interest, but there is little controversy here, no politics; instead, almost every paragraph suffers from over-qualification.

One almost wishes that Dr. Gabrielson had shunned this revisionary stint and addressed himself to a critical analysis of existing trends in wildlife conservation, a task few Americans are so well qualified to do. In this book he seems too often to have worked in an editorial straight-jacket.—Roland C. Clement.

A Field Guide to Bird Songs arranged to accompany roger tory peterson's "a field guide to the birds." Houghton Mifflin Company, Boston, 1959. $10.00.

This adjunct to Peterson's "A Field Guide to the Birds" is a comprehensive and systematic collection of recordings of the songs and calls of 305 species of North American birds found east of the Rocky Mountains. The recordings have been placed on both sides of two 12-inch long-playing records (with six to eight separate bands on each side) and arranged to accompany, page-by-page, the most recent edition of Peterson's Guide. The recordings were made in the field by the Laboratory of Ornithology, Cornell University, under the direction of Dr. Peter Paul Kellogg and Dr. Arthur A. Allen. Credit is given to 27 individuals who contributed one or more recordings or assisted in other ways.

The total playing time is approximately 80 minutes, nearly equally divided between non-passerines and passerines. Each species receives about 4 to 28 seconds of playing time and is introduced very briefly by Arthur Allen who gives the bird's name and corresponding page in Peterson's Guide. Almost every bird voice is carefully edited and beautifully clear.

Here, at a very reasonable price, is another precision tool to facilitate field identification of birds. Included are the songs and calls of 18 ducks and geese, 15 falconiform birds, 4 alcids, 10 woodpeckers including the Ivory-billed, 8 vireos, 30 warblers, 43 fringillids, and so on. One hears the voice of a Kirtland's Warbler in Michigan, a colony of Gannets in Quebec, and a clear "honk" of a Canada Goose in New York State. In many cases a quick and easy comparison of the voices of related species can be made, as with Black-capped, Carolina, and Brown-capped Chickadees. However, the compactness of the recordings makes it nearly impossible to make an immediate comparison of such species as the Yellow-throated and the Red-eyed Vireos without picking up the Blue-headed and Black-whiskered Vireos in between.

The two records are contained in an attractive, sturdy, book-like jacket. Printed inside is a list of the species, arranged in playing sequence and marked according to the side of the record and number of the band. Thus, it is easy to find the approximate location of a given species on the records.

As described by Peterson in an oral introduction to the records, an effort was made to select the most typical song or call of the species. I believe this has been accomplished. Almost all of the recordings are of very high quality, clear and precise. With very few exceptions, background noise is at a minimum. One marvels at the labor and technical achievement of accumulating the songs and calls of a high percentage of the birds of eastern and central North America and placing them in a carefully edited sequence on two records. An extreme case of the painstaking effort involved is 28 seconds of Red-winged Blackbird calls put together from 5 states and one Canadian province. For other species, such as some of the warblers and sparrows with simple songs, there are only two to four songs in a matter of four to ten seconds before the next species is introduced. To those accustomed to listening to much longer intervals per species as on most bird records, the short intervals for the songs and the speed in passing from bird to bird may be somewhat distracting at first, but after a little practice in listening, the short intervals usually prove entirely adequate and efficient. However, in a very few cases, the time allowed is definitely too brief. For instance, the two "mews" from the Redhead are not enough; one needs more than the two calls of the Red-headed Woodpecker; and the whistle of the wings of the Common Goldeneye is cut off too short. Also, the Pine Grosbeak is almost inaudible.

Every member of the growing army of serious bird watchers should have a copy of "A Field Guide to Bird Songs." However, grade school children, high school students and older beginners should not start with it, but rather with bird call records which emphasize fewer birds taken more slowly. On the other hand, all high schools should have "A Field Guide to Bird Songs" available for those students who develop an active interest in birds. College ornithology classes will find it a tremendous asset. An advance copy was used in the ornithology course at the University of Michigan Biological Station last summer, and proved to be an excellent teaching medium. It is reported that the students nearly wore it out.—NICHOLAS L. CUTHBERT.

This issue of *The Wilson Bulletin* was published on June 24, 1960.

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-list (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. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

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Th 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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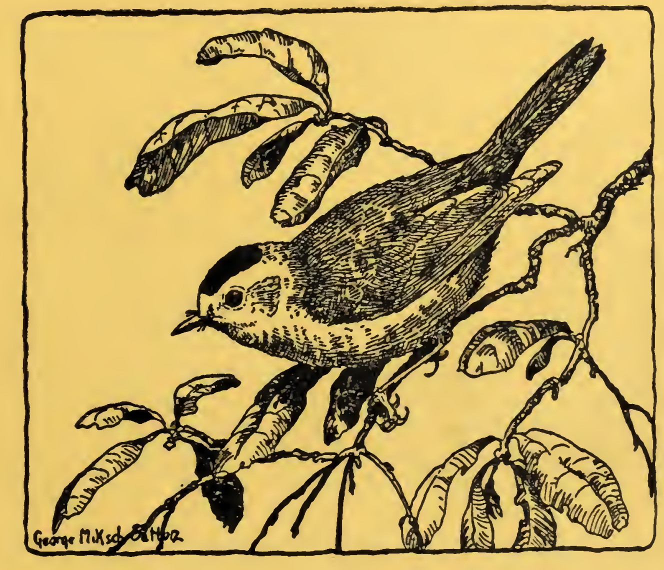

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A CRÈCHE OF ROCKHOPPER PENGUINS

The chicks are about 24 days old. Three "guards" are in the immediate vicinity. Photographed at New Island in the Falkland Islands, January 22, 1954, by Olin Sewall Pettingill, Jr., and published with the permission of Walt Disney Productions.

CRÈCHE BEHAVIOR AND INDIVIDUAL RECOGNITION IN A COLONY OF ROCKHOPPER PENGUINS

BY OLIN SEWALL PETTINGILL, JR.

Chicks of several species of colonial-nesting penguins customarily leave their nests and huddle in groups. Earlier observers of this behavior concluded that the chicks were actually coaxed or driven into these formations by their parents, a few of which took up stations close by as "guards" or "nurses" to protect the groups from molestation. The groups were consequently called "nurseries" or "crèches." Along with the belief that the crèches were formed and guarded by the adults was the notion that individual parent–offspring attachments disappeared. Adults thereafter fed chicks communally regardless of family relationships, and the ability of parents to recognize their offspring as individuals, and *vice versa*, virtually ceased, if it had existed at all.

True crèche behavior has long been known to occur in four colonial-nesting penguins—the Emperor (*Aptenodytes forsteri*) and Adélie (*Pygoscelis adeliae*), which are strictly Antarctic in distribution, and the King (*Aptenodytes patagonica*) and Gentoo (*Pygoscelis papua*). But crèche behavior in these species is by no means uniform. All chicks in a colony of King Penguins may mass together in one crèche (Roberts, 1940:223–224), as do chicks in a colony of Emperors (Stonehouse, 1953:20). On the other hand, chicks in colonies of Gentoos and Adélies have been reported by a number of observers to bunch up in more than one crèche per colony. According to Richdale (1951:270), a crèche of either species may contain approximately 20 to 30 individuals, although Sladen (1958:59) noted that a crèche of Adélies may be comprised of 100 or more chicks.

Opinions vary with respect to parent–offspring attachments, once the chicks congregate in crèches. Most observers have contended that chicks are fed more or less communally. Levick (1914:96–97) states, for example, that the individual care of Adélie chicks by their parents is abandoned; the adults provide food for the particular crèches in which their young have gathered and "remain faithful" to these crèches "for the rest of the season." The so-called guards around the crèches were, he presumed, the parents of chicks in them. Like most other observers he considered it impossible for adults to recognize their chicks. Recently Sladen (1958:61), by marking both adults and chicks of Adélie Penguins, determined that Adélie adults continue to recognize and feed their own individual chicks at crèche age and that the supposed guards are actually "unsuccessful breeders" and "non-breeders." On the basis of what he has learned from marked birds, it would appear that the earlier observers have overlooked the prevalence of parent–offspring attachments and misinterpreted the status of the guards.

In a visit to the Falkland Islands in 1915–16, Rollo H. Beck (quoted by Murphy, 1936:424) observed that chicks of the Rockhopper Penguin (*Eudyptes crestatus*), which has colonies in many isolated parts of the archipelago, leave their nests when about two-thirds grown and gather in bands of a dozen to 20 individuals. Richdale (1951:270–271) has suggested that Beck's findings may not indicate a true crèche formation, but a behavior comparable to that in the noncolonial Yellow-eyed Penguin (*Megadyptes antipodes*), a species which he has studied extensively by marked individuals. Richdale found that a dozen or so Yellow-eyed chicks may gather in a group along a path that leads from their nests to the sea. This is not a crèche, he believes, but merely a coming together of chicks out of a "penchant for company." An adult may be with them "for the same reason" although "it need not necessarily be a parent of one of the chicks."

THE ROCKHOPPER PENGUIN COLONY

When Mrs. Pettingill and I arrived in the Falklands in October, 1953, to film penguins and other wildlife for Walt Disney Productions, we hoped to follow up Beck's observations on the Rockhopper Penguin by marking a few adults and their young and then following their behavior from day to day. The opportunity came when we established our base for four and a half weeks (December 29, 1953 to January 30, 1954) on New Island and were within easy walking distance of a huge seabird colony that contained, by our rough estimation, 20,000 breeding pairs of the Rockhopper Penguin. At Kidney Island, where there was a smaller aggregation, we had a chance to make a few additional observations before and after our stay on New Island.

The New Island colony extended over the upper slopes of several rock-strewn bluffs, 200 to 300 feet above the sea. Because the bluffs were separated by intervening crags and crevices, the colony was discontinuous, being comprised of several sections, one to each bluff. Between the colony and the sea were perpendicular cliffs, cutting off access to the colony except through two steep ravines. The entire penguin population consequently climbed through these ravines on well-worn paths until, above the cliffs, it spread out on many paths to the different bluffs where the nests were located.

When we first visited the colony on December 29, about 80 per cent of the nests contained chicks of ages ranging from the day of hatching to about one week; 10 per cent contained chicks somewhat older; the remainder held eggs. All the nests were being attended by at least one adult. We noted that the ages of the chicks in any one section of the colony were usually the same, but that there was a considerable difference in ages among the sections. Apparently nesting in some sections of the colony had started earlier than in others.

Of the few nests with eggs, about 70 per cent held one egg only; the others held no more than two eggs. We occasionally noticed a nest with as many as two chicks, but we were never certain whether two chicks in a nest belonged to the same parents, or whether one chick had come from a neighboring nest, perhaps prompted by our having disturbed the *status quo.* Gwynn (1953:4) believed it a very rare occurrence for a pair of Rockhoppers to rear two chicks and observed no such instance himself.

Throughout the daylight hours at New Island adult Rockhopper Penguins moved up and down the paths between the sea and the colony, but toward evening there was a noticeable increase in the number of birds coming up to the colony. As each bird arrived at the nest, it was joined by its waiting mate in a mutually performed display, or "greeting ceremony," accompanied by raucous vocal sounds.

METHODS OF STUDY

We were easily able to identify the sexes of nesting Rockhoppers by the bill, which, as Murphy (1936:418) has pointed out, is longer, higher, and wider in the male. The difference in the over-all bill size was so evident that it was possible for us, after a little experience, to determine the sex of one bird without another bird of the opposite sex present for comparison.

On January 4 we selected for special study 10 nests that were near together on the edge of a section of the New Island colony farthest inland from the sea. We marked one nest X and the others 0 through 8. Nine of the nests contained one chick each; the other (Nest 3) held one egg. All the chicks were uniform in size and estimated by us to be six days old. Each chick was being brooded by a male; the egg in Nest 3 was being incubated by a female. We marked all the chicks and adult males present by painting on their backs large bright yellow marks corresponding to those given their nests, and the female with red. The paint we used was Testors Dope, a commercial product which dries quickly and holds fast for at least two weeks.

CHRONOLOGY OF OBSERVATIONS

In the period from January 5 through 15 we made 12 visits to the 10 selected nests in order to note the position of the chicks and parents with respect to their nests and to one another, and to make observations on activities and behavior. An abridged account of our observations, obtained after arriving at the nests, follows:

January 5, mid-morning: All chicks being brooded by the same correspondingly marked males. A female close to the male on Nest X. *Late afternoon* (about an hour before sundown): All chicks being brooded by same males. No female in evidence near Nest X, but Nests 2, 4, 7, and 8 each has a female standing beside it. These four birds were caught and their backs marked in red with the numbers of their nests.

January 7, late afternoon: All chicks being brooded by same males; no females present.

January 8, late afternoon: All chicks being brooded by same males. The only female present is Female 8 beside Nest 8. She has evidently just returned from the sea as she is very clean and glossy.

January 9, late afternoon: All chicks being brooded by same males. The only female present is beside Nest 6. She was caught and marked with the number of the nest.

January 10, late afternoon: Chicks X, 0, 1, 2, 4, 5, and 8 being brooded by same males. Chick 6 being guarded by Female 6; no male present. Male 7 sitting on his nest, but the chick has moved under a rock about five feet away.

January 11, early afternoon: Males X, 0, 1, 2, 4, 5, and 6 are on their nests and partially covering their chicks. Though Males 7 and 8 are sitting on their nests, their chicks are huddled with four other unmarked chicks of similar age five feet away. *Evening:* All males are on their nests. Chicks 1 and 5 not under males and cannot be found in the gathering dusk. All other marked chicks, including Chicks 7 and 8, are under males.

January 12, late afternoon: All males on their nests, except those of Nests 6, 7, and 8 which are absent and cannot be found. All chicks—including Chicks 1 and 5, which were unaccounted for the evening before, and Chicks 6, 7, and 8, which are unguarded —are in or beside their nests.

January 13, evening: All chicks are in or beside their nests, except Chick X, which has moved to a point under a rock near Nest 5, 15 feet away, and Chick 2, which is in a crèche. Males on all nests, except Nest 7, which has no attending adult. Females 6 and 8 are standing beside their nests.

January 14, evening: All chicks are huddled in two different crèches. One, in the area of the 10 marked nests, contains Chicks X, 0, 1, 2, and 7 together with three unmarked chicks of similar age; the other, just outside the area, contains the remaining four marked chicks and five unmarked chicks. Males 0, 1, and 7 on their nests. No other marked adults observed.

January 15, morning: All chicks in one large crèche, containing altogether 18 individuals, just outside the area of the 10 marked nests. No marked adults observed, but as many as six unmarked adults of both sexes stand near the group.

On all our visits, Nest 3, which contained one egg, was always being attended by the marked female. A male, however, stood beside her on January 8 and 13. On January 10, the egg was found a foot from the nest and broken, but the female was still sitting on the nest on this date and during our succeeding visits until January 14 when we found the nest unoccupied.

Crèche Formation and Related Behavior

We noted that the chicks remained steadily with their brooding parents until well after the first week. The first chick we found out of the nest was Chick 7, on January 10, at 12 days of age. The first case of huddling in a crèche was seen on January 11. This involved Chicks 7 and 8, at 13 days of age. But it was not until January 14, when all 9 chicks were 16 days of age, that all were in crèches. Sladen (1958:60) concluded that the average age of an Adélie chick, when it goes into a crèche, is about one month.

The chicks left their nests of their own accord, even while their parents were brooding them. Departure from the nests was sometimes caused by disturbances. For example, when a group of nests with brooding adults was approached abruptly by us, the chicks left their nests and parents, occasionally to hide under rocks, but more often to join other chicks. Or when a brooding adult and its chick were vigorously attacked by a strange adult, the chick soon left and frequently sought the company of chicks its own age. During the first absences of their young, the adults continued to sit on their nests alone, but by the time all the young had gathered in crèches, the adults no longer sat steadily on their nests and eventually deserted them entirely.

The end of a chick's stay in a crèche seemed to be determined by hunger. When in need of food, it returned to its nest site. If a parent was already on the nest, it proceeded to beg, but if not, it waited either on or near the nest, or begged for food from a neighboring adult without success. The return from a crèche was frequently hastened by a parent arriving at the nest and joining the other parent in a greeting ceremony, thereby providing a clamor sufficient to attract the chick's attention and stimulate its coming back sooner than it might have otherwise.

Among our marked birds we recorded two instances in which chicks left their crèches to join their own parents and be fed. The first was on January 13. Male 2 was alone on his nest while his chick was in a crèche 10 feet away. Female 2 soon returned from the sea to the nest and was at once joined by the male in a greeting ceremony. In a few minutes the chick left the crèche, approached its parents at the nest, gave begging calls for a short period, and was thereupon fed by the female. The second instance, on January 14, involved the family at Nest 0. What we recorded in all respects duplicated the above observations at Nest 2. In this case the chick emerged from a crèche only four feet away.

Elsewhere in the colony we saw many chicks leave crèches, walk up to displaying adults at nests, beg, and be fed. Usually each chick left by itself, but now and then we saw chicks leave a crèche together to meet an adult at a nest all the while begging anxiously, but only one chick, undoubtedly the offspring of the adult concerned, ever succeeded in getting food. The other chicks were refused food and were often vigorously repelled by jabs from the bill and whacks from the flippers.

As the chicks approached full body size (about January 25 to 29), they were fed more often by parents away from their nesting sites. Quite commonly they left crèches and approached adults as they entered the colony from the path or began walking through the colony. In places where no nests had ever been, they begged for food and frequently received it. When full growth had been attained, or nearly so, and the crèches had become loosely formed (see below), the chicks seemed to be fed anywhere in the colony and even down the path to the sea where they wandered.

Fig. 1. A crèche of Rockhopper Penguins at New Island, Falkland Islands, January 22, 1954. The chicks are about 24 days old.

Crèches varied from day to day in number, size, and composition. At first they were many and small, each one of about a half dozen individuals; later they were fewer and larger, containing as many as 15 to 35 individuals. Rarely did the crèches contain the same combination of individuals for more than a few hours, because they were almost constantly reforming throughout the day. On leaving their nests after feeding, the chicks gathered in different combinations each time. (The Frontispiece of this article shows a few chicks starting a new crèche.) However, in their later stages, crèches more often contained the same individuals since they involved nearly all the chicks in a given section of the colony (see Fig. 1).

On January 15, when we terminated our daily visits to the marked nests, the chicks were 17 days of age—about two-thirds grown—and still down-covered. Crèche formation was at its peak, as all the individuals were in groups. Judging by what we saw in all sections of the colony during occasional visits from January 15 to 30, the crèches continued to be closely compacted groups until the chicks attained nearly full body size and had lost their down. Thereafter, the crèches became looser, the chicks standing farther apart and showing a decreasing tendency to huddle. Later, during mid-February, in the Kidney Island colony, we found crèches nonexistent; all chicks were widely dispersed among yearling birds and molting adults.

During evenings in the New Island colony, when more adults returned than at any other time in the twenty-four hours, the crèches tended to be smaller because many chicks had joined their parents for food. But the crèches nevertheless stayed formed all night. Just before midnight on January 22 we found young in crèches, though the crèches were noticeably smaller than they were during the day.

DISCUSSION

Our observations show that chicks of the Rockhopper Penguin are normally fed exclusively by their own parents up to, and during, the crèche stage. In the Adélie Penguin, Sladen (1958:60–61) saw only two instances of a parent giving a strange chick food, and never saw any unmarked adult feed a marked chick of marked parents. It was his conclusion that, if parent Adélies were lost, the chick died. It would therefore seem that the parent–chick bond, through the crèche stage, is a strong one in the colonial-nesting penguins. But after the chicks attain full body size and the crèches break up, I am not at all sure that the chicks are then fed, as a general rule, by their parents. At Kidney Island, in February, when the crèches were no longer in evidence, we saw fully grown young being fed by adults on the paths at great distances from the nest sites. I noted at least one instance when an adult, climbing up from the sea, responded to the begging of a fully grown young bird by regurgitating food; then, continuing up the cliff, the same adult was accosted by another begging young bird of identical size and obliged it by regurgitating more food.

The question of whether or not parents recognize their own young as individuals, and *vice versa*, interested us greatly. Our findings tend to confirm those of Sladen (1958:73) on the Adélie Penguin, namely, that adults recognize their own young, and the young their parents, by the time the young gather in the crèches. Richdale (1951:276–279) has also reported that, in the Yellow-eyed Penguin, parents and young recognize each other, but he does not indicate when recognition begins.

I am inclined to believe that a Rockhopper chick of crèche age has already become familiar with the particular greeting ceremony of its parents and learned to associate it with availability of food. On hearing and/or seeing the ceremony from the crèche, the chick promptly recognizes its parents and, if hungry, approaches them at once. I am also inclined to believe that parents recognize their chicks by appearance and begging calls. This is borne out in the cases I have described where an adult refuses food to all chicks except one, no doubt its own. Sladen (1958:72–73) holds similar concepts, based on observations closely corresponding to ours. He believes, however, that parents and chicks recognize each other more by sight than by any other means.

The Rockhopper chick's urge to leave the nest and participate in crèche formation is no doubt innate, since it shows up without fail at a certain age in all individuals. Entering a crèche is, therefore, a social response that appears early in the life of a bird noted for its pronounced social habits.

Besides satisfying an urge for companionship, does the crèche have other functions? One possibility is that a crèche may be a means whereby chicks, still downy but becoming too large to be satisfactorily brooded by their parents, may continue to offset loss of their body heat by huddling together. Admittedly this idea would seem to be more applicable to crèches of penguins in the Antarctic where air temperatures are prevailingly lower than in the Falklands. Rockhopper chicks, we found, huddled together at any time, even during the warmest hours of the warmest days. It seems to me that there would have been a fluctuation in intensity of crèche behavior in accordance with fluctuation in air temperature, had the crèche been a means of conserving body heat.

A more certain function of the crèche is that it may provide protection through "safety in numbers." We noticed that whenever we disturbed Rockhopper chicks of crèche age at their nests their tendency was to collect in bunches rather than to scatter and hide at random. Moreover, whenever we approached a crèche, the chicks in it, instead of scattering, bunched still closer together and began moving away from us as a compact group. I could not escape the conviction that huddling in a crèche was a deterrent to attacks by the Falklands' principal predator on penguin chicks, the Skua (*Catharacta skua*). Time and again we saw Skuas kill lone chicks unguarded by their parents, but no instance of a chick taken from a crèche. Most certainly the crèches must have been in some way discouraging to Skuas for otherwise we would have seen at least a few chicks taken from them. Contrary to our observations, Sladen (1958:66) noted instances in which Skuas actually pulled Adélie chicks from the crèches. However, he was impressed by the fact that Skuas were much more inclined to take weakling chicks or others that were slow to learn the dangers of being isolated from crèches.

Almost invariably we saw adults, males and females, loitering in the vicinity of the crèches (see Front. and Fig. 1), but their relationships, if any, to the chicks in the crèches were not determined. None of our marked adults was ever seen near the crèches—they were either attending their nests or absent from the colony. I watched one adult approach a crèche containing a half dozen chicks about two weeks old and attempt to brood first one and then another; and several times we watched adults approach crèches, wantonly torment the various chicks by jabs with bills and strikes with flippers, and then casually retire. It was my conclusion that these were in some cases parents which had lost their young, and in other cases were wandering nonbreeders, such as Sladen (1958:61) had noted in Adélie Penguins. In no sense did they play the role of guards. They moved away from us without reluctance or protestation, even before the crèches moved. And they showed no aggressiveness toward Skuas which occasionally flew low over them or walked up close. However, it is entirely possible that these loitering adults inadvertently served as guards against Skuas by the mere fact that they were adults and thus potentially capable of warding off attacks on the chicks near which they were standing.

SUMMARY

Chicks of the Rockhopper Penguin in the Falkland Islands show true crèche behavior by leaving their nests of their own accord after about 12 days of age and huddling in groups. The crèches become fewer and larger as the chicks grow older. Crèche formation reaches its peak when the chicks are about 17 days of age. As the chicks attain nearly full body size and lose their down, the crèches become increasingly less compact until they break up entirely. The chicks are not fed communally, at least through the crèche stage; instead, they are fed exclusively by their own parents. The ability of adults and young to recognize each other as individuals seems apparent. A crèche satisfies a chick's innate urge for companionship, functions possibly as a means of offsetting loss of body heat, and almost certainly provides protection against the Skua through "safety in numbers." Adult birds which commonly loiter in the vicinity of crèches are in some cases parents which have lost their young and in others wandering nonbreeders. Although these adults play no guarding role whatsoever, they may inadvertently serve, by their mere presence, to ward off attacks by Skuas.

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WAYNE, MAINE, JANUARY 18, 1960

A POPULATION STUDY OF THE SPARROW HAWK IN EAST-CENTRAL ILLINOIS*

BY JAMES HARRIS ENDERSON

The aim of this investigation was to obtain an understanding, both quantitative and qualitative, of the population movements of the Sparrow Hawk (*Falco sparverius*). A study similar to this one was carried on in Michigan and Wyoming by the Craigheads (1956). No organized study of the Sparrow Hawk has been made in Illinois. Fifty years ago this species was a "very common breeder" in the immediate area of this study, according to Hess (1910), and this holds true today. The Sparrow Hawk is a permanent resident in central Illinois.

A study area of 43 square miles was outlined during the winter 1958–59, five miles southeast of the University of Illinois campus (Fig. 1). This area is typical of the region, i.e., fertile cultivated land. The only areas with standing timber are those immediately adjacent to the river. Scattered trees occur in farm yards and along fences and roads.

I extend sincere thanks to my advisor, Dr. S. C. Kendeigh, for his many suggestions concerning all phases of this work. The efforts and interest of Dr. R. R. Graber and of my wife Dayle are also appreciated.

METHODS OF STUDY

It was not possible to census the entire area during each daily trip, but the area was covered many times in the course of the study. No attempt was made to search every likely location for Sparrow Hawks, but all conspicuous perches were scanned with the aid of binoculars. Fortunately, the birds seemed to prefer areas within a few yards of the roadways for hunting and perching. The order of coverage of the area was not systematic, except that when a bird was located I tried to find it on subsequent trips. No censuses were taken on days of low visibility or heavy precipitation.

It soon became apparent that some means of identifying individual birds would be necessary in order to trace their movements more accurately. Birds were seldom observed at the same location on successive trips.

Two types of traps were used to catch birds for marking. The first trap used was of the bow-net type, described in detail by Tordoff (1954). From February 10 to March 25, 16 Sparrow Hawks were caught with this type of trap. Because the success of this trap was relatively low, another type was then employed. It consisted of a small circular wire cage, the top of which was covered with many nylon nooses (Berger and Mueller, 1959). A live house mouse (*Mus musculus*) was placed in the trap as bait. When using

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* Revised portion of M.S. Thesis submitted at the University of Illinois.

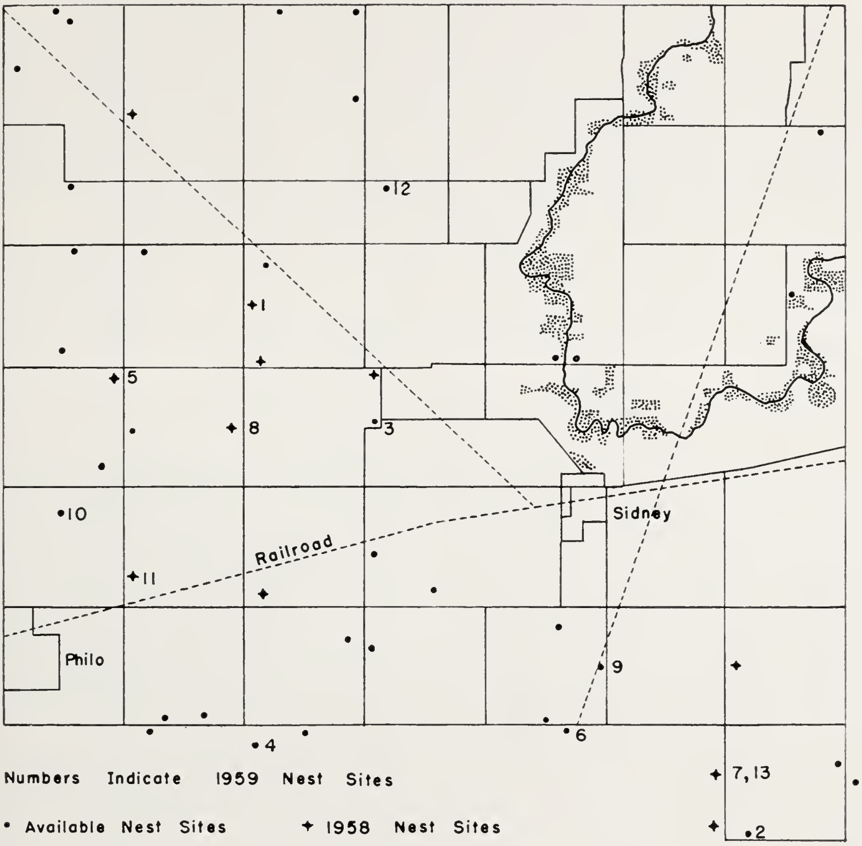

FIG. 1. The study area.

this trap, as many as eight Sparrow Hawks were caught and marked in a single day. During the period between April 3 and April 13, 23 birds were caught, bringing the total to 39. Between April 13 and July 6 an additional falcon was caught, and three were retrapped. Forty-two per cent of the Sparrow Hawks observed on the area, and 76 per cent of the breeding population, were caught.

All birds caught were banded with Fish and Wildlife Service bands. In addition, each bird was marked by means of a notch or "hole" in the primaries or secondaries of either or both wings. The location of this mark was varied to give individuals identity. The "hole" effect was most satisfactory. It was achieved by removing the barbs from the feather shafts in a circular area about one and one-half inches in diameter. With binoculars such a mark was visible for at least a quarter of a mile while the bird was in flight. A similar procedure of removing barbs was used on the tail with less success. Finally, most birds were provided with a short leather strap on one leg. This strap facilitated recognition of a perching bird as a marked individual, so that unnecessary trapping efforts would not be made. Aside from an initial annoyance with strap and band, none of the marking methods is known to have interfered with the normal activities of the bird.

A total of slightly over 3000 miles was traveled by automobile on the area during 308 hours from December 1, 1958 to July, 1959. During this time, approximately 500 observations of Sparrow Hawks were recorded. Forty adult birds were trapped and marked (22 males, 18 females).

The Effect of Weather on Censusing

In December and January there was a correlation between weather conditions and the number of Sparrow Hawks observed. A less formal count was made of other raptors on the area, and the weather seemed to affect their observed numbers. This was not true during censusing of winter hawk populations in central Michigan (Craighead, 1956). Fig. 2 presents data correlating census results with weather conditions as measured on the campus seven miles from the study area. Wind velocities were recorded on the rooftop of the Water Survey Building. According to the State Climatologist these may average one-third lower than those in the open country.

Fig. 2 suggests a correlation between high wind velocity, low temperature, and low bird-per-mile count. On censuses taken between December 4 and 18, January 15 and February 11, and February 15 and 27, low bird-per-mile counts were obtained during periods of generally low temperatures and high wind velocities. Between March 13 and 18, high wind velocity seems to have resulted in a low census count despite moderate temperatures. However, on the census taken on December 3 and on the February 27 census, few or no birds were seen although temperatures and wind velocities appeared normal. In general the correlation does not continue into warm weather.

These census results are probably caused by two factors: (a) the buffeting effects of the wind causing the birds to seek shelter, and (b) the increased loss of body heat due to wind and low temperature. Several observations of Sparrow Hawks under these conditions support this theory. Apparently low temperature alone does not cause the birds to seek shelter. On different occasions Sparrow Hawks were seen perched near or on the ground avoiding wind, or on a branch close to the tree trunk. In these positions the birds would be inconspicuous to an observer.

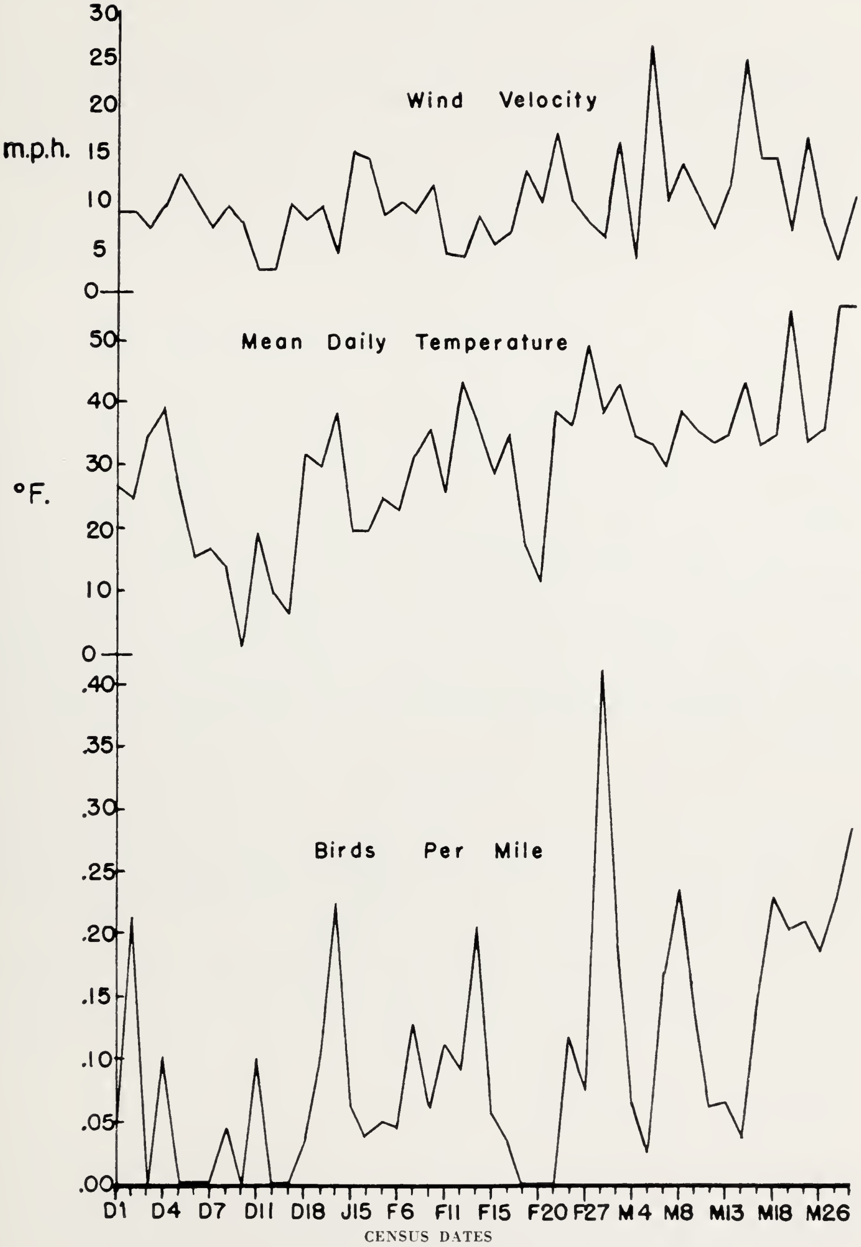

FIG. 2. The effects of wind velocity and temperature on censusing.

RECORDS OF INDIVIDUAL BIRDS

Before trapping and marking of birds began, a bird of the same sex seen on a subsequent trip within three-fourths of a mile of the site of the first observation was considered to be the same bird. This distance is less than one-half the winter range of Sparrow Hawks in Michigan (Craighead, 1956). The uncertainty as to individual identity was reduced somewhat by the relatively low winter population density on the area, with individual birds being well isolated. If a bird were not observed for a period of two to three weeks, it was considered to have left the study area.

The duration of occurrence of individuals on the study area (Fig. 3) is shown by drawing lines between the first and last dates of observation. These lines, when placed in chronological order of the first appearance, show the growth of the population in the spring. An "x" at the end of a line indicates a nesting failure. Bird 1 was caught accidentally in a padded steel trap set for large hawks, and because of a broken leg was not released on the area. Females 13 and 14 remained on the study area for over two weeks, but did not select a nesting site. Birds 25 and 29 remained near a group of trees for approximately two weeks but showed no nesting behavior. They were not considered a breeding pair. Birds 12, 16, 21, 33, 36, and 37 were marked birds which remained on the area for a short period only and were among those termed transients. Bird R near the top of Fig. 3 was a female that renested with Male 22 after destruction of the young of that male mated to Female 28.

POPULATIONS

Wintering.—The true wintering population may have consisted of only four birds (Fig. 4). Four birds on 43 square miles is in close agreement with data collected in Michigan, where 37 square miles supported five Sparrow Hawks during the winter (Craighead, 1956).

Transient.—There is evidence from banding returns that Sparrow Hawks from the northern plains area winter in the vicinity of Texas and that more northerly breeders migrate farther south than do more southerly breeders (Roest, 1957). These migrants effect an increase in the population in Central Illinois during the spring.

Beginning in early February, a total of 58 transients, i.e., birds not associated with nest sites, were observed. This undoubtedly does not represent the total number that passed through the area because observations were fragmentary. These transients reached their highest observed densities between February 25 and May 4 (Fig. 4). Peaks in their abundance on the area occurred on March 4, April 10, and April 12. Transients continued to be observed until the end of the observations in June. Transients observed

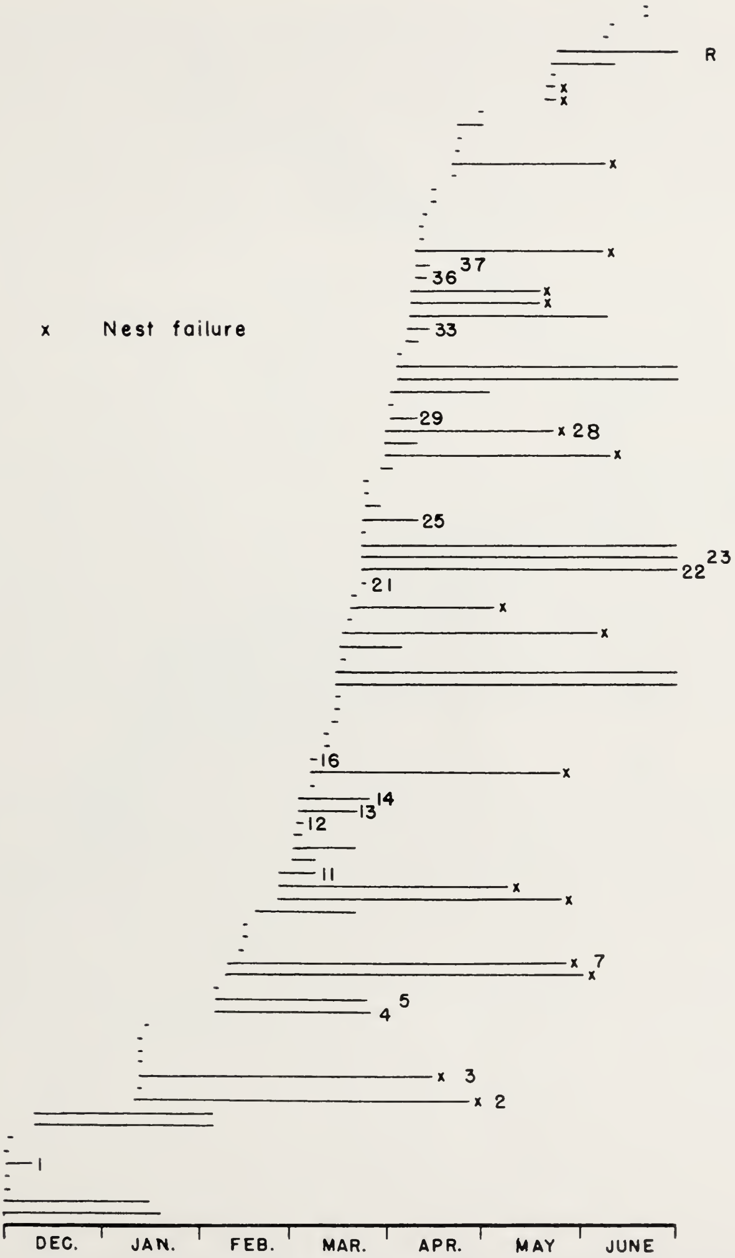

FIG. 3. Duration of occurrence of individuals on the study area.

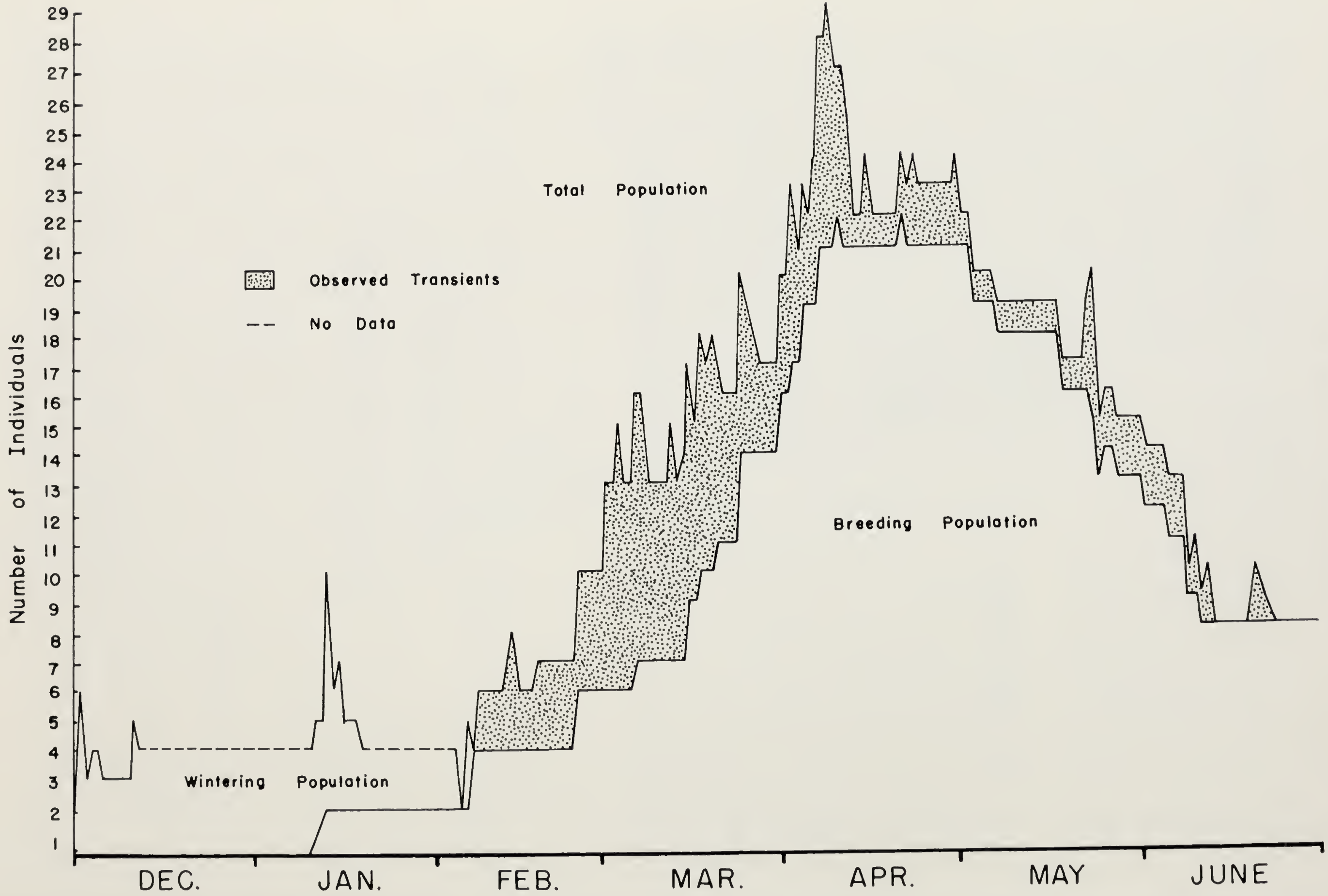

Fig. 4. Variations in the Sparrow Hawk population.

after the beginning of the nesting period may have been unsuccessful breeding birds from other areas, or part of a nonbreeding population.

Breeding.—The potential breeding population built up steadily, beginning with one bird on January 11, until a peak of 22 birds was reached on April 11 and on April 22. After April 22 there was a gradual decrease in the number of breeding birds until the end of the observation period. The majority (94 per cent) of the unsuccessful breeding pairs left the study area soon after the failure of their nests.

Twelve pairs of Sparrow Hawks were recognized as breeding birds, as demonstrated by their selection of nest cavities. An additional female renested with one of the original males, bringing the total number of breeding individuals to 25, or 0.58 breeding birds per square mile. This population is denser than that found in Michigan in 1948 when 0.22 breeding birds per square mile were recorded (Craighead, 1956).

Breeding individuals entered the area in greatest numbers (15) during the period when transients were appearing in greatest numbers, i.e., between March 15 and April 10. These dates encompass the period of arrival of breeding Sparrow Hawks at Corvallis, Oregon (Roest, 1957).

The members of a pair may arrive separately, or they may arrive together. The males of five pairs were observed first. The female was observed first for another pair, both appeared on the area simultaneously in three cases, and no observations were made in this respect for the remaining three pairs.

RANGE AND NEST DATA

An approximation of the diameter of the bird's range can be obtained by means of a line connecting extreme observation points. In Fig. 5, Ranges 3, 4, and 5 are those of nonbreeding birds which left the area before egg-laying. Ranges 3 and 4 are those of a nonbreeding pair. Ranges 2, 6, 7, and 23 are those of breeding birds.

The three nonbreeding bird ranges recorded in late winter have maximum observed diameters of 1.4, 2.0, and 1.3 miles; the average is 1.5 miles. This figure is less than the 2.2 miles average of winter ranges observed in Michigan (Craighead, 1956). This difference may be due to an error introduced when observing unmarked birds in the Michigan study, or it may be caused by the fact that the study area in Michigan, having 11 per cent tree cover and bushy areas is a less favorable habitat for hunting by Sparrow Hawks, causing them to range farther to meet food requirements.

Ranges 2, 6, 7, and 23 represent home ranges in the vicinity of nest sites. The average maximum diameter of these ranges is 1.4 miles. This agrees closely with the 1.5-mile average diameter for breeding ranges observed in Michigan and in Wyoming.

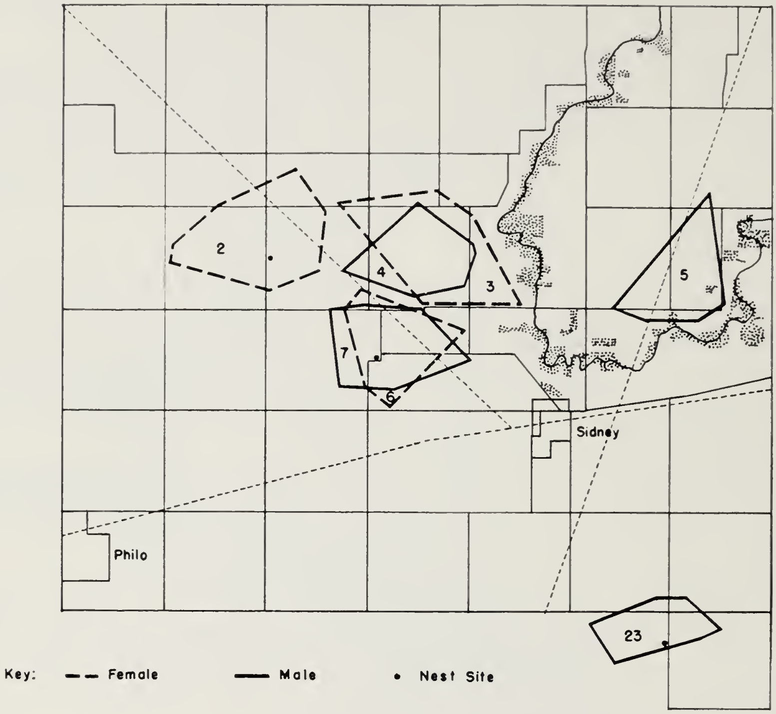

FIG. 5. Observed ranges of individual Sparrow Hawks.

The nest site does not necessarily lie in the center of these home ranges. Evidently certain areas for hunting are preferred to others by nesting birds.

Although observations of egg and brood dates were not thorough, practical approximations can be made. The first egg was laid on the study area on April 16. The first complete clutch of five was completed about April 22. The last clutch of five was completed about April 29. On May 20, the first bird on the study area hatched, and the last on the area hatched about May 28. The young of the renesting pair did not leave the nest until about July 20, although the other nestlings on the area had left the nest by June 19.

SUMMARY AND CONCLUSIONS

(1) Weather conditions under which observations of Sparrow Hawks were made affected the success of the censusing; fewer birds were observed during periods of high wind velocity and low temperatures.

(2) The dates of first occurrence of individuals on the 43-square-mile study area in the spring follow a sigmoid curve.

(3) Although the wintering population fluctuated in numbers, approximately four birds were present on the area during December and January.

(4) Transients, totaling 58, were observed on the area from early February to the last of June, being most numerous in March and April.

(5) The breeding bird population increased from January 11 to the middle of April, and then decreased.

(6) Twenty-five Sparrow Hawks were recognized as breeding birds, an average of 0.58 individuals or 0.29 pairs per square mile.

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18 SOUTH MAY ST., JOLIET, ILLINOIS, AUGUST 15, 1959

NEW LIFE MEMBER

Mr. Frederick M. Helleiner, of Swastika, Ontario, Canada, is an elementary school teacher and boy scout adviser who is interested in the field distribution of birds. Most of his field work is done in the Timiskaming District of northern Ontario, but he has also compiled a list of the birds of the Peace River District of Alberta.

Mr. Helleiner has been an active member of the Wilson Ornithological Society since 1952, presented a paper at the Society's 1955 meeting in Stillwater, Oklahoma, and now becomes a Life Member. In addition, he is a member of the A. O. U., a director of the Federation of Ontario Naturalists, President of the Kirkland Lake Nature Club, and a member of the Ottawa Field Naturalists' Club, the Toronto Field Naturalists' Club, and the Saskatchewan Natural History Society.

MEASUREMENT OF SOME LAKE-SHORE TERRITORIES OF THE SONG SPARROW

BY RODERICK A. SUTHERS

THIS paper presents data concerning the size and measurement of four adjacent Song Sparrow (*Melospiza melodia*) territories located along the northwest shore of Bear Paw Point, Lake Itasca, Clearwater County, Minnesota.

An attempt has been made to compare the territorial variations within a single species. Song Sparrows nesting on islands have been reported to fledge young successfully in areas less than one-tenth the size required in mainland situations (Beer *et al.*, 1956). In the present study, lake-shore territories were measured in order to retain the effects of shore line on territory size without the probable insular influences affecting the results of Beer *et al.* (*ibid.*) and Swedberg (1957).

The shore line studied rises a few feet above the level of the lake. The ground dips inland to form a boggy area—especially pronounced in the areas occupied by Pairs 2 and 3—before rising again to a mixed forest of conifers and hardwoods. The Song Sparrows held a single row of territories between this forest and the lake. The woods in this strip were rather open because of much windfall. Dominant canopy species included black ash (*Fraxinus nigra*), American elm (*Ulmus americana*), basswood (*Tilia americana*), paper birch (*Betula papyrifera*), and balsam fir (*Abies balsamea*). In the shrub layer, alder (*Alnus crispa*), paper birch, balsam fir saplings, and raspberry (*Rubus idaeus*) were present. The ground cover was of grasses (*Poa palustris, P. pratensis*), sedges (*Carex* sp.), and a little cattail (*Typha latifolia*). The nomenclature used here follows that of Fernald (1950).

The area was mapped with the aid of a compass and by pacing. Later accurate measurement of 11 of the approximately 80 paced distances indicated that pacing may have given results averaging about 3 per cent too long. I do not believe this exaggeration has a significant effect on the results, since the distances paced were rarely as long as 100 feet and often were less than 50 feet. Observations were made from 4:00 to 9:40 a.m. and from 3:15 to 7:35 p.m. (Standard Time).

Territories were measured according to the method described by Odum and Kuenzler (1955). The position of either member of a pair was recorded at approximately 5-minute intervals on a map of the study area. After about every 10 such spot observations, the outermost were connected by straight lines to form the largest possible polygon. The area of this polygon was then plotted on a graph using area as the ordinate and the number of observations as the abscissa. This was repeated for each additional 10 observations, and a smoothed curve was drawn through the successive points. *Maximum territory*, as defined by Odum and Kuenzler (*ibid.*), is the point at which, according to the observation-area curve, an additional 10 observations increases the area less than 10 per cent. I also determined the point at which 10 observations increased the area less than 1 per cent. This I shall call the *utilized area* to avoid confusion with the maximum territory.

I am indebted to J. T. Emlen, Jr., J. J. Hickey, W. H. Marshall, and W. D. Stull of the Lake Itasca Forestry and Biological Station for advice during the course of this study. I also wish to acknowledge the financial support of The Edward L. Rice Zoology Scholarship from Ohio Wesleyan University, for which I am very grateful.

RESULTS AND DISCUSSION

The maximum territories varied from 0.30 to 0.65 acre and averaged 96 per cent of the utilized area (Table 1). Although measurements of the utilized area for Pair 3 were not completed to the 1 per cent increment level, the observation-area curve for this pair indicates that 0.55 acre is probably within 0.01 acre of the actual size of the utilized area.

TABLE 1

COMPARISON OF UTILIZED AREA AND MAXIMUM TERRITORY

Type of Measurement	Pair				Mean
	No. 1	No. 2	No. 3	No. 4	
Utilized area (acres)	0.34	0.68	0.55[1]	0.31	0.47
Maximum territory					
acres	0.32	0.65	0.53	0.30	0.45
as per cent of utilized area	94	96	96	97	96

[1] Measured with a 4.4 per cent increase as a result of the final 10 observations; all other utilized areas involved a 1 per cent increase or less in the final 10 observations as defined in the text.

Palmgren (1933) observed that a pair of birds may utilize only a part of its territory for from one to several successive days. Thus, if a territory is measured in a short period of a few days, the entire territory may not be included. I used two methods to check the possibility of this kind of error in my measurements: Remeasurement of the territory several days after the utilized area was first determined, and spot observations distributed over successive days after the initial determination of size.

The territory of Pair 2 was remeasured four days after the utilized area had been calculated. This new polygon added 0.02 acre not previously included and so increased the utilized area by 3.1 per cent. The territory of Pair 1 was remeasured eight days after the utilized area was calculated. The new polygon lay entirely within the utilized area as previously calculated.

TABLE 2
REPORTED SONG SPARROW TERRITORY SIZES (IN ACRES)

	Minimum	Mean	Maximum
Mainland (Nice, 1937, 1943)	0.5	0.67	1.5
Lakeshore (this study)	0.31	0.47	0.68
Island (Beer *et al.*, 1956)	0.04	—	—
(Swedberg, 1957 MS)	—	0.2	—

Nine spot observations distributed over six successive days, for Pair 4, gave a polygon enclosing 16 per cent of the utilized area and lying entirely within it.

Mainland territories in central Ohio were studied extensively by Nice (1943:152). She found that "in a region well filled with Song Sparrows" the average territory size was about two-thirds acre with a range from 0.5 to 1.5 acres. She emphasized (1937:205, 207) that "a fundamental trait of the Song Sparrow is that *it does not allow itself to be crowded*" and that the upper limit of a Song Sparrow population is fixed by territorial behavior.

Insular territories have been studied in Basswood Lake, Minnesota, by Beer *et al.* (1956). Two islands, each with an area of 0.04 acre, were found to have a pair of Song Sparrows nesting on them. One of these, Island 8, was used as a nesting area in each of six successive years. Swedberg (1957 MS) studied Song Sparrow territories on Schoolcraft Island, Lake Itasca, Minnesota. The territories of these pairs averaged 0.2 acre.

The four lakeshore territories I measured averaged 0.47 acre and were thus intermediate between sizes reported for mainland and those reported for island situations (Table 2).

As pointed out by Stickel (1954) and by Odum and Kuenzler (1955), caution must be used in comparing sizes of territories calculated by different methods. The home range, defended territory, and utilized territory may vary considerably among themselves and with the nesting cycle. Food-carrying activities of the parent sparrows which I observed would indicate that I measured their territories during the late incubation and young nestling stages. There appeared to be no measurable areas that were not utilized in any of the four territories. Pair 1 was even found to use several hundred square feet of upland forest floor as a feeding area, indicating that territorial boundaries may not always be safely assumed from the characteristics and distribution of the vegetation.

If home range is defined as the area in which an animal is usually found during a given season (Burt, 1946:20), then utilized area is probably analogous to the seasonal home range of Burt (*ibid.*). Stenger and Falls (1959), using a modified Odum and Kuenzler method on the measurement of Oven-

TABLE 3
PERCENTAGE OF UTILIZED AREA REMAINING WHEN OUTER OBSERVATIONS WERE EXCLUDED

Per cent of Observations Excluded	Pairs				Mean
	1	2	3	4	
2	79 (0.27) *	96 (0.65)	95 (0.52)	97 (0.30)	92 (0.44)
5	74 (0.25)	91 (0.62)	95 (0.52)	87 (0.27)	87 (0.42)
7	68 (0.23)	87 (0.59)	95 (0.52)	87 (0.27)	85 (0.40)
10	47 (0.16)	84 (0.57)	91 (0.50)	87 (0.27)	78 (0.38)
Number of Observations	49	67	41	62	54.75

* Acres in parentheses.

bird (*Seiurus aurocapillus*) territories, reported the outer 5 per cent of their spot observations were more isolated than the rest. They termed the area excluding these the "total utilized territory." While these authors imply that this 5 per cent is easily identified, the map that they present as an example shows the excluded percentage to be 6.4. Stenger and Falls found that these utilized areas for adjacent males varied in position from day to day but were distinct on any given day. This variation in daily position is not evident for the four Song Sparrow pairs that I studied.

When I excluded the outer 2, 5, 7, and 10 per cents from the utilized areas there resulted a rather even decrease in the size of territories of Pairs 1 and 2, but for Pairs 3 and 4 the progressive subtraction gave uneven results (Table 3).

It would be interesting to know if the extremely small territories of some island-nesting birds are supplemented by feeding areas on nearby shores. The two island territories of 0.04 acre described by Beer *et al.* (1956) were about one-eighth mile or less from the shore (L. D. Frenzel, pers. comm.). Schoolcraft Island is approximately 190 yards from the nearest shore. During June and July, 1959, L. D. Frenzel (pers. comm.) on several occasions saw Song Sparrows fly between Schoolcraft Island and the west shore—a distance of about 330 yards. During this same period, Mrs. J. J. Hickey (pers. comm.) saw a male Yellow Warbler (*Dendroica petechia*) fly from the east shore of Lake Itasca to Schoolcraft Island (*ca.* 200 yards). During 3 hours of observations from a canoe, however, in the early morning of July 5 and in the evening of July 13, 1959, I saw no Song Sparrows leave the island. Those seen in transit may well have been part of a drifting population of unmated birds, for it is difficult to conceive of a strongly territorial bird with a Type A territory (Nice, 1941) regularly leaving it to feed in an undefended area or defending a separate feeding area.

The size of a bird's territory is no doubt determined by a number of interrelated factors. The relative importance of a given factor varies from one species to another. Dixon (1956) found that the distribution of blocks of woodland was an important factor contributing to the stability of Plain Titmouse (*Parus inornatus*) territories. These habitat features tended to form "neutral boundaries," i.e., boundaries not adjoining another territory (Southern and Morley, 1950). The inland boundary, as well as the lake-shore frontage, of the Song Sparrow territories I measured qualifies as such a neutral boundary. Stenger (1958) reports that the territory size of Ovenbirds varies inversely with the amount of invertebrate food present in the litter of the forest floor. In his study of the Song Sparrow (*M. m. samuelis*) population of San Pablo Salt Marsh, Richmond, Contra Costa County, California, Johnston (1956*a*) found that the size of the territory varied with the density and that the birds tended to "select particular habitats over others that they could conceivably live in" (Johnston, 1956*b*). Young (1951), however, found that density of Robins (*Turdus migratorius*) is not limited by their territories, which can be compressed and often overlap.

As habitat approaches the optimum for a species, it is logical to assume that the size of the maximum territory approaches that of the space actually utilized, which is itself decreased. The lower limit of the latter may be surprisingly small when all a species' requirements are met. The shore-line community is especially rich in insect life, has sufficient light to provide a band of dense brush required by Song Sparrows, and offers them immediate access to water. Thus it probably provides an optimal habitat for this species. In small islands the ratio of shore line to area is, of course, increased, and maximum densities of Song Sparrows reported for these islands seem to be logical. I do not, however, feel that the minimal figure of 0.04 acre for insular Song Sparrow territories (Beer *et al.*, 1956) should be accepted without further investigation in which the possibility of the birds crossing water to the mainland is completely ruled out. More information is needed concerning the distance island-inhabiting birds will fly *daily* over water.

SUMMARY

The territories of four pairs of Song Sparrows nesting along a lake shore in Clearwater County, Minnesota, were measured. The utilized area averaged 0.47 acre. The maximum territory averaged 96 per cent of the utilized area. Checks on original measurements in one case added 0.02 acre to the utilized area, and in two other instances did not change it. Deduction of given percentages of the peripheral locations caused a fairly even decrease in size of

two territories, but caused an uneven decrease in the others. The size of lakeshore territories was found to be intermediate between those reported by other workers for Song Sparrows on islands and for those on mainlands.

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129 GRISWOLD ST., DELAWARE, OHIO, NOVEMBER 3, 1959

SEASONAL CHANGES IN WOOD DUCK ROOSTING FLIGHT HABITS[1]

BY ELWOOD M. MARTIN AND ARNOLD O. HAUGEN

Most people are aware that such birds as crows and blackbirds congregate nightly in large numbers at roosts during late summer and fall, but few people know that Wood Ducks (*Aix sponsa*) have a similar habit. Wood Ducks prefer marshes and swamps in wooded bottomlands for many of their activities including roosting.

Morning and evening roosting flight habits of Wood Ducks were studied from March through November, 1958, in Iowa as part of an investigation of Wood Duck census techniques (Martin, 1959). Little effort had been made previously to determine Wood Duck flight habits. Such information is necessary to evaluate roosting flight counts.

Muskrat Lake, a backwater slough along the lower reaches of the Iowa River in Louisa County, Iowa, was the main Wood Duck roosting flight study area. Wood Duck roosts were found by observing and tracing flights to and from the roosts. Two flights followed narrow, well-defined paths to roosts, and counts were made along those routes as well as at the roosts. Observation points were established where a clear view of flying Wood Ducks, silhouetted against a background of sky, could be obtained to facilitate counting during poor light at dawn and dusk. Observations of morning and evening flights at Muskrat Lake permit examination of some interrelationships between seasonal change and Wood Duck roosting flight habits.

CHANGES IN FLIGHT TIMES

Several changes in roosting flight habits occurred as the season advanced. Both morning and evening flights changed gradually, occurring nearer darkness and over shorter periods of time as the season advanced (Figs. 1, 2).

Linear regression techniques similar to those of Snedecor (1956) were employed to aid in describing the changes which occurred in the Wood Duck roosting flights at Muskrat Lake as the season progressed from early August to late October. Because the statistical analyses were only approximate for the data involved, emphasis was placed on the descriptive tools of regression techniques rather than on tests of significance, though the latter were not omitted.

Time at which the first Wood Duck was seen leaving the roost, time at which Wood Ducks were leaving the roost in greatest numbers, and time when the last Wood Duck was seen leaving the roost were plotted for each morning flight count (Fig. 3). For purposes of computation, dates were

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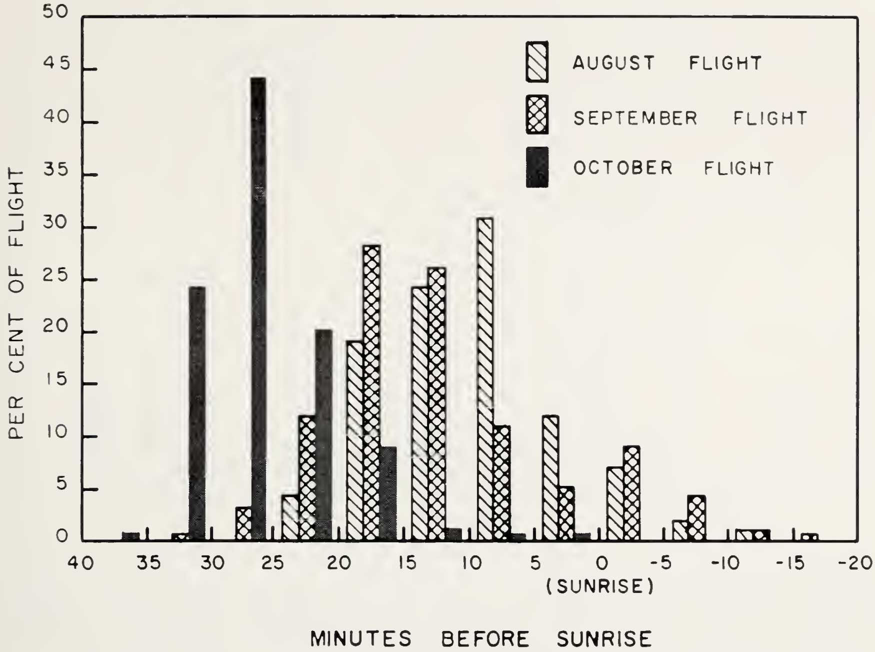

Fig. 1. Average daily distribution of morning roosting flight activity of Wood Ducks at Muskrat Lake in 1958. (August averages based on a 134-bird index from six counts. September averages based on a 283-bird index from 10 counts. October averages based on a 1106-bird index from seven counts.)

numbered consecutively, with August 1 as the zero-point. The regression coefficient, the statistic computed and tested, is affected neither by choice of origin nor by corresponding choices of intercept points. Numbers corresponding to dates of counts were then used in calculations. Linear regression of daily flight time on date of count measured from August 1 was computed for each of the three times mentioned above (Fig. 3). Each regression coefficient is significant at the 0.1 per cent probability level. The regressions indicate that on the average for each 10-day period which passed, Wood Ducks left the roost 4 minutes earlier relative to sunrise. Similar calculations were made for times of earliest, peak, and latest roosting flight activity for each evening flight observed at Muskrat Lake (Fig. 4). Each regression coefficient is significant at the 0.5 per cent probability level. The indication is that on the average for each 10-day period later in the fall, Wood Ducks arrived at the roost about 7 minutes later relative to sunset.

The method of analysis is approximate for this type of data. Changes in

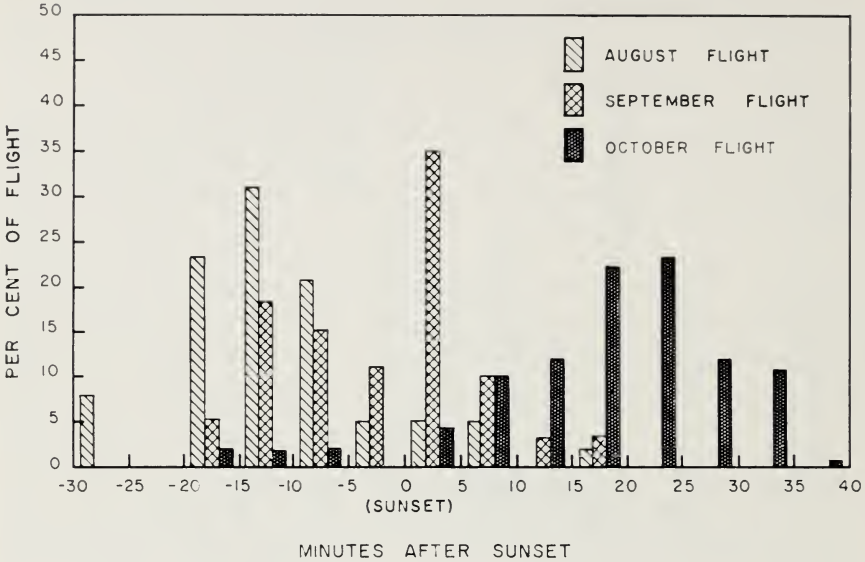

Fig. 2. Average daily distribution of evening roosting flight activity of Wood Ducks at Muskrat Lake in 1958. (August averages based on a 39-bird index from five counts. September averages based on a 199-bird index from six counts. October averages based on a 1057-bird index from seven counts.)

habitat (water level, food supply) or changes in population size as well as chronology of the season may have influenced the time schedule of Wood Duck roosting flight activity. Also, these regressions of flight times on dates are probably not linear, but instead, slope more steeply early in the season and less steeply later in the fall. The approximations are suitable for practical applications to field work, however.

Major morning flight activity in September and October took place before sunrise, and major evening flight activity in October occurred after sunset. Martin (1957) found similar habits in Wood Ducks in Indiana. Smith (1958) reported that in Louisiana in both late August and late September, greatest evening flight activity took place between one-half hour before sunset and darkness, which also agreed with findings in southeast Iowa. Hester (1955), working in North Carolina, also noted that evening flights occurred well after sunset late in the season. Observations made in north-central Iowa subsequent to this study indicated that morning and evening flights in that area in August occurred nearer darkness than they did in southeast Iowa. Evening flights on the north-central area in August occurred after sunset, and morning flights started one-half hour before sunrise and lasted 20 minutes.

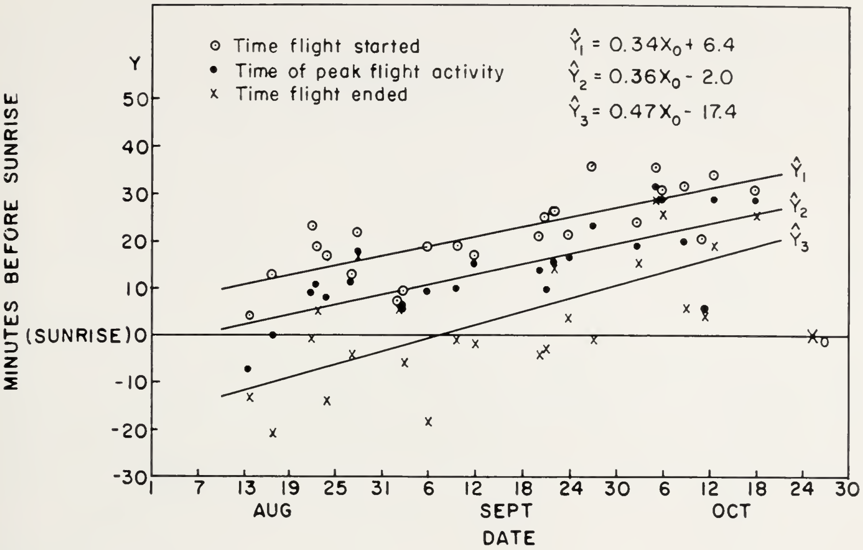

Fig. 3. Comparison of the starting, peak, and ending times for morning roosting flights of Wood Ducks at Muskrat Lake in 1958. The linear regression of time on date of count is plotted for each.

Duration of Flight Activity

Duration of flight activity tended to shorten in both evening and morning flights as the season progressed. Converging lines on Figs. 3 and 4 indicate this change. It is more evident when the period of greatest activity is traced through the season. Duration of periods of major morning flight activity (about 90 per cent of the Wood Ducks seen in a flight) averaged 19 minutes (range 6 to 40 minutes) in August, 17 minutes (range 2 to 34 minutes) in September, and only 6 minutes (range 4 to 12 minutes) in October. Average duration for major evening flight activity was 25 minutes (range 12 to 50 minutes) in August, 23 minutes (range 13 to 50 minutes) in September, and 16 minutes (range 6 to 30 minutes) in October. Greatest day-to-day variation in duration of flight activity occurred early in the season when the number of birds in the area was relatively small. Despite high October populations, flights were extremely concentrated in time, particularly morning flights. Evening flights came to the roost in smaller groups and over a longer period than were recorded for morning flights from the roost. Martin (1957) noted a similar difference in Indiana. Morning flights usually left almost en masse in October when greatest numbers of Wood Ducks were present. This made estimation of numbers difficult, especially because the birds left well before sunrise when visibility was still poor.

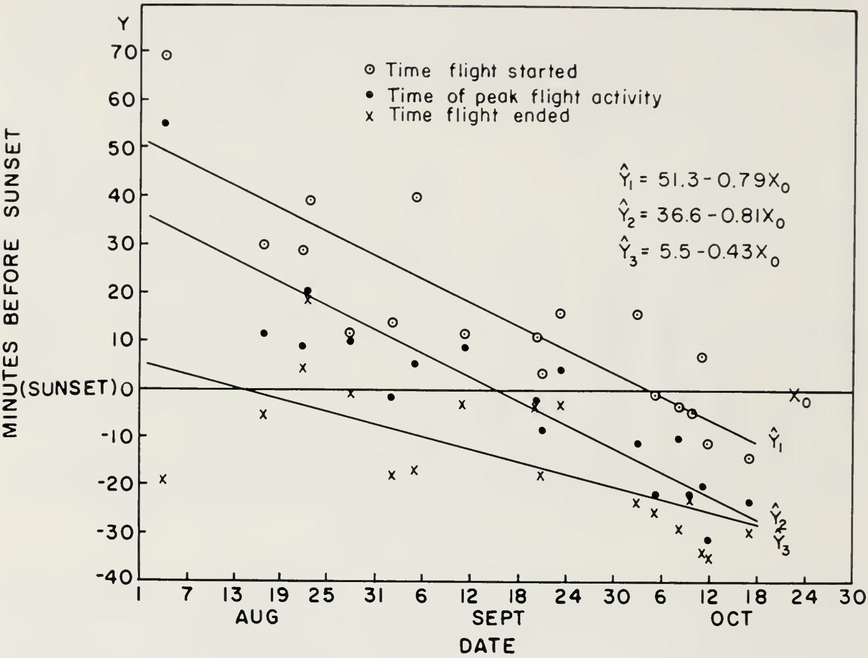

Fig. 4. Comparison of the starting, peak, and ending times for evening roosting flights of Wood Ducks at Muskrat Lake in 1958. The linear regression of time on date of count is plotted for each.

Discussion

Knowledge of seasonal changes in Wood Duck roosting flight habits may be useful in evaluating Wood Duck roosting flight counts as possible indexes of abundances. In early fall, evening roosting flights began about 45 minutes (±15 minutes) before sunset with little activity after sunset. Counts made during this period of time and ending shortly after sunset will include most Wood Ducks in a roosting flight. Early fall morning counts should begin about 30 minutes before sunrise and continue until about 15 minutes after sunrise. To be reliable, the counts must be made from suitable observation points and under weather conditions conducive to good visibility. Arrival of waves of new migrants may spread flights over longer periods with more apparently random flight than usual.

Well-defined feeding flights occur prior to evening roosting flights in some areas. In such areas roosting flight habits may be somewhat different from those observed in this study where large-scale evening feeding flights were not noted. Additional research effort on other areas should contribute useful information on this point.

It is important to keep in mind that fall Wood Duck populations are mobile and changing, so the observer must study the flights carefully and be ready to modify his work schedules as conditions seem to warrant.

The peak population of Wood Ducks (300) at Muskrat Lake occurred during the second week in November.

SUMMARY

Wood Ducks congregated nightly at roosts in late summer and fall. Both morning and evening roosting flights changed gradually, occurring nearer the hours of darkness and over shorter periods of time as the fall season advanced. Major morning roosting flight activity early in the fall occurred during a period of about 45 minutes, usually ending by 15 minutes after sunrise. Early fall evening roosting flight activity occurred primarily during the 50-minute period ending shortly after sunset. Late season (October and November) roosting flight activity took place before sunrise and after sunset.

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DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY, IOWA STATE UNIVERSITY, AMES, IOWA, JANUARY 19, 1960 (ORIGINALLY SUBMITTED SEPTEMBER 13, 1959)

LAYSAN TEAL IN CAPTIVITY

BY S. DILLON RIPLEY

In August, 1958, I received two pairs of Laysan Teal (*Anas laysanensis*) from Hawaii through the courtesy of the Bureau of Sport Fisheries and Wildlife, Department of the Interior. I am most grateful to Mr. Ross Leffler, Assistant Secretary of the Interior, and Mr. Daniel Janzen, Director of the Bureau, for their cooperative interest in the project for bringing some Laysan Teal into captivity for observation and study, and to Mr. Paul Breese, Director of the Honolulu Zoo, for facilities extended through his interest and enthusiasm, as well as to the authorities of the Territorial Board of Agriculture and Forestry of Hawaii, especially Mr. Richard Warner of that staff who actually participated in the capture of a number of these curious birds.

Laysan Teal have had a varied history since their discovery by Palmer, Rothschild's collector, in 1891. Laysan Island is about two miles long and one mile wide with a small brackish pond in the center, and lies in the Leeward chain of the Hawaiian Archipelago, about 800 miles northwest of Honolulu. From a population of about a hundred in 1902, the ducks were nearly extinct in 1911 and 1912, no more than seven being recorded in the latter year. Their numbers had crept up to 20 in 1923 when Dr. Alexander Wetmore visited the island, taking six specimens for the National Museum collection at the time.

The most direct prejudicial influence on the Laysan Teal was perhaps the introduction of rabbits on the island about 1903. The effects of this introduction were disastrous as the vegetation was largely destroyed and three bird species became extinct on the island, the Laysan Island Rail (*Porzanula palmeri*), the Laysan Millerbird (*Acrocephalus familiaris familiaris*), and the Laysan Honeyeater (*Himatione sanguinea freethi*).

At a later time, the date is not clear, the rabbits on Laysan were exterminated with the result that the vegetation has now been restored and there is a prolific growth of grasses, portulaca, casuarina, solander and a few coconut palms. Insects are now abundant although presumably many of the endemic species are extinct along with a host of endemic plants. From the observations of Warner (in litt.) it appears that the present population of teal is largely insectivorous. Currently the population has jumped from 33 in 1950 to over 300 in 1956, and to over 500 in 1958. Such a violent oscillation in numbers makes the taking of precautionary measures doubly advisable from an ecological point of view. A downward oscillation could as easily be produced as an upward one, and it is now a project of study to see if an introduction of these teal might be made to a neighboring island in the chain such as Lisiansky, and also if a buffer population could not be established in captivity.

In connection with the recent observations of the birds by Warner and others two interesting habits were noted. Teal were never seen on the water. They were always in the grass and low bushes, and appeared to be exclusively insectivorous. Two speculations occur here. Is it possible that these birds can absorb metabolic water from their insect diet? In addition is it possible that the teal, once the rabbits have been eliminated, are to some extent taking over the niche vacated by the loss of the rail? Field studies might be most rewarding in this connection.

Captive Birds

In 1943 I speculated that this teal would never be kept in captivity and might indeed be already extinct. How much I enjoyed then seeing these four birds loaned to me by the Bureau of Sport Fisheries and Wildlife arrive at Litchfield. In the first few months we catered to their diet, offering them fresh turf, flies, insect food seined from ponds, and fresh lettuce, as well as pellets. Later the birds adjusted to artificial food readily, and were liberated on two small ponds in early April.

No striking display activities were noted. This was perhaps due to lack of personal opportunity for observation rather than anything else. Head-stretching or pumping was noted, head-up, tail-up (once), chasing or nod-swimming with head low on the water, and a very well-defined female threat display. The threat display was addressed to another larger duck, and in general aggression is characteristic of these birds. Fighting was observed with Hawaiian Ducks (*Anas platyrhynchos wyvilliana*), and the pairs had to be separated to avoid any possible risk. Threat display was accompanied by a low *gaeck gaeck*, similar to that of the Mallard (*Anas platyrhynchos*). On one occasion a typical pumping movement similar to those described by Lorenz for other species of *Anas* (1951, 1952) was followed by copulation.

One female (F. and W. band No. 535-15283) nested twice, both times laying five eggs. A female that nested at the Wildfowl Trust last spring also laid five eggs. Perhaps this is normal for a clutch. The female, while sitting on the nest, concealed in a dense clump of alder, uttered her threat calls when human beings, and presumably other ducks, approached the nest. The eggs were very large for the size of the bird. One which has been preserved measured 58.5 × 40.2 mm., larger than the measurement given by Delacour (1956) and equalling the size of a Mallard's egg, a typical one of which measures 60 × 40 mm.

Four ducklings hatched from the first nest on July 8, 1959. The second clutch of four hatched on August 13 and 14. The downy plumage of these birds (Fig. 1) differs significantly from the plate by Peter Scott in Delacour's

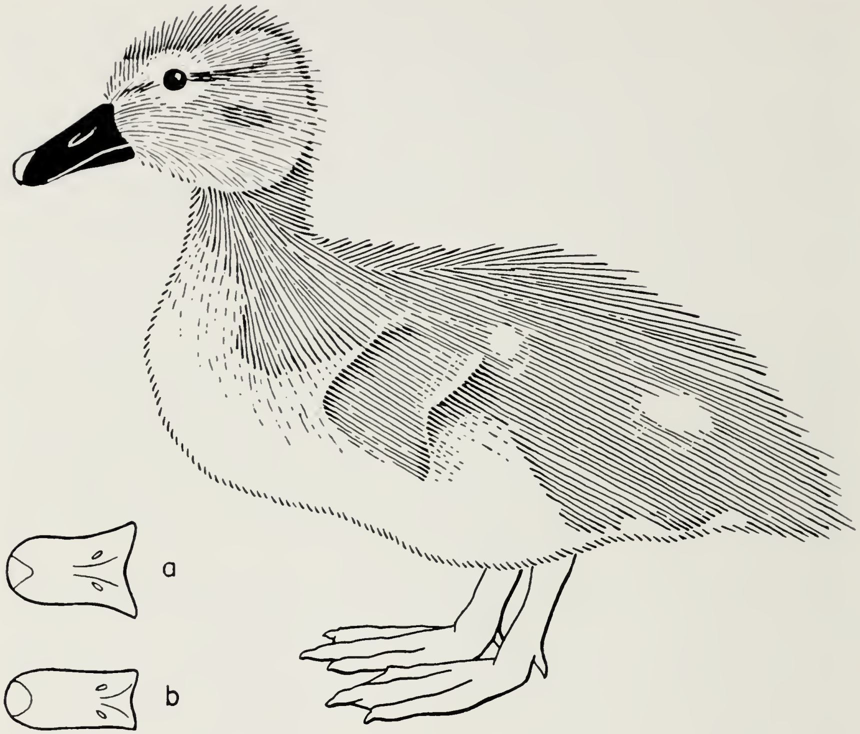

Fig. 1. Downy duckling Laysan Teal showing plumage pattern and outlines of bill shapes in distal view; a. Laysan Teal day-old, b. Mallard day-old.

volume (1956). The humeral and tail spots are reduced, the dark line through the eye is only indicated anterior to the eye, and the dark cap does not reach anteriorly across the forehead to the bill, but is separated. The forehead is colored like the cheeks. The color of these ducklings was dull yellowish brown above and dull yellowish below. The cheeks and forehead were brownish yellow. The legs were dull greenish yellow anteriorly, and dull greenish brown posteriorly. The most noticeable characteristic of these ducklings was the broad spatulate bill, very broad for a duckling, colored brown with a pinkish tip.

As the ducklings have grown, the spatulate effect has continued. The impression was that these were indeed baby Cape Shovelers (*Anas smithi*), or Cinammon Teal (*Anas cyanoptera*). The bill is far more pronouncedly spatulate than the Hawaiian Duck or, of course, the Mallard. By three weeks, flank feathers had appeared, characteristically coarsely patterned as in the adult Laysan Teal, chocolate brown in color with broad dark brown edges. By November all these young birds are in apparently adult plumage with the exception that the white around the eye is confined to a narrow ring, no more than 2 mm. in width. In addition, two of the young males have a greenish iridescent suffusion to the feathers of the head and upper neck.

CONCLUSION

The size of the eggs of the Laysan Teal, and the size of the ducklings are both extraordinarily large in proportion to the adult birds which are the size of teal. There is apparently an allometric rate of growth which differs markedly from the Mallard, involving not only initial size of the egg and young, but also body proportions. There must be adaptive value for this isolated, reef-inhabiting duck in having an egg and duckling at hatching age so large in proportion to the adult. In addition, the bill in shape and size suggests an adaptation to insectivorous diet.

Delacour and Mayr (1945) have emphasized the conservative nature and taxonomic value of downy plumages of waterfowl. On the basis of the rather striking downy plumage differences, proportionate growth differences, bill structure, small size and coarse plumage, I would be inclined to keep *Anas laysanensis* as a monotypic species within the Mallard, *platyrhynchos* superspecies.

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HEART WEIGHTS OF NORTH AMERICAN CROWS AND RAVENS

BY DAVID W. JOHNSTON AND FRANCIS S. L. WILLIAMSON

In recent years when so much attention has been focussed on human cardiovascular problems and their amelioration, the study of cardiophysiology in mammals has contributed much toward our understanding of these problems, but basic research in other vertebrates has lagged far behind in this respect. Feral birds, for example, have scarcely been examined since the pioneer investigations on heart rate by Odum (1941). Some revival of interest in this field is indicated by the recent reports of Hartman (1954) and others whose studies have centered on anatomical relationships between avian heart weight and such variables as body weight and altitude. From a perusal of these papers, it is evident that many more data are needed from feral birds before the physiological questions can be answered. Nonetheless, it has been known for many years that the largest birds (in terms of body weight) have the smallest or lightest hearts, relative to body weight, and vice versa. In the Passeriformes, the Common Raven (*Corvus corax*) is evidently the largest living representative, not only in terms of body weight but also in linear measurements. Presumably, ravens and their close relatives, the crows, should have relatively small hearts or heart/body weight ratios.

The present report was undertaken to demonstrate the heart/body ratios of these large passerines. Included in our study are data for 13 ravens, 9 Fish Crows (*Corvus ossifragus*), and 43 Common Crows (*C. brachyrhynchos*).

METHODS

The 65 specimens discussed in this paper were taken in late spring or summer, thus representing local breeding populations. Wintering, migrating, or molting individuals have been excluded; our data for birds in these conditions may be used for later considerations. All were collected between 1955 and 1959 at or near sea level. The Fish Crows came from southern Georgia, principally along the coast. Common Crow specimens were taken in the Macon, Georgia, area, and in Washington, west of the Cascade Range from localities ranging from the San Juan Islands south to the Olympia area and the Olympic Peninsula. The ravens were collected at Anchorage, Alaska, except for two individuals from the Olympic Peninsula of Washington. Taxonomically, according to the A. O. U. Check-list (1957:377–379), the Common Crows of Georgia represent the subspecies *paulus*, and the Washington birds belong to a separate species *caurinus*. The ravens from Alaska represent the subspecies *principalis* and those from western Washington, *sinuatus*. Evidence has been amassed by Johnston (in press), however, to show that *C. b. paulus* is synonymous with *C. b. brachyrhynchos*, and that *C. caurinus* is simply a well-marked subspecies of *C. brachyrhynchos.*

Weights were obtained in essentially the same method utilized by Norris and Williamson (1955). Birds fresh from the field were weighed on a double-beam balance to the nearest 0.1 gram, and the heart was preserved in 10 per cent formalin. At a later time each heart was thoroughly dried on filter paper, the major vessels were trimmed off close to the organ, and clotted blood was carefully removed before the heart was weighed on a triple-beam balance to the nearest 0.01 gram. Even though Hartman (1954, 1955) weighed only fresh hearts, in our study weights of the formalin-preserved hearts were considered to be as accurate as fresh weights might be, especially since Norris and Williamson (1955:79) demonstrated an insignificant weight difference between the same heart weighed fresh as compared with a later weight taken after formalin-preservation.

RESULTS

Complete data on body and heart weights are given in Table 1 because there are so few extant reliable weights of these birds. Many collectors, preparators, and taxonomists have failed to recognize the two distinctive age groups (first-year and adult) of these and some other corvids, so that many specimens labelled "adult" are in fact first-year birds, and vice versa. It is essential that these differences be recognized so that data obtained from individual specimens might be treated according to the proper age group; otherwise, questionable or erroneous conclusions might be reached. Hartman (1955:231), for example, did not distinguish age groups for the various corvids utilized for his heart ratios, and one would suspect that the data presented there are not precisely accurate. For this reason, plus the fact that he combined data for the two sexes, his data might not be strictly comparable to those given in Table 1. Nonetheless, his figure of 1.20 (heart weight/body weight) for a male of *brachyrhynchos* from Ohio is in general agreement with the average of 1.23 for eight adult males from Georgia. The average of 10 specimens from Florida (0.98) given by Hartman suggests that Common Crows of that region are large birds with relatively small hearts.

Hartman (1955:223 *et sqq.*) did not find any significant sex differences in heart ratios for the many species given in his compilation, but his samples were usually less than 10. Whether or not our data presented for the two sexes can be considered as "significantly different" is a debatable point because these are also small samples. In the largest comparable sample (*brachyrhynchos* from Washington), average weights do indicate some degree of sex difference in the heart ratios (1.12 for males and 1.07 for females), but these differences are not significant at the 5 per cent level. Norris and Williamson,

TABLE 1

BODY AND HEART WEIGHTS OF CROWS AND RAVENS

	Number	Body Weight	Heart Weight	Ht. wt./body wt.
Corvus ossifragus				
adult male	1	310	2.70	1.15
first-year male	2	292.4* (268.5–316.3)	2.43 (2.36–2.50)	1.26 (1.07–1.34)
adult female	5	283.6 (268.6–294.0)	2.59 (2.17–3.00)	1.11 (0.96–1.34)
first-year female	1	300.5	2.24	1.34
C. brachyrhynchos				
Georgia				
adult male	8	447.8 (415.5–509.0)	3.68 (2.77–4.43)	1.23 (1.09–1.52)
adult female	6	403.3 (372.6–444.3)	3.27 (2.95–3.78)	1.24 (1.10–1.34)
first-year female	1	414.0	3.06	1.35
Washington				
adult male	19	415.2 (388.8–486.3)	3.74 (3.00–5.11)	1.12 (0.78–1.33)
adult female	8	367.9 (314.6–421.2)	3.46 (3.04–3.86)	1.07 (0.86–1.19)
first-year female	1	348.9	3.04	0.87
C. corax				
Alaska				
adult male	2	1593.3 (1540.6–1646.0)	14.29 (12.03–16.55)	0.90 (0.73–1.07)
first-year male	2	1355.1 (1305.0–1405.2)	13.91 (13.67–14.14)	1.03 (1.01–1.05)
adult female	1	1233.0	11.77	0.95
first-year female	6	1169.0 (1008.3–1294.0)	12.66 (11.03–15.69)	1.08 (0.98–1.29)
Washington				
adult male	1	1016.7	10.52	1.03
first-year female	1	969.3	11.18	1.15

* Mean weight in grams followed by extremes in parentheses.

however, reported (1955:81) that ". . . both *Cyanocitta stelleri* and certain fringillid species show higher heart ratios in males than in females. (This is likewise true of *Aphelocoma coerulescens*. . . ." Since their samples included 24 *Cyanocitta* and 84 *Aphelocoma*, it is possible that larger samples of *Corvus* might reveal sex differences of a significant nature. For other passerines Williamson and Norris (1958:91) presented additional data indicating some sex differences in heart ratios.

The values of 0.78 (*brachyrhynchos* from Washington) and 0.73 (*corax* from Alaska) represent the smallest heart ratios known for any of the Corvidae. This particular raven was the heaviest (1646.0 grams) of all those examined here. and had the largest linear measurements (wing—441 mm., tail—242, tarsus—68.9, bill from nostril—53.9, depth of bill—28.4). On the other hand, the adult male raven from Washington (heart ratio = 1.03) had the following measurements: weight—1016.7 grams, wing—380 mm., tail—212, tarsus—65.2, bill from nostril—48.6, depth of bill—26.0. The differences in

(Ed. note: Attach the following note to the margin of p. 250 of the September, 1960, **Wilson Bulletin.**)

CORRECTION—HEART WEIGHTS OF NORTH AMERICAN CROWS AND RAVENS.—Through an accident in mathematical computations, a few of the values in the original table (*Wilson Bulletin*, 72:250) were incorrect. The first nine lines of the column headed "ht. wt./body wt." should read as follows: 0.87; 0.84 (0.75–0.93); 0.91 (0.75–1.04); 0.75; 0.82 (0.66–0.92); 0.81 (0.75–0.91); 0.74; 0.90 (0.75–1.28); 0.95 (0.84–1.17). In the text and summary it will be necessary to substitute the corrected values above, and the results would indicate that (1) ravens have somewhat larger hearts than the other two species (2) in these three species adult males tend to have slightly smaller hearts than females, and (3) adult crows' hearts tend to be larger than those of the first-year birds, though the opposite relationship is likely in ravens. I would like to absolve the Editor of this journal and my colleague, Mr. Williamson, for these errors.—DAVID W. JOHNSTON, *Department of Biology, Wake Forest College, Winston-Salem, North Carolina, October 26, 1960.*

these weights and linear measurements compare favorably with the averages given by Ridgway (1904:259–262) for the subspecies *principalis* and *sinuatus*, respectively. Body size, however, is obviously not the only factor to be considered, because in smaller corvids (*Cyanocitta*), heart ratios as small as 0.80 have been reported by Norris and Williamson (1955:81). There are undoubtedly some complicating variables, such as activity and basal metabolism which influence these ratios in addition to sex, age, climate, and altitude.

The data in Table 1 also suggest that first-year crows and ravens have larger hearts than do adults of the comparable sex. As a matter of fact, with the exception of one *brachyrhynchos* from Washington, in these three species, values for first-year birds are uniformly greater than those for adults of the same sex. These data are of further interest since Hartman (1955:224) reported either no differences between age groups or that young birds had smaller hearts than adults. In these corvids, however, it must be remembered that maturation is more protracted than that found in the usual passerine types, the latter attaining essentially "mature" or "adult" size, proportions, and coloration in a year or less. Our data for *Corvus* substantiate Hartman's statement (1955:237) that "the age at which heart size attains adult magnitude appears to differ among species."

Finally, a possible factor to be considered in heart weights is that of fat deposits. As yet, there is no clear evidence to indicate that this is a significant factor in birds of the size considered here, for major fat deposits in subcutaneous and abdominal areas are likely proportional to those around the heart. Although excessively "fat" birds were not examined in this study, light or moderate fat deposits were sometimes noted upon dissection of abdominal areas, but the same birds had some fatty deposits around the heart. Thus, it appeared grossly that additional weight of a heart attributed to fatty deposits would be proportional to additional body weight as the result of subcutaneous and abdominal deposits of fat. It might be argued that lean body and heart weights would be more accurate, but this is not necessarily true since *entirely* fat-free birds would be exceptional in nature anyhow. In fact, Odum and Perkinson (1951:220) showed that heart lipids in the White-throated Sparrow (*Zonotrichia albicollis*) increased in premigratory individuals along with total body lipids, though not proportionately.

SUMMARY

Body weights, heart weights, and heart weight/body weight ratios are given for 65 North American crows and ravens. The samples included two species of crows and two subspecies of ravens, the latter being the largest passerine birds. Data were presented for both adults and first-year birds of both sexes when available.

The adult Common Ravens from Alaska proved to be the largest birds examined, and had the smallest heart ratios (even among extant data for other corvids), averaging 0.90 for males and 0.95 for a single female. Adult Common Crows from Georgia had average heart ratios of 1.23 for males and 1.24 for females, whereas those from western Washington were 1.12 and 1.07, respectively. Adult Fish Crows tended to have heart ratios somewhat intermediate between those of the Common Ravens and Common Crows (1.15 for a male and 1.11, an average of five females).

In these three species males have heart ratios sometimes greater than, sometimes less than, those of females, but these differences do not appear to be significant.

Comparisons between heart ratios of adults and those of first-year birds of the same sex showed that adults of these three species have smaller hearts than the first-year birds. The reason for this difference is unknown at present.

Whether fat deposits are significant as variables in relative heart size seems to be purely speculative at the present time, but there was no conclusive evidence from these studies that even a moderately fat crow or raven had a significantly different heart ratio from that of a lean individual.

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EVALUATION OF AN AURAL RECORD OF NOCTURNAL MIGRATION

BY RICHARD R. GRABER AND WILLIAM W. COCHRAN

In an earlier paper (1959), we described a technique for detecting and automatically recording the calls of nocturnal migrants.

During the fall (August-October) of 1957, the spring (April-May) and fall of 1958, and the spring of 1959, we used this technique on 175 nights to collect data on bird migration in Champaign County, Illinois.

In the present paper we have placed emphasis on presentation of these audio data rather than on their interpretation. We have, however, attempted to determine how well the data compared with other types of observations, and to consider especially the aural record in relation to weather at Champaign.

Acknowledgments

We are particularly indebted to Edgar C. Hayden, Walter W. Wood, and their associates at the University of Illinois Satellite Tracking Station for use of station facilities; to Glenn E. Stout, Eugene A. Mueller, Donald W. Staggs, and Floyd A. Huff of the State Water Survey, and to Captain John D. Taylor and other staff members of the Weather Station at Chanute Air Force Base for supplying us with detailed weather data and helping us interpret it; and to Frank C. Bellrose of the Illinois Natural History Survey for valuable suggestions and enthusiastic encouragement.

Methods

For details on the principal method of study we refer the reader to our technique paper (1959). Here we need only summarize. Amplified calls of nocturnal migrants were recorded nightly on tape. The recording was controlled by an automatic timer which sampled 1½ minutes out of each 10 minutes during the night, providing a 1½-hour-long tape representing 10 hours. Tapes were audited daily and the time of calling of migrants and the number of each type of call recorded on a data sheet. We noted species names only when we felt certain of the identity of the call. Otherwise the phonetics for the call was recorded and, when possible, a general identification, such as: "warbler, possibly *Oporornis*."

In computing "flight-call densities" we have, for simplicity, used the area pattern shown in Graber and Cochran (1959:228), though the pattern actually varies somewhat with the sound source.

We have expressed flight-call densities as number of calls per mile, per hour, or per night, following Lowery's (1951) work on flight density. Unless otherwise stated, when we refer to a relative volume of migration (heavy or light), we mean migration volume as indicated by our records of calling of nocturnal migrants. We recognize the difference between high volume of migration and high incidence of calling by nocturnal migrants. Mass flights would go undetected by our system if migrants remained silent.

To obtain data to compare with the audio record, Graber (1) made daily censuses of migrants in local woodlands during at least part of each migration season. (2) checked a local television tower daily and collected specimen data of kills, and (3) made lunar observations of migration on two nights in the spring of 1959.

Our audio station was purposely located in open country and the nearest woodlands were approximately 8 miles away, near Urbana, Illinois. In censusing migrants this same area and the same census route were used daily. The route through open park lands, dense shrub thickets and mature woodland was about 1 mile long and required about one hour (0600–0700) to cover. Only individuals of species known to be nocturnal migrants were counted. Census figures were recorded on field data cards and the day-to-day change in the migrant population was graphed to facilitate comparison with the audio record. The graph was based on a point system in which each apparent departure or arrival of a species in the area, and each obvious change in numbers of individuals of a species, counted a unit on the graph. A new species arrival was counted only when at least two individuals were seen.

We strove for a continuous aural record each season, but equipment failure or power failure caused some gaps in the record. We were still experimenting in the fall of 1957, and the record for that season is particularly sketchy, providing data for only 38 nights in the period from August 17 to October 14. The record for fall, 1958, was uninterrupted and ran from September 7 to October 24. The spring records ran from April 13 to June 1 (1958), and from April 8 to May 30 (1959). Each spring record contained lapses of six nights (not consecutive).

All figures referring to time of day in this paper represent Central Standard Time.

Mass Migrations—Timing and Weather at Champaign

Though some migrants were heard on 85–89 per cent of the nights recorded, most of the volume of migration (67–88 per cent) passed on a relatively few nights (23–42 per cent of nights recorded). Figs. 1–2 and Table 1 present data on these mass migrations.

A relationship between mass migration and frontal systems has been recognized at least since the time of Cooke (1888), and a number of authors have reviewed the subject. Most of the mass movements of birds detected in this study were associated with frontal systems—warm fronts in spring and cold fronts in fall.

This association was apparent in the coincidence of timing between the movement of the front and the birds (Figs. 1–2 and Table 2). In fall, 1958,

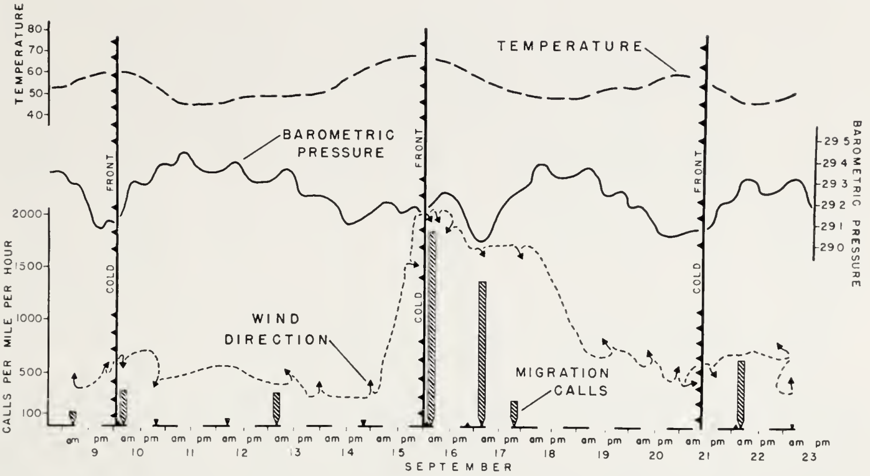


FIG. 1. Timing of nocturnal migration with frontal passage and changes in minimum nightly temperature (in °F.), barometric pressure (in inches) and wind direction at Champaign, Illinois, in September, 1958. Bar graph shows volume of migration as indicated by calling of nocturnal migrants. Black base line indicates night hours, and time markers indicate 12 midnight and 12 noon. Arrival time of first migrants is shown by black apexes.

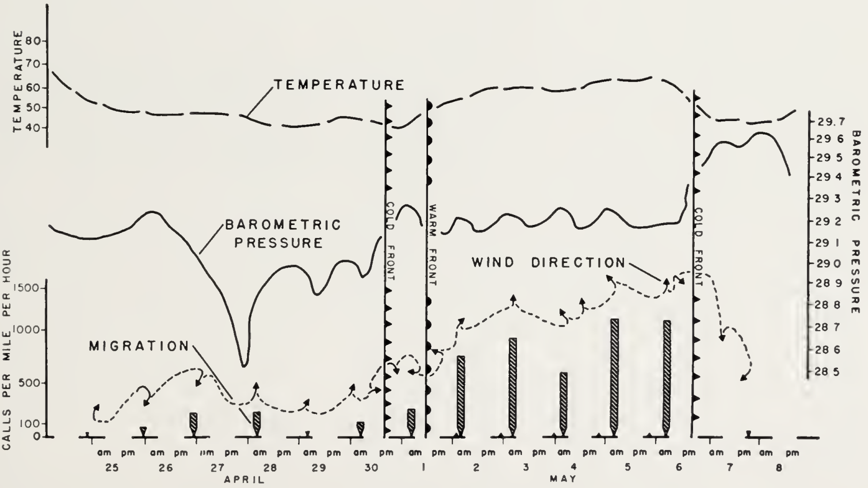


FIG. 2. Timing of nocturnal migration with frontal passage and changes in minimum nightly temperature (in °F.), barometric pressure (in inches), and wind direction at Champaign, Illinois, in spring, 1959. Black base line indicates night hours, and time markers indicate 12 midnight and 12 noon. Arrival time of first migrants is shown by black apexes.

TABLE 1

MASS MIGRATION IN RELATION TO SEASONAL VOLUME

Season	Total number of nights recorded	Number of nights with migration	Per cent of nights with migration	Total volume of migration[1]	Mass Migration			
					Number of nights	Per cent of nights[2]	Volume	Per cent of total volume
Spring, 1958	44	39	89	34,615	9	23	23,270	67
Fall, 1958	47	40	85	59,620	14	35	52,560	88
Spring, 1959	46	40	87	90,920	17	42	78,145	86

[1] Volume of migration as indicated by calls of migrants per mile per season.
[2] Per cent of nights on which any migration was recorded.

heavy migration accompanied each of the six cold fronts which occurred in the study period. When the fronts passed in the night (four times) an increase in calling of migrants began within 20 minutes to two hours after the passage. Two of the cold fronts passed Champaign in the daytime—one at 1200, with the first migrants coming 12 hours later; and one at 1700, with migrants following in five hours.

The greater lag between migrants and fronts which pass in the daytime (versus night) reflects the fact that migration ceases during the day. Frontal speeds varied between 5–25 mph. and averaged about 15. With their own speed plus the speed of the frontal winds, migrants could not consistently remain behind the front without the daytime rest.

In spring, also, migrants lagged behind frontal passage. During the two years studied virtually all of the spring warm fronts passed Champaign in the daytime. Because day length is longer in spring than in fall, one would expect the interval between front and birds to be longer in spring also, and thus our data show it to be (Figs. 1–2).

From the audio data it is possible to obtain some impression of the frequency with which migrants overtake fronts. Assuming a base flight speed of 20 mph for birds, and adding tail-wind data, we calculate that migrants would have overtaken spring warm fronts only once in four mass flights. In this case, May 16–17, 1958, the front's speed was only 5 mph, and the fastest migrants would have overtaken the front about 0300. The migration on this night was very heavy and migrants were possibly "piling up" behind the front.

In fall, migrants overtook fronts in five of six mass flights, but in most cases the closing of birds with fronts would have occurred between 0400 and 0500, i.e., at about the time for the night's migration to end. Consistently the pre-dawn peaks in calling came earlier on mornings when migrants were overtaking the fronts, and the time of the peak in calling appeared to correlate

TABLE 2

MAJOR MASS MIGRATIONS AND FRONTAL SYSTEMS AT CHAMPAIGN, ILLINOIS, IN SPRING

Date	Front	From	Wind change		Speed (mph)	Arrival[1] time of front	Arrival[2] time of migrants	Difference	Volume[3] of migration
			From	To					
May, 1958									
2– 3	Warm	S	NE	S	15	1100– 2	0200– 3	—15:00	1775
16–17	Warm	S	NE	SE	5	1000–16	2300–16	—13:00	6400
17–18	Front stationary C. Illinois (24 hours)		Continues S–SW;			Migration continues, but slowing			2625
21–22	Warm	S	NW	S	20	1300–21	2100–21	— 8:00	4900
May, 1959									
1– 2	Warm	SW	NW	SW	12	1300– 1	0230– 2	—13:30	7700
2– 6	Front moves to N. Wisconsin (12 hours)		Continues S–SE;			Heavy migration continues			9050/night
15–16	None		NW	Calm–SW		1300–15	0100–16	—12:00	930
16–18			Continues SW–SE			Heavy migration continues			5885/night
18–19	Warm	S	Continues S–SE		15–20	0030–19, Heavy migration continues			3935
19–22	Front moves to N. Wisconsin (12 hours)		Continues S–SE;			Heavy migration continues			3780/night
September, 1958									
9–10	Cold	NNW	W	N	20–25	0240–10	0300–10	— 0:20	3860
12–13	None		NE	Calm		1600–12	0400–13	—12:00	3100
15–16	Cold	NW	SW	N	5	0130–16	0330–16	— 2:00	12,900
16–18	Front moves to S. Illinois (12 hours)		Continues N–NW;			Heavy migration continues			6290/night
21–22	Cold	NW	SW	NW	17	1200–21	0030–22	—12:30	6700
25–26	Cold	NW	SW	NW	16	1700–25	2200–25	— 5:00	3100
26–27	Front moves to S. Illinois (12 hours)		Continues NW;			Migration continues, but slowing			1660
October, 1958									
4– 5	Cold	NW	SW	N	18	0030– 5	0230– 5	— 2:00	1600
16–17	Cold	NNW	SW	NW	10	0300–17	0200–17	1:00	1700

[1] Hour and date of arrival of front.
[2] Hour and date of the start of a peak in migration.
[3] Volume of migration in terms of bird calls per mile per night.

with the time of the closing of the gap between birds and fronts, i.e., when the closure occurred later, the peak in calling also occurred later.

Interestingly, on the night of the tower kills in the falls of 1957 and 1958, migrants were pressing the front especially closely, and on the night of the larger kill (1957) birds overtook the front earlier in the night. This is discussed later with the tower-kill data.

In only one instance did a large number of migrants reach Champaign in advance of a front. On October 16–17, 1958, at 0200 the first migrants were heard one hour in advance of an oncoming slowly moving cold front. This shows that migrants will, at times, overtake and pass the front, but in *all* observed cases of mass migration the vast majority of birds trailed the front.

In September, cold fronts which pass through Champaign almost invariably come from the west-northwest, originating on the northwest Pacific coast, and moving eastward to the central Dakotas and Minnesota. In this area (Dakota-Minnesota) the fronts turn decidedly to the southeast and pass ultimately off the Atlantic coast from east-southeastern United States.

In reaching Illinois these fronts sweep an area 2000 miles long and several hundreds of miles wide in northern United States and southern Canada.

Probably, birds from the Pacific northwest which generally represent a different fauna than that found in Illinois do not follow the front across the continent. However, certain species, such as Swainson's Thrush (*Hylocichla ustulata*), could conceivably come to Illinois from as far as British Columbia behind a front.

In September, the species of migrants which occur in the Champaign area in greatest abundance are probably the Swainson's Thrush, Ovenbird (*Seiurus aurocapillus*), American Redstart (*Setophaga ruticilla*), Tennessee Warbler (*Vermivora peregrina*), Magnolia Warbler (*Dendroica magnolia*), and Bay-breasted Warbler (*Dendroica castanea*). All of these have large areas of breeding range which lie in the path of the cold fronts. On the other hand, neither the Veery (*Hylocichla fuscescens*) nor the Hermit Thrush (*Hylocichla guttata*) is *abundant* here in migration, yet both species have large portions of their breeding range in the regions covered by the cold fronts. Conversely, the Gray-cheeked Thrush (*Hylocichla minima*) is a common September migrant here, yet most of this species' breeding range lies north of the frontal sweep. We have no way of knowing how far migrants may follow a front, or, indeed, if they actually follow the frontal path. The aural data suggest this possibility, however.

Despite the similarity which different fronts show in their direction of movement and area of coverage, the volume of migration which follows different fronts is highly variable. In fall the volume of a particular mass movement of birds appears to show a relationship to the time interval between the end of a mass migration and the subsequent appearance of another cold front. As this interval increases the volume of migration also increases. The relationship was apparent in the fall data both in 1957 and 1958. In the fall of 1958 when the migration-cold front interval was only two days, the subsequent migration lasted only one night, and the volume was 300 calls per hour per mile. For other intervals the figures were: three days—one night of migration at a volume of 400 calls per hour per mile; for three and one-half days—one night, 600 calls; and for six days—three nights of migration, 1100 calls. This relationship can be explained by the reasonable assumptions that all migrants in an area do not develop the condition of "Zugunruhe" simultaneously, but with the passage of time, more and more birds come into the restless state. When a front passes, those migrants which exhibit nocturnal restlessness take flight. If a second front passes the region soon after the first, relatively few migrants will have attained the physiological state in which they are responsive to frontal passage. If the second front does not pass for several days, more migrants in the region will have become responsive. Thus, successive fronts "sweep" more and more birds southward. In spring this time-volume relationship was not evident.

Initiation of Flight

From the time-relationship between arrival of migrants and fronts, it is reasonable to assume that something about the passing of a front initiates the mass flights and that birds do not take wing until the front is past. Devlin (1954:94–95), from observations of the moon and in the field, considered the hour just before nightfall to be the critical time as far as the initiation of nocturnal migration was concerned in spring. He also suggested that migrants do not often take flight in the middle of the night. The fact that there is usually a lag between the time of frontal passage and the passing of the first migrants tends to support Devlin's view. Migrants taking off at night immediately after a front passed would ordinarily overtake it quickly, whereas migrants that start only at sundown or shortly after would be following the front by an interval of the number of hours between the time the front passed and sundown. Ball (1952:67–68) twice observed single birds taking flight in the early morning, but it is not known whether these observations represented mass migration.

Several times calls of nocturnal migrants were heard at Champaign shortly after sundown. The initial calling of migrants was also heard as late as 6½ hours after sundown following the passage of a front. Presumably, no matter what time of the day a front passes, nocturnal migrants will respond at sundown if the proper conditions (established by the front) still obtain.

Of the factors which the front may change, wind, temperature, and pressure have been most commonly considered as being important to migration. Devlin (1954:95) believed that certain conditions of wind and temperature at sundown stimulated migration. Lowery (1951) showed that migrants generally moved with the wind, and indirect evidence presented by Bennett (1952) and several other authors supports his data. Bagg *et al.* (1950) presented an excellent discussion of migration in relation to barometric pressure and other meteorological phenomena.

It is worth while to consider the audio record in relation to such factors.

Migration and Surface Winds.—In fall, 1958, virtually all (93 per cent) of the calling of nocturnal migrants occurred during hours when surface winds were from the north-northwest (76 per cent) or calm (17 per cent), notwithstanding the fact that winds were predominantly southerly during the migration season (Figs. 3–5). Twenty-seven per cent of the night hours were calm.

In spring, 1958, most of the calling (72 per cent) occurred during hours when surface winds were south-southwest (54 per cent) or calm (18 per cent), though the winds were predominantly northerly. Twenty-three per cent of the night hours were calm. In spring, 1959, most of the calling (84 per

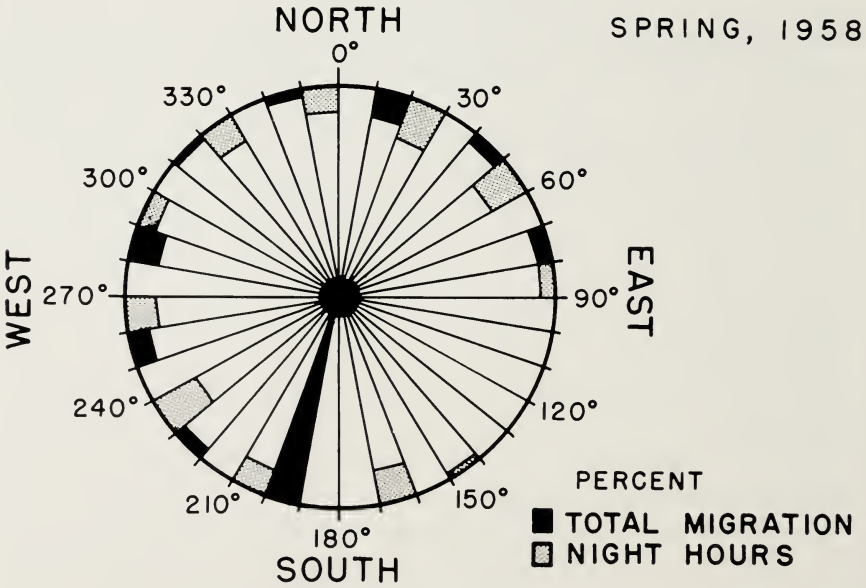
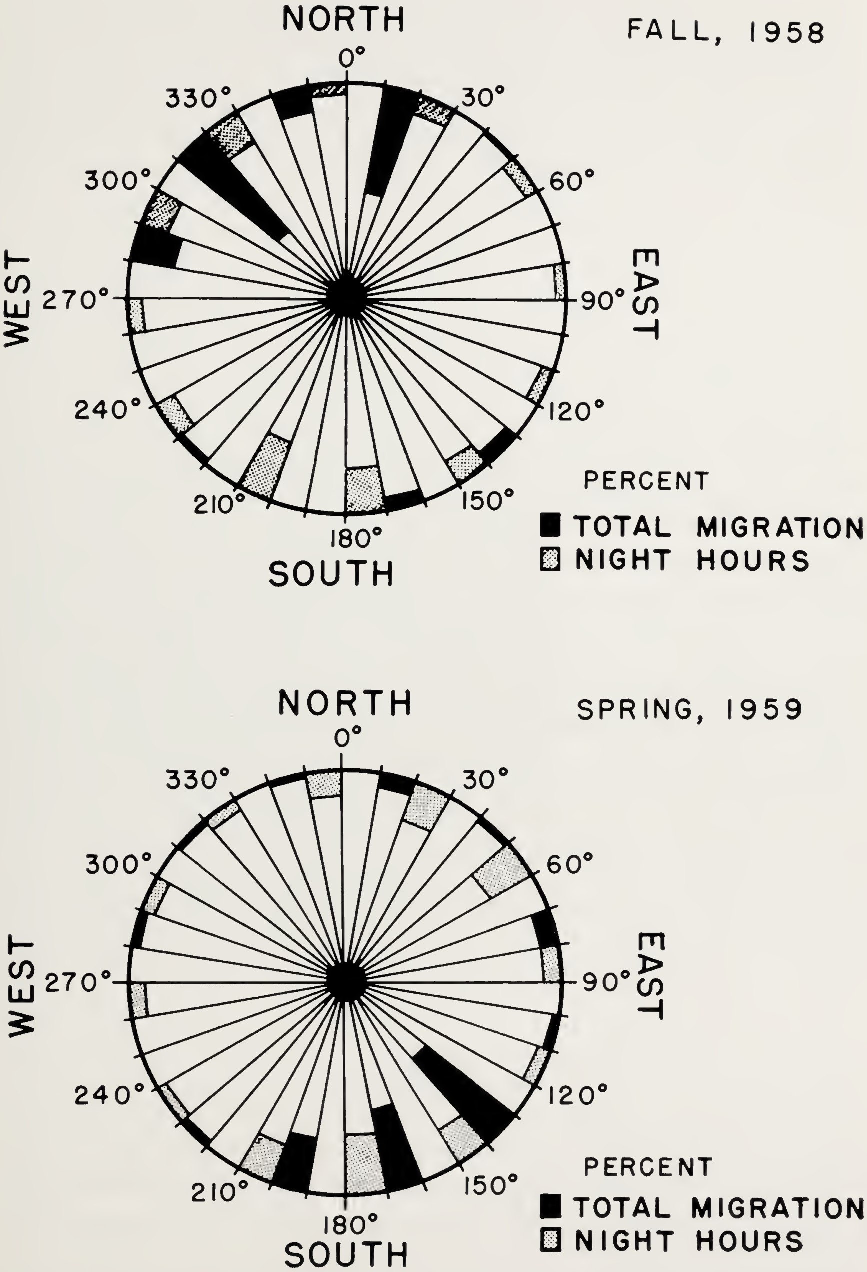


Fig. 3. Total seasonal volume of migration occurring with specific wind headings. Gray shading shows per cent of night hours during the season that wind held a specific heading. Black shading shows per cent of total migration occurring *with* the wind heading indicated.



FIGS. 4 (*above*) and 5 (*below*). Total seasonal volume of migration occurring with specific wind headings. For key, see Fig. 3.

cent) occurred when winds were from the south-southeast (58 per cent) or calm (26 per cent). Sixteen per cent of the night hours were calm. Maximum surface winds coinciding with heavy migration did not exceed 12–14 mph.

We have not made similiar calculations for winds aloft because of a lack of detailed data, but on an average, winds above 1500 feet show a clockwise rotation of 30° and an increase in velocity of about half the speed of surface winds.

Assuming northward flight in spring and southward flight in fall, it is clear that birds migrated with the winds. The question remains as to whether frontal passage was associated with a change in wind which favored migration. Figs. 1–3 show definitely in the affirmative. In fall, migration occurred when the wind shifted from southwest to northwest, and such a shift usually coincided with the passage of a front from the northwest.

In spring, migration occurred with a wind-shift from the north to the south. Often a 360° rotation in wind direction from southwest to northwest to north (coinciding with a cold front) to northeast to southeast (coinciding with a warm front) to south-southwest preceded by 48 hours the very heavy spring migrations. Such wind-shifts were usually associated with the passage of fronts, but one of the heaviest migrations in spring (May 17–18), 1959, did not coincide with a definite frontal system though a wind-shift west to south did occur. On this occasion southerly winds continued for at least six nights and so did the migration. The passage of a warm front on May 19 did not cause an increase in the volume of migration. The conditions which favored migration were already established before the front arrived. This observation indicates that a definite frontal system, per se, is not important to migration, though the conditions which favor migration are usually associated with the passage of a front.

The change in wind which precedes the arrival of migrants occurs relatively quickly, often in a matter of one or two hours. Velocity as well as direction is usually involved, and the change is one which an animal might detect very easily.

On only four nights, May 25–26, 1958, April 26–27 and May 22–24, 1959, was there notable migration apparently against the wind. Winds aloft (second standard level) were favorable (southerly) for the April date, but not for the migrations on May 22–24. The lateness of the dates suggests the possibility that migrants are more likely to move under unfavorable circumstances late in the season. This same view was expressed by Cooke (1888: 16–25), who believed that late in the season (spring) some migration occurred on every night.

Migration and Changes in Temperature, Humidity, and Pressure.—Changes in temperature, pressure, and humidity which accompany passage of a front might also conceivably be detected by migrants.

In fall, most waves of migration coincided with periods of relatively high night temperatures, though with the 24-hour trend toward falling temperatures (Fig. 1). In spring, mass migrations came consistently in periods when temperatures were rising, often following a short period when night temperatures were lower than average (Fig. 2). The tendency for birds to migrate on warm nights was more pronounced in spring than in fall.

Daily fluctuation in temperature was so great in both spring and fall that it seemed unlikely that migration could be triggered by the subtle temperature changes which accompany a front, especially in view of the fact that at sundown, the presumed time of take-off, the temperature is usually falling steeply. Temperature and humidity are so closely interrelated that it is difficult to evaluate them separately. Humidity as indicated by dew-point temperature tends to follow the curve of minimum nightly temperatures. Dew-point is less variable than temperature, and changes in dew-point are usually subtle.

In fall, at least, no particular condition of temperature or humidity correlated with migration if the winds were adverse (note conditions during the period September 15–18, 1958, in Fig. 1). In spring, warming temperatures and increasing humidity so consistently accompany southerly winds that the factors, again, are difficult to evaluate separately.

At Champaign, the beginning of heavy migration usually accompanied rising barometric pressure in fall and falling pressure in spring (Figs. 1–2). Though it does not fluctuate so much as temperature, pressure is highly variable. However, the pressure changes which accompany a front are not usually extraordinary, so pressure change (at least by itself) seems unlikely as a factor to initiate migration.

In summary, the factors which most consistently precede or accompany the initial wave of birds in a mass migration are: in fall, wind direction change from southwest to northwest, relatively high night temperature but with falling trend, and rising barometric pressure; in spring, wind change from southwest to north to southeast to south, rising temperature, and falling barometric pressure.

Of these factors, the wind changes correlate most directly with fluctuations in volume of migration. The audio data indicate that it is the wind which probably exerts the dominant influence in initiating and halting a mass flight.

Once migration was initiated, it continued past a point of observation until the migrant swarm passed, if the proper conditions held. In fall, mass migration appeared to discontinue if surface winds became southerly. Cessation of fall migration, or at least of nocturnal calling, coincided also with relatively low night temperature and high barometric pressure, though not invariably.

In spring, migration was discontinued when winds switched from south-

TABLE 3

ANALYSIS OF MIGRATION AND CLOUD COVER

Tenths of cloud cover	Per cent of time with condition	Per cent of migration occurring
Fall, 1958		
0–5	67	44
6–9	13	9
10	20	47
Spring, 1958		
0–5	55	36
6–9	25	45
10	20	19
Spring, 1959		
0–5	30	39
6–9	20	27
10	50	34

erly to northerly. Again not invariably, such a change was accompanied by low night temperature and high pressure. Thus on May 2–6, 1959, heavy migration continued nightly with southerly winds until halted by a windshift (with a cold front) from the south to the north-northwest. This is an example of the situation described by Bagg *et al.* (1950:18) that in spring "pronounced movement will take place . . . through a given region during the interval between the passage of a warm front . . . and the subsequent arrival of a cold front."

Cloud Cover and Migration.—In view of the interesting work of Sauer (1958) and Bellrose (1958) on celestial orientation in birds, it is worth while to consider the audio record of migration in relation to cloud cover because opaque overcast could conceivably interfere with celestial orientation.

Tables 3 and 4 present data on migration and cloud cover. Table 3 indicates that migration is not particularly reduced on nights with opaque overcast. No consistent tendency is shown and the condition of overcast appears to be incidental to other factors as far as volume of migration is concerned.

Table 4 summarizes data on migration and opaque overcast in greater detail. On the nights of May 2–3 and September 15–17, 1958, and April 26–27 and May 17–18, 22–23, 1959, heavy migration coincided with complete overcast. Birds flying at elevations of a few hundred feet could not have seen the stars on those nights. In one case (September 15–17) opaque overcast lasted as long as 59 hours in the Champaign region, and in all of the cases mentioned the overcast was widespread, extending over several states. It is possible that in most cases birds could have been flying above

TABLE 4

MASS MIGRATIONS AND OVERCAST

Date	Hours	Volume	Period of continuous opaque cover		Lowest layer		Second layer		Third layer		Geographic extent of overcast
			Start	End	10ths	Altitude (feet)	10ths	Altitude (feet)	10ths	Altitude (feet)	
May, 1958											
2	2000–	1775	2–1900	3–1900	1	800	6	1600	6	2300	Ill., S. Wisc., Ind.,
	2300				6	700	4	1300	u[1]		Ohio, Ky., Tenn., Ark.,
3	0000–				10	500	u		u		Mo., Iowa, Minn.
	0500				6	900	4	1900	u		
September, 1958											
15	2000–	12890	15–0900	17–2000	10	3800	u		u		Ill., S. Wisc., Mich.,
	2300				5	u	3	1600	2	2300	Ind., E. Mo., E. Iowa
16	0000–				7	1200	3	4000	u		
	0500				8	400	2	800	u		
16	2000–	10265			8	3500	10	8000	u		Ill., Wisc., Mich., Ind.,
	2300				10	400	u		u		Ky., Tenn., Miss., N.
17	0100–										La., Ark., Mo., Iowa,
	0500				10	300	u		u		Minn.
April, 1959											
26	2000–	1698	26–1100	27–0900							Ill., Wisc., Mich.,
	2300				4	1300	6	2300	u		Ohio, Ind., Ky.,
27	0000–										Tenn., N. Ark., Mo.,
	0500				10	10000	u		u		Iowa, Minn.
May, 1959											
17	2000–	7834	17–1100	18–0600	10	1200—	u		u		Ill., S. Ind., Ky., Tenn.,
	2300				10	1600	u		u		Mo., SE Iowa
18	0000–				2	600—	8	2000			
	0500				2	800	8	2000	u		
22	2000–	2112	22–0800	23–2200	10	600	u		u		Ill., Wisc., S. Mich.,
	2300				10	400	u		u		Ohio, N. Ind., W. Ky.,
23	0000–				10	300					W. Tenn., Miss., La.,
	0500				10	300	u		u		E. Tex., Okla., Kans.,
											Ark., Mo., Iowa

[1] u=unknown

at least the lower cloud layers, but in all of the cases cited, migrants probably began their night's migration in Illinois under opaque overcast without having seen direct sun or other starlight for as many as 14 hours.

The importance of favorable wind conditions to migration has already been stressed. With only one exception (April 26–27, 1959) heavy migrations under overcast occurred with favorable winds. *This fact implies that migrants were able to identify wind direction without the stars for orientation.* It is also conceivable that migrants fly at such times even though they are dis-oriented, but this seems unlikely in view of the frequency with which migration and overcast coincide.

Comparison of Tower Kills and Audio Record

Brewer and Ellis (1958) presented data on kills which occurred at the WCIA tower, Champaign County, Illinois, between 1955 and 1957. Our sound station was located approximately 8.5 miles southeast of this tower, and since fall, 1957, we checked the tower daily in migration season. The major kills occurred in fall on the nights of September 21–22, 1957, and September 15–17, 1958. There were other kills, but none in which more than six specimens were found.

Comparison of our recordings with kill data (Table 5) shows some interesting similarities and differences.

The number of types of calls correlated well with the number of species killed, but in each case more species were heard calling than were killed. The record for individual species suggests a possible differential rate of calling for different species from night to night, and points out one of the pitfalls for the investigator who depends entirely on the audio technique.

However, there appears to be a rough correlation between numbers of thrushes calling and thrushes killed. This ratio for all thrushes for the three kills was 8:4, 90:60, and 70:64 per cent. In each case per cent of total calls exceeds per cent of total kill, which indicates that the thrushes are vociferous by comparison with other species, for instance, the Bobolink (*Dolichonyx oryzivorus*).

Correlation between flight-call density and flight density as determined from tower-kill data was variable. The smallest kill occurred on the night (September 15–16) when the *highest* call density was recorded. The density ratio (call:kill) for this night was 1:1.7. For the other two nights the ratios were 1:3100 for both. The density as determined from kill data is consistently higher. Cochran and Graber (1958) showed that migrants are apparently attracted to tower lights, a fact which could tend to raise densities calculated from kill data out of proportion to the true density.

All three kills were associated with mass migration accompanying cold fronts from the northwest and 10/10 opaque stratus or strato-cumulus cloud

TABLE 5

COMPARISON OF AUDIO RECORD AND TOWER KILL

Audio record species	Per cent of all calls	Tower kill species	Per cent of birds killed
	September 21–22, 1957		
Hylocichla A	3	Swainson's Thrush	2
Hylocichla B	5	Gray-cheeked Thrush	2
Hylocichla C	0.6		
Bobolink	1	Bobolink	0
Total	9.6	Total	4
Number of types of calls	44 plus	Number of species killed	25
Flight-call density	7235 calls/mile/night	Flight density	226,171 birds/mile/night
	September 15–16, 1958		
Hylocichla A	74	Swainson's Thrush	10
Hylocichla B	10	Gray-cheeked Thrush	50
Hylocichla C	6		
Total	90	Total	60
Number of types of calls	6	Number of species killed	4
Flight-call density	12,900 calls/mile/night	Flight density	21,747 birds/mile/night
	September 16–17, 1958		
Hylocichla A	51	Swainson's Thrush	39
Hylocichla B	7	Gray-cheeked Thrush	22
Hylocichla C	12	Veery	3
Bobolink	1	Bobolink	11
Total	71	Total	75
Number of types of calls	20	Number of species killed	17
Flight-call density	10,265 calls/mile/night	Flight density	319,684 birds/mile/night

cover. At Champaign on the night of September 21–22, 1957, the lowest cloud layer did not fall below 3500 feet. On both September 15–16 and 16–17, 1958, the lowest layer was 3500–3800 feet early in the evening but fell to 300–400 feet by 0600.

Heavy fall migrations also occurred on September 7–8, 12–13 (highest density of season), and 14–15, 1957, and on September 7–8, and 21–22, 1958. These instances were not accompanied by continuous opaque cloud cover, and produced no kills.

There were no large kills at the tower in spring, notwithstanding the fact that on the night of May 17–18, 1959, there was opaque overcast with clouds as low as 600 feet, and the call density was 7834 per mile, i.e., higher than the density (7235) recorded on the night of the kill in September, 1957. This was the only incidence in which the volume of migration exceeded 7000 calls/mile and coincided with relatively low opaque overcast without producing a kill.

It is obvious that overcast may be only a contributing factor to the kills. It was suggested above that the occurrence of kills at the WCIA tower might be related to the circumstance of migrants overtaking a front. Kills did occur on nights when migrants caught up with slow-moving fronts, and the largest kill occurred when birds overtook the front earlier in the night.

On October 16–17, 1958, migrants passed a front at Champaign, but under clear skies, and no kill occurred. Again on May 16–17, 1958, migrants overtook a front at Champaign, but there was not complete overcast and no kill. On May 17–18, 1959, when heavy migration coincided with opaque overcast no kill occurred, but neither was there a frontal system involved.

Newman (1958:4) described a number of kills which occurred in fall, 1957, well behind a front, but our audio data suggest that at Champaign it was the combination of circumstances—heavy migration, complete overcast, and slow-moving front (which migrants overtake)—that effected large kills. Under clear skies migrants will overtake a front and continue to fly even into adverse winds without becoming confused. This may imply that night migrants are utilizing celestial orientation. On the other hand, as long as migrants are flying with favorable winds behind a front, no kill will occur even if skies are completely overcast.

Comparison of Audio Record with Field Observations

A number of valuable studies of migration have been conducted by the indirect method of observing changes in the local population of migrants during the daylight hours (Bennett, 1952; Raynor, 1956). Though our general conclusions are similar to Bennett's (1952) for Illinois, our data suggest that the indirect method at times may be misleading.

Correlation between peaks of migration as determined by nocturnal auditing and by diurnal field observations was poor (Fig. 6). Indications by audio record of heavy migration were not always corroborated by the diurnal observations (note records for September 13, 1957, May 4–6 and 18, 1959). Conversely, indications of migration by diurnal observation were not always evident on the taped record (note records for September 26–28, 1957, and May 10, 1959). The very heavy migration (audio record) of September 12–13, 1957, continued at least until daylight, yet a thorough search on September 13 of several woodlands within a radius of 10 miles of the audio station revealed very few migrants. Arvin (in Nolan, 1958:41) reported a similar occcurrence in southern Texas. He heard calls of migrants on 13 consecutive nights in August but never found large numbers of migrants during the day in this period. Nolan (1958:34) stated that the cold front of September 21–22, 1957, did not precipitate notable migration in the Illinois region, though the audio record for that period shows heavy migration.

There are several possible explanations for these discrepancies. When migration calls are detected at night but no migrants are observed in the daytime, it is conceivable that the migrant swarm might completely pass an area during the night, or that the record of nocturnal calling gives us an exaggerated impression of large-scale migration, for calls of birds in the night may be more conspicuous than grounded migrants. Note in Fig. 6 that the record of diurnal observation tends to be less fluctuating than the record of calling. It is also conceivable that the local population of migrants could turn over completely, yet appear unchanged to the observer, i.e., if the observer counted 20 Swainson's Thrushes and 10 Magnolia Warblers on two consecutive mornings he might logically assume that the migrant population had not changed, even though the individual birds were entirely different on the two mornings.

The situation in which a change in the migrant population is evident, though no migration calls have been detected, may reflect the inadequacy of the audio technique. The difference between the audio and field records in late September and October, 1958 (Fig. 6), is of special interest here. The audio record in this period was largely negative, while the field record showed migration. It has already been shown (Figs. 1, 2) that heavy migration as indicated by calling tends to occur on relatively warm nights. If temperature does affect the rate of calling, reduced calling on the cooler nights of late September and October could account for the difference in volume of migration as indicated by field observation and flight-call counting. Any other factor that affects the rate of calling of migrants would, of course, affect the correlation (or lack of it) between the two sets of data.

Some Species Records.—One of the most promising aspects of study with the audio technique is the acquisition of detailed information on migration patterns and habits of individual species. Such information depends upon the investigator's ability to precisely identify nocturnal notes. The matter of identification of the night call notes is complicated because certain species have what amounts to a night vocabulary, using a particular call only during nocturnal migration, or in daylight only at the beginning or termination of a flight. Ball (1952:49) has discussed such call notes of the *Hylocichla* thrushes.

Some species, however, utter night calls which are the same as or similar to those used in the daytime. The Dickcissel's (*Spiza americana*) night call is one which can be heard on the nesting territories frequently in daytime, especially in late summer, though it is seldom used after spring migration and before juveniles begin to appear in the nesting areas. Cuckoos utter full "songs" in flight regularly in spring, though they also use double- or triple-noted flight calls.

The real problem groups as far as identification is concerned are the calls of a number of species of warblers and small sparrows. Their "chips" or "lisps" are sharp, short, high-pitched calls which do not differ distinctively from species to species. Many of these identifications can probably be worked out with careful field study and careful study of recorded calls. Until this is done the investigator cannot realize maximum benefit from the audio method.

Whole groups of birds may migrate in silence. For instance, we have very few records of duck calls (in contrast to geese), and it seems probable that ducks are generally silent in night migration. It is also possible, of course, that very few ducks have crossed our station.

Fig. 7 shows the records of calling for several species of nocturnal migrants in the spring, 1958 and 1959, and provides information on annual variation in migration patterns. Except in the case of the Yellow-shafted Flicker (*Colaptes auratus*), migration came earlier in 1959 than in 1958. Bagg (1958) discussed the spring migration of 1958 in North America in relation to weather and pointed out that migration lagged before mid-April. Nolan (1958:356), in summarizing field notes for the Middle-Western prairie region, stated that the migration was late until mid-April, and that though the schedule caught up in late April and May, migration waves did not attain remarkable proportions. In contrast, the spring migration of 1959 in the prairie region was ahead of schedule (Newman and Lowery, 1959). These statements are corroborated by the audio record (Fig. 7).

Lunar observations.—We made lunar observations at our sound stations for only two hours, one each on April 24 and May 19, 1959, both times between 2300 and 2400, the hour when highest densities are usually recorded in lunar observations.

On April 24 the hour-station-density for 2330 was 1558 birds. No migration was recorded by the sound station in this hour and the flight-call density for the entire night was 270 calls.

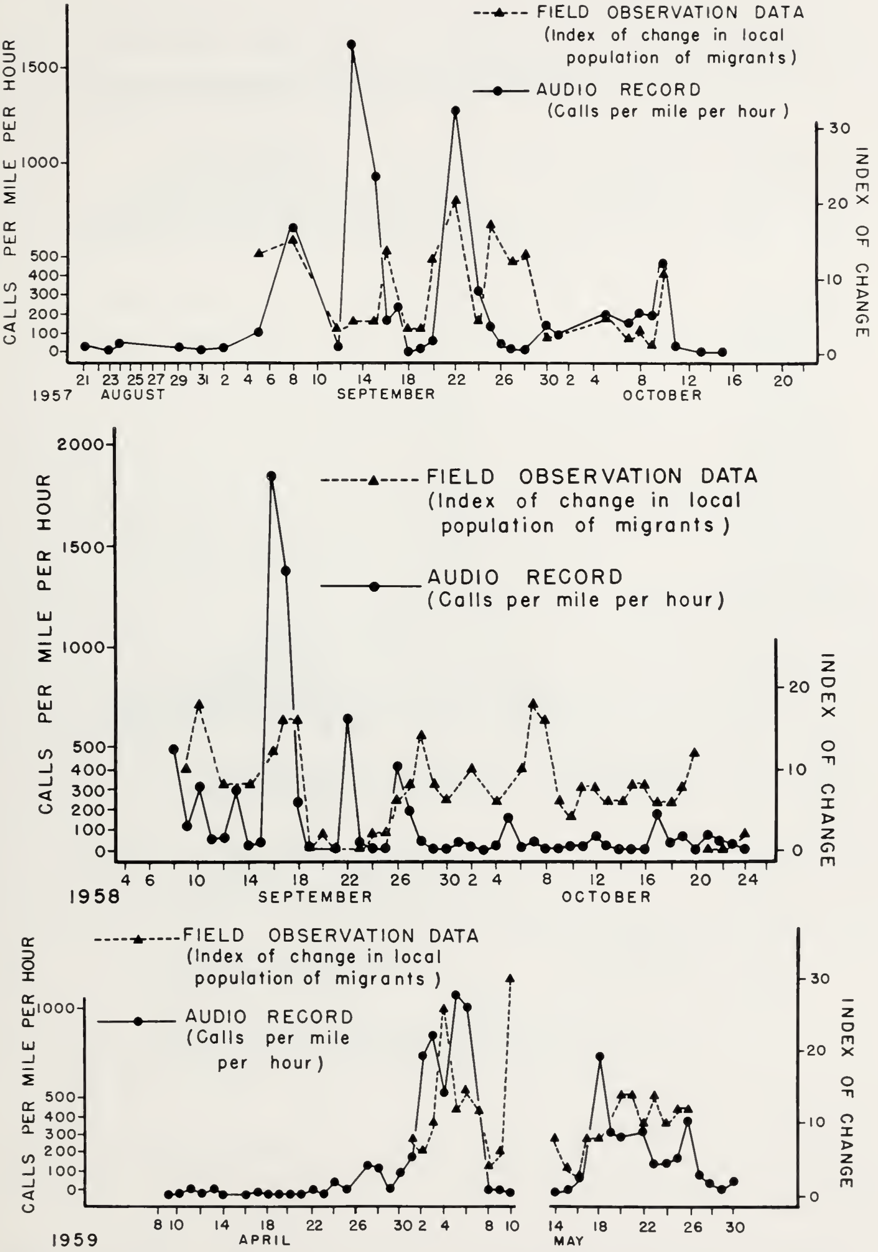


Fig. 6. Records of calling of nocturnal migrants compared with daily field observations on local population of migrants. Index of change indicates observable day-to-day change in migrant population. Not all points are plotted, but all fall on the graph lines.

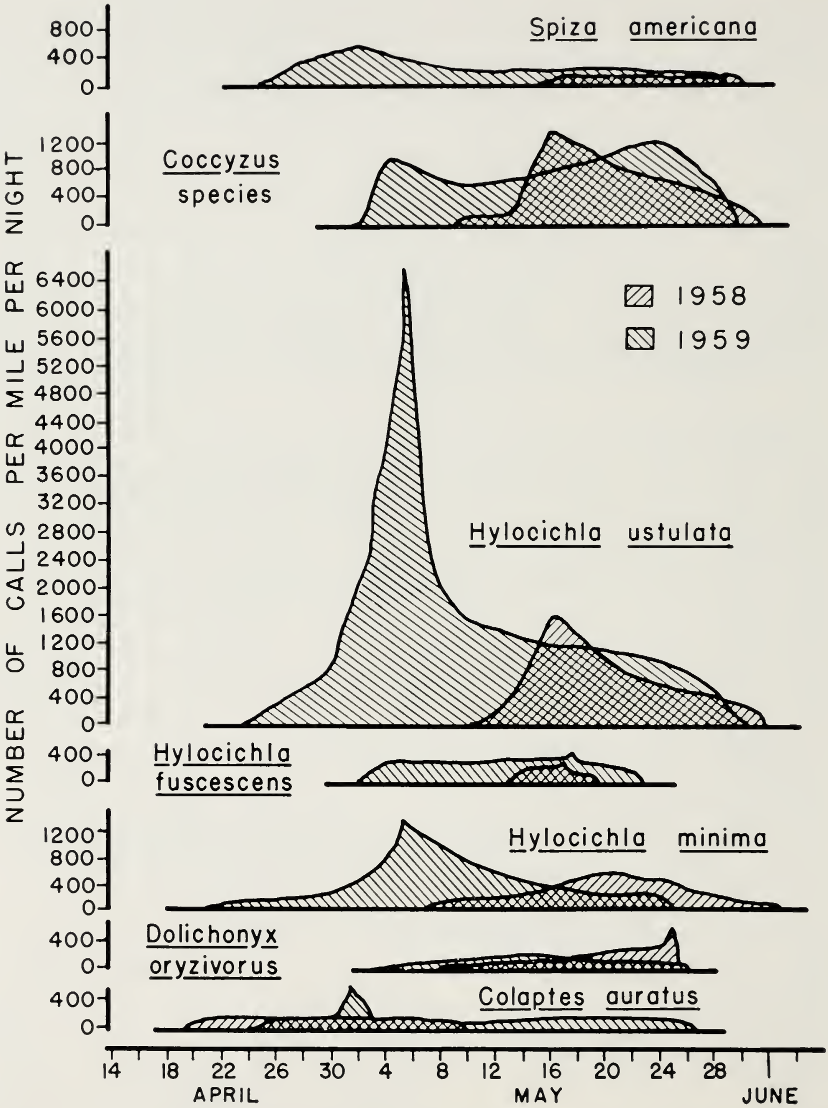


Fig. 7. Records of nocturnal calling for 7 species of migrants at Champaign, Illinois, in spring seasons of 1958 and 1959. Migration did not occur on every night, and figures show only an outline of peaks in migration.

On May 19 the hour-station-density (from lunar observations) for 2330 was 2224 birds. The hour-flight-call-density was 231 calls and the density for the night, 3666.

Both methods, then, show the same general difference, i.e., heavier migration on May 19. The magnitude of the difference indicated by the two methods (1:1.4 for lunar data and 1:13.6 for audio) indicates the expected greater variability inherent in the latter method.

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THE CAROLINA PARAKEET IN PIONEER MISSOURI[1]

BY DANIEL MC KINLEY

The colorful Carolina Parakeet (*Conuropsis carolinensis*) was among the many species of birds found by early travelers in Missouri. These screeching, sociable birds, the individuals almost waggish in their demeanor, the flocks resplendent in their gay feathers, brightened many a man's day. As with the Passenger Pigeon (*Ectopistes migratorius*), this species is now only a part of history. Except for a few museum specimens, the only records remaining of these delightful birds are in the vigorous prose of numerous diaries kept by people who saw them.

Widmann (1907:113–116) wrote a good account of the parakeet in Missouri. I have summarized his findings in each region of the state, for his important work is no longer freely available. Otherwise, all reports have been arranged chronologically for each region of the state. Records for marginal counties of states bordering Missouri have been included, to make the picture as complete as possible.

French explorers recorded the earliest observations on parakeets in the Missouri area, but some of their reports are too general to be precisely placed; others apply to the bird in a general way in all its range. Many such interesting reports, besides the ones I have used, may be consulted in Wright's valuable historical review (1912).

Two general comments by early geographers are interesting, for they indicate something of the attention parakeets had from hardheaded pioneers and something of the status of the parakeets in the lore of the day. Alphonso Wetmore (1837:30–31) wrote in the 1830's: "The paroquet found in Missouri deserves notice, as peculiar in character and attractive in its plumage. This is a bird strongly resembling the green parrot in colour and form; and it is reported of them, that at night they repose within the cavity of a hollow tree, hanging by their curved Roman nose-beaks. This report may require confirmation." Just previous to Wetmore, Schoolcraft, in a list of Missouri birds, wrote (1819:37): "The *parakeet* is a beautiful bird; it is a kind of parrot: its colours are green, yellow, and red, all bright colours, and it is a pleasing sight to see a flock of them suddenly wheel in the atmosphere, and light upon a tree: their gaudy colours are reflected in the sun with the brilliance of the rainbow: they are a noisy bird, but their notes are disagreeable." It is not clear to what extent Schoolcraft based his description upon personal observations or information collected in Missouri, for the only place on his 1818–1819 trip that he specifically mentioned seeing the birds was on the Mississippi River, above Brazeau ("Obrazo") Creek, July 16, 1818: "We frequently meet the paroquet on the banks of the river, and have passed

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[1] Contribution from The Missouri Cooperative Wildlife Research Unit, Columbia.

several large flocks to-day. This is a kind of parrot, a beautiful bird, which is very common in Louisiana, Missouri, and Kentucky" (*ibid.*:232).

MISSISSIPPI VALLEY

Some of the early Mississippi Valley observations summarized here undoubtedly were meant to apply to either or both banks of the river. In July, 1673, Joliet wrote (Thwaites, 1896–1901, 58:99) that near the mouth of the Illinois River, "Parroquets fly in flocks of 10 to 12." And the same summer, above the mouth of the St. Francis River (Tennessee side?), he remarked: "We killed a little parroquet, one half of whose head was red, The other half and The neck yellow, and The whole body green" (*ibid.*, 59:149–151). Charlevoix thought the parakeets he saw on the Illinois River (north-central Illinois) in September, 1721, only stragglers at that time of year, although he stated that on the Mississippi they were found at all seasons (Charlevoix, 1923, 2:189–190). That this was true, at least for the winter as far north as Quincy, Illinois (opposite Marion–Lewis county line, Missouri), is suggested by a trader's reminiscences of 1800–01: "The long Winter, from November until Spring, had to be worn out: and I did my share of rambling with my gun, shooting paroquets, picking and eating pecans, and breaking through the ice with narrow escapes" (Anderson, 1882:149). From nearby Pike County, Illinois, came the assertion, undated as to season but probably referring to the 1830's, that "Of the parrot . . . there are great numbers . . ." (Burlend, 1936:98).

Other Mississippi River records can be considered winter observations. Probably referring to his 1810 visit to Missouri (if a first-hand observation), Nuttall (1832:546) wrote that the parakeet was "so far hardy as to make its appearance, commonly in the depth of winter, along the woody banks of the Ohio . . . and Mississippi and Missouri around St. Louis . . . when nearly all other birds have migrated." On the Ohio, just above its mouth, Audubon found parakeets in December, 1810 (Audubon, 1942:152): "The large sycamores with white bark formed a lively contrast with the canes beneath them; and the thousands of parroquets, that came to roost in their hollow trunks at night, were to me objects of interest and curiosity."

The distribution of the parakeet in the Mississippi Valley seemed to be well known, for Drake (1815:118–119) described the bird as resident "constantly along the Mississippi, Ohio, and their tributary rivers, as far north as 39°30′, and is seen occasionally up to 42°."

Not far from the place where Schoolcraft saw parakeets in July, 1818 (quoted above), Peale (1946–47:157) noted on June 2, 1819, when just above Cape Girardeau, that "parrakeets are still to be seen." About the same time, Estwick Evans (1819:306), presumably referring to the Tennessee shore, but in the latitude of southeastern Missouri, told of the geese, ducks, and swans that he saw in the Mississippi where "numerous paroquets occupy the trees on its banks. . . . they go in flocks, and their notes are rapid, harsh, and incessant. It is remarkable, that this bird is subject to a disease resembling apoplexy." (The possibility of "apoplexy" is not too remote; see the interesting account of "Doodles," the pet Carolina Parakeet belonging to Paul Bartsch (1952).)

Paul-Wilhelm (1835:145; Bek transl., page 155) saw parakeets in the deep woods at the mouth of the Ohio in April, 1823 (Illinois side); their cries were rivaled by the noise of five species of woodpeckers.

Timothy Flint recorded several personal observations on parakeets during his descent of the Ohio in 1816, just before his travels in the Missouri region began. Toward the lower end of the Ohio he remarked how his "children contemplated with unsated curiosity the flocks of parroquets fluttering among the trees, when we came near the shore" (Flint, 1826:84). And of the Mississippi Valley, he wrote (1828, 1:108; 1832, 1:71–72):

> This is a bird of the parrot class, seen from latitude 40° to the gulf of Mexico. Its food is the fruit of the sycamore, and its retreat in the hollow of that tree; and is a very voracious bird, preying on . . . all kinds of fruit. They fly in large flocks, and are seen in greatest numbers before a storm, or a great change in the weather. They have hooked, ivory bills, a splendid mixture of burnished gilding and green on their heads, and their bodies are a soft, and yet brilliant green. Their cry, as they are flying, is shrill and discordant. They are said to perch, by hanging by their bill to a branch. When they are taken, they make battle, and their hooked bill pounces into the flesh of their enemy. They are very annoying to fruit orchards, and in this respect a great scourge to the farmer. We have seen no bird of the size, with plumage so brilliant; and they impart a singular magnificance to the forest prospect, as they are seen darting through the foliage, and among the white branches of the sycamore.

Esthetically, this view is hard to reconcile with Flint's bald statement (1828, 2:73), in reference to Missouri: "The beautiful parroquet frequents the sycamore bottoms, and poorly compensates by the extreme beauty of its plumage for the injury it does the orchard and garden fruits."

Flint's sentiment on the destructiveness of parakeets was echoed by John Mason Peck (1831:50), who discussed the birds of the central Mississippi Valley: "the paroquette, with its fine plumage, annoys the orchards and gardens"; but he later modified his stand somewhat (Peck, 1853:34): "It annoys the orchards by eating the fruit . . . but its favorite food is the seeds of the cocklebur, which it devours greedily. And. . . . it may be the farmer receives as much benefit in the destruction of this annoying weed as will compensate the loss of his apples."

On the Mississippi, above the Ohio, in March, 1833, Maximilian saw "trees quite covered with these beautiful birds" (Wied, 1857:104). It was also in this region that a Lutheran pioneer, on his way to establish a colony in Missouri in the winter of 1838–39, saw parakeets (Graebner, 1919:14). Eifrig placed the event either in Kentucky or in Mississippi County, Missouri, since it is not clear which side of the river the man was on. While on a hunt on "a large and beautiful farm," a party "hunted a small species of Parrot, of which many were killed. They made a savory dish" (Eifrig, 1929). Baird (1858:68) listed an undated specimen from Cairo, Illinois, just across the Mississippi from southeastern Missouri, presented to the National Museum by Kennicott. Pindar (1925:86) heard that parakeets were occasional visitors to Fulton County, Kentucky, at the mouth of the Ohio, until 1878. Since relatively little is known of the parakeet in the Mississippi Valley above St. Louis (other than observations of Anderson and Burlend already quoted), it is worth remarking that Smith and Parmalee (1955:36) report, on the authority of T. E. Musselman, a sight record of a flock of parakeets in Adams County, Illinois, about mid-April, 1884. That is a late date for that area.

Northern Missouri

North Missouri records for the parakeet are few. Widmann (1907:115) quoted the observations of Hoy who found the birds numerous in Grand River Valley, Livingstone County, in May, 1854 (Hoy, 1865). Trippe heard in 1872 that flocks of the birds had been known in extreme southern Iowa (Decatur County), but was not able to learn exact dates (Trippe, 1873:233).

Missouri Valley

Among early travelers on the Missouri River who recorded parakeets. Widmann cited Townsend (1839:131), who saw them at Boonville, April 8, 1834; Wied (in the German edition of his Travels, 1839–41, 1:261, 263, 272–273), who reported them from Boonville westward in April, 1833, and near St. Charles in May, 1834 (*ibid.*, 2:361); Audubon (Audubon and Coues, 1898, 1:468, 469, 470, 476; 2:173), who saw several flocks and collected some birds in May and again in October, 1843; Hoy (1865), who killed one parakeet April 21, 1854, at Boonville; and Hayden (1862:154), who supplied general information on the species in the lower Missouri as a whole for 1855–57. Widmann also presented previously unpublished records from Platte County, where the last birds were seen in the early 1850's; from Warren County, where the last report was 1867; and Franklin County, where the last known date was 1865. From the Missouri Valley, also, came one of Widmann's last reports of the parakeet: Atchison County, Kansas, across the Missouri River from Platte County, in 1904 (Widmann, 1907:116).

Lewis and Clark saw the parakeet in 1804. Clark noted in his journal June 26 at the mouth of the Kansas River: "I observed a great number of Parrot queets this evening" (Lewis and Clark, 1904, 1:59). And a note by Clark (*ibid.*, 6:122) said: "*Parotqueet* is seen as high as the Mahar

[Omaha Indian] Village"—that is, to near the present town of Homer, Dakota County, Nebraska (Swenk, 1934:55).

The next record that I have is the substantial contribution of Peale, who ascended the Missouri with the Long expedition in the summer of 1819. He "heard the cries of a flock of parrakeets" when only a short distance up the Missouri River on June 1. Traveling overland north of the Missouri, near the end of June, in St. Charles or Montgomery County, he wrote: "In what few bottoms we have come through we saw turkeys and heard the screech of parrakeets." Parakeets abounded in the "buttonwood" (sycamore) forests on Loutre Island in the Missouri at the Montgomery–Warren County line, and they were still "numerous" near Cedar creek at the Callaway–Boone County line, Franklin, Howard County, and near Ft. Osage (now Sibley, Jackson County) (Peale, 1946–47:162, 267, 268, 270, 273, 275, 282). Peale reached Ft. Osage on August 1.

Paul-Wilhelm, an observant German nobleman, walked and paddled up the Missouri Valley in the summer of 1823. Just before reaching the Gasconade River, June 1, he noted (1835:221; Bek transl., p. 234): "For several days I had hardly heard the song of a single wild bird. Only the piercing cries of flocks of restless parrots and the occasional hammering of a red-headed woodpecker broke the deathlike silence." About the middle of June, he walked opposite Tabo Creek (that is, in Carroll or Ray County) (*ibid.*:254; Bek transl., p. 268): "The great amount of game, especially the great number of turkeys, and the sight of countless birds, especially the great flocks of parrots, as also the splendid luxuriant trees, together with the incomparable fragrance of the linden trees in full bloom, all these things would have repaid me amply for the strenuous foot-journey, if my attention had not been diverted in a painful manner by countless insects." By the end of June, Paul-Wilhelm (*ibid.*:246; Bek, p. 279) was above Ft. Osage when he observed: "Both banks are low, and the left was very sparsely settled. I do not recall ever having seen so many parrots in one place. When I shot one of these from a tree on which hundreds of these birds were sitting, the others did not fly away, but only made a horrible noise. The same is true if they sight a bird of prey. The flesh of these parrots is tough and black. Fish like it, however, and so it is used for bait." Parakeets were also seen (*ibid.*:274; Bek transl., p. 289) above Little Platte River, Platte County, and "great flocks" of them were seen near present St. Joseph in mid-July (*ibid.*:278; Bek transl., p. 294).

Duden saw parakeets in the winter of 1825, in Warren County; but in his letters of two years' residence, he mentioned them only once. They were destructive in orchards, he wrote a friend; "in particular, they hurl themselves in swarms upon apples" (Duden, 1829:93). It is not plain if he based his statement of their destructiveness on personal observation. There is another record of the species from the same region at that time, for Bernhard saw several parakeets in the forests of "large and very thick sycamores" near St. Charles in April, 1826 (Bernhard, 1828, 2:99).

Beginning the decade of the 1830's, Ferris saw parakeets just west of Franklin in February, 1830 (Ferris, 1940:10): "Near the village we met with innumerable flocks of paroquets . . . whose beautiful plumage of green and gold flashed above us like an atmosphere of gems." J. T. Irving saw parakeets on the Missouri at Leavenworth in August, 1833 (Irving, 1955:25). They were plentiful at Independence in April, 1834 (Townsend, 1839:139); while, in June of the same year, Sir Charles Augustus Murray (1839, 1: 184), when just west of Leavenworth, exercised his fowling-piece upon the only feathered things present, "a small flock of green Perroquets." Unlike Paul-Wilhelm, he found them palatable. A species of parrot "that fly in droves" was reported from near Columbia about 1835 by the wife of the Boone County pioneer, Lenoir; ". . . they are not so large but their plumage brighter—we intend getting some to tame; if you can ketch one and handle it some it will not leave you" (Atherton, 1943–44:290). Count Arese saw several flocks of parakeets in the Ft. Leavenworth–St. Joseph area in summer, 1837 (Arese, 1934:67).

In a remarkably beautiful tribute to the parakeets that had "ceased to come to central Missouri since many years," Gert Goebel, a German immigrant, wrote of the species in early Franklin County. I feel that the account deserves full quotation (from Goebel, 1877; Bek transl., 1919–25, 16:549–550):

> Until the later thirties great flocks of paroquets came into our region every fall and frequently remained till the following spring. They were a small variety, about the size of a dove. They were bright green in color, and their heads were orange colored. These flocks of paroquets were a real ornament to the trees stripped of their foliage in the winter. The sight was particularly attractive, when such a flock of several hundred had settled on a big sycamore, when the bright green color of the birds was in such marked contrast with the white bark of the trees, and when the sun shone brightly upon these inhabited tree tops, the many yellow heads looked like so many candles.
>
> This sight always reminded me vividly of a kind of Christmas tree, which was used by the poorer families in my native city [Germany]. A few weeks before Christmas a young birch tree was set in a pail of water. In the warm room it soon began to produce delicate leaves. When on Christmas eve such a tree was decorated with gilded and silvered nuts and with apples and candies, it did not look unlike one of these bird-covered tree tops, only these enormous Christmas trees of the forest looked vastly more imposing than the little birch in the warm room.
>
> As the settlements increased and the forests were more and more cleared away, these birds ceased to come. The few old settlers of the days, when the paroquets frequented these parts, feel just as little at home as those beautiful birds did; they long for peace and quiet, whether above the earth or beneath, it does not matter.

(It is interesting that Bek, editor and translator of Goebel and Duden, was impressed by Goebel's eloquent testimony; he had considered Duden's remarks on parakeets [cited above] as a flight of the latter's Romantic imagination: Bek had lived 30 years in Missouri without seeing any parakeets! [Bek, 1919–25, 16:550].)

On the Missouri Valley trip in 1843, Audubon gave but casual attention to parakeets in Missouri. On May 7 and 8, 1843, near the northwestern corner of the state, he wrote in his journal (Audubon and Coues, 1898, 1: 476): "Indigo birds [*Passerina cyanea*] and Parrakeets plentiful. . . . We saw Parrakeets and many small birds, but nothing new or very rare." Parakeets and Indigo Buntings in the same breath! (Widmann notices some other Audubon references.) In his journal of the Audubon trip, Edward Harris (1951:55) noted that the first parakeets were seen at Boonville, April 29 (not Independence, where the first ones were killed [Audubon and Coues, 1898, 1:468]). The Harris group is reported to have procured 13 parakeets on the trip upriver and eight on the passage down the Missouri; of these, 10 apparently fell to Harris as his share (Harris, 1951:207, 210, 211). This must refer only to parakeets preserved as museum specimen skins, for Audubon wrote that at least 17 parakeets were killed near St. Joseph on May 4 (Audubon and Coues, 1898, 1:470).

J. N. Baskett, while unfortunately giving no specific records, summed up the situation for about 1850 (Lewis and Clark, 1904, 6:122): "The parroquet has now practically been exterminated throughout the West; but it was found in abundance in the region of Jefferson City, Missouri (and probably even farther down the river), up to the middle of the nineteenth century." (This was written about 1900.)

There are two records of the parakeet from central and western Missouri in the 1850's that bear out Baskett's statement. Bruff wrote, on April 21, 1849, a short distance above Jefferson City: "We wooded, on the right bank Paroquets numerous" (Bruff, 1949:5). Baird (1858:68) listed the 12 specimens of parakeets collected by Warren and Hayden (Hayden, 1862:154) on April 24 and 25, 1856, on or near "Bald Island," Nebraska, near Atchison County (Swenk, 1934:56). In this area, near Brownsville, Nemaha County, Nebraska, an abundance of parakeets still survived a few years later: "I remember one season some young men raised a hundred or more of them for sale, sending them to other states. During the year 1866, or thereabout, they all suddenly disappeared, and never since to my knowledge have been seen. . . . Their nesting places were in the hollows of old trees on the island referred to" (about 10 miles above Brownsville) (Furnas, 1902). This report is probably the nearest approach to a genuine nesting record for the Carolina Parakeet in the Missouri region.

From central Missouri, where the parakeet had been so often seen in the 1820's and 1830's, a correspondent informed Cooke (1888:124) that they were still present at Fayette in 1884–85, but were nearly extinct. The species was included in 1883 without comment in the contemporary fauna of Howard and Chariton counties (Anon., 1883:389–390). (Of some 70 county and other regional Missouri histories that I have examined, this and the confused parakeet reference in the Dunklin County history [Smyth-Davis, 1896] listed elsewhere are the only accounts of the parakeet that I found [McKinley, 1960].)

The bird had been abundant at one time about Kansas City, according to Harris (1919:270). He recorded a specimen then in the Kansas City Public Library, taken by Bryant in 1894, and remarked further: "In some unaccountable manner a lone bird strayed into the Courtney [Jackson County] bottoms in 1912 and was observed by Bush for several weeks before it finally disappeared" (*ibid.*). If the latter record is correct (and Bush seems to have been an active and reliable naturalist), it is the last date, by several years, for the parakeet in Missouri. The American Ornithologists' Union (1957: 267) cautiously lists this as "possibly an escaped cage bird," but mentions as the last reported kill for the region a parakeet taken opposite Platte County, at Potter, Atchison County, Kansas, in August, 1904 (see Widmann, 1907: 116; Remsburg, 1906; and Anon., 1906).

Southern Missouri

The parakeet is mentioned only once in the county histories of southern Missouri (actually, this relatively poor section of the state has had few histories written on its counties); that is a puzzling reference to the bird at an early date in Dunklin County (Smyth-Davis, 1896:25). That parakeets did occur in that area is confirmed by Featherstonhaugh's observations made in early November, 1834, while he was in what is now Butler County. He saw the first cane (*Arundinaria*), and then remarked: "We had also other indications of a Southern latitude here: small flocks of parroquets were wheeling and screaming about in the bright sun, and showing their brilliant colours to the greatest advantage" (Featherstonhaugh, 1844:83).

In May, 1840, Tixier (1940:106) saw huge flocks of parakeets in the "points" of forest along prairie streams between Independence and Harrisonville in western Missouri. Later, in August, he saw them near the mouth of the Osage, as he returned by boat down that river to St. Louis (*ibid.*:279). He was by then in fairly well settled, cleared land along the Osage River.

Widmann (1907:116) reported Merriam's second-hand record from Stone County in the autumn of 1891 (Merriam, 1892). Both the map of Hasbrouck (1891) and Butler's distribution data (1892:53) indicated that the Oklahoma population of parakeets reached almost to or quite into Missouri in the early 1890's. Nice (1931:101–102) listed several reports for northeastern Okla-

TABLE 1

RECORDS OF THE CAROLINA PARAKEET IN MISSOURI

Occurrences recorded by month		Occurrences recorded only by season	
January	0		
February	1	Spring	1
March	1	Summer	7
April	8	Autumn	2
May	4	Winter	5
June	6	"All Seasons"	2
July	4		
August	3	Occurrences for which there are no specific seasonal data	
September	0		
October	1	13	
November	1		
December	1		

homa, but she had, however, no specific records from counties bordering Missouri. Widmann reported a final sight record from Stone County, Missouri, in July, 1905 (Widmann, 1907:116).

DISCUSSION AND SUMMARY

There is no lack of reliable, even eloquent, testimony on the abundance of the Carolina Parakeet in Missouri, at least for the broad river-bottom forests along the Mississippi and Missouri rivers. Travelers who saw no other creatures (or, if they did, thought them unworthy of their journals) wrote of the magnificence of flocks of parakeets they saw in the state, both in winter and in summer (spring and summer records predominate: see Table 1). A pioneer woman wrote about them in her letters; a German settler cherished their memory; preachers dwelt on their beauty. They were certainly common into the 1840's; Audubon's party shot them without concern in 1843. Widmann gave the 1850's as the decade of the last common flocks in Missouri, but there were some later congregations, apparently even colonial nestings, in the region into the 1860's (Furnas). Probably the last Missouri specimen of which there is record was taken at Kansas City in 1894, but there were sight records in or near Missouri for 1904, 1905, and 1912. No nests were recorded from Missouri, although several observers claimed in a general way that sycamore trees were used for both nesting and roosting. Furnas's account is the best nesting record for the region, I believe.

The birds' passing is a mystery. They were undoubtedly held in disfavor for their destruction of fruit, but that point ought not to be overemphasized. They never appeared on a bounty list, and they were almost totally ignored in the county histories. Surely, if they were ever a scourge to agriculture, their names would have appeared more commonly on the pages of these two records of materialism and manifest destiny. Some were probably shot for food or other uses, but the number could not have been great. More often, perhaps, they were shot because they furnished an easy, returning target. Primeval numbers of parakeets are not easy to guess at: they were noisy, colorful, and conspicuous birds that went about in flocks; the extent of their wanderings is not known. That is, probably anyone with an eye for birds would see them; and, if they wandered very much, one flock might be seen by people in different areas. Perhaps they had a liking for the kind of habitat created by man, at least for purposes of feeding; if so, the lack of a general sentiment in pioneer society for their protection may have been their downfall. The possibility that disease was responsible cannot be ruled out, but except for a suggestion of "apoplexy," I have no evidence for it.

Since parakeets used hollow trees for roosting and nesting, there may have been connections between the disappearance of the birds and the wholesale cutting of "bee trees." The European honey bee barely preceded the American white man in invading the central parts of America, and it became extremely abundant within a short time. I am convinced, by numerous references collected during a search through early literature, that the magnitude of destruction of hollow trees by "bee hunters" in search of honey and wax is little appreciated. What effect, if any, that had on the parakeet is unknown. Perhaps the bees themselves discouraged nesting and roosting flocks of parakeets. Reasons for their decline are made doubly difficult to evaluate by the lack of knowledge of the breeding biology, habitat, and social requirements of the species.

Excellent reviews of the parakeet in Oklahoma (Nice, 1931) and Nebraska (Swenk, 1934) have been published. Nothing has been added to parakeet literature in Kansas since the time of Goss (1891). In Iowa and Illinois the relatively scanty material can be found in Anderson (1907), DuMont (1933), Cory (1909), and Smith and Parmalee (1955). The best review of the bird in early Arkansas is in Howell's paper (1911). The collected records for Kentucky and Tennessee so far published are not exhaustive and much remains to be done in the case of Illinois, Arkansas, and Kansas.

Acknowledgments

This study has been rewritten from part of a master's thesis, "A Wildlife Chronology for Missouri." It is an attempt to bring together for naturalists the many scattered historical records on the Carolina Parakeet. I wish to thank William H. Elder and Thomas S. Baskett, Missouri Cooperative Wildlife Research Unit, University of Missouri, for advice and encouragement, and to record my indebtedness to three helpful librarians: Ann Todd Rubey, University of Missouri; Sarah Guitar, Missouri State Historical Society, Columbia; and Norman L. Ford, Josselyn Van Tyne Memorial Library, University of Michigan, Ann Arbor.

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BIOLOGY DEPARTMENT, SALEM COLLEGE, WINSTON-SALEM, NORTH CAROLINA, OCTOBER 7, 1959

GENERAL NOTES

Nests of Lesser Swallow-tailed Swift in México.—Prior to Edwards' (1959. *Auk.* 76:358–359) discovery of an occupied nest on the trunk of a tree at Tikal, Guatemala, the Lesser Swallow-tailed Swift (*Panyptila cayennensis*), north of Honduras, was known only from a bird taken at Presidio, Veracruz, México, in June, 1943 (Moore. 1947. *Proc. Biol. Soc. Wash.*, 60:143–144). Edwards' note appeared shortly after I had submitted the following related observation made some 160 miles from Tikal, but in Mexico. These developments fulfill Moore's expectation and suggest that the Veracruz specimen may not represent a disjunct population.

On July 24, 1958, at Palenque Ruins, Chiapas, Mexico, elevation about 800 feet, I found a remarkable nest under the portico of the Temple of Inscriptions. From my sketch and notes made on the scene, I have been informed that it was a nest of *P. cayennensis.*

The nest, about 18 inches long, was fastened on the corbeled wall some 12 feet above the floor. Only the upper one-third, about 6 inches in diameter, was attached. The remainder, consisting of slender entrance tubing, hung vertically free. Honey-colored and rough-textured, it seemed to be made entirely of long-tailed achenes that glistened. A torn place in the top, however, exposed numerous small feathers.

This swift, known to nest in buildings, makes either a straight tube, or one with a bulbous top. The Palenque nest was of the latter type. Essentially, it fitted accounts given by Richmond (1898. *Auk*, 15:7–10), Haverschmidt (1954. *Wilson Bull.*, 66:67–69; 1958. *Auk*, 75:121–130), Sick (1958. *Auk*, 75:217–220), and others, except that the free-hanging entrance tube was bifurcated.

Beneath its bulbous top, the nest tapered before branching into two nearly parallel tubes forming the lower third of the structure. Both orifices were smooth inside, between two and three inches in diameter, and perfectly round. The left tube was about two inches shorter than its mate, with a slight outward tilt. It seemed possible that both tubes were functional, rather than the shorter one's being a "false entrance," such as Salvin (1863. *Proc. Zool. Soc. London*, p. 191) shows for the Great Swallow-tailed Swift (*P. sancti-hieronymi*). They were nearly equal in diameter and emerged symmetrically; whereas, in Salvin's drawing the "false entrance" is quite short, appearing as an inverted, open pocket midway on the outside of a long, six-inch-wide tubular nest.

I saw a second nest (badly damaged and apparently single-tubed) high on a wall inside the ground floor of the nearby Observatory ruin. The caretaker, attributing such nests to "swallows now gone for the season," voluntarily remarked that these birds had built in the ruins in previous years also.

Deploring destruction of nests of this rare Mexican bird, Sr. Miguel Alvarez del Toro, Instituto de Ciencias Naturales de Chiapas, is conferring with authorities toward ending an abuse that is doubly distressing, since, according to Haverschmidt (1954. *op. cit.*: 68–69), a nest may be used for more than one season.—Lovie M. Whitaker, *1204 West Brooks Street, Norman, Oklahoma, July 29, 1959.*

Ross Goose taken at Horseshoe Lake, Illinois.—While undertaking research dealing with Canada Geese (*Branta canadensis*) in the area of Horseshoe Lake, Alexander County, Illinois, during the fall of 1956, two small white geese were repeatedly seen on and near the refuge. Very few Snow Geese (*Chen hyperborea*) were in the area that season and none was reported killed. On November 26, one of the two small white geese was killed by a hunter and given to me for mounting. It was a Ross Goose (*Chen rossii*) in full adult plumage but the sex was not determined. The accompanying bird was similar in size to the bird collected but had typical grey juvenal plumage.

The following measurements were taken from the skin: culmen 39 mm., total length 572 mm., wingspan 1376 mm., and tarsus 69 mm. The mounted bird is in my collection at Campbell, Missouri.

In searching the literature for reports of Ross Geese in the Mississippi Valley the following were found. Texas: one killed and two others sighted in Wharton County, winter 1954 (Miller, 1954. *Condor*, 56:132); one was taken in Jefferson County, December, 1953, and another killed on Lissie Prairie near Eagle Lake, January 3, 1954 (Buller, 1955. *Auk*, 72:298). Louisiana: one taken on Little Vermilion Bay, February 23, 1910 (McAtee, 1910. *Auk*, 27:338); one taken in Cameron Parish, 1916 (Arthur, 1931. Birds of La., Dept. of Conservation Bulletin No. 20, p. 126). Kansas: one seen in Wyandotte County, November 22, 1951 (Tordoff, 1956. Checklist of Birds of Kansas, Univ. of Kansas Publications—Museum of Nat. History, 8(5):314). Missouri: Mike Milonski, manager of the Busch Wildlife Area, Weldon Springs, Missouri, remembers one taken by his brother while hunting on the Mississippi River near St. Louis about ten years ago.—GLEN SMART, *Missouri Cooperative Wildlife Research Unit, Columbia, Missouri, July 14, 1959.*

Comment on the flight distance of the Great Blue Heron.—Orr and Sudia (1960. *Wilson Bull.*, 72:198), measured the flight distance of Great Blue Herons (*Ardea herodias*) at Lake Itasca, Minnesota. They report considerable variation of this flushing distance among what are assumed to be different individuals. Variation was not so great between successive flushes of the same individual.

Probably these authors are not aware of the fact that many herons in Itasca Park have become quite tame. The park is a sanctuary, and firearms have been prohibited, except during deer seasons, for many years. Very little molesting of wild animals occurs here. As a result, some herons have found that human occupants of boats are not to be feared but are in fact to be welcomed because dead yellow perch (*Perca flavescens*) found around fishing boats represent an easily obtained food supply. In the past 15 years I have always found at Lake Itasca several herons which have adopted the habit of alighting on shore near fishing boats or circling near to look for perch. Sometimes two or three will keep watch at the same time. We always keep some perch in the boat to throw out for them. Typically, the heron flies out to the dead fish, settles down in the water, leisurely picks up and swallows the fish, then struggles into flight and goes back to shore to watch again from a vantage point on a tree, stub, log in the water, or just the ground. Sometimes the fish is carried to the shore before being swallowed, and then it is usually washed down with a few sips of water. One heron may accept several perch in succession. If the fish is not thrown far enough away from the boat, it may be ignored or the heron may fly out and shy away more than once before returning to shore. Presumably not all the herons present on the lake have learned this method of obtaining food.

As Orr and Sudia state, marked individuals should be used in determining flight distance. In addition, such work should be carried on where unusual tameness is not a factor.—WM. H. LONGLEY, *Kasson, Minnesota, July 14, 1960.*

Additional notes on the singing height of Ovenbirds.—Stenger and Falls (1959. *Wilson Bull.*, 71:125–140) recently presented data on utilized territory of the Ovenbirds (*Seiurus aurocapillus*) of Algonquin Park, Ontario, in a variety of habitats. These data include measurements of the stratum (height) from which nine males sang (singing height or song perch). A study now in progress at the William Hutcheson Memorial Forest, a mature oak forest on the Piedmont of New Jersey, offers some additional data for comparison. Forty-eight censuses to date, 30 during June and July of 1958, 10 in June, 1959, and others in April and May, 1959, have included observations of the singing height of at least 30 territorial males each year in the 63 acres of the forest. Stenger and Falls report that their birds sang from the lower branches of the canopy of each forest studied, which would be at heights of somewhat less than 45, 50, 55, or 85 feet according to the type of forest (Stenger and Falls, *op. cit.*, Table 1), and they observed that the height of song perches was proportional to the height of the canopy. At Hutcheson Forest, where the canopy is from 50 to 95 feet high, only 3 per cent of the singing males utilized sub-canopy perches. The majority, 71 per cent, of song perches were in the understory which is primarily of dogwood, 10 to 35 feet high. A few records (16%) show singing birds utilizing shrub or herbaceous perches. Evidently in this old oak forest, canopy height is not as important as it is in the aspen, conifer-birch, or maple-beech of Algonquin Park. Stenger and Falls indicate that in effect the Ovenbirds sang just below the densest layer of the forest canopy. Some interpretation is necessary here for Table 1 of Stenger and Falls (*ibid.*) indicates the "lower canopy" in the maple forest is the densest (85 per cent coverage at 35 feet, median values) rather than the "upper canopy," and this would then place Ovenbird singing height at near 35 feet rather than just under 85 feet, the former figure then being close to that observed at Hutcheson Forest. At any rate, singing height, or song perches at Hutcheson Forest is not as clearly related to density as in the Ontario forests, for both the dogwood understory and the oak canopy are essentially continuous, except in the area of windthrows, yet the birds utilize the lower continuous understory rather than the dense oak canopy. Territorial size does not seem to be related to height of song perches as the former is less variable than the latter, a fact in agreement with the findings of Stenger and Falls. Perhaps neither density or height of vegetation per se is a significant variable in determining singing height, though some factor operating as a consequence of density, for example, the extent of territory visible to the bird, may be involved. Certainly more data are needed on height of activity of this and other woodland species.—JEFF SWINEBROAD, *Department of Biological Sciences, Douglass College, Rutgers University, New Brunswick, New Jersey, July 7, 1959.*

Courting dance of the Whip-poor-will.—One dark night I was listening to a Whip-poor-will (*Caprimulgus vociferus*). He was very close but I could not see him. Suddenly his song stopped and a buzzing sound took its place, much as if a mechanical toy were running down. I could not imagine any bird making such a sound. I heard no more song and feared some animal had caught the bird.

Then came the summer of 1947, when a Whip-poor-will sang every night from my porch roof, his song often punctuated by the buzzing. On June 14, I stationed myself at a window opening onto the roof. It did not seem quite as dark as usual, or perhaps he sang a little earlier. There he was, almost on a level with me and not more than three feet away. I could see him very clearly, and watched his every move.

His actions as he sang reminded me of an opera singer. He turned to the left, sang *whip-poor-will*, faced the front, repeated it, and then sang it again facing right. He did this for several minutes, turning after each *whip-poor-will.* Suddenly his song stopped. He spread his wings and tail, and thrust his head forward and down. Seeming to use his head as a pivot, he turned around and around, all the time making the mechanical buzzing sound with which I had become familiar. In the increasing darkness I could not see another bird, but I feel there must have been a female nearby watching, and that

I had observed the courtship dance of the Whip-poor-will. This dance differed markedly from the courtship dance and behavior described by others, as quoted by Bent (1940. U.S. Natl. Mus., Bull. 176:164–165).—Margaret F. Fuller, *Route 2, Frazeysburg, Ohio, August 5, 1959.*

Black Vulture extends breeding range northward.—Raymond W. Smith, reporting in 1891 the breeding of the Black Vulture (*Coragyps atratus*) in Warren County, Ohio, wrote (*Cin. Soc. Nat. Hist. Jour.*, 14:113), "This is, I think, the northernmost record of this vulture breeding, and the first record of its breeding in the state." Edward S. Thomas, having found a nest in Hocking County, Ohio, in 1923, wrote (1928. Ohio State Mus. Sci. Bull., Vol. 1, No. 1), "This seems to be the northernmost breeding record of the species in Ohio, possibly in the United States." This Hocking County site has remained the most northern location of the species reported breeding in Ohio until the present record of a nest identified by us on July 26, 1959, in the northeast corner of Licking County, about one mile south of the Knox County line in Ohio, and about 45 miles north of the Hocking County location.

Of the records of the advance northward of this species in its breeding range in the United States, the one nearest to the Licking County site is that of April, 1952, near Gettysburg, Pennsylvania, which is apparently about 30 miles south of this new nest (Grube, 1953. *Wilson Bull.*, 65:119).

The present nest contained two eggs when discovered on July 1, 1959, a late date for a Black Vulture's nesting. The nest lacked positive identification until July 26, when we saw two nestlings covered with the tan down distinctive of the young of the Black Vulture, while an adult Black Vulture perched 15 feet away. The nestlings were estimated to be about two days old.

The finding of this nest is verification of earlier indications of the nesting of this species in this region. Greider, who has been watching birds here since 1942, first saw one or two Black Vultures from time to time in the summer of 1952, and the birds have been seen here in small numbers every summer since. Wagner reported observations in the area from 1955 to 1958 (*Aud. Field Notes*, 9:381; 10:144, 254, 387; 12:260, 282).

We have data on the food of the adults and on the appearance and behavior of the nestlings as they have grown. These details (and photographs) are available for anyone interested.

On August 22, 1959, the young birds remained at or near the spot where they were hatched. This is in an open area roughly 10 feet by 40 feet framed by boulders, and at the top of a ridge covered with fairly dense small second growth. This area is about six feet below the level of the ground above. The location is in the hilly unglaciated country of the Allegheny Plateau at the foothills of the Appalachians.—Marie Greider, *61 North 24th Street, Newark, Ohio,* and Elizabeth Sidwell Wagner, *Utica, Ohio, August 25, 1959.*

ORNITHOLOGICAL NEWS

A conference on the potential role of birds in the epidemiology of certain viruses affecting man was held at the National Institutes of Health on April 4, 1960. The purpose was to bring ornithologists and virologists together in a joint effort to suggest solutions for these problems. A result of the discussions was recognition that many ornithological aspects need more research. For example, dates of arrival and of departure, number of migrants, distribution in South America and in southern United States, and also several physiological aspects are important problems that ornithologists might explore in more detail. The Public Health Service supports basic research that often has intrinsic ornithological value. Information about applications for grants may be obtained from: Research Grants Division, U.S. Public Health Service, Bethesda 14, Maryland. The ornithologists present at the conference were David E. Davis, Pennsylvania State University, University Park, Pennsylvania; Allan Duvall, Patuxent Research Refuge, Laurel, Maryland; William W. H. Gunn, Ontario Society of Naturalists, Toronto, Canada; and Herbert Friedmann, U.S. National Museum, Washington 25, D.C.

Thirteen 2″ × 2″ color transparencies, used by Mr. H. W. Kale to illustrate his paper on the Worthington's Long-billed Marsh Wren on Saturday morning, May 7, 1960, at Gatlinburg, Tennessee, are missing. Several of the slides were aerial photographs, two were of a young wren, and the others were of tables showing mortality, population density, etc.

If anyone can help Mr. Kale locate his slides, please do so. His address is: The University of Georgia Marine Institute, Sapelo Island, Georgia.

JOSSELYN VAN TYNE MEMORIAL LIBRARY

The following gifts have been recently received. From:

American Museum of Natural History—9 pamphlets, 8 reprints
Holly Reed Bennett—10 books, 20 journals, 6 reprints
Andrew J. Berger—1 reprint
C. T. Black—1 journal, 17 pamphlets, 157 reprints
William H. Burt—5 reprints
L. L. Dice—6 journals, 12 reprints
J. C. George—18 reprints
Charles Hartshorne—5 reprints
C. Stuart Houston—1 book
University of Kansas Museum of Natural History—1 journal
Leon Kelso—1 journal, 3 translations
Owen A. Knorr—1 journal
T. Lebret—1 reprint
Daniel McKinley—1 journal, 24 reprints
Harold F. Mayfield—9 journals, 4 pamphlets, 9 reprints
Margaret M. Nice—2 pamphlets, 23 reprints
D. F. Owen—2 reprints
Carl D. Riggs—4 reprints
Saskatchewan Museum of Natural History—17 reprints
Walter E. Scott—1 reprint
Robert K. Selander—4 reprints
J. Murray Speirs—1 reprint
O. A. Stevens—12 journals, 15 reprints
Texas Ornithological Society—55 newsletters
Heather Thorpe—1 pamphlet
Harrison B. Tordoff—2 journals
Charles Walker—2 reprints
L. H. Walkinshaw—1 translation
Wisconsin Conservation Department—1 pamphlet
University of Wisconsin Agricultural Experiment Station—3 reprints
H. E. Wolters—1 reprint

ORNITHOLOGICAL LITERATURE

Bent's Life Histories of North American Birds. Two volumes. Edited and abridged by Henry Hill Collins, Jr. Harper & Brothers, New York, 1960: 8¼ × 5¼ in. Vol. 1 (Water Birds), xxviii + 356 pp.; vol. 2 (Land Birds), x + 374 pp. $5.95 per volume.

These are not life histories. They are not "the best of Arthur Cleveland Bent's monumental work on the birds of North America, abridged for convenient reading and reference," as the dust jackets proclaim. Bent's work was monumental because it was complete. Perhaps I have misunderstood the real meaning of "abridge." Consulting my dictionary, I find three definitions. The third is "to deprive; cut off." The publishers are eminently correct in using the word only if they refer to this category.

Volume 1 contains an introduction, a section entitled "Notes," which describes the editor's treatment of the original Bent material, a page of acknowledgments (and here Mr. Collins is called the "author"), a reprint of the "In Memoriam: Arthur Cleveland Bent," by Wendell Taber, which was published in the October, 1955, *Auk*, the individual species accounts from Gaviiformes through Charadriiformes, a bibliography, and a geographical and general index. Volume 2 contains further notes and acknowledgments, species accounts from the Columbiformes through the Passeriformes except the Fringillidae, the largest family in North America, and concludes with a bibliography, brief biographies of some of the contributors to Bent, and the two indices. While all serious ornithologists know that the Fringillidae are still to come in the Bent series, there is no mention on the dust jacket that this publication omits this family. One has to delve into the introductory remarks for the information.

What constitutes a life history? Mr. Bent, in the introduction to his first volume on diving birds, says, "After a few introductory remarks where these seem desirable, the life history of each species is written in substantially the following sequence: Spring migration, courtship, nesting habits, eggs, young, sequence of plumages to maturity, seasonal molts, feeding habits, flight, swimming and diving habits, vocal powers, behavior, enemies, fall migration, and winter habits."

One comparison will suffice. The first species in the Collins books is the Common Loon (*Gavia immer*). Mr. Collins devotes a page to it. One-quarter is delightful atmosphere by Bent and the remainder is a quotation describing early morning actions of a family of loons. Yet Mr. Bent devotes over eleven pages to habits under the following subtitles: spring, nesting, eggs, young, plumages, food, behavior, fall, and winter. In addition, there are two pages of photographs and one and a half of distribution records, with spring and fall migration dates from localities throughout the range of the species and egg dates.

The publishers say these volumes make the "essence" of Bent available in convenient form. How can the essence of a life history be boiled down from a dozen pages to one? The "essence," in these volumes, is the one trait in each species which the editor has decided is the most characteristic or interesting. Yet these are called life histories! The publishers further say that "This careful abridgment brings together the best of Bent for easy reference and reading. It uses full excerpts, not condensations." I find condensations in the text and totally inadequate references. I find on the back flap of the Volume 2 jacket that "John Burroughs writes from his Hudson cabin," yet under Burroughs in the bibliography are listed two books with no page references. Similarly, Olin Sewall Pettingill is listed there as having contributed his field notes, yet, under Pettingill, there are no specific references whatsoever.

One claim of the publishers is correct. These volumes do include some of the best of the prose which Mr. Bent used so beautifully. Had the publishers entitled this abstract something which more truly described the contents, I would have no quarrel. But apparently they have deliberately chosen a misleading title and have misrepresented the contents upon the dust jackets. It is high time that reputable publishers stopped trading on old and honored book titles for the sale of their merchandise.—PHILLIPS B. STREET.

Tan Vat Road
Locust, New Jersey
23 May 1960

Dr. Olin Sewall Pettingill, Jr.
c/o The Editor
The Wilson Bulletin
Kalamazoo College
Kalamazoo, Michigan

Dear Dr. Pettingill:

I am writing in reply to your review of the *Complete Field Guide to American Wildlife*, by Henry Hill Collins, Jr., published by Harper & Brothers (*The Wilson Bulletin*, March 1960, vol. 72, No. 1, pp. 109–111), in which you malign both my work and character.

I note with interest that your accusations are somewhat all-encompassing: of Harper & Brothers, you say, "the same page makeup, the same use of boldface and italic type, range maps . . . as in Peterson-Mountfort-Hollom's *Field Guide* . . ."and of Collins, "he has strived . . . to pull together between two covers as much material . . . from currently successful guides . . ." I note too you fail to name the members of the Editorial Advisory Board listed in the book. They seem to be important men in their fields; I know that they are regarded as such. I also know—and I have copious letters to prove so—that the illustrations of mine which you criticize were reviewed by the chairman of this board, corrected, and, finally, passed. I would in no way infer that the comparative quality of these illustrations reflects on those who passed them, but I am confident that plagiarism is an absurdity.

For myself, I unequivocally deny having plagiarized, or "copied from" anyone. I did, indeed, consult many authorities and have been greatly influenced by them. I used every resource, including the well-represented collection of bird skins at the American Museum of Natural History as well as studies from life and innumerable books. I will answer your accusations in terms of your reference:

Figure 7 (Collins) compared with page 10 (Peterson)

First of all, any artist not doing his own book must act under the direction of that which the supplied text demands. The artist may or may not argue certain points, but in the end his work is specifically described. In this case my directions were, "Double-crested cormorant, in silhouette, to size; one sitting, one swimming, one standing." I suggested another, standing in the spread-eagled position. My instructions were (not unreasonably) to consult, in particular, two closely competitive field guides, Peterson's and Pough's (Eckelberry), in order to check thoroughly against possible errors (which would, of course, be rechecked by competent authorities upon completion of my work). My resulting silhouette illustration does closely resemble Dr. Peterson's page 10 illustration. I certainly did check Dr. Peterson's illustration and text, noting that the elevation of the bills on my birds did approximate the angle which Dr. Peterson, as a foremost authority, gave his. There are only so many poses suitable for field identification, and in this type of work he would be a poor artist who placed artistic cleverness over common logic. Beyond that, these birds are very familiar to me.

As to your criticism, consider my position at the time: (1) I had before me Dr. Peterson's drawing, and others, which I had been advised to compare; (2) I had to work in silhouette because that was what was demanded of me; (3) I should not violate one of the rules (where possible) of book illustrations, that is, to face the subject away from the center line. You see the result, and you call it "copied." I did, as you see, face my sitting bird "in," as did Peterson, and the spread-eagled bird is the same. As you have in another sketch, you can accuse me of having "turned the swimming bird around." But what of the flying bird? And the water is, you must agree, of a different nature than is Dr. Peterson's. If "to copy" is to have four birds made from three, perhaps you are right.

Figure 26 (Collins) compared with page 67 (Peterson)

Here we have much the same problem: how to keep it from being "like Peterson." I will agree with you in this case. My turkey vulture shows a nearly identical resemblance to Dr. Peterson's. I can assure you that my "copying" was inadvertent. My effort at combining these types of flight, obviously my own effort, went unmentioned.

All of the raptorial birds shown, with the exception of the peregrine and marsh hawk, are commonly found near my home, and four of them, including the bald eagle, have nested less than a half mile away within the past year.

Figure 45 (Collins) compared with page 162 (Peterson)

You say "here and there the artist has simply rearranged the subjects and made minor alterations," giving the swallows as a case in point. I reiterate: it was not my book and I was simply following instructions: "arranged on a wire." If this should sound in any way an excuse, I do not mean it to be. Personally, I liked the wire. My actual source of reference was a photograph of martins on a wire by Mr. Wharton Huber, in Stone's *Birds of Old Cape May*, vol. 2, p. 695. From that photograph I "stole" my idea of a slack wire. I did not (and *could* not) credit Mr. Huber. But I cannot help but think that Mr. Huber would not have minded.

Figures 14, 15, 19 and 20 (Collins) Ducks.

May I say here, first of all, that your statement, "He has taken pains to have all the ducks fly in the opposite direction," seems unnecessary when a quick inspection will clearly indicate that *all* the plates in Collins' book face the same direction, i.e., to the right.

As for the ducks themselves, they are, as are Dr. Peterson's, rendered in a wash technique. There is a great similarity, I will admit, but they were in no way "copied." By a simple juxtaposition I could easily have placed the mergansers on top, or in the middle of the plate. I could have mixed them with the pond ducks or designedly have altered the wing pattern from a uniform wing (as in Peterson) to varied poses of flight. I chose to do them the way they are seen. Again, they are portrayed according to specific instructions as to which bird was to be shown. And all of these species are well known to me in life.

Plate 6 (Collins) Herons.

I have no argument whatever with your statement that all of the "illustrations in color are amateurish in the extreme." That is your opinion. And your opinion that there was "no conscientious endeavor" on my part is also your own. Your statement about the male American Redstart is pertinent. My error is obvious. I can assure you that I made others, but most were corrected in time by Mr. Collins and his advisors. But again, your insinuation that I copied Don Eckelberry's "body attitudes and views" is abhorrent. There is no doubt at all that my American Bittern strongly resembles Mr. Eckelberry's (Plate 14, Pough). However, I believe you will encounter a surprising similarity between my own attempt and that of Fuertes (Plate 23, p. 242, *Birds of*

America). The "stake-driver" is a "back yard" bird to me; he lives in the swamp below my window. I hear him and I see him. I am well aware of the length of his toes and that they will often overlap. I have, in fact, a "stuffed" specimen of him. Notice, if you will, that the inner toes of my bittern *do not overlap.* I would challenge a jury to find, upon a close investigation, exactly who copied from whom.

In regard to the "body attitudes and view" of my green heron versus Mr. Eckelberry's, I again must call attention to Mr. Fuertes (Plate 23, p. 242, *Birds of America*). You will notice that my bird, however weak you may consider the rendering, is at least stepping out with some vigor, as he daily (in season) goes soberly up and down the narrow strip of beach below my lawn.

As to the Great Blue Heron, I agree that mine somewhat closely follows Mr. Eckelberry's. However, were Mr. Eckelberry's rendering, Fuertes', and my own compared minutely, one would find that there is a similarity between all three.

My point is that there is a right reason for drawing birds in the position in which they are seen because they are typical.

I have long admired Dr. Peterson's work. More recently, I have followed Mr. Eckelberry's work with consummate interest; he is, in my opinion, a truly fine artist. I have *learned* from these very gifted artists, not "copied." You will note that my adult night heron has a similar arrangement of crest feathers to that shown by Mr. Eckelberry. You will notice that Fuertes (and many others) also used it. Surely the bird itself is in no way similar, except for its species and age. If Mr. Eckelberry (or anyone else) should tell me that all poses and attitudes which he has ever used were entirely original and did in no way reflect either Audubon, Fuertes, others, or photographs other than his own, I should be frankly amazed. You gave just praise to Mr. Richard Ryan. Can it be truly said that Mr. Ryan personally tramped the ranges of his maps, or did he borrow competent information from other authorities? I would in no way argue about your conclusions as to the quality of my illustrations but I strenuously object to your manner of attack.

Your mention of credit where credit is due suggests to me that a dual justice might be rendered. If my art work under my name is legally proved to be all that you say, you can be assured that a second edition will bear a proper recognition of its sources. But in like manner I believe it not untoward to suggest that your attitude in this manner is not entirely without prejudice. I, too, from its first edition, have owned, used and cherished Roger Tory Peterson's *Field Guide to the Birds.* My name is also Peterson. I also paint birds. Perhaps you have not noted the similarities in name and circumstance. I can assure you that Harper & Brothers and Mr. Collins have been well aware of this similarity and have never considered using my name in a manner to in any way capitalize upon Dr. Peterson or his enviable reputation. I was chosen to do the Collins book not as an ornithologist (which I am not) but as an artist who has some familiarity with birds (which I am). I have never at any time knowingly exploited this similarity in names or circumstance between Dr. Peterson and myself.

There is no doubt that your harsh criticism of my work will do me professional injury. I would in no way demand a retraction of your opinions as to the quality of my work, but I believe you have overstepped your authority in rendering a judgment on morals. I should be content with the publication of this rebuttal in the *Wilson Bulletin* that your readers may have the opportunity of checking for themselves, point for point, reference for reference, and inclusive of all references, the accusations you have leveled against me.

Very truly yours,
S/ Russell Francis Peterson
Russell Francis Peterson

The Techniques of Drawing and Painting Wildlife. By Fredric Sweny. Reinhold Publishing Corporation, New York, 1959: 8½ by 10½ in., 144 pp., many illustrations in black and white and color. $10.00.

This book is an attractive, colorful, profusely illustrated guide which will probably prove stimulating to embryonic wildlife artists. The brevity and over-simplification of the text will perhaps unduly encourage young artists to go into the field under the false impression that it is a comparatively simple task to take the necessary steps to become a successful wildlife artist. Whether this is intentional or not, it probably will enhance the sales appeal for the publisher. The following understatement typifies this tendency: "The wildlife artist should first develop a thorough knowledge of the anatomy of animals, birds, and fish, their habitat and behavior, and then be very discerning in the use of that knowledge. A certain amount of field work will be necessary to achieve this informative background." Skimming so lightly over a lifetime of study and experience to gain "this informative background" impresses a naturalist as a bit misleading, to say the least. Perhaps this is legitimate, however, since the book purports to discuss *techniques* of wildlife illustrating.

Again the zoologist is a bit irritated to find the three major sections of the book entitled "Birds," "Fish," and "Animals." The author throughout the text erroneously uses the word "animal" as synonymous with "mammal," not recognizing the fact that birds and fishes are as much animals as are the mammals.

Mr. Sweny has a sweeping freedom in his sketching technique that is pleasing, and his use of gray paper with lampblack and opaque whites is very effective. I was pleased with his emphasis on abstract designs as basic to good completed paintings. His simplified anatomical drawings are good for a basic understanding of the action of different animals. However, rather serious errors appear, indicating that his observations of details are not always accurate. For example, on page 26 in the sketch of the lower aspect of a duck's wing feather arrangement, he demonstrates the impossible by correctly showing the posterior vanes of the primary flight feathers overlapping the anterior vanes, while viewed from above the same arrangement appears. Although partially explained on page 25, he apparently does not understand how the narrow stiff anterior vane overlies the wider weak posterior vane, thus giving the latter support on the down stroke while allowing the feathers to open up like check-valves on the up-beat. The Gadwall using the upper wing on page 26 would find his check-valves opening on his down-beat! On page 32 the feet of various species of birds fall far short of having the character they might due to the artist's failure to recognize the correct groupings of scutes or scales, especially at the junctions of the legs and toes and at the bases of the claws. Again, on page 112, the two halves of the deer hoof are incorrectly shown joined together at the posterior margin.

The mammal (animal) section has some very good action sketches of deer in various gaits; it goes into considerable detail in the terminology of bones and muscles; and carries a painting through all the steps that Mr. Sweny takes in completing a painting. As is often the case with artists, his completed paintings do not fulfill the promise displayed in his sketches.

It is interesting and informative to know what the oil painting procedures of Mr. Sweny are, what colors comprise his palette, the surface on which he chooses to paint, etc. It seems definitely limited, however, not to find any discussion of other materials, techniques, brushes, and canvases that other painters in oil might consider desirable. Furthermore, no mention is made of watercolor, pen and ink, gouache, and all the other techniques one might employ in wildlife drawing and painting. The elaborate table of contents and the index (5 pages of 3 columns each of closely-spaced type) are quite misleading as to the amount of information in the volume. In this it follows the modern trend of allowing pictures to carry the bulk of the book and reducing the informative text *ad absurdum.* In fact, this book might better be entitled "The Techniques of Fredric Sweny in Drawing and Painting of Wildlife."—W. J. BRECKENRIDGE.

INSTRUCTIONS TO YOUNG ORNITHOLOGISTS: BIRD BIOLOGY. By J. D. Macdonald. Museum Press Limited, London, 1959: 5½ × 8½ in., 128 pp., frontispiece, 16 pls., 20 figs., 2 tables. 12*s* 6*d* (about $1.75).

The author achieves admirably the stated purpose of this little book "to provide a brief outline of the whole life of birds" in order to satisfy the desire of bird watchers, young in years or young in the study of birds, for knowledge of birds in addition to that of identification. In a book of this size many subjects must be omitted. Twelve topics that have been included are: Preparation for Mating; Nests and Eggs and Family Care; Population; Migration; Distribution; Habitats and Adaptations; Adaptations for Flight; Feathers; Collecting and Digesting Food; Lungs and Heart; Other Anatomical Features; Variation and Evolution.

Writing is clear and concise. Previous training in biology is not necessary for understanding. Halftones and line drawings are of high quality. The table of bird weights on p. 81 may surprise readers when they learn how little birds in general weigh. The use of examples "biased in favour of British readers" lessens little the usefulness of the book to Americans.

This book should prove useful in the libraries of schools, teachers, and beginners in ornithology.—OSCAR M. ROOT.

A NATURAL HISTORY OF NEW YORK CITY. By John Kieran. Houghton Mifflin Company, Boston, 1959: 5¾ × 8¾ in., xvi + 428 pp., many drawings by Henry Bugbee Kane. $5.95.

With the publication of "A Natural History of New York City" we have another book devoted to wildlife in a great metropolis, and from an author qualified by nearly fifty years of residence. "London's Natural History" (Collins, London, 1945) was one of the first, if not the first, to take as its topic the fauna and flora of a huge city. Its author, R. S. R. Fitter, had always lived in London. "Unseen Life of New York: As a Naturalist Sees It" (Duell, Sloan and Pearce, New York; and Little, Brown and Company, Boston, 1953) by William Beebe was a more recent contribution along the same line. In all three books the authors set the stage by first giving an historical account of the setting (Dr. Beebe devoted over half of his book to the past), but from there on their methods of presentation diverge. Mr. Fitter proceeded to discuss the effects of smoke, trade, traffic, etc. on wildlife. Dr. Beebe, under such chapter headings as "Too Small To Be Seen," and "Too Clear To Be Seen" chose to discourse entertainingly and at length on a few creatures to the exclusion of many others. Mr. Kieran, however, has undertaken to show *how* and *where* wildlife exists in a metropolitan environment. His task has been a formidable one for he has attempted to discuss *all* forms of life from plankton and protozoa. His purpose is to interest people, not to provide a compendium of information. New Yorkers and others with a fondness for the great city will relish the many personal reminiscences based on a half century of nature-walking seldom beyond the view of tall buildings. In the two chapters on birds, one-fifth of the book, the author is more at ease and loquacious, for he is dealing with his favorite subjects. Ornithologists will be interested particularly in the way such birds as the Peregrine Falcon have adjusted themselves to the world of skyscrapers. The sensitive lithographs by Henry Bugbee Kane greatly complement the text.—OLIN SEWALL PETTINGILL, JR.

PROCEEDINGS OF THE FORTY-FIRST ANNUAL MEETING

BY AARON M. BAGG, SECRETARY

The Forty-first Annual Meeting of the Wilson Ornithological Society was held at Gatlinburg, Tennessee, from Thursday, May 5, to Sunday, May 8, 1960. The meeting was sponsored by the Knoxville Chapter of the Tennessee Ornithological Society. The local Committee, under the energetic direction of Mrs. Robert A. Monroe, Chairman, and Paul Pardue and David Highbaugh, Co-Chairmen, was most efficient in organizing a truly excellent meeting, to the interest and enjoyment of the 332 registered members and guests who attended.

Four sessions were devoted to papers, and two business meetings were held, all in the Huff House. The meeting opened with an informal reception there on Thursday evening, when Arthur Stupka showed slides of the Great Smoky Mountains National Park. Thursday evening was also the occasion for the meeting of the Executive Council, at the Mountain View Hotel. On Friday evening, the Knoxville Chapter of the T. O. S. presented an informal showing of movies and slides in the Huff House. The Annual Dinner was held on Saturday evening at the Mountain View Hotel, with Lawrence H. Walkinshaw presenting the President's Address. This was followed by an excellent color film, *Four Seasons at Hawk Mountain,* presented by Maurice Broun, in the Huff House. The Local Committee had decorated the tables attractively, at the dinner, with a souvenir pewter reproduction of the Dogwood flower at each place setting.

Early-morning field trips were scheduled for Friday and Saturday. On Sunday, members could choose among field trips to Andrews Bald, Newfound Gap, and Clingman's Dome, as well as other parts of the Great Smoky Mountains National Park.

First Business Session

President Walkinshaw called the meeting to order at 9 a.m., Friday, May 6. Mr. Paul Pardue, President of the Tennessee Ornithological Society, welcomed the members and guests of the Wilson Ornithological Society. President Walkinshaw responded on behalf of the Society.

The Proceedings of the Fortieth Annual Meeting were approved as published in *The Wilson Bulletin* for September, 1959.

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 voted to accept the invitation of the Federation of Ontario Naturalists, the Audubon Society of Canada, and the Royal Ontario Museum, to the Wilson Society, to hold its 1961 meeting at Britannia Lodge, in the Muskoka District of Ontario, June 8–11, 1961.
2. The Council instructed the secretary to proceed with arrangements for the 1962 Wilson Society meeting to be held at Purdue University, in Indiana, sometime in April, 1962.
3. The Council approved the suggestion that the possibilities of an early-May, 1963, Wilson Society meeting in Charleston, S. C., be explored.
4. The Council re-elected 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 Treasurer for 1959

General Fund

Balance as shown by last report, dated December 31, 1958 (Includes $103.27 in reserve for Library Fund)			$ 4,474.70
RECEIPTS			
Dues:			
Active memberships	$5,267.50		
Sustaining memberships	939.00	$6,206.50	
Subscriptions to *The Wilson Bulletin*		997.09	
Sale of back issues and reprints of *The Wilson Bulletin*		273.61	
Interest and dividends on savings and investments		592.98	
Gifts		6.00	
Miscellaneous		141.54	8,217.72
Total receipts			$12,692.42
DISBURSEMENTS			
The Wilson Bulletin (printing and engraving)		$6,414.03	
The Wilson Bulletin (mailing and maintentance of mailing list)		788.62	
Treasurer's expense (printing, postage, safe deposit box and transfer of records)		376.81	
Back issue expense (reprinting and postage)		51.49	
Committee expense (Membership and Endowment)		47.19	
Annual Meeting expense		251.76	
International Council for Bird Protection (for membership in 1958 and 1959)		50.00	
Josselyn Van Tyne Memorial Library book fund (to separate account)		103.27	
Louis Agassiz Fuertes Research Fund (to separate account, Council action)		175.00	
Miscellaneous		128.74	
Total disbursements			$ 8,386.91
Balance on hand in First National Bank, State College, Pennsylvania, December 31, 1959			$ 4,305.51

Josselyn Van Tyne Memorial Library Book Fund

RECEIPTS		
Reserve in General Fund (to separate account)	$ 103.27	
Sale of duplicates and gifts	288.10	
Total receipts		$ 391.37
DISBURSEMENTS		
Purchase of books	$ 107.96	$ 107.96
Balance on hand in First National Bank, State College, Pennsylvania, December 31, 1959		$ 283.41

Louis Agassiz Fuertes Research Fund

RECEIPTS		
Transfer from General Fund (to separate account, Council action)	$ 175.00	
Gift	50.00	
Total receipts		$ 225.00

DISBURSEMENTS

None		
Balance on hand in First National Bank, State College, Pennsylvania, December 31, 1959		$ 225.00

ENDOWMENT FUND

Balance in Savings Account as shown by last report, dated December 31, 1958		$ 1,120.58
RECEIPTS		
Life Membership payments	$2,165.00	
Patron Roger Tory Peterson	400.00	
Patron Mrs. Herbert Carnes	400.00	
Patron R. M. Strong (anonymous donor)	500.00	
Redemption of U.S. Savings Bonds	6,194.25	
Stock dividends received (included below):		
3 shares Massachusetts Investors Trust		
17½ shares Fireman's Fund Insurance		
Total receipts		$10,779.83
DISBURSEMENTS		
Purchase of U.S. Treasury 4% Notes due May 1963 and U.S. Treasury 4% Bonds due October 1969	$ 7,003.85	
Balance in Savings Account, First National Bank, State College, Pennsylvania, December 31, 1959	3,775.98	
Total disbursements		$10,779.83
SECURITIES OWNED		
$5,000 U.S. Treasury 4% Notes due May 15, 1963 at 96¾	$4,837.50	
$5,000 U.S. Treasury 4% Bonds due Oct. 1, 1969 at 94¼	4,712.50	
15 shares Kaiser Aluminum & Chemical Co. 4¾ cum. cvt. pfd. at 121	1,815.00	
391 shares Massachusetts Investors Trust at 13.94	5,450.54	
87½ shares Fireman's Fund Insurance at 51½	4,506.25	
25 shares Owens-Illinois Glass Co. 4% cum pfd. at 108¼	2,706.25	
(Securities listed at closing prices December 31, 1959)		
Total securities owned		$24,028.04
Total in Endowment Fund, December 31, 1959		$27,804.02

Respectfully submitted,
/s/ MERRILL WOOD
Treasurer

Research Grant Committee

Harvey I. Fisher, chairman, reported that his committee was fortunate this year in having "eight good candidates for the Grant." He added his belief that "notices published in our own *Bulletin*, as well as in *Auk* and *Condor*, called attention to the Louis Agassiz Fuertes Research Grant, and resulted in this fine response." The committee recommended that one grant of $100.00 be awarded to Mr. Robert T. Lynn, 1016 E. Arkansas, Norman, Oklahoma, to study "the comparative behavior of the Carolina and Bewick's wrens."

Membership Committee

Hazel Bradley Lory reported that, while she had no formal statement to make, the work of the committee was progressing and bearing fruit, for the membership of the Wilson Society now exceeds 1500, and for the second year in a row there has been a net gain in membership.

Library Committee

William A. Lunk, chairman, reported by letter as follows:

In the past year the Library Committee has functioned routinely, although without formal meetings during the period, and with a minimum of new business to transact.

No further action has been taken on adjusting the stocks of back issues. An increasing storage problem continues to exist, and eventually an official decision as to the wisest disposition of surpluses will have to be forthcoming. In the past, several possibilities have been discussed, but no conclusions reached.

Some of the surplus items set aside for sale are still available, and lists will be furnished on request to those interested. Money from book sales has gone to swell the library's New Book Fund, which in spite of recent purchases contains a current balance of some $280. There are always desiderata; but a substantial cash balance is desirable in the event that wanted books become available. Contributions to this fund are solicited, as are recommendations from any of the membership regarding specific items that might be acquired. Also, it is suggested that members wishing to make donations of individual items could contact the committee for appropriate suggestions.

Much credit is still due Norman Ford (Technical Aide, Bird Division, Museum of Zoology, University of Michigan) for his attendance to all routine business of the Josselyn Van Tyne Memorial Library. The close cooperation between the Wilson Ornithological Society and the Bird Division Library continues to work to mutual advantage.

The library is now regularly receiving 104 journals, 79 as exchanges and 25 as gifts. In addition, 73 separate donations have been received (including Mrs. Van Tyne's): 295 reprints, 122 books (110 of these from Mrs. Van Tyne), 49 journals, 29 pamphlets, 8 translations, and 23 color prints. Approximately 40 out-of-town loans, involving 120 items, were made during the year—and, as in the past, there was constant use of the material by persons on the campus or visiting.

The committee wishes to express appreciation for the continued support of the members, but to urge more general participation. Donations, whether of cash or books, requests for loans, and constructive suggestions, are all welcome.

Endowment Committee

Richard Zusi, chairman, reported by letter as follows:

This committee, at present comprising only the chairman, began functioning in December, 1959. At that time the most important task seemed to be to send letters soliciting Life Memberships before the members had paid their 1960 dues; consequently I did not take time to set up a committee. A committee will be set up in time to send letters before the next dues notices are mailed.

Life Memberships in the Wilson Ornithological Society on December 7, 1959, totaled 165, with an additional 4 patrons. Since that time there have been 12 new Life Members, 7 of whom have joined in response to my letters. I sent 102 letters between December 31 and January 13. Many members may already have paid their dues and decided to wait until next year to think about Life Membership, as several indicated to me.

All letters were typed individually, and a mimeographed list of Life Members was enclosed with each. Our thanks should be extended to Mrs. Jennie Boynton, secretary of the Zoology Department of the University of Maine, who did the secretarial work, refusing remuneration for it.

Temporary Committees

The President appointed the following temporary committees:

Auditing Committee

David E. Davis, Chairman
Dorothy Bordner
Ward Sharp

Nominating Committee

O. S. Pettingill, Jr., Chairman
John T. Emlen, Jr.
Burt L. Monroe

Resolutions Committee

Leonard C. Brecher, Chairman
Karl E. Bartel
W. D. Stull

SECOND BUSINESS SESSION

The final business session was called to order at 3:00 p.m., Saturday, May 7.

On motion duly made and seconded, the report of the Membership Committee was accepted, and the candidates were elected to membership in the Society.

Report of the Auditing Committee

The committee reported by letter that they had examined the books and accounts of the treasurer and had found them to be in excellent condition. The committee added that "the records are neatly kept and receipts and expenditures are posted promptly."

On motion duly made and seconded, the report of the Auditing Committee was accepted.

Report of the Resolutions Committee

Leonard C. Brecher, chairman, read the following report:

WHEREAS the Wilson Ornithological Society is in session at its Forty-first Annual Meeting in Gatlinburg, Tennessee,

BE IT RESOLVED that the Society express its appreciation to the Local Committee under the leadership of Mrs. Robert A. Monroe, Chairman, and Mr. Paul Pardue and Mr. David Highbaugh, Co-Chairmen, for the careful planning and organization which have 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 Knoxville Chapter of the Tennessee Ornithological Society for its hospitality in providing refreshments, transportation, and leadership for the field trips;

AND BE IT FURTHER RESOLVED that the Society thank the National Park Service, Mr. Fred Overly, Superintendent, Mr. Arthur Stupka, Naturalist, and other members of the park personnel for their cooperation in our use of the Great Smoky Mountains National Park;

AND BE IT FURTHER RESOLVED that the Society express its appreciation to Dr. Lawrence H. Walkinshaw for his devoted service during his two years of office as President of the Society;

AND BE IT FURTHER RESOLVED that our members continually alert their legislative representatives to the need of creating new—and maintaining present—wilderness areas and wildlife habitats, and for the necessity of having spraying programs approved by the Fish and Wildlife Service;

AND BE IT FURTHER RESOLVED that the members of the Society living near television towers be urged to organize and maintain suitable records of the quantities and species of the birds killed by impact with such towers, and see that such specimens are put to scientific use.

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, Harold F. Mayfield; First Vice-President, Phillips B. Street; Second Vice-President, Roger Tory Peterson; Secretary, Aaron M. Bagg; Treasurer, Merrill Wood; Elective Member of the Executive Council, Harvey I. Fisher (term expiring 1963).

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, May 6

1. Jack P. Hailman, Bethesda, Maryland. *A Field Study of the Mockingbird's Wing-flashing Behavior*, slides.
2. Frederick V. Hebard, Philadelphia, Pennsylvania. *The Origin and Nature of Feigning.*
3. John William Hardy, Museum of Natural History, University of Kansas. *Remarks on Social Behavior in the Orange-fronted Parrot,* Aratinga canicularis, slides, movies.
4. Kenneth C. Parkes, Carnegie Museum, Pittsburgh, Pennsylvania. *An Intergeneric Hybrid in the Family Pipridae.*
5. W. E. Clyde Todd, Carnegie Museum, Pittsburgh, Pennsylvania. *Audubon's Labrador Records.*

Symposium: *The Ecological Significance of Bird Weights.* (papers 6 through 10). Eugene P. Odum and Herbert L. Stoddard, presiding.

6. David W. Johnston, Wake Forest College, Winston-Salem, North Carolina. *Body Weights in Relation to Heart Weights in Birds.*
7. James Baird, Norman Bird Sanctuary, Midletown, Rhode Island. *Weights and Bird Banding with Special Reference to the Catbird.*
8. Carl W. Helms, Hatheway School of Conservation Education, South Lincoln, Massachusetts. *Weights and Winter Survival in Buntings.*
9. Clyde E. Connell, Valdosta State College and the University of Georgia. *The Significance of Fat-free Weights with Special Reference to the Savannah Sparrow.*
10. Eugene P. Odum, University of Georgia. *Flight Ranges of Some Migrating Birds as Calculated from Weights.*
11. Douglas James and Wayne James, University of Arkansas, and Robert Frazer, Taunton High School, Massachusetts. *Nocturnal Orientation Independent of Stars,* slides.
12. Herbert L. Stoddard, Sr., Thomasville, Georgia. *Bird Casualties at a Florida TV Tower.*
13. Thomas W. Finucane, Kingsport, Tennessee. *The Fall Migration of Hawks across Tennessee,* slides.

Saturday, May 7

14. Charles H. Trost, Pennsylvania State University. *Pileated Woodpeckers in Captivity,* slides.

15. James T. Tanner, University of Tennessee. *The Stimuli for the Start of the Reproductive Season in Juncos*, slides.
16. Lester E. Eyer, Alma College, Alma, Michigan. *The Golden-winged Warbler at Itasca State Park, Minnesota*, slides.
17. Maurice Brooks, West Virginia University. *Swainson's Warbler in the Southern Appalachians.*
18. Herbert W. Kale, II, University of Georgia. *Population Ecology of Worthington's Marsh Wren* (Telmatodytes palustris griseus) *in Georgia's Salt Marshes*, slides.
19. Harold Mayfield, Waterville, Ohio. *Nest Success Calculated from Exposure*, slides.
20. Paul A. Stewart, U. S. Bureau of Sport Fisheries and Wildlife, Gadsden, Alabama. *Nesting Success of Birds Following a Field Application of Heptachlor*, slides.
21. William B. Robertson, Jr., Everglades National Park, Homestead, Florida. *The Bald Eagle Breeding Population of Southern Florida*, slides.
22. Edmund A. Hibbard, St. John's University, Collegeville, Minnesota. *Birds of the Missouri River Valley as Affected by the Garrison Dam in North Dakota*, slides.
23. David Kenneth Wetherbee, U. S. Fish and Wildlife Service, Mass. Coop. Wildlife Research Unit, Amherst, Massachusetts. *Comparative Embryonic Condition of Redwinged Blackbird and Other Species at Hatching*, slides.
24. Thomas A. Imhof, Alabama Department of Conservation, Fairfield, Alabama. *New Distributional Information from Alabama*, slides.
25. Maurice Broun, Hawk Mountain Sanctuary, Kempton, Pennsylvania, and John B. Holt, Jr., North Andover, Massachusetts. *Camera Studies of Nesting Hawks and Owls*, slides.
26. Donald J. Borror, Ohio State University, and William W. H. Gunn, Federation of Ontario Naturalists. *Songs of the White-throated Sparrow.*
27. Ben B. Coffey, Jr., Memphis, Tennessee. *Swift Flocks South of the Border.*
28. Harvey I. Fisher, Southern Illinois University. *The Avian Problem on Midway Atoll*, slides.

ATTENDANCE

Members and guests who registered totaled 332 persons. Twenty-eight states, plus Ontario, were represented.

From **Alabama**: 7—*Auburn*, Julian L. Dusi; *Birmingham*, Blanche H. Chapman, Blanche E. Dean; *Fairfield*, Thomas A. Imhof; *Gadsden*, Paul A. Stewart; *Huntsville*, Mr. and Mrs. James C. Robinson.

From **Arkansas**: 1—*Fayetteville*, Douglas James.

From **California**: 2—*Pasadena*, Dr. and Mrs. Robert L. Taylor.

From **Florida**: 7—*Daytona Beach*, Mr. and Mrs. C. H. Ekdahl; *Homestead*, Mr. and Mrs. Vernon C. Gilbert, William B. Robertson, Jr.; *Ormond Beach*, Jean M. Hudson, Roy D. Hudson.

From **Georgia**: 39—*Athens*, Herbert W. Kale, II, Eugene P. Odum; *Atlanta*, Orpha P. Baber, Ruth H. Gogel, Lida M. Mackenzie, Mrs. J. C. Oliver, Dr. and Mrs. Richard A. Parks; *Augusta*, J. Fred Denton; *Columbus*, Mr. and Mrs. L. A. Wells; *Dalton*, Hermon King, Maurine King, Mr. and Mrs. Ollie Munn; *Demorest*, Mrs. Charles Neal; *Griffin*, Dolly Brooks; *Macon*, M. Alma Cooke; *Marietta*, Manilla B. Land, Mrs. Marine W. Snow; *Milledgeville*, Katherine Weaver; *Mount Berry*, Alta Stevens; *Naylor*, Clyde E. Connell; *Pine Mountain*, Winslow M. Shaughnessy; *Rome*, Mrs. W. A. DuPre, Mrs. Ligon Henderson, Mrs. Wright King, Louise Nunnally, Virginia Starr; *Sandersville*, Mrs. Elizabeth P. Newsom, William Rawlings, Jr.; *Savannah*, Marjorie E. Canterberry, Mary E. Darby; *Thomaston*, Mrs. S. J. Carswell; *Thomas-*

ville, H. L. Stoddard, Sr.; *Warner Robins*, Mr. and Mrs. Thomas J. Cater, Jr.; *Waycross*, Eugene Cypert, Mrs. Eugene Cypert.

From **Illinois**: 18—*Blue Island*, Karl E. Bartel; *Carbondale*, Harvey I. Fisher, Mrs. Harvey I. Fisher; *Chicago*, Mrs. Amy G. Baldwin, Donna Finucane, Margaret Lehmann, Gerald B. Ryan, Paul A. Schulze; *Cicero*, Marcella Valenta; *DeKalb*, William E. Southern, Jerrold H. Zar; *Evergreen Park*, David Cobb; *Franklin Park*, William R. Stemke; *Lake Bluff*, Mr. and Mrs. Albert J. Zimmermann; *Momence*, Hazel Bradley Lory; *Urbana*, Mrs. Colleen Helgeson Nelson; *Willow Springs*, Floyd Swink.

From **Indiana**: 9—*Connersville*, Edna Banta; *Hanover*, Dan Webster; *Indianapolis*, Charles S. Berriman, III, Robert L. Dilts, Virginia-Rae Dilts, Betty Jean Moore; *Muncie*, Harold Zimmerman, Helen Zimmerman; *West Terre Haute*, Mrs. James H. Mason.

From **Iowa**: 3—*Davenport*, Mrs. Charles I. Hied, Peter Petersen, Jr., Mrs. Peter Petersen.

From **Kansas**: 2—Mr. and Mrs. John William Hardy.

From **Kentucky**: 12—*Anchorage*, Mr. and Mrs. Burt L. Monroe, Sr.; *Bowling Green*, Gordon Wilson; *Henderson*, Mr. and Mrs. William H. Rheade; *Louisville*, Leonard C. Brecher, Mrs. F. W. Stamm; *Madisonville*, James W. Hancock; *Paducah*, Esther Smith; *Princeton*, Cynthia Counce; *Winchester*, Mr. and Mrs. A. H. Mayfield.

From **Louisiana**: 9—*Baton Rouge*, Dr. and Mrs. George Lowery; *New Orleans*, Mrs. Dorothy M. Russell, Stephen M. Russell; *Shreveport*, Mrs. H. C. Hearne, Mrs. Ethel D. Jones, Horace H. Jeter; *Thibodaux*, Mrs. Electa Levi, Ava R. Tabor.

From **Maryland**: 6—*Easton*, Edith D. Adkins, Mrs. Walter S. Galloway, Dorothy Vernon Smith; *Garrett Park*, Clarence L. Buck; *Royal Oak*, Mrs. Catherine Bauer; *Towson*, Margaret Martin.

From **Massachusetts**: 3—*Dover*, Mr. and Mrs. Aaron M. Bagg; *Medford*, Marion Thiesfeldt.

From **Michigan**: 28—*Alma*, Dr. and Mrs. Lester E. Eyer; *Ann Arbor*, Dorothy Blanchard, Mr. and Mrs. Ralph M. Branch; *Battle Creek*, Dr. and Mrs. Lawrence H. Walkinshaw; *Grayling*, Mr. and Mrs. Fenn M. Holden; *Jackson*, Keith Arnold; *Kalamazoo*, Walter A. Ash, H. Lewis Batts, Jr., Jane Bell, Judith A. Centa, Eva Mae Eicher, Nancy Ericson, Monica Evans, Mary Ann Kahl, David Larson, Bob McLean, Mary Murch; *Lansing*, Mr. and Mrs. W. R. Freeman; *Leonard*, Mrs. Don S. Miller; *Marquette*, Mrs. Mary Spear Ross; *Midland*, Richard Koerker; *Mt. Pleasant*, Irene F. Jorae, JoAnn Coleman.

From **Minnesota**: 2—*Collegeville*, Edmund A. Hibbard; *Duluth*, P. B. Hofslund.

From **Mississippi**: 4—*Biloxi*, Dr. Carl B. De Forest; Vivian C. De Forest; *Crystal Springs*, Fannye A. Cook, Mai Brown.

From **North Carolina**: 1—*Winston-Salem*, David W. Johnston.

From **New Jersey**: 16—*Audubon*, Clarence E. Stasz; *Bound Brook*, Bertram G. Murray, Jr.; *Caldwell*, Kenneth Crowell; *Jamesburg*, Jeff Swinebroad; *Mountainside*, Mr. and Mrs. Albert Schnitzer; *New Brunswick*, Thomas C. Crebbs, R. Alan Lewis; *Orange*, Mrs. W. A. Wachenfeld; *Pompton Plains*, Mr. and Mrs. Frank P. Townsend; *Ramsey*, Mrs. J. Y. Dater; *Spotswood*, Mr. and Mrs. Stanley S. Dickerson; *Upper Montclair*, Mr. and Mrs. Frank P. Frazier.

From **New York**: 12—*Bronx*, Eva Sobol; *Brooklyn*, Peter C. Wolcott; *Buffalo*, Mr. and Mrs. Edward C. Ulrich; *Jacksonville*, Mr. and Mrs. Alfred T. Graham; *Jamestown*, O. G. Burgeson; *Mamaroneck*, Robert S. Arbib, Jr.; *New York City*, John K. Terres; *Niagara Falls*, Stuart Whitmire; *Williamsville*, Mr. and Mrs. Harold D. Mitchell.

From **Ohio**: 10—*Ashtabula*, Howard E. Blakeslee; *Cleveland*, Mildred Stewart; *Columbus*, Dr. and Mrs. Donald J. Borror; *Delaware*, Mr. and Mrs. William D. Stull; *Lakewood*, Mr. and Mrs. William A. Klamm; *Waterville*, Mr. and Mrs. Harold Mayfield.

From **Oklahoma**: 4—*Muskogee*, Forrest Bebb, Mr. and Mrs. M. R. Bebb, Mary P. Bebb.

From **Pennsylvania**: 18—*Beaver*, W. E. Clyde Todd; *Bethlehem*, Mr. and Mrs. Richard J. Kent; *Chester Springs*, Mr. and Mrs. Phillips B. Street; *Kempton*, Mr. and Mrs. Maurice Broun; *Lancaster*, K. B. Corbett; *Lock Haven*, George E. Grube; *Philadelphia*, Frederick V. Hebard, Daniel L. Hebard; *Pittsburgh*, Kenneth C. Parkes; *State College*, Earl R. Bordner, Mrs. Earl R. Bordner, Dorothy L. Bordner, Charles H. Trost; *University Park*, Mr. and Mrs. Merrill Wood.

From **Rhode Island**: 2—*Middletown*, James Baird; *Jamestown*, Mrs. Allan G. Davenport.

From **South Carolina**: 4—*Greenville*, Mr. and Mrs. George F. Townes; *Travelers Rest*, M. Ruth Gilreath, Lillie Hart.

From **Tennessee**: 90—*Chattanooga*, Mr. and Mrs. T. Stanley Barr, Ralph T. Bullard, Jr., Edith Fenn, Mabel Norman, Mr. and Mrs. Henry Sliger, Virginia Sliger, Mary Tunsberg, Mr. and Mrs. E. M. West; *Cookeville*, Beulah Clark, Mr. and Mrs. Ralph L. Dunckel, Caprice Haile; *Elizabethton*, Kenneth H. Dubke, Mr. and Mrs. Lee R. Herndon, Frank Ward; *Fountain City*, Bill Pardue, Martha Pardue, Pat Pardue, Paul Pardue, Tom Pardue; *Gatlinburg*, Elsie Janson, Mrs. Nelson B. Rue, Mr. and Mrs. Arthur Stupka; *Greeneville*, Mr. and Mrs. Richard Nevius, Helen K. White; *Jackson*, John A. Cheek, II; *Kingsport*, James Finucane, Joseph Finucane, Thomas Finucane; *Knoxville*, Tee Brichetto, Jessie Dempster, John Elson, Mary Enloe, Mr. and Mrs. Harold S. Garlinghouse, David Highbaugh, Joseph C. Howell, Mrs. Joseph C. Howell, Mr. and Mrs. William Johnson, Mr. and Mrs. J. T. Mengel, Mr. and Mrs. R. A. Monroe, J. B. Owen, Mrs. E. E. Overton, Mrs. Thomas Swindell, James T. Tanner, Doris Thomson, Mr. and Mrs. Samuel R. Tipton, Mr. and Mrs. George R. Wood; *Lebanon*, Martha Campbell, Dixon Merritt, Ruth Merritt; *Maryville*, Ralph Zaenglein; *Memphis*, Mr. and Mrs. Ben B. Coffey, Jr., Mary Davant, Mr. and Mrs. Henry A. Schiller, Alice Smith, Mrs. Arlo I. Smith; *Nashville*, Dr. and Mrs. O. C. Ault, Charles E. Farrell, Mary W. Frazer, Albert F. Ganier, Will Hon, John Ogden, Mr. and Mrs. Gene Ruhr; *Newport*, John N. Pattison; *Norris*, Mrs. Earl F. Olson; *Oak Ridge*, Lois Barclay, Mr. and Mrs. Robert J. Dunbar, Julia I. Moore; *Powell*, William F. Gallagher; *Smokie Heights*, Mr. and Mrs. W. Glynn Roehr; *Ten Mile*, Mrs. James Hlaunicka; *Williamsport*, Mrs. Katherine A. Goodpasture.

From **Virginia**: 7—*Bristol*, E. H. Dickey, Mr. and Mrs. H. M. Crosley; *Norfolk*, Mrs. Floy Burford, Mrs. J. D. Gregory, Mr. and Mrs. Jack P. Hailman.

From **West Virginia**: 5—*Huntington*, R. van Blaricom; Morgantown, Mr. and Mrs. Maurice Brooks, George R. Maxwell, II, Earl N. McCue.

From **Wisconsin**: 2—*Madison*, Judy Cooper; *West Bend*, Marvin E. Vore.

From **Wyoming**: 1—*Casper*, Mrs. Lucy Rongstald.

From **Ontario**: 2—*Pickering*, J. Murray Speirs; *Toronto*, William W. H. Gunn.

No Address: 6—Earl Bishop, Keith Blackmore, Ruth Castles, Mrs. J. H. McWhorter, Katheryn Paullus, Dan Schreiber.

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, R. 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), 218 Main St., Glenville, West Virginia	1959
Adams, William Hensley, Jr., Route 2, Madisonville, Tennessee	1951
*Adelson, Richard Henry, Remsen's Lane, RD 1, Oyster Bay, L.I., New York	1938
*Afsprung, Arthur E., 3308 Bishop St., Cincinnati 20, Ohio	1948
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
Allen, Arthur A(ugustus), Fernow Hall, Cornell University, Ithaca, New York	1914
Allen, Arthur W(esley), 561 Eastern Blvd., Watertown, New York	1959
Allen, Robert P(orter), Box 205, Tavernier, Florida	1947
Allen, Ted T(ipton), Dept. of Biology, Flint Hall, University of Florida, Gainesville, 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, 2639 N. 14th St., Milwaukee 6, 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, Sprit Lake, Saskatchewan, Canada	1957
Anderson, Anders H(arold), 3221 E. Kleindale Rd., Tucson, Arizona	1937
Anderson, Frank G., Dept. of Sociology, University of Maryland, College Park, Maryland	1951
Anderson, John M., R.R. 4, Winous Point Club, Port Clinton, Ohio	1938
†Annan, Ormsby, 715 Red Cedar Rd., Okemos, Michigan	1956
Anthes, Clarence A(lvin), 707 N. Moreland Blvd., Waukesha, Wisconsin	1939
Arbib, Robert S(imeon), Jr., 128 Lawn Terrace, Mamaroneck, New York	1947
Armington, Sven, Blanchegatan 18, Stockholm No., Sweden	1948
Armstrong, Edward T., 550 Avenue E, Bayonne, New Jersey	1960
*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
†Aronoff, Arthur Edward, Dept. of Zoology, University of Michigan, Ann Arbor, Michigan	1948
Ashton, Randolph, 800 Crown St., Morrisville, Pennsylvania	1941
*Atkeson, Thomas Zephaniah, P.O. Box 1643, Decatur, Alabama	1953
Austin, Mrs. Harold C., 1116 Mandana Rd., Oakland 10, California	1950
Austin, Oliver L(uther), Jr., 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 June 7, 1960

Babcock, Charles D., 36th St. and Woodland Ave., Reading, Pennsylvania 1959
Badger, Lester R., R.R. 1, Box 528, Excelsior, Minnesota 1957
Baepler, Donald H., Div. of Science & Mathematics, Central Washington College of Education, Ellensburg, Washington 1955
†Bagg, Aaron Moore, Farm Street, Dover, Massachusetts 1948
Bailey, Alfred Marshall, Museum of Natural History, City Park, Denver 6, Colorado 1928
*Bailey, Harold H(arris), Rockridge 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, Queens' Park at Bloor, Toronto 5, Ontario, Canada 1939
Baird, James, Norman Bird Sanctuary, Third Beach Road, Middletown, Rhode Island 1954
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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
Balsom, Mrs. Amos Parker, 2209 E. Stratford Court, Milwaukee 11, Wisconsin 1949
Banks, Clinton S(eeger), 202 Wilma Ave., Steubenville, Ohio 1945
Banks, Richard C(harles), Museum of Vertebrate Zoology, Berkeley 4, 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. and College Ave., Regina, Saskatchewan, Canada 1946
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
Barth, R. H., Jr., Biological Laboratories, Harvard University, Cambridge 38, Massachusetts 1957
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, Algona, Iowa 1936
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Bartsch, Paul, "Lebanon," Gunston Hall Rd., Lorton, Virginia 1894
Bastin, Eric W(alter), 43 Inglewood Dr., Apt. 2, Hamilton, Ontario, Canada 1951
Batchelder, Edgar M(arden), 56 Orchard St., Marblehead, Massachusetts 1941
*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, Jr., Route 2, Middletown, Delaware 1945
Baylor, L(eslie) M(ilton), 1302 South Fourth Ave., Pocatello, Idaho 1954
Beardsley, M(argaret) Hortense, 330 N. Chestnut St., Ravenna, Ohio 1941
Bebb, Forrest, 1300 Boston Ave., Muskogee, Oklahoma 1955
Bebb, Maurice R(obert), 1234 Fondulac St., Muskogee, Oklahoma 1955
Beddall, Mrs. Barbara G(ould), 2502 Bronson Rd., Fairfield, Connecticut 1958
Beecher, William J(ohn), Chicago Academy of Sciences, 2001 N. Clark St., Chicago 14, Illinois 1948
Beer, James R(obert), Dept. of Entomology and Econ. Zoology, University of Minnesota, St. Paul 1, Minnesota 1957
†Behle, William H(arroun), Dept. of Biology, University of Utah, Salt Lake City, 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. Surv., Agri. Research Center, Beltsville, Maryland 1946
Bell, Miriam, Toledo State Hospital, Toledo 3, Ohio 1958
Bellrose, Frank, Jr., Illinois Natural History Survey, Havana, Illinois 1935
Bender, Charles R(ichard), 364 Alex Hamilton, San Antonio 1, Texas 1960
*Bender, R. O., Coble's Mill Rd., Bridgeton, New Jersey 1957
Bennett, A. F., 800 South Minick, Denison, Texas 1955
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 E. MacArthur Rd., Milwaukee 17, Wisconsin 1953
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Berrett, Delwyn Green, Museum of Zoology, Louisiana State University, Baton Rouge 3, Louisiana 1959
Betts, Amelia J(eannette), Baldwin City, Kansas 1953
Betts, Mrs. Charles E., 1065 Madison Ave., Albany 8, New York 1959
Biaggi, Virgilio, Jr., College of Agriculture, Mayaguez, Puerto Rico 1945
Bibbee, P. C., Concord College, Athens, West Virginia 1958
Biddle, E. Turner, Leiters Ford, Indiana 1960
Binford, L(aurie) C(harles), Museum of Zoology, 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 Biology, University of Florida, Gainesville, Florida 1957
Black, Charles T(heodore), Route 1, Box 480, East Lansing, Michigan 1935
Blake, Charles H(enry), P.O. Box 613, Hillsboro, North Carolina 1950
Blake, Mrs. Grace S., 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
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Bliese, John C(arl) W(illiam), Dept. of Biology, Nebraska State Teachers College, Kearney, Nebraska 1951
Bock, Walter (Joseph), 7630-85 Drive, Woodhaven 21, New York 1953
Bodsworth, Fred, 294 Beech Ave., Toronto 8, Ontario, Canada 1956
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Bond, Richard M(arshall), Kings Hall, 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
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Bordner, Dorothy L., 926 W. Beaver Ave., State College, Pennsylvania 1959
Borell, Adrey Edwin, Soil Conservation Service, Building 50, Federal Center, Denver 25, Colorado 1936
Borror, Donald J(oyce), Dept. of Zoology and Entomology, Ohio State University, Columbus 10, Ohio 1927
Boughner, W. C., Claire Drive, R.D. 2, Somerville, New Jersey 1956
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Bourdo, Eric Albert, Jr., Ford Forestry Center, L'Anse, Michigan 1951
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Bower, Mrs. F. L., R.F.D. 1, Lee's Hill Rd., Basking Ridge, New Jersey 1954

Boyd, Elizabeth M(argaret), Mount Holyoke College, South Hadley, Massachusetts 1941
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Brady, Alan, RD 1, Bridgetown Pike, Langhorne, Pennsylvania 1959
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Brandes, K(enneth) W(illiam), 51 Stevens St., Wellsville, New York 1959
Brandt, John Henry, Tr. Terr. of Pacific Islands, Truk, E. Caroline Islands (via Guam) 1958
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Brewer, Richard Dean, Dept. of Biology, Western Michigan University, Kalamazoo, Michigan 1949
Brigham, Edward M(orris), Jr., Kingman Memorial Museum, Battle Creek, Michigan 1931
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Broadbrooks, Harold E(ugene), Southern Illinois University, Alton Residence Center, Alton, Illinois 1948
Brodkorb, Pierce, Dept. of Biology, University of Florida, Gainesville, Florida 1951
Brody, Gerald L(ee), Dept. of Pathology, University of Michigan Medical Center, Ann Arbor, Michigan 1954
Brooke, Mrs. Margaret, 126 - 51st St., Des Moines 12, Iowa 1958
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Broun, Maurice, Route 2, Kempton, Pennsylvania 1935
Brown, Jerram L., Museum of Vertebrate Zoology, Life Science Bldg., Berkeley 4, California 1950
Brown, John Warner, Oatka Farm, Scottsville, New York 1959
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Brown, N(orman) Rae, Faculty of Forestry, University of New Brunswick, Fredericton, New Brunswick, Canada 1945
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Brueggemann, Anna L(ouise), 584 Sheridan Ave., Columbus 9, Ohio 1943
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Buck, Mrs. J(ohn) P(aul), R.R. 1, Box 332, Hamlet, Indiana 1960
Buckland, George (Henry) (Edward), Box 343, Route 1, Batavia, New York 1949
Bucknell, Donald N(eedham), 134 Wonham, Ingersoll, Ontario, Canada 1953
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Bull, John L., 1148 Virginia St., Far Rockaway, New York 1952
Bullard, Ralph T., Jr., 5427 Slayton Ave., Chattanooga 10, Tennessee 1960
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Burner, Florence H(elen), 1336 Crofton Rd., Baltimore 12, Maryland 1948
Burnham, Gladys L(ou), Dept. of Biology, Clarendon Jr. College, Clarendon, Texas 1954
Burns, Robert David, Dept. of Zoology, University of Oklahoma, Norman, Oklahoma 1948
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Burton, Donald E(rnest), 171 Stratearn Rd., Toronto 10, Ontario, Canada 1953
Burtt, Benjamin P., 109 Haffenden Rd., Syracuse 10, New York 1956
Burtt, Harold E., 2163 N. Starr Ave., Columbus 21, Ohio 1953
Bushman, John, Ecological Research, University of Utah, Dugway, Utah 1951
*Butsch, Robert Sterns, Exhibit Museum, University of Michigan, Ann Arbor, Michigan 1947
Byers, Mrs. Esther, 2905 San Rafael, Tampa, Florida 1951
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, Bay City Junior College, Bay City, Michigan 1954
Calvert, Earl Wellington, RR 2, County Home, Lindsay, Ontario, Canada 1937
Calvin, Robert L(eal), RD 3, Pulaski Rd., New Castle, Pennsylvania 1951
Camp, Mrs. Dorothy I(rene), RD 1, Stuart Lake, Marshall, Michigan 1957
Campbell, Louis W(alker), 4531 Walker Ave., Toledo 12, Ohio 1926
Campbell, Mildred F(lorence), 29 N. Hawthorne Lane, Indianapolis 19, Indiana 1938
Cansfield, William Buck, Clear Lake School Camp, Dowling, Michigan 1958
Cantwell, Mrs. L. R. (Ida), R.D. 2, Mattoon, Illinois 1959
Cardinali, Mrs. Lillian E., Jolian Farm, RD 2, Box 460, Jamesburg, New Jersey 1958
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
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Carson, L(enwood) B(allard), 1306 Lincoln St., Topeka, Kansas 1948
Carter, Charles E(dward), 1339 - 30th St., Orlando, Florida 1958
Carter, Dennis (Lee), Wildlife Research Center, Denver Federal Center Bldg. 45, Denver 25, Colorado 1947
*Carter, Mrs. E. W., Route 2, Perrysburg, Ohio 1946
†Cartwright, Bertram William, c/o Ducks Unlimited (Canada), 201 Bank of Commerce Bldg., Winnipeg, Manitoba, Canada 1930
Cassel, J(oseph) Frank(lin), Dept. of Zoology, North Dakota Agricultural College, Fargo, North Dakota 1940
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 1262, Lynchburg, Virginia 1944
†Chalif, Edward Louis, 37 Barnsdale Rd., Short Hills, New Jersey 1947
Chamberlain, B(arnwell) Rhett, Route 1, Box 30, Matthews, North Carolina 1957
Chamberlaine, Lee B., 145 Dorwin Ave., Syracuse 5, New York 1957
Chambers, Glenn D., 110 Stephens Hall, Wildlife Bldg., University of Missouri, Columbia, Missouri 1959
*Chambers, W(illie) Lee, Route 1, Box 410, 830 Robinson Rd., Topanga, California 1909
Chaniot, George E., Jr., 1069 West Prairie, Decatur, Illinois 1956
Chapelle, Francis O(berlin), Quarters 15, West Point, 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 S. 19th St., Birmingham, Alabama 1953
Chapman, Herman Floraine, 712 South Dakota Ave., Sioux Falls, South Dakota 1947
Chapman, Lawrence B., R.F.D. Box 90, Hubbardston, Massachusetts 1940
Chase, Charles Greenough, Mere Place, R.D., Brunswich, Maine 1959
Chase, Theodore, Jr., Farm Street, Dover, Massachusetts 1960
Chell, Thomas Ross, 69 Hansen Dr., Bourbonnais, Illinois 1952
Chinery, D. J., 119 Kingsmead Ave., Worcester Park, Surrey, England 1959
Choate, Ernest A., 411 Rodman Ave., Jenkintown, Pennsylvania 1954
Chutter, Mildred C., Box 229, Athens, Ohio 1936
Clark, Mrs. Ben P., 2736 Hilltop Circle, Gadsden, Alabama 1952
Clark, George A(lfred), Jr., Peabody Museum of Natural History, Yale University, New Haven, Connecticut 1955
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Clement, Roland C(harles), 18 Senga Rd., South Norwalk, Connecticut 1941
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*Clow, Marion, Box 163, Lake Forest, Illinois 1929
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Coffey, Mrs. Lula C(ooper), 672 N. Belvedere, Memphis 7, Tennessee 1952
Coggeshall, Robert D., Billington Rd., East Aurora, New York 1956
Cogswell, Howard L(yman), Dept. of Biological Sciences, Mills College, Oakland 13, California 1944
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, University of California, Los Angeles 24, California 1956
Collins, Charles T(hompson), 337 West End Rd., South Orange, New Jersey 1959
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Conrad, Charles L(ouis), 137 N. 11th St., Wheeling, West Virginia 1937
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Cook, Fannye A(dine), 270 East Georgetown, Crystal Springs, Mississippi 1923
Cooke, Thomas Turner, 71 MacCulloch Ave., Morristown, New Jersey 1959
Coombes, Robert Armitage Hamilton, The Zoological Museum, Tring, Hertfordshire, England 1936
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Cottrille, W(illiam) Powell, 6075 Brown's Lake, Jackson, Michigan 1949
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Cox, George W., Vivarium Bldg., Wright and Healy Sts., Champaign, Illinois 1954
Coy, Roy E., St. Joseph Museum, St. Joseph, Missouri 1953
Crawford, Alan, Jr., White Horse Rd., Devon, Pennsylvania 1949
Creager, Joe C(lyde), L.A. Cann Rd., Drawer 1267, Ponca City, Oklahoma 1947
Crichton, Vincent, Chapleau, Ontario, Canada 1948
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Croft, Joseph E., 2366 Gladstone Ave., Louisville 5, Kentucky 1956
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Cuthbert, Nicholas L., 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, Dept. of Biology, Cornell University, Ithaca, New York	1957
*D'Angelo, Angelo (Ralph), 32 Hamilton Ave., Hasrouck Heights, New Jersey	1949
Daniels, Estrilla (Myrtle), 270 S. 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), Jr., Flicker Pt., Algonquin Park, Norfolk 5, Virginia	1943
Dater, Mrs. John Y., 259 Grove St., Ramsey, New Jersey	1949
Davant, Mary, 861 N. McLean Blvd., Memphis 7, Tennessee	1952
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Davidson, Mrs. W. F., 332 Summit Ave., St. Paul 2, Minnesota	1953
Davidson, William Mark, 1504 Bodell St., Orlando, Florida	1933
Davis, Clifford Vernon, Dept. of Zoology and Entomology, Montana State College, Bozeman, Montana	1945
Davis, David E(dward), Dept. of Zoology and Entomology, The Pennsylvania State University, University Park, Pennsylvania	1940
Davis, Jane S(trahan), 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 W. 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 N. 13th Ave., Phoenix, Arizona	1957
Dawn, Walter H(enry), 176 Wentworth St., Charleston, South Carolina	1945
Dean, Mrs. Blanche Evans, 2100 - 20th Ave., South, Birmingham 9, Alabama	1947
Dechen, Mrs. Lillian Orvetta, 14 Summer St., Port Dickinson, via Binghamton, New York	1939
Deck, 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, A. & M. College, College Station, Texas	1953
DeGroot, Dudley Sargent, Athletic Branch, S.A.D., USAREUR, APO 245, c/o Postmaster, New York, New York	1948
Dehner, Eugene W(illiam), St. Benedict's College, Atchison, Kansas	1944
†Delacour, Jean Theodore, Los Angeles County Museum, Exposition Park, Los Angeles 7, California	1944
Dempster, Rulon T., 1027 Edgmont Ave., Chester, Pennsylvania	1959
Denham, Reginald (Francis), 100 Central Park, South, New York 19, New York	1948
Denton, J(ames) Fred, 1510 Pendleton Rd., Augusta, Georgia	1935
de Schauensee, Rodolphe Meyer, Devon, Pennsylvania	1945
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*Devlin, Joseph M(ark), 218 S. 43rd St., Philadelphia 4, Pennsylvania	1953
Dexter, Ralph W., Dept. of Biology, Kent State University, Kent, Ohio	1958
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Dickerman, Robert W(illiam), Museum of Natural History, University of Minnesota, Minneapolis, Minnesota	1955
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*Dickerson, Mrs. Stanley S., 222 DeVoe Ave., Spotswood, New Jersey	1956
Dickinson, J(oshua) C(lifton), Dept. of Biology, University of Florida, Gainesville, Florida	1939
Dilger, William C., Laboratory of Ornithology, Cornell University, Ithaca, New York	1957
Dilts, Robert L., 5702 E. 38th St., Indianapolis 26, Indiana	1960
Dingle, Edward von Siebold, Huger, South Carolina	1921
Dixon, J(ames) B(enjamin), 2266 Cranston Dr., Escondido, California	1936
Dixon, Keith Lee, Dept. of Zoology, Utah State University, Logan, Utah	1946
†Doering, Hubert R., 242 E. Walton Pl., Chicago 11, Illinois	1945
Dogger, James R., Dept. of Entomology, North Dakota Agricultural College, Fargo, North Dakota	1954

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Duebbert, H(arold) F(ranklin), North Dakota Game and Fish Dept., Oaks, North Dakota 1957
Duffield, Mrs. John W., 1472 Eskridge Way, Olympia, Washington 1948
†Dugan, William Dunbar, 221 Pierce Ave., Hamburg, New York 1945
Duhke, Kenneth H., Box 984, Elizabethton, Tennessee 1960
DuMont, Philip A(tkinson), 4114 Fessenden St., N.W., Washington 16, D.C. 1928
Duncan, Robert, 1151 Fulton Ave., San Antonio 1, Texas 1956
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Dyer, William A., 402 John St., Union City, Michigan 1947
*Dzubin, Alex, 317 Field Husbandry Bldg., University of Saskatchewan, Saskatoon, Saskatchewan, Canada 1956
Easterla, David Arlen, Wildlife Conservation Bldg., University of Missouri, Columbia, Missouri 1959
†Eastman, Whitney, H(askins), 7000 Valley View Rd., Minneapolis 24, Minnesota 1941
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Platt, Dwight R(ich), Dept. of Biology, Bethel College, North Newton, Kansas 1959
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Porter, Richard Dee, Dept. of Biological Sciences, Texas Western College, El Paso, Texas 1950
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Potter, David M., 3 Prospect Court, Hamden 14, Connecticut 1946
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Powell, Leon W., Jr., 451 Southland Dr., Danville, Virginia 1960
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Prather, Millard F(illmore), P.O. Box 599, Fairfield, Alabama 1940
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Quay, W(ilbur) B(rooks), Dept. of Zoology, University of California, Berkeley 4, California 1949
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Radke, Mrs. Eleanor L., Box 138, R.D. 1, East Chatham, New York 1959
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Rand, Austin L., Chicago Natural History Museum, Roosevelt Rd. and Lake Shore Dr., Chicago 5, Illinois 1950
Randall, Clarence B(elden), 30 W. 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
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Rett, Egmont Z(achary), Museum of Natural History, Santa Barbara, California	1940
Reynard, George B., 105 Midway, Riverton, New Jersey	1950
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Rich, Mrs. Eva, 149 - 79th St., New York 24, New York	1952
Richards, Tudor, Dublin, New Hampshire	1951
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Richter, Carl H., 703 Main St., Oconto, Wisconsin	1947
Richter, G(eorge) William, 231 E. Main St., Canfield, Ohio	1954
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Rimsky-Korsakoff, V(ladimir) N(icholas), 220 Middle Rd., Sayville, L.I., New York	1951
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Rising, Gerald R(ichard), 108 Avalon Rd., Rochester 18, New York	1953
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Roberts, J(ohn) O(uvry) L(indfield), 108½ Charlotte St., Sarnia, Ontario, Canada	1960
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Robins, C(harles) Richard, The Marine Laboratory, University of Miami, Virginia Key, Miami 49, Florida	1949
Robinson, Mrs. James C(arr), 1701 Oakwood Ave., N.E., Huntsville, Alabama	1959
Robinson, Peter J., 333 Crossman St., Jamestown, New York	1956
Robinson, Thane S., Western Michigan University, Kalamazoo, Michigan	1952
Roesler, Mrs. Carol S., June Rd., Cos Cob, Connecticut	1949
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Rogers, Gerald T., 7 Smart Rd., West Acton, Massachusetts	1956
Rogers, John P., Wildlife Bldg., University of Missouri, Columbia, Missouri	1956
Rogers, K(ay) T(rowbridge), Dept. of Zoology, Oberlin College, Oberlin, Ohio	1952
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Romaine, Mrs. Lawrence B., Weathercock House, Middleboro, Massachusetts	1958
Root, Richard Bruce, Museum of Vertebrate Zoology, University of California, Berkeley 4, California	1953
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Rosche, Richard Carl, 48 Darmouth Ave., Buffalo 15, New York	1953
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Schwartz, Charles Walsh, 131 Forest Hill, Jefferson City, Missouri 1950
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Scott, Peter, The New Grounds, Slimbridge, Gloucestershire, England 1947
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Shellenberger, Emmett L(ee), Akron Museum of Natural History, 500 Edgewood Ave., Akron 7, Ohio	1954
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Shimanski, Walter, 115 Grove Ave., Woodbridge, New Jersey	1960
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Short, Lester L(eRoy), Jr., Dept. of Biology, Adelphi College, Garden City, New York	1953
Short, Wayne, 1800 S. Bayshore Lane, Coconut Grove, Florida	1941
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Sibley, Fred C(harles), Dept. of Zoology, University College, Ibadan, Nigeria	1953
Sick, Helmut M., Fundaco Brasil Central, Av. Nilo Pecanha 23 III, Rio de Janeiro, D.F., Brasil	1951
Sieh, James G(erald), Biology Station, Spirit Lake, Iowa	1948
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†Simmons, Edward McIlhenny, Avery Island, Louisiana	1942
†Simmons, Grant Gilbert, Jr., Lake Ave., Greenwich, Connecticut	1949
Simon, Stephen Wistar, Dept. of Biology, Ashland College, Ashland, Ohio	1947
Singleton, Albert Roland, 3968 Marburg Ave., Cincinnati 9, Ohio	1948
Skutch, Alexander F(rank), San Isidro del General, Costa Rica, C.A.	1944
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Sloan, Norman F(rederick), 3045 Emerson Ave., Minneapolis 8, Minnesota	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
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†Smith, Harry M(adison), 400 W. 119th St., New York 27, New York	1936
Smith, Marion L(ucille), 429 S. 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
Snapp, Mrs. R. R., 310 W. Michigan, Urbana, Illinois	1940
Snead, Mrs. Idalene F., 845 S. 42nd St., Birmingham 6, Alabama	1956
Snider, Mrs. Patricia Rae, 744 E. Rockland Rd., Libertyville, Illinois	1959
Snow, Mrs. C. S., 2211 Chester Blvd., Richmond, Indiana	1950
Snyder, Dana Paul, Dept. of Zoology, University of Massachusetts, Amherst, Massachusetts	1949
Snyder, David H(ilton), 105 East Stephens Hall, 915 College Ave., Columbia, Missouri	1960
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Snyder, L(ester) L(ynne), Royal Ontario Museum of Zoology, Queen's Park at Bloor St., Toronto 5, Ontario, Canada	1929
Sooter, Clarence Andrew, U.S. Public Health Service, N.I.Hi., D.R.G., R.F.R.D., Bethesda 14, Maryland	1940
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Southern, William, Dept. of Biological Sciences, Northern Illinois University, Dekalb, Illinois	1954
Spangler, Iva M., 128 E. Foster Parkway, Fort Wayne, Indiana	1939
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Steirly, Charles C., Waverly, Virginia ... 1958
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Stevenson, Henry M(iller), Dept. of Zoology, Florida State University, Tallahassee, Florida ... 1943
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Stewart, Orville M(ilton), c/o Merle-Smith, Oyster Bay, L.I., New York ... 1950
Stewart, James R(ush), Jr., 844 Natchez, Shreveport, Louisiana ... 1954
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Stupka, Arthur, R.D. 1, Gatlinburg, Tennessee ... 1935
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Sturges, Franklin W., Southern Oregon College, Ashland, Oregon ... 1955
Sudia, Theodore W., Dept. of Plant Pathology and Botany, University of Minnesota, St. Paul 1, Minnesota ... 1959
Summers, Lawrence, Dept. of Chemistry, University of North Dakota, Grand Forks, North Dakota ... 1956
Sundell, Robert A(rnold), 94 Main St., Frewsburg, New York ... 1951
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Taylor, J(ohn) Kenneth, 128 Charles St., New York 14, New York 1959
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Thomas, Jack Ward, Box 491, Llano, Texas 1957
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Ulrich, Mrs. Edward C., 193 LaSalle Ave., Buffalo 14, New York	1952
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will be held at
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on June 8–11

This will be the first annual meeting of the Society held in Canada.

December 1960

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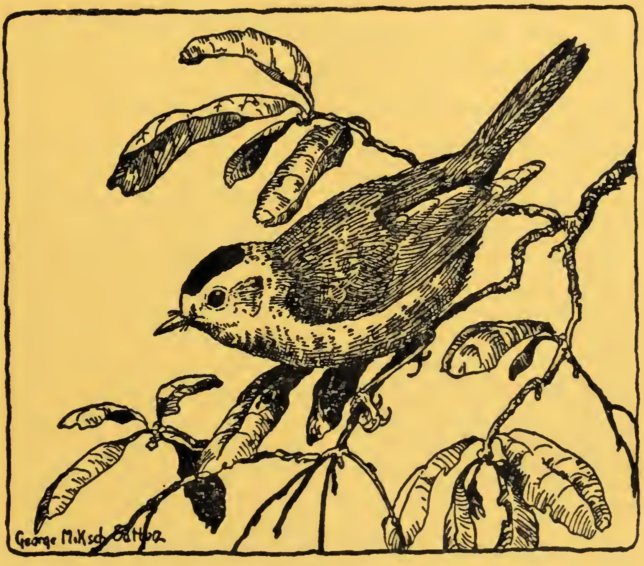

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CONTENTS

Mockingbird wing-flashing between attacks on a dummy Screech Owl.

ON THE FUNCTIONS OF WING-FLASHING IN MOCKINGBIRDS

BY ROBERT K. SELANDER AND D. K. HUNTER

In recent years, several notes in this journal have called attention to the distinctive wing-flashing of the Mockingbird (*Mimus polyglottos*), in which the wings are opened upward at about 45° in a series of jerking movements, then closed. In this display, large white wing patches are exposed. The function of this behavior remains unknown; but, since the display is most frequently seen being performed by birds that are foraging on the ground, it has been suggested (Gander, 1931; Allen, 1947) that exposure of the contrastingly patterned wings facilitates food-getting by startling the more active insect types and illuminating the more sluggish types in dark areas on the ground. This interpretation has been questioned, however, by Sutton (1946) and Halle (1948), who noted that wing-flashing also occurs in the Calandria Mockingbird (*Mimus saturninus*), and by Haverschmidt's (1953) and Whitaker's (1957) observations on *M. gilvus*, species which lack white patches in the wings.

An understanding of the functional significance of this behavior will be achieved only when we have more complete information on the behavioral contexts in which it appears. Therefore, the following notes on its use in agonistic situations may be of some value.

OBSERVATIONS

On April 17, 1960, we watched a pair of Mockingbirds mob a Screech Owl (*Otus asio*) that was perched in an oak tree on the campus of the University of Texas, Austin. Observations began at 3:40 p.m., when our attention was attracted by the familiar "predator call" of the Mockingbirds, a rasping *chew* sound introduced with an accented note and having a sharply descending inflection. Nasal *chew* notes of constant pitch were also being given. In the oak tree, the Mockingbirds were moving excitedly around the owl at distances from one to three feet, with the body plumage compressed, the tail widely fanned, and the folded wings held slightly out from the body, apparently in readiness for flight. The fanned tail was repeatedly flicked upward, and calling was almost continuous. Occasionally one of the birds made a rapid pass at the owl. Periodically one or the other Mockingbird gave a typical wing-flash; and, in a ten-minute period, we recorded 16 wing-flashes. Significantly perhaps, most wing-flashes were given when the birds were backing away from the owl and none was given by a bird about to attack. Some wing-flashes seemed to be directed to the owl, others were perhaps given to the other Mockingbird, and some seemed to be undirected. As in Mockingbirds displaying while foraging, the wing-flashes of the mobbing birds varied in intensity; in some the wings were only partly opened, while at the other extreme they were all but fully spread. The mobbing continued for an hour as we watched; but, since the owl soon shifted to a new position high in the tree, we were unable to follow closely the activities of the Mockingbirds.

On April 20, 1960, we were able to elicit mobbing attacks on a dummy Screech Owl and to photograph the display (Front.). In three tests, each lasting 15 minutes, the dummy was placed within the territories of three pairs of birds. In the first test, eight wing-flashes were noted as the birds mobbed the owl, which was placed on a traffic sign six feet above the ground; in the second, response was weak and intermittent, and only three wing-flashes were recorded. In the third test, with the dummy on the ground, one bird, probably the male of the pair, gave a total of 105 wing-flashes, and its mate gave four. The male (?) wing-flashed many times on the ground between flying attacks on the dummy and also wing-flashed on a wire 8 feet above the dummy and in a nearby bush. On the ground, wing-flashes were given at distances varying from a few inches to several feet from the dummy. Many were given as the Mockingbirds faced the back and sides of the owl, and some were given as they faced away from the dummy. We wish to emphasize the fact that the wing movements of these birds were identical with those of birds wing-flashing while foraging.

Mr. Thomas R. Hellier has kindly supplied notes on the behavior of a Mockingbird near Ottawa, Kansas, in the summer of 1956. On three occasions in a 15- to 20-minute period, he saw a Mockingbird fly from a tree to the ground and wing-flash several times in succession as it walked toward a domestic cat that was resting on the ground at the base of the tree. The bird approached the cat from behind and from the side and flew up to the tree as the cat became alert and turned to face it. Apparently wing-flashing may be used as Mockingbirds are reacting to a variety of predators, for Hicks (1955) reports wing-flashing by a bird attacking a blacksnake.

Mockingbirds also wing-flash in agonistic encounters with individuals of their own species at territorial boundaries and within such boundaries. And they may be induced to display by setting out a dummy Mockingbird within their territories. In May, 1956, Selander performed several experiments of this type in connection with a demonstration of territoriality for an ornithology class. The following excerpts from his notes are typical. Sex determinations were based on relative body size, males being larger than females.

May 1.—A male dummy in horizontal posture was placed on a lawn chair within the territory of a pair of Mockingbirds attending recently-fledged young. One bird gave loud *chew* notes, then both birds came to the chair with the "heavy" flight characteristic of birds defending territory. One (the male?) gave wing-flash display, fanning the tail at the same time; he then flew at the dummy, striking it with bill and feet. Both birds wing-flashed several times, then the male (?) again attacked. At this point the episode was interrupted and the dummy removed.

May 4.—A wingless dummy in resting posture on a T-post was set out within the territory of a pair of Mockingbirds that was feeding a young fledgling. Both birds approached the dummy and wing-flashed several times. One bird flew to a perch above the dummy and gave a low-intensity wing-flash. The other then flew to the ground and wing-flashed strongly several times. Meanwhile, the first bird returned to the T-post and wing-flashed once. It then flew up and away but turned back and made a passing attack on the dummy, following which it flew to the ground, where both birds wing-flashed many times, perhaps directing their displays to each other. To this point, both birds had been silent, but now one, probably the female, began to give *chew* notes. The male (?) soon began calling and made another attack on the dummy, hitting it with bill and claws. Then he rejoined the female (?) on the ground and the two birds displayed strongly several times as they faced one another. This episode ended as both Mockingbirds flew away.

May 6.—A dummy with wings wired in wing-flash position was set out on the ground. The male (?) came to the dummy and displayed before it, walked around in back, and struck it six times from behind. Meanwhile, the female (?) came to the edge of bushes 10 feet away and wing-flashed. Later, when the male (?) had left the dummy, the female (?) came to the ground, calling repeatedly, gave a weak display, walked around the dummy giving increasingly more intense versions of the display, and finally gave a full display before walking away.

DISCUSSION

Whatever the biological significance of wing-flashing in Mockingbirds may be, the behavior appears early in development and is almost undoubtedly innate, for we have seen it in nestlings and it has previously been observed in young fledglings (Allen, 1947; Sutton, 1946).

The fact that the wing-flashing occurs while Mockingbirds are mobbing an owl, are reacting agonistically to dummy Mockingbirds placed in their territories, or are disputing territory with live Mockingbirds at territorial boundaries and elsewhere is open to several interpretations. If we assume that wing-flashing is not a typical social display—that is, that it has no function in communication among members of the species—but, rather, functions only in foraging, its occurrence in agonistic contexts could be attributed to "displacement" (Tinbergen, 1952), as suggested by Brackbill (1951). And since mobbing or fighting Mockingbirds clearly show ambivalence of tendencies to attack and to flee, it is perhaps not surprising to find irrelevant or "displacement" activities appearing. In owl-mobbing behavior, which does not differ greatly if at all from the behavior of birds reacting to Mockingbird dummies, the folded wings are held out slightly from the body in preparation for flight, and chance movements of the bird or flight-intention flicks of the wings may result in "transitional actions" (Lind, 1959) leading to "displacement" wing-flashing.

A second hypothesis is that wing-flashing is genuine agonistic display serving a threat function. If this is the case, the apparent mutual display of paired Mockingbirds confronted with a dummy might be interpreted as redirected aggressive behavior. Following this line of argument, the fact that Mockingbirds commonly wing-flash while foraging, sometimes in the apparent absence of other Mockingbirds, could be explained if the display also serves as a method of territorial advertisement, calling attention to the presence and position of the territory owner when it is not actively standing guard or patrolling its territory.

All evidence considered, we are inclined to think that Sutton's suggestion (1946) that wing-flashing is primarily a "gesture indicating wariness, suspicion, [and] distrust" is more nearly correct than any other. We suggest that wing-flashing in the Mockingbird represents a highly ritualized flight-intention movement of the wings, which, evolving originally as a social signal or wariness, has acquired a secondary function in food-getting. It is possible that it may also function to intimidate other birds in addition to indicating an apprehensive "mood." This theory would account for its frequent use by birds that are mobbing an owl or are reacting to the presence of a live or dummy Mockingbird in their territory. We further suggest as a working hypothesis that the Mockingbird's use of the display while foraging may be individually conditioned. Perhaps when first foraging on the ground, the young Mockingbird is apprehensive and gives the display; insects are flushed as a result, and in time the bird comes to associate wing-flashing with foraging, reinforcement being provided by the capture and eating of insects.

The hypothesis that we are advocating, and which is actually an extension of that proposed by Sutton, has the advantage of accounting for the appearance of the display in such different contexts as foraging and mobbing. It also eliminates the necessity of invoking "displacement" as a causal factor, which is perhaps desirable considering the difficulties involved in distinguishing between "displacement activity" and nondisplacement behavior (Hinde, 1959:593).

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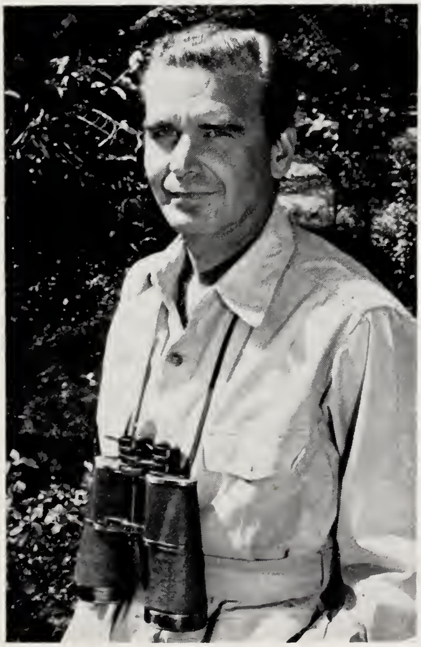
DEPARTMENT OF ZOOLOGY, THE UNIVERSITY OF TEXAS, AUSTIN, TEXAS, APRIL 20, 1960

NEW LIFE MEMBER



Paul A. Schwartz, of Caracas, Venezuela, a new Life Member of the Wilson Ornithological Society, has been an active member of the Society since 1952. A mechanical engineer by profession, Mr. Schwartz is a contributor to the serious literature of ornithology. He has published a life history of the Rusty-breasted Ant Pitta (*Grallaricula ferrugineipectus*), and some two dozen of his excellent color photographs of birds may be seen in Gilliard's "Living Birds of the World." Some of his extensive field notes on South American birds were used for text material in that book also.

In addition to life history studies and photography, Mr. Schwartz is interested in nesting studies, migration, and sound recording. He is also a member of the A. O. U., Cooper Ornithological Society, Laboratory of Ornithology of Cornell University, Sociedad Venezolana de Ciencias Naturales, Sociedad de Ciencias Naturales La Salle, and the Hawk Mountain Sanctuary Association.

A FIELD STUDY OF THE MOCKINGBIRD'S WING-FLASHING BEHAVIOR AND ITS ASSOCIATION WITH FORAGING

BY JACK P. HAILMAN

The peculiar "wing-flashing" behavior of the Mockingbird (*Mimus polyglottos*) has been the subject of much study and discussion among American field workers, and yet there is little agreement on the biological function of this behavior. The most prevalent theory, perhaps, is that the motions are associated with hunting insects (e.g., Gander, 1931; Hebard, 1949*a*, 1949*b*; Wampole, 1949; Brackbill, 1951). However, Sutton (1946) believed that wing-flashing is an alarm reaction, because several observers reported it when birds were confronted with strange objects or situations (e.g., Michener and Michener, 1935:106; Laskey, *in* Sutton, 1946; and Sutton, 1946). Recently Brackbill (pers. comm.) has come to believe that the behavior is produced by hostile or fear motivation. Others have termed wing-flashing a sexual display (Forbush, 1929:320), and one observer (Tomkins, 1950) concluded that "it has no present value to the species."

Disagreement concerning the form of the behavior as well as its function has arisen. Sutton's (1946) painting shows a Mockingbird with its wings held high above its back, but Wampole (1949) describes the wings as being moved horizontally. Many authors do not describe the motions they call "wing-flashing."

METHODS

Field observations were made from June to August, 1958, at eight localities in the suburbs of Washington, D.C., and from April to July, 1959, in Norfolk, Virginia. The 1959 study was of adults only, since it was terminated before general fledging time, and involved only about three pairs of birds; the 1958 observations were of both young and adults.

For statistical purposes, each individual Wing-flash is assumed to be an independent observation. This assumption seems valid, because each Wing-flash is usually spaced from the next by a definite time interval, even when no other motions intervene.

Standard statistical methods are used. Probability of a proportion in a sample was determined by either the exact binomial or the normal approximation, as noted. Comparisons of proportions from two samples are made with the proportions test outlined by Wallis and Roberts (1956:429), utilizing the Yates correction for an uppertail probability; this is valid because the direction of the alternative hypothesis was anticipated. Throughout, probabilities of below .01 are taken as significant, those from .01 to .05 as bordering significance, those of .05 to .10 as possibly indicative of difference, and those above .10 as insignificant.

Since the 1959 birds were drawn from a different statistical population than were the 1958 birds (different in geography, time of study, time of year, and age composition), data from the two populations are compared only with qualification. It is also possible that any systematic errors by the observer (say, in recording the number of hitches/Wing-flash) were different in 1958 and 1959. Only the corresponding segment of 1958 population is compared to 1959.

ACKNOWLEDGMENTS

I am indebted to Mrs. Lovie Whitaker and Dr. George M. Sutton for comments on the manuscript. I am especially grateful to Dr. Robert K. Selander for sharing his ideas about Wing-flashing and supplying me with several photographs comparing Wing-flashing in different behavioral situations. See Dr. Selander's paper (Selander and Hunter, 1960) for another view on the function(s) of "wing-flashing."

FORM OF WING-FLASHING

The term "wing-flashing" is fairly descriptive of the Mockingbird's behavior, and has been so frequently used in the literature that a change in terminology here could not be justified. Nevertheless, the term has been used to designate a variety of unrelated motions (see discussion in Hailman, 1959), so that some distinction is necessary. For the remainder of this paper, the capitalized term "Wing-flash(ing)" refers to the specific behavior pattern of the Mockingbird described below: the term "wing-flashing" refers to behavior previously described in the literature which cannot definitely be assigned as true Wing-flashing, and as a general term for discussing similar wing motions of other species.

Wing-flashing of the Mockingbird takes place as follows: the bird stands on the ground with body held in normal position (spinal column at an angle of about 35° with the ground), and with its head forward, begins the wing motions. Sometimes birds tilt the head slightly to the side or down in front, but most birds look nearly straight ahead. The wings are opened simultaneously in a series of distinct motions, or "hitches." The number of hitches is variable in a given individual, and is usually one to three, occasionally four or five. The direction in which the wings open is also variable, which may account for some of the disagreements in the literature. Sometimes the wings seem to be opened nearly vertically above the bird; at other times nearly horizontally, the latter occurring especially when the bird is running while Wing-flashing (which is rare). When the number of hitches is few, the direction is not evident.

When the wings are hitched open, the white patches appear to "flash," hence the original term. (However, quite similar "wing-flashing" occurs in other species of the Mimidae which have no wing patches. See Whitaker, 1957, and wing-flashing in other species, below). Once the wings have been extended, they are brought back to the body in one smooth, quick and direct motion. This closure concludes the Wing-flash proper, and behavior which follows is variable.

Wing-flashing by Adults

Two principal hypotheses were investigated: that Wing-flashing is a social or sexual display, and that Wing-flashing is a foraging motion. If Wing-flashing displays the white patches as a signal to other birds, it seems reasonable that (a) the presence of other birds would elicit Wing-flashing, (b) Wing-flashing would usually be performed only when other birds are present, and (c) the performance would affect in some way the behavior of birds present, especially other Mockingbirds. It was quickly evident from field study that none of these conditions existed. Finding no other evidence that Wing-flashing serves a communicative function, I turned to the second possibility.

It was necessary to find how the Mockingbird forages, and then whether or not foraging and Wing-flashing were associated, and if they were, what the nature of the association was. Feeding of adults on the ground during spring and summer in general resembles the behavior of Robins (*Turdus migratorius*), running over bare areas, stopping and occasionally striking. Ground foraging of the Mockingbird may be divided into three principal patterns: (1) look down into the grass (to spy prey?); (2) run or hop a few inches, presumably when no prey is seen in the immediate area; and (3) strike. The association of these three motions with Wing-flashing was investigated in detail.

Wing-flashing and Foraging on the Ground.—If, as suggested by several previous observers, Wing-flashing startles insects or other prey into betraying themselves, it would be expected that Mockingbirds would often strike just after Wing-flashing. Therefore, quantitative data were gathered on the number of times Mockingbirds struck after Wing-flashing, the number of times they did not, and what the birds did if they did not strike. The data are arranged in columns corresponding to the category of behavior following the Wing-flashing (Tables 1–5). These data were also divided into rows according to the number of hitches in each Wing-flash.

The 1958 results (Table 1) show an extremely high association (about 96 per cent) of Wing-flashing followed by one of the motions of foraging (80 versus three non-foraging occurrences). The probability of a difference this great or greater by chance alone is significantly small to be discounted ($P = < .0001$ by exact binomial). In this sample about one Wing-flash in five was followed by strike at prey, and about half of these strikes were seen to produce captures.

I noticed in the 1958 study that a bias was introduced into my field data because often after Wing-flashing a bird ran or looked down, and then struck. Because I took no systematic notes on this "second" motion after Wing-flashing, these sequences are not reflected as strikes in Table 1. There-

TABLE 1
WING-FLASHING BY ADULTS ON THE GROUND IN 1958

Wing hitches	Behavior following Wing-flash			
	hop/run	look	strike (capture)	other
1	7	6	2 (2)	2[1]
2	15[2]	12	6 (3)	0
3	8	13	6 (2)	1[3]
4	1	2	0	0
5	1	1	0	0
Total	32	34	14 (7)	3

[1] One bird flashed immediately after strike, but gave no reaction after Wing-flash. Other bird gave no reaction.
[2] One bird ran, gave the "predator warning call" (Hailman, in prep.), and stopped foraging.
[3] Bird appeared to be frightened while Wing-flashing and flew away quickly.

fore, in re-evaluating the behavior with the Norfolk Mockingbirds in 1959, I created two new categories: "hop/run–strike" and "look–strike."

Table 2 also shows that the association of Wing-flashing with foraging motions (about 99 per cent) in 1959 is highly significant (256 of 258 observations; probability of chance difference: $P = < .0001$ by exact binomial). In fact, a test on the proportions shows that the 1959 birds' Wing-flashes may have been more closely associated with foraging than were the 1958 Wing-flashes ($P = .087$). In 1959, well over two-thirds of the Wing-flashes were followed by actual strikes, either immediately or with a short run or look-down intervening. This number is far above that expected by chance (191 strikes versus 67 nonstrikes is highly significant at $P = < .0001$ by the normal approximation to the binomial) and is significantly greater than strike occurrence by the 1958 birds ($P = < .001$ by proportions test). Strike success was not recorded in 1959.

It is interesting to note the details of "non-foraging" Wing-flashes (notes to Tables 1 and 2). The observations suggest that when Wing-flashing was not followed directly by foraging behavior, some other motivating factor was present, such as frightening stimulus, presence of young birds, etc., which conflicted with foraging. The bird (Table 1) which Wing-flashed after striking may have been stimulated by some sort of "surplus" motivation; in any case, the observation is generally within the context of foraging.

Furthermore, the average intensities (as measured by the number of hitches/Wing-flash) of the behavior pattern seem to be higher when associated with foraging than when not. In Table 1, the mean intensity of "foraging" Wing-flashes is 2.30 hitches, whereas the mean intensity of "non-foraging" Wing-flashes is 1.67. In Table 2, the mean foraging intensity is 2.46 and the mean nonforaging intensity is 1.00. The few nonforaging

TABLE 2

WING-FLASHING BY ADULTS ON THE GROUND IN 1959

Wing hitches	Behavior following Wing-flash					
	hop/run	look	hop/run–strike	look–strike	strike	other
1	10	12	4	0	45	2[1]
2	9	8	1	0	41	0
3	4	6	4	4	45	0
4	6	9	5	2	40	0
5	1	0	0	0	0	0
Total	30	35	14	6	171	2

[1] One bird gave no action; other bird looked at young Mockingbird nearby.

observations in each case preclude a meaningful statistical comparison, but the consistent large differences are indicative of lower intensity in nonforaging situations.

The Wing-flashing of Mockingbirds on the ground is used as a standard by which to compare Wing-flashing in other instances recorded in 1958. Due to the variables already discussed, it is not appropriate to use the 1959 data for exact statistical comparisons. However, the 1959 data (Table 2), if anything, show a closer connection between Wing-flashing and foraging (especially striking) than do the 1958 data (Table 1), and a mean intensity of the same order.

Wing-flashing Aloft.—A few times Mockingbirds were seen to Wing-flash while perched on fences, bushes, trees, and other places above the ground; these observations are summarized in Table 3. During the 1958 study period, Wing-flashing aloft accounted for about 10 per cent ($^9/_{92}$) of all adult Wing-flashing seen (Tables 1 and 3). Aloft, eight Wing-flashes were definitely associated with foraging on the ground, while the other was followed by a strike and capture aloft. The connection of Wing-flashing and foraging is thus 100 per cent ($^9/_9$. highly significant at $P = < .002$ by exact binomial), although this perfect correlation in a small sample does not indicate a greater connection of Wing-flashing and foraging while aloft than on the ground. (Proportion test with Table 1 shows $P = .098$. which does not indicate a significant difference.)

Again, taking hitches as a measure of intensity, it is possible to compare the intensities of Wing-flashes aloft with those on the ground. The 3-hitch level was the highest given by aloft birds, which suggests that motivation is less than on the ground. Calculating the mean intensity of Table 3 (foraging) Wing-flashes reveals a mean of 1.78, compared to a mean of 2.30 of foraging intensities of Table 1, also suggesting a difference.

TABLE 3

WING-FLASHING BY ADULTS PERCHED ALOFT IN 1958

Wing hitches	Behavior following Wing-flash				
	look at ground[1]	fly to ground	fly to ground and strike[2]	strike aloft[2]	other
1	2	0	0	1 (1)?	0
2	3	1	1 (1)?	0	0
3	0	1	0	0	0
Total	5	2	1 (1)	1 (1)	0

[1] All birds perched at heights less than 6 feet.
[2] Numbers in parentheses indicate captures, as in Table 1.

WING-FLASHING BY FLEDGED YOUNG

During the 1958 study period, 41 Wing-flashes by about seven fledged young Mockingbirds still in the "dependency period" were observed (Tables 4 and 5), 32 of which were performed on the ground. The "dependency period" is tentatively defined as that time after which young animals have left the nest, but during which time they are dependent upon at least one parent for food and/or protection (Hailman, 1960*a*), and seems to be an important time in the development of behavior.

Considering only the Wing-flashes on the ground (Table 4), 21 of 32 Wing-flashes were followed by one of the three motions of ground foraging (probability of chance difference by normal approximation $P = .056$, which borders significance). If the "begging" were included as a category of foraging, the proportions would be considerably larger; this treatment is considered below. Considering the "beg" column as "non-foraging" observations, the percentage of foraging Wing-flashes is considerably lower in fledged young than in adults (about 63 per cent versus 96 per cent). A proportion

TABLE 4

WING-FLASHING BY FLEDGED YOUNG ON GROUND IN 1958

Wing hitches	Behavior following Wing-flash				
	hop/run	look	strike (capture)	beg[1]	other
1	3	4[2]	4 (0)	1	4
2	0	2	2 (0)	0	1
3	1	0	3[3] (2)	4	1
4	0	2	0	0	0
Total	4	8	9 (2)	5	6

[1] All birds gave species begging call.
[2] One bird gave begging call.
[3] Two birds gave begging call.

test on the raw data shows this difference to be highly significant ($P = < .001$).

Furthermore, the Wing-flashes of fledged young seem to produce a lower strike success and have a lower average intensity. Strike success was only two out of nine, but is not significantly lower than that of the 1958 adults (Table 1), which was seven out of 14 ($P = .175$ by proportions test). Perhaps the small samples obscure a difference. The mean intensity of fledged young foraging Wing-flashes is 1.86, and is lower than the mean intensity for adults (2.30 of Table 1). Further, the mean intensity for the "beg" column in Table 4 is higher (2.60), and that of the "other" column lower (1.50), than the foraging intensity, although the small samples preclude meaningful statistical comparison.

Finally, there are several other considerations of Table 4 to be noted. First, the young showed a new behavior, "begging," following Wing-flashing, and this category accounts for about 12 per cent ($^{5}/_{41}$) of the observations. Second, the "other" behavior is not readily attributable to conflicting drives or distractions, as were those of adults. That is, when a young bird did not forage or beg after Wing-flashing, it simply did nothing noticeable. The Wing-flashing appeared to be largely undirected and irrelevant. Last, several foraging observations in Table 4 were accompanied by the screech-like "begging-call" of the species, the same as is given while the young are actually begging (notes to Table 4).

If, as suggested above, the begging observations are considered to be part of "foraging" behavior, the proportion of "foraging" Wing-flashes (26 of 32) becomes highly significant ($P = < .001$ by the normal approximation). This also makes proportions of "foraging" behavior similar to that of adults —although still not as high (about 81 per cent versus 96 per cent) and statistical tests on the raw data show the differences to be insignificant ($P = .165$ approximately, by proportions test). Including begging also raises the mean intensity of the young's foraging Wing-flashes to 2.00 which is similar to the 2.30 mean of adults. Thus the parameters of Wing-flashing by fledged young on the ground resemble those of Wing-flashing by adults, when the former group includes "begging" as a foraging response.

A few observations were made of fledged young Wing-flashing while perched aloft (Table 5). These constitute 18 per cent ($^{9}/_{50}$) of the observations of fledged young, whereas aloft Wing-flashes were only about 10 per cent of the adult total. Probably the begging-calls of the young aloft more often called my attention to their Wing-flashing than did any factor of the adults' behavior aloft. All the Wing-flashes of young birds aloft were followed by begging ($^{9}/_{9}$, $P = < .002$ by exact binomial).

TABLE 5

WING-FLASHING BY FLEDGED YOUNG PERCHED ALOFT IN 1958

Wing hitches	Behavior following Wing-flash	
	beg[1]	other
1	9	0

[1] All birds gave begging-call. Adult bird within 5 feet of young in every case.

DISCUSSION

To state that Wing-flashing is definitely used in foraging is the conclusion of this paper but not the end of the problem. The exact mechanism by which Wing-flashing is utilized is still in doubt, for instance, and how the behavior develops is still unknown.

An inference from this study is that Wing-flashing frightens insects into betraying themselves (see Hailman, 1960*b*, for other evidence), and therefore increases foraging efficiency of the Mockingbird. But even if this were true, does Wing-flashing flush insects by casting a shadow over them, or by reflecting light upon them, or by some other mechanism? Allen (1947) suggested the white under-wings reflected light into the grass; if so, does this actually frighten insects, or does it just enable the bird to see them better? I am continuing observations on this problem.

My observations on young birds show that the actual motor pattern of Wing-flashing is developed at fledging, but that "proper" (adult) use of it is not. That is, young birds give Wing-flashing irrelevantly without association with foraging motions, or while begging. Many previous observers have noted that young birds tend to Wing-flash when confronted with strange objects or in strange situations (Michener and Michener, 1935:106; Laskey, *in* Sutton, 1946; Sutton, 1946; J. R. Michener, Laskey, and Brackbill, all in pers. comm.). The connection of Wing-flashing and begging (also mentioned by Sutton, 1946) suggests that internal hunger stimuli may contribute to the motivation of this behavior in young birds. These facts suggest that young birds capable of performing the motions early in life learn how to use them later, perhaps when insects jump or twitch before them.

The phylogenetic origin of the wing motions is unknown. Sutton (1946) believed Wing-flashing to be a modification (ontogenetic or phylogenetic?) of the wing-fluttering of begging young. In my experience the motions are quite dissimilar, the latter being a loose vibratory motion of the wings while they are held slightly out from the side in contrast to the hitching upward of Wing-flashing: I never saw any intermediate motions. Wing-twitching motions of the Starling (*Sturnus vulgaris*), which are analogously associated with insect capture, closely resemble wing-flicks of flight intention (Hailman, 1959), but no such similarity exists in the Mockingbird. Although the Mockingbird's behavioral repertoire includes many other wing movements (such as courtship flights, "wing-flickering," Spread-display, etc.), none resembles Wing-flashing closely enough to suggest common origin.

PREVIOUS REPORTS OF WING-FLASHING

The many previous reports of Wing-flashing in the literature have generated a number of hypotheses and disagreements about the behavior. The variation in actual form of Wing-flashing should now be settled (above, and Wampole, 1949; Tomkins, 1950; Brackbill, 1951). Many authors have concluded from their observations that the function of Wing-flashing is foraging; others who have not stated this conclusion, nevertheless have included information in their reports which indicates that it is true (e.g., Michener and Michener, 1935:106, 111, 118; Sutton, 1946; Sprunt, *in* Bent, 1948:307–308; Tomkins, 1950; Whitaker, 1957). Only two references I have seen do not mention foraging: Forbush's (1929:320) early account casually refers to this behavior as "courtship," and Hicks (1955) called a predator reaction "wing-flashing," although the actual form of the behavior observed is not described.

Recently, Selander and Hunter (1960) have shown that Mockingbirds use a Wing-flashing-like behavior when mobbing owls or dummies, and possibly in intraspecific hostile encounters. I suggested to Selander that this pattern might be different from, but very similar to, true Wing-flashing. However, he has seen the motions in the foraging context described here, and is "convinced that the wing motions do not differ" (pers. comm.).

Nevertheless, I believe that many of the conclusions in the papers which assign a function other than foraging to Wing-flashing can be explained by four factors: (1) observations were of young birds, in which the foraging connection is not yet made; (2) behavior observed was not Wing-flashing, but may have been one of the other numerous wing motions of the Mockingbird (male wing-droop display, vertical and swoop song-flights, female precopulatory wing-quivering posture, young begging posture, etc.); (3) the entire behavioral situation was not observed (*i.e.*, there were other motivating factors present, such as young, which distracted the Mockingbird's attention from feeding); and (4) single observations may have been of the rare cases in which Wing-flashing is not connected directly with foraging (see Tables 1–3).

WING-FLASHING IN OTHER SPECIES

In Mimidae.—Several other species of the family Mimidae use apparently homologous motions. Halle (1948) observed Wing-flashing in the Calandria

Mockingbird (*Mimus saturninus*), as well as in *polyglottos*, and noted that the former was "doing the same thing in the same way" as the latter. Another member of the genus, the Graceful Mockingbird (*M. gilvus*), Wing-flashed while foraging (Haverschmidt, 1953), using apparently similar movements: in fact, it is a quite common habit of this species (Haverschmidt, pers. comm.). Whitaker (1957:361) also observed this species giving the "same jerky movements used by *polyglottos*" while foraging. Neither *saturninus* nor *gilvus* has wing patches. Laskey (*in* Sutton, 1946:208) "observed an adult Brown Thrasher (*Toxostoma rufum*) opening and closing its wings while investigating something . . . where it had been hunting food." Tomkins (1950) also reports having seen this species ". . . flash its wings in identical fashion" to the common Mockingbird. Thomas (Whitaker, 1957) has apparently observed Wing-flashing by the Brown Thrasher many times.

Wing motions of the Blue Mockingbird (*Melanotis hypoleucus*), seen by Skutch (Whitaker, 1957:362), and of the Catbird (*Dumetella carolinensis*), mentioned by Vaurie (1957:309–310), may bear some relation to true Wing-flashing, but no good description of their physical form is yet available, and they do not appear to occur in a foraging context (at least from preliminary descriptions), as do the Wing-flashing motions of the species mentioned above.

In non-Mimidae.—It is obvious that merely because motions are termed "wing-flashing" it does not make them either homologous or analogous to Wing-flashing of the Mockingbird; such behavior has previously been discussed and cited (Whitaker, 1957; Hailman, 1959). However, many species of non-mimids do possess analogous wing-movements which are used in foraging, apparently to flush prey. Sutton (1946) mentioned such motions of the Roadrunner (*Geococcyx californianus*) and the Least Bittern (*Ixobrychus exilis*). Whitaker (1957) cited accounts of wing movements in foraging African herons. To these could be added the Starling's (*Sturnus vulgaris*) "wing-twitching" used in insect capture (Hailman, 1959) and two kinds of wing movements by the Louisiana Heron (*Hydranassa tricolor*) during foraging (Hailman, 1960*c*). I think it is significant that of the Galapagos finches, only the insect-eating "*Certhidea* repeatedly flicks the wings partly open when hopping about the bushes," while the seed- and fruit-eating forms do not do this (Lack, 1947:146).

CONCLUSIONS

From my own observations and from the reports of others, the following conclusions about Wing-flashing may be formulated: (1) In adults, it is definitely a foraging motion, but it is possibly also used in predator displays; (2) In young birds the connection with foraging is not as great; factors of hunger, fear and curiosity seem instrumental in eliciting the behavior. The major problems concerning Wing-flashing now seem to be: (a) exactly how is the behavior used in foraging: (b) what is the exact role of Wing-flashing in inter- and intraspecific hostile situations: and (c) how does the behavior develop?

SUMMARY

The Mockingbird (*Mimus polyglottos*) lifts its wings in jerky motions termed Wing-flashing. The number of "hitches" in which the wings are spread varies between one and five, and the direction of spread varies from nearly horizontal to nearly vertical. Wing-flashing is not used as a display to other birds. The behavior following 83 Wing-flashes of adults on the ground in 1958 consisted of one of three foraging motions: running, looking down, and striking, except for three observations. Likewise, 1959 data showed 256 of 258 Wing-flashes followed by foraging. All of the nine Wing-flashes given aloft were followed by foraging.

Fledged young on the ground followed Wing-flashing by 21 foraging motions and five begging postures; six Wing-flashes were given irrelevantly. Aloft, all of the nine were followed by begging.

Previous reports on functions of Wing-flashing differ in conclusions, but upon re-examination all indicate that foraging was probably the principal factor involved; probable causes of other conclusions are discussed. Apparently homologous motions are used in other Mimidae species for foraging, and many unrelated species use various forms of wing motions in foraging.

In adults, then, Wing-flashing is used in foraging, possibly to flush insects: but in young birds it is often given irrelevantly, and seems to be motivated by hunger and curiosity.

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4401 GLADWYNE DRIVE, BETHESDA, MARYLAND, JULY 5, 1960

MIGRATION OF THE SANDHILL CRANE EAST OF THE MISSISSIPPI RIVER

BY LAWRENCE H. WALKINSHAW

Over a period of years I have assembled many records of the Sandhill Crane (*Grus canadensis*) from North America. The two subspecies (*G. c. canadensis* and *G. c. tabida*) generally seem to follow three different migration routes. Some cranes wander from these main routes but few migrate east of a line from James Bay to eastern Georgia. Many migration records exist from Wisconsin, Michigan, northeastern Illinois, Indiana, western Ohio, eastern Tennessee, and in recent years from Georgia, and some apparently from northern Florida, indicating a definite migration route from northwest to southeast in fall and vice versa in spring. Apparently there are few records from Alabama and Mississippi except for the resident Florida Sandhill Cranes (*G. c. pratensis*) in the far south. Some cranes are observed migrating across Minnesota, a few in western Iowa and Missouri, but none across Arkansas and Louisiana.

The central migration route seems to extend from Mexican wintering grounds, Texas, and New Mexico, northward east of the Rockies, but mainly through the western parts of Oklahoma, Kansas and Nebraska, and through South and North Dakota into Saskatchewan and Manitoba. It also extends across the eastern parts of Colorado, Wyoming, Montana, and Alberta. Apparently there is a division of this route north of the United States, some flocks going into Manitoba northward while others cross western Saskatchewan and eastern Alberta northward to Alaska and Yukon Territory, even in some cases to northeastern Siberia. Some cranes migrate from Alaska along the Pacific states and British Columbia to southern California, probably also to Baja California, Sonora, and western Chihuahua. The migration route from Alaska to northeastern Siberia crosses the Bering Straits but some cranes appearing on Bering Sea islands suggest a possible long flight at times across water.

Since it is impracticable to use complete data for all three main migration routes in one paper, I have tried to amass the chief data from east of the Mississippi (Fig. 1), hoping to do similarly later with each of the other two routes. The large number of sight records of the Sandhill Crane from Indiana (where the species has not bred for 30 years) and several from eastern Tennessee, central Kentucky, and north and central Georgia show the direction of flight.

We do not know whether cranes fly continuously from northern Indiana and southern Michigan to their wintering grounds or whether they stop in isolated spots for night roosting. They might stop only when weather conditions become unfavorable. It does seem as though cranes would be observed

FIG. 1. Map of Sandhill Crane migration east of the Mississippi River. ●—breeding records; ○—areas where cranes have been observed outside normal breeding areas.

on the ground more often if they did stop for the night. Only occasionally are they seen on the ground.

Southern Michigan and northern Indiana are about 900–950 air-miles from the Okefenokee Swamp. Cranes fly about 32 to 35 miles per hour, so it would require 25 to 30 hours of flying time to make the journey, providing all flying conditions were favorable.

Small fall concentrations now occur in Michigan (at times 150 cranes) in both the Upper and Lower Peninsula breeding areas. There has been a gradual increase in recent years in these numbers. Larger concentrations sometimes occur in central Wisconsin (as many as 600) and much larger concentrations at Jasper-Pulaski Game Preserve in northern Indiana. Here cranes have steadily increased during recent migrations so that nearly 2000 gather in spring and in fall at one time. No one knows from where these birds have come nor where they are going. No one knows how long they remain, whether some come early, stay a few days and then move on, being replaced by other groups, or whether some birds remain for many weeks. Possibly some of these cranes may migrate much farther north than central Wisconsin and northern Michigan. Some may go into northwestern Ontario where cranes have been found in summer in recent years.

Concentrations of cranes have occurred in central Florida in both winter and summer on the Kissimmee Prairie. In other Florida areas only a few cranes have been found in winter. An average of six Christmas bird counts per year were made in Florida from 1934 through 1945, yet none listed any Sandhill Cranes. Eleven areas have listed the species between 1946 and 1958, in addition to the Okefenokee Swamp in southern Georgia. During 1957, nine of 23 areas listed a total of 107 cranes in Florida and 190 from the Okefenokee Swamp.

Allan Cruickshank (letter, January 5, 1959) commented on a winter increase of cranes in Florida each year. He wrote:

> Whereas no intensive careful survey has been made of Sandhill Cranes in our section of Brevard County, it is very obvious to anyone who does much field work that there is a definite increase during the winter months. The species is represented locally by only a few pairs from mid-March until late October. During the winter small groups, occasionally scores, are found. Our Christmas counts for the last four years are: 1955, 81; 1956, 64; 1957, 55; 1958, 32. On the 1955 count, H. Bennett and I counted 77 in one plowed field. On the other hand, during March, April, May (I am away in June, July, August), September and October, I have covered our best crane territory during a full day and observed from none to three pairs.
>
> The decrease on Christmas counts does not reflect a decrease of the species, but a decrease in the plowing operations on a large ranch within our Christmas count circle.

Dale W. Rice, having considerable interest in the Sandhill Crane from work he had done in Indiana and Texas, spent three springs at the University of Florida at Gainesville, from February, 1953 to June, 1955 and did considerable work in the field during that time. In a letter from Rice (January 12, 1959) he gave the following information:

> Sandhill Cranes are permanent residents on Payne's Prairie, six miles south of Gainesville. This is the "Alachua Savanna" of William Bartram, who found cranes there about 1775. On the basis of several field trips to this area, total populations of resident cranes were as follows: 1953 before nesting, 9 cranes; after nesting, 14 cranes. 1954 before nesting, 13 cranes; after nesting, 19 cranes. I know of no other place in the Gainesville area where cranes breed. It is possible that there are small resident populations elsewhere on the prairies of north Florida.
>
> The following records include all my observations on cranes other than those that were without doubt resident Florida Sandhill Cranes. I believe that they were all migrating Greater Sandhill Cranes, because of (1) the size of the flocks, (2) the season of occurrence, and (3) behavior. The large flocks on Payne's Prairie were always seen out on the open grassland, and never in the sloughs occupied by the resident birds.
>
> *Spring 1953*
>
> 13 March—at 1145, I saw three cranes flying high overhead, heading northwest, over the University of Florida Campus.
> 14 March—Between 1030 and 1050, I saw 41 cranes (three flocks of 6, 12, 23 birds respectively) circling overhead. They seemed to be circling and not going anywhere in particular.
> (15 March—I went to Payne's Prairie hoping to find the flocks seen on the 14th, but saw only one pair of cranes.)
>
> *Autumn 1953*
>
> 7 November—At 1400, I saw 46 cranes (two flocks of 42 and 4) feeding on the open grassland of Payne's Prairie.
> 14 November—At 0800, 9 cranes were seen on Payne's Prairie, and at 1300, a flock of 42. (On 19 November, I found only 4.)
>
> *Spring 1954*
>
> 11 March—Dr. Archie Carr saw a flock of 13 flying over the campus. I saw a flock of 4 over the campus.
> 12 March—Edward L. Mockford saw a flock of 13 over the campus and the same the next day.
> 17 March—I observed a flock of 15 cranes flying over Hogtown Prairie, three miles west of Gainesville. (On 21 March, I saw only two cranes on Payne's Prairie.)
>
> I had no observations for autumn, 1954.
>
> *Spring 1955*
>
> 10 March—Between 1000 and 1030, three separate flocks of cranes, containing 9, 19, and 5 (total 33 birds), respectively, passed high over the campus heading NNW.
>
> The cranes that were flying over and apparently "going somewhere" in spring were pointed directly toward Indiana. Dr. Claude Adams, and Mr. Thomas Hicks, at that time both graduate students in ornithology at the University, and both long time residents of Florida, told me that they had seen what they thought were migrating flocks of cranes quite regularly in the spring and/or fall.

Since the great Okefenokee Swamp has become a National Refuge, *G. c. pratensis* has nested there regularly in fairly large numbers at times. However, there are times when concentrations in winter occur there also. This could also be a stopping place during migration.

Cypert (1957) reported an increase in cranes in the Okefenokee Swamp during the 1956–1957 winter. The area, he wrote, consists of 330,000 acres of the swamp's 400,000 acres. During the winters of 1954–1955 and 1955–1956 the population was estimated at 200 cranes; during 1956–1957, 1000 cranes. On an all-day hike, January 29, 1957, 522 cranes were recorded on the Chesser Prairie; flocks were present on all the prairies in lesser numbers. After the middle of March, no large numbers were observed. He wrote: "Several factors may have contributed to this apparent decline (after mid-March) in population: (1) some of the birds evidently migrated to nesting grounds elsewhere; (2) there was a rise in water levels, a fact which might have made the swamp less attractive to cranes and caused part of them to leave; and (3) during the nesting season cranes are more scattered and are less likely to be seen."

Even the deeper water of spring, 1957, however, would not compare with that when I studied the cranes there during late March and April, 1945, when we navigated Chesser Prairie in a duck boat because the water was too deep to wade. Cranes nested then in goodly numbers.

Apparently there has been no increase in numbers of wintering cranes in Jackson County, Mississippi, and only two cranes have been reported at any season from southern Louisiana in recent years. During the winter of 1950–1951, two cranes remained at the Sabine National Wildlife Refuge (Lowery, 1955). Near Elberta, Baldwin County, Alabama, flocks of six and four were found between December 1, 1957 and March 20, 1958, and in early February, 1958, a flock of 12 (Newman, 1958*a*). However, two cranes also remained here into June, 1958, near Romar Beach, indicating a breeding group (Newman, 1958*b*). Other cranes observed in recent years in southeastern Alabama and in western Florida, all of which could have been migrants, are: A flock of 6, Prattville, Alabama, September 24, 1932 (Imhof, MSS); a flock of 14, 27 miles west of Pensacola, Florida, in southern Alabama, November 30, 1947 (Weston, 1948); 94, near Fruitville, Florida, November 27, 1955 (Stevenson, 1956); 3, 20 miles northeast of Pensacola, November 25, 1956 (Newman, 1957).

G. c. pratensis nests through much of Florida, Jackson County, Mississippi, probably Baldwin County, Alabama, and the Okefenokee Swamp of southern Georgia.

The following are some of the more important records of the Sandhill

Crane east of the Mississippi River and north of Florida and southern Georgia during the migration season.

GEORGIA

SPRING MIGRATION

Charlton Co., Chesser Is. March (*ca.* 1916), 100 in flight; March 19, 1933, 19; March 20, 1940, 200 flying high overhead in a northwesterly direction (Walkinshaw, 1953); winter, 1956–1957, large numbers (522 on January 29), disappeared by mid-March (Cypert, 1957).

Bibb Co., Macon. March 20, 1955, 6 in V-formation flying northward at 400 feet, 13 one hour later in late afternoon (Johnston, 1956).

Jones Co., Piedmont National Wildlife Refuge, Round Oak. March 6, 1952, 60 in a flock flying northward (Chamberlain and Chamberlain, 1952); March 11, 14, 15, 1957, 4 flocks flying north (some 525 to 550 cranes) (Chamberlain, 1957).

Jasper Co., Jackson Lake. March 24, 1940, 40 flying in long irregular wedge at 150 feet (Wharton, 1940).

Augusta region. May, 1894, 2 (Burleigh, 1958:212).

Fulton Co., Atlanta. March 7, 1953 (10 a.m.), 2 flocks—80 and 35, each in rough V-formation flying north, some calling (Peters, 1953).

Dawson Co., Dawsonville. March 23, 1958, 34 (Kahl, 1958).

Habersham Co., Clarkesville. April 24, 1944, 3 flying over; April 24–25, 1955, 1 cripple (Chamberlain, 1955).

FALL MIGRATION

Fulton Co., northern portion. Nov. 1, 1951, 3 (2 of which were shot but not saved) (Peters, 1952).

Forsyth Co., Lake Lanier. Nov. 10, 1957, about 35 flying southeast in V-formation at about 600–700 feet (Chamberlain, 1958).

Jones Co., Piedmont National Wildlife Refuge. Nov. 1, 1942, 15 flying silently southward in V-formation at 600 feet (Fleetwood, 1942); Oct. 31, 1949 (9:30 a.m.), 15 flying south at 200 feet (Ambrosen, 1950); Oct. 24, 1957, 20 flying over (Chamberlain, 1958).

Irwin Co., Osierfield. Nov. 18, 1959, 62 flying SSE at 400 ft. (Hopkins, 1959).

Chatham Co., Savannah. Oct. 19, 1956, 5 flying over city (Tomkins, 1956).

Ware Co., Waycross. Oct. 29, 1957, 19 flying over (Chamberlain, 1958).

Charlton and Camden counties, Coleraine. Oct. 27, 1945, and Nov. 27, 1947, cranes flying south (Hebard, 1953).

Camden Co., Kingsland. Dec. 20, 1950 until Jan. 20, 1951, 2 apparently wintered (Witter, 1956).

SOUTH CAROLINA

Georgetown Co., Hasty Point Plantation. Nov. 23, 1928, 1 (Metcalf, 1929).

North Santee River, Rice Hope Plantation. Dec. 19, 1941, specimen of *G. c. tabida* identified by H. C. Oberholser (Sprunt and Chamberlain, 1949:191).

Eston Co., Mt. Pleasant. Oct. 18, 1890, specimen of *G. c. canadensis* taken (Sprunt and Chamberlain, *ibid.*).

NORTH CAROLINA

Robeson Co., Lennon's Marsh. Nov. 21, 1957, 2 specimens of *G. c. tabida* (N. Carolina State Museum) (T. Burleigh, letter).

TENNESSEE

SPRING MIGRATION

Chattanooga. June 1, 1935, specimen taken (Butts, 1936).

Cumberland Co., Crab Orchard. March 13, 1939 (7:30 a.m.), 13 on ground, frightened and flew to north (Adams, 1939).

Anderson Co., Oak Ridge National Laboratory. Feb. 25, 1950, 4 flying over and calling (Howell, 1952).

Knox Co., Knoxville. March 25, 1954, 4 flying over, calling (Brooks, 1954).

Shelby Co., Memphis. Feb. 1, 1953, 2 flying into field, then rose and headed northward (Barbig, 1953).

FALL MIGRATION

Bedford Co., Shelbyville. Aug., 1936, specimen taken from flock of 4 (Edney, 1940).

Anderson Co., Norris Lake, Sequoia Pt. Oct. 21, 1951, 4 calling and circling overhead (Howell, 1952).

Union Co., near Hurricane. Nov. 10, 1956, 4 calling and flying over (Brooks, 1957).

Sevier Co., Seymour. Oct. 22–24, 1942, 50 present on wheat field for 3 days—one was shot (Ijams, 1942).

Shelby–Tipton county line, Third Chickasaw Bluff, Twelve Outlets. Nov. 30, 1820, large flock (Deaderick, 1940).

KENTUCKY

SPRING MIGRATION

Eubank. March 8, 1894 (Bent, 1926:251).

Jefferson Co., Louisville, Goose Is. March 19, 1933, 13 in flight (Carpenter, 1933); April 3, 1938, 1 present from March 31 to April 6 (Monroe, 1938); March 19, 1950, 9 flying in V-formation, then in single line northward (H. B. Lovell in letter).

Edmonson Co., Mammoth Cave area. March 30, 1958 (4 p.m.), 5 flying over (Dilley, 1958).

FALL MIGRATION

Jefferson Co., Louisville. Nov. 8, 1956, 11 flying in southerly direction (Stamm, 1957).

WEST VIRGINIA

Mason Co., Point Pleasant. Sept., 1934, 1 taken (Brooks, 1944).

PENNSYLVANIA

Waynesburg, Wayne Twp., Tom or Hoover's Run. Spring 1900 or 1901, 1 specimen taken; May, 1902, 1 (Todd, 1940).

NEW JERSEY

Cape May Co., Light House Pond. Oct. 6, 1958, 2 (Choate, 1959).

MASSACHUSETTS

Barnstable Co., Orleans, North Beach. Sept. 1, 1955, 1; Barnstable. Until mid-October, 1955, 1—probably same bird (Morgan and Emery, 1956).

OHIO

SPRING MIGRATION

Clermont Co., 18 miles east of Cincinnati. May 9, 1948, 1 (Spencer, 1948).

Montgomery Co., Spring Valley. March 22, 1959, 4 (Edith C. Blincoe, *Journal Herald* Staff Writer, Dayton).

Huron Co., Plymouth. April 1, 1911 (Todd, 1911).

Sandusky Co., 5 miles northeast of Fremont. May 14, 1937, 16 (Dr. and Mrs. T. H. Langlois); May 18, 1937, 3 (L. E. Hicks in letter). Two miles east of mouth of bay. March 23, 1939 (Hicks, *ibid.*).

Ottawa Co. March 18, 1954, 10 (H. Mayfield in letter).

Lucas Co., Grand Rapids, along Maumee River. March 29, 1941, 2 (Mayfield, *ibid.*).

Ashtabula Co., Pymatuning Reservoir, Ohio side. March 20, 1937, 1; March 25, 1938, 1 (L. E. Hicks in letter).

Alliance, March 23, 1886 (Bent, 1926:251).

FALL MIGRATION

Lucas Co., Sylvania. Oct. 23, 1949 (2 p.m.), 28 flying south in single file, not very high and calling (R. Whiting in letter).

Ashtabula Co., Ashtabula. Nov., 1949, 3 (Mayfield, 1950).

Mercer Co., southside Grand Reservoir. Nov. 26, 1943, 7 (L. E. Hicks in letter). Lake St. Marys. Oct. 14, 1945, 1 (Clark, 1946).

Fairfield Co., Buckeye Lake. Oct. 9, 1926, 5 flying (Trautman, 1940).

In addition to the above, Bent (1926:252) gave Ohio dates from Chardon (Geauga Co.), Nov. 7, 1888; Medina (Medina Co.), Nov. 8, 1920; Canton (Stark Co.), Nov. 5, 1911.

INDIANA

(See Fig. 2)

SPRING MIGRATION

Ripley Co., Versailles State Park. Week of March 18–25, 1945, 2 seen and heard (R. E. Mumford in letter).

Knox Co., Bicknell. March 18, 1906 (Cooke, 1914).

Owen Co. March 16, 1956, 1 (Keller, 1958).

Putnam Co., Greencastle. March 9, 1952 (9:50 a.m.), 18 flying due north on warm day; wind south, 10–12 mph (Cope and Snow, 1952) (Mumford, letter).

Marion Co., southern part. March 25, 1956, 1 (Keller, 1958). Indianapolis. March 19, 1953 (1 p.m.), 3 flying northwest (Nolan, 1953). Oaklandon Reservoir. March 2, 1946, 4 (Rice, 1946); March 16, 1946, 6 flying north (Rice in letter).

Hancock Co., Greenfield. April 21–28, 1952, 1 injured (J. D. McCall in letter to Mumford).

Wayne Co., Richmond. March 31, 1956, 2 (J. B. Cope in letter).

Delaware Co., Muncie. April 9 (period from 1923 to 1931) (H. Zimmerman in letter to Mumford).

Tippecanoe Co. March 25, 1950, 3 flying (Marks and Wright, 1950).

Benton Co., Oterbein, 8 miles north. March 14, 1959, 2 flying north at 150 yds. at 1:20 p.m., and flock of 22 at 300–400 yds. at 3:20 p.m. (R. E. Mumford in letter).

Carroll Co. April 7, 1885 (Evermann, 1888).

Fulton Co., Rochester. March 4, 1891 (Bent, 1926).

Kosciusko Co., North Webster. April 21, 1958, 2 flying ENE at 11 a.m. (J. D. McCall in Pittman–Robertson Report). Small groups of two to four have been reported over Kosciusko or Noble counties in the springs of 1955, 1956, and 1958.

Noble Co., Diamond Lake. March 14, 1955, 4; March 27, 1956, 3 in flight (R. Thomas in Indiana Pittman–Robertson Report).

Jasper–Pulaski counties, Jasper–Pulaski Game Preserve. April 10, 1935, 24; April 7, 1939, 40 and 200; spring, 1941, 150 (spring peak 300) (Gorrell, 1941); March 17 to April 16, 1942, peak of 350 (Waggener, 1943); March 10, 1943, first crane of the year;

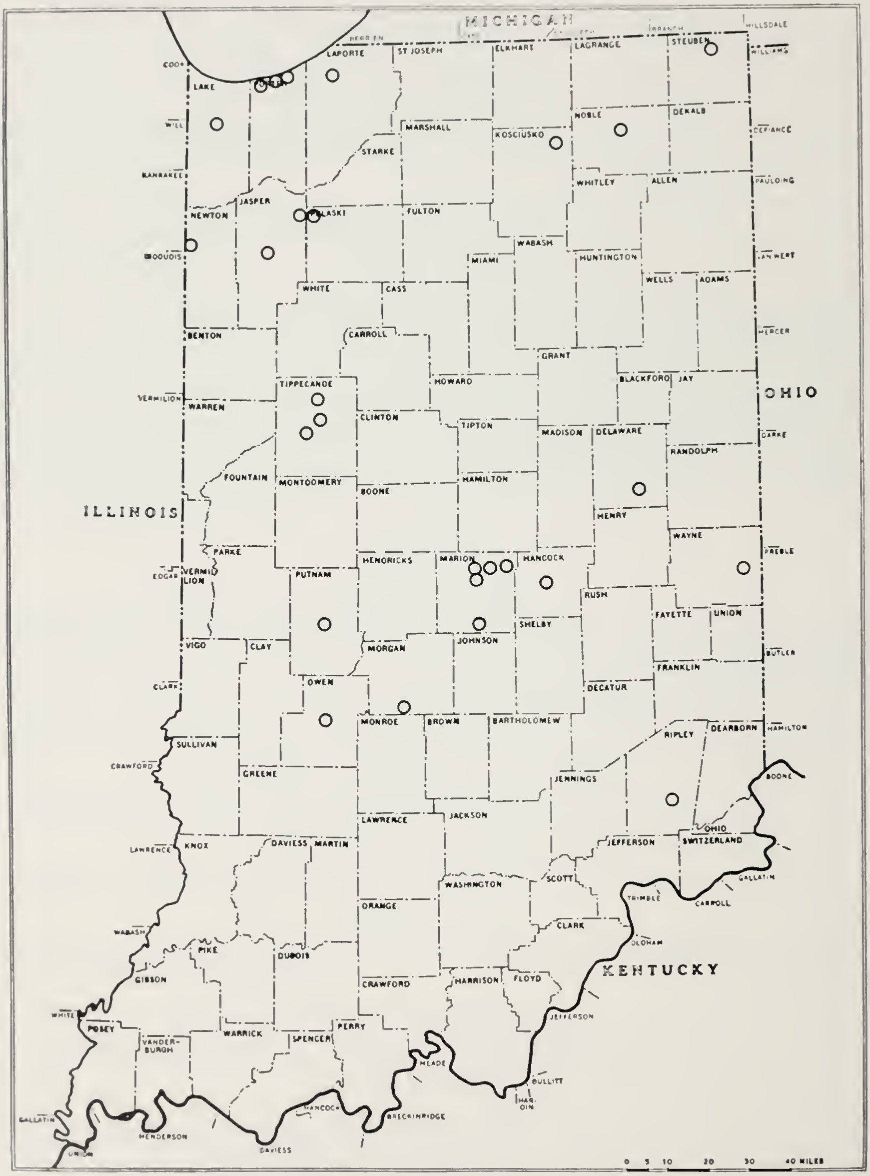

FIG. 2. Recent migration records of the Sandhill Crane in Indiana.
(Map copyrighted by Rand McNally & Co., Chicago)

March 11, 6; March 21–30, 350; May 28, 1—the last crane; March 18, 1944, 100; April 8, peak 695, June 8, the last crane (Walkinshaw, 1949:122); Feb. 26, 1945, 2—the first cranes of the year; March 25–31, 500; April 25, 7—last cranes (Mumford, 1950); March 20, 1946, 350; March 24, 406; April 7, 23—last cranes (Mumford, *ibid.*); March 11, 1947, first cranes; March 16, 39; March 30, 180; April 12–13, 190; last on May 2 (Mumford, *ibid.*); March 27, 1948, 200; March 28, 582 (Walkinshaw, 1950*b*); April 10, 17 (Mumford, *loc. cit.*); March 3, 1949, 6; April 2, 641; April 13, 11 (Mumford, *ibid.*); March 4, 1950, 7; March 25, 548; April 1, 628; May 2, 7; June 15, 2 stayed all summer (Mumford, *ibid.*) Feb. 25, 1951, 43; March 30, 331; March 31, 588; April 4, 63; April 20, 75 (Mumford in letter); Feb. 3, 1952, 1; Feb. 22, 1; March 8, 6 (Mumford, *ibid.*); March 29, 862; April 7, 300; March 28, 1953, 1019; March 29, 1164 (Grow, 1954), and 1214; Feb. 21, 1954, 3 (R. Grow in letter); March 19, 900; April 8, 80 (R. Mumford in letter); April 6, 1955, 144; March 23, 1956, 1560; March 24, 1716; Feb. 24, 1957, 27; March 30, 1524; April 10, 140 (Mumford, *ibid.*); March 27, 1958, 273; March 29, 1375; March 30, 345.

Newton Co., Willow Slough Game Preserve. March 20, 1951, 18; March 24, 1951, 7; March 29, 1951, 29; March 15, 1952, 18; March 22, 1952, 28; March 29, 1952, 12; April 5, 1952, 12; March 13, 1955, 1; Feb. 28, 1956, 5; March 31, 1957, 4 (Burr, 1957); March 18 and 23, 1958 (D. N. Martin in Indiana Pittman–Robertson Report); March 12, 1959 (Madden, verbal).

Marshall Co., Lake Maxinkuckee. April 6, 1885 (Evermann, 1920).

Lake Co., Crown Pt. April 2, 1949, 105 in flight (R. E. Phillips in letter to Mumford).

Porter Co. March 14 to April 20, 1957, 4 records (Burr, 1957); April 5, 1958, 1 (Burr, 1959). Baileytown. April 2, 1945, flocks of 14, 17, and 11 (Lewy, 1945); March 30 to April 22, 1951, 8 flocks—8–60 cranes (Mayfield, 1951*b*); April 1, 1955, 1 (R. Grow in letter).

Indiana Dunes. April 16, 1920, 1 (Sanborn, 1922): April 7, 1917, 3 (H. L. Stoddard in notes to Mumford); April 5, 1942, 5 (Smith, 1942); April 12, 1942, 57 (Smith, *ibid.*); March 31, 1949, 2 (D. H. Boyd in letter to Mumford); April 2, 1949 (Boyd, *ibid.*); April 2, 1950 (Boyd, *ibid.*).

LaPorte Co. March 21, 1953, 5 (M. Sweet in letter to Mumford); April 5, 1958, 44 (Burr, 1959).

Steuben Co., Pokagon State Park. April 9, 1943, 3 flying north.

FALL MIGRATION

Newton Co., Willow Slough Game Preserve. Sept. 20, 1951, 2; Sept. 22, 1952, 3; Oct. 7, 1954, 18; Sept. 18, 1956, 10; Oct. 3, 1956, 51 (Mumford in letter).

Jasper–Pulaski counties, Jasper–Pulaski Game Preserve. Oct. 15, 1941, 50; Nov. 1, 72; Nov. 27, 36; Sept. 17, 1942, 2; Oct. 20–27, 120–135; Nov. 12, 87; Nov. 13, 27; Nov. 25, 23 (Walkinshaw, 1949:112); Oct. 5, 1943, 12; Oct. 23, 160; Oct. 28, 143; Oct. 29, 66; Nov. 12, 9; Oct. 9, 1944, 2; Oct. 10–14, 13; Oct. 15–21, 56; Oct. 22–28, 127; Nov. 5–11, 128; Nov. 12–18, 135; Nov. 26 to Dec. 2, 39 (Mumford, 1950); Oct. 15, 1945, 66; Oct. 17, 90; Oct. 21, 250; Oct. 23, 150; Nov. 8, 65; Nov. 30, 8 (Mumford, *ibid.*); Sept. 30, 1946, 15; Oct. 27, 210 (Mumford, *ibid.*); Oct. 19, 1947, 106 (Mumford, *ibid.*); Oct. 4–10, 1948, 100; Oct. 11–17, 330; Oct. 18–31, 400; Oct. 17, 232; Dec. 15, 4—the last (Mumford, *ibid.*); Sept. 24, 1949, 3; Sept. 25, 7; Sept. 27, 15; Sept. 28, 39; Oct. 21, 190; Oct. 23, 623; Nov. 5–6, 500; Dec. 13, 17; Dec. 15, 1—last bird, had a broken leg (Mumford, *ibid.*); Sept. 13, 1950, 3; Sept. 14, 11; Sept. 27, 54; Oct. 5, 169; Oct. 10, 188; Oct. 17, 205; Oct. 24, 219; Oct. 25, 266; Oct. 27, 328; Oct. 29, 370; Oct. 31, 392; Nov. 3, 429; Nov. 6, 728; Nov. 12, 17, and 27, 811; Nov. 30, 706; Dec. 5, 622; Dec. 8, 310; Dec. 11, 122; Dec. 13–14, 5—the last (Mumford in letter); Oct. 7, 1951, 18; Oct. 14, 250; Oct. 15, 178; Oct. 20, 400; Oct. 28, 500; Nov. 4, 405; Nov. 11, 593; Nov. 24, 350; Dec. 1, 83; Dec. 5 and 8, 25; Oct. 14, 1952, 100; Oct. 27, 1192; Nov. 8, 393; Nov. 9, 317; Oct. 31, 1953, 600; Nov. 1, 1040; Dec. 8, 200; Sept. 22, 1954, 22; Oct., 150 plus; Oct. 23, 304 (Burr, 1955); Oct. 30, 1500 estimated; Oct. 31, 750 plus; Oct. 3, 1955, 75 (D. Martin in Indiana Pittman-Robertson Report); Oct. 18, 275 (D. Martin, *ibid.*); Nov. 12, 850 estimated; Nov. 1, 1958, 1500 estimated; Nov. 2, 1767; Nov. 26, 16.

Pulaski Co., Tippecanoe State Park. Oct. 17–24, 1943, 3 (Mumford in letter).

DeKalb Co., Waterloo. Sept. 7, 1904 (Bent, 1926).

Tippecanoe Co. Oct. 20, 1956, 3 (Burr, 1957). Lafayette. Nov. 18, 1949, 5 (Mayfield, 1950).

Delaware Co., Muncie. Oct. 25, 1955, 7 (Satter, 1956).

Marion Co., Indianapolis. Oct. 26, 1944, specimen; Nov. 24, 1950, 135 flying south at 400 feet in large wedge-shaped flock at 1 p.m. and calling (Rice, 1951). Oaklandon Reservoir. Nov. 7, 1948, one or two flocks heard very high, flying south—unable to see birds (Rice, 1949); Oct. 26, 1950, 32—probable—observed by farmer in cornfield.

Morgan Co., Mooresville. Nov. 24, 1957 (between 11 a.m. and noon), groups of 25, 8, 13, and 16 flew over, and one flock heard only (West, 1957).

Morgan–Monroe counties, Morgan–Monroe State Forest. Nov. 4, 1953, 30 flying south at 2:15 p.m. (Mumford in letter).

Knox Co., Bicknell. Oct. 27, 1894 (Cooke, 1914:13).

Vanderburgh Co., Diamond Is. Nov. 3, 1820 (Perkins, 1936).

ILLINOIS

(See Fig. 3)

SPRING MIGRATION

Wabash Co., Mt. Carmel. March 1, 1863, March 4, 1868 (Cooke, 1914:12).

Marion Co., Odin. Feb. 19, 1890 (Black, MS).

Fayette Co., Vandalia. April 10, 1894 (Black, MS).

Scott Co., Griggsville. March 24, 1884 (Bent, 1926).

Champaign Co., Rantoul. April 17, 1909, March 28, 1914, April 2, 1916 (Black, MS).

Iroquois Co., NE of Beaverville. March 29, 1952, 10 (Walkinshaw, Wing).

Whiteside Co., Tampico. March 8, 1887 (March 25—six-year average) (Cooke, *loc. cit.*).

DeKalb Co., Genoa. April 19, 1953 (Smith and Parmalee, 1955).

Cook Co., Orland. March 23, 1920 (Black, MS). Orland Wildlife Refuge, McGinnis Slough. April 8, 1940. Blue Is. March 31, 1940, 23 (Bartel, 1940). Willow Springs. March 27, 1954, 31 flying NW and calling (Mrs. W. T. Lory in letter). Hinsdale. May 20, 1923 (Black, MS). Chicago region. April 17, 1877 (Black, MS); April 7, 22, 1917, April 22, 1920, April 3, 1928 (Ford *et al.*, 1934; Black, MS); April 28, 1934, March 25, 1948, March 20, 30, 1949 (Ford, 1956).

Lake Co., Waukegan. April 3, 1939 (Boulton and Pitelka, 1939).

Florida (Illinois). March 19, 1888 (Bent, 1926).

FALL MIGRATION

Lake Co., Lake Forest. Aug. 22, 1877 (Black, MS). Barrington, Bakers Lake. Oct. 11, 1958, 35 flying. Lake Bluff. Nov. 7, 1948 (Smith and Parmalee, 1955).

Cook Co., Chicago region. Sept. 16–17, 1929, Sept. 4, 1932, Oct. 24, 1947, Aug. 28, 1949 (Ford, 1956).

Will Co., Crete. Sept. 11, 1915 (Eifrig, 1919).

Bureau Co., Bureau. Oct. 27, 1906 (specimen, U.S. Nat. Mus., 200 965).

Mason Co., Havana. Oct., 1951, 1 (S. C. Kendeigh, letter).

Champaign Co., Rantoul. Oct. 29, 1917 (Black, MS). Urbana. Nov. 13, 1954, 1 wounded (Smith and Parmalee, 1955).

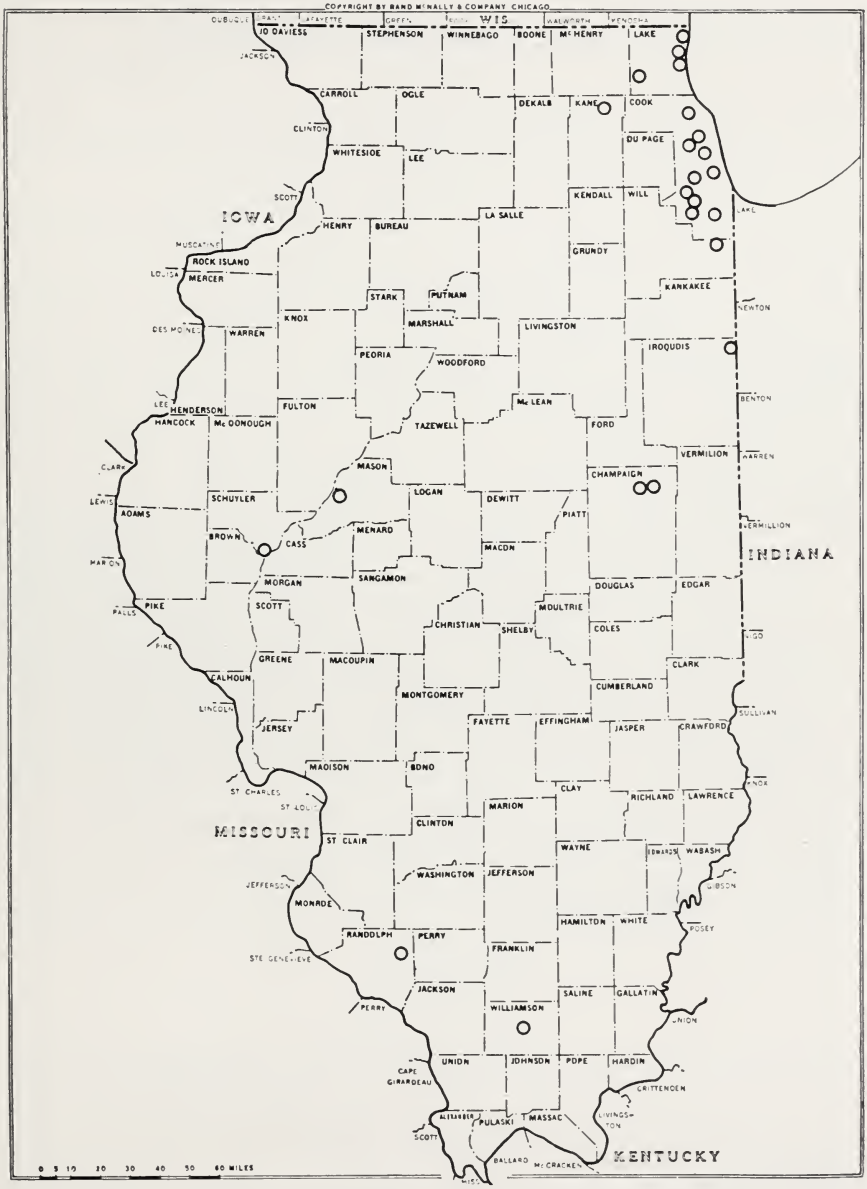

FIG. 3. Recent migration records of the Sandhill Crane in Illinois.

Schuyler Co., 10 mi. north of Beardstown. Nov. 3, 1946, 4 (T. E. Mussellman in letter).

Randolph Co., Sparta. Sept. 5, 1950, 1 (Mayfield, 1951*a*).

Williamson Co., Crab Orchard Wildlife Refuge. Nov. 7, 1952 (Smith and Parmalee, 1955). Crab Orchard Lake. Oct. 7, 1954 (Smith and Parmalee, 1955).

ONTARIO

Below is a summary of records of the Sandhill Crane from Ontario.

1772: Mouth of Severn River. Forster (1772) indicated that the species nested here.
1862: Kent Co. Two adults with 2 young (McIllwraith, 1894).
1869: Rondeau. Specimen collected by J. Oxford (Nat. Mus. Canada).
1872: Toronto. A pair was collected in the fall by G. Warren (Roy. Ont. Mus. Zool.).
1881: Kent Co. Two observed, one collected (Allin, 1943).
1882: Mitchell Bay, St. Claire Flats. A pair observed (Allin, 1943).
1890: Leeds Co., Mud Creek. A pair shot (J. Thompson). Escott. Flock flying over (Toner *et al.*, 1942).
1892: Thunder Bay Dist., Silver Is. One shot from flock of 5 on Sept. 27 (Allin, 1943).
1893: Mt. Forest. Reported in April (Allin, 1943).
1935: Gore Bay. Mounted specimen, said to have been taken several years earlier (Williams, 1942).
1939: Ft. Williams, 50 mi. SW. Sept. 30, 4 flying over (Allin, 1943).
1941: Port Arthur, 30 mi. NE. Sept. 6, 2 (Allin, 1943).
1950: Junction of Asheweig and Winisk Rivers (Lat. 54.25°; Long. 87.5°). C. A. Elsey observed cranes as follows: May 9, 2; May 11, 1; May 16, heard; May 17, 2; May 22, 2. The Indians of the region, when they observed a picture of the Sandhill Crane, reported that cranes nested there regularly (Baillie, 1951, and letter from Elsey, March 10, 1952). Nikip Lake, near the headwaters of the Severn River (Lat. 52.5°; Long. 91.5°). A. T. Cringan worked here steadily from June 6 until Sept. 9 in the field and heard cranes on June 30 and Aug. 26, and observed 2 on Aug. 3. Wawa Lakes, between Kapuskasing and Moosonee. A. S. Hawkins observed 2 cranes June 24 (letter, Feb. 14, 1952, and Baillie, 1951).
1952: Thunder Bay Dist., Lappe. Oct. 9, 1952, specimen of *G. c. canadensis* (Baillie, 1953).
1955: North shore of Lake Ontario, Oshawa Marsh. May 8, 1 (Baillie, 1955).
1957: Point Pelee. Oct. 5, 1 (Bennett *et al.*, 1958).
1958: Moosonee, 9 mi. east. May 23, 2; May 24, 1 (Gunn, 1958).

In addition to the above records there is a specimen (Nat. Mus. Canada) taken at Beaumaris.

MICHIGAN

(See Fig. 4)

SPRING MIGRATION

Monroe Co., Petersburg. Earliest, March 8, 1892 (9-year average, March 15) (Cooke, 1914). Erie Twp., March 24, 1940, 4 in flight (W. Anderson in letter).

St. Joseph Co., Lockport and Fabius Twps. April 11, 1926, 1; March 20, 1947, 2 in flight (O. M. Bryens in letter). Constantine Twp., Three Rivers State Game Area. March 20, 1952, 3 in flight.

Berrien Co., Paw Paw Lake. March 30, 1952, flocks of 5 and 17 in loose circling formation drifting NW at 500 feet (A. Ammann, letter).

Kalamazoo Co., Ross Twp., W. K. Kellogg Bird Sanct. March 21, 1941, 2 in flight; March 22, 1941, 3 in flight (M. D. Pirnie, verbal comm.). Oshtemo, 2 mi. east. April 8, 1951, 1 (J. B. Fleugel, verbal comm.). Gourdneck State Game Area. March 14, 1952, 3 (A. Ammann, State Cons. Dept. notes).

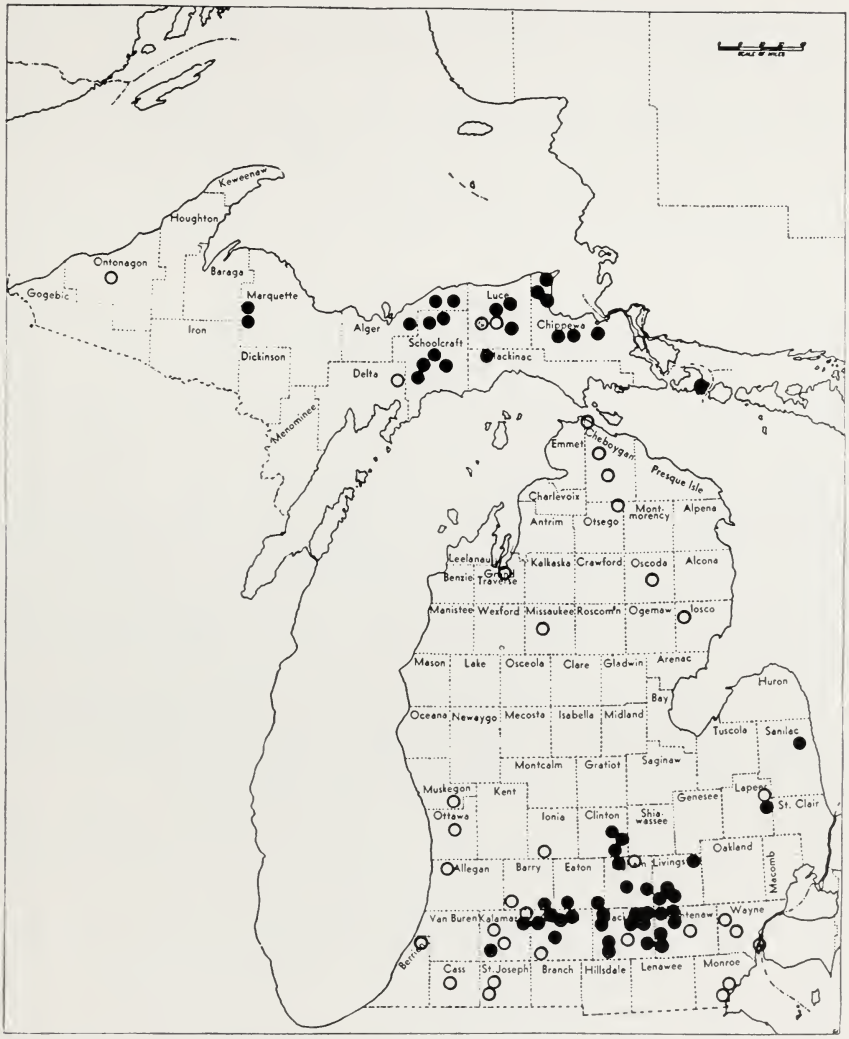

Fig. 4. The Sandhill Crane in Michigan. ○—Migration records outside known breeding areas. ●—Known breeding areas.

Calhoun Co., 6 mi. north of Union City. March 5, 1951 (3–4 p.m.), 6 flying north at 300–400 feet (W. A. Dyer, verbal comm.). Convis Twp., B. W. Baker Sanct. area (including a 3-mi. radius). April 3, 1932, 2; March 26, 1933, 3; March 25, 1934, 3; March 14, 1935, 5; April 9, 1936, 2; March 25, 1937, 2; March 26, 1938; March 22, 1939; March 24, 1940, 2; March 22, 1941, 1; March 15, 1942, 2; March 18, 1943, 6; March 7, 1944; March 13, 1945, 2; March 7, 1946, 2; March 20, 1947, 1; March 20, 1948, 4; Feb. 26, 1949, 1; March 18, 1950, 1; March 6, 1951, several heard in p.m.;

March 8, 1952, 2; March 11, 1953; March 18, 1954, 3; March 10, 1955, 3 and 1; March 3, 1956, 2; March 14, 1957, 1; March 5, 1958, 2; March 11, 1959, 2; March 18, 1960, 3 (Walkinshaw, 1950*a*).

Jackson Co., Springport Twp., Sects. 2, 10, 21. March 17, 1952; March 21, 1953, 4; Feb. 25, 1955, 2; March 17, 1957, 2. Waterloo Twp. March 5, 1922, 4; March 20, 1923, 2; April 10, 1926, 2; March 25, 1929. Sections 26 and 27. March 24, 1936; March 22, 1937; March 20, 1938; March 15, 1939; March 24, 1940; March 22, 1941; March 19, 1942. Sect. 30. March 4, 1945; March 8, 1946; March 13, 1947; March 10, 1949, 7; March 8, 1952; March 12, 1953, heard; March 12, 1955, 2; March 10, 1956, 1–7, by three different groups; March 16, 1957, 2 at Spring Lake. Sect. 35. March 22, 1958, 6 in 3 areas.

Leoni Twp., Sect. 2 (now the Phyllis Haehnle Mem. Sanct.). March 28, 1937, 3; March 23, 1939, 2; March 31, 1940, 6; March 23, 1941, 7; March 12, 1942, 2; March 3, 1951, 1; March 10, 1952, 8; March 12, 1953, 3; March 17, 1954, 4; March 4, 1955; March, 1956; March, 1957; March 11, 1958, 3; March, 1959. Summitt Twp. March 24, 1954, 2. Norvell–Grass Lake Twps., Bessey Lake. March 28, 1954, 2. Jackson. Feb. 28, 1948 (Wallace and Black, 1948); March 7, 1953, 9 (Wickstrom, 1953). Jackson, 3 mi. SE. March 12, 1953 (11 a.m.), 3 flying NE at 1000 feet.

Washtenaw Co. March 12, 1933, 4 (J. R. Greeley, Univ. Mich. notes); March 3, 1936, 3 in flight (N. A. Wood, verbal comm.). Sharon Twp., Sect. 8. March 27, 1941, 3; March 22, 1953, 2; March 28, 1954, 5. Lyndon Twp., Boyce Lake. March 12, 1955, 3; March 21, 1956, 2; March 27, 1957, 2; March 22, 1958, 8.

Wayne Co., Plymouth. March 14, 1945, 3 flying in westerly direction. Dearborn. March 14, 1949, 14 flying west (O'Reilly, 1951). Grosse Ile. March 21, 1952 (Wickstrom, 1952).

Allegan Co., Fillmore. March 6, 1942, in flight (N. T. Peterson, verbal comm.).

Barry Co., Johnstown Twp., Sect. 24. March 23, 1941, 1; March 20, 1942, 2; March 28, 1947, 1; March 26, 1948, 1; March 15, 1955, 1; March, 1959, 1. Prairieville Twp., Baker Lake. March 3, 1951, 3 in flight (M. D. Pirnie, verbal comm.).

Eaton Co., Bellevue Twp. March 22, 1939 (D. Hall, verbal comm.).

Ingham Co., Meridian Twp., Sect. 2. March 29, 1952, heard (M. D. Pirnie, verbal comm.). Locke. Feb. 19, 1857; March 19, 1858; March 16, 1859; March 8, 1860; April 2, 1861; March 27, 1862; March 31, 1863; April 12, 1864; March 20, 1865; April 3, 1866; March 25, 1867; March 13, 1868; March 28, 1869; March 31, 1870; March 9, 1871; March 28, 1872; March 19, 1873; March 20, 1874; March 27, 1875; April 8, 1876; March 30, 1877; March 15, 1878; April 9, 1879; March 30, 1880; March 29, 1881; March 1, 1882; March 13, 1883 (Atkins, 1884). Stockbridge. March 26, 1929; March 23, 1930. Lansing. March 25, 1950 (Wickstrom, 1950).

Livingston Co., Unadilla. March 24, 1911, flock of about 20 (Wood, 1951:144–145); March 13, 1952, 2; March 10, 1955, 5; March 22, 1958, 2. Iosco Twp., Sects. 24, 35, 36. March 26, 1939, 2; March 27, 1941, 3; March 22, 1952, 2.

Ionia Co., Woodbury. March 27, 1932, calling flock flying north in low clouds in early p.m. (birds not seen).

Clinton Co., Bath Twp., Park Lake. March 24, 1934; March 19, 1935. Corey Marsh, 2½ mi. NE of Park Lake. March 12, 1936; March 8, 1937; March 13, 1938, 3; March 14, 1939, 2; March 27, 1940; March 23, 1941, 4; March 19, 1942, 2; March 14, 1943; March 11, 1944; March 1, 1946; March 18, 1947, 3; March 17, 1948; March 8, 1949 (10:30 a.m.), 3; March 23, 1950; March 6, 1951; March 10, 1952; March 11, 1953, 2; March 12, 1954, 3; March 15, 1955, 2; March 10, 1956, 3; March 14, 1957, 3; March 18, 1958, 3; March, 1959. Rose Lake Expt. Station. March 19, 1939; March 25, 1940, 3; March 24, 1941, 4; March 24, 1942, 4; March 14, 1943, 2; March 17, 1944, 5; March 15, 1945, 2; March 1, 1946, 3; March 20, 1947, 1; March 17, 1948; March 7, 1949; March 13, 1950; March 6, 1951; March 19, 1952, 1; March 11, 1953; March 12, 1954; March 15, 1955; March 10, 1956, 3; March 14, 1957, 3; March 18, 1958, 3; March, 1959. Victor Twp., Sects. 28, 32, 33. March 2, 1953 (Wickstrom, 1953); March 13, 1955, 2 heard; March 11, 1956, 4.

Ottawa Co., Allendale Twp., Sects. 17, 21. April 8, 1951, 15 in flock flying north at 100 feet on bright sunny day (P. Hovingh, J. Ponshair, verbal comm.).

Muskegon Co., T9N, R15W, Sect. 36. May 3, 1954, 5 on ground had been there 10 days (Mich. Dept. Cons. notes).

Lapeer Co., Imlay City. March 15, 1945, 5 (Wallace, 1945).

Lake Co., Luther. April 7, 1955, 4 (Black, 1955).

Iosco Co., Hale. April 26, 1953 (Wickstrom, 1953).

Oscoda Co., Mio. April 7, 1955, 10 in flight (Black, 1955).

Otsego Co., T32N, R1W, Sect. 4. May 5, 1940, 2 (H. Tubbs in letter).

Cheboygan Co., Afton. April 1, 1953, 2 flying at 60 feet northward (E. Shultz, verbal comm.).

Schoolcraft Co., Blaney Park. April 4, 1935; April 10, 1936, 2; April 17, 1940, 2; April 13, 1941, 1; April 11, 1942, 2; March 31, 1943, 2; April 11, 1944, 1; March 25, 1945; March 12, 1946, 1; April 13, 1947, 2; April 5, 1948, 1; April 10, 1949, 1; April 8, 1950, 2; March 29, 1952; April 4, 1953, 2; April 6, 1954; April 16, 1958, 1. Seney National Wildlife Refuge. April 12, 1936; April 8, 1937; March 29, 1938, 2; April 5, 1939, 4; April 13, 1940, 1; April 3, 1941, 1; April 2, 1942, 2; April 8, 1943; April 15, 1944; April 13, 1945; March 28, 1946; April 11, 1947; April 7, 1948; March 29, 1949; April 17, 1950; April 10, 1951; April 9, 1952; April 16, 1953; April 6, 1954; April 3, 1955; April 7, 1956; April 2, 1957; April 9, 1958; April 4, 1959, 4 (U.S. Fish and Wildlife Service Notes).

Luce Co., McMillan. April 15, 1922; April 2, 1925, 2; April 25, 1929, 1; April 10, 1932, 2; April 20, 1934, 1; April 13, 1935, 7; April 16, 1939, 2; April 21, 1940, 1; April 7, 1941, 1; April 15, 1942, 1; April 17, 1943, 1; April 8, 1945, 2 (O. M. Bryens, letter).

Chippewa Co., Rudyard. April 20, 1958, 2 (Kenaga, 1958).

FALL MIGRATION

Ontonagon Co. Nov. 18, 1955, 2 flying south (E. Bacon in letter to M. D. Pirnie).

Delta Co., T43N, R18W, Sect. 32. Oct. 8, 1931, 9. T43N, R19W, Sect. 15. Oct. 8, 1931, 23 (K. Christofferson, letter).

Alger Co., T47N, R17W, Sect. 33. Sept. 12, 1949 (Nelson, 1950).

Schoolcraft Co., Seney. Sept. 25, 1895 (Barrows, 1912:151). Seney National Wildlife Refuge. Sept. 12–24, 1936; Oct. 14, 1939; Oct., 1939, 80 in one flock; Oct. 16, 1940, 25; Oct. 2, 1941, 26; Oct. 19, 1943; Oct. 8, 1944; Oct. 28, 1945; Oct., 1946; Oct. 6–9, 1947; Sept. 27, 1948; Sept. 15, 1949; Oct. 8, 1950; Oct. 1, 1951; Sept. 20, 1952; Oct. 11, 1953; Sept. 14, 1954; Oct. 3, 1955; Sept. 18, 1956; Sept. 25, 1957; Sept. 7–13, 1958 (notes from Seney National Wildlife Refuge). Blaney Park. Oct. 10, 1939, 6; Sept. 13, 1940, 4; Sept. 26, 1946, 1; Sept. 25, 1947, 2; Sept. 19, 1948, 2; Sept. 20, 1949, 2; Sept. 30, 1950, heard; Sept. 23, 1952, 4; Sept. 12, 1953, 3; Oct. 22, 1954, 1. Manistique. Sept. 19, 1935, 18 (K. Christofferson, letter).

Luce Co., T45N, R11W, Sects. 9, 10. Sept. 15, 1929, 2; Sept. 29, 1930, 8; Sept. 8, 1931, 4; Oct. 8, 1931, 14; Sept. 21, 1932, 2; Oct. 18, 1935, 10; Oct. 3, 1936, 3; Oct. 9, 1939, 14; Oct. 15, 1942, 15; Sept. 16, 1945, 1 (O. M. Bryens in letter). Sleeper Lake, T48N, R10W, Sects. 33, 34. Sept. 4, 1950, flocks totaling 54 at roost; Oct. 7, 1950, only 3 in same roost. Swamp Lakes, T49N, R9W, Oct. 4, 1945, 75 in one flock. Newberry. Sept. 24, 1945, 36 flying low to south and calling.

Chippewa Co., Whitefish Point. Oct. 2, 1929, male collected (Wood, 1951:146). Fibre. Oct. 1, 1936, 9 (Wood, *ibid.*).

Cheboygan Co., Mackinac City. Sept. 30, 1953 (11 a.m.), 28 flying fairly high southeast over straits (A. Ammann in letter).

Otsego Co., Grass Lake, T32N, R1W, Sect. 5. Oct. 1, 1958, 43 flying south (A. Ammann in letter).

Grand Traverse Co., Weather Lake. Sept. 7–8, 1955, 2 (H. Mahan).

Missaukee Co., Lake City, 2 mi. SE. Oct. 6, 1951, 22 flying south and calling at 10 a.m. (M. D. Pirnie in letter).

Ottawa Co. Oct. 23, 1909, specimen in Grand Rapids Museum (Wood, 1951).

Clinton Co., Bath Twp., Rose Lake Expt. Station and Corey Marsh. Nov. 16, 1935; Oct. 9, 1938, 2; Oct. 1, 1939, 23; Oct. 25, 1940, 2 (peak, Oct. 11—16 cranes); Oct. 15, 1941, 2; Oct. 17, 1942, 4; Oct. 3, 1943, 17; Oct. 14, 1944, 20 and 7; Oct. 5, 1946, 12 and 8; Oct. 23, 1947, 1; Oct. 13, 1950, 11; Oct. 16, 1950, 4; Oct. 15, 1951, 14; Oct. 15, 1952, 50–65 flying; Oct. 15, 1953; Oct. 3, 1954, 13; Oct. 21, 1956, 17; Oct. 22, 1958, 4 (C. T. Black in letter). Bath Twp., Park Lake. Oct. 1, 1950, 50 flying (E. Goff in Mich. Dept. Cons. notes).

Barry Co., Johnstown Twp., Sect. 25, and Assyria Twp., Sect. 19. Nov. 9, 1957, 2; Nov. 19, 1958, 5; Nov. 10, 1959, 8.

Ingham Co., east of Lansing. Nov. 9, 1947, 50 flying SE in V-formation at 400 feet and occasionally calling. Stockbridge. Oct. 14, 1929, 4.

Livingston Co., Putnam Twp., T1N, R4E, Sect. 30. Dec. 15, 1946, 2 (F. N. Hamerstrom, Jr., in letter). Iosco Twp. Oct. 17, 1951. Unadilla Twp., Sect. 31. Oct. 8, 1955.

Calhoun Co., Convis Twp., Sects. 3, 6, 10, 11, 14, 15. Oct. 13, 1934, 8; Oct. 6, 1938, 2; Oct. 1, 1939, 16; Nov. 3, 1940, 9; Oct. 24, 1941, 3; Oct. 8, 1942, 3; Nov. 11, 1943, 2; Nov. 12, 1944, 1; Nov. 15, 1945, 2; Nov. 16, 1946, 2; Nov. 9, 1947, 5; Nov. 25, 1948, 7; Nov. 20, 1949, 14; Nov. 10, 1950, 6; Oct. 28, 1951, 10; Nov. 1, 1952, 12; Nov. 15, 1953, 9; Nov. 13, 1954, 4; Nov. 9, 1955, 29; Nov. 10, 1956, 4; Nov. 2, 1957, 11; Nov. 22, 1958, 5; Nov. 15, 1959, 11. From 1943–1959 the last dates are within 2 days or less of actual departure dates.

Jackson Co., Springport Twp., Sects. 10, 11, 15. First week of Nov., 1952, 5 (O. C. McPherson, verbal comm.). Leoni Twp., Sect. 2. Oct. 24, 1935, 2; Oct. 7, 1949, 9; Oct. 22, 1950, 5; Nov. 2, 1957, last; Oct. 14, 1958, 91; Oct. 1, 1959, 66. Waterloo Twp., Portage Marsh, Portage Lake, Whitehead Lake. Oct. 4, 1936, 3; Oct. 24, 1937, 5 (Wood, 1951); Oct., 1938, 56 (W. Moechel, verbal comm.); Oct. 20, 1940, 9 (peak Oct. 6—46 cranes); Oct. 19, 1941, 8 (peak Oct. 9—45 cranes); Nov. 6, 1942, 20 (peak Oct. 17—48 cranes); Oct. 14, 1943, the last (Oct. 10—36 cranes); Oct. 15, 1944, 40; Oct. 15, 1945, 10 (peak Oct. 6—38 cranes); Oct. 16, 1950, 16 (peak Oct. 14—46 cranes); Oct. 14, 1951, 84; Oct. 12, 1952, 98 (last on Oct. 30—2 cranes); Oct. 7, 1953, 99; Oct. 10, 76; Oct. 17, 31; Oct. 2, 1954, 81; Oct. 10, 2; Oct. 8, 1955, 80; Oct. 5, 1957, 127; Oct. 6, 131; Oct. 4, 1958, 107. Norvell Twp., Sect. 33. Oct. 1, 1954, 2 (M. D. Pirnie, verbal comm.). Manchester. Nov. 24, 1896 (Cooke, 1914:13). Hanover Twp., Sect. 8. Oct. 1, 1952 (C. Owens, letter).

Washtenaw Co., Lyndon Twp. Oct. 25, 1900. Sect. 8. Oct. 21, 1951, 30; Oct. 10, 1953, 35; Oct. 17, 1953, 28; Oct. 10, 1954, 47; Oct. 2, 1955, 77; Oct. 8, 1955, 67; Oct. 6, 1957, 65; Oct. 10, 36; Oct. 4, 1958, 53; Oct. 14, 45; Oct. 23, 33. Sect. 19. Oct. 13, 1940, 33. Dexter Twp.–Lima Twp., 4-mile Lake. Sept. 27, 1953, 4. Sharon Twp., Sect. 8. Oct. 19, 1930, 10; Oct. 8, 1955, 9.

Cass Co. Sept. 3, 1950, 1 (Wickstrom, 1951).

Monroe Co., Erie Twp. Oct. 19, 1948, 3 in flight (Wallace and Black, 1949).

WISCONSIN

SPRING MIGRATION

Rock Co., Johnstown. April 4, 1894, specimen of *G. c. canadensis* (Kumlien *et al.*, 1951:29); March 30, 1958, 8 flying (MacBriar, 1958).

Racine Co., Racine. April 13, 17, and 20, 1946 (Barger, 1946*b*).

Dane Co. March 21, 1948, 2 (Robbins, 1948*b*). Madison. May 14, 1943, 2 (Barger, 1943*b*); April 15, 16, 1947, 69 (Robbins, 1947*b*); April 27, 1949, 2 (Robbins, 1949*b*). Mazomanie. March 31, 1950, 2 (Robbins, 1950*b*).

Jefferson Co. April 2, 1950, 2 (Robbins, 1950*b*); March 27, 1952, 1 (Strelitzer, 1952); April 4, 1954 (Besadny, 1954*c*); April 15, 1957 (Lound and Lound, 1957*b*). Busseyville. April 26, 1869, flying north in night (Schorger, 1944).

Waukesha Co. May 13, 1954 (Besadny, 1954*d*); March 30, 1940, 4 (Barger, 1940*b*). Waukesha. April 7, 1950, 16 (Robbins, 1950*b*).

Sauk Co., Sauk City. May 8, 1938, 2 (Grange, MS).

Columbia Co. March 27, 1954 (Besadny, 1954*c*). Poynette. May 7, 1940, 2 (Barger, 1940*c*); March 22, 1941, 24 (Barger, 1941*b*); April 14, 1947 (Robbins, 1947*b*); May 2, 1957 (Lound and Lound, 1957*b*); April 27, 1958 (MacBriar, 1958).

Dodge Co. April 3, 1898, 9; April 5, 1900, 1 shot; April 7, 1900, 1; April 8, 1904, flock; April 22, 1924, flock (notes from W. E. Scott). Horicon. May 5, 1942 (Barger, 1942); March 19, 1945, 25 (Smith and DuMont, 1945); April 1, 1950, 10; April 7, 1950, 34; April 9, 1950, 1 (Robbins, 1950*b*); March 31, 1957, 9 (Lound and Lound, 1957*b*). Kekoskee. April 8, 1944, 75 (Barger, 1944).

Monroe Co. Feb. 28, 1951, 2 (Grange, MS).

Juneau Co., Clearfield. April 20, 1939, 3 (Laboda, 1939).

Adams Co. April 14, 1953 (Besadny, 1953); April 30, 1954 (Besadny, 1954*c*); April 6, 1955 (Foster, 1955); April 8, 1957 (Lound and Lound, 1957*b*); April 3, 1958 (MacBriar, 1958).

Marquette Co. Jan. 8, 1941, 1 dead and 1 alive (Barger, 1941*a*). Endeavor Marsh. March 29, 1943, 2 (Barger, 1943*b*); May 20, 1944, 4 (Barger, 1944); April 10, 1935, 300 (B. Kimball in report to Aldo Leopold).

Green Lake Co. April 20, 1950 (Robbins, 1950*b*); April 15, 1951, 26 flying over (Strelitzer, 1951); March 28, 1952, 12 (Strelitzer, 1952). Town of Seneca, Sect. 16. April 30, 1949, 400 plus (N. A. Damaske, pers. comm.); May 11, 1950, 70 plus. Sect. 17. April 25, 1950, 36; May 11, 1950, 42. Sect. 3. May 11, 1950. 600 in flight. Town of St. Marie. April 30, 1949, 250 plus; April 25, 1950, 10.

Waushara Co. March 30, 1940 (Barger, 1940*a*).

Manitowoc Co. May 17, 1950, 2 (Robbins, 1950*c*); May 12, 1956 (Lound and Lound, 1956).

Calumet Co. March 23, 1949, 25 flying west (Grange, MS).

Jackson Co., Hoffman–Stebbins Range, T20–21N, R1E. Late March, 1936, April 9, 1937 (Hamerstrom, 1938). April 25, 1957, 7 (Lound and Lound, 1957*b*).

Wood Co. March 29, 1942 (Mathiak, 1942); April 4, 1949, 2 (Robbins, 1949*b*); March 29, 1952 (Strelitzer, 1952). Cranmoor. April 1, 1929 (Grange, MS). Babcock, Sandhill Game Farm. April 9, 1937; March 28, 1950; March 21, 1952, 4 (Grange, MS). Wisconsin Rapids. April 1, 1947 (Robbins, 1947*b*).

Outagamie Co. April 28, 1954 (Besadny, 1954*c*). Shiocton. April 17, 1947, 15 (Robbins, 1947*b*); March 29, 1958 (MacBriar, 1958).

Shawano Co. June 1, 1950 (Robbins, 1950*b*).

Polk Co. April 29, 1950 (Robbins, 1950*b*).

Burnett Co. May 10, 1952 (Strelitzer, 1952); April 9, 1956 (Lound and Lound, 1956); April 2, 1957 (Lound and Lound, 1957*b*); April 4, 1958 (MacBriar, 1958).

Sawyer Co. May 5, 1941 (Barger, 1941*c*).

Ashland Co., Outer Is. May 23, 1950, 2 (Robbins, 1950*c*).

FALL MIGRATION

Vilas Co. Sept. 27, 1958 (Kemper, 1959).

Barron Co. Oct. 8, 1957, 1 (Lound and Lound, 1958).

Burnett Co. Sept. 4, 1956 (Lound and Lound, 1957*a*).

Dunn Co. Oct. 1, 1953 (Besadny, 1954*a*).

Chippewa Co. Oct. 1, 1957, 1 (Lound and Lound, 1958).

Oconto Co., Peshtigo Marsh. Sept. 3, 1940, 3 over (Barger, 1940*d*).

Shawano Co. Aug. 27, 1953, 6 (Besadny, 1954*a*).

Trempealeau Co. Nov. 2, 1953 (Besadny, 1954*b*).

Jackson Co., Grimshaw Range. Oct. 20, 1936, most cranes gone; Nov. 8, 1936, last 2 left (Hamerstrom, 1938).

Wood Co. Oct. 10, 1936; Oct. 6, 1957 (Lound and Lound, 1958). Pittsfield. Sept. 20, 1924. Remmington. Oct. 3, 1939, 3 (Scott, 1939*b*). Babcock. Nov. 6, 1950 (Robbins, 1951*b*). Amundson Cranberry Marsh. Oct. 15, 1940, 14; Oct., 1941, 21; Oct., 1948, 21 (Grange, MS). Babcock, Sandhill Game Farm. Oct. 16, 1949, 31; Oct. 28, 1950, 25 (Oct. 24—55 cranes); Oct. 31, 1951, 30 plus (Oct. 21 and 22—34 cranes); Oct. 15, 1952, 22 (earlier Oct.—46 cranes) (Grange, MS). Babcock, Y-ditch. Oct. 28, 1949, 44 (Grange, MS).

Outagamie Co., Shiocton. Oct. 9, 1882 (Gruntvig, 1894–1895:100); Oct. 11, 1949, 8 (Robbins, 1950*a*). New London. Oct. 14, 1928; Oct. 20, 1935; Nov. 7, 1938 (supplied by U.S. Fish and Wildlife Service); Oct., 1940, 34 (Barger, 1940*f*); Oct. 3, 1941, 17 (Dayton, 1941); Oct. 18, 1949, 15 (Robbins, 1950*a*); Sept. 21, 1955 (Foster, 1956); Sept. 15, 1956 (Lound and Lound, 1957*a*); Oct. 1, 1957 (Lound and Lound, 1958).

Adams Co. Sept. 21, 1941, 19 (Barger, 1941*d*); Oct. 4, 1941, 2 flocks—75 and 200 cranes; Sept. 28, 1942, 200 (A. Leopold in notes); Oct. 17, 1947, many (Robbins, 1948*a*); Oct. 23, 1948, large flock (Robbins, 1949*a*); Oct. 22, 1953, 2 (Besadny, 1954*a*); Sept. 14, 1954 (Besadny, 1955); Sept. 26, 1955, last (Foster, 1956). Ship Rock. 100 left before Oct. 20, 1934. Near Hancock. Oct. 8, 1939, 75–100 (Scott, 1939*b*). Town of Colburn. Oct. 8, 1940, 52 (Barger, 1940*e*); Oct. 3, 1957 (Lound and Lound, 1958).

Waushara Co. Nov. 5, 1948, 46 (Robbins, 1949*a*); Sept. 12–Oct. 8, 1950, flocks (Robbins, 1951*a*). Wild Rose. Sept. 16, 1950, 28; Sept. 17, 1950, 34 (Grange, MS). Wautoma. Sept. 6, 1952 (9:35 a.m.), 2; (4:55 p.m.), 6 (Grange, MS).

Marquette Co., Endeavor Marsh. 1892, 1000 (Grange, MS); Sept. 30, 1939, 8 (Scott, 1939*a*); Oct. 12, 1939, 36; late Oct., 1940, 150 (Barger, 1940*e*); Nov. 4, 1941, large flock (Barger, 1941*e*); Sept. 15, 1946, 14; Sept. 28, 1946, 50 (Robbins, 1947*a*); Sept. 21, 1948, 29 (Robbins, 1949*a*); Sept. 12 to Oct. 8, 1950, flocks (Robbins, 1951*a*); Sept. 21, 1953, 2 (Besadny, 1954*a*); Oct. 15–22, 1955, peak (Foster, 1956). Nashkoro Twp., T17N, R11E, Sect. 34. Sept. 12, 1950, 6 (N. Damaske in letter). Between Briggsville and Endeavor. Oct. 10–16, 1954, large flock (Besadny, 1955).

Green Lake Co. Sept. 13, 1946, 63; Oct. 7, 1947, 250 (Robbins, 1948*a*; Grange, MS); Oct. 8, 1948; Oct. 17, 1948 (Robbins, 1949*a*); early Oct., 1949, 700 (Robbins, 1950*a*);

Sept. 12 to Oct. 8, 1950, large flocks (Robbins, 1951*a*); Oct. 15, 1952, 1400—in part in Marquette Co. (last on Nov. 15) (Strelitzer, 1953); Oct. 22, 1953, 37 (Besadny, 1954*a*); Sept. 24, 1954, 400 (Besadny, 1955); Oct. 15–22, 1955, peak (Foster, 1956); Sept. 27 to Oct. 18, 1956 (Lound and Lound, 1957*a*); Oct. 5–6, 1957 (Lound and Lound, 1958). Lake Puckaway. Oct. 22, 1933, 20 flying over (Grange, MS). Near Princeton. Sept. 25 to Oct. 3, 1941, 90 (Scott, 1941); Sept. 20, 1953, 175 (Besadny, 1954*a*); Sept. 30, 1958, 300 (Kemper, 1959). Town of Seneca, Sects. 16, 17. Oct. 16, 1949, 600; Sept. 14, 1950, 36; Oct. 12, 23; Oct. 31, groups of 36 and 75 (N. Damaske in letter). Sect. 9. Oct. 31, 1950, 125. Sect. 20. Sept. 2, 1950, 3. Sect. 11, R11E. Sept. 11, 1950, 31 (N. Damaske in letter). Town of St. Marie, Sect. 31. Oct. 16, 1949, 200 plus; Oct. 12, 1950, 20; Oct. 31, 15 (N. Damaske in letter).

Sheboygan Co., West of Cedar Grove. Sept. 24, 1936, 1; Oct. 1, 1937, 7 (notes from W. E. Scott).

Columbia Co., Poynette. Oct. 16, 1940, 31 (Barger, 1940*e*) (Grange gave Oct. 15); Oct. 4, 1957 (Lound and Lound, 1958).

Dodge Co. Oct. 18, 1892, flock; Sept. 20, 1901, flock. Horicon Marsh. 1864 (?), 300—1 shot; Nov. 26, 1945, 1; Nov. 6, 1948, 40 (Barger, 1946*a*; Robbins, 1949*a*). Mud Lake. Oct. 20, 1949 (Robbins, 1950*a*).

Dane Co. Sept. 27, 1953 (Besadny, 1954*a*); Oct. 24, 1955, 6 flying south (Foster, 1956).

Jefferson Co. Oct. 17–18, 1942, few (Barger, 1943*a*); Oct. 4–19, 1950 (Robbins, 1951*a*); Oct. 12, 1956 (Lound and Lound, 1957*a*:37).

Waukesha Co. Sept. 20, 1949, 12 (Robbins, 1950*a*).

Milwaukee Co., a few miles north of Milwaukee. Dec. 10, 1939, 1 (Scott, 1940).

Rock Co. Oct. 28, 1949 (Robbins, 1950*a*).

Walworth Co. Nov. 6, 1940, 18 (Barger, 1940*f*). Delavan. Oct. 23, 1892 (Cooke, 1914:13); Oct. 3, 1897 (spec. Milw. Pub. Mus.). Lake Geneva. Nov. 4, 1937, 4 flying over lake (Grange, MS); Oct. 5, 1954, 50 (Besadny, 1955).

Kenosha Co. Oct. 19, 1947, 25 flying NW at New Munster (Robbins. 1948*a*; Grange, MS).

CONCLUSION

Since 1910 apparently the majority of Sandhill Cranes have migrated from northern Ontario, northern Michigan and central Wisconsin, into northern Indiana; and in more recent years to Jasper–Pulaski Game Preserve. From here and from southern Michigan cranes definitely proceed toward southern Georgia, and apparently on into Florida.

Migration records are shown on Fig. 1. But more significant are the numbers of cranes observed. In western and southern Illinois, there are only five recent records, only three of which indicate the exact numbers, totaling six cranes. From eastern Illinois I have obtained information on 31 groups of cranes, but exact numbers were available in only five records, totaling 100 cranes. Outside of the Willow Slough and Jasper–Pulaski Game Preserve in northern Indiana, where the cranes concentrate for many weeks, I find 57 observations of cranes listing a total of at least 703 birds. Farther east in Ohio there are only 14 records totaling at least 78 cranes, and these mainly from the western part of the state. Records from Massachusetts, Pennsylvania, West Virginia, New Jersey, and South Carolina in recent years give no more than one or two cranes in a group. In Kentucky there are only five recent records totaling 39 cranes. In western Tennessee only one record of two cranes; while in eastern Tennessee there are eight records totaling 84 cranes. On the other hand, 1294 migrating cranes have been counted in 27 groups going over Georgia. The line of flight appears to be from the northwestern part of the state through the Atlanta region and the Piedmont National Wildlife Refuge area to the Okefenokee Swamp area. Usually there appears to be no winter increase in the cranes in the Okefenokee National Wildlife Refuge, but during the winter of 1956–1957, 522 were counted on January 29. A winter increase in Florida, together with observed flights in March and November in the northern part of the state, indicate the regular wintering area is usually in central or southern Florida.

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819 NORTH AVE., BATTLE CREEK, MICHIGAN, MARCH 17, 1959

ORIENTED OVERLAND SPRING MIGRATION OF PINIONED CANADA GEESE

BY WILLIAM J. HAMILTON III AND MERRILL C. HAMMOND

Several attempts have been made to re-establish breeding flocks of Canada Geese (*Branta canadensis*) on former nesting ranges in the north-central states. In recent years the United States Fish and Wildlife Service has trapped both young and adult wild birds and released them as pinioned adults in large enclosures on potential breeding marshes. Geese were trapped from the fall concentration at Swan Lake National Wildlife Refuge at Sumner, Missouri. Band returns suggest that these birds are from the Eastern Prairie population of *B. c. interior* whose breeding range centers along the western edge of Hudson Bay between Fort Severn and Fort York (Hanson and Smith, 1950).

In the years following restocking of refuges in Minnesota, Nebraska, and North and South Dakota, no pair-formation or nesting occurred, even though most of the birds reached a minimum age of five years. Birds that escaped from the enclosures, or that were liberated in unfenced marshes, showed a definite tendency to move northward. This paper documents the nature and extent of these overland spring movements by flightless geese.

Observations

In the following discussion, northward movements are described in terms of distance and direction of travel. The true azimuth from the point of release to the sighting or recovery is reported in parentheses following the record. Thus, 360° means a movement directly to the north, 010° a movement 10 degrees east of north. When satisfactory evidence indicates that the observation is of a previously reported group, the azimuth is from the last sighting. The magnetic deviation for this area is about 11° east.

Mud Lake Refuge, Holt, Minnesota.—Over 100 pinioned captive Canada Geese, primarily birds wild-trapped at Swan Lake in 1951 and 1952, were being held at the Mud Lake Refuge in 1955. Shortly before May 20, 1955, 60 to 70 of these geese escaped from their pen. On May 20 and May 31 several birds from the flock were recaptured by refuge personnel in a field on the open prairie 6 miles north of the pen (360°). Some of those birds which escaped were later sighted in a field a half mile south of Thief Lake, 10 miles north of the release pen (011°). None of these birds were recaptured and apparently all perished during the hunting season that fall. The point of escape did not connect directly to any watercourse, and the intermediate sightings and recaptures in open farmland suggest that the Thief River to the east was not used as a travel route. Thief Lake was not visible to the birds from the pen.

Valentine Refuge, Valentine, Nebraska.—With the clearing of ice in April, 1956, 50 geese from Swan Lake were released from an 11-acre pen at Pony Lake on the Valentine Refuge. In May two groups of geese (9 and 16 individuals) were recaptured on the southern end of Ballard State Marsh, 6.9 (358°) and 6.4 (006°) miles north of Pony Lake. Of the 25 remaining geese, 16 were recaptured in the fall of 1956 on South Marsh Lake, just to the northeast of Pony Lake. Since several geese were sighted north of the Marsh Lakes on Red Deer Lake after the May recapture, it is possible that some of the autumn South Marsh Lake recoveries had returned overland from a more northern area. In April, 1957, 72 geese, including some of the participants in the 1956 movement, were released at Pony Lake. After a few days of delay the flock traveled across the Marsh Lakes and overland to the north. Two birds were recovered on a small temporary pond 9.1 miles (019°) from the release site and the remaining flock of 67 birds was recaptured on rolling ranchland 3.6 miles farther north (359°), 12.7 air miles from the initial release site. In both years the initial movement away from Pony Lake was through an elevated pass to the northeast in spite of a more accessible lowland escape route to the southeast. Having thus reached the Marsh Lakes, water and marshland may have facilitated and directed the movement for the next 3 miles before high country and restricted visibility were again encountered. The final 6 miles of the movement in 1957 passed through rolling hills devoid of natural water sources.

Crescent Lake Refuge, Ellsworth, Nebraska.—In late May of 1957 approximately 120 geese escaped from the pen at refuge headquarters. The majority of these birds were recaptured 2.7 miles to the north (356°) on June 2, 1957. On that date they were still moving north. Near the escape site visible water lay only to the south, yet the initial route took the birds nearly a mile overland to Goose Lake and from there the movement again struck into waterless open country to the north. A chain of lakes to the northeast of Goose Lake would have combined a watercourse with a generally northward (approximately 050°) route, yet the movement did not deflect in that direction.

Arrowwood Refuge, Kensal, North Dakota.—A flock of Swan Lake birds was released from a holding pen adjoining Jim Lake on April 17, 1957. On May 26, 17 of these birds were sighted on the James River 10.8 miles north (353°) of the release site. Several birds, presumably the same group, were sighted on June 17, 6.8 miles north (355°) of the last sighting, and on June 24, 17 geese were captured 3.3 miles still farther north (347°). On May 1, 1958, 24 or 25 geese, including some of the birds recovered from the previous year's migration, escaped from the Jim Lake holding compound. On May 7 three geese were recaptured 2.0 miles north (005°) of the pen. Ten pinioned geese were sighted on May 22 at the point of the May 26, 1957, sighting (353°). On June 4 a farmer reported nine geese in a slough 3.6 miles northeast of the release site (056°), and on June 20 another report located two geese 7.3 miles from the release site (088°). On June 10, and in the following days, between 12 and 18 pinioned geese were reported on the James River east of Grace City, 24.8 miles from the point of release (002°). This undoubtedly included the birds sighted May 22. Much of the movement in 1957 probably followed the course of the James River and its impoundments (Jim Lake, Arrowwood Lake), but both the June 17 and June 24 sightings were away from the river and its tributaries. The main body of the 1958 migration probably also followed the waterways of the James River to the point of the June 10 sighting. It is interesting to note that the location of this sighting was on the north side of the river just past the first point beyond the release site where the river course deviated significantly for any great distance from a generally north–south direction. Where the river turned to the west progress ended. Perhaps further movement to the north was limited by the reluctance of the birds to cross the bed of the Great Northern Railway. The birds recaptured May 7 apparently made the entire journey overland, in spite of the northwesterly course available on nearby Jim Lake. The birds sighted June 4 and 20 must also have moved almost entirely overland.

Lacreek Refuge, Martin, South Dakota.—On March 21, 1957, approximately 47 Swan Lake birds were released. They remained at the release point until the first week in May when about 32 birds moved out. The first 5 miles of migration was probably over a chain of lakes to the north. Movement to the location of recoveries farther to the north could only have been accomplished by considerable overland movement. On May 29. 1957, 16 geese were recaptured at a stock pond 17.6 miles from the release point (356°) and 11.3 miles beyond the last waterway. Five geese were recaptured in an alfalfa field on June 4, 13.7 air miles (353°) from the release site and 8.1 miles beyond a potentially guiding watercourse. Two other recaptures of three and two birds were made to the north of the release site (333°, 017°).

The results of these observations are summarized in Fig. 1. In addition to the actual movements recorded above, penned birds at Lostwood (North Dakota) and Crescent Lake (Nebraska) refuges regularly crowded the north fence lines in spring and early summer.

DISCUSSION

Timing of migration.—The period of passage for wild Canada Geese at the pertinent refuges is recorded in Table 1. together with the period of movement of the pinioned birds. From these data it is at once apparent that the movement of the pinioned birds started later and continued longer than the natural migration through the area. This can not be accounted for by the tardy release of the captives, since at least one flock (Lacreek) did not initiate movement until over a month after release.

The protracted migration period, well into June, perhaps bears out Merckel's (1956) suggestion that the experiences of birds are important in ending migration once the breeding grounds are reached. The nature of this experience, whether recognition of familiar country, celestial cues or some other change, and how it acts to end migration are two of the many unsolved mysteries of bird migration. The transportation and observation of landbound geese might be a productive method of investigating this problem.

Rate of movement.—Table 2 summarizes those parts of the movements for which the rate of advance by pinioned birds could be accurately determined. The distance traveled per day was found by dividing air distance traveled since the last sighting by the number of intervening days. Some error is thus inherent in these calculations due to differential underestimation of the length of the actual path taken. Observations 2. 6. and 7 represent the progress of the 1957 Arrowwood release, and records 3 and 5 both represent the same fragment of the 1958 Arrowwood release. For these flocks for which more than one report is available there is no indication of a slowing of the movement late in the season when the natural migration of Canada Geese through the area had ended. If the data for all localities are taken together the result

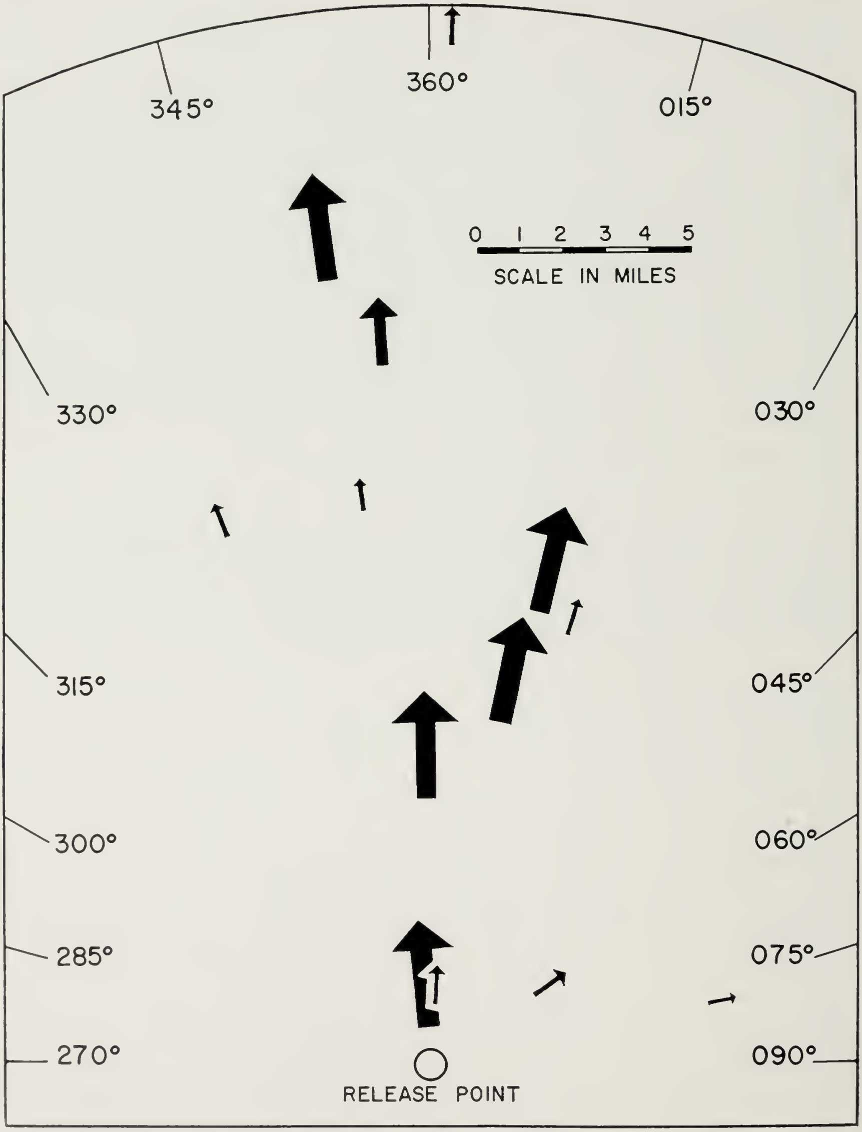

Fig. 1. True compass direction taken by migrating pinioned Canada Geese. The heaviest arrows represent flocks which did not fragment in their movement, the smaller arrows portions of fragmented flocks.

is the same, i.e., no indication of a slowing of the walking migration up to the time the birds were recaptured.

Orientation of migration.—Fig. 1 clearly establishes the northward move-

TABLE 1

TIMING OF MIGRATION OF WILD AND PINIONED CANADA GEESE

Refuge	First arrivals	Main migration	Release of captives	Movement of captives
Mud Lake	3/30/55	4/10 to 4/16/55	5/19 ± 2/55	5/19 to 5/31/55
Arrowwood	3/17/57	4/21/57	5/17/57	until 6/24/57
	3/24/58	4/4 to 4/7/58	5/1/58	5/1 to 6/10/58
Lacreek	2/13/57	3/3 to 3/4/57	3/21/57	5/4 ± 3 to 5/29/57
Crescent Lake	2/17/57	3/10 to 3/23/57	5/20 ± 5/57	until 6/2/57

ment of the released birds during May and June. The conditions of transplantation and release allow some opportunity for analysis of the directional cues which may have been utilized in these movements. Since all the Swan Lake birds had migrated at least once it is possible that some of the birds were familiar with the terrain over which they moved and were following familiar landmarks in an attempt to return to a familiar northern breeding area. But the use of remembered landmarks seems unlikely when we recall the limited horizon of visibility available to a bird with its head less than a meter from the ground and the different perspective from this position.

Recent investigations have demonstrated celestial orientation in a wide variety of avian species (Kramer, 1957; Sauer, 1957), including several species of waterfowl. With his special technique of releasing and following free-flying waterfowl, Bellrose (1958 and personal communication) has recently obtained evidence that the Canada Goose is capable of utilizing celestial cues. Thus, for this species, it is at least possible that the celestial environment was the orienting cue.

The direction of overhead passage of wild migrants could also have provided the necessary orienting cues, at least for the initial movement. Table 3 compares the direction taken by wild migrants and walking geese with the

TABLE 2

RATE OF MIGRATION OF PINIONED CANADA GEESE

Observation number	Refuge	Mean travel date	Date of movement	Nature of terrain	Average miles/day	True azimuth
1	Arrowwood	5/4	5/1 to 5/7/58	overland	.33	005°
2	Arrowwood	5/6	4/17 to 5/26/57	waterways	.36	353°
3	Arrowwood	5/11	5/1 to 5/22/58	waterways	.51	353°
4	Mud Lake	5/25	5/19 to 5/31/55	overland	.50	011°
5	Arrowwood	6/1	5/22 to 6/10/58	waterways	.74	010°
6	Arrowwood	6/6	5/26 to 6/17/57	both	.31	355°
7	Arrowwood	6/20	6/17 to 6/24/57	overland	.47	347°

Table 3

Direction Taken by Free-flying and Pinioned Canada Geese

Refuge	Direction of overhead migrants	Miles to probable breeding grounds	True azimuth to probable breeding grounds	Direction taken by walking geese
Mud Lake	Due north	700	011°±10°	360°, 011°
Arrowwood	North to northwest	800	019°±11°	355°, 353°, 353°, 347°, 002°, 005°, 056°, 088°
Lacreek	Almost due north	1100	016° ± 8°	356°, 353°, 333°, 017°
Valentine	———	1100	018° ± 7°	359°, 358°, 006°, 019°
Crescent Lake	North	1250	016° ± 8°	356°

direction to the probable breeding grounds. Such a mimetic mechanism of orientation would not be unexpected in this species where social behavior is such a significant feature of migration, and where tradition has been shown to play a major role in some features of travel (Hochbaum, 1955). However, such overhead migration could not have been the sole orienting cue since much of the oriented movement took place after natural migration had ended.

The importance of guides could conceivably be experimentally investigated by comparing the accuracy of orientation of pinioned birds on relatively featureless terrain with and without overhead migrants. Furthermore, if a bird will orient appropriately while walking over the ground, then some birds could be repeatedly utilized to test diurnal and seasonal variation in intensity and accuracy of orientation. Such a technique could go beyond caged *Zugunruhe* studies in testing the influence of the visual environment, particularly habitat changes and responses to them. In suitably homogeneous terrain celestial orientation responses could be tested in those species which can not be shown to demonstrate directional *Zugunruhe* responses in small cages. But more important, features of social organization and leadership, heretofore largely neglected in experimental studies, might be investigated.

ACKNOWLEDGMENTS

The following Fish and Wildlife Service personnel contributed observations and records of movements of the goose flocks: Kenneth Krumm, Wm. Ireland, Lloyd Ramelli, Richard Rogers, George Wiseman, Nelius Nelson, Corley Hall, Jack Frye, Herbert Dill, Robley Hunt, and Arthur Hughlett. Several local residents also reported sightings. Dr. A. Starker Leopold carefully read the manuscript and made many helpful suggestions.

SUMMARY

Adult pinioned Canada Geese escaped or were released at several National Wildlife Refuges in Minnesota, Nebraska, and the Dakotas, well south of the

natural breeding range of this population. Subsequent sightings and recoveries indicate an accurate northward movement of these earth-bound birds during and after the period of normal goose migration. Overland movements up to 24.8 air miles were recorded. The rate of progress was more or less uniform throughout the season, ranging from .31 to .74 miles per day. The cues guiding the birds northward are not known, but some possibilities are discussed.

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MUSEUM OF VERTEBRATE ZOOLOGY, BERKELEY 4, CALIFORNIA; AND UNITED STATES FISH AND WILDLIFE SERVICE, LOWER SOURIS REFUGE, UPHAM, NORTH DAKOTA, DECEMBER 8, 1959

SOME INDIAN MIDDEN BIRDS FROM THE PUGET SOUND AREA

BY LOYE MILLER

At an earlier date (1957) I published the results of a study of some nine thousand bird bones from an Indian midden at The Dalles, Oregon. In consequence, Peabody Museum of Harvard University has more lately invited me to study a comparable collection made by their staff in the Puget Sound area. I am indebted to Mr. Alan L. Bryan of that institution for loan of their material, and for permission to make this study. I have also enjoyed helpful discussions with Dr. Raymond B. Cowles of the University of California at Los Angeles, and with Messrs. Eugene Christman and Wm. J. Hamilton III of the Museum of Vertebrate Zoology at Berkeley, on the subjects of thermals, gliders, and Indian taboos. My thanks are extended to these fellow scientists for their contributions to the work.

The collection here discussed includes about five hundred bones or fragments thereof, which were obtained from nine Indian middens on the shores of Puget Sound. Mr. Bryan refers to them as "shell middens" so I assume that marine shells constitute the major mass. I have little information on fish or mammal remains from the sites, beyond a few mustelid bones and one black bear claw that turned up among the bird remains. Mr. Bryan's correspondence indicates large ungulates to be common, together with small carnivores and marine mammals.

As in the Oregon collection, the bird bones are highly fragmented, for reasons which have thus far eluded me. Curiously, however, a few very fragile bones have been preserved intact. There appears to have been no appreciable mineralization of these bones, such as had progressed to some degree in the Oregon mound. They are stained variously by the matrix but are of firm texture. When held in the Bunsen burner flame they blacken, and give off much smoke of most offensive odor. The Oregon bones reacted very lightly to the flame and gave off little odor. Such evidence as is available suggests much less antiquity for this than for the Oregon site. Charred bones are few, though they are more abundant than in the Oregon collection. The rarity of immature bones suggests that there were no important nesting sites within the radius of the Indians' activities. This is quite in contrast with the Emeryville mound studied by Howard (1929).

The Avifauna

There are many aspects in which the Puget Sound fauna differs from that of the midden at The Dalles. The Washington middens are a salt-water accumulation located in what is known as the Northwest Humid Belt. The Oregon midden is located in the Great Basin Faunal Area, in a semi-arid

TABLE 1
RELATIVE ABUNDANCE OF BIRD FAMILIES BY SITES

Family	Approximate abundance	
	Washington Sites %	Oregon Site %
Gaviidae	14.8	—
Podicipedidae	8.0	—
Pelecanidae	.4	—
Phalacrocoracidae	—	21.8
Anatidae	61.	2.3
Cathartidae	—	16.2
Accipitridae	2.5	27.7
Tetraonidae	.8	.23
Gruidae	.8	—
Rallidae	—	.24
Scolopacidae	.4	—
Laridae	5.9	26.
Alcidae	2.9	—
Strigidae	.4	.49
Corvidae	.8	5.1

environment that is little influenced by the great Columbia River flowing through treeless country. Some faunal differences are therefore to be expected, but not all are so simply accounted for. Table 1 indicates relative abundance of bird families represented in the Washington sites, as compared with the Oregon site.

Unfortunately, the percentages of occurrence in the two mounds are calculated upon slightly different bases, but the over-all picture is not greatly distorted. (The percentages for the Washington sites are based on the number of bones. Those for the Oregon site are based on the number of packages in which the species occur. Exact numbers of bones from the Oregon site are not now available to me.)

DISCUSSION

Some forty years of beachcombing along the Southern California coast and islands have given me a fairly definite picture of what the sea might yield, in the way of birds impaired in vitality or freshly dead and therefore ripe for harvest by various predators. A primitive Indian would surely qualify as one such predator with none too fastidious an appetite. Under stress of food shortage, he might even qualify as a scavenger. It is not unlikely, therefore, that many of the bird bones in our midden represent the food-gathering labor of squaws and children. Every family in Table 1, and most of the genera involved, are represented in my own gleanings as a beachcomber for skeletal material. Puget Sound is far from the open ocean. Therefore, the shearwaters and fulmars so abundant at times on our beaches, and the Short-tailed Albatross of our Indian middens, are not represented in the Washington collection.

Gaviidae.—Loons of two sizes are abundant, the larger not distinguished from *Gavia immer.* The smaller could include both *G. arctica* and *G. stellata.* Age and sex factors bring about such variation in size and topography of skeletal elements that an unassociated bone, particularly if it be imperfect, is not assignable with confidence to species. I am confident that *G. arctica* is the commoner species, but *stellata* may also be present.

Podicipedidae.—Much the same can be said of the grebe remains. *Podiceps grisegena* and *Aechmophorus occidentalis* are both present. The smaller grebes certainly include *Podiceps caspicus.* Estimates of quantitative relations are not ventured, however.

Pelecanidae.—A single fragment of a humerus is the only record for *Pelecanus,* and there is no cormorant. Both these birds are commonly cast up on the beach, and the cormorant was extremely abundant in the Oregon midden. Both families were abundantly represented in the Emeryville shell mound of San Francisco Bay (Howard, 1929) which, like the Washington sites, was well removed from the shore of the open ocean. Skins of pelicans should have been in demand as clothing for a primitive people, had these birds been abundant in the area. Why the pelicans and cormorants are not well represented is a mystery.

All ciconiiform birds are conspicuous by their absence. Herons, sparingly represented at Emeryville, were also absent from the Oregon midden.

Anatidae.—Geese and ducks were extremely rare among the nine thousand bones from the Oregon site. They made up more than two-thirds of the collection from the Emeryville mound, however; and likewise in the Washington collection they are the most abundantly represented family (61%).

Goose bones are few, but the salt-water and estuarine ducks are in great abundance. The scoters, Canvasback, scaup, Bufflehead, and Mallard all appear. What others may be represented in the great mass of fragmentary duck bones, I feel it unwise to state. The scoters and the Mallard, however, stand out prominently. Jewett *et al.* (1953) mention all these and others as wintering on the Sound in numbers. As a Pleistocene fossil, the Mallard (*Anas platyrhynchos*) is one of the most abundant and widely distributed of ducks. Today it is likewise almost ubiquitous and highly adaptable to varied conditions, including the artificial environment of the barnyard. I look upon it with great respect, as a natural species at the height of its vigor and plasticity.

Cathartidae.—Representatives of this family are conspicuous by their total absence—much to my disappointment. They were abundant and surprisingly diverse in the Oregon midden, and well represented in the mound at Emeryville. A single condor bone (*Gymnogyps californianus*) was identified from an Indian midden near Coos Bay in southern Oregon (Miller, 1942). The Turkey Vulture (*Cathartes aura*) is a common scavenger about the beaches and estuaries of southern California while the late Pleistocene gravels and asphalts of coastwise California have yielded abundant and varied remains of condors and smaller vultures. They are conspicuous birds in life, and their large quills would make strong appeal to the Indian mind, one would think. How are we to account for their absence from Puget Sound middens? During conversations with colleagues it was suggested to me that cathartids were rare because they find less favorable conditions for their characteristic and essential soaring flight in the coastwise airs, than they do farther inland where rising thermal currents are more frequently available. Such may be the case, but that factor is not so important as to eliminate the group from the fauna of beach, marsh and estuary. Jewett *et al.* (1953) cite many records of condors observed by early travelers to the coastal area, from the mouth of the Columbia River to Ft. Vancouver and into British Columbia at Burrard Inlet. The Turkey Vulture is recorded as breeding at Bellingham, Washington, and in British Columbia. It would seem then that cathartids are, or have been, well known in coastwise Washington within the historical period, and were surely present at the time these Indian middens were being accumulated.

In the paper on the Oregon midden (Miller, 1957) some discussion was ventured concerning the ceremonial usage of condors, eagles, and ravens by Indians of various tribes, and it was suggested that the great abundance of condor and eagle bones in that mound was due to ritual usage. That impression has grown even stronger in my thinking with the passing of time. It is readily conceded, however, that a custom widely spread throughout Oregon. California, and Arizona might have been totally foreign to the ritual of Puget Sound tribes. Mr. Eugene Christman, in conversation, suggested that these large birds may even have been taboo as sacred deities not to be touched by human hands. Again, their remains, if such came to hand, might have been burned or buried in special and remote places. Some such explanation seems more plausible than that these striking species were not present, or were of no interest to a primitive people living as a natural element in the general biota of the area.

Accipitridae.—Even more conspicuous than the cathartids and probably much more abundant along the coasts and estuaries, would be the Bald Eagle (*Haliaeetus leucocephalus*), an inveterate fisherman and beachcomber, not to say pirate. Furthermore, eagles have seemingly appealed to men of all times and tongues. Why not to the Indians? They must have been an important element in the Puget Sound biota of pre-Columbian times, but only five bones were found in the Washington midden. The eagle is the second most important element in the fauna of the Oregon midden.

The genus *Buteo* is represented by a single bone fragment that is not distinguishable from *B. jamaicensis.* None of the smaller hawks, falcons or the Osprey appears in the collection.

Tetraonidae.—Only two bones of this family are found in the collection, a complete ulna and, strange to say, an almost perfect furcula. Why this fragile "wishbone" should have been preserved when more rugged bones are fragmented is an unsolved question. Likewise, problematic is the small number of bones. They are not distinguishable from the Blue Grouse (*Dendragapus obscurus*), a species that is abundant throughout the state "from sea level to timberline." Its behavior often borders on a state of "stupidity" giving it the widely applied name of fool-hen. My own experience with it would suggest that no great skill or craftiness on the part of a primitive hunter would be necessary to add this acceptable item to his menu on frequent occasions. Were the Indians so well supplied with maritime food species within the immediate vicinity that they made no short forays into the fresh-water brushlands adjacent to camp? The presence of abundant ungulate bones would oppose such suggestion.

Gruidae.—An imperfect coracoid and the distal condyles of a right tibiotarsus represent a crane somewhat larger than the average of the race *Grus canadensis canadensis.* Cranes were lacking in the Oregon midden but were fairly well represented in the Emeryville mound.

There are no rail or coot bones. The widely ranging and abundant American Coot (*Fulica americana*), though preferring fresh water during the nesting season, is not uncommon in winter on sea coasts and estuaries. I was surprised not to find it in the Puget Sound collection.

Laridae.—In view of the tremendous number of gull bones recovered from the Oregon midden it is surprising to find that they are so rare in the Washington collection. The Oregon midden is located on the south bank of the Columbia River east of the Cascade Range. There is no quiet water there at present and no extensive beach, although there is some indication of a small diverticulum of perhaps intermittent nature that once provided quiet water at certain seasons. The Washington middens lie at the mouth of Puget Sound practically at tide level where gulls should be extremely abundant. Since marine shells make up the major part of the midden refuse, perhaps we might conclude that gulls were not tempting to the Indian appetite. Still, loons and grebes are of frequent occurrence, though possibly these were brought into camp for their densely feathered skins to be used as "raincoats."

Alcidae.—The auks and murres are even less abundant than the gulls, and all bones are from mature birds. Seemingly there were no nesting colonies nearby.

Scolopacidae.—A single bone represents the great group of the shore birds.

Strigidae.—The owls are represented by a single bone of the Great Horned Owl (*Bubo virginianus*). The immediate environment was probably not attractive to the owls, nor would their flesh strongly attract the Indian except perhaps as "medicine." The bones of large ungulates and bear, however, indicate that the Indians hunted farther afield. Numerous petroglyphs on rocks near the Oregon site indicate an awareness of owls. Probably a superstitious fear made the Indian avoid close contact with these birds.

Corvidae.—Two bones of a crow not distinguishable from *Corvus caurinus* are the only representatives of the passeriform birds. Jewett *et al.* (1953) state, "Great numbers of Northwestern Crows are to be observed along the ocean beaches, the Strait of Juan de Fuca, and in the Sound region." They become almost domestic at times so must have been frequent camp "hangers-on" of the midden sites. Despite an uncanny ability to take care of themselves they must have been occasionally available had the Indians cared to make use of bodies or feathers. Like the owls, they must have been shielded by Indian psychology.

This paper represents a study of bird remains actually in hand—a study made by an ornithologist interested in living, active, flying creatures grouped into a fauna that had developed through the years in response to a set of environmental factors held in delicate balance by variable forces, any one of which may be responsible through its own variability for an imbalance that could distort the whole picture. A primitive race of the natural species *Homo sapiens* had been for some thousands of years an element in the ecologic environment at the Puget Sound site. Did he exert a pressure of some magnitude? I doubt it. He was not a planter, not a herdsman, not a destroyer of the landscape by fire, by cutting or trampling of large areas. He was a simple fisherman and hunter of limited prowess. The picture he painted on the sands of his own "kitchen midden floor" is frustratingly incomplete. Yet some of its lines are fascinating.

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ZOOLOGY DEPARTMENT, UNIVERSITY OF CALIFORNIA, LOS ANGELES, CALIFORNIA, JULY 25, 1959

GENERAL NOTES

Anting of a captive Slate-colored Junco.—Although the peculiar behavior by which birds apply ants to their plumages is now well known through several excellent reviews (e.g., Ivor, 1956. *Nat. Geog.*, 110:105-119; Whitaker, 1957. *Wilson Bull.*, 69: 195-262), no actual description of "anting" by the Slate-colored Junco (*Junco hyemalis*) appears to have been published. On March 27, 1958, I observed one of my captive juncos anting, apparently with sawdust. I released the bird in a small empty room in the Harvard Biological Laboratories (Cambridge, Massachusetts) as part of a series of experiments on emberizine behavior. I watched the bird through an observation window as it explored the floor, which was covered with a layer of sawdust and wood shavings. As I was about to introduce another junco into the experimental room, the first individual began performing motions which I realized were those of anting.

The junco stood on the floor with legs rather spread, in contrast to its usual stance. It pecked several times into the sawdust, and then began quickly stroking the undersides of its primaries with its bill. Because I had not recognized the anting immediately, I did not note the sequence or exact morphology of these first motions. The bird pecked once more into the shavings and again touched the underwings and the flanks with something in its bill. Again, the motions were of a stroking type, as opposed to dabbing movements. The wings were spread only slightly while their distal ventral surfaces were stroked, and the tail was not touched. There was no tripping or other tumbling-like motion. The junco anted for about a minute and a half, after which it began hopping around the floor, continuing to investigate its new environment.

Because it was not possible to distinguish what had been in the bird's bill at the time of anting, I subsequently examined quite carefully the general area in which the bird had been standing and found nothing other than the wood shavings and dust. It is possible that a single ant or beetle was found and utilized by the junco, but I could find no evidence of it. Other juncos released in the room did not ant, and in subsequent experiments the bird referred to above never did so again.

Anting by the Slate-colored Junco was reported to occur by Ivor (1941. *Auk*, 58:416), and later mentioned by Ivor (1943. *Auk*, 60:54) and Bagg (1952. *Jour. Mamm.*, 33:243), but neither author gave a description of the behavior. Whitaker (*op. cit.*, 232) indicates that at least ten New World emberizine species are known to ant, and, as was stated above, the behavior in one form or another is widespread among birds.

The anting reported here was the "active" type, where the bird picks up material to rub on its plumage, as opposed to the "passive" type where ants are allowed to crawl over the bird (Whitaker, *op. cit.*). The motions used were of a stroking nature, differing from the dabbing motions of Whitaker's captive Orchard Oriole (*Icterus spurius*), but apparently similar to movements used by other species (Whitaker, *op. cit.*, 208). The tail area, usually a primary target of anting, was ignored by my junco. This fact, along with the short duration of the observation, and the lack of tumbling and extreme posturing, suggest that anting was of quite low intensity.

The purpose of anting has long been questioned by observers. Several authors have attempted to link anting with feeding, plumage care, or parasite removal, and Whitaker (*op. cit.*, 195) lists many other explanations which have been proposed. My junco neither fed nor preened after anting, nor was it visibly infested with ectoparasites (I examined the bird in the hand several times). The latest theory is probably that of Whitaker, who presents good evidence that ants (or substitutes) utilized give off a burning or "thermogenic" stimulus to the bird which is pleasurable to it in some manner. I have seen no record of sawdust being used by birds, nor does Whitaker mention its use by any species. If the junco did use sawdust, and not just a passing isolated insect, it is interesting to suggest what possible thermogenic properties sawdust contains; or, if it is not thermogenic, what provoked the junco to ant with it. Whitaker (in letter) has speculated that the sawdust may have been treated with a burning stimulant, or might have contained tannic acid. Unfortunately, no analysis of the material was made at the time.

In her review, Whitaker (*op. cit.*, 237 ff.) devotes considerable space to a discussion of the type of stimulus the bird receives, and the "object" of anting. Her principal suggestion is that some kind of sexual stimulation may be derived from applying thermogenic material to the area of the vent, and this explains some of the display-like motions which often accompany anting. My junco gave no indications of performing any of the known sexual displays of the junco (Sabine, 1952. *Auk*, 69:313–314), and the bird's apparent lack of the usual overt expression of some kind of "pleasure" may have been due to the low intensity of the anting bout.

I am grateful to Professor E. O. Wilson and to W. J. Bock for making the experimental room available. I am especially indebted to Mrs. Lovie M. Whitaker for reading the original version of this note and supplying many interesting suggestions about the subject of anting.—Jack P. Hailman, *4401 Gladwyne Drive, Bethesda, Maryland, August 17, 1959.*

Notes on feeding and fecal-sac disposal of sapsuckers.—On July 10, 1959, I observed a pair of Yellow-bellied ("Red-naped") Sapsuckers (*Sphyrapicus varius*) nesting in a grove of aspen at Grayling Creek, near West Yellowstone, Montana. Some aspects of their feeding behavior and their disposal of fecal sacs seem worth recording. Just 48 feet north of the nest tree, and facing it, was a dead bracket fungus on a tree trunk, about 16 feet from the ground. This fungus was used as a sort of "work-shelf" by the sapsuckers. To it they brought insects (mostly salmon-flies, Plecoptera) to be pounded before being fed to the young birds. Sometimes they flew directly to the nest and fed to the young the insects held in the forepart of their bills, then flew back to the fungus shelf to pound the remaining insects to the right consistency for feeding. Both parents used the shelf in this manner. One bird always flew north and east to catch insects, flycatcher-fashion, over Grayling Creek; the other always flew south.

Insects were sometimes left on the shelf to be collected later. One bird brought an oblong white object about an inch and a half long and placed it on the shelf, picked at it a couple of times, then flew away, leaving the object behind. After long study with binoculars, I could make nothing of it but a reptile egg, although I know of no turtles or egg-laying snakes in this area. The object was left on the shelf through several feedings of the young. I left the vicinity of the nest for about 45 minutes to get a ladder, but when I returned the object was gone.

When a fecal sac was removed from the nest (always done by the male), it was carried to the same fungus shelf. Here the sac itself was eaten by the bird, the fecal contents dropping to the ground. The area immediately below the shelf was well littered with excrement, some adhering to the edge of the shelf and to the tree below the shelf. During my period of observation no sacs were carried away from the nest and simply dropped as is the habit of many birds. The fecal sacs of all other birds I have watched are opaque, while that of the sapsucker is transparent.

I have watched sapsuckers use a common insect-killing and "sewage disposal" place at two other Montana localities, Upper Red Rock Lake and Madison River Canyon, in other years. In both cases these were farther away from the nest tree.—Mary Wible, *Carter Camp, Pennsylvania, September 16, 1959.*

Aves incendiaria.—No serious ornithologist today questions the fact that birds ant. Anting with ants or other agents having aromatic or "thermogenic" properties has been demonstrated; or anting within sight of such susbtances; or within sight of objects which directly have nothing to do with the "heat" stimulus, per se, but which have been associated with the production of heat by conditioning (Lovie M. Whitaker, 1957. *Wilson Bull.*, 69:195–262; Maurice Burton, 1959. "Phoenix Re-born"; and others).

Novel, however, is the concept that anting birds may be instrumental in the spread of fire.

In his fascinating book, "Phoenix Re-born," Burton leaves no doubt as to the capabilities of birds as firebugs. At times his tame Rook (*Corvus frugilegus*), Niger, could not resist "disporting itself on a heap of burning straw"—much like the Phoenix of legendary fame—and, still more incredible, would take to casting burning straw about the aviary, ant on an isolated ember and *fan it into flames* with its wings, igniting combustible material near by! Neglected embers would die out.

Playing with fire is not confined to aviary birds alone. Burton cites several instances where wild birds have been suspect—by carrying glowing cigarette ends or other burning substances to their nests and setting them afire. An officer of the Guilford Fire Brigade actually saw a nest smouldering in a tree. Burton himself has observed birds anting on the wing over heath fires and states that it is common to see all kinds of birds flocking at the edge of bush-fires, ostensibly to harvest the fleeing insects.

The startling fact is that Old World corvids have been incriminated since ancient times. Says Burton (*op. cit.*, p. 89):

> There are a number of stories in the ancient books from Roman times down to the seventeenth century, of birds seen carrying glowing embers in their bills and alighting on thatched roofs, setting them afire. There is nothing in these stories to tell us whether the birds anted with the embers once they landed on the roofs. It was, however, sufficiently commonplace for jackdaws, magpies, choughs and crows—all close relatives of the rook—to carry embers in this way for them to be spoken of as *aves incendiaria.*

Are New World corvids so very different from their overseas cousins? There is reason to believe that they are not, though this is conjectural and based upon the flimsiest evidence. At this point of unenlightenment, it would seem short-sighted to exclude *any* bird from the incendiary tag.

Whitaker (*op. cit.*, citing F. W. Miller, 1952. *Auk*, 69:87–88; and *Anon.*, 1952. *Life*, Dec. 8, p. 186 [Photo]) mentions two instances, unrelated, of a captive Blue Jay (*Cyanocitta cristata*) being drawn to lighted cigarettes; one bird anted with them, the other merely held them in its bill. H. Roy Ivor (1958. *Wilson Bull.*, 70:288) discusses his tame Steller's Jay's (*C. stelleri*) predilection for anting with the "hot carbonized end" of a blown-out match and for snatching a lighted cigarette from the mouth of a visitor, subsequently tearing it to bits.

As for definite records of bird-caused fires, there are next to none for the United States. Burton cites(*op. cit.*, pp. 104–106) two reports from the American journal *Fire Engineering* in which birds are strongly implicated. One entry, for April 1954, is entitled "Squirrel smoking in bed?" and concerns a fire which took place in Central Park, New York City. Smoke was found issuing from a hole 25 feet up in a 50-foot sycamore and the flames were duly extinguished. No mention is made of anyone's having *seen* a squirrel, nor is a bird suggested as the culprit. As Burton explains, "It is one of the unfortunate features of these entries in fire-brigade journals that they are laconic in the extreme." In other words, it is not customary to associate birds with fire-spreading.

The other entry, dated June 1954, is about an owl—"Out Beloit, Kansas way"—who inadvertently set fire to some 700 acres of pasture. Wings aflame, it had been forced to leave the burning tree in which it had been nesting; as it touched upon farmland, the blaze spread. Burton theorizes about the origin of the fire: perhaps some other bird had been performing like a Phoenix in the owl tree and raised a conflagration which caught the owl unawares as it dozed in a hollow.

Less speculative is Burton's reference (*op. cit.*, p. 107) to a newsclipping from the *Courier–Journal* of Louisville, Kentucky, for January 14, 1958. Fire Chief Kenneth Reeve of Franklin placed the blame directly on a bird. To quote from the account: "He said there simply was no other way the fire, which caused very little damage, could have started in a downtown building. He reported a sparrow must have picked up a lighted cigarette and carried it to a nest in the eave of the structure . . ."

Most convincing is this communication from Ann Arbor, Michigan. My father, A. D. Moore (letter, Dec. 27, 1959) wrote after an interview with Harold Gauss of the Ann Arbor Fire Department:

> I stopped Harold and said I had a serious question. What about birds starting fires? The answer was immediate and positive. Of course they do. Incident: in 1925, the Old Methodist Church had a roof fire. Harold remembers it clearly, for water pressure was often low in those days. When he climbed the ladder with the hose, and got within a few feet of the fire, no water came. He held the hose vertical, looked down the hole, and saw the water, doing its best, but stopped a yard or so down from the nozzle. When the pumper was started, he got water. The ridge row of the roof had collected a lot of nests, sparrow and pigeon, as he remembers it. The nests were afire.
>
> Harold says they have had to put out nest fires more than once on top of the Allenel Hotel; and more than once on another downtown building he named.

It must be emphasized that two facts are inescapable: (1) some birds ant with or near smouldering substances or flames; (2) certain fires have been traced to birds. The implications are tremendous. To what degree are birds responsible for sprouting and spreading fires under tinder-dry conditions? Those crows and ravens along the road . . . could they be interested in cigarette butts as well as carrion? Those fires which start unaccountably on roof tops, in isolated trees or palms, on the side of a billboard . . . could an ember-carrying sparrow be to blame? Those jays hopping about the picnic tables . . . could a dying campfire, unattended, be far more irresistible than the tidbits?

It is obvious that a fund of information is needed to fill out the story of *aves incendiaria* and their kind in the Western Hemisphere. I would welcome any observations to this end.—Jeanne Moore Goodman, *Cedar Crest Cabin, Fallsvale (east of Redlands), California, March 31, 1960.*

Marsh Hawk breeding in northwestern Arkansas.—Nesting records of the Marsh Hawk (*Circus cyaneus*) are sparse for the state of Arkansas. Baerg in his "Birds of Arkansas" (1951. *Univ. of Ark. Col. of Ag. Bull.* no. 258:52) states that the Marsh Hawk nests uncommonly in the northwestern section of the state. Bent (1937. *U.S. Nat. Mus. Bull.* no. 167:92) excludes Arkansas as a part of the breeding range for this species. The 5th edition of the A.O.U. Check-List (1957:115) does likewise.

On April 13, 1954, I discovered a solitary Marsh Hawk nest (no eggs) quite accidentally while on a field trip within the confines of Fort Chaffee Military Reservation, 8 miles south of Fort Smith, Arkansas. The nest site was located in a remote locality 2 miles west of the camp proper. This area was formerly a firing range for military training.

The nest was situated on dry ground at the base of a 5-foot persimmon tree about 500 yards from a well-traveled gravel road. The nest was surrounded by lush vegetation, which included pubescent paspulum (*Paspalum pubescens*), persimmon (*Diospyros*

TABLE 1
INCUBATION PERIOD OF THE MARSH HAWK

Egg numbers	Date laid	Date hatched
1	April 14	May 6
2	April 16	May 8
3	April 17	May 9
4	April 20	May 13
5	April 22	May 14
6	April 23	May 16

virginiana), sassafras (*Sassafras albidum*), and patches of running blackberries. A natural spring occurred about 300 yards east of the nest site.

The nest cover was composed largely of dead arrow grass (*Aristida purpurascens*). A few small twigs surrounded the exterior of the nest, which was about 20 inches in over-all diameter.

From April 13 to May 19, 1954, I made daily trips to the nest site, a total of 40 trips and 196 man-hours. By April 23, six eggs had been laid (Table 1). Incubation period of the last egg lasted 24 days. Only the female incubated during the period of study.

Between April 14 and May 15, I obtained food data from 63 pellets regurgitated by the adult and young (Table 2). I collected the pellets within a few feet of the nest.

TABLE 2
PELLET ANALYSIS OF THE MARSH HAWK

	No. pellets containing remains
Reptiles	
Plains garter snake (*Thamnophis radix*)	14
Unidentified snakes	7
Amphibians	
Leopard frog (*Rana pipiens*)	3
Unidentified amphibians	1
Birds	
Redwinged Blackbird (young) (*Agelaius phoeniceus*)	16
Unidentified passerines	2
Others	
Crayfish (*Cambarus diogenes*)	11
Eastern cottontail (*Sylvilagus floridanus*)	9
Total	63

Table 2 shows that snakes and young Redwinged Blackbirds, prolific and widespread forms, were the primary food items. An interesting food item was the crayfish, which ranked third in frequency. Young cottontail rabbits also ranked high as a food item.

On May 20, 1954, the Marsh Hawk nest was found to be completely destroyed, with no trace of the six young. The cause was unknown, but it is my belief that man was involved since well-traveled roads nearly surrounded the nest site.—EUGENE J. WILHELM, JR., *Dept. of Geography & Anthropology, Louisiana State University, Baton Rouge, Louisiana, September 24, 1959.*

Behavior of birds on warm surfaces.—It is well known that certain parallelisms of posture and movement may occur in the sunning, bathing, dusting, and anting activities of birds. Recent evidence that the sensation of heat can be a common factor supports the view that these are not separate and distinct habits but a behavioral complex. With exact relationships and motivations yet to be determined, any activity in which elements of these behaviorisms are associated with heat should be of interest. See Conway (1959. *Wilson Bull.*, 71:188–189) and sources therein.

On July 15, 1957, at 1:05 p.m., I startled two adult Arkansas Kingbirds (*Tyrannus verticalis*) from a fallow flower bed at the University of Oklahoma Infirmary. One bird returned immediately and spread itself out flat, neck extended with bill nearly touching the sunny ground, the full-spread wings and flared tail pressed upon it. For a minute or two the bird remained motionless. Its ventral plumage was hidden from view, but I noted with interest that the dorsal plumage was not raised, not even the pileum. Soon the bird lifted its breast and, in a low squat, made two hurried preening strokes along the outer primaries of one wing, before resuming the spread-eagle pose. Banging of a door caused it to fly.

At once I examined the bed, marking the place used. The hard-baked earth bore no sign of mulch, manure, animal life, or of dust-bathing. Moments later, Mr. Ralph E. Reed, staff pharmacist, using a Nitrogen-filled Incubating Thermometer on that spot, obtained a reading of 60° C. (140° F.). Air temperature was 95° F. at the local weather station.

Fifteen minutes later and 60 yards distant, two kingbirds preened in full sunlight on the limb of a tree.

A related incident occurred on a concrete court, centered with a pedestal bath that was frequented by two grown but still dark-eyed Brown Thrashers (*Toxostoma rufum*). At 11:45 a.m., on July 28, 1959, I noticed one of these birds, alone on the court, behaving strangely.

The thrasher squatted, breast and tail on the concrete, wings slightly drooped, head and body feathers lifted. Incipient bathing? But the bath was unoccupied and the court entirely dry. Soon the bird began to run about in short spurts, rodent fashion, with belly close to the substrate, wings lax, contours fluffed. Between runs, it performed movements suggestive of low-intensity dusting or bathing, but did not duck the head. Whenever it paused, the ventral plumage obviously was so spread that the apteria must have been close to, if not touching, the concrete. Moving on a wide circle, the bird chanced into the shadow of the bathing bowl. Instantly it assumed sleek posture, looked about, then ran on out into the sunny area, where it just as automatically puffed itself up and resumed the run–"bathe"–run sequence. It had come nearly full circle when two House Sparrows (*Passer domesticus*) alighted on the court. The thrasher started toward them, now running normally, veered, and disappeared among some shrubs.

This bird, or its sibling, again was on the court 30 minutes later, behaving in the same manner. At no time during these events did the thrasher hold out its wings, though whenever it "bathed" their edges brushed the flooring, and the tail was spread. The court, clean-washed from the previous day's rain, was too hot for comfort, as tested with the palm of the hand, while the shadowed area was relatively cool. The weather was humid, with a reported temperature of 86° F. at 11:30 that morning.

Five days earlier, in bright sun at 9:30 a.m., an immature, hand-raised Blue Jay (*Cyanocitta cristata*), then free-living, flew to an iron clothesline post, expecting to be fed. It took food from my hand and, spreading the wings laterally on the cross-arm, almost instantly assumed the sunning position shown for the species by Hauser (1957.

Ibid., 69:86, Fig. 1). Thus it remained for nearly two minutes, food in bill, before departing. The metal was quite warm.

The role of strong light relative to warm surface is by no means clear in these cases, yet it seemed to me that kingbird, thrasher, and jay all were reacting mainly to the unusually warm surfaces. One wonders whether the behavior of immature Bank Swallows (*Riparia riparia*) that congregated by the thousands on pavement of a "6,000-car parking lot" in Michigan, during late hours of a July morning, may have been triggered by a high surface temperature, possible under the conditions stated (Crockett and Nickell, 1955. *Jack-Pine Warbler*, 33:86). These birds "appeared to be displaying incipient mating, nest building, and brooding behavior." Similarly suggestive is an account of immature "barn swallows" on Fire Island, N.Y., "at play" in early fall (Booth, 1932. *Nature Magazine*, 20:21–22). For about 30 minutes some 40 birds jostled to launch themselves down the face of a sand dune on their "stomachs," not flying but using wings "as if they were oars." Ascent was made by "flapping and pushing their wings in the sand in the funniest manner." Their odd tracks extended the height of the slope. Chill of weather and warmth of sand were seen as factors in this activity, in which "parent birds" took no part.—Lovie M. Whitaker, *1204 West Brooks Street, Norman, Oklahoma, January 18, 1960.*

Bell's Vireo in New Jersey.—On September 15, 1959, during the Operation Recovery bird-banding program at Island Beach, New Jersey, Mr. and Mrs. Albert Schnitzer of Mountainside, N.J., trapped in a mist net a small, brown-eyed vireo unfamiliar to them. They brought the bird to banding headquarters where it was identified as a Bell's Vireo (*Vireo bellii*). Recognizing that the presence of this species in New Jersey had never been verified, I collected the bird with their approval. It was a female with skull not ossified; it weighed 10.2 grams; it was in little-fat condition; and the largest ovum was less than 1 mm. I have compared the specimen with reference material in the American Museum of Natural History collection and identified it as a representative of the Midwestern race *V. b. bellii.* Subspecific determination was confirmed by Eugene Eisenmann.

Although this species has been reported previously from New Jersey (Fables, 1955. Ann. List of New Jersey Birds, p. 75) and from the New York City region (Cruickshank, 1942. Birds Around New York City, *Amer. Mus. of Nat. Hist. Handbook Series* No. 13:364), both of these writers have rightly considered the species as "hypothetical," pointing out the possibility of confusion with immatures of *V. griseus.* I am unable to find any undoubted recent records for the east coast. Apparently the only other specimen from east of the Appalachians was taken by Ned Dearborn in Durham, New Hampshire, on the extraordinary date of November 11, 1897 (Brewster, 1901. *Auk*, 18:274).

I am indebted to the late Dr. F. C. Lincoln for making data on previous records available to me.—Joseph R. Jehl, Jr., *385 Grove Street, Clifton, New Jersey, October 23, 1959.*

American Coot successfully escapes from a Bald Eagle.—On March 20, 1955, I was overlooking a portion of the Mannington marshes northeast of the city of Salem, New Jersey. Almost 6 inches of snow had fallen during the night but the morning was clear. A mixed flock of ducks including Pintail, Baldpate, Black, Green-winged Teal and a few Mallard were feeding along the edge of open water extending from the road about 30 yards to the north where marshy vegetation began and continuing for another 50 yards to higher ground with a border of shrubbery and small trees. In the open water was a flock of about 50 Coots (*Fulica americana*). I had finished scanning the flock of ducks when I noticed that they suddenly became alert; a moment later they took flight almost as one bird. Simultaneously, the Coots scurried together and began "running" and swimming toward a culvert under the road connecting two sections of the marsh. Just then, I noticed an adult Bald Eagle (*Haliaeetus leucocephalus*) coming across the road, not very high and moving very fast. It made a quick pass at a lone Coot which had become separated from the flock and was at the moment of the strike behind a loose screen of low vegetation. By dodging behind an old mallow plant in which the Eagle was momentarily entangled, the Coot escaped this strike. Without attempting to gain altitude the Eagle made a second strike at the Coot, now in the open but in shallow water. This time the Coot waited until the last second, submerged and almost instantly popped to the surface like a cork. The Eagle of course had been carried by its momentum some distance past the Coot swimming toward the safety of the culvert but not in any apparent hurry. The Eagle now circled until it reached an altitude of perhaps 20 feet whence, after several false starts, it made a third pass at its intended prey. After two more futile strikes, the Eagle gave up and flew away, although the Coot was still some distance from the safety of the culvert. The technique of a well-timed submersion and an immediate resurfacing, which did not seem to require great physical exertion, appeared to be one which could have been continued for a long time.

This is the second time that I have seen Coots use under-road culverts as a refuge from an attacking eagle. As an incidental note, the flock scurrying for the culvert kicked up some spray while "running." I saw nothing resembling the splashing defense described in the literature.—R. O. BENDER, *Cobb's Mill Road, R.D. No. 1, Bridgeton, New Jersey, October 1, 1959.*

The Fish Crow in easternmost Oklahoma.—Since the 4th edition of the A.O.U. Check-List (1931) the known breeding range of the Fish Crow (*Corvus ossifragus*) has been extended north and west in Arkansas, and west into east-central Oklahoma. Bent (1946. *U.S. Nat. Mus. Bull.* no. 191:282) only mentions this species as occurring in central Arkansas near Little Rock. Baerg states in his "Birds of Arkansas" (1951. *Univ. of Ark. Col. of As. Bull.* no. 258:107) that the Fish Crow is found in the vicinity of Van Buren, Crawford County, throughout the year, and in other areas farther south. The species has also been reported from Fort Smith, and this fact is mentioned in the 5th edition of the A.O.U. Check-List (1957).

In January, 1954, I saw six Fish Crows feeding on dead fish along the south embankment of the Arkansas River, about 8 miles west of Moffett, Oklahoma. Later in the month I discovered a small roost of about 800 crows on an island in the Arkansas River about 18 miles west of Moffett, this number including 33 Fish Crows. Tall willows (35–40 feet) were utilized in roosting, but the *ossifragus* remained apart from the Common Crows (*Corvus brachyrhynchos*), occupying the extreme end of the roost. On April 20, 1954, I found a Fish Crow's nest 8 miles west of Moffett, Oklahoma. The nest was situated about 30 feet above the ground in a red oak. Examination revealed four eggs. The last visit I made to the nest site (May 1) showed no change.

The partiality of the Fish Crow to major water bodies is exemplified by these observations, all of which were made near the Arkansas River. It would not be surprising to discover the Fish Crow farther up this river, where it may have been overlooked.—EUGENE J. WILHELM, JR., *Dept. of Geography & Anthropology, Louisiana State University, Baton Rouge, September 24, 1959.*

Birds breeding at Cap des Rosiers, Québec.—The easternmost point along the north coast of the Gaspé Peninsula, Province of Québec, is an area of rocky headlands, coniferous forests, and wave-washed cliffs projecting out into the Gulf of St. Lawrence. Three miles short of Cap Gaspé, the extreme tip of the peninsula, the cliffs of Cap des Rosiers rise up 900 feet above the sea. Here are found many breeding birds of both land and sea. Much has been written of the Gannets (*Morus bassanus*), Black-legged Kittiwakes (*Rissa tridactyla*), Common Puffins (*Fratercula arctica*), and others of Bonaventure Island and Percé, some 23 miles southward; the birds of the Cap des Rosiers area are equally interesting. I observed them while encamped there from August 5–7, 1959.

Dense forests, mainly white spruce and balsam fir, extend to the edge of the cliffs. Mountain maple and white birch are present in small numbers, and there are a few cleared spots of grassy meadows. Alders fringe the margins of the cliffs. Mountain ash, bunchberry, and fireweed were in full color. Breeding land birds of this area, accompanied by fledglings, included the Eastern Wood Pewee (*Contopus virens*), Magnolia Warbler (*Dendroica magnolia*), American Redstart (*Setophaga ruticilla*), Pine Grosbeak (*Pinicola enucleator*), American Goldfinch (*Spinus tristis*), Slate-colored Junco (*Junco hyemalis*), and White-throated Sparrow (*Zonotrichia albicollis*). Several broods of some of these were present. Also observed in the vicinity, and doubtless breeding here, were the Yellow-shafted Flicker (*Colaptes auratus*), Hairy Woodpecker (*Dendrocopos villosus*), Gray Jay (*Perisoreus canadensis*), Black-capped Chickadee (*Parus atricapillus*), White-breasted Nuthatch (*Sitta carolinensis*), Robin (*Turdus migratorius*), Golden-crowned Kinglet (*Regulus satrapa*), Solitary Vireo (*Vireo solitarius*), and Pine Siskin (*Spinus pinus*). The Veery (*Hylocichla fuscescens*) and Common Redpoll (*Acanthis flammea*) were also seen.

The higher cliffs, probably pre-Pleistocene in age, are separated from those below by a plateau several hundred yards in width sloping down to the sea. The lower cliffs, of sandstone formation, attain a maximum height of about 190 feet. On narrow ledges and in crannies of these lower cliffs, for a distance of nearly half a mile and at all elevations from the high tide line to the summit, were breeding colonies of sea birds. Most of the young had hatched, and many were flying or attempting to do so. Species noted here are listed below.

Double-crested Cormorant (*Phalacrocorax auritus*).—About 50 pairs were seen about the cliffs, nesting in small groups high up on the rocks. Some young were out of the nest, but many remained and were being fed on fish. The adults, diving from the surface, caught most fish well inshore. After repeated dives they returned to the ledges to dry out. An interesting trait in their flight behavior was evident one morning when most of the cormorants were on the rocks, in bright sunlight. Two of them, from different sections of the cliffs, launched themselves at one time into the air, circled independently several times over the water, flew back and forth for about three minutes before the cliffs, and then returned to their original sites. Almost at once, in rotation, two more birds took off and repeated this procedure. It was as though two roving sentinels patrolled the area while the others relaxed.

Herring Gull (*Larus argentatus*).—This species nests at many localities in the Gaspé; several hundred were present on the cliffs at Cap des Rosiers, perched at all elevations on the rocks. Most of the young were flying. Fish were caught, well beyond the line of breaking surf, by diving from considerable heights. An adult, resting on the rocks, was once disturbed by a young murre which stumbled into its immediate area. The intruder was seized by the head and shaken vigorously, then was carried off, still struggling weakly, and dropped into the deeper water to drown. The gull remained on the surface near by for a few minutes until the murre sank from sight, not to reappear.

Razorbill (*Alca torda*).—A dozen or so, some of them immature, were seen on the rocks, closely associated with gulls or cormorants, or swimming with stubby tails upturned and diving for food nearby. Apparently the young were all out of the "nest" by this time.

Common Murre (*Uria aalge*).—A score or more of these sharp-billed alcids were clustered in several groups low on the rocks; others dived or rested on the water. Most of the young were fledged. One, smaller than the rest, had either fallen from its natal crevice or was making its initial descent to the sea. A breaking wave, higher than most, buffeted it about on the rocks and then washed it out to deep water. It struggled ineffectually for a minute or more, and then another wave cast it up on the rocks again, where it secured a foothold.

Black Guillemot (*Cepphus grylle*).—The small "sea pigeons," jet black with pure white wing patches, nest apart from other species in the deep rocky fissures, rather high up. The young were all in flight, but dozens were on the water or fluttering with swift wing-beats over the surface. They fish well inshore, often beneath the breaking surf. One was observed while feeding, ducking suddenly under the water and swimming, like the other alcids, with its wings. During the course of 15 dives, it stayed submerged on the average for 23 seconds, and rested on the surface for 20 seconds between dives.

From time to time other species mingle with the colonies of breeding sea birds, but usually in small numbers and briefly. Observed among these birds at Cap des Rosiers were the Great Black-backed Gull (*Larus marinus*), Kittiwake, Common Tern (*Sterna hirundo*), Common Raven (*Corvus corax*), Common Crow (*Corvus brachyrhynchos*), and Gannet. No intolerance was noted between these intruders and the resident population. —RICHARD H. MANVILLE, *U.S. Fish and Wildlife Service, Washington 25, D.C., September 28, 1959.*

A fatal and a near-fatal strangling accident of small birds.—On May 7, 1959, on the Madison River bank near West Yellowstone, Montana, I found an adult female Audubon's Warbler (*Dendroica auduboni*) strangled by a horse hair. The hair, 25 inches in length, was caught in the tall marsh grass by one end, with the other end free. The warbler, which was still warm when found, was apparently a nesting bird. All eggs had been laid and only two very small yolks were visible in the ovary. The specimen, preserved as a mummy with the horse hair intact, is now in the collection of Carnegie Museum, Pittsburgh, Pennsylvania.

I witnessed what was almost a similar tragedy at the Bear River Marsh Refuge near Brigham City, Utah, on May 15, 1958, while I was trying to photograph Barn Swallows (*Hirundo rustica*) gathering mud for their nests. As each bird flew to the mud puddle, it plucked, on the wing, a dry grass stem 8 to 12 inches long. Then, with the piece of grass grasped in the center with the bill, it lit, gathered a load of mud, and returned to the nest site. Suddenly, one of the swallows began to struggle frantically. I found that it had become hopelessly entangled in about 10 feet of gut leader discarded by a fisherman. Part of this leader had been trampled into the mud, leaving a number of free loops. The swallow, after gathering its mud nearby, had flown into and had been entrapped by one of these loops. I cut the bird free only minutes before it probably would have strangled to death. When released, it flew to a telephone wire and spent some time preening its ruffled feathers.—MARY WIBLE, *Carter Camp, Pennsylvania, September 16, 1959.*

Common Grackles anting with moth balls.—On June 27, 1960, at about 5:00 a.m. (CDT), I heard a great chatter of grackles in the front yard. There were about 25 or 30 Common Grackles (*Quiscalus quiscula*), and on the walk were about 10 more with moth balls in their bills. They would rub the moth balls under the wings, along the breast and belly, along the back between the wings, and in the anal area. They would drop the moth balls, shake and shiver, and some would drag themselves along on the walk and in the grass. Those doing this would definitely rub the area of the vent on the walk and in the grass. They would fluff their plumage, and run the bill down the wing quills without the moth ball. Even the young ones took it up, but many of them would fall over. Some rolled in the grass as they tried to rub the moth balls over their feathers. Their antics were so varied it would be hard to describe them all. (See Hill, 1946. *Wilson Bull.*, 58:112; Whitaker, 1957. *Wilson Bull.*, 69:195–262.)

On June 29, 1960, Frank Bellrose and I observed them again anting with the moth balls, this time at about 7:00 p.m.

My observations indicated that the grackles never anted with the moth balls during the middle of the day. They would sometimes pick them up, but never ant with them. The early morning hour and from one to two hours before dusk seemed to be the anting time for them.

On July 10, 1960, one large adult male anted from 4:54 p.m. to 5:23 p.m. He completely and systematically rubbed every feather he could reach on his body, then the wing and tail feathers, with a small moth ball. He knocked over two other adult males who apparently tried to get his moth ball away from him.

I found that I could get the grackles to ant sooner by placing moth flakes in the grass among the moth balls. Apparently the fumes from the flakes made some of the birds' ectoparasites move about, because the birds would immediately start to peck rapidly in first one place, then another, and then ant vigorously with a moth ball.

I observed one young bird chip a part of a moth ball and eat it. Later, I saw an adult bird do the same thing. In both cases, after anting awhile with a moth ball, they both acted like they were very sick. They both walked over by a rose bush and stood with drooping wings and a disinterested attitude. Within an hour they both flew away. On July 20, 1960, grackles were still anting with moth balls.

During my observations I have noted other birds in the area. A Red-headed Woodpecker (*Melanerpes erythrocephalus*) took a moth ball from the ground and flew with it to his nest in a hole in a nearby tree. One Starling (*Sturnus vulgaris*) fluffed his feathers but did not ant. Blue Jays (*Cyanocitta cristata*), young and old, did not ant. Robins (*Turdus migratorius*) did not ant with the moth balls, but I observed an adult male Robin ant over a nest of very large (⅜-inch) brownish-black ants.—Leo H. Borgelt, *219 North Promenade Street, Havana, Illinois, July 22, 1960.*

NEW LIFE MEMBER

Francis L. Jaques, bird artist and illustrator for thirty-five books on birds, mammals, and other outdoor subjects, is a new Life Member of the Wilson Ornithological Society. Mr. Jaques has painted some eighty backgrounds for exhibits in museums including the American Museum of Natural History, the Boston Museum of Science, the Peabody Museum of Yale, the Minnesota Museum of Natural History, the University of Nebraska State Museum, etc. His special interests in ornithology include studies of game and sea birds, and the conservation of their habitats.

Mr. Jaques has been a member of the Society since 1939, and is also a member of the A.O.U., the Linnaean Society of N.Y., and the Explorers' Club.

ORNITHOLOGICAL NEWS

The 1961 annual meeting of the Wilson Ornithological Society will be held at Huntsville, Ontario, Canada, on June 8–11. This will be the first annual meeting of the Society held in Canada.

The Wilson Bulletin now goes to each of the fifty states, the District of Columbia, the Canal Zone, Puerto Rico, the Virgin Islands, and forty foreign countries.

Most back numbers of *The Wilson Bulletin* are available and may be ordered from the Treasurer. Numbers not available from the Society may be obtained as Xerographic enlargements (prints) made from microfilms. For further information write to University Microfilms, Inc., 313 No. First Street, Ann Arbor, Michigan. Prices depend upon size of enlargement desired, and the Society receives a royalty on all such sales.

Awards for ornithological research are made in April of each year by the Frank M. Chapman Memorial Fund Committee of the American Museum of Natural History, New York. Applications should be received by March 1.

The Thirteenth International Ornithological Congress will be held at Cornell University, Ithaca, New York, from June 17 to 21, 1962. The President is Professor Ernst Mayr.

These Congresses are scientific meetings which have been held at intervals since 1884. Since 1926, a four-year cycle has been maintained except for a twelve-year interruption caused by World War II. The previous Congresses have been held in continental Europe and England.

Persons wishing to receive further announcements, and membership application forms for the Congress, should send their names and permanent mailing address to the Secretary-General, Professor C. G. Sibley, Fernow Hall, Cornell University, Ithaca, New York, before February 1, 1961.

The Division of Biological and Medical Sciences of the National Science Foundation announces that the next closing date for receipt of basic research proposals in the Life Sciences is January 15, 1961. Proposals received prior to that date will be reviewed at the spring meetings of the Foundation's advisory panels and disposition will be made approximately four months following the closing date. Proposals received after the January 15, 1961 closing date will be reviewed following the summer closing date of May 15, 1961.

The next closing date for submission of proposals for specialized biological facilities is March 1, 1961. The NSF has two programs for support of facilities, one for general graduate level university laboratories and the other for specialized biological facilities. The latter are defined as discrete research installations which are unique, one-of-a-kind, or at least less than ordinary in that they are not a usual part of a university department.

Inquiries should be addressed to the National Science Foundation, Washington 25, D.C.

The American Institute of Biological Sciences, with support from the National Science Foundation, has embarked upon a program of foreign biological literature translation. The first phase of this program is the translation of Russian biological journals and monographs. Additional information may be obtained by writing to the A.I.B.S., 2000 P Street, N.W., Washington 6, D.C.

ORNITHOLOGICAL LITERATURE

The Waterfowl of the World. By Jean Delacour. Volume Three. Eiders, Pochards, Perching Ducks, Scoters, Golden-eyes, Mergansers, and Stiff-tailed Ducks. Country Life Limited, London, 1959: 8 × 10 inches, 270 pp., 46 maps and 20 color plates by Peter Scott. 6 guineas.

The third volume of this sumptuous production has now appeared; previous volumes were reviewed in *The Wilson Bulletin*, vol. 67, 1955, pp. 314–317, and vol. 71, 1959, pp. 288–289. Many of Dr. Elder's comments in his review of the first volume apply to the work as a whole, and will not be duplicated here. A three-volume set was originally planned, but supplementary material intended for the third volume proved to be of sufficient amount to warrant publication of a fourth volume. This is to include "some general chapters on the morphology, anatomy and biology of the family; on history, sport, conservation, care and breeding; and also a bibliography. . . . It will also contain additions and corrections that have come to light since the publication of the first two volumes."

Such a volume, supplementing the first three, is badly needed, and it is perhaps unfair to review a single volume of the work without knowing just what will appear in the final part. Emphasis in the present review, therefore, will be on what is included rather than what is omitted from volume three.

As is well known, Delacour's "Waterfowl" is a large and expensive work, reminiscent in its format of the era of lavishly produced illustrated monographs of bird families. The typography is handsome, the binding attractive (in appearance if not in strength), the margins wide, and the colored plates abundant. This emphasis on physical appearance, with its concomitant high price, inevitably leads to conjecture as to the audience for whom the book is intended, and I confess that this question has me puzzled. One might suspect that the aim is toward that group often referred to as "rich sportsmen"; if this is the case, there is much technical matter, taxonomic and otherwise, that would seem superfluous. If aimed at the scientist, there is too much vagueness in the text ("Second year males resemble adults, with brown spots here and there," p. 20). Few scientists (at least in biology) and fewer students can justify a total personal expenditure of well over $60 for a publication of this type, and must hope that the libraries of their respective institutions can fit such a purchase into their budgets.

One of the major drawbacks of the book in its attempt to be all things to all people stems, it seems to me, from a deliberately chosen policy. Delacour states in his introduction (p. 15) ". . . the familiar species have been dealt with briefly as detailed information is readily available in other works. But the less known ones have been treated at greater length and important new information on them given as completely as possible." I firmly believe that this policy was ill-advised, although it undoubtedly enabled the book to be published more quickly. The mass of "detailed information . . . readily available in other works" for the common species is, in a group as popular and important as the waterfowl, so extensive and so widely dispersed that the greatest contribution Delacour could have made would have been a thorough synthesis of this vast literature. As it is, Dr. Elder pointed out in his review of the first volume that Delacour overlooked or ignored numerous important papers dealing with species covered in that volume. Because of this stated policy of the author's, we find in volume three the anomalous situation in which 7½ pages are devoted to the rare Brazilian Merganser (*Mergus octosetaceus*), and less than 4½ pages each to the holarctic Goosander and Red-breasted Merganser (*M. merganser* and *M. serrator*). Of the material on the Brazilian Merganser, no less than 5½ pages are allotted to a direct quotation of the excellent paper by Partridge (1956. *Auk*, 73:473–488), a reference readily available in its entirety to any interested reader. The scientist and the student will turn to the original paper rather than to Delacour's abridgment for information about the Brazilian Merganser, and I suspect that most other potential readers of the book would prefer a relatively greater amount of space devoted to species they are likely to encounter personally.

Dr. Elder has previously commented on the amount of space devoted to accounts of each species in captivity. It is, of course, a truism that any book begins to be out-of-date from the moment of publication, but it seems unnecessary to augment the opportunities for obsolescence through the frequent listing of waterfowl collections in which a species is or is not represented "at present."

Generalizations made in the text sometimes appear to go beyond what is justified on the basis of known facts. In the account of "General Habits" of the pochards, the statement is made that "All species assume their adult plumage and breed in the first year" (p. 44). This could be definitely determined in wild birds only with marked individuals. And if the evidence afforded by captive birds be accepted, it must be noted that, as of the date of Delacour's writing, three species of pochards had never bred in captivity (*Aythya novae-seelandiae* has since bred at Slimbridge—a good example of the ephemerous nature of statements about "present" status in captivity). On p. 171, the casual dismissal of the complicated plumage cycle of the Old-squaw (*Clangula hyemalis*) as "of no real importance" is a value judgment out of place in the writings of a scientist.

Classification follows essentially that proposed by Delacour and Mayr in 1945. The major change is the segregation of the eiders as a separate tribe Somateriini, considered to be an offshoot of the Anatini, following Humphrey (for a dissenting opinion, see Johnsgard, 1960. *Condor*, 62:31). Taxonomic judgments at the subspecific level are quite inconsistent. Delacour admits *Somateria mollissima faeroeensis*, although calling it "a poorly characterized subspecies." On the other hand, *S. m. sedentaria*, which also, to Delacour, "seems to be poorly characterized," is denied recognition (although it is an excellent race, as anyone who has ever examined the pale females and downy young can testify). The supposed western race of Harlequin Duck, *Histrionicus histrionicus pacificus*, is admitted on the strength of its "rather larger bill," although Dickinson (1953. *Bull. Mus. Comp. Zoöl.*, 109:139) showed that less than 50 per cent of a sample including 32 eastern and 35 western specimens could be separated on this or any other basis. Delacour gives no comparative measurements to support his statement about bill size. He does give measurements for most subspecies based on size (there is an apparent misprint in the figures for culmen length of the American Golden-eye on p. 181), but in no case does he indicate the size of the series on which these figures are based, nor whether the measurements are original or compiled.

Details of distribution as presented in the text and on the maps must be evaluated by specialists, but I have found inaccuracies in the treatment of some of the species with which I happen to be familiar. For example, the breeding of the Ring-necked Duck (*Aythya collaris*) in the Adirondack region of New York was first reported by Severinghaus and Benson in 1947 (*Auk*, 64:626–627), and the population there has expanded in subsequent years, but is not shown on the distribution map (p. 75). In fact, a comparison of Delacour's map for this species and that presented by Mendall (1958. *Bull. Univ. Maine*, 60, no. 16: Fig. 3) is quite instructive. The "new colony in Pennsylvania" mentioned by Delacour refers to nestings between 1936 and 1939 in the newly-flooded Pymatuning Lake (several other species of waterfowl bred here for a few years after the lake was created). Mendall (*op. cit.*, p. 298) believed that a few pairs may have nested at Pymatuning as late as 1954, but Grimm (1952. *Birds of the Pymatuning Region*, Pa. Game Comm., Harrisburg:84) knew of no nesting after 1939.

Various minor errors have been perpetuated from older literature (see also Dr. Elder's review of volume one in this regard). There seems to be no basis for the ascription of a yellow iris to the male King Eider (*Somateria spectabilis*), although it is so described in, among other works, *The Handbook of British Birds* (see Sutton and Parmelee, 1955. *Arctic*, 8:145). The downy young of Steller's Eider (*Polysticta stelleri*) does have light dorsal spots, *contra* Delacour and other authors (Parkes, MS. *Handbook of North American Birds*).

The colored plates are such an important feature of this work that many people are in the habit of referring to it as "Delacour and Scott," although Peter Scott served as illustrator only, not as coauthor. Mr. Scott has avoided monotony in his fine series of portraits by using a variety of background colors, and by varying his style of painting to some extent. As a matter of personal preference, I like the crisper figures and relatively uniform backgrounds of the series of paintings of *Anas* in volume two better than the softer (and seemingly more hastily-painted) figures and "busy" backgrounds of such plates as those of the wood ducks, comb ducks, and stiff-tails of volume three.

At least one error has crept into the plates. The "male in eclipse" of the Carolina Wood Duck (*Aix sponsa*) on plate VII is actually a female; the male retains his distinctive white facial markings when in "eclipse." And among ducks with as complicated a series of plumage changes as the large eiders, in which the aspect of the young males is almost constantly changing during the first two years of life, a figure labeled "immature male" is rather meaningless (plates I and II). When illustrating birds in anything other than a definitive "adult" plumage, more artists should follow the example of Schiøler in his classic "Danmarks Fugle"; in the latter work both the collecting date and presumed age in months of the figured specimen are given in the caption.

In some instances Mr. Scott has apparently been the victim of poor color reproduction. The heads of the female mergansers on plate XVI, for instance, are not nearly red enough (this is, to my eye, one of the least successful plates in the book). The bill of the male King Eider on plate II, on the other hand, appears to be too red (compare Sutton and Parmelee, *op. cit.*, Fig. 1). The browns of plate IV (Canvasback, Redhead, European Pochard) are not accurate.

These criticisms do not alter the fact that we will not have again for many years, if ever, as complete a set of generally excellent portraits of the world's waterfowl, painted by a man who has studied almost all of them in life and most of them in the field. Perhaps it will be possible at some future time to reprint these plates in a more inexpensive format, as was done for such works as Roberts' "Birds of Minnesota" and Forbush's "Birds of Massachusetts," in order to make the illustrations available to every student and admirer of waterfowl.

As mentioned earlier, reviewers of a single volume of an uncompleted work are at something of a disadvantage, particularly in the present instance in which the promised fourth volume is to remedy some of the shortcomings of the first three. Although the text thus far contains much of interest and usefulness, viewed in the light of Captain Delacour's international reputation as an authority on waterfowl it can only be characterized as disappointing.—KENNETH C. PARKES.

WILDLIFE OF MEXICO. THE GAME BIRDS AND MAMMALS. By A. Starker Leopold. University of Califrornia Press, Berkeley and Los Angeles. 1959: 7 × 10½ in., xiii + 568 pp., 194 figs., 1 map in color. 18 tables, 2 color plates. $12.50.

Mexico's diverse geography and climate have led to the formation of a biota that is unusually rich and varied. In spite of this wealth, or perhaps because of it, there are few countries that show less concern for the conservation of their plant and animal resources or that exploit them with such devastating effectiveness. This is not new. From Díaz del Castillo in the sixteenth century, through Humboldt and Gadow, to the present, people have marveled at the diversity and richness of the Mexican landscape and chronicled and lamented its abuse. Now, however, the burgeoning population and economy of Mexico have accelerated this exploitation and the vast undisturbed areas which once existed are rapidly disappearing. Perhaps even worse than the destruction of virgin country is the denudation of huge tracts of agricultural land through faulty cultivation. Caught between dwindling habitats and increased hunting pressure, the wildlife is decreasing at a critical rate. Mexico must soon implement a sound conservation program or large portions of its flora and fauna will be forever lost.

"Wildlife of Mexico" was written with the intent of arousing popular interest in the fauna and creating concern for its conservation. It is, therefore, a "popular" book, but the biologist will find much of value in this attractive and exceedingly well-written volume.

The book is divided into three parts. The first, "The Wildlife Resource and its Management," contains brilliantly clear descriptions of the physiography of the country, the use to which the land is put, the manner in which the wildlife is utilized, and the present ineffective program for wildlife conservation. A plan for establishing refuges, improving habitats, educating the sportsmen, and implementing similar projects is also presented.

The chapter on "The Mexican Landscape" contains the best generalized account of the vegetation of Mexico to be found anywhere. Excellent photographs and a map in color greatly enhance the effectiveness of this description. Unfortunately, the map depicts only the former extent of the various vegetation types, although the present range is often markedly different. The text usually indicates where such discrepancies occur, but it would seem that a map showing these differences would be particularly valuable.

It is evident from the chapters on the exploitation of the land and its wildlife that Leopold understands and likes the Mexican people. Because he is *simpático* he is not pedantic and exasperated, which one must surely become if one attempts to apply American standards and practices of wildlife conservation to the Mexican scene, without a full appreciation of Mexican customs and viewpoints. Leopold is no head-in-the-clouds conservationist who insists that in order to preserve one must set aside areas where the land is not utilized, and the animal population is allowed to achieve its own level without the manipulations of man. Rather, he recognizes that the wildlife resources of Mexico can be harvested for the benefit and enjoyment of the people. This is an important point in a country where the whole idea of conservation is new and where the "What's in it for me?" attitude generally prevails, whether from mere ignorance or genuine need imposed by poverty.

The second part of the book treats of the game birds. The "game birds" are the types generally considered to be such in the United States. Resident species are thoroughly covered; transient or wintering forms (e.g., ducks) are briefly noted. Small birds, even though they may belong to game bird groups, as the *Columbigallina* and *Claravis* ground doves, are omitted, as are all of the Charadriiformes. Some species within these groups, particularly the ground doves, are of considerable local importance as food. One might quibble about their omission. A line must be drawn somewhere since in certain areas of the country almost any animal, ranging from flycatchers and lizards to caterpillars and grasshoppers, is considered fair "game." I should like to see the ground doves and some shorebirds covered in the book, but would not insist upon the inclusion of grasshoppers.

The birds are grouped by orders and families. A general discussion of the attributes and distribution of the group precedes the species accounts. Each species is treated separately; exceptions are the four sibling species of *Leptotila* doves and three of Tree Quail.

A full-page black and white drawing illustrates every resident species; the nonresident forms are grouped, with two or more species to a page. These drawings, by Charles Schwartz, are handsome and have considerable vitality. Insets are used often to illustrate features of particular interest, such as the shape of a crest or the differences between the races of a species. Schwartz is a master at conveying an impression of the bird's habitat through simple background details like a corn stalk fragment, a philodendron leaf, or a distant thatched hut. An outline map showing the range of the species in Mexico also is included in each drawing.

The illustrations are supplemented in the text by descriptions of coloration and by measurements, including weights. A paragraph devoted to range includes details relative to habitat, abundance, and migration which are not evident on the outline maps.

A generalized life history account of the species follows. This varies greatly in length and detail according to the species considered. Here is assembled information which, for the most part, has not been available in a single source or which is totally new. The account ranges from estimates of population densities, descriptions of food and habitat requirements, and data on breeding to recommendations for managing species and comments on their culinary qualities. The sportsman will find the account interesting; the biologist will welcome the synthesis of much scattered information.

The third section of the book is devoted to game mammals and follows the same pattern used for the birds. The Grizzly Bear and Ocelot are illustrated in color. These plates are not nearly so effective as Schwartz's black and white drawings.

Appendices on Mexican game laws and regulations, a bibliography, and a good index conclude the volume.

This is a fine book. When it is translated into Spanish, which is said to be imminent (p. 2), it should help toward stirring local interest in Mexico's wildlife, and, we hope, will stimulate a forceful effort to preserve it. There is little likelihood, unfortunately, that such an elaborate and comparatively expensive book will have a wide circulation in Mexico, but possibly it will reach and influence the more affluent Mexicans who, perhaps, are in the best position to initiate serious conservation efforts. If this fails, "Wildlife of Mexico" will at least stand as an opulent obituary.—RAYMOND A. PAYNTER, JR.

CHECK-LIST OF BIRDS OF THE WORLD. A continuation of the work of James L. Peters. Volume IX. Edited by Ernst Mayr and James C. Greenway, Jr. Museum of Comparative Zoology, Cambridge, Mass., 1960: 6½ × 9¼ in., xii + 506 pp. $6.00.

The primary purpose of the average review is to help the reader to decide whether he wishes to buy, or have his institution buy, the book being reviewed. The reviewer likes to believe that an enthusiastic notice will help to stimulate sales, and that a real "roasting" will keep his readers from wasting their money. This approach cannot be used, however, for a volume of a standard reference work such as the Peters "Check-list." Such a book may be virtually indispensable to many readers, without any relation to possible defects or inadequacies. One simply *must* have the volume for one's professional library. The reviewer, therefore, addresses his words as much to the authors and editors of the reference work as to the reader, in the hope that constructive suggestions and corrections may be adopted in later volumes.

Few reference works are more important to the working ornithologist than the check-list commenced by the late James L. Peters in 1931, and completed through Volume 7 (of a projected 15) at the time of his death in 1952. The project is being continued by an international group of taxonomists under the direction of Ernst Mayr and J. C. Greenway, Jr., of the Museum of Comparative Zoology at Harvard. The relative difficulty of certain of the remaining families of passerine birds and the limitations of time available to the various authors of this project have necessitated a publication schedule which does not coincide with the numerical sequence. As mentioned above, Volume 7 was the last completed by Peters himself; the present volume is no. 9, and the next to appear will probably be no. 15.

A few changes in format characterize Volume 9, which includes the first 13 families of oscines. A useful binomial heading has been added for every species as a guide to the eye; this is a distinct improvement. Synonymies are limited to names not cited by Hellmayr (New World) or by Hartert or Sharpe (Old World). Descriptions of ranges, particularly of winter ranges of migratory forms, have been given somewhat fuller treatment than was done by Peters. The volume itself was printed in Denmark, presumably to save on costs. For a work set up in type by printers whose native tongue is not English, it is gratifyingly free of typographical errors, but among those few that were not caught are some in words that are not English (cf. "Linneaus" twice on p. 115; "**Troglodytns**" on p. 423).

The sequence of families is that outlined previously by Mayr and Greenway (1956. Breviora, no. 58:1–11). This sequence has been the source of no little controversy, and I will confine myself to stating that I ally myself completely with the viewpoint expressed by Storer (1959. *Condor*, 61:152–153). That the 1956 classification is not, after all, sacrosanct is indicated by two reversals of decision at the family level; the Palm-chat, *Dulus*, is given full family rank rather than being placed as a subfamily of the Bombycillidae, and the Prionopidae of 1956 (which included the strange Bornean *Pityriasis*) are reduced to a subfamily of the Laniidae, with *Pityriasis* given a subfamily of its own at the opposite end of the family from the Prionopinae.

The editors admit, in an introduction, that the multiple authorship of this and future volumes results in an unevenness of taxonomic viewpoint (well illustrated by the contrast in treatment between the adjacent families Troglodytidae and Mimidae in this volume). They point out, quite rightly, that Peters himself had shifted toward broader generic and specific concepts in the course of his seven volumes, and it is obviously impossible to state that Peters would or would not have approved of certain "lumpings" in this volume. A certain degree of continuing conservatism on Peters' part is manifested, for example, among the swallows, the manuscript for which he had completed before his death; the Barn and Cliff Swallow assemblage is divided into three genera rather than combined into one as advocated (I believe rightly) by Mayr and Bond (1943. *Ibis*: 334–341).

I find that most of the criticisms of this volume that I have jotted down while going through it prove to be concerned with matters of editorial policy, and are matters that, should the editors find my criticisms constructive, can be changed in forthcoming volumes. Perhaps the most serious fault of the present volume has to do with the establishment of author (or editor) responsibility for a given statement.. The names of the authors responsible for the various families are given only at the beginning of that family in the text; adding this information to the table of contents would save much thumbing back and forth. To indicate to the reader of this review just which families are included in Volume 9, and who the authors are, a summary follows: J. L. Peters (Alaudidae, Hirundinidae, Campephagidae [part]); C. Vaurie (Palearctic Motacillidae and Troglodytidae); C. M. N. White (African Motacillidae); E. Mayr (Southeast Asian Motacillidae, Campephagidae [part]); J. C. Greenway, Jr. (American Motacillidae, Bombycillidae, Dulidae, Cinclidae); H. G. Deignan (Campephagidae [part], Oriental Pycnonotidae); A. L. Rand (African Pycnonotidae, Laniidae, Vangidae); J. Delacour (Irenidae); R. A. Paynter, Jr. (American Troglodytidae); J. Davis and A. H. Miller (co-authors of Mimidae with no division of responsibility indicated).

For those families originally prepared by Peters, there is no indication as to who brought the manuscripts up to date after his death in 1952 (numerous later papers are cited), although, as for all other families, there are footnotes stating by whom the manuscript for that family was "read." In the family Campephagidae, Peters and Mayr are each listed as being responsible for part of *Coracina.* A new name in this genus, *C. tenuirostris numforana,* is introduced on p. 187 with no indication as to its proper authorship.

An addendum on the last page of the text picks up a species and a subspecies inadvertently omitted from their proper places, and introduces another new name to replace one found to be preoccupied. This name, *Pycnonotus barbatus zeilae,* is not credited to any author. As it refers to an African bulbul, one would assume the author to be A. L. Rand, but I am informed that Dr. Rand saw this name for the first time when the book was published. The authorship of this name should be clarified in print as soon as possible. Unlike previous volumes of the Peters check-list, there is no list of newly proposed names. In addition to the two new names mentioned above, I found, by diligent page-thumbing, *Pycnonotus cafer wetmorei* Deignan (p. 236) and *Hypsipetes amaurotis nagamichii* Deignan (p. 295). I may have missed others.

In view of this rather careless handling of nomenclatorial matters, it comes as something of a shock to find the footnote initialled by Mayr (p. 193), rejecting a substitute name proposed by Ripley (1952. *Condor,* 54:362), giving as justification a highly dubious nomenclatorial technicality. This is not the place to go into details, but I can say that if Mayr believed Ripley's name to be invalid, he should have proposed a substitute. As it now stands, the name *panayensis* is used for two different forms of the genus *Coracina* in what is supposed to be the definitive check-list of birds of the world.

The footnote mentioned above is almost the only one in the book to which initials have been appended, and it was presumably done in this case because Mayr and Peters were each responsible for part of the genus *Coracina* (but see above with respect to the authorship of *C. tenuirostris numforana*). One would assume that all other footnotes were to be credited to the author of the family involved. However, the unsigned footnote on p. 131 was not written by Vaurie, the author of the section in which it appears; in fact, the opinion expressed in the footnote is directly contrary to that held by Vaurie (pers. comm.).

The introduction specifically states that "no new material has been added after July 1, 1958." I heartily commend the publication of such closing dates (absent in all too many check-lists, including that of the A.O.U.), but strongly urge that they be faithfully observed once set. In Volume 9, I note the inclusion of *Hypsipetes everetti samarensis* Rand and Rabor (p. 288), published in the *Auk* for January, 1959. Rand also cites Vaurie's "Birds of the Palearctic Fauna" (1959) in his list of references for the family Laniidae, although no other author (including Vaurie himself) does so. It may be argued that such last-minute inclusions add to the completeness of the volume. On the other hand, they are unfair to other authors who may have published new forms or revisionary studies between the announced deadline and the publication date, and whose works have *not* been taken into account.

One of the major departures in style from earlier volumes in the Peters series is the introduction of English vernacular names, which are alleged to have been adopted "where a species occurs in English speaking countries and has a well known vernacular name." The application of this principle, as the editors admit, has been inconsistent. Examination of the names applied to members of a large genus such as *Pycnonotus* reveals many such inconsistencies. For example, *P. urostictus*, which is given an English name, is a species confined to the Philippines, a country in which English is more widely used than the "national language" of Tagalog. But *P. goiavier*, probably the most common species of bulbul in the Philippines (and widely distributed elsewhere in southeast Asia), is given no English name. Since this check-list is written in the English language, I believe that the proper step would have been to apply English names to all species or to none. Standard reference books in English are available for virtually all parts of the world's avifauna, and attempts are now being made to standardize English names of birds from primarily non-English-speaking countries (cf. Eisenmann, "The species of Middle American birds." 1955. *Trans. Linn. Soc. N.Y.*, 7: 128 pp.). Selection of appropriate English names for all species in the Peters list would do much to help such stabilization.

As in my review of Vaurie's check-list of Palearctic birds (1959. *Wilson Bull.*, 71: 286–288), I do not propose to dwell at any length on my own reaction as a taxonomist to the handling by various authors of groups I have studied. Differences of taxonomic opinion, I repeat, are inevitable, and need not be listed or mentioned unless an author is an outrageous extremist, certainly not the case here.

I may say in passing that I had felt for some time, on a purely empirical basis, that the family "Irenidae" as constituted in the present volume was an artificial one. It was therefore of great interest to me to see Wetmore's recent and highly plausible suggestion (1960. *Smithsonian Misc. Coll.*, 139, no. 11:19) that *Irena* should be placed in the Oriolidae, leaving *Aegithina* and *Chloropsis* as the family Chloropseidae.

Again as done in my review of Vaurie's check-list, I propose to indicate here, for the benefit of interested readers of the *Wilson Bulletin*, the differences (other than mere differences of sequence) in taxonomic treatments of the A.O.U. Check-list and the new Peters volume. These are as follows:

1. *Iridoprocne* is included within *Tachycineta* (see Brodkorb, 1957. *Jour. Paleontology*, 31:130–131).
2. *Progne cryptoleuca* is considered conspecific with *P. dominicensis* (see also Eisenmann, 1959. *Auk*, 76:532).
3. *Petrochelidon pyrrhonota hypopolia* is considered inseparable from *P. p. pyrrhonota*, and *P. p. minima* doubtfully distinct from *P. p. melanogaster* of Mexico.
4. *Petrochelidon fulva cavicola* of Cuba (accidental in Florida) is considered inseparable from *P. f. fulva* of Hispaniola.
5. *Anthus pratensis* (accidental), treated as monotypic by A.O.U., has an additional subspecies in Ireland (*theresae*).
6. *Lanius ludovicianus miamensis* Bishop is admitted (see Rand, 1957. *Auk*, 74: 503–505).
7. The specific name of the Bohemian Waxwing is *garrulus*, not *garrula* (see Parkes, 1958. *Auk*, 75:479).
8. The Ptilogonatidae are placed as a subfamily of the Bombycillidae, with a footnote stating that this relationship has not been proved.
9. The specific name of the Cactus Wren is *brunneicapillus*, not *brunneicapillum* (see Mayr, 1958. *Auk*, 75:225).
10. *Catherpes* is included within *Salpinctes.*
11. *Telmatodytes* is included within *Cistothorus.*
12. *Cistothorus palustris dissaëptus* is considered inseparable from *C. p. palustris* (but

see Parkes, 1959. *Ann. Carnegie Mus.*, 35:275–281), and *C. p. iliacus* and *C. p. laingi* revert to the "Prairie" and "Alberta" Marsh Wrens respectively.

13. *Troglodytes troglodytes tanagensis*, *seguamensis*, *stevensoni*, and *petrophilus* are all considered inseparable from *T. t. kiskensis.*
14. *Troglodytes aëdon baldwini* is considered inseparable from *T. a. aëdon*, *T. brunneicollis* is considered conspecific with *T. aëdon*, and *T. a. vorhiesi* is considered inseparable from *T. a. cahooni* of Mexico.
15. *Toxostoma bendirei* is considered polytypic, with two additional races in Mexico.

—Kenneth C. Parkes.

Life Histories of Central American Birds. II. Families Vireonidae, Sylviidae, Turdidae, Troglodytidae, Paridae, Corvidae, Hirundinidae, and Tyrannidae. By Alexander F. Skutch. Illustrated by Don R. Eckelberry. Cooper Ornithological Society, Pacific Coast Avifauna No. 34, 1960: 7 × 10½ in., 593 pp., 100 figs., 1 col. pl. $15.00 ($14.00 in paper covers).

This volume of life history studies of tropical birds is the second major contribution to a series of assembled reports of critical studies made by Alexander Skutch. Having already covered five families from the Fringillidae through the Coerebidae in Part I, Skutch here presents work involving eight families from the Vireonidae through the Tyrannidae. This volume is considerably larger than the first, and includes studies of 59 species, as follows: Vireonidae, 3; Sylviidae, 2; Turdidae, 5; Troglodytidae, 12; Paridae, 1; Corvidae, 2; Hirundinidae, 3; Tyrannidae, 31. This work does not pretend to provide a complete coverage of all Central American birds, but a good sampling of representative species, for many of which detailed information has been almost completely lacking heretofore.

The treatment of each successive species follows the same general pattern which was established in Part I. It opens with a description of the bird's plumage and general appearance, its distribution, and something of its habits, including food habits, in an introductory section. Next come separate sections on voice, nest building, eggs, incubation, the nestlings, and finally a summary. Where more information is available for a species there may be additional titled categories, and where there is only a small amount of material it may be presented with fewer subheadings or none. Five of the reports are short résumés of longer papers which Skutch has previously published elsewhere. Original reports of as little as three pages in length have been included here, along with others extending to more than 15 or 20 pages. This is commendable because so many species are poorly known, the material might not otherwise be available for many years, and even an incomplete life history contributes greatly to a more nearly complete understanding of the Central American avifauna.

Most of the observations upon which this book was based were made in Guatemala, Honduras, Costa Rica, or Panama, during the period from 1929 to 1956.

Adding to the attractiveness and usefulness of the book are the numerous photographs, and the black-and-white halftones of birds, and the color frontispiece of three small flycatchers. With the exception of the three flycatchers depicted in color, each species in the book is represented by a drawing within the pages devoted to that species account. As far as I can determine, no separate credits are given for the photographs, so I assume that they are the contributions of the author. The bird drawings, obviously the work of an accomplished artist well acquainted with the species involved, were done by Don R. Eckelberry.

The section on flycatchers particularly, comprising 291 pages, is certain to intrigue as well as inform the reader as he follows Skutch's progression from the species which build open, bowl-shaped nests to those which build completely enclosed, hanging nests; from species in which the male participates to a considerable extent in nesting activities, to those in which it takes no interest in the nest. Most readers will marvel at the extent and accuracy of the information on roosting, time of egg laying, incubation periods, nestling periods, family activities, and characteristic mannerisms, in species after species, some bold and colorful, others extremely plain and retiring.

The uniformity of approach, methods, organization, and interpretation evident in these studies is one of the major virtues of the series. The preparation of a summary for each species, except in the five reports which are summaries in themselves, further consolidates and unifies the presentation. Although there are nearly 200 titles in the list of Literature Cited, this work is not intended as a compilation of all known life-history data for each species. Therefore, some students may know a few details which are not included here, and certainly many additional facts will be learned in the future. For example, we could supplement Skutch's findings by mentioning that *Turdus assimilis* frequently occurs at 8,000 to 10,000 feet elevation in Mexico; that *Catharus aurantiirostris* may be found in parts of Mexico at 7,000 to 8,000 feet elevation; that *Legatus leucophaius* regularly uses the nest of *Icterus gularis* in Mexico. Eventually a compiler will add such fringe information to the detailed basic material which Skutch provides. However, the excellence and thoroughness of the presentation here is such that further developments will be more in the nature of broadening the picture of each species rather than bringing it into sharper focus. Skutch has such a wealth of information that it is most appropriate that here he should restrict himself largely to presenting the results of his own observations, rather than attempting a complete compilation for each species. He has acted as a compiler to the extent of presenting a summary of available information on the natural history of each of the eight families, in a separate section of five or more pages, at the end of the group of species accounts for that particular family.

Because of the writer's knack for presenting facts in an interesting manner, because of the inherent interest which life history material holds for many readers, because of the fact that most of the species treated are intriguing or unusual in many ways, and because the American tropics seem to have a glamorous fascination for many North Americans, this book should have wide popular appeal in addition to its great scientific value.—ERNEST P. EDWARDS.

WINTER FOODS OF THE BOBWHITE IN SOUTHERN ILLINOIS. By Edward J. Larimer. Illinois Natural History Survey Division Biological Notes No. 42, May, 1960: 8½ × 11 in., paper covers, 35 pp., illustrated.

This paper adds 34 counties in southern Illinois to the long list of geographic areas for which the food habits of the Bobwhite have been analyzed. The findings are based on data from crops of 4606 Bobwhites taken by hunters in two 31-day periods (November 11 to December 11) in 1950 and 1951. Larimer found, as have others, that Bobwhites subsist primarily on vegetal materials of cultivated origin in the early winter.—THANE S. ROBINSON.

HAWKS AND OWLS: POPULATION TRENDS FROM ILLINOIS CHRISTMAS COUNTS. By Richard R. Graber and Jack S. Golden. Illinois Natural History Survey Division Biological Notes No. 41, March, 1960: 8½ × 11 in., paper covers, 24 pp., illustrated.

Christmas bird censuses in the state of Illinois in the 52-year period, 1903–1955, have yielded data on 28 species of hawks and owls. For those who feel that such censuses are significant from the quantitative standpoint, this paper will be of interest. The information extracted by Graber and Golden indicates that there has been a marked decline in the raptor population of Illinois since 1903, with the Rough-legged Hawk being most severely affected. Only a few species seemingly are on the increase. These include raptors that have been placed on the protected list, such as the Sparrow Hawk, Bald Eagle, and Marsh Hawk. The authors conclude that humans have been instrumental in regulating the seeming population trends of Illinois hawks and owls.

William E. Clark, photographer with the Illinois Natural History Survey, is to be commended for the excellent photographs of nine species of raptors that are reproduced, in black and white, in this publication.—Thane S. Robinson.

A Treasury of New Zealand Bird Song: An Album of Three Records of the Songs of New Zealand Birds in the Forests, Mountains and Countryside. By Kenneth and Jean Bigwood. Accompanied by a booklet, Thirty New Zealand Birds, by Gordon R. Williams. A. H. & A. W. Reed, 182 Wakefield Street, Wellington, 1959: 7 × 7 in., 40 pp., photos. Paper covered. Album and booklet, boxed, about $6.30; records available separately at $2.00 each.

A fine addition to the slowly growing list of "natural sound" recordings! On the "extended play" (45 r.p.m.) records are preserved the voices of six native songbirds, 12 introduced songbirds (including the Australian Bell-magpie), some parrots, the Kiwi and other flightless species, some water birds, etc. The quality is excellent, as can be seen by comparing the English species, e.g., Blackbird and Skylark, with other available reproductions. The spoken commentary is graceful; yet anyone trying to study the songs soon finds the reiteration of the already memorized sentences an annoying distraction. Would it not be better to have no commentary and more songs? The booklet describing the species is pleasantly and ably written. It presents briefly the history of the New Zealand avifauna, and does what can reasonably be done (or a trifle more?) to gloss over the destructiveness of man, and to bring out the partially compensating enrichments of the fauna and flora due to him. There is an admirable essay on "Bird songs and calls." It contains a curious mistake. Perhaps in Australasia it is *almost* the case that the "songbirds, or Oscines" are "the only ones that have true song." Yet the 8600-odd species of the world's birds had just been mentioned, and however one defines "true," hundreds of non-Oscines truly sing. If the criterion is territory advertisement, then non-Oscine examples may well exceed 1000; and if one requires also recognizable musical character, they are still numerous. Thus the 15-second ascending chant of the Antbird (*Chamaeza ruficauda*) in Brazil; or the famous twilight song of the Wood Pewee (*Contopus virens*). There is a delightful specimen of musical rhythm in a hummingbird of Jamaica, *Mellisuga minima*, also in the non-parasitic cuckoo of North America, *Coccyzus erythropthalmus*.

Presumably certain New Zealand species, such as the Wattle Crow (*Callaeas cinerea*), were not recorded because they could not be found (extinct?). But why omit the White-eye (*Zosterops lateralis*)?

Of the native songsters, outstanding are the Tui (*Prosthemadera novaeseelandiae*), the Bellbird (*Anthornis melanura*), the Grey Warbler (*Gerygone igata*), and the Robin (*Petroica australis*), a flycatcher. The first two of these are certainly among the most fascinating of all avian musicians. The writer admits himself mightily puzzled: he did positively identify and make careful notes on singing Tuis and Bellbirds during a short stay in the islands, and the songs they sang had only a remote resemblance to those on this record. Apparently the differences of local dialect, or the individual and seasonal variations, to which Williams refers, go far indeed. I wonder if Captain Cook's quoted testimony to the Bellbird's music was not really a response to a mixed and, to him, indistinguishable chorus of both species, which often sing from neighboring trees, and as this record shows, rather similarly (though I *thought* I observed wide and clear differences at Rotorua and Waikaramoana).

We should be most grateful to the three producers of this valuable set.—CHARLES HARTSHORNE.

VII BULLETIN OF THE INTERNATIONAL COMMITTEE FOR BIRD PRESERVATION. Published by the I.C.B.P., 1958: 250 pp., 16 pls. Mostly in English, but parts in German, French, and Spanish. Paper bound, $2.10. (Order from G. W. Merck, Secretary, I.C.B.P., New York Zoological Society, 30 East 40th Street, New York 16, N.Y.)

An introduction by President Jean Delacour is followed by a declaration of principles, all in four languages. Results of the Fifth and Sixth Conferences of the European Section, held in Italy in 1952 and Holland in 1956, and the Ninth and Tenth Conferences of the I.C.B.P., held in Switzerland in 1954 and Southern Rhodesia in 1957, follow. The discussions include:

(1) Protection of migrating birds and establishment of refuges on migration routes. Refuges established in Belgium, France, Great Britain, Hungary, and The Netherlands and the species benefited are given.

(2) Birds which are a menace to other species. The Herring Gull (*Larus argentatus*), Black-headed Gull (*Larus ridibundus*), and Black-backed Gull (*Larus marinus*), are considered, and the results of many censuses taken in Europe are given with appraisals of the damages and benefits which the species effect.

(3) Oil pollution in the seas. This problem and actions taken in different countries are discussed. Many countries have now ratified the resolutions set up by the I.C.B.P.

(4) Preservation of wildfowl, including much discussion on species with diminishing numbers.

(5) Effect of trade in plumage, cage birds, and carcasses on bird populations. Egret feathers still come to Europe from Venezuela, Gray Jungle Fowl from India, and Birds of Paradise plumes through New Guinea.

(6) Need of protection of birds of prey. Much of the report centers on Holland and the damages and benefits which species there are responsible for. Little mention is given about recent laws enacted in many states in the United States.

(7) Birds threatened with extinction. Thirteen species are listed as being in grave danger. Some, such as the Hawaiian Goose (*Nesochen sandvicensis*) and the Whooping Crane (*Grus americana*), are being helped, but little can be done for others such as the Eskimo Curlew (*Numenius borealis*) or the Cuban Ivory-billed Woodpecker (*Campephilus principalis bairdii*). There is a good summary of the location of the latter in Cuba with numbers observed. The status of the Japanese Crane (*Grus japonensis*) is likewise given.

(8) The effects of pesticides, insecticides, etc. on wildlife. The dangers and effects are discussed by different writers. In many cases protection to man and domestic animals has been enforced, but lack of protection to wildlife has resulted in much damage to birds, mammals, fish, and other forms.

(9) Bird protection. Reports from 17 countries are given.

This is a really worth-while publication. The reader will get much out of it and at the same time help support the I.C.B.P. by purchasing it. Bird protection is an international problem. A refuge created for one species usually benefits many biological forms. With the worldwide explosion of human population, we must consider now many of these serious problems lest we lose not only a few forms, but thousands.—LAWRENCE H. WALKINSHAW.

INDEX TO VOLUME 72, 1960

This index includes, in addition to names of genera, species, and authors, references to the following topics: anatomy, behavior, distribution, food habits, fossils, measurements, migration, molts and plumages, nesting, parasitism, physiology, populations, predation, taxonomy, voice, and weights. Also included are references of biological significance to mammals, reptiles, and amphibians.

This issue of *The Wilson Bulletin* was published on December 14, 1960.

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-list (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. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. 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.

Wilson Ornithological Society

ANNUAL MEETINGS

1st	1914	Chicago, Illinois
2nd	1914	Chicago, Illinois
3rd	1915	Columbus, Ohio
4th	1916	Chicago, Illinois
5th	1917	Pittsburgh, Pennsylvania
6th	1919	St. Louis, Missouri
7th	1920	Chicago, Illinois
8th	1921	Chicago, Illinois
9th	1922	Chicago, Illinois
10th	1923	Cincinnati, Ohio
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
29th	1947	Columbus, Ohio
30th	1949	Madison, Wisconsin
31st	1950	Jackson's Mill, W. 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
42nd	1961	Huntsville, Ontario, Canada
43rd	1962	Lafayette, Indiana