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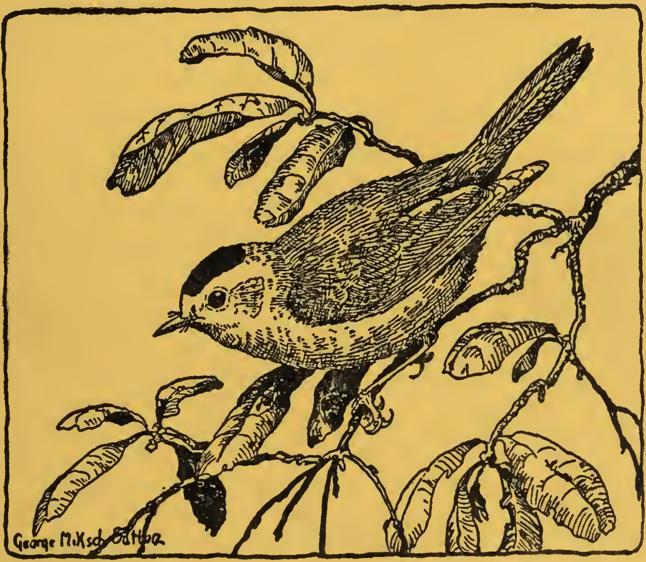

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WHITE-CRESTED COQUETTE *(Paphosia adorabilis)*
Males and female (lower), life-size, from a watercolor painting by Don R. Eckelberry.

LIFE HISTORY OF THE WHITE-CRESTED COQUETTE HUMMINGBIRD

Alexander F. Skutch

At the end of October 1936, the *Inga* trees that shaded the small coffee groves in the narrow valley of the Río Buena Vista in southern Costa Rica flowered profusely. The fluffy stamen-clusters of the spreading leguminous trees attracted many hummingbirds of several kinds, among which I glimpsed a crested species new to me. Hoping for a better view of this exciting stranger, I watched in the grove on a sunny morning when the hummingbirds were very active; but to my great exasperation, every time the plumed bird came in sight one of the larger kinds drove him away. Finally, I discovered that after each round of visits to the *Inga* flowers he returned to rest and preen on the same exposed twig of a coffee bush, only five feet above the ground. Here on his favorite perch he permitted me to examine him within arm's length at my leisure. Never before had I met a hummingbird at once so ornate, so small, and so confiding.

I had no difficulty in identifying him as a White-crested Coquette (*Paphosia adorabilis*). In the same coffee grove were a number of females of the same species, and a young male just beginning to acquire the adult plumage.

The White-crested Coquette has a restricted range from central Costa Rica to western Panamá. It appears to be confined to the Pacific slope except in central Costa Rica, where the low continental divide permits it to cross to the Caribbean slope, on which it has been found around 3,000 feet above sea level. Its altitudinal range is from about 1,000 to 4,000 feet. If it enters the forest, it evidently remains high in the treetops where it is rarely noticed. I have seen few of these readily identified hummingbirds except where there is a profuse display of flowers attractive to them. Among these are the *Inga* trees planted as shade for the coffee, as already mentioned. Near the plantation where I met my first adult male was another small grove where, in early November, I found a number of others, some of whom were scarcely less confiding. During the years when I had a hedge of *Stachytarpheta* along two sides of my dooryard, many Coquettes came, along with a multitude of other hummingbirds, to sip nectar from the small purple flowers of this straggling shrub of the verbena family.

At this hedge I recorded males in full breeding plumage chiefly from August to March. Males in various stages intermediate between the juvenal plumage, which resembles that of the female, and the ornate nuptial attire were seen from late May to the beginning of October. I hesitate to conclude from these observations that the males lose their head plumes and go into "eclipse" after the breeding season. Since, as in many other hummingbirds, the Coquettes appear to wander widely in search of plants that blossom profusely, it may be that the adult males went elsewhere from mid-March to late August, in which five-month interval I recorded only one at my house, in June; although females and males in transitional plumage were present in this period, and females visited the *Stachytarpheta* throughout the year.

COURTSHIP

Toward the end of October, I watched a male Coquette in full regalia display to a female who rested on a low, slender twig close by the flowering hedge. Hovering in front of her, he oscillated rapidly from side to side, in a most peculiar lateral flight such as only hummingbirds, of all feathered creatures, appear to be capable of performing. Always keeping his breast toward the quiescent female, he swung now toward his left wing and now toward his right, alternating his direction with surprising swiftness. The length of his sideward swing between the opposite turning points seemed not to exceed one foot. The female always kept her bill pointed directly toward the displaying male. Soon she rose slowly above her perch, hovering on wing as only a hummingbird can; and he continued to float in front of her, now oscillating more slowly than before. A few seconds later they separated.

At the end of April, when the only Coquettes at the hedge were in female attire without head plumes, one of these unornamented individuals perched on a *Stachytarpheta* bush, while another, equally plain, hovered in the air, facing it, a few inches away. After this had continued for less than a minute, the first hummingbird left its perch and slowly rose into the air; and the one that had been hovering ascended with it, still facing it, and now began to oscillate rapidly from side to side, in a movement with an amplitude of only a few inches. After a few seconds, the display ended and the birds flew off in different directions. This performance resembled that of the adult male that I had earlier watched, but the lateral oscillation was shorter and less regular. I wondered whether the performer was an adult male in eclipse plumage or an immature individual.

Although hummingbirds of many kinds sing persistently and more or less melodiously from stations where they are to be found day after day in the breeding season, I have not discovered the White-crested Coquette behaving in this way.

NEST AND EGGS

On our farm at Quizarrá, in the basin of El General at about 2,500 feet above sea level, I have seen four nests of the White-crested Coquette. Two of these nests held eggs at the beginning of January and had evidently been built in the preceding month. In another nest the eggs hatched about 5 February and the young flew at the end of the month. The latest nest held eggs at the end of February, and in early March they were deserted. These few records indicate that this hummingbird, like a number of other species, breeds early in the dry season, when flowers are abundant. The latest nest was apparently abandoned because of the increasing dryness and paucity of blossoms.

The highest of these four nests was situated about 60 feet up in a dead tree at the forest's edge. A dying orchid plant hung below a mossy branch of this tree, and to the upper side of a slender stem of the orchid the nest was attached. The other three nests were in guava trees (*Psidium guajava*) growing near our house, at heights of about 16 to 21 feet above the ground. They were built upon slender twigs far out from the trunk, where they were only slightly shaded and screened by the terminal foliage and would have been conspicuous if they had not been so small. One nest was placed in an open V-shaped crotch. Another was supported at its base by a thin lateral twig, but its upper portion was quite unattached. Each nest was a tiny open chalice of downy materials, well covered on the outside with gray or greenish gray foliaceous lichens.

The contents of the three low nests could be seen in a mirror raised on a long pole. Each of them contained two minute white eggs when they were found.

INCUBATION

Nest 2 was situated close by the house, where it could be conveniently watched from a window. On 30 January 1947, when the incubation period was drawing to an end, I watched from 5:35 to 11:35 AM, and on the following day my vigil extended from 11:52 AM until 5:30 PM, when the light was growing dim. The morning of 30 January was sunny and cool, and the afternoon of 31 January was lightly clouded, with intermittent sunshine. Only the female attended the nest, and I saw no male of the species in the vicinity. In nearly 12 hours of watching, I timed 38 sessions on the eggs, ranging from about 1 to 34 minutes and averaging 10.4 minutes. There were 39 recesses ranging from less than 1 to 23 minutes and averaging 7.1 minutes. The female Coquette spent 59.4 per cent of the day on her nest.

In the morning the hummingbird was more active than in the afternoon, and both her sessions and recesses averaged shorter. Her 23 sessions in the forenoon averaged 9.5 minutes, whereas her 15 sessions in the afternoon averaged 11.9 minutes. Her 23 recesses before noon averaged 6 minutes and her 16 recesses after noon averaged 8.7 minutes. Although she came and went more often in the morning than in the afternoon, the range of her sessions and absences was nearly the same in both parts of the day. In both the forenoon and the afternoon she took one session that lasted 34 minutes. Her longest absence in the morning was 23 minutes and her longest in the afternoon was 22 minutes. In both parts of the day, her shortest sessions, like her shortest recesses, were one or two minutes.

As she approached and left the nest, the hummingbird's flight was slow and irregular, with short advances separated by momentary pauses, when she hovered on wings vibrating too rapidly to be visible, and much jerky up-and-down movement caused by raising and lowering her tail. Like other incubating hummingbirds, she often brought material to add to her nest. Between 6:30 and 7:45 AM, she brought nine small pieces of lichen or similar material, which she stuck to the outside of the cup, although it was already so well covered that there seemed not to be space for another piece. After 7:45, I could detect nothing in her bill as she returned, but the way she wiped her bill over the outside of the nest after settling in it suggested that she had brought cobweb and was spreading it over the outer surface. She continued this until 1:25 in the afternoon.

A Snowy-breasted Hummingbird (*Amazilia edward*) often came to rest in the nest tree, which appeared to be his preferred station. Whenever he ventured close to the nest, the much smaller Coquette chased him away without much difficulty. Apparently maternal solicitude gave her the force to drive off this larger and rather aggressive hummingbird. In the coffee grove where I found my first male White-crested Coquette, the Snowy-breasted Hummingbirds were numerous and often chased the Coquettes from the white flowers of the *Inga* trees. Once a Snowy-breasted darted up and struck a perching Coquette with his breast, but the latter did not even shift his position on the twig.

On 7 January 1955, my wife and I, watching by turns, made a continuous record of activities at Nest 4 from 5:25 AM until 5:40 PM. The morning was brilliantly clear; but after noon clouds began to gather and soon the sky was almost wholly overcast, although no rain fell during the day. The female hummingbird alone attended her two eggs, taking 37 sessions which ranged from less than 1 to 78 minutes and averaged 13.4 minutes. Her 38 recesses varied in length from less than 1 to 22 minutes and averaged 5.7 minutes. She incubated with the high constancy of 70.2 per cent. Her attentiveness, however, fluctuated considerably with the time of day and was especially low between 8:00 and 10:00 AM, when she devoted much time to the nest itself, sometimes sitting for a minute or even less, flying off to search for material, then returning in a minute or so to add it to her structure. Her 30 sessions before noon averaged only 8 minutes in length and her 31 recesses averaged 4.7 minutes. In striking contrast to this, her seven sessions after noon averaged 36.1 minutes and her seven recesses averaged 10 minutes.

In the hour and a half between 8:30 and 10:00 AM, this hummingbird seemed to bring something to her nest at least 11 times. Although once she came with a tuft of seed down almost as big as herself, most of the material was in small pieces, and usually it was invisible to us. But frequently when we could detect nothing in her bill, after settling in the nest she bent over and rubbed her bill carefully over the outer surface, evidently applying cobweb. As she did this, she spread her wings over the nest's rim. At other times she seemed to knead the material in the bottom of the cup with her feet. She was last seen to add cobweb at 12:50 PM, after which she gave no more attention to the nest itself and attended her eggs far more steadily.

Nest 3 was found in 1949 by Mr. Darwin E. Norby, who with Barbara Norby made a day-long record of incubation, which they have kindly summarized for me. In 12 hours they timed 49 sessions that ranged from about a quarter of a minute to 18 minutes and averaged 6 minutes. There were 51 absences that varied from three-quarters of a minute to 22 minutes and averaged 8 minutes. The eggs were covered only 42.9 per cent of the day. This abnormally low constancy suggested that the female was now, at the end of the dry month of February, having difficulty in finding enough food. A few days later the eggs were abandoned, as already told.

THE NESTLINGS

In the nest in the guava tree close beside the house, the eggs hatched on 5 February or in the following night. From 5:40 to 10:40 AM on 8 February, I watched the female hummingbird attend her two nestlings, to which she brought food 12 times in the course of five hours. Each feeding occupied from 22 to 54 seconds; but since I could see nothing of the young birds except occasionally the tip of a bill, I could learn no further details. The mother brooded for 18 periods ranging from 2 to 19 minutes and averaging 7.1 minutes. Her 17 absences lasted from 3 to 18 minutes and averaged 9.4 minutes. She was at the nest for 43.2 per cent of the five hours, including the time devoted both to feeding and brooding.

On 15 February, when the two nestlings were about ten days old, I again watched from 5:40 to 10:40 AM. Although the morning was cloudy and cool, the hummingbird did not brood after her first morning departure from the nest at 5:42 AM. She brought food to the nestlings nine times in the five hours, and on each of these visits she appeared to regurgitate several times to both of them, alternately. However, from the window I could see little of them until late in the morning, when they often raised their heads well above the nest's rim at mealtime.

By 25 February, the two nestlings, now about 20 days old, were well feathered, and I could see much of their bodies protruding above their nest's rim while I watched from the window from 5:35 to 10:35 AM. On this bright, cool morning the female did not brood. During the five hours she made 12 visits for feeding, on each of which she regurgitated to both nestlings. On some visits she fed both of them twice, alternately; but on others only one of them was fed twice; and on yet other visits each received a single portion. When the mother regurgitated to a nestling only once, it appeared not to desire more. The young hummingbirds preened much, and from time to time they stood up in the nest and flapped their wings vigorously, an exercise which they often took just after receiving nourishment, first one and then the other.

One of these young White-crested Coquettes left the nest between dawn and 7:45 AM on 27 February, and the other took wing in my presence at 8:25 on the same morning. It appeared to sever contact with the nest quite spontaneously, and soon after leaving it was fed by its mother on a neighboring bough of the guava tree. These young hummingbirds were in the nest 21 or 22 days.

At no time was a male seen to take an interest in any of these four nests. On the morning when I found Nest 4, a male Coquette flew by it without stopping to investigate; but aside from this, none was seen in the vicinity.

SUMMARY

The White-crested Coquette is found in clearings on the Pacific slope of southern Costa Rica from about 1,000 to 4,000 feet above sea level. It is not often seen except where a profusion of flowers, such as those of *Inga* or *Stachytarpheta*, attracts a number of individuals to a plantation or dooryard. It is almost fearless of man.

Males in transitional plumage were seen from late May to October. Males in full nuptial regalia were rarely seen between March and August.

A flying male displayed before a perching female by oscillating rapidly sideward through an arc of about one foot, the while keeping his head toward her.

At about 2,500 feet above sea level in southern Costa Rica, nesting occurs in the early part of the dry season, from December through February. Three nests were built in guava trees in clearings, from 16 to 21 feet above the ground, and another was in an orchid plant hanging about 60 feet up at the forest's edge. The minute downy cup is well encrusted with grayish lichens on the outer surface.

In three instances, the set consisted of two white eggs. At these three nests, the females took attentive sessions which ranged from less than 1 to 78 minutes in length, although those in excess of half an hour were rare. Recesses lasted from less than 1 to 23 minutes. In 12 hours of observation at each nest, these three females incubated with a constancy of 59.4, 70.2, and 42.9 per cent; but the last was apparently losing interest, for a few days later her eggs were abandoned. In the morning, the incubating females brought much new material to their nests.

In the first five hours of the morning, one female brought food to her two nestlings 12 times when they were about three days old, 9 times when they were about ten days old, and 12 times when they were about twenty days old. Often she regurgitated to both nestlings twice, alternately, on a single visit. At one nest, the nestling period was 21 or 22 days.

No male was at any time seen to take an interest in nests or young.

EL QUIZARRÁ, SAN ISIDRO DEL GENERAL, COSTA RICA, 22 MARCH 1960

BREEDING BIOLOGY OF THE LEAST BITTERN

Milton W. Weller

The Least Bittern (*Ixobrychus exilis*) is one of the most inconspicuous of all marsh birds. It is neither shy nor rare within its range but is merely a quiet bird which lives out of sight among marsh emergents. Observations on the species have been numerous but brief, and no detailed study of any phase of its breeding biology has been published. However, considerable data have been reported on the closely related Little Bittern (*I. minutus*) of Eurasia. The data presented here were obtained during 1958–1960 at Goose and Little Wall lakes near Jewell, Iowa, and at Trumbull and Rush lakes near Ruthven, Iowa.

Information was collected during marsh investigations sponsored by the Iowa State University Alumni Research Foundation and the National Science Foundation Teacher Research Participation Program. I am indebted to Cecil E. Spatcher and Robert A. Buckley for field assistance, to Drs. Andrew J. Meyerriecks and Ralph S. Palmer for assistance with literature, and to Dr. Meyerriecks for comments on the manuscript. Dr. Thomas Kent and Fred Kent of Iowa City, Iowa, permitted use of unpublished data.

GENERAL HABITS

Of the two North American bitterns, the Least Bittern leads a more over-water existence than does the American Bittern (*Botaurus lentiginosus*). The American Bittern usually is a shore-line wader which nests in edge emergents with the nest resting on the ground (Abbott, 1907; Vesall, 1940; and present study). The Least Bittern spends its time over deeper water where it uses emergent vegetation as "stepping-stones." It feeds on the open-water side of the emergents by clinging to the vegetation and extending its long neck (Eastwood, 1932; Sutton, 1936). Saunders (1926) reported that these small herons rarely missed their target and were constantly on the move when hunting. When alarmed, they assume the "freezing" action so characteristic of the group (Palmer, 1909; Allen, 1915), and when approached they take flight with legs dangling.

NEST SITES

Nesting usually occurs in emergent vegetation several feet in height. Of 89 nests found during the present study (Table 1), 50 nests found by Trautman (1940), and 30 nests found by Beecher (1942), most were in *Typha, Carex, Scirpus,* and plants of similar physiognomy. Occasionally, nests are found in *Phragmites* (Bent, 1926; Dillon, 1959), *Sagittaria* (Potter, 1917), and *Salix* or *Cephalanthus* stems in water (Bales, 1911; Baker, 1940; Potter, 1917; Trautman, 1940). One nest found by Provost (1947) was supported by barbed wire. A nest on the ground in weeds was reported by Roberts (1936: 192) and nests on bog or drift were found by Cooke (1881), Chapman

TABLE 1

NESTING COVER OBSERVED DURING PRESENT STUDY

Vegetation	No. nests
Typha spp.	13
Typha-Scirpus acutus	23
Typha-Scirpus fluviatilis	2
Typha-Salix	1
Scirpus acutus	14
Scirpus fluviatilis and *S. acutus*	11
Scirpus fluviatilis	15
Carex spp.	3
Phragmites communis	2
Mixture of any three above	5
Total	89

(1900), and Abbott (1907). Nests in *Salix* or Mangrove (*Rhizophora*) over ground were noted by Trautman (1940) and Howell (1932), respectively. Old nests of a Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*) and a White-crowned Pigeon (*Columba leucocephala*) were reported as bases for bittern nests by Roberts (1936) and Beatty (1943).

A natural clump of vegetation of the previous year usually forms the foundation for the nest. The importance of this old vegetation was shown by changes in the distribution of nests at Goose Lake in central Iowa. During 1958, considerable emergent vegetation remained in the center of the marsh after winter. The five nests found were in this cover. During the spring of 1959, a water level increase caused the loss of most of the old vegetation so that little cover existed in the center of the marsh when nesting started. All seven nests found during 1959 were in the edge vegetation, and although new and dense vegetation developed in the marsh center by the time of the second nestings, no nests were found there. These central emergents were used for feeding, however.

The nest base also is formed by bending down of new and old vegetation, and then short stems are added on top. Potter (1917) reported that "sticks" brought to a nest site among *Sagittaria* were laid in a criss-cross pattern like the spokes of a wheel (Fig. 1). Wackernagel (1950) made a similar generalization for the nest of the Little Bittern. The platform usually consists of the same species of vegetation as the base, but it may differ when floating debris is used. However, material rarely is carried more than a few feet. Bent (1926:85) mentions a nest built in "rushes" and constructed entirely of "sticks." A similar nest found during this study was constructed of willow

FIG. 1. Nest in hardstem bulrush at Goose Lake, Iowa, showing criss-cross pattern of nest material.

sticks, but they had been gathered from within a few feet of the nest and placed in some isolated stalks of cat-tail.

The size of the nest probably varies with the type of vegetation and the particular clump selected for the nest, but most nests are 5 to 8 inches in diameter. Bent (1904) gave measurements of two nests as 4 × 7 and 5 × 7 inches, presumably the dimensions being width and length. Simmons (1915) reported a nest 6½ inches across, and Baker (1940) found one 8 inches in diameter. A nest located by Pearson (1909) was 4 inches deep and 9 inches across.

Nests normally are placed from six up to 24 inches above water but often sink to water level from the combined weight of young and adults. Nests were found in water three to 38 inches deep; nests over land (Saunders, 1926; Roberts, 1936; Trautman, 1940) probably result from water level declines. That water conditions are important to nesting populations was shown by water level changes in Rush and Trumbull lakes in northwestern Iowa. Bitterns were common at both lakes during 1958; four nests were found in a small area of one lake and adults were seen regularly. Only one nest was found at the other lake because no intensive nest hunting was done, but the abundance of young seen in late summer indicated that numerous birds were present. In mid-May of 1959, when bitterns arrived in Iowa, water levels at both of the lakes were so low that there was little water at the base of emergent vegetation. Despite the fact that field work in the area was more intensive during 1959 than 1958, only one adult was seen at each lake and no nests or young were found.

Nests are usually located adjacent to a patch of open water, as observed not only in this study but by Cooke (1881), Simmons (1915), Saunders (1926), and Nero (1950). Of 87 nests observed for this feature in Iowa, all were 6 inches to 20 feet (averaged about 8 feet) from open water of lakes, channels, or openings made by muskrats.

PRE-LAYING ACTIVITIES

Evidence for territoriality in bitterns is limited. Kent (1951) found that nests were evenly spaced in a small lake, and observations during my study substantiate this conclusion. Relative concentrations probably develop in particularly suitable habitat. Kent (1951) found 19 nests in a 44-acre marsh, and Beecher (1942) found one nest per four acres of usable vegetation. Wood's observation (1951) of 15 nests in two acres of vegetation is exceptional. During the present study, 62 nests were found in the 83-acre Goose Lake during 1960, but some of these probably represent renests or second nests. Several cases were noted of two active nests only 15–20 feet apart. Only one observation suggests territorial behavior: Davidson (1944) saw a paired male assume a hump-shouldered defensive attitude before an intruding male. This conflict ended in the retreat of the intruder.

Nest-building seems to be performed mostly by the male. Davidson (1944) noted that at a single nest the male did most of the building although the female was present. He brought material for the female when she was on the nest. Other nest-building behavior observed later in incubation (see below) also implies that males do most of the building.

During the present study, only one nest was found prior to laying; this nest essentially was complete seven days before laying. The presence of a blind may have influenced this delay, but there is also the possibility that the nest is used as a site for courtship and copulation. No courtship display has been observed, but a "cooing" call has been described by several authors. I have never heard any such sound attributable to bitterns. Their calls have been either a coarse *gack-gack* given by birds on the nest or occasionally an *ank-ank* given by birds flushed in the marsh. However, it seems logical that the cooing call might be a courtship note given from the nest to attract females.

Copulation was witnessed at the nest twice during the present study. The first instance was two or more days after the nest was built and five or six days prior to egg-laying. In the second case, the nest held two eggs. Prior to copulation the male touched the back of the female's neck gently and preened her scapulars. Copulation on the nest during incubation is apparently common in the Little Bittern (Wackernagel, 1950; and Wijnaendts, 1954) and has also been observed in the European Bittern (*Botaurus stellaris*) by Yeates (1940).

TABLE 2

CLUTCH SIZE OF THE LEAST BITTERN (BASED ON INCUBATED OR FULL CLUTCHES)

Area	Authority	No. nests	No. eggs in clutch
Texas	Simmons (1915)	1	5
Ohio	Trautman (1940)	4	3
	Trautman (1940)	9	4
	Trautman (1940)	7	5
	Trautman (1940)	3	6
Iowa	Provost (1947)	1	4
	Provost (1947)	1	5
	Kent (1951, *in litt.*)	2	3
	Kent (1951, *in litt.*)	2	4
	Kent (1951, *in litt.*)	9	5
	Present Study	1	2
	Present Study	8	3
	Present Study	19	4
	Present Study	29	5
	Present Study	2	6
New Jersey	Potter (1917)	2	5
New York	Saunders (1926)	1	5
Ontario	Macoun and Macoun (1909)	1	5
	Macoun and Macoun (1909)	1	6
Wisconsin	Nero (1950)	1	5
Michigan	Baker (1940)	2	5
Minnesota	Roberts (1936)	4	4
Manitoba	Dillon (1959)	1	6
	Dillon (1959)	1	4
California	Moffitt (1939)	1	5
	Bancroft (1930)	1	5
	Willet and Jay (1911)	1	5
	Total	115	Mean = 4.48 ± .31

LAYING AND CLUTCH SIZE

The rate of egg-laying was reported by Trautman (1940) as one per day in four of six nests he observed. Others took slightly longer. In four nests I studied, the rate of laying was one egg per day in three nests, while another female required six days to lay five eggs. Incubation started with either the first or second egg, as indicated by embryonic development visible through a field candler. Incubation starts at the same time in the Little Bittern (Witherby, 1943:153).

A summary of data on clutch size is presented in Table 2. As far as possible, it includes only records of complete and incubated clutches. Even these records

TABLE 3

CLUTCH SIZE AND CHRONOLOGY OF NESTING*

Date	No. nests	Clutch Size Mean and S.D.**	Range
June 2–15	22	3.59 ± .67	2–5
June 16–30	28	4.89 ± .49	4–6
July 1–17	9	4.77 ± .25	4–5
	59	4.39 ± .43	2–6

*Based on 46 nests found during the present study and 13 nests located by Kent (**in litt.**) in 1951.

**Differences between means of early June and late June significant at the 99 per cent level; differences between means of late June and early July not significant.

could not be evaluated properly because laying rates were unknown or not stated in the paper. In at least two cases during this study, it was found that eggs damaged by predators were removed by the adults and incubation continued normally. Thus some small clutches reported in the literature may have been only part of a larger clutch. Four to five eggs are usual clutches in North America. Too few data are available to demonstrate latitudinal variation, but most clutches of six are reported from northern states. An even more interesting variation is suggested: of 46 complete clutches observed in this study, and 13 complete clutches found by Tom Kent in east-central Iowa (Kent, 1951, *in litt.*), all clutches found after mid-June—many of which may be renests or second nests—had four to six eggs; those found during early June had two to five eggs (Table 3). These differences are significant and demonstrate a pattern of seasonal change in clutch size which is the reverse of most double-brooded species (Lack, 1954:35), suggesting that the parents can feed more young in mid- than in early summer. A decline in clutch size in late summer is probable. This timing, as well as the late arrival and nesting of the species, probably is related to the chronology of available food organisms. Such a relationship has been shown for the Barn Owl (*Tyto alba*), which has a second and larger brood only when vole populations are high (Lack, 1954:35).

Also of interest for comparison is the clutch size of the Little Bittern (Table 4). While data are limited, it is apparent that clutch size of the European species is nearer six than five, as shown by both average and range. Clutches of eight have never been reported for the Least Bittern and clutches of seven are rare, but Witherby (1943:153) noted even larger clutches in the Little Bittern. He suggested that several females were laying in one nest.

Various workers have suggested that the Least Bittern rears two or three broods per season. No data from marked birds are available, but the chro-

TABLE 4

CLUTCH SIZE OF THE LITTLE BITTERN AS REPORTED IN THE LITERATURE

Area	Authority	No. nests	No. eggs in clutch
Germany	Groebbels (1935)	1	5
	Lucanus (1914)	1	7
Switzerland	Wackernagel (1950)	3	5
	Wackernagel (1950)	2	6
	Wackernagel (1950)	2	7
Holland	Wijnaendts (1954)	1	5
		10	5.8 Mean 5–7 Range
Less detailed; no. of nests not given:			
Germany	GroBkopf & Graszynski (1958)	–	7–8
	Steinfatt (1935)	–	5–6
Holland	Oort (1922)	–	5–7 (up to 8,9)
England	Witherby (1943: 153)	–	5–6 usual (also 4,7,8,9,10)

nology of nesting birds found during the present study suggests that two broods do occur (Fig. 2). These data undoubtedly are influenced by the varying intensity of nest hunting.

INCUBATION PERIOD

The incubation period of the Least Bittern has been determined as 15 days by Allen (1915), 16–17 days by Bent (1926), and 17 days by Bergtold (1917), but it was not clear from what point incubation was timed. Four nests observed in this study hatched in 19 to 20 days from the time of laying of the first egg (when incubation started) to the time when the first egg hatched. When timed by Heinroth's method (Nice, 1954) of counting from the laying of the last egg to the hatching of the last egg, incubation was 17–18 days in five nests. Using the same method, Baker (1940) reported a nest hatching in 18 days. Thus hatching requires only about three days while five to six days are required for laying the clutch.

Using Heinroth's method, data for the Least Bittern agree with that on Little Bitterns: GroBkopf and Graszynski (1948) reported 16.5 days, Oort (1922) found 17 days (range of 16–18 days), Groebbels (1935) reported 18–19 days, and Wackernagel (1950) approximately 19 days.

INCUBATION BEHAVIOR

Nest Maintenance and Incubation.—Incubation attentiveness is an extremely strong drive in bitterns. Chapman (1900), Allen (1915), Potter (1917), and Frost (1936) all reported birds which were so broody they could be

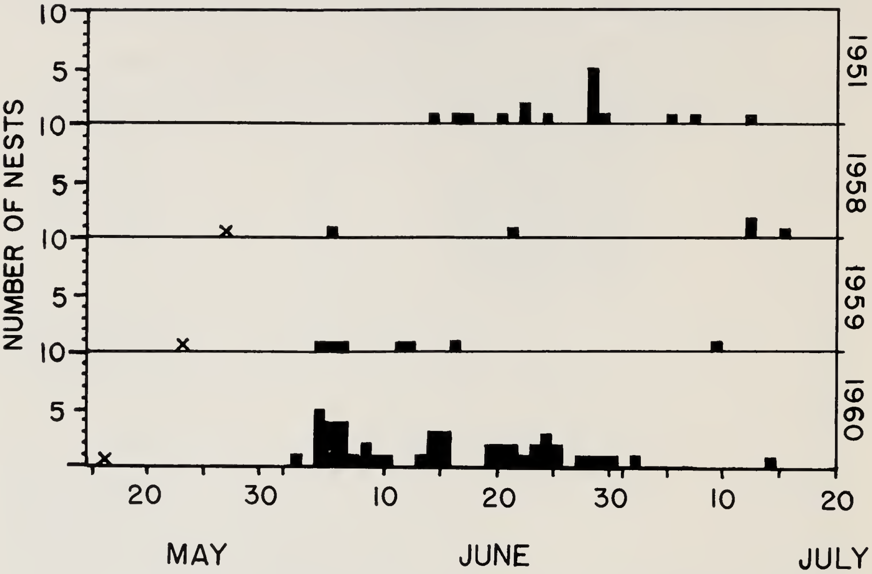

Fig. 2. Chronology of nest initiation in 1951 (Kent, *in litt.*) and 1958–1960 (present study). X = arrival of adults. Data calculated from either nest-initiation or hatching dates.

lifted from the nest. Two such birds were observed during this study. Wright (1946) found much individual variation among adult Least Bitterns which he studied, and Koenig (1953) reported similar variation among Little Bitterns and other European birds. During the incubation period, birds were never seen flying to the nest but landed in the nest area and approached the nest by quietly walking through the vegetation. Gabrielson (1914) reported that a clump of vegetation behind the nest was used as a landing site. The bird often hesitated at the edge of the nest to "roll" the eggs with the bill. Then it settled on the eggs by pushing the breast downward and rocking gently from side to side ("settling"). The posture maintained during incubation varies with the individual and the nest site. During long periods of incubation, the head is held low with the bill resting on the edge of the nest. The eyes are closed only occasionally.

Nest-building activities are few. Vegetation hanging over the nest is pulled down and worked into the nest. Continuous pulling of vegetation too strong to be pulled free results in a canopy. If the bird leaves the nest, it often returns with material which it adds to the structure. Or it may reach from the nest and pull material from the water. Experiments with artificial nests (see below) provided a source of material which was often utilized by the bird for its own nest.

Table 5

Nest Building and Nest Jabbing in Relation to Stage of the Nesting Cycle

	MALE		FEMALE	
	Minutes per poke or jab*	Observation time	Minutes per poke or jab*	Observation time
Incubation				
Nest 2 1958	—	None	30.0	6 hrs.
Nest 3 1958	12.0	6 hrs.	40.0	10 hrs.
Nest 1 1958	17.7	3 hrs., 50 min.	50.7	2 hrs., 32 min.
Nest 1 1959	20.9	5 hrs., 14 min.	29.5	3 hrs., 27 min.
Hatching				
Nest 1 1958	5.2	3 hrs., 48 min.	8.5	2 hrs., 50 min.
Nest 4 1958	10.9	2 hrs.	8.4	3 hrs., 30 min.

*This figure calculated from the number of "periods" of building activity, including "pulls," "pokes," or "jabs."

A nest-building action which appears more common than pulling of nest material—at least during the latter part of incubation—is "jabbing." With or without rolling the eggs with its lower mandible, the adult stares at the nest and jabs the bottom of the nest with either closed or open bill. This activity increases during the hatching period, but its exact function can only be hypothesized. Nest sanitation among the Ardeidae is commonly lacking (see Gross, 1923, on Black-crowned Night Heron, *Nycticorax nycticorax*; and Gabrielson, 1914, on the American Bittern), yet the Least Bittern uses a nest for nine days or more (Nero, 1950), and many nests remain exceptionally clean. Often a fragment of shell, a dragonfly wing or the feather sheaths of the young bird are the major evidences of nest use. Gabrielson (1914) noted one unsanitary bittern nest in river bulrush; a similar nest was found during the present study but was considered unusual. As with many young birds, defecation by juvenal Least Bitterns seems to be stimulated by the feeding of the parent and by handling. The fecal matter is of fluid mucous-like consistency. As the bird defecates, this fluid material flows over the nest material without clinging and flows through the holes in the nest. Possibly those holes formed by the "jabbing" activity of the parent assist in nest sanitation. Ryves (1946) considered sanitation as one of the possible functions of similar movements in passerines. Elimination of nest insects and aeration of the nest are other possible functions.

Table 5 summarizes nest-building activity such as pulling at vegetation, and jabbing the bill into the bottom of the nest. In three nests in which data were recorded during the incubation period, there were fewer periods of nest-building activity during incubation than during hatching. Also, it is apparent that the male performed nest-building movements more often than the female.

FIG. 3. Use of the wings in changing position on the nest.

Comfort Movements.—During long hours of incubation, turning is the most frequent movement. This is invariably accomplished with alternate opening and pushing with or refolding of the wings (Fig. 3). A quick rise and complete fluffing of feathers and shaking of the body is another common comfort movement. This may or may not be accompanied by preening, turning, poking, and settling. Partial shakes of either body or head also occur.

Gaping is common, especially following a period of alertness to food or intruders. A similar movement (Fig. 4) involves tongue stretching. Meyerriecks (*in litt.*) terms this "gagging" in the Green Heron (*Butorides virescens*). The

FIG. 4. Gagging.

FIG. 5. Preening.

bill is opened rapidly and more widely than in the threat posture. In one case, the gape was combined with a neck-stretch and wagging of the head and eventually the bird left the nest to drink, defecated, and returned to incubate. Another apparent fatigue-relaxing movement is the bill-stretch: the tips of the mandibles are held together but the mouth is opened proximally.

Irritations in the head region are scratched directly with one foot while balancing on the other. Body irritations are preened with a nibbling of the bill (Fig. 5). Extensive preening is usually started in the "ruff" of the lower neck—the powder-down area. Neck feathers are fluffed and individual feathers are preened with the bill tip from top to bottom. The mandibles are in slight but constant motion during the preening. The breast seems to be preened most often. Then the back of the lower neck, the belly, and flanks are preened but no definite order was noted. The greater primary coverts, primaries, and undercoverts are preened individually. There seems to be relatively little preening of the back. Feathers and other debris are removed from the bill by licking it with the tongue.

During warm periods, the head is held in any shady spot irrespective of the position of the body. Drinking is more common during warm periods and usually takes place a few feet from the nest. Panting is another means of cooling, and the "last resort" was seen in one case where the male left the nest, walked into water nearly three feet deep, and floated for a minute before returning to the nest and young.

After a rather long period of incubation, a female gave two calls not otherwise heard. The head feathers were fluffed, the head and bill were held vertically, and a *graa-wa-wa-wa* call given as the head and bill were returned to their normal horizontal position. Later the same call was given but preceded by the *gack or quek*, which is a more common call given while on the nest.

Nest Relief Display.—Throughout incubation and brooding of the young, both sexes take turns on the nest. This change has a distinctive, though not elaborate, display. When one member of the pair comes to the nest, the incubating bird may ignore the oncomer, merely look alert, or assume a threat-like posture similar to that directed toward avian intruders. This seems to depend on the individual and the stage of the nesting cycle. The bird on the nest raises the crown feathers (these are also raised when drinking, leaving the nest, and with certain disturbances) and calls a low coarse *gra-a-a.* The oncoming bird, especially the male, has its crown and often its body feathers erect (Fig. 6a). When coming on the nest, both sexes shake their bills from side to side with the mandibles open, making a slight "rattling." At this time, the crown of the head is pointed toward the incubating bird and the bill points downward. This rattling seems very important in nest relief but also occurs when a lone bird of either sex returns to the nest after drinking. This posture was observed during incubation and brooding. Gabrielson (1914) described this action and noted a male doing this for fully 10 minutes before the female stepped from the nest and flew away. I have never observed a delay of this length, but one female refused to leave despite the fact that the male rattled for nearly five minutes. The male left and returned a short time later and repeated his performance. He finally entered the nest, whereupon the female departed. In this case, as in Gabrielson's study, there were young in the nest. At other times, the bird on the nest rarely hesitated. Usually, the bird on the nest also erects its crown feathers and stands. The oncoming bird depresses its crown feathers and assumes a posture with head lower than the standing bird (Fig. 6b). The air is one of cautiousness; at this time the necks may be crossed and the bill occasionally touches the back of the neck (Fig. 6b). The incubating bird then leaves (Fig. 6c), often taking flight from a nearby clump of vegetation.

On some occasions, the male of one pair placed a bulrush stem in the nest—but did not give it to the female as noted by Potter (1917). On another occasion, a female brought a stick of vegetation to the nest while the male was on the nest. Occasionally, sticks were brought back to the nest when birds of either sex left for food or drink. This type of behavior may be the forerunner of the more elaborate nest-relief behavior of other herons involving transfer of nest material.

Incubation by both sexes with a nest-relief display seems important to the strength of the nest attachment and to the maintenance of constant nest attentiveness. I never witnessed a bird leave a nest (under normal conditions)

Fig. 6a. (Top) Male approaching nest with crown and body feathers erected. Female has crown depressed.

Fig. 6b. (Bottom) Submissive attitude of female as she enters nest.

without first undergoing the nest-relief ceremony and having the mate take its place. When birds were flushed from the nest, the bird of the same sex always returned. Birds of either sex left to catch food, drink, or gather nest material but always returned within a minute and were not out of view of the nest. However, it appears that when both sexes are near the nest, the mate not on the nest will take over if one bird is frightened away.

Whether this display is truly vital to any change-over at the nest is uncertain. In an attempt to evaluate this, a stuffed male bird was placed on the nest. If the female returned, would she ignore a male which incubated rather than

FIG. 6c. Male's crest erected as female departs. Note her depressed crown feathers.

displayed? In two of the three trials on two different nests, males returned. Oncoming birds of both sexes approached cautiously, with typical erect crest and body feathers, and came on the nest despite the presence of the dummy. In all cases, they approached from behind the bird, hissed, and pecked it at the back of the head. To prevent desertion of the nest and damage to the skin, the incubating bird then was flushed from the nest.

Comparative Attentiveness of the Sexes.—The unique sexual dimorphism among the members of the genus *Ixobrychus* allows easy determination of relative attentiveness of the sexes in incubation. Groebbels (1935) presented data on one nest of *I. minutus*: in 14 hours and 35 minutes of observation, the female incubated the eggs 9 hours and 33 minutes while the male attended the nest only 5 hours and 2 minutes. Observations at five nests during this study totaled 54 hours and 39 minutes. During this time, the females incubated 32 hours and 35 minutes (59 per cent), while the males incubated only 22 hours and 4 minutes. Although there is a great deal of chance involved in which bird is on the nest when the observer is present, the length of the observations suggest that the female does most of the incubating. The longest period of incubation observed was by a female which incubated for five hours. During this time she left the nest briefly when frightened by the observer and then briefly when the observer left the blind. After an hour away from the nest, the investigator returned to find the female still incubating. Two additional hours of observation showed that the female incubated at least seven of the eight hours of observation. Several males incubated at least three hours, but longer observations were not available. Females did more feeding and drinking at the nest, presumably because they incubated for longer periods.

Fig. 7. Male watching food below nest.

Experiments with Artificial Eggs and Nests.—Experiments with artificial eggs and nests were attempted (1) to determine whether the sight of exposed eggs would stimulate incubation behavior despite the fact that the eggs were not in the proper nests, and (2) to learn whether both birds would incubate simultaneously if two nests were provided. In neither of two attempts did both birds appear. Nevertheless, birds of both sexes presented with artificial nests were much interested in them. One used the nest material for construction of its own nest. The rough-textured balsa eggs used in the first experiment apparently were not adequate to induce incubation but produced some interesting results. The balsa eggs were placed in the real nest and the real eggs were placed in the artificial nest. The male returned and immediately removed three of the balsa eggs and started over to the artificial nest. Then he returned to the real nest but obviously was not comfortable and finally left. The female came on immediately and without hesitation dropped out or carried away the two remaining artificial eggs; then she incubated on the empty nest, in full view of the artificial nest containing the real eggs. Apparently the nest is a stronger attraction than the displaced eggs when the nest is a conspicuous structure. Allen and Mangels (1940) reported similar behavior in Black-crowned Night Herons. Among species such as gulls which can easily roll their eggs into the nest, Tinbergen (1953) found that Herring Gulls usually preferred the eggs to the nest site but this depended on the local terrain.

Food Consumed.—During the intensive observation at nests, three females and two males were observed to feed while incubating. All birds spent considerable time observing the movements of prey items in the water below. When food is near, the crest and body feathers may be erected (Fig. 7) and

TABLE 6

FOOD ITEMS REPORTED IN THE LITERATURE

Authority	Number of birds	Foods
Adults		
Eifrig (1915)	1	2 sunfish
Gosse (1847)	–	small fish and crustacea
Roberts (1936)	2	crayfish (pincers removed) and snails
Saunders (1926)	–	small fish and arthropods
Simpson (1939)	7	small fish, insects, frogs, mammal
Wetmore (*in* Howell, 1932)	93	40% fish, 21% dragonflies, 12% insects, 10% crayfish, 18% miscellaneous
Young		
Gabrielson (1914)	–	frogs
Nero (1950)	–	minnows

gaping is common. Food which came within reach of the incubating birds made up most of the prey items, but the bird got off the nest and went to the water for prey for six of 34 observed feedings. Items taken were: five unidentified items, probably frog tadpoles; six unidentified insects; one grasshopper; 21 damselflies; and one tadpole. In addition, a male was observed feeding frog legs to the young. Despite the fact that snails were common around the nest, they were never eaten. However, Roberts (1936) reported snails in the stomachs of two specimens he examined. Success in capturing previously-spotted prey appeared to be nearly 100 per cent. There are relatively few data on food habits (summarized in Table 6).

Reaction of Adults to Potential Predators.—Chapman (1900) saw a Long-billed Marsh Wren (*Telmatodytes palustris*) pierce the eggs in a bittern nest; he regarded this as interspecific territory dispute. Common Crows (*Corvus brachyrhynchos*), Blue Jays (*Cyanocitta cristata*), and blackbirds may take eggs for food. Damage to only one egg in the nest does not always cause desertion; damaged eggs are removed and nesting continues normally. Marsh wrens, blackbirds, and Black Terns (*Chlidonias niger*) are often threatened by incubating birds by depressing the crown and withdrawing the neck preparatory to striking. Crown feathers may be raised and lowered when intruding birds are at a distance. When near, the bill is held open and a *gra-a-a* call may be given. The most intense aggressive posture involves withdrawing the head and spreading the wings with their dorsal surfaces facing forward. This posture is directed toward men (Chapman, 1900; Allen, 1915) and occasionally is assumed at wrens.

FIG. 8. (Left) Freezing behavior at the approach of a Great Blue Heron.
FIG. 9. (Right) Female removing egg shell from the nest.

Two observations were made during the present study which suggest behavior toward large predators. In one, a female suddenly rose from the normal incubation posture to the "freeze" (Fig. 8), and a Great Blue Heron (*Ardea herodias*) flapped over. The same female and another were observed watching buteos which were soaring at such heights that they could not be identified by the observer. That buteos may prey on bitterns was assumed when a young Red-tailed Hawk (*Buteo jamaicensis*) was found standing in water on a weak but live adult female bittern.

Predators on young probably include turtles, as Trautman (1940) saw one take an adult. During this study, several dead and partly eaten young bitterns were found in the water near a nest. The absence of fish in the lake implied that turtles were responsible. A garter snake (*Thamnophis ordinatus*) was observed which was attracted to young bitterns, but Kent (1951) saw a water snake (*Natrix sipedon*) pass directly over a nest without attacking the young.

HATCHING SUCCESS

Of 38 nests observed for hatching data, at least one egg hatched in 32 (84 per cent). Average clutch size of this group was 4.0, and averages of 3.5 young were reared per successful nest and 3.0 for all nests observed. These success data are believed to be biased upward by the fact that most nest loss occurs during the first few days of laying and building when eggs are more likely to be exposed. Few nests were found in this early stage but many empty nests were located which probably had been deserted. Because these nests could not properly be evaluated, only nests with complete histories were used for success data.

CARE OF THE YOUNG

Behavior of Adults During Hatching and Rearing.—During hatching and rearing, the adults seem more hesitant to leave the nest. Nest relief displays by the oncoming bird are more intense and of longer duration. When the brooding bird finally leaves, it may stay away for only a short time. Hatching is often observed closely by the adult and as soon as the young are free from the shells, these are carried away (Fig 9) and dropped in the water or eaten.

After the young are free of the shell and before they are dry, they are fed by regurgitation. Apparently, the adult's bill must be lowered to the young before feeding occurs. If hungry, the young grab the bill violently (see Bates, 1943, for a description of this in the Little Bittern). However, the bill may be raised again if the adult is not ready to feed. The stimulus causing feeding response in adults is not clear. The adults seem to feed only if the young are active. The young open the bill in a fashion similar to the gaping of passerines but this does not seem regular. "Peeping" calls by the young seem more prevalent when they are hungry and may serve as the releaser. Or, the bill of the young may be a stimulus when it is held vertically (as when hungry) but not when held horizontally or slanted so that the down of the head hides the bill from view.

Gabrielson (1914) noted that all young in a nest were fed at each feeding, but Davidson's (1944) data indicated that this varied. In general, feeding of young occurs only when the young grab the bill—again suggesting that food is only regurgitated by a sign stimulus from the young—and therefore the number of young fed depends on their desire to feed. Gabrielson found that the young were fed only four times in one day, and Davidson's (1944) data also suggested a limited feeding schedule. During the present study, only two of the five nests were observed for a significant period after hatching. During 11 hours and 54 minutes of observation on two of these nests, females were on the nests 6 hours and 6 minutes and males brooded 5 hours and 48 minutes. During this time, females attempted to feed some or all young once every 20 minutes while males fed every 10 minutes. This agrees with statements by Gabrielson (1914) and by Breckenridge (*in* Roberts, 1936:194) that the male does most of the feeding. However, the rate of feeding undoubtedly varies with the age of the young and the nature of the food.

Young may be shaded by an adult standing over them (Fig. 10).

FIG. 10. Shading of young and panting and sunning by the male.

Innate Responses of the Young.—When just free from the shell and still wet, the young bittern is equipped with those reflexes vital to its survival. The gripping response of the feet is weak but apparent whenever the bird is moved or its feet are removed from a solid surface. If turned on its back or side, it attempts to right itself by swinging its feet and grasping. When held on an inclined plane, the feet push forward and prevent the bird from slipping. The bird is nearly able to hold itself on a branch when newly hatched and birds one day old or more certainly can keep from falling from the nest by this means. At several days of age, the bird can firmly grip twigs and remain in that posture for some time (see Nero, 1950). When gripping a piece of vegetation, the bird uses its wings and curved neck as well as its feet and counterbalances the body with the head.

The eyes are closed for nearly ten minutes after the bird leaves the shell and it does not respond to artificial bills for about 35 minutes. At that time, it can hold its head up for only a few seconds. Two moves are apparent within 15–20 minutes after hatching; the bill is opened in a quick gape-like movement but is not held open as in passerines. Also, the base of the bill is stretched as in adults. The ability to hold up the head possibly is vital to survival for the adult is probably stimulated to feed by the raised head of a hungry bird. The juvenile is attracted as soon as the adult's bill is placed before it. It feebly moves the bill toward the adult's bill and turns its head in order to grip the adult's bill. The regurgitated food then passes down the adult's bill and commonly strikes that of the juvenile. As the juvenile's mandibles follow the food down to the tip of the adult's bill, the food is easily taken. In this fashion, the young also are directed to food which may fall into the nest and the young quickly learn to recover this. During early feedings, the adults recover any food dropped into the nest. On one occasion, two young of three or four days of age were competing for a pair of hind legs of a frog. This invariably resulted in each getting one of the two legs and a tug-of-war ensued so that the legs fell to the bottom of the nest. The small size of the young and the large size of the legs prevented recovery by the juveniles. The male reswallowed and regurgitated this pair of legs eight times and the result was always the same! The legs were still not consumed when I was forced to leave the blind.

As the young reach about three days of age, they respond to any non-bittern form by "freezing." At five to seven days, they assume the aggressive posture with the neck down, the head ready to strike, and the wings held open with their dorsal surfaces facing forward. Portielje (*in* Tinbergen, 1953:214) showed that a distinct head shape was essential in models to release the striking attack of European Bitterns. During this posture, young Least Bitterns sway back and forth from side to side. This behavior is common in adult American and Least Bitterns and reportedly occurs as a camouflaging mechanism when marsh vegetation is moved in the wind (Saunders, 1926). However, Elliott (1951) reported this behavior in a captive Least Bittern indoors. At six to nine days, the young leave the nest, apparently to seek shade and possibly to feed as well. They move through the reeds with great skill but occasionally get wet in doing so. Their color is light tan, common to the young of many marsh birds, and they are well camouflaged in the nest and in old vegetation. They return to the nest when the adult comes to feed them. Whether or not the adults feed the young in the vegetation is not known. Nero (1950) had to fence birds to keep them at the nest but also found banded young in the area of the nest at 27 days of age (Nero, 1951).

Experimental Analysis of Feeding Responses of Juveniles.—That the adult's bill is the stimulus for feeding behavior in juveniles and that there is a simple innate response in juveniles is indicated from tests with model bills. A yellow pencil was sufficient stimulus for some birds, and one juvenile of six to seven days of age grabbed the yellow leg of the male and tried to feed! Unfortunately, too few young were available to test all newly hatched young without the influence of learning and to make tests statistically significant. Nevertheless, they indicate an instinctive feeding response.

Models of flat cardboard and three-dimensional models of cardboard and wood were used. There was no difference apparent, but three-dimensional

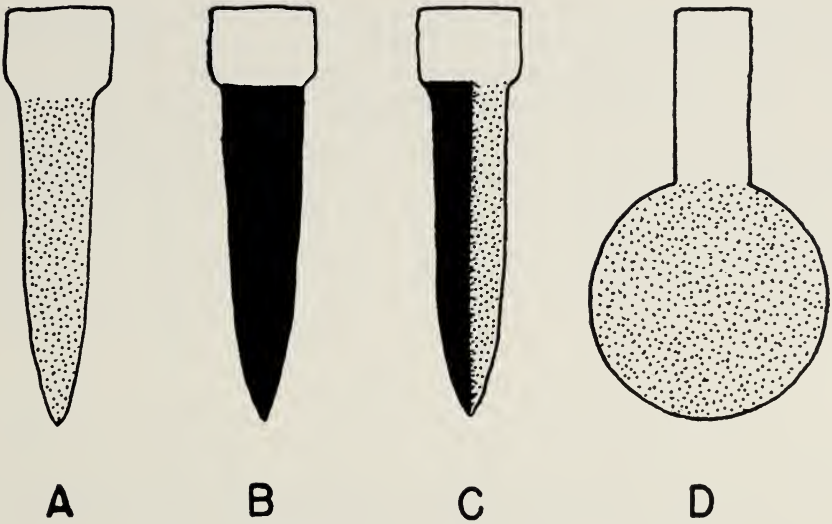

FIG. 11. Models used to test feeding responses of young.
A = yellow or gray; B = black; C = black and yellow; D = yellow or gray.

models of wood were selected for use in the field because of their durability. These were painted gray, black, yellow, and yellow and black (Fig. 11). In testing, the bill was held vertically in front of a bird and moved up and down gently for five seconds. The response was recorded as positive or negative, although several grabs at the bill often were made during that period. Most tests were performed on birds of one to four days of age although aggressiveness at the latter age occasionally voided results. Some birds were sleepy and could not be awakened; others were not stimulated by the bill and probably had just been fed by the parents. Those tests which produced some positive results are summarized in Table 7 and show that any elongate object may produce a grabbing response. The effectiveness of gray was surprising and stresses the value of an elongate form as part of the releasing mechanism. To test the significance of color, gray cardboard was cut in a circular form (Fig. 11) and painted yellow on one side. In tests, the yellow stimulated a feeble pecking (not grabbing as with bill models) but gray resulted in no response. Thus, color as well as form is part of the releaser which causes feeding behavior. When birds were presented the cardboard circles, it is of interest that very little effort was made to turn the head, and pecking was directed at the edge. Similar tests with a square model provided similar results but with greater tendency to turn the head parallel to the edge of the model. The importance of parallel positioning of juvenile and adult bills as a second step in releasing feeding response was tested by presenting artificial

TABLE 7

RESPONSE OF YOUNG BIRDS TO ARTIFICIAL BILLS

(NUMBER OF POSITIVE RESPONSES OVER NUMBER OF TESTS)

Age of young	Gray	Black	Yellow	Black and Yellow	No. of Individuals
Newly hatched*	$\frac{0}{6}$	$\frac{0}{6}$	$\frac{6}{6}$	$\frac{4}{5}$	6
1–4 days	$\frac{11}{16}$	$\frac{10}{31}$	$\frac{25}{31}$	$\frac{28}{30}$	16
Totals	$\frac{11}{22}$	$\frac{10}{37}$	$\frac{31}{37}$	$\frac{32}{35}$	22

*At least two of these had never been fed by the parents.

bills to young in a horizontal position. A positive response resulted in 8 of 13 trials.

Based on present limited data, the response of young birds seems to be a two-step reaction. The elongate form and yellow color stimulate an initial reaction. Secondly, the juvenile presumably aligns its normal line of vision so that the adult's bill is horizontal. Both sexes have a reddish base to the bill and this is brighter in the male than in the female (and the male does most of the feeding), but the significance of this red area as a releaser was not tested experimentally.

SUMMARY

The nesting behavior and habitat of Least Bitterns was studied in several glacial lakes and marshes in Iowa. Eighty-nine nests were found, and intensive observations from blinds were made at five nests. Nests were mainly in *Typha* spp., *Scirpus acutus*, and *Scirpus fluviatilis*. Clutch size varied from two to six eggs with the smaller clutches being found early in the season. Copulation occurs on the nest during early incubation and possibly there prior to incubation. Incubation required about 19 days from the laying of the first egg to hatching of the first egg and 16–17 days from the laying of the last egg to the hatching of that egg. The species appears to be double-brooded in Iowa, at least in some years.

Nest incubation movements are: bringing material to the nest, pulling in material from above, and bill-jabbing in the nest bottom. During incubation, the bird rolls the eggs with the lower mandible, settles on the eggs by a rocking motion, and remains alert during even long periods of incubation. Comfort movements were shaking, turning, gaping, scratching, preening, drinking, and panting. Both sexes incubate, and nest relief includes a simple display of erecting the crown and body feathers, "rattling" of the bill, and

occasional crossing of bills or touching of bill to back. The oncoming bird slips under the incubating bird. During nearly 55 hours of observation, the female incubated 59 per cent of the time. Incubating adults fed on passing damselflies and other insects, and occasionally left the nest to take nearby prey. Wrens, blackbirds, hawks, snakes, and turtles are thought to prey on eggs, young, or adult bitterns.

During hatching, adults remove the egg shells or eat them. Both sexes feed the young by regurgitation but the male feeds more often than does the female. Innate responses of the young which are considered important to survival are gripping of the feet, holding vegetation with the wings, and balancing with the head. The stimulus for feeding in young probably is a yellow-colored and elongate structure. These releasers were tested briefly experimentally. The releaser for parental feeding behavior is unknown but is probably the sight of raised bill of the juvenile.

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DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY, IOWA STATE UNIVERSITY, AMES, IOWA, 12 AUGUST 1960 (ORIGINALLY SUBMITTED 21 MARCH 1960)

LATE-SUMMER FOOD OF RED-WINGED BLACKBIRDS IN A FRESH TIDAL-RIVER MARSH

Brooke Meanley

In late summer, during molt, large numbers of Red-winged Blackbirds (*Agelaius phoeniceus*) feed and roost in marshland, and from there make forays into the uplands. Certain fresh tidal-river marshes in the Delaware Valley and Chesapeake Bay region where there are great beds of wild rice (*Zizania aquatica*) attract hundreds of thousands of redwings.

The period when wild rice seed is available coincides with the ripening period of a part of the corn (*Zea Mays*) crop. The availability of rice has been shown to reduce feeding pressure on corn. Robert T. Mitchell (1953. U.S. Fish and Wildlife Service unpublished report) found that in the lower Delaware River Valley damage was heavier in fields where corn matured before and after the wild rice than in those where corn ripened during the time the wild rice seed was available. The following year Mitchell and John T. Linehan reported (1954. U.S. Fish and Wildlife Service unpublished report) that damage to cornfields adjacent to marshland was three times as great as to comparable fields farther from marshland.

The importance of wild rice and other marsh plants to the redwing during the period when wild rice seed is available, was studied further in 1958 and 1959. Results are reported in the present paper. Field observations were made in wild rice beds in a 200-acre fresh tidal marsh on the Patuxent River near the mouth of Lyon's Creek, Anne Arundel County, Maryland (Fig. 1). Additional food-habits data were obtained by analysis of stomach contents of 130 birds collected while they were feeding in the marsh. Collections were made between 8:00 AM and 4:00 PM, from 5 August to 30 September. Birds that left the area before 8:00 AM or arrived after 5:00 PM were not collected because it was not possible to be sure that these birds were using the marsh as a feeding area.

THE PLANT COMMUNITY

The Patuxent River marsh is typical of the fresh tidal-river marshes of the coastal plain province. Similar marshes are located in the upper reaches of most coastal-plain rivers. They are characterized by the richest mixture of marsh flora of any of the major marsh communities in the Chesapeake Bay area.

Important plants in this community are wild rice, three species of smartweed (*Polygonum*), Walter's millet (*Echinochloa Walteri*), river bulrush (*Scirpus fluviatilis*), spatter-dock (*Nuphar luteum*), arrow-arum (*Peltandra virginica*), arrowhead (*Sagittaria latifolia*), pickerelweed (*Pontederia cordata*), marsh-

FIG. 1. Fresh tidal-river marsh, Patuxent River, Maryland. The dominant vegetation here is wild rice.

mallow (*Hibiscus* sp.), rice-cutgrass (*Leersia oryzoides*), water-hemp (*Amaranthus cannabinus*), and two species of cat-tail (*Typha latifolia* and *T. glauca*).

Seed production is at its peak during August and September. Rice seed is produced from about 15 August to 15 September; dotted smartweed (*Polygonum punctatum*) from mid-July to 30 October; and millet from about 15 August to 15 October. The seeds of halberd-leaved tearthumb and arrow-leaved tearthumb (*Polygonum arifolium* and *P. sagittatum*) are present in quantity after 1 September; and rice-cutgrass after 15 September.

FIELD OBSERVATIONS

Hordes of redwings begin to invade the Patuxent River marsh soon after the nesting season. This is in late July and about the time of the onset of molt. Wild rice towers over all other marsh plants and blackbirds frequently use it for perching. The wild rice is then in bloom and the birds occasionally eat the staminate flowers. This may be done while the birds search for seed which has not yet formed, for the flowers do not seem to constitute an important part of the diet. The marsh during this period may contain hundreds of redwings hovering in the air as they grasp the panicle or seed head of the rice plant in an attempt to loosen flower or developing seed.

The ripened rice seed is long, slender, cylindrical, and armed with an even longer and more slender awn and a thin hull covered with short stiff bristles. A feeding bird removes the hull by holding the seed crosswise and revolving it in its bill. Birds feeding on wild rice often acquire a greenish stain on the sides of their bills near the base.

As the wild rice and dotted smartweed reach optimum seed production the redwing nears the height of its molt and begins to restrict its activity. The population in the Patuxent marsh probably is at its maximum at this time. An estimated 50,000 birds were roosting there on 2 September 1959.

Although the marsh offers both a retreat and source of food, at least some of the birds do part of their feeding elsewhere. Throughout the period of wild rice availability, corn continues to show up in some gizzards. Also, some molting redwings, without tail and minus some flight feathers, were seen in labored flight to upland areas.

By the end of September, any remaining wild rice seed is embedded in the mud. By this time most birds have completed their molts. Some have begun to migrate and the great summer flocks have diminished in size.

Adults fed more commonly on wild rice in the Patuxent marsh than did juveniles. Of 130 redwings collected at random while they fed on rice, only 11 were juveniles or birds of the year. The same preponderance of adults was found among birds caught by mist-netting. There were only 40 juveniles among 300 redwings netted in daylight hours from 15 August to 15 September.

STOMACH ANALYSIS

Seeds of marsh plants formed the bulk of the food of redwings collected, (Table 1). Dotted smartweed, wild rice, and Walter's millet were the most important. Dotted smartweed occurred in 93 stomachs and comprised 38 per cent of the total volume of food in the series of 130 stomachs examined. Seeds of smartweed may have been utilized to a greater extent than seeds of other marsh plants because they were easily obtained and were available in greater quantities and over a much longer period than any other marsh seeds. Even during the optimum period of wild rice availability, the smartweed was utilized 15 per cent more than rice.

Other smartweeds, the large-seeded halberd-leaved tearthumb, and the arrow-leaved tearthumb, generally mature after 1 September. They are not so abundant as dotted smartweed and were relatively unimportant in the redwing's diet during the period covered by this study. Rice-cutgrass and water-hemp also were relatively scarce and fall in this category.

Walter's millet occurred in 62 stomachs and formed 11 per cent of the total volume. Large flocks of female redwings were constantly observed feeding in beds of this millet, whereas males rarely were seen there. Seeds of

TABLE 1

FOOD OF 130 RED-WINGED BLACKBIRDS COLLECTED DURING LATE SUMMER IN THE PATUXENT RIVER MARSH

Food	Per cent of stomachs	Per cent of total volume
PLANTS		
Dotted smartweed	88	38
Wild rice	61	24
Walter's millet	46	11
Corn	26	12
Halberd-leaved tearthumb	18	4
Ragweed	4	1
Panic-grass (*Panicum* sp.)	3	1
Arrow-leaved tearthumb	3	1
Rice-cutgrass	3	1
Crab-grass	2	Trace
Wheat	1	1
Undetermined native grasses	1	Trace
Water-hemp	Trace	1
INVERTEBRATES		
Beetles, mostly weevils	48	1
Grasshoppers	12	3
Undetermined insects	12	Trace
Caterpillars	3	1
Leaf-hoppers	3	Trace
Spiders	3	Trace
Stink-bugs	2	Trace
Ants	1	Trace
Giant water-bugs	Trace	Trace

this plant occurred in stomachs of 51 of the 67 females, but in only 11 of the 63 males.

Corn appeared in 35, approximately one-fourth, of the stomachs. The presence of this grain in stomachs from birds collected while they were feeding in the marsh supports the field observation that redwings visit the uplands even when smartweeds, wild rice and millets are abundant in the marsh. Further evidence of forays into the uplands is the presence of minor quantities of the following seeds in the stomachs: ragweed (*Ambrosia artemisiifolia*), crab-grass (*Digitaria* sp.), other undetermined native grasses (Gramineae) and wheat (*Triticum aestivum*).

Insects, of which Coleoptera and Orthoptera were the most important, formed only 5 per cent of the total volume of food consumed. Weevils (Curculionidae) occurred in 44 stomachs, and were taken more frequently than other insects, possibly because these slow-moving insects were easily caught.

Other insects taken included caterpillars (Lepidoptera), leaf-hoppers (Homoptera), ants (Hymenoptera) and stink-bugs (Hemiptera). Spiders (Arachnida) occurred in four stomachs. Only one aquatic insect, a giant water-bug (*Belostoma* sp.), was taken.

DISCUSSION

Red-winged Blackbirds spend a great amount of time feeding on marsh foods during late summer, and their depredations on corn fields apparently are reduced. However, the great attraction of wild rice and smartweed results in an influx of vast numbers of redwings to fresh tidal-river marshes, thus creating great potential pressure on adjacent corn fields. The presence of corn in stomachs collected in the marsh, and the obvious devastations in corn fields adjacent to marshes, indicate that the protection to corn is incomplete and that its importance should not be overemphasized.

SUMMARY

During late summer in the Delaware Valley and Chesapeake Bay region, hundreds of thousands of Red-winged Blackbirds feed in wild rice beds of fresh tidal-river marshes. The period during which wild rice seed is available coincides with the ripening period of a part of the corn crop, and there is evidence to indicate that the availability of the wild rice reduces bird feeding pressure on corn in the area. The importance of wild rice and other marsh plants to the redwing during the period when wild rice seed is available was studied further by field observations and by analysis of stomach contents of 130 birds collected in wild rice beds of the Patuxent River in southern Maryland. Seeds of marsh plants formed the bulk of the food of redwings collected. Dotted smartweed, wild rice, and Walter's millet were the most important food plants. Corn was the fourth most important item. It occurred in 35, approximately one-fourth, of the stomachs.

PATUXENT WILDLIFE RESEARCH CENTER, LAUREL, MARYLAND, 2 MARCH 1960

WEATHER AND EARLY SPRING MIGRATION IN IOWA

Beth Proescholdt

It is generally accepted that certain weather conditions are associated with migration, as shown in studies by Bagg *et al.* (1950), Williams (1950), Gunn and Crocker (1951), and many others, although there is considerable speculation as to whether the reaction is to the general weather situation as such, or to one or more particular factors linked with it (Lack, 1960; and others). In this study I have attempted to analyze the meteorological events that were associated with a migration of 18–24 March 1959, at points in Iowa, as well as in a reverse migration on 25 March in north Marshall County, Iowa.

To supplement my information I wrote to several observers whose kindness in sharing their records was much appreciated. Valuable assistance was given by Henry Hurst, meteorologist of the U.S. Weather Bureau, Des Moines, Iowa, in supplying and interpreting certain weather data. To Dennis Carter I am grateful for reading the manuscript and offering suggestions.

NORTHWARD MOVEMENT

The mid-March weather in Iowa was dominated by a high-pressure system that by 18 March was centered over West Virginia. This followed a huge low-pressure cell that had moved northeastward—the "low" that on 14 March had brought Iowa its second blizzard in ten days. Temperatures soared on 18 March as the clockwise wind circulation around the high-pressure center gave Iowa southerly winds and bright sunshine, weather typical of the westward portion of a high-pressure area. These conditions accounted for the first period of continuous 24 hours of above-freezing weather of the season. A low-pressure area, while not originating in the southwest as in the ideal situation described by Bagg and his colleagues (1950), but centered over central Manitoba, intensified the southerly winds. This weather was favorable to a strong northward movement of birds into Iowa, pressure-pattern flying as described by Bagg *et al.* (1950), involving following winds and rising temperatures. Williams (1950) found that high temperatures were associated with big rushes in spring; Devlin (1954) associated spring migration with southerly winds; and Dennis (1954) found that warm weather and southerly winds were favorable to northward departures from Texas.

At Spirit Lake on 18 March, James G. Sieh noted the first influx of waterfowl and blackbirds. This movement continued for several days.

Although a cold front with strong NE winds crossed the state on 19 March, migration continued, with Dr. Milton W. Weller noting the first big push in northern Story and southern Hamilton counties. Blackbirds, Marsh Hawks

(*Circus cyaneus*), Common Crows (*Corvus brachyrhynchos*), Mallards (*Anas platyrhynchos*), Pintails (*Anas acuta*), and Snow Geese (*Chen hyperborea*) were well disturbed. "All were battling a strong northeast wind," observed Dr. Weller.

Iowa was on the eastern edge of a high-pressure center on 20 March, with light northerly winds and slightly cooler temperatures. That day Fred Kent observed near Iowa City "a huge influx of new migrants," Common Grackles (*Quiscalus quiscula*), Robins (*Turdus migratorius*), Red-winged Blackbirds (*Agelaius phoeniceus*), ducks, gulls, hawks, shrikes, meadowlarks, and others. These birds, perched in trees and flying, were apparently mostly overnight arrivals.

On 21 March northerly winds sent temperatures 15 to 20 degrees below normal. However, Fred Kent counted additional arrivals, ducks and hawks, in his area.

The days of 19 March through 21 March had weather characteristic of the eastern side of a "high" (generally thought to be more unfavorable to migration), and included accompanying northerly winds considered adverse winds by Imhof (1953:188): "Birds are generally grounded by strong head winds, but when the winds lessen they probably move on." The birds observed had possibly been held back by the snows and cold weather of the first two weeks of March—the relationship postulated by Hinde (1951:336) and cited by Lack (1960): "if the internal changes are well advanced then migration may occur even under apparently unfavorable conditions. . . ."

By 22 March, Iowa was again on the western edge of a high-pressure area, with strong southerly winds and fair skies. On that morning in north Marshall County, I saw many mixed flocks of blackbirds flying north, only a prelude to the movement observed later. In the afternoon migration continued at an accelerated rate. From 3:00 to 4:00 PM I saw approximately 25,000 blackbirds of various species pass over the fields. In one five-minute period in that hour I estimated at least 7,000 birds passed. As each flock of 80 or 100 birds passed I lifted my binoculars for a better look, and behind them, out of eye-range but clearly visible with binoculars, 300 to 500 birds were visible flying northward. For many minutes, as this pattern of heavy movement continued, there was not a moment when a large group of birds was not passing or pausing to rest in fields or trees close by. Some of these flocks were of blackbirds of different species, some were entirely of Common Grackles, some were entirely of Starlings (*Sturnus vulgaris*), with smaller numbers of Red-winged Blackbirds. Thousands of birds must have passed this one pinpoint on the map during the day, for migration continued for the remainder of the afternoon. A more detailed study of the 22 March weather reveals that a low-pressure area, while again not originating in the southwest, but centered that day over the Saskatchewan-Manitoba border, intensified the southerly winds in this area. This situation (similar to that of 18 March) is described by Hochbaum (1955:118) as a "trough of southerly winds moving up the middle of the continent." In our area the warm front associated with the low-pressure system arrived at 12:00 PM on 22 March, and the cold front reached here around 1:00 PM, 24 March. So for 49 hours we were in the warm sector of the "low," the time of the strongest observed movement of birds. Bagg *et al.* (1950), Lowery (1951), and others found that in spring pronounced movement occurs during this interval. During the hour of greatest observed activity, from 3:00 to 4:00 PM on 22 March, the wind was south at 21 mph with gusts to 33 mph, with clear skies and temperatures from 52 to 55°F.

With our area still in the warm sector of the low on 23 March, the temperatures climbed into the 70's in southern and central Iowa with SW winds averaging 13 mph, and fair skies. The lowest barometric reading of the period, 29.80 inches, was reached at 4:00 PM and remained within .02 inches of that reading until 6:00 AM, 24 March. Robbins' study (1949) showed that "seven of the nine flights occurred at minimum points in the pressure curve, and the other two took place only one day away from a minimum." This minimum barometric reading, therefore, was only one day away from the strong movement of birds on 22 March, and coincided with Fred Kent's observations near Iowa City of "more ducks, Red-tailed Hawks, and huge flocks of blackbirds" on 23 March. Migration in north Marshall County continued in full swing on 23 March and the morning of 24 March, with gulls, Snow Geese, Killdeer (*Charadrius vociferus*), and hundreds of blackbirds on the move.

At about 1:00 PM on 24 March, the wind veered to the north as a slow-moving cold front (marked stationary on the weather maps) crossed the state. However, the warm air moving around the low had moved a great amount of warm air to the north of the quasi-stationary front, and the front had to move southward considerably before the cold air reached Iowa.

REVERSE MIGRATION

On 25 March the sky was heavily overcast with a NE wind ranging from 12 to 23 mph, and gusts to 34 mph, weather associated with high pressure. The center of this high was around Hudson Bay, with the clockwise winds bringing cold arctic air into Iowa. That morning in the village of Liscomb, in Marshall County, about 100 Slate-colored Juncos (*Junco hyemalis*) flew into our trees and bushes and gradually worked in a northerly direction. They were the only birds observed going north that day. All other birds seen were exhibiting what seemed to be a reverse migration. During the morning hours several small blackbird flocks and one group of 30 Robins were seen flying south over our house. At 1:15 PM about 300 blackbirds of various species arrived from the north, paused to rest for a few moments in our trees, then flew off to the southwest. At 4:00 PM approximately 1,000 blackbirds were seen approaching from the north and heading south parallel to the Iowa River bottomlands. This flock was moving in a slowly-swirling manner. By this time a light rain was falling as a low-pressure (storm) area moved northeastward from the Oklahoma-Texas region.

During the night, with the temperature hovering just above freezing, rain accompanied a strong gusty NE wind. All the next day, 26 March, in Marshall County, rain fell intermittently, mixed at times with sleet and hail. Rain fell across the state, with up to two inches in central and southern Iowa and up to five inches of snow in northern Iowa. Hail and high winds accompanied the rain in some areas. Early on 27 March the low-pressure cell responsible for the storm moved out of the state and completed that weather cycle.

DISCUSSION

There seems to be no doubt that the birds observed moving south or southwest on 25 March were reversing their normal migration pattern for that season. It would seem that these birds were retreating before the much colder air and strong northerly winds associated with the eastern edge of a high-pressure area. Just as clearly, the migration movement earlier discussed was associated with another combination of weather. This mass northward movement would seem to have been initiated on 18 March, with weather typical of the western edge of a high-pressure system—strong southerly winds and fair skies, with an opposing low-pressure area intensifying the winds. Another similar weather pattern on 22 March, along with the warm sector of the low-pressure system, was favorable to continued migration of "wave" proportions until the adverse weather following the cold front of 24 March arrived.

SUMMARY

This study outlines the weather in March 1959 that was favorable to a strong northward movement of birds observed in Iowa. Meteorological conditions also appeared to effect a reverse migration. The weather associated with the northward movement was that of the western edge of an area of high pressure and the warm sector of a low-pressure system. The reverse migration followed weather associated with the eastern edge of a high-pressure area with a cold front and northerly winds, and occurred just before a severe storm from the southwest entered the area.

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LISCOMB, IOWA, 15 FEBRUARY 1960

SOME SIZE GRADIENTS IN NORTH AMERICAN BIRDS

A. L. Rand

In 1871, J. A. Allen wrote that increase in size with increase in latitude was so well known for the birds of eastern North America that any further demonstration of it was unnecessary. Hamilton, in 1958, writes that he can find little evidence for the application of Bergmann's rule (wing length and presumably body size being greater in colder climates) within New World species. Obviously these two statements need to be harmonized!

HISTORICAL NOTE

There has been a great deal of work done on correlating patterns of geographical variation in size of birds since J. A. Allen wrote. The situation has been found to be much more complex than a simple increase in size with a decrease in temperature.

Allen was writing in the infancy of the study of geographical variation. He was attempting to codify it by the use of a subspecies concept, and also to codify it by formulating rules outside the use of the subspecies concept. This was the pioneer stage.

A second stage was reached in regard to subspecies when the concept was accepted and an attempt was made to indicate all geographical variation by subspecies names. A third stage is being reached with the realization that every even moderately separated population probably differs from every other, and that to name as a subspecies every one that can be shown to be different in some way would stultify the concept and render it completely useless. Subspecies names as used by many taxonomists now indicate only some of the more obvious geographical variants.

Indeed some students of geographical variation are groping for a more useful way to indicate geographical variation than using taxonomic nomenclature. A system of numbers or letters, in effect a formula, has been suggested, and has actually been used in analyzing variation in some species. But until human mentality will use latitude 40° 42′ N; longitude 74° W for Manhattan Island, instead of saying New York City, subspecies names will not be entirely superseded by formulae.

Concepts of zoogeographical rules, which deal with the same material in part as do subspecies, are in somewhat the same situation as subspecies concepts. They have passed through the same phases: (a) being established, (b) attempts made to cram all observed variation into them, (c) the realization that environmental factors are so complex and interacting that our "rules" can hope to outline only parts of the more obvious correlations. The dissatisfaction with "rules" is part of the same dissatisfaction with subspecies, and the solutions of both are bound up together. The fact that "rules" for the character gradients are less sharply defined, especially in the allocation of single specimens, has delayed their re-evaluation. The most important step has been the generalization of Huxley in pointing out that a more general, neutral term, cline, can be used for any character gradient without attaching an interpretation to it. Certain apparent exceptions are characterized as stepped clines, and it is realized that while one cline in one character may have a certain geographical pattern, another character may show a different pattern.

CLIMATE AND GEOGRAPHY

That northern localities have colder temperatures than more southern ones is only partly true. It is true in general for the United States east of the Rocky Mountains, with average annual temperatures in southern Florida of 75° F., and Texas of 70° F., and in northern Maine of 40° F. and central North Dakota of 40° F., and a rather regular decrease from south to north in between (excepting the small area of the Alleghanies). However, while the isothermal lines in this area run more or less east and west, the case is different in the Rockies and west to the Pacific Coast. Here many of the isothermal lines have a north-south trend, and areas in both Montana on the Canadian border, and in northern New Mexico (600 miles farther from the north pole than Maine) have 40° F. as the average annual temperature.

That is, in the eastern United States (except for the Alleghanies), latitude is a good guide to temperature; in the west it is a very poor one. (U.S. Dept. of Agri., 1941, p. 703, with different facets of the climate mapped on following pages.)

Rainfall gives a somewhat similar picture, with rainfall decreasing from 60 inches on the Gulf of Mexico to 30–40 inches in the northeast United States; much of western North America and northeastern Canada have less than 20 inches. However, the picture near the Pacific Coast is complicated.

SIZE

The word size continually appears in discussing some character gradients. In the present state of the study of geographical variation in birds, the use of the word size has not the necessary precision. In more popular writing it has its place, where it may mean wing length, total length, weight, or apparent bulk. But in more technical papers it should be replaced by the measurement which is actually meant. Allen equated wing length with weight, and this assumption is still common. While it is valid in some cases, it is not always true. If accepted for samples of birds of the same species from distant areas with widely different environments, there is danger of falling into grievous error.

The available data on weights are poor, incomplete, and scattered. One is tempted to apologize when using them. But there are some data available, and it is better to use them than to depend entirely on speculation for data when discussing weight variation and its implications.

SIZE AND GEOGRAPHY

The wing length of a species may remain fairly uniform over a wide area, as is well shown by the Ruffed Grouse (*Bonasa umbellus*), which ranges from northern Georgia to Nova Scotia and west to Alaska and northern California. The species breaks up into 12 races, based mainly on color, yet the average wing length of subspecies varies only from 178 (once) and 181 to 186 mm. (Aldrich and Friedmann, 1943).

However, variation in wing length is sometimes considerable, and we look for parallel variation in different species and hope to find this correlated with environmental factors. Even if such correlations are real, we can hardly expect the same set of factors to be operative over the whole of North America, with its wide range of environments. They vary from subtropical in southern Florida, forests and prairies of the lowlands and hills of the eastern and central part of the country, arctic barrens of the north, and the deserts, scrubs and forests of the mountains and valleys of the western part of the continent. Consequently I have presented the data by geographical areas within which some consistency is evident or to be expected. While I have confined myself largely to cases where both wing length and weight are available, I have also kept in mind that there is a greater body of data on wing length alone, which may be indicative and at least points the way to further investigation.

Ideally, size should be compared with habits and the local environmental conditions of the populations, and at various times of year, as well as geography. But in this paper I am correlating size with geography, and mentioning a few of the possibly correlated environmental factors of the breeding ranges.

WING, WEIGHT, AND GEOGRAPHY

One aspect of this is one of the most widely quoted ecological rules, often stated as: Within a species, birds from higher latitudes are larger. It seems to have application, but is by no means the whole story, its applicability varying in different parts of the continent. Another aspect which may be important is the relatively lighter weight of some western populations of widespread species. As might be expected, there are exceptions to both generalizations.

Eastern North America.—Increase in wing length and weight with increase in latitude is shown by ten species as follows:

(a) nine species in eastern United States, eight of them listed in Table 1, and the United States population of the Sandhill Crane (Table 2); and

TABLE 1

COMPARISON OF WING LENGTHS AND WEIGHTS OF GEOGRAPHICALLY SEPARATED BIRDS

Species and Location	Wing Length (mm.)		Weight (grams)	
	♂	♀	♂	♀
Hairy Woodpecker (*Dendrocopos villosus*)				
Southeastern United States	113	112	(1) 58	(2) 50
Northeastern United States	120	119	(11) 73	(12) 63
Downy Woodpecker (*Dendrocopos pubescens*)				
Southeastern United States	88	88	(1) 23	(4) 21
Northeastern United States	94	94	(23) 26	(19) 28
Carolina Chickadee (*Parus carolinensis*)				
Southeastern United States	59	55	(5) 9	(4) 8
Northeastern United States	64	61	(13) 10	(24) 9
Tufted Titmouse (*Parus bicolor*)				
Southeastern United States	77	76	(5) 20	(2) 18
Northeastern United States	80	77	(17) 22	(12) 20
Blue Jay (*Cyanocitta cristata*)				
Southeastern United States	126	121	(4) 78	(6) 71
Northeastern United States	137	134	(10) 88	(7) 86
Red-winged Blackbird (*Agelaius phoeniceus*)				
Southeastern United States	112	92	—	(4) 35
Northeastern United States	120	98	—	(7) 43
Common Grackle (*Quiscalus quiscula*)				
Southeastern United States	133	119	(8) 108	(6) 79
Northeastern United States	144	126	(23) 120	(9) 101
Cardinal (*Richmondena cardinalis*)				
Southeastern United States	90	84	(4) 37	(1) 32
			(7) 39	(10) 38
Northeastern United States	94	90	(16) 45	(13) 42
			(30) 43	(10) 44

The data on weight are from Amadon, 1944; Hartman, 1955; and Norris and Johnston, 1958; the data on wing length from standard taxonomic sources. Averages only are given. Numbers in parentheses are numbers of specimens.

TABLE 2

COMPARISON OF WING LENGTHS AND WEIGHTS OF SPECIES NESTING ON THE ARCTIC BARRENS

Species and Location	Wing Length (mm.)		Weight (lbs.)	
Canada Goose (*Branta canadensis*)				
Mid continent	410–550		6 –18	
Arctic barrens	350–480		4 – 5	
Snow Goose (*Chen hyperborea*)				
No. Alaska to So. Baffin Island	387–450		4 – 6½	
No. Baffin Island to No. Greenland	425–485		5½–10½	
Sandhill Crane (*Grus canadensis*)	♂	♀	♂	♀
Florida, etc.	501	477	(3) 10	(1) 8¼
Mid continent, etc.	539	533	(7) 11⅞	(4) 9½
Arctic barrens, etc.	468	447	(11) $9\frac{13}{16}$	(10) $8\frac{13}{16}$

Data from Delacour (1954) and Walkinshaw (1949). Numbers in parentheses are numbers of specimens.

Table 3

Comparison of Wing Lengths and Weights of Birds from Three Widely Separated Areas in the United States

Species and Location	Wing Length (mm.)		Weight (grams)	
	♂	♀	♂	♀
Hairy Woodpecker (*Dendrocopos villosus*)				
Southeastern United States	113	112	(1) 58	(2) 50
Northeastern United States	120	119	(11) 73	(12) 63
Western United States (Nevada)	133	131	(1) 74	(3) 61
Downy Woodpecker (*Dendrocopos pubescens*)				
Southeastern United States	88	88	(1) 23	(4) 21
Northeastern United States	94	94	(23) 26	(19) 28
Western United States (Nevada)	99	100	(6) 26	(2) 25
White-breasted Nuthatch (*Sitta carolinensis*)				
Southeastern United States	87	85	—	—
Northeastern United States	90	88	(20) 20	(21) 20
Western United States (Nevada)	90	88	(5) 16	(2) 16
Loggerhead Shrike (*Lanius ludovicianus*)				
Southeastern United States	98	97	(12) 48	(6) 47
Western United States	99	98	(20) 48	(14) 50
Lower California	101	—	(7) 45	—
Rufous-sided Towhee (*Pipilo erythrophthalmus*)				
Florida	80	76	(11) 44	(4) 36
Georgia, etc.	85–87	80–83	(11) 45	(6) 44
Northeastern States	87	83	(44) 41	(10) 38
California (Hastings)	87		(13) 38	

Data on weight from Linsdale (1936), Miller (1931), Hartman (1955), Norris and Johnston (1958), and Davis (1957). Wing length is from standard taxonomic sources. Numbers in parentheses are numbers of specimens.

(b) one species, the Snow Goose, of the Arctic barrens (Table 2).

Exceptions to this are three in number, as follows:

(a) the Rufous-sided Towhee of the Eastern United States, which is longer-winged but lighter in weight in the Northeast (Table 3); and

(b) the Canada Goose and the mid-continent and northern populations of the Sandhill Crane (Table 2).

For comparison, Chapman (1912) listed 27 species which had longer-winged northern subspecies in eastern North America, and seven with shorter-winged northern subspecies.

Western North America.—Both environmental factors and geographical variation in the mountainous western part of the continent are complex.

As one might expect, the detailed studies of jays by Pitelka (1951), shrikes by Miller (1931), juncos by Miller (1941), and nuthatches by Norris (1958), indicate that latitude and size variation do not correlate well.

Eastern and Western United States.—In Table 3, I have listed five species in which populations from the western United States are relatively lighter in weight, compared with wing length, than populations from the eastern United

Table 4

Comparison of Wing Lengths and Weights by Subspecies

Subspecies and Location	Wing Length (mm.)		Weight (grams)	
	♂	♀	♂	♀
Warbling Vireo				
(*Vireo gilvus swainsoni*) (Nevada)	67	66	(10) 11	(10) 11
(*V. g. gilvus*) (Kansas on migration)	73	70	(12) 15	(5) 16
Solitary Vireo				
(*Vireo solitarius cassinii*) (Nevada)	72	72	(8) 15	(6) 14
(*V. s. solitarius*) (Maine)	75	—	(5) 16	(5) 16
Scrub Jay (♂ only)				
(*Aphelocoma coerulescens*)				
Florida	115	—	(2) 78	—
12 western subspecies	118–143	—	79–125	—

Data from Linsdale (1936), Hartman (1955), Tordoff and Mengel (1956), and Pitelka (1951). Numbers in parentheses are numbers of specimens.

States. In two of these (Downy and Hairy Woodpecker), the wing length of the western birds is greater, but the weight is about the same. In two others (nuthatch and towhee), the wing is the same but the weight is less in the west; in the shrike the Lower California bird has a lighter weight.

In two species of vireos (Table 4), the wing length and the weight are both less in the two western populations.

In the Scrub Jay (Table 4) the Florida population is both shorter-winged and lighter in weight than any of the western populations.

That is, for eight species, one is a case of smaller wing and lighter weight in the east; two are cases of smaller wings and lighter weight in the west, and five are cases in which the western populations are relatively lighter-bodied.

WING LENGTH CORRELATIONS

There are other cases of greater wing length at both higher and lower latitudes in the eastern part of North America, and of birds with larger wings in the west and southwest, but I have no weight data. However, there are two other categories which I want to mention in regard to variation in wing length, as similar correlations may be found in weight variation.

Wing Length and Altitudes.—There seem to be no clearly demonstrated altitudinal subspecies in North America. The mountain subspecies, of which we have a number, are latitudinal representatives as well.

Marshall (1957: 57–58), in his studies of Arizona birds, has shown that what have been considered altitudinal subspecies there are capable of another interpretation, i.e., a latitudinal one.

This does not mean, however, that there is no evidence for increase in wing length with increase in altitude in the New World, as has been stated by some

TABLE 5

WING LENGTHS OF TWO GROUPS OF VIREOS ON CARIBBEAN ISLANDS

	VIREO OLIVACEUS Superspecies	VIREO GRISEUS Superspecies
	Wing, male only 67–82 mm.*	Wing, male only 55–66 mm.*
Bahamas	80	64
Florida Keys	80	—
Tortugas	—	63
Old Providence	—	61
Cozumel	—	62
Grand Cayman	74	—
Cuba	—	56
Jamaica	—	58
Hispaniola	83	—
Puerto Rico	—	65
St. Kitts	80	—

Data from Hamilton (1958).
*Range in averages of continental populations.

authors. Traylor (1950) has presented good evidence for this type of geographical variation in birds in the mountains of Bolivia.

Wing Length Irregularity in the West Indies.—The data Hamilton (1958) gives for two West Indian vireos, *V. olivaceus* (superspecies) and *V. griseus* (superspecies), are very interesting as indicating no obvious pattern to the variation in wing length. Not latitude, longitude, size of island, humidity, or temperature seem to fit the pattern of variation. As only one of the 11 islands concerned has both species, it seems that interspecific competition is not concerned. On the Bahamas where both occur, in each case a large but not the largest race of each species occurs.

Hamilton (1958: 334) says that *Vireo olivaceus* and *V. griseus* show the tendency for insular populations to have "greater wing length and relatively longer bill length (see Murphy, 1938)."

A survey of the tabular material on wing length, Table 5, does not support this aspect of the statement, nor does Murphy (1938) discuss wing length, in the paper cited.

Rather, these island vireos seem to be cases of the irregularity which is conspicuous in island populations. Similar irregular variation may account for some of the variation in series of continental populations.

CHARACTER GRADIENTS

Characters sometimes change gradually, giving a cline. The measurements for the Hairy Woodpecker for the eastern United States (Table 6) is a good illustration of a character gradient or cline.

But the term cline, and especially stepped cline, is often used when the

TABLE 6

CLINE IN WING LENGTH FROM NORTH TO SOUTH

Species and Location	Wing Length (mm.) ♂	Wing Length (mm.) ♀
Hairy Woodpecker (*Dendrocopos villosus*)		
Maine and New Brunswick	125–129	123
New York and Pennsylvania	119–122	116–120
Maryland and District of Columbia	119	—
Virginia	117–118	118
North Carolina	119	115
South Carolina	116	113
Georgia	113	113
Florida	113	111

Data from Ridgway (1914:202–203).

characters are uniform over a considerable area, then suddenly change to another. These cause one to wonder if some other than environmental factors may not be at work. The towhees (Table 3) are a case in point, in which the wing from New England to Georgia averages about 87 mm.; in Florida it averages 80 mm. (males only), and it is especially interesting that the change in weight does not occur in the same place as does that in wing length.

Another case is that of the Carolina Wren in which the wing length of the male averages 62 mm. in the peninsula of Florida, but only 60 mm. from northern Florida to New England (Lowery, 1940). In such cases, the question arises if the terms character gradient or cline are properly used for the whole geographical range, when such a small proportion of it actually shows a cline.

SPECIES SHOWING TWO TYPES OF VARIATION

I have wing and weight data on three species which, depending on the area the samples come from, show two types of variation. The Downy and Hairy Woodpeckers show increase in wing length and weight from south to north in eastern North America, but are relatively lighter in weight in the western part of the country (Table 3). Two types of change with latitude are shown by the Sandhill Crane. The southern birds (Florida) are medium in wing and weight; the mid-continent birds are large (increase in size with latitude); the northern birds are smallest (decrease in size with latitude), see Table 2.

DISCUSSION OF CORRELATIONS

The above correlations are based on facts. That the geographical factors are the direct, causal factors is improbable. Rather, the causal factors are probably correlated with the geography.

The following correlations are to be considered here, though others, such as interspecific competition and migration, could play a part:

Temperature.—The classical increase in size, both wing length and weight, in colder parts of the species range, is evident in eastern North America; 10 cases of positive correlation; three cases of exceptions.

Aridity Effect.—This, as Hamilton (1958: 320–327) proposed it, has no factual basis whatever. On the basis of longer wing length of populations from the western part of North America, he postulated a greater body weight, and then discussed the physiology of greater weight in more arid regions. But, he had no weights. Outside the vireos, he presented wing lengths for only four species: Downy Woodpecker, White-breasted Nuthatch, Loggerhead Shrike, and Cardinal. Of these, I have presented weights as well as wing lengths for the first three, and the western birds are not heavier than eastern populations, though their wing lengths are indeed longer in two cases, and all three are relatively lighter in weight.

Habitat Effect.—Both Miller (1931: 102–105) and Pitelka (1951: 366) have suggested that where the interstices of the habitat are smaller, one would expect birds to fly less and to be smaller-winged, with heavier bodies; openness of habitat may correlate with more space in which the bird may fly, and greater need for flight, and result in birds being longer-winged, or relatively longer-winged. I have pointed out elsewhere (Rand, 1961) that between species, the birds that fly most are relatively longer-winged and lighter in weight. In the present paper I have given data on several species in which this may apply to western populations.

Randomness of Variation (Lack of correlations).—In the complexity of adaptations, one would expect some birds to adapt in other ways than by size. They have to be some size, and they may exist in spite of their precise size.

SUMMARY AND CONCLUSIONS

The complexity of variations and the factors that bring them about are so great that we are fortunate in being able to see partial correlations over limited areas, and being able to use subspecies names and ecological rules to codify part of our knowledge.

The only effect for which there is evidence enough to be convincing is that decreasing temperature correlates with larger wing and weight (this is in accord with Bergmann's rule), and this only in eastern North America.

Suggestive is the evidence that relatively longer-winged (or lighter-bodied) western representatives of birds may occur in the more open habitats there (which last may be correlated with aridity), where more flying is involved in the daily life of the bird.

This points up the fact that wing length is not always an indicator of body

weight within a species, especially when birds from quite different environmental conditions are compared.

More than one factor could be in operation at one time, working in different directions, canceling or modifying each other.

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NEW LIFE MEMBER

Jayson A. Walker, of Waterloo, New York, has been an active member of the Society since 1949. He is especially interested in the banding and photographing of birds, but is also interested in the study of flowering plants, reptiles, and amphibians. Mr. Walker is also a member of the AOU, Federation of New York State Bird Clubs, and the Eastern Bird Banding Association. We welcome him as a new life member of the Wilson Ornithological Society.

INTRASPECIFIC VARIATION IN PASSERINE BIRD SONGS

Donald J. Borror

The vocalizations of birds are of interest to ornithologists because of the role they play in behavior, and because of their value in species recognition. These vocalizations are subject to intraspecific variation, but the accurate study of this variation involves somewhat different techniques than are involved in the study of morphological variation. Developments in recording and sound-analyzing equipment in the last fifteen years or so have made it possible to study variation in bird vocalizations with a degree of accuracy comparable to that of morphological studies.

My colleagues and I at Ohio State University have been making tape recordings of bird songs since 1948, and we now have over 4,400 recordings, representing nearly 250 species. A great many of these have been analyzed by means of a sound spectrograph, and while we may not have as many recordings as we would like, to make a thorough study of variation in any species, perhaps enough recordings have been obtained and analyzed to present some general points regarding the intraspecific variation in the songs of birds in the order Passeriformes.

An individual bird may produce a variety of sounds; we are concerned here with the particular vocalizations of passerine birds that are called *songs.* Song may be defined as the vocalizations, usually given only by the male and usually more complex in character than the bird's various call notes, which appear to have one or more of three principal functions: (1) to advertise the presence of the male, (2) to attract a female, and (3) to repel other males of the same species. The distinction between song and other vocalizations is not always sharp, partly because the songs of some birds may be of a relatively simple character and not very different from the bird's other vocalizations, and partly because the exact function of many vocalizations is not clearly understood. Most of the songs discussed in this paper are termed advertising or territorial songs by many ornithologists.

Theoretically, many sorts of variation might occur in passerine song. Song might vary in an individual bird, in different individuals of a local population, and/or in the birds of different (geographically separated) populations. The songs of an individual might vary with age, time of day, season of the year, the presence of other birds, or other factors. Different individuals, either in a local population or in geographically separated populations, might sing songs of different patterns, or show different preferences for a limited number of song patterns.

SONG DEVELOPMENT IN THE INDIVIDUAL

A male passerine bird usually begins to sing when it is several months old, and thereafter sings principally (or solely) during the breeding season. In species where different individuals sing essentially the same song it is probable that the song patterns are largely hereditary, but in species where different individuals sing somewhat different songs (the situation in the majority of passerine birds), it is probable that at least some features of the songs are learned by listening to other birds. The role of learning in song acquisition has been pointed out by a number of investigators, including Thorpe (1951, 1954, 1956, 1958*a*, 1958*b*), Koehler (1951), Poulsen (1951, 1958), and Lanyon (1957, 1960).

The early season singing of birds whose song patterns are at least in part learned is somewhat atypical; the patterns are erratic and somewhat abortive, and the birds sound as though they were trying to decide just what patterns to sing, and to perfect their singing technique. Later in the season, as the bird perfects its song patterns, little of this type of singing is heard. Many passerine birds that sing during their migration sing songs that are a little different (e.g., more variable, with the patterns less well defined) from the songs sung by these birds on their nesting grounds; such birds are probably in the "perfecting" stage of their song development. Once the bird's song patterns are perfected they appear to be largely fixed for the rest of the bird's life; there appears, based on my study of the songs of a number of individual birds over periods of two to four years, to be relatively little variation from year to year in the song patterns of a given individual.

Our collection of bird recordings contains a number in which the songs are very atypical for the species, and closely resemble the songs of another species. Some birds rather regularly mimic the songs and calls of other species (the Mockingbird and Starling are well known examples), but occasionally other birds—species not generally considered mimics—will do this. Tasker (1955), for example, reports a Chipping Sparrow with the song of a Clay-colored Sparrow, and Hulme (1950) reports a Chaffinch mimicking the song of a Hedge Sparrow. Among our recordings of such atypical mimicry are recordings of a Rufous-sided Towhee and a Bachman's Sparrow singing Field Sparrow songs, a Field Sparrow singing a song similar to that of a Prairie Warbler, and a Red-eyed Vireo singing towhee-like songs. I have seen a Blue Jay that was exposed since it left the nest only to Robin song, and which sang a robin-like song. It seems likely that these cases of mimicry are the result of the bird learning its song from another species.

LOCAL VARIATION

Different species of passerine birds differ in the amount of variation in the songs of a given individual and in the songs of different individuals. The

TABLE 1

AN OUTLINE OF THE INTRASPECIFIC VARIATION IN THE ADVERTISING SONGS OF PASSERINE BIRDS

Songs of a Given Individual	Songs of Different Individuals			
	Of the Same Pattern	Of a Few Different Patterns	Of Many Different Patterns	Of Many Different Patterns
		Much Overlapping	Some Overlapping	Little or No Overlapping
Of One Pattern	Least Flycatcher Traill's Flycatcher*	Savannah Sparrow Grasshopper Sparrow	Yellowthroat Chipping Sparrow Slate-colored Junco	
	White-breasted Nuthatch	Ovenbird Kentucky Warbler White-throated Sparrow		
Of a Few Patterns	Wood Pewee Phoebe Traill's Flycatcher*	Black-throated Green Warbler Parula Warbler	White-eyed Vireo	Indigo Bunting Field Sparrow Vesper Sparrow
	Blue-winged Warbler		Tufted Titmouse Cerulean Warbler American Redstart	
Of Many Patterns			Rufous-sided Towhee Carolina Wren Cardinal Bachman's Sparrow	Wood Thrush Hermit Thrush Song Sparrow Lark Sparrow

* The reason for Traill's Flycatcher appearing in two places in this table is discussed on p. 74.

types of intraspecific variation found in the advertising songs of a number of passerine birds are outlined in Table 1. This table does not include species that sing more or less continuous songs, such as the Catbird, Brown Thrasher, and Red-eyed Vireo, because the songs of these species have not yet been studied in sufficient detail; such species would probably fit somewhere in the lower right-hand part of the table. Most passerine birds that sing short isolated songs (in contrast with more or less continuous songs) would probably fit into one of the four top center squares. Most nonpasserine birds probably fit in the left-hand square in the top row.

The songs of some species consist of a definite sequence of notes and phrases, and the different songs of a particular pattern sung by a given individual are practically identical; in other species, where all or part of the song consists of a series of similar notes or phrases, different songs of a particular pattern sung by a given individual may differ in the number of such notes and phrases. In the squares of Table 1 containing a broken line, the different songs of a particular pattern sung by a given individual of the species above the broken line are practically identical, but in the species below the broken line the number of notes or phrases in different parts of the song may vary. In squares with no broken line, the different songs of a particular pattern sung by a given individual of all the species listed are subject to variation in the number of notes or phrases they contain.

In some species of passerine birds (for example, the species listed in the top row of the table) the songs of a given individual are all of the same pattern; in others (the species listed in the middle row of the table) each individual may sing songs of two to five different patterns; in still other species (those listed in the bottom row of the table) each individual may sing songs of six or more different patterns.

The greatest amount of variation in the songs of a given individual was found in the species listed in the bottom row of Table 1. The maximum number of song patterns in our recordings of a single individual is 8 for a Rufous-sided Towhee (Borror, 1959*a*), 11 for a Cardinal, 13 for a Song Sparrow, 13 for a Hermit Thrush (Borror, 1960), 18 for a Wood Thrush (Borror and Reese, 1956), 22 for a Carolina Wren (Borror, 1956), 37 for a Bachman's Sparrow, and 58 for a Lark Sparrow. Variation within patterns occurred in all these species. The songs of a given pattern in the Song Sparrow, for example, may vary in the number of phrases of a given type in different parts of the song, in the presence or absence of certain notes or phrases, in where (along a certain sequence of notes and phrases) the song ends, and/or in the particular types of phrases with which the song begins or ends; the variation in Song Sparrow songs is such that the delimitation of patterns is occasionally somewhat arbitrary. In the 462 songs we have recorded from one Maine Song Sparrow, which had 13 distinct song patterns, there were 187 different songs.

In some species (those listed in the left-hand column of Table 1) the songs of different individuals are of the same pattern, with only slight individual differences (see Figs. 1, 4, and 5). In other species (those listed in the second column of the table) the songs of different individuals are occasionally of different patterns, but our recordings do not contain more than 12 different song patterns for any of these species; it is quite common ("much overlapping" is the way this is described in the table) to hear different individuals singing songs of the same pattern. In still other species (those listed in the third column of the table) the songs of different individuals are usually different, and our recordings contain more than 12 patterns for each of these species; it is only occasionally that one hears different individuals singing songs of the same pattern. In still other species (those listed in the right-hand

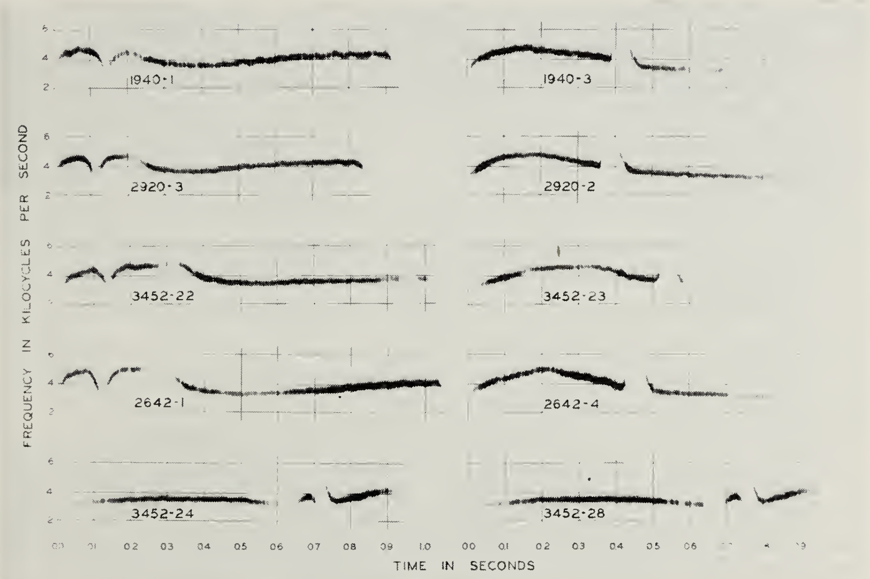

Fig. 1. Audiospectrographs* of Wood Pewee songs. The four upper graphs on the left are of *pee-ah-wee* songs, the four upper graphs on the right are of *peee-ah* songs, and the two graphs at the bottom are of *aaah-didi* songs; 3452 is a recording of the daybreak song, and the other recordings are of daytime songs. 1940, New Albany, Ohio, 26 May 1956; 2920, Lincoln Co., Maine, 30 June 1957; 3452, Bloomington, Indiana, 1 June 1958; 2642, Franklin Co., Ohio, 15 May 1957.

column of the table), our recordings of which contain many different patterns, one rarely if ever hears different individuals singing songs of the same pattern.

The greatest amount of variation in the songs of a given species was found in the birds listed in the right-hand column of Table 1. Our recordings do not contain any instance of two different birds singing songs of the same pattern in the cases of the Indigo Bunting, Vesper Sparrow, Wood Thrush, Hermit Thrush, or Lark Sparrow, and only a few such instances in the cases of the Field Sparrow and Song Sparrow. The different patterns of Field Sparrow songs are fairly similar, and the delimitation of these patterns is somewhat subjective; with a fairly strict delimitation of patterns, only about 2 per cent of our Field Sparrow recordings represent cases of a given pattern being sung by different individuals. The song patterns of the other

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* The recordings from which the song graphs in this paper were made are in the collection of recorded animal sounds of the Department of Zoology and Entomology, Ohio State University. I made them all with a Magnemite recorder, Model 610-E, using a tape speed of 15 inches per second; the graphs were made with a Vibralyzer. The first of the two numbers on each graph is the number of the recording, and the second (unless otherwise indicated) is the song in the recording, from which the graph was made.

species in this column differ more than those of the Field Sparrow, and can generally be more objectively delimited, but except for the Song Sparrow we do not have a large number of recordings of any of these species.

Of the 501 recordings we have of Song Sparrows, 356 are from 46 birds in an area of about 40 acres in Maine, and were obtained over a period of several seasons. These 356 recordings contain 2,868 songs, of about 200 patterns (the exact number depends somewhat on how strictly the patterns are delimited). We have over a hundred songs from each of eight different birds from this area, and in these eight birds the number of song patterns per bird varied from 6 to 13 (average, 8.25). Taking into account the variations within patterns, there were 1,494 different songs in the 2,868 recorded from these 46 birds; only 6 of the 1,494 variations, and about a dozen of the two hundred patterns, were sung by different birds.

It is probably very unusual, except possibly in the cases of the Field Sparrow and Song Sparrow, to find two individuals of the species listed in the right-hand column of the table singing songs of the same pattern. Cases of two or more individual Song Sparrows singing songs of the same pattern probably occur only within a local population. It may be that in some of these species no two birds ever sing songs of the same pattern.

There is a great deal of variation in song pattern in the species listed in the third column of the table, even though our recordings contain a number of instances of a given pattern being sung by different individuals. For example, we have 138 different song patterns in 113 Cardinal recordings, 127 patterns in 12 Bachman's Sparrow recordings (seven birds), 93 patterns in 71 Rufous-sided Towhee recordings (Borror, 1959*a*), 45 patterns in 84 Yellowthroat recordings, and 36 patterns in 86 Chipping Sparrow recordings.

GEOGRAPHIC VARIATION

Any bird observer with a critical ear for patterns in bird songs will note that the song patterns of many passerine birds differ somewhat in different areas, but these differences have been critically studied in only a few species. "Local dialects" have been described for the Chaffinch by Marler (1952), Poulsen (1958), and Thorpe (1954). Lanyon and Fish (1958) have discussed the geographic variation in the songs of the Western Meadowlark, and I have published some data on the geographic variation in the songs of the Carolina Wren (Borror, 1956), the Rufous-sided Towhee (Borror, 1959*a*), and the Chipping Sparrow (Borror, 1959*b*). It may be of interest to mention here a few additional examples, based on my studies.

Bachman's Sparrow (*Aimophila aestivalis*).—The songs of this species typically consist of one or two introductory notes followed by a trill; the introductory notes are relatively long and usually steady in pitch, and the

TABLE 2

CHARACTERISTICS OF THE TRILL IN THE SONGS OF SEVEN BACHMAN'S SPARROWS

Character		3 birds in Ohio	4 birds in Florida
Phrase Length* (in sec.)	Range	0.032–0.220	0.040–0.230
	Average	0.124	0.166
Number of Phrases	Range	1–20	4–11
	Average	8.94	7.67
Number of Different Phrase Types	1-noted	12	2
	2-noted	34	15
	3-noted	22	23
	4-noted	1	12
	Total	69	52
Average number of notes per phrase		2.17	2.87
Total number of songs recorded		447	81

* Phrase length is the length of time from the beginning of one phrase to the beginning of the next; the reciprocal of this figure is the number of phrases per second.

trill consists of a rapid series of similar phrases. A given bird may sing songs of a number of different patterns, each pattern consisting of a characteristic introduction and type of trill phrase. In recordings of seven individuals of this species I studied, three from Ohio (*A. a. bachmani*) and four from Florida (*A. a. aestivalis*), and containing 528 songs, there were 127 different song patterns (37 in the songs of one Ohio bird). Several song patterns occurred in the songs of two or three birds in the same state; there was no pattern that occurred in the songs of both an Ohio and a Florida bird. Data on certain features of the trill in the Ohio and Florida songs are given in Table 2; these data indicate that (1) the trill phrases are uttered more slowly, on the average, by the Florida birds than by the Ohio birds (about six per second in Florida songs and eight per second in Ohio songs), (2) the trills in the Florida birds contain, on the average, fewer phrases than those of the Ohio birds, and (3) the trill phrases of the Florida birds contain, on the average, more notes than those of the Ohio birds. (It might be said that the Florida birds had a "southern drawl.")

Song Sparrow (*Melospiza melodia*).—The songs of this sparrow consist of a series of different phrases (mostly 1- to 4-noted), and usually a trill; many of the notes are buzzy. The song begins with a series of similar phrases, either two to four (rarely one or five) uttered at a constant rate, or four to 20 that increase in tempo. A given bird has a vocabulary of a large number of notes and phrases, and these are variously combined to produce up to a dozen or more different song patterns; the different patterns of a given bird are often quite different. The songs of a given pattern may vary, as noted above (p. 60).

Our Song Sparrow recordings include 388, of some 70 birds, from Maine (*M. m. melodia*); 356 of these are of 46 birds in an area of about 40 acres, and the rest are from varying distances up to 160 miles from this 40-acre area. The vast majority of the songs of the birds in the 40-acre area contain notes and phrases that occur also in the songs of other birds in this area; the songs of birds outside this area contain fewer notes and phrases like those of birds in the area, and the farther away from this area the bird is the fewer the similarities in notes and phrases. In the songs of the Ohio Song Sparrows (*M. m. euphonia*) that have been analyzed to date (of 66 birds, and containing 501 songs of 110 different patterns), the phrases are nearly all different from those of the Maine birds.

Song Sparrow songs are of two general types, those beginning with two to four (rarely one or five) similar and equally spaced phrases, and those beginning with four to 20 similar phrases that increase in tempo; most song patterns can be readily classified into one of these two categories. Songs of the first type were much more common, making up 83.8 per cent of the Ohio patterns and 86.7 per cent of the Maine patterns (these differences in percentage are not significant).

A Song Sparrow apparently has an inborn tendency to sing songs of two general types, but it learns its phrases by listening to other, nearby Song Sparrows. As a result, the songs of different birds in a local population contain similar notes and phrases (but usually arranged differently), while the songs of birds in separated populations contain different phrases. The farther away two populations are, the less likely they are to use similar phrases in their songs.

Cardinal (*Richmondena cardinalis*).—To date I have analyzed 113 recordings of Cardinal songs (containing 946 songs from 100 birds in eight states). These songs consist of 1–43 loud, clear, whistled phrases uttered at rates of 0.9 to 9.0 phrases per second. The songs studied contained 82 different types of phrases (plus a buzzy trill), of which 31 were one-noted, 37 were two-noted, 11 were three-noted, 2 were four-noted, and 1 was five-noted. Cardinal songs may be one-parted, that is, all the phrases alike and uttered at a uniform rate (except possibly the first two or three phrases, which are often slower), or they may contain up to five parts (with the phrases of one part different from those of the next part). The songs are occasionally followed by a buzzy trill (a series of abruptly up-slurred notes, 27–31 per second) that may last up to 1.5 seconds. By giving each phrase type a number, any given song pattern could be represented by one to five numbers (one number for one-parted songs, two for two-parted songs, and so on). The songs of a given bird may vary in pattern (up to 11 in one Florida bird), and the songs of a given pattern may vary in the number of phrases they contain. There were 138 different patterns in the songs studied, of which 47 were one-parted, 64 were two-parted, 21 were three-parted, 4 were four-parted, and 2 were five-parted.

It is fairly common to hear two Cardinals in a given area singing songs of the same pattern, but it is less common for birds in different areas (i.e., different local populations, in areas separated by four miles or more) to sing songs of the same pattern. Of the 138 patterns found, however, 18 (14 one-parted and 4 two-parted) were sung by birds in different areas; 4 of these were sung by birds in two different states, and 1 pattern was sung by birds in four different states.

The songs of the Ohio birds, *R. c. cardinalis* (797 songs, of 85 birds, and containing 114 song patterns), contained 68 different phrase types, of which 27 were one-noted, 27 were two-noted, 11 were three-noted, 2 were four-noted, and 1 was five-noted; these phrase types averaged 1.87 ± 0.11 notes per phrase. The songs of the Florida birds, *R. c. floridana* (73 songs, of 8 birds, and containing 20 song patterns), contained 20 different phrase types, of which 7 were one-noted, 11 were two-noted, and 2 were three-noted; these phrase types averaged 1.75 ± 0.14 notes per phrase. Ten phrase types (6 one-noted, 3 two-noted, and 1 three-noted) occurred in the songs of both the Ohio and Florida birds. The phrases of the Ohio and Florida birds contained about the same number of notes.

There was no tendency in the songs studied for the birds in different states to sing songs containing a different number of parts. The song patterns in both the Ohio and Florida birds contained an average of 1.9 parts.

Data comparable to the above have been published for a few other species of passerine birds. It has been shown (Borror, 1956) that there are significant differences in the songs of Ohio and Florida Carolina Wrens (representing *Thryothorus ludovicianus ludovicianus* and *T. l. miamensis*, respectively), principally in the phrase rate and the number of phrases in the song; the songs of Florida birds contained, on the average, more phrases and the phrases were uttered more rapidly than in the Ohio birds (the reverse of the situation in the trill of Bachman's Sparrow, described above). In the Rufous-sided Towhee (*Pipilo erythrophthalmus*) it has been shown (Borror, 1959*a*) that the songs of the two subspecies *erythrophthalmus* and *alleni* differ slightly, while the songs of different individuals of the subspecies *erythrophthalmus* as far apart as Ohio and Maine are not significantly different. Studies of Chipping Sparrow songs (Borror, 1959*b*) have shown that there is a great deal of variation in the songs of different birds, but that there is no significant geographic variation within the subspecies *Spizella passerina passerina*, comparing the songs of Ohio and Maine Birds.

In the passerine songs I studied (all from the eastern part of the United States and Canada), there is evidence that in at least some species the songs of different subspecies may differ slightly; within a single subspecies the variation is principally of the sort that might be described as "local dialects," that is, with the birds of different local populations differing in song patterns, but with no significant geographic trends evident.

DIURNAL VARIATION

Most passerine birds sing more consistently in the early morning hours than in the middle of the day; song is usually at a minimum early in the afternoon, and in many species increases again in late afternoon or evening. This phenomenon has been studied in many species, and is apparently correlated with light intensity (Wright, 1912, 1913; Allard, 1930).

A number of birds sing a little differently at daybreak than during the day, and a few sing a little differently at dusk. Distinctive daybreak songs (also called morning twilight songs) have been described for the Wood Pewee (Allard, 1934; Craig, 1943) and for the Crested Flycatcher and the Scissor-tailed Flycatcher (Nice, 1931). We have recordings of distinctive daybreak singing of the Wood Pewee, Crested Flycatcher, and Acadian Flycatcher. There are undoubtedly many other species that sing somewhat differently at daybreak than during the rest of the day. The situation in the Wood Pewee may serve to illustrate the peculiarities of daybreak song.

In its normal daytime singing the Wood Pewee sings songs of two different patterns, *pee-ah-wee* and *peee-ah* (Fig. 1). These two patterns are sung more or less alternately, at the rate of about six or eight a minute; most birds sing about three times as many *pee-ah-wee* songs as *peee-ah* songs. The bird sings a little differently at daybreak; in addition to the two song types just mentioned, it sings a third type, *aaah-didi* (Fig. 1). These three songs are often sung in a definite sequence, at the rate of about 20 songs a minute. This daybreak song begins about an hour before sunrise and lasts about half an hour.

The special daybreak songs of these flycatchers are undoubtedly influenced by light intensity, but their significance to the birds is not clearly understood.

SEASONAL VARIATION

Song is an aspect of bird behavior associated with the breeding season. It begins in the spring, with the onset of the breeding season, usually at a date characteristic for the species. Saunders (1947) presents data on the beginning of song in the spring for a number of species; these dates vary in a given year for different species, and to some extent (usually not more than a week or two) from year to year in a given species. Some species stop or reduce their singing during certain parts of the nesting cycle, for example, after mating or when they are feeding young; the Song Sparrow ceases singing when it acquires a mate, and begins again when nest building starts (Nice, 1943:118–119).

Song declines after the breeding season and this decline is usually rather gradual, although some species may stop singing rather abruptly. A number of investigators have presented data on the cessation of song in late summer (Bicknell, 1884, 1885; Fry, 1916; Saunders, 1926, 1938, 1948a, 1948b; Baerg, 1930; Vaurie, 1946; Mehner, 1952); the time of cessation varies in different species, and from year to year (as much as two to four weeks) in a given species. The cause of cessation of singing is probably hormonal; cessation usually occurs with the approach of the postnuptial molt.

Some species begin singing again after the postnuptial molt. In general, those species that change color at the postnuptial molt sing in the fall, but the reverse is not always true (Bicknell, 1884; Saunders, 1948). A few species (for example, the Carolina Wren) may sing every month of the year. The songs sung by some species in late fall or winter are often of a rather primitive type (Saunders, 1948), and probably represent "learning" or "practicing" by immature birds (see the discussion on the development of song in the individual, p. 58).

OTHER VARIATION

It might be presumed that, in birds having a number of different song patterns, the different patterns had different meanings to the birds, or particular patterns were sung only under specific circumstances. This may be the case in some birds, but is probably not the case in others; a given type of song or song pattern may serve all the functions of song mentioned above (p. 57), or different functions may be served by different types of songs.

The normal singing rate of a Song Sparrow singing its advertising song is about four to six songs a minute, and it may sing for several minutes at this rate—either from a particular perch or while moving about and feeding. It will sing songs of one pattern for a while, then change to another pattern for a while, then to another, and so on through all or a part of its repertoire. If recorded Song Sparrow songs, of either this same individual or another individual, are played to a bird on its territory, the bird reacts in a characteristic fashion: its singing rate increases to eight or ten songs a minute, and it shows signs of agitation and hops around the speaker. The particular song patterns it sings under these circumstances are the same ones it sings when it is undisturbed; what is changed by the playback is not the bird's song patterns, but its singing rate. I have observed this reaction of Song Sparrows to playbacks on numerous occasions.

Some birds occasionally utter a very soft song that may or may not be of the same pattern as its normal song; such songs are often called secondary

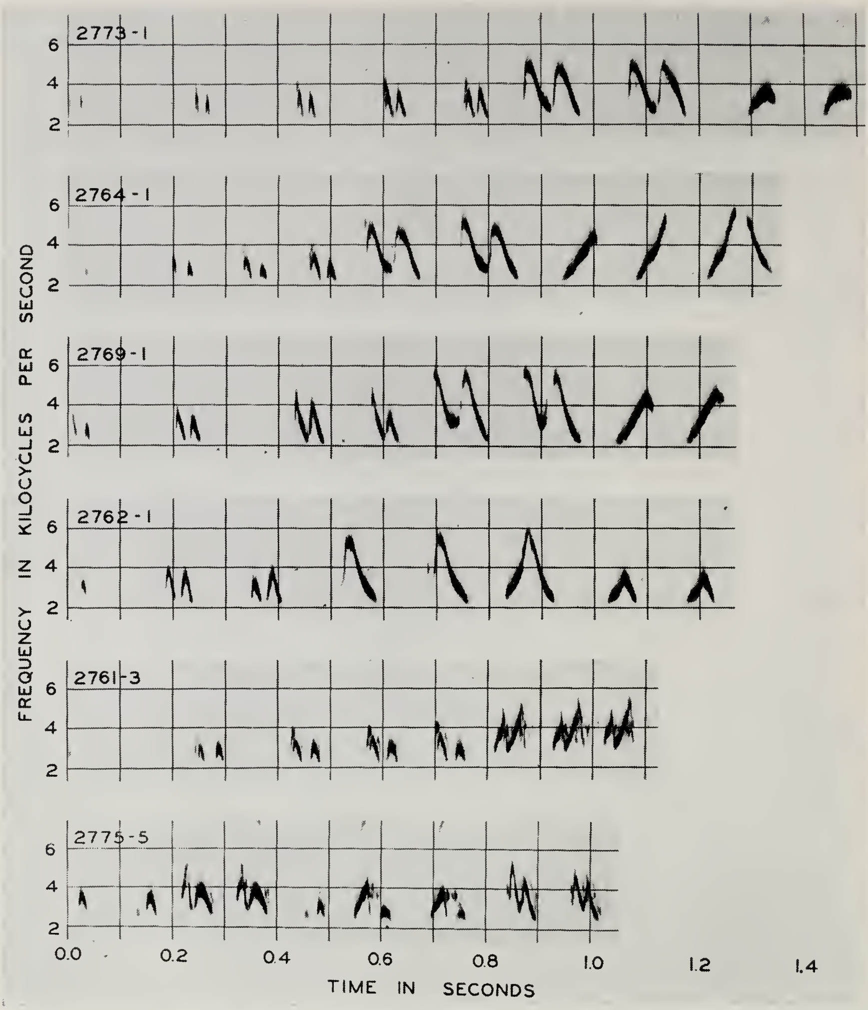

Fig. 2. Audiospectrographs of advertising songs of the Kirtland's Warbler, all from recordings made in Oscoda Co., Michigan, 31 May 1957.

songs, whispering songs, or subsongs (Van Tyne and Berger, 1959:138–139). The significance of such songs is not always clear, but in some species (e.g., the Kirtland's Warbler) these whispering songs appear to function in repelling an intruding male.

A comparison of the advertising and whispering songs of the Kirtland's Warbler is shown in Figs. 2 and 3. The advertising songs of this warbler are of two general types; the songs of one type (the four upper graphs in Fig. 2)

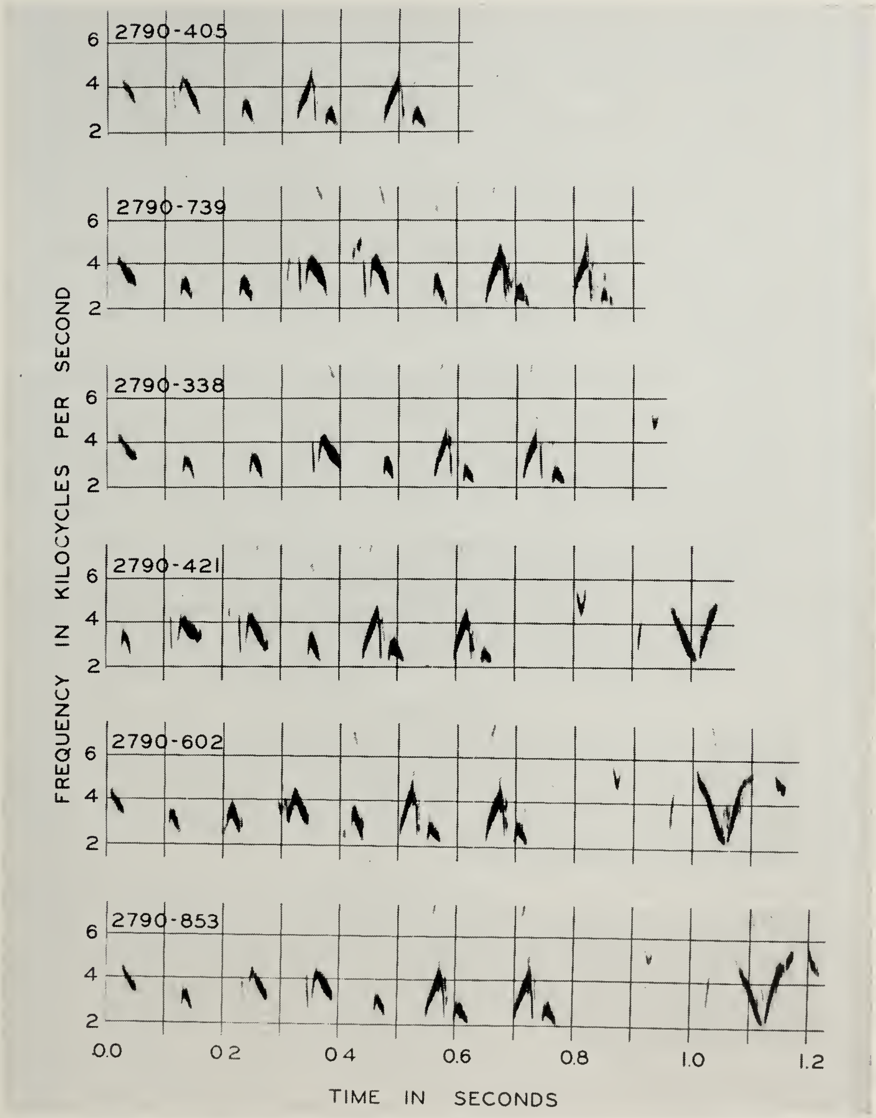

Fig. 3. Audiospectrographs of whispering songs of the Kirtland's Warbler, sung in response to playbacks of the advertising songs on the bird's territory; recorded in Oscoda Co., Michigan, 31 May 1957. The second of the two numbers on each graph is the location of the song in the recording (in minutes and seconds from the beginning).

are somewhat similar in quality and tempo to the songs of the Northern Waterthrush, and the songs of the other type (the two bottom graphs in Fig. 2) are a little like those of a House Wren. Whispering songs (Fig. 3), which were obtained by playing back a recording of the advertising song on the bird's territory, are much softer than the advertising songs and quite variable in length; they are somewhat similar to the wren-like advertising song.

Many birds have songs which are heard only infrequently, and which are of a somewhat different type than the usual territorial song. The term "flight song" has been used for some such songs (e.g., in the Ovenbird), "twilight song" for others (e.g., in certain flycatchers), and still other terms for others. The biological significance of such songs is known in only a few cases; for example, the "sustained song" of the Grasshopper Sparrow (Smith, 1959), which consists of a typical advertising song followed by a series of buzzes, appears to function in courtship.

Song is primarily a vocalization of the male, but the females of some species may sing occasionally (Nice, 1943:129–132). I have one recording of a female Song Sparrow that was apparently stimulated to sing by playbacks of Song Sparrow songs; its songs were typical for the species, but of a different pattern than any its mate sang. In some species the two sexes sing (the same or different patterns) either simultaneously or alternately. It is not uncommon to hear a pair of Cardinals singing songs of the same pattern (alternately). This type of singing is sometimes called responsive singing, antiphonal singing, or duetting, and occurs in a number of species (Van Tyne and Berger, 1959: 140).

DISCUSSION

Two questions arise with regard to the large amount of intraspecific variation that occurs in the songs of many passerine birds: (1) how the bird student can ever learn to recognize these many song patterns, and (2) the significance of this variation to the birds themselves.

Recognizing Bird Songs.—In most species that sing a number of different song patterns, the patterns are of one or a few general types, and the songs are usually of a characteristic quality. One recognizes the songs of a given species, even patterns he has never heard before, after first becoming familiar with the type(s) of song patterns that species sings and with the quality of the songs. The field identification of bird songs generally involves also some knowledge of what species might be expected to be singing at a given time and place; the importance of this basis of song identification becomes evident when one tries to identify song recordings in the laboratory. If the field observer has an ear for pattern in bird songs, he will eventually be able to recognize individual birds by their songs; this is particularly true for the species listed in the two right-hand columns of Table 1.

Significance of Song Variation to the Birds.—Certain types of songs are known to play a role in courtship or in territorial defense, as we have seen, but the significance to the birds of much of the intraspecific variation in the advertising songs can for the most part only be guessed. Such data as are available on this point suggest two things, one regarding the ability of the bird to recognize different individuals of its own species, and the other regarding the role played by song in bird speciation.

Individual Recognition.—The advertising songs of an individual Ovenbird are of one pattern (or phrase type), differing only in the number of phrases in the song. One may occasionally find different Ovenbirds with identical phrases, but the songs of different individuals are often different (Table 1). Weeden and Falls (1959) have shown that an individual Ovenbird can distinguish between the songs of different individuals of their species, and can recognize the songs of particular individuals (their neighbors); they react more strongly to songs of nonadjacent birds than to songs of their neighbors. This is apparently a mechanism that reduces strife between birds in adjacent territories once the territorial boundaries are established, and enables the bird to recognize (and possibly cope with) the greater danger of encroachment on its territory by "strangers."

The Role of Song in Speciation.—Song in passerine birds often plays an important role in sexual and species recognition; this has been demonstrated in a number of species (Dilger, 1956; Stein, 1958). Certain vocalizations have been shown to play a similar role in many other animals, including fish (Tavolga, 1956, 1958*a*, 1958*b*; and others), amphibians (Blair, 1955, 1956, 1958; and others), and insects (Alexander, 1957; Alexander and Moore, 1958; Walker, 1957; and others). On the other hand, song in some passerine birds is not the principal means of species recognition; for example in the meadowlarks (*Sturnella magna* and *neglecta*) specific recognition is by call notes rather than song (Lanyon, 1957). Because of the role of song in species recognition, variation in song may lead to speciation; the situation in certain flycatchers may serve to illustrate this point.

An interesting feature of some flycatcher songs is the fact that each individual has two types of songs, or song patterns, which it sings more or less alternately, and different individuals of the species have essentially the same patterns. This is the case, for example, in the Wood Pewee, Phoebe, and Traill's Flycatcher.

The Wood Pewee in most of its singing sings songs of two different patterns, *pee-ah-wee* and *peee-ah* (Fig. 1). These two songs are not sung in any fixed sequence, but a bird generally sings about three times as many songs of the first type as the second.

The Phoebe also sings two types of songs more or less alternately. One type, the "buzz" song (Fig. 4), consists of a slurred note followed by a buzz, and the other, the "sputter" song (Fig. 4) consists of a similar slurred note followed by a sputter. The two types of songs are readily distinguishable by

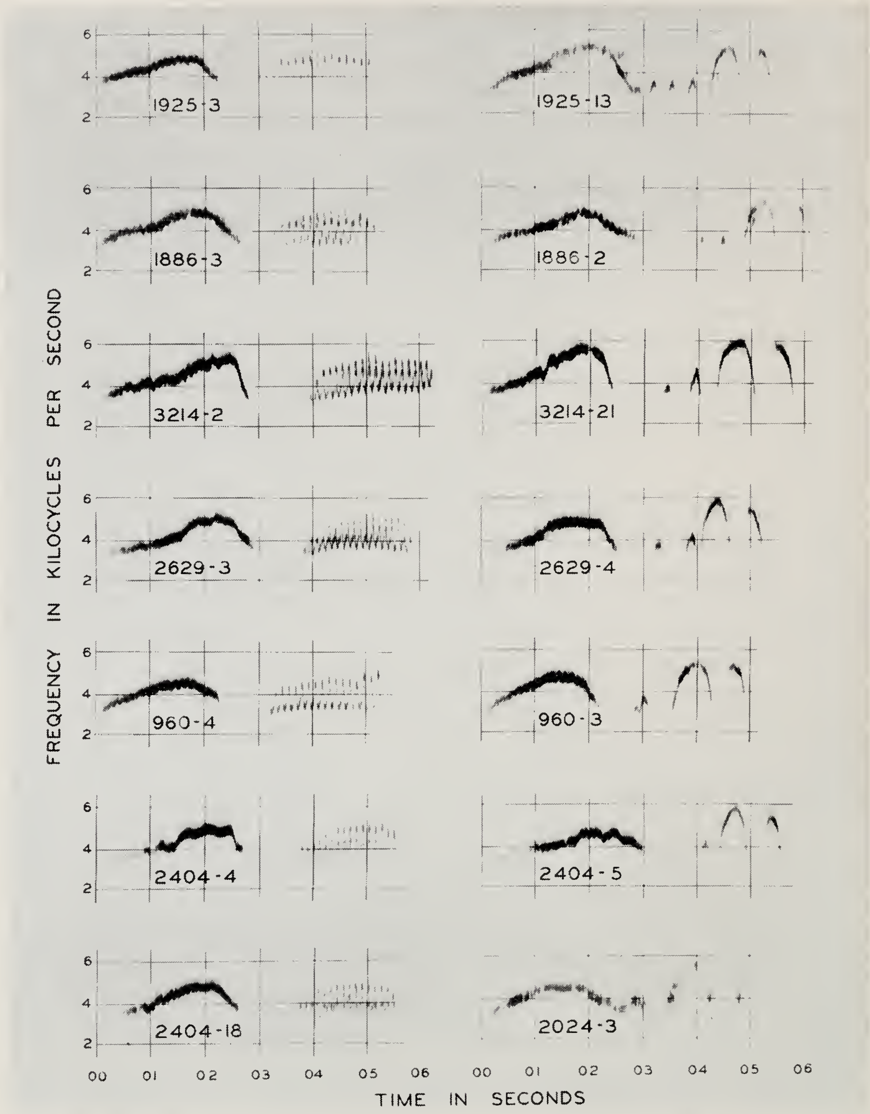

FIG. 4. Audiospectrographs of Phoebe songs; buzz songs on the left and sputter songs on the right. 1925, Columbus, Ohio, 23 May 1956; 1886, Columbus, Ohio, 19 May 1956; 3214, Franklin Co., Ohio, 15 April 1958; 2629, Columbus, Ohio, 13 May 1957; 960, Columbus, Ohio, 26 April 1954; 2404, Columbus, Ohio, 31 March 1957; 2024, Lincoln Co., Maine, 13 June 1956.

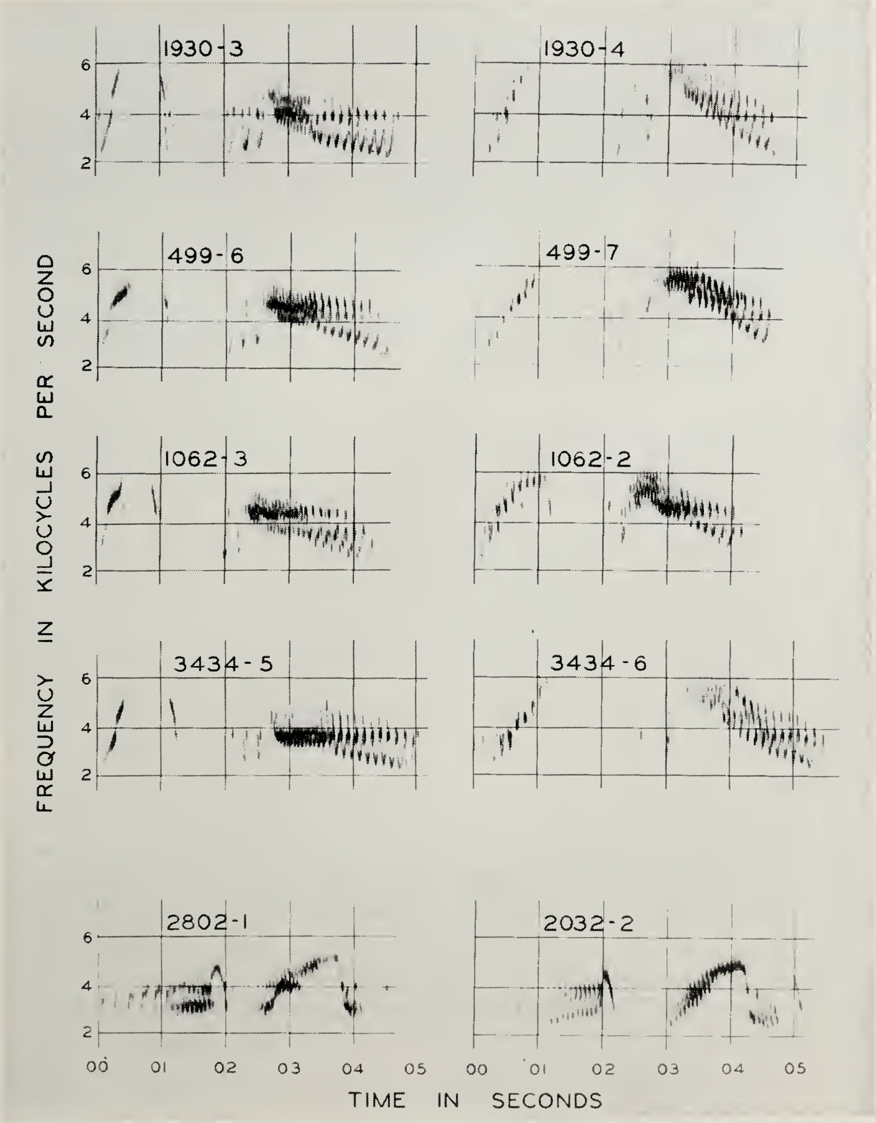

FIG. 5. Audiospectrographs of Traill's Flycatcher songs. The eight upper graphs are of the *fitz-bew* bird, with *fitts-bew* songs on the left and *fizz-bew* songs on the right; the two graphs at the bottom are of the *fee-bee-o* bird. 1930, Columbus, Ohio, 23 May 1956; 499, Columbus, Ohio, 18 May 1953; 1062, Columbus, Ohio, 22 May 1954; 3434, Reynoldsburg, Ohio, 21 May 1958; 2802, Mio, Michigan, 1 June 1957; 2032, Lincoln Co., Maine, 13 June 1956.

TABLE 3

SONG TYPES IN PHOEBE RECORDINGS

Source of Recordings	Number of Recordings	Number of Songs		
		Buzz Type	Sputter Type	Total
Ohio	12	184	99	283
Maine	3	22	30	52
Total	15	206	129	335

ear. The occurrence of these two song types in our Phoebe recordings is shown in Table 3. One of the Ohio recordings (with 3 songs) and two of the Maine recordings (with a total of 21 songs) contained only sputter songs; all the other recordings contained songs of both types. The different proportion of the two song types in the Maine and Ohio recordings is statistically significant (chi square = 9.568); the buzz type of song is more common in the Ohio birds and the sputter type is more common in the Maine birds.

The song situation in Traill's Flycatcher is much like that in the Phoebe, but with an added complication. The birds occurring in the northern part of the country, at least from New England west to the northern Great Lakes region and the upper Mississippi Valley, have a song that is generally described as *fee-bee-o,* while the birds farther south, at least in eastern United States, have a song usually described as *fitz-bew.* The songs of the *fee-bee-o* bird are apparently all of one pattern, but those of the *fitz-bew* bird are of two patterns.

The two song patterns of the *fitz-bew* bird are scarcely distinguishable by ear in the field; they differ in the character of the first part of the song. One pattern (the four upper graphs on the left in Fig. 5) begins with two short, sharp notes, and might be termed the *fitts-bew* song, while the other (the four upper graphs on the right in Fig. 5) begins with an upslurred buzz, and might be termed the *fizz-bew* song; the second part of the song is similar in the two patterns. These two song patterns are sung more or less alternately. Our 16 recordings of the *fitz-bew* bird (all from central Ohio) contain 314 songs, 225 of the *fitts-bew* type and 89 of the *fizz-bew* type; each recording contains songs of both types. Our four recordings of the *fee-bee-o* bird (three from Maine and one from Michigan) contain 37 songs, all of the same type (the two bottom graphs in Fig. 5).

Stein's work on Traill's Flycatcher (1958) indicates that where the two song forms of this bird (*fitz-bew* and *fee-bee-o*) come together in central New York they appear to be distinct species. The morphological differences between the two populations are very slight and overlapping, but the populations differ in certain aspects of nesting behavior; the birds of each population give a characteristic reaction to songs of their own type, but not to songs of the other population.

It seems probable that the *fee-bee-o* form of this bird evolved from the *fitz-bew* form. A local population of the *fitz-bew* bird in the northeast, which had only the *fizz-bew* song, became isolated from the birds to the south and west—probably during a glacial period of the Pleistocene—and during a period of isolation its song evolved to the *fee-bee-o* type. Now, where the two populations have come together again (in central New York), they behave like distinct species. The Phoebe has probably had much the same history, but the divergence of the northeastern birds from those of the midwest does not appear to have gone as far as it has with Traill's Flycatcher.

SUMMARY

This paper presents an outline of the variation in passerine bird song, based principally on the study of tape recordings by means of a sound spectrograph. Song is the vocalization, usually given only by the male and usually more complex in character than the bird's various call notes, which serves to advertise the male, attract a female, and/or repel other males; most of the discussion in this paper refers to what is usually called the advertising song.

Both inheritance and learning play a part in the acquisition of song patterns by the individual. The early season singing of many species, as the birds are perfecting their song patterns, is somewhat primitive; once these patterns are perfected they are largely fixed for the rest of the bird's life. Occasional individuals in some species apparently learn their song from another species.

Different species of passerine birds differ in the amount of variation in the songs of a given individual and in the songs of different individuals. Individuals of some species have advertising songs of only one pattern, while those of other species may have two to many patterns; 58 patterns were found in the songs of one Lark Sparrow. In some species the songs of different individuals are of the same pattern, but in most species the songs of different individuals may differ. The variation within a species may vary from only a few patterns to a situation in which different individuals seldom if ever sing songs of the same pattern.

Data are presented on the geographic variation in the songs of Bachman's Sparrow, Song Sparrow, and Cardinal (two subspecies in each case). Studies of songs recorded in the eastern United States and Canada indicate that in at least some species the songs of different subspecies may differ; most of the intraspecific variation encountered in the songs from this area might be described as "local dialects," with birds of different areas differing in song patterns, but with few significant geographic trends evident.

Most passerine birds exhibit a daily cycle of singing activity, singing most consistently in the early morning, with the song at a minimum early in the afternoon. Some species sing a little differently at daybreak.

Song is usually associated with the breeding season, beginning in the spring and ceasing in midsummer; some species stop or reduce their singing during certain parts of the nesting cycle, and some may sing after the postnuptial molt.

The same types of song may serve all the functions of song, or different types may serve different functions. Many birds have songs of a different type than the territorial song, that are heard only infrequently ("flight" songs, "twilight" songs, etc.); the

function of these songs is not clear in every case, but in some cases they play a role in territorial defense or courtship. The females of some species sing occasionally, often in response to the male.

The large amount of intraspecific variation in many passerines complicates the problem of the student trying to learn to recognize birds by their songs. Field identification by song is based on the type of song pattern the bird sings, the quality of the song, and a knowledge of what might be expected to be singing at a given time and place. A person with an ear for pattern in bird songs will eventually be able to recognize individuals of many species by their songs; there is evidence that some birds can recognize other individuals by their songs.

Because of the role of song in species recognition, variation in song may lead to speciation; evidence is presented of such speciation trends in certain flycatchers.

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HUNTING AREAS OF THE LONG-EARED OWL

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Several studies have been made of the feeding habits of the Long-eared Owl (*Asio otus*) (Armstrong, 1958; Geis, 1952; Spiker, 1933; Warthin and Van Tyne, 1922), and have shown this species to feed primarily upon small mammals, particularly the meadow vole (*Microtus pennsylvanicus*). This would indicate that the Long-eared Owl utilizes open, grassy habitats as hunting areas. To my knowledge, however, no study has been made to determine whether the owls are merely feeding in the nearest area that offers a suitable food supply or whether they select some particular habitat (i.e., open, grassy areas).

During the period of September 1957 through September 1958 a study of the ecology of small mammals was conducted in the University of Michigan's Mud Lake Research Area, located in northern Washtenaw County, Michigan. Part of this study consisted of determining the relative abundance of small mammals in all the major habitats in the area. These included most of the typical habitats in the vicinity of the Research Area. A black spruce (*Picea mariana*) stand located approximately in the middle of the Research Area was used as a roosting site by Long-eared Owls. It appeared possible, therefore, that a study of this owl's food habits, as revealed by an examination of the pellets found under the roost trees, might indicate in which habitat the owls were hunting.

I wish to thank Mr. Norman L. Ford for the identification of the bird remains.

DESCRIPTION OF THE STUDY AREA

The Mud Lake Research Area includes about 250 acres. Eight major habitats occur in the area: abandoned field ("old field"), oak-hickory upland, hardwood swamp, spruce swamp, bog mat, birch-aspen swamp, and grass-sedge marsh. These habitats have been described in detail elsewhere (Getz, 1959MS). The habitat features important in regard to this study are discussed below.

METHODS

The basic data revealing the relative abundance of small mammals were obtained by trapping a rectangular portion of each habitat. Seventy-five snap-traps were placed in a grid pattern with a 12-meter interval. Each habitat was trapped for two three-night periods, one in November 1957, and the other in January 1958. In addition to the grid data, a line of snap-traps, with a trap interval of three meters, was placed through each habitat. These transects were trapped for seven nights in September 1958. Monthly live-trapping was con-

TABLE 1

RELATIVE ABUNDANCE OF SMALL MAMMALS IN THE MAJOR HABITATS OF THE MUD LAKE RESEARCH AREA*

Species	Hardwood Swamp	Bog Mat	Spruce Swamp	Spruce Burn	Oak-hickory upland	Old Field	Birch-Aspen Swamp	Marsh
Masked shrew (*Sorex cinereus*)	6	16	11	11	0	1	11	5
Short-tailed shrew (*Blarina brevicauda*)	3	3	1	6	16	8	8	20
White-footed mouse (*Peromyscus leucopus*)	7	1	1	2	30	3	18	3
Deer mouse (*Peromyscus maniculatus*)	0	0	0	0	0	1	0	0
Meadow vole (*Microtus pennsylvanicus*)	0	1	0	0	0	15	0	60
Bog lemming (*Synaptomys cooperi*)	0	3	0	4	0	1	0	5
Jumping mouse (*Zapus hudsonius*)	1	2	0	0	0	1	2	8
Totals	17	26	13	23	46	30	39	101

* Based on 225 trap-nights.

ducted in the marsh and old field from September 1957 through September 1958. These latter two sources of data have been used to modify the results of the grid trapping. A more detailed account of the sampling methods is given by Getz (*op. cit.*).

In September 1958, approximately 125 pellets were collected from beneath the roost trees in the spruce stand. Identifications were made of the remains of the mammals and birds that occurred in these pellets, and from their unweathered condition, it is assumed that the prey were captured during the period of the small-mammal study. Comparisons were made of the food habits of the owls and the distribution of the prey species.

RESULTS

The species (Table 1) and numbers of each recovered from the pellets are as follows: masked shrew, 2; short-tailed shrew, 3; white-footed mouse, 6; deer mouse, 5; meadow vole, 161; bog lemming, 4; Bobwhite (*Colinus virginianus*), 2; Common Grackle (*Quiscalus quiscula*), 1; Evening Grosbeak (*Hesperiphona vespertina*), 2.

As in the previous studies, the meadow vole is by far the most important prey item. The abundance of vole remains and the paucity of remains of other species indicate that the owls were hunting primarily in areas in which voles occurred. The meadow vole was found in only three of the habitats studied (old field, bog mat, and marsh; Table 1). Since the vole population was very low on the bog mat, and there were very few masked shrew remains in the pellets, this habitat can be eliminated as a major hunting area. Of the two remaining, the old field is the most likely habitat in which the owls hunted. The relative abundance of prey items in the pellets agrees with that of the species present in the old field more than with that of those in the marsh. The presence of remains of deer mice, which occurred only in the old field, is particularly important evidence that this habitat was utilized. The Bobwhite further indicate that the owls were hunting in an upland area rather than in the low, marshy area. Also, one would expect to find the remains of a greater number of short-tailed shrews, as well as a few jumping mice, if the marsh had been utilized to any extent.

The use of the old field rather than the marsh as a hunting area may be related to differences in cover conditions. The vegetation in the marsh consisted of a dense stand of grasses and sedges having an average height of approximately one meter. Even in the winter when the vegetation had fallen over, an almost solid canopy was formed over the surface. The small mammals occupied runways at the base of the vegetation, so it would be difficult for the owls to see, let alone capture them. The vegetation of the old field was relatively sparse and at most ¼-meter tall; over much of the field it was shorter. Although there was some dead grass present, the surface was still partially exposed. The voles would, therefore, be more susceptible to predation in this habitat than in the marsh. The survival rates of the voles inhabiting the old field were less than of those in the marsh (Getz, in press). This may in part be a result of higher predation by such predators as the Long-eared Owl.

When taking into consideration the over-all abundance of small mammals in each habitat, it appears that the owls selected open, grassy areas rather than timbered areas. Excluding the marsh (which had a ground cover shielding the mammals from view) at least two other habitats (birch-aspen and oak-hickory upland) offered a potential food supply as large as or larger than that of the old field. These areas were also nearer the roost than was the old field. Although the surface was relatively free of vegetation, both areas had a considerable amount of underbrush present. The Long-eared Owl, therefore, appears to utilize open, grassy situations as hunting areas even though other types of habitats nearer to their roost may offer a larger food supply.

SUMMARY

Comparisons were made of the food habits of Long-eared Owls and the distribution of small mammals in the habitats surrounding the owls' roost. It was found that the Long-eared Owls fed primarily on the meadow vole, and hunted in an old-field habitat. They apparently did not utilize a near-by marsh, although it contained more voles than the old

field. The use of the old field appears to be related to a lesser amount of cover in this habitat than in the marsh. Timbered areas nearer the roost than the old field and having a greater abundance of small mammals were not utilized. The Long-eared Owls, therefore, apparently prefer open, grassy areas to timbered areas.

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GENERAL NOTES

A wren singing combined House and Carolina Wren songs.—Although the House Wren (*Troglodytes aëdon*) is both a familiar and intensively studied species, there is little or no reported evidence of its engaging in vocal mimicry. The repeated utterance of songs of both House and Carolina Wrens (*Thryothorus ludovicianus*) by a singer apparently belonging to the former species is therefore of interest. The incidents occurred at Bloomington, Indiana, in a suburban yard next to a large undeveloped tract; both House and Carolina Wrens were breeding commonly in the immediate area. The first of the songs was heard on 10 May 1959, at 10 AM. House Wrens had returned to Bloomington on about 18 April, and I had passed the particular spot repeatedly since that date without remarking anything unusual.

During about ten minutes spent within earshot, I heard 30 loud songs, only one of them an unembellished, normal House Wren performance. In all the others a House Wren song, possibly of slightly reduced length, was immediately followed by one, two, or three identical descending Carolina phrases. The one-phrase utterances outnumbered the combined total of the others by at least two to one. The singer was perched in and moving through a tree beside a house; a nest box hung at about ten feet, and most songs were sung at approximately this height.

On my next visit, at 5 PM on 12 May, only typical House Wren songs were heard for several minutes. Then came five combinations, each consisting of a series of three or four Carolina phrases like those heard on 10 May, each series succeeded without pause by a normal House Wren song. It will be noted that many full Carolina Wren songs contain only three or four phrases (Borror, 1956. *Auk*, 73:211–229). Indeed, as I listened to the singer I could also hear the songs of House and Carolina Wrens from several points nearby, and I could detect no differences between these "pure" performances and their respective counterparts in the double vocalizations described. I heard no more combination songs at this time or later, although I passed the yard often during the summer. The wren house in the tree seemed never to be occupied.

A possible connection between the extraneous Carolina notes and a characteristic element of some House Wren songs is suggested by the observations of Kendeigh on the latter bird (1941. *Ill. Biol. Monog.*, 18(3):20). "The song often begins with churring, guttural or sharp staccato notes or squeaks differing from the main body," and the same sounds are sometimes appended as a sort of suffix. While the Carolina phrases described herein may thus be an elaboration of a usually formless part sometimes added to the typical song, this explanation does not account for their imitative effect.

Vocal mimicry in the Troglodytidae is summed up by Armstrong (1955. The Wren, p. 84) with the statement that "as a group [wrens] seem little prone to add to their repertoire by imitation." Saunders (1929. *N.Y. State Mus. Handbook*, 7:31–32) tells of a House Wren lacking all normal song, but although several of its performances suggested those of other species, none did so "clearly enough as to make me think them imitations." In contrast, both the Carolina Wren (Bent, 1948. *U.S. Natl. Mus. Bull.*, 195:211–213; McAtee, 1950. *Wilson Bull.*, 62:136) and Bewick's Wren (*Thryomanes bewickii*) (Howell and Oldys, 1907. *Auk*, 24:149–153) have been regarded as good mimics.

A striking parallel with the present case is Thomas' (1943. *Wilson Bull.*, 55:192–193) report of a wren singing Bewick's and House songs in brief alternate series. This bird appeared to be a typical Bewick's except that its tail may have been shorter than average and was flirted less freely, and Thomas presents the possibility that the singer was a hybrid rather than a Bewick's Wren with an acquired second song. In this connection it is interesting that both the wrens heard by Thomas and by me were rendering faithful reproductions of the songs of closely related forms, and it may be relevant too to note that Armstrong (*op. cit.*) believes that the Winter Wren (*Troglodytes troglodytes*) does not learn its song but can perform it without having heard others of its species. On the other hand, probably the best argument for caution in explaining a bivalent repertory by assuming hybridization is presented by Lanyon's study of sympatric Eastern and Western Meadowlarks (*Sturnella magna* and *S. neglecta*) (1957. *Publ. Nuttall Orn. Club*, 1:1–67). Although there have been a number of cases of individual meadowlarks with both Eastern and Western songs, Lanyon found that males learn their songs and sometimes those of the other species, and he concluded that there is no clear instance of hybridization in the wild.—Val Nolan, Jr., *Indiana University, Bloomington, Indiana, 4 December 1959.*

House Wrens and Bewick's Wrens in Northern Ohio.—In the spring and summer of 1957 I observed the nesting of a pair of Bewick's Wrens (*Thryomanes bewickii*) in Pepper Pike Village (Cleveland), Cuyahoga County, Ohio. This in itself was a rare and noteworthy occurrence, but even more noteworthy was the fact that the Bewick's Wrens occupied a nesting territory directly adjoining the nesting territory of a pair of House Wrens (*Troglodytes aëdon*).

Sutton (1930. *Wilson Bull.*, 42:13), writing of the nesting wrens of Brooke County, West Virginia, concludes that "the House Wren and Carolina Wren may inhabit precisely the same region without friction; but the House Wren and Bewick's Wren, or the Bewick's Wren and Carolina Wren, evidently do not." Referring to the Bewick's Wren and the House Wren in the vicinity of Johnson City, Tennessee, Tyler and Lyle (1947. *The Migrant*, 18:28–29) state that "when these two wrens meet, they fight to the death." Pough (1946. Audubon Bird Guide, Eastern Land Birds, p. 100) asserts that, "In parts of the Midwest this species [Bewick's Wren] appears to be extending its range northward at the expense of the house wren. Neither will tolerate the other on its breeding territory."

On the afternoon of 21 April 1957, I discovered the male Bewick's Wren in a scrub field area in Pepper Pike Village and observed it for several hours during which time it sang repeatedly. At first it seemed to be wandering about over the field, stopping to sing in the few scattered trees, but later in the afternoon it kept to a small, abandoned orchard at one side of the field. I did not return to the area until 4 May, when I found a pair of Bewick's Wrens in the orchard. They were there on 5 May as well, but on neither day did I hear the male singing.

On the evening of 6 May, I again visited the orchard, finding both Bewick's Wrens there. At about 7:30 PM, for the first time I heard a House Wren in the orchard. Shortly thereafter the male Bewick's Wren and the House Wren began to fight—chasing each other in short flights through the tangled branches of several fallen apple trees in the center of the orchard or occasionally ascending into the crowns of standing trees. Then for some three to four minutes the disputants separated, the House Wren all the while keeping up a vehement scolding. Following this interlude the two birds resumed their fighting which quickly reached its peak of intensity. The scene of this encounter was the dense leafy crown of a fallen apple tree; thus my view of the birds was largely obscured. Occasionally, however, I caught glimpses of them when they flew down among the tussocks of grass beneath the tree, and it seemed that they were actually in physical contact at those times. Throughout the fighting, which lasted for 10 to 12 minutes with only momentary pauses, both birds kept up a furious outcry. One of them (which one I could not determine) uttered a strange squealing note. At the conclusion of these separate encounters, or sometimes just before the close, the Bewick's Wren would often break into song but would utter only the four opening notes. Throughout the period of fighting, the female Bewick's Wren was nearby and called *plit* repeatedly. When the dispute finally ended, the male Bewick's Wren flew to the topmost branch of a large apple tree in the middle of the orchard and sang his full Song Sparrow-like song as well as a briefer song consisting of first a subdued buzz and then several sweet, clear notes.

Both the Bewick's Wrens and a pair of House Wrens were in the orchard on the morning of 8 May, but they did not engage in fighting. The House Wrens kept to the west end of the orchard, where the male, which sang frequently throughout the morning, was busily cleaning out a cavity in a dead stub of a pear tree. The Bewick's Wrens confined their activities to the eastern half of the orchard.

From 8 May through 15 June, I visited the orchard eight times and spent a total of 17½ hours there. At no time did I observe any conflict between the two species of wrens, nor did I ever see either species go beyond what was approximately the mid-line of the orchard. Located at this mid-line was the large apple tree from which the Bewick's Wren sang at the conclusion of the fight on the evening of 6 May, and from which it sang frequently thereafter. Just once, on the afternoon of 10 May, I observed both the Bewick's Wrens and the male House Wren simultaneously in the central portion of the orchard; the latter was singing. At all other times the House Wrens held to the western half, the Bewick's Wrens to the eastern half, though both species often foraged outside the orchard itself but in areas adjacent to their respective halves. Of the two territories, that of the Bewick's Wrens was considerably the larger. These birds sometimes flew about 200 feet north of the orchard to feed among a brush-grown pile of rocks and rubble, whereas the House Wrens did not go more than 80 or 90 feet beyond the orchard.

On the morning of 9 June, I discovered the nesting site of the Bewick's Wrens in a woodpecker's hole in the dead branch of a fallen apple tree. The branch was parallel to the ground, with the entrance hole on the underside. Both male and female were carrying food to the young. Meanwhile, the House Wrens were nesting in the cavity in the pear tree at the west end of the orchard. The orchard measured 217 feet long and 195 feet wide, and the nest sites of the two wrens were 125 feet apart. The nest site of the Bewick's Wrens was 82 feet in from the east end of the orchard; the site of the House Wren's nest was about 10 feet in from the west end.

When I visited the orchard again on 15 June, the Bewick's Wrens were feeding their five bob-tailed fledglings assembled in the leafy crown of a large fallen apple tree. The House Wrens were still carrying food to their young in the nest in the pear tree. On my final visit on 7 July, the two adult House Wrens and one or two young birds were foraging through the west end of the orchard. In a large hawthorn tree about 100 feet beyond the northwest end of the orchard, two Bewick's Wrens fidgeted about and buzzed frequently.

In the spring and early summer of 1958 I visited the orchard several times but never observed either species of wren there nor anywhere in the immediate vicinity.

According to Williams (1950. Birds of the Cleveland Region, p. 104, 106), the House Wren is a "common migrant; common summer resident" in the vicinity of Cleveland, Ohio, but the Bewick's Wren is a "rare migrant; rare summer resident." Williams cites just one nesting record for the Bewick's Wren: in 1944 at Kent, which is on the southeastern periphery of the Cleveland region. A more recent nesting occurred in the summer of 1952 near Mogadore Lake, which is also at the extreme southeastern boundary of the Cleveland region (Wiley, 1952. *Cleveland Bird Calendar*, 48,3:3). Also, and concurrent with the 1957 nesting of the Bewick's Wrens in Pepper Pike Village, a pair nested successfully in Cuyahoga Falls, Summit County, which is about 25 miles south of Cleveland (Wiley, 1957.

Cleveland Bird Calendar, 53,3:13). The nesting in Pepper Pike Village is the first authentic record for Cuyahoga County.

Elsewhere in northern Ohio the Bewick's Wren is considered rare. Thus to the east of Cleveland, in Ashtabula County, Hicks (1933. *Wilson Bull.*, 45:187) described this species as "very rare and not definitely known to breed." To the west (Toledo), Campbell (1940. *Birds of Lucas County*) described it as "the rarest of the wrens which visit Lucas County." Even in the central portion of Ohio, in the vicinity of Columbus, the Bewick's Wren is classed as an uncommon summer resident (Borror, 1950. A Check List of the Birds of Ohio).—DONALD L. NEWMAN, *14174 Superior Road, Cleveland Heights 18, Ohio, 15 February 1960.*

An albinistic Carolina Wren.—Gross (*In* Bent, 1948. *U.S. Natl. Mus. Bull.*, 195:127) reports albinism apparently rare in the Troglodytidae. Since then Bond (1949. *Cassinia*, No. 37:23) has recorded a completely albinistic House Wren (*Troglodytes aëdon*). On 6 December 1959, I banded a Carolina Wren (*Thryothorus ludovicianus*) which when at rest showed a white stripe near the outer edge of each wing, and a touch of white on each side of the lower back. I found that primaries Nos. 5 and 6 in each wing were white to within about half an inch of their tips, where they began shading into normal color, and that one secondary covert in each wing was white to within a short distance of the tip. —HERVEY BRACKBILL, *2620 Poplar Drive, Baltimore 7, Maryland, 9 December 1959.*

Neonates and incubation period of Chimney Swift.—An egg of the Chimney Swift (*Chaetura pelagica*), determined to be fresh by candling on 14 June 1958, was hatched in a forced-draft incubator on 30 June. The pink-skinned neonate hatched 372±11 hours after initiation of artificial incubation. In two other eggs of this clutch that failed to hatch, embryonic development was indiscernible on the sixteenth day. Robert E. Stewart of Laurel, Maryland, donated this clutch from his chimney and Aelred Geis donated another day-old specimen from that locality that was hatched in nature for corroboration.

The incubation period in the artificial incubator of 372±11 hours (15.50±.46 days) contrasts with the incubation period in nature in this species. Whereas MacNamara (1918. *Ottawa Nat.*, 32:39–42) noted a period of 16 days, the period is obviously lengthened considerably by adverse environmental conditions: 19 days has been noted most frequently (Amadon, 1936. *Auk*, 53:216–217; Kendeigh, 1952. *Illinois Biol. Monographs*, 22:1–356; and Sherman, 1952. Birds of an Iowa Dooryard). In the Common Swift (*Apus apus*), the Lacks (1951. *Ibis*, 93:501–546) have shown that the period varies between 18.5 and 24.5 days. The secondary effects of moisture loss from the eggs in depressing egg temperatures may be an important cause of variability, for chimneys are notoriously drafty nesting sites. The methods and conditions of incubation in this study were as previously standardized (Wetherbee, 1959. Artificial incubation of wild birds' eggs and developmental condition of neonates, University Microfilms). The swiftlet looked much like a neonatal passerine except that the toenails, which were duskily pigmented, were extraordinarily long and gracefully pointed, not short and hooked. This character of the toenails was noted previously in another apodiform, the Ruby-throated Hummingbird (*Archilochus colubris*) (Wetherbee, *loc. cit.*). There was also a blunt alular spur, not pigmented, on the swift at hatching. The long toenails are undoubtedly of adaptive significance in clinging to the precariously situated shelf-like nest and also in actual locomotion (see Kennard, *in* Bent, 1940. *U.S. Nat. Mus. Bull.*, 176:275).

The neonates had no down. Four nestlings in the pin-feather stage I took at Gainesville, Florida, also have no signs of natal down. Other workers have noted the absence of natal down; but it is necessary to corroborate such statements because of the unfortunate lack of objectivity in the literature regarding this point. The generalization that "swifts and hummingbirds are completely naked" at hatching (Wallace, 1955. An Introduction to Ornithology, p. 47), moreover is erroneous, for at least some hummingbird species do have neossoptiles. Downy pterylosis of the Ruby-throated Hummingbird was recently described (Wetherbee, 1958. *Bird-Banding*, 29:232–236). *Apus apus* is hatched naked (Witherby *et al.*, 1938. Handbook of British Birds, 2:248). While Legg (*Condor*, 1956. 58:183–187) described the just-hatched Black Swift (*Cypseloides niger*) as naked, his statement that the two-week-old nestling is completely covered with "down" seems incompatible with his description of the day-old bird unless it is deemed necessary to reopen the argument that neossoptiles might be generated after hatching. Dixon (*Condor*, 1935. 37:265–267) also noted the Black Swift as naked at hatching. Legg (personal communication, 7 October 1955) thought that the "down" might be an adaptation for the nesting habitat of cool and moist situations. It seems probable that what is being referred to here is *not* natal down, but emerging teleoptiles.

There is a very crude correlation between cavity-nesting and nakedness of neonates in passerines (Wetherbee, 1957. *Bull. American Mus. Nat. Hist.*, 113:339–436) that may be applicable in this species. The bill had a dusky pigmentation like that of the toenails and this contrasted with the light pink of the rest of the body. The bill was without special rictal flanges and without special mouth coloration. Therefore, the assumption that the possession of flanges and mouth colors is a specialization for parental guidance in feeding the young in dark nesting cavities (Ticehurst, 1908. *British Birds*, 2:186–194) is not supported, for Barton (*Auk*, 1958. 75:216–217) has demonstrated that this species has had ample time to develop cavity-nesting evolutionary responses.

The eyelids of the neonatal Chimney Swift are closed craniad over the irides at a relatively low level of embryonic differentiation. Fischer (1958. *New York State Museum and Science Service Bull.*, 368) notes that they do not open until the sixteenth to twentieth day after hatching. Considering the disparity in development of the eyes and the feet, we have here an obvious differential acceleration that even defies axial-gradient growth. It is another example of the inadequacy and absurdity of the words "precocial" and "altricial" in ornithology (see Wetherbee, 1959. Comparative phylembryogenetic dimensionality of neonatal birds, University Microfilms).—David Kenneth Wetherbee, *U.S. Fish & Wildlife Service, Massachusetts Cooperative Wildlife Research Unit, University of Massachusetts, Amherst, Massachusetts, 30 November 1959.*

Unusual nesting behavior of Chimney Swifts.—The Chimney Swifts composing a nesting colony on the campus of Kent State University usually pair soon after their annual return in the third week of April. Occasionally a few shift about from one possible mate to another over a brief time, but soon settle down with a mate for that season. However, one female, banded with No. 21-128574, was involved in an unusual type of nesting behavior for this species in the summer of 1959. Her life history is briefly reviewed here.

No. ---74 was banded 20 August 1953 as a juvenile bird. She was captured in a flock of 18 swifts composed of both adult and juvenile birds which were roosting together following the nesting period for that season. In 1954, this female returned to the campus, but did not nest. Chimney Swifts do not ordinarily nest until their second year. In 1955, she nested for the first time, in Air Shaft L1. In 1956, she was not recaptured, but the following year she was found nesting in Shaft V1 on the roof of another building. Because this shaft had not been trapped the previous year, it is possible this female had nested there in 1956 as well. When she was found again in 1957, she and her mate had a seasonal visitor, forming a threesome in Shaft V1. The nature of such nesting by threesomes has already been published by me (1952. *Wilson Bull.*, 64:133–139).

The following year she continued to nest in the same shaft with her same mate, but without a seasonal visitor. In 1959, her mate again returned to Shaft V1 for nesting, but No. ---74 went to Shaft M7 where she roosted for three nights with another female. Seldom are two females found roosting together. The other female soon left and No. ---74 roosted there alone until 16 May. The other female then returned to this shaft with a mate, and they remained there to nest. In the meantime, No. ---74 went into Shaft L1 where she roosted alone until 24 May when she was found in Shaft J1, roosting side by side with another swift. On some nights she was found roosting alone, while other nights she was not located at all. On 7 June, No. ---74 was found working on a nest foundation 13.7 feet down on the west wall. Unlike most nests of the Chimney Swift, this one was not glued to a vertical wall but was placed on a narrow horizontal shelf which projected for a few inches from the wall. On 10 June, an egg was laid, and that evening the female was on the nest while her mate roosted below the nest. On 20 June, the female was found at nighttime roosting alone in an adjacent shaft, J2, while her mate was in J1 roosting beside another female (24-167709), which was captured at that time as a return for the year. This female had been banded the previous August. The nest with the egg prepared by No. ---74 was abandoned. This was the first time that such behavior has been noted among nesting Chimney Swifts. The following night female No. ---09 roosted alone in J1; the other two birds in this threesome were not located. The next day all three dropped out of sight. On 24 June, the male and the replacement female roosted in Shaft J1, about one inch apart, but again ignored the nest with the egg. Two nights later the new female was there alone, but following this date she abandoned this shaft. On 2 July, the original female (No. ---74) returned to J1 where she roosted alone for that night. That same night the other female roosted alone in Shaft L1. In the evening of 16 July, female No. ---09 was again alone in Shaft L1. Four nights later she was there again by herself while the male and his original mate returned to J1, but continued to ignore the nest with its egg. Nesting was never completed by any of these birds that season.

Another instance of unusual behavior is described as follows. The swifts which nested in Shaft N9 in 1958 returned to it in 1959 where they were reunited, but soon dropped out of sight and were not found together again that season until 9 October. On that date they were in a roosting flock of 15 swifts in Shaft V1, but their whereabouts during the nesting season is not known. On 3 June, the male was recaptured for the second and last time in Shaft N9 where he was roosting with three unbanded birds. Two of the newly banded birds (24-167740 and 24-167741) remained in this shaft presumably to nest. However, these birds apparently were incompatible as shown by the following behavior. In the evening of 5 June, No. ---40 was in the shaft alone. Three and four nights later both were present, but roosted six inches apart. In the evening of 10 June, one roosted on the north wall while the other was on the south wall. By this time all of the other resident swifts had completed their nests and most of them were incubating eggs. On 20 June, the two birds were found side by side on the south wall, but the next night they roosted two inches apart. On 22 June, only one roosted for the night in the shaft. Two nights later both were together again roosting five inches apart. On 26 June, one was on the north wall while the other was on the east wall, but the next night they were again side by side on the south wall. On 2 July, they were found roosting on a nest foundation. Progress on nest construction was slow, and on 9 July the birds were found roosting on opposite walls. The nest foundation, 20 feet down on the south wall, was deserted. In the evening of 20 and 21 July, the two birds again roosted side by side on the wall opposite the deserted nest foundation. On 23 July, they were once more separated, one on the north wall and one on the east wall. Nesting was never completed by these two birds. A similar case of incompatibility was reported earlier by me (1951. *Amer. Midl. Nat.*, 46: 227–229).—Ralph W. Dexter, *Department of Biology, Kent State University, Kent, Ohio, 10 March 1960.*

Downy Woodpeckers scaling bark on diseased elms.—Woodpecker activities may, at certain times, have interesting associations with diseases of trees. West and Spiers (1959. *Wilson Bull.*, 71: 348–363) mentioned that some of the three-toed woodpeckers which invaded southward in 1956–1957 were observed chipping off the outer bark of elms, thus revealing the fawn-colored inner bark. One observer suggested that the invaders were seeking the *Scolytus* beetle, which is a vector of the Dutch elm disease. This disease is important in the ecology of woodpeckers in the vicinity of Seneca, Maryland, for I have found the nest holes of Pileated (*Dryocopus pileatus*), Red-bellied (*Centurus carolinus*), and Downy and Hairy Woodpeckers (*Dendrocopus pubescens* and *D. villosus*) in trees killed by its effects. Diseased elms are recognizable by the engraving of multibranching tunnels which the beetle provides for its eggs and larvae. Of the above species, only those of the genus *Dendrocopus* consistently feed on the various stages of *Scolytus*, which occur in great concentration in the bark of some elms. This food supply attracts Downy Woodpeckers in particular. In observations made from 1956 to 1959, I have noticed that these woodpeckers may begin scaling the bark on dying elms as early as 15 September, and continue to do so until late in April. I have seen as many as four of them busy on one elm. Flakes of bark litter the ground below such trees, and trunks and limbs become fawn-colored as the openings of hundreds of minute tunnels are revealed. Such elms are of no further interest to the woodpeckers in a succeeding year. The remaining bark begins to fall off in large pieces at this time. Hairy Woodpeckers work on diseased elms in much the same manner, but I have only a few records of their doing so. The report of West and Spiers that *Picoides articus* and *P. tridactylus* both fed on elms during their invasion is of interest, among other reasons, because the bark-scaling activity appears to be especially characteristic of the genus *Dendrocopus* and systematists regard *Picoides* and *Dendrocopus* as belonging to closely related genera.—Lawrence Kilham, *7815 Aberdeen Road, Bethesda 14, Maryland, 21 January 1960.*

A winter record of the Forster's Tern for Rhode Island.—On 6 January 1960, an immature Forster's Tern (*Sterna forsteri*) was seen along the shores of the Sakonnet River in Middletown, Newport County, Rhode Island. When first seen the bird was perched on a buoy about 400 feet from shore; it later flew along the shoreline and passed within 50 feet of my car. While on the buoy, it was studied for several minutes through a 20× telescope and it was especially noted that the dark patch behind the eye was restricted and did not extend around the nape. Later, when the bird was seen in flight, the paleness of the upper parts was particularly conspicuous. A half-hour after the original sighting I returned to collect the bird but it had disappeared. It should be noted, therefore, that (1) the bird was observed for 10 or more minutes under the best of conditions (at noon on a bright clear day), (2) it is a species well-known to me, and (3) I was fully aware at the time of the unique aspect of the record. A check of the literature indicates that this is the first winter record of this species for Rhode Island, and the latest winter record north of Cape May, New Jersey.—James Baird, *Norman Bird Sanctuary, Third Beach Road, Middletown, Rhode Island, 29 January 1960.*

LETTER TO THE EDITOR

In *The Wilson Bulletin* for September 1958 (p. 281), appears an account of the Spotted Sandpiper escaping a Cooper's Hawk by diving into the water. The authors, Martin and Atkeson, say they have not found another instance in the literature. However, in *The Auk* of July 1928 (p. 371), I recorded a similar incident, which occurred long ago, a boyhood observation on the Red River in Minnesota. It must have been about 1906, and I can only determine that it was either a Sharp-shinned or a Cooper's Hawk.

On 4 September 1914, on Charlton Island in southern James Bay, Canada, while approaching a turnstone on the beach, I heard a "swish" close by and saw a small hawk, which looked like a Pigeon Hawk, slanting down to the water's edge after a Spotted Sandpiper. The sandpiper flew out over the water, could not dodge, so dropped into the water and went below the surface. The hawk flew on.

These incidents in Minnesota, Alabama, and Canada show that the Spotted Sandpiper, wherever it may be, does not hesitate to go into water, and there can handle itself very well.—Olaus J. Murie, *Moose, Wyoming, 8 January 1960.*

NEW LIFE MEMBER

The photograph shows Walter R. Spofford, new life member of the Society, photographing a nest of Golden Eagles in the Appalachian Mountains last June. An Associate Professor of Neuroanatomy at the State University New York Medical College, and a graduate (Ph.D.) of Yale University, Mr. Spofford is presently working on biochemical systematics with egg-white proteins in the Falconiformes. He is also interested in molting patterns, distribution, and life histories of falconiform birds (especially the Appalachian Golden Eagles). His papers and notes are on experimental neuroembryology, molting in Gyr Falcons and Golden Eagles, and tree-nesting of Peregrine Falcons. Mr. Spofford has been an active member of the WOS since 1928, is a life member of the AOU, and an active member of the BOU, Cooper Ornithological Society, Linnaean Society of New York, Tennessee Ornithological Society, Federation of New York Bird Clubs, Avicultural Society, and the Falconry Club of America.

ORNITHOLOGICAL NEWS

LOUIS AGASSIZ FUERTES RESEARCH GRANT

This grant, established in 1947, is devoted to the encouragement and stimulation of young ornithologists. One particular desire is the development of research interests among amateur ornithologists. Any kind of ornithological research may be aided. Recipients of grants need not be associated with academic organizations. Each proposal is considered primarily on the basis of possible contributions to ornithological knowledge.

An anonymous donor gave $500 to found the fund; later donors have provided some $600. The Council of the Wilson Ornithological Society has added funds as necessary to provide at least one $100 grant annually.

Although grantees are not required to publish their studies in *The Wilson Bulletin*, it is hoped that they will submit their manuscripts to the Editor of the *Bulletin* for consideration.

Since its inception the Fuertes Research Grant has been awarded to 15 persons, many of whom have continued their research work. The recipients are listed below.

1948—Leonard R. Mewaldt, Life history of Clark's Nutcracker.
1949—Stephen W. Eaton, A comparative study of the genus *Seiurus*.
1950—Henry E. Childs, Population dynamics and life history of the Brown Towhee.
    Byron E. Harrell, Ecology of the Rancho del Cielo, Tamaulipas, Mexico.
    Arnold J. Petersen, Reproductive cycle in the Bank Swallow.
    Harrison B. Tordoff, Comparative osteology of the subfamilies of the Fringillidae.
1951—Howard L. Cogswell, Territory size and its relation to vegetation structure and density among birds of the chaparral.
1952—Robert W. Nero, Territorial and sexual behavior in the Red-wing.
1953—No award.
1954 William C. Dilger, The isolating mechanisms and relationships of the thrush genus *Hylocichla*.
1955—Robert G. Wolk, Analysis of reproductive behavior in the Black Skimmer.
1956—John B. Millar, An investigation of possible factors involved in the initiation of migration.
    Lester L. Short, Jr., Hybridization and isolating mechanisms in North American flickers.
1957—Millicent (Mrs. Robert L.) Ficken, Comparative study of the behavior of the Canada Warbler and the Redstart.
1958—Harold D. Mahan, Studies of growth and temperature regulation in the Red-wing.
1959—No award.
1960—Robert T. Lynn, Comparative behavior of the Carolina and Bewick's Wrens.

Application forms may be obtained from Harvey I. Fisher, Southern Illinois University, Carbondale, Illinois. Completed applications must be received by 15 April 1961.

On 9 January, the New York Zoological Society awarded its gold medal to Dr. Roger Tory Peterson as "an inspired interpreter of birds for the benefit of mankind."

The first triennial award of the Gill Memorial Medal of the South African Ornithological Society for contributions to ornithology south of the Zambezi has been made to Dr. J. M. Winterbottom, Hon. Secretary of the Society since 1951 and Director of the Percy Fitzpatrick Institute of African Ornithology.

FROM THE AOU

The Josselyn Van Tyne Memorial Fund will have a sum of $300 available for research awards at the end of the fiscal year, 31 July 1961. Any student of birds is invited to apply for part or all of this amount.

Ten duplicate copies of an application are desired for distribution to members of the Research Committee who will determine how the funds will be allotted. The application should give a full description of the proposed research, the type of help required (equipment, travel, assistance, etc.), the amount of money desired, and the background and training of the applicant. With young men or women just starting their careers, a supporting letter from one or more recognized ornithologist would be helpful.

Applications should be submitted not later than 1 June 1961, to S. C. Kendeigh, Chairman, Vivarium Building, University of Illinois, Wright and Healey Sts., Champaign, Illinois.

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 15 May 1961. Proposals received prior to that date will be reviewed at the summer meetings of the Foundation's advisory panels and disposition will be made approximately four months following the closing date. Proposals received after the 15 May 1961 closing date will be reviewed following the fall closing date of 15 September 1961.

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

REQUESTS FOR INFORMATION

Alarmed by persistent reports of a downward trend in the population of Bald Eagles, the National Audubon Society has launched a study aimed at determining the status of the species. This project is designed to cover at least five years and to gather data from all parts of North America. The study will consist of two parts, first an inventory based on the number of active nests located, and second an investigation of various aspects of eagle biology. Information is urgently needed on the location of active eagle nests and also on wintering concentrations of eagles. If you have information on these or any other facets of eagle biology, please communicate with: Alexander Sprunt IV, Box 231, Tavernier, Florida.

I have been studying the life history of the Pigeon Hawk (*Falco columbarius richardsonii*) in western Saskatchewan and I would appreciate any information on the following topics from other parts of this species' range: migration dates, nesting dates, nesting habitat, location and type of nest, clutch size, brood size, sex ratio of young, food habits, species hawks defend territory against, unusual behavior of any kind, habits of wintering birds, habitat during winter, and interspecific agonistic relationships. I would also appreciate any data on sex and weight of specimens in private collections. Please send all information to Glen A. Fox, Box 783, Kindersley, Saskatchewan, Canada.

THE JOSSELYN VAN TYNE MEMORIAL LIBRARY

Books: List B-5

The following titles are of books added to the library since publication of List B-4, in December 1958 (*Wilson Bulletin*, 70: 384–385).

Those wishing reprints of this and the earlier book lists should contact the Josselyn Van Tyne Memorial Library (Wilson Ornithological Society), Museum of Zoology, The University of Michigan, Ann Arbor, Michigan.

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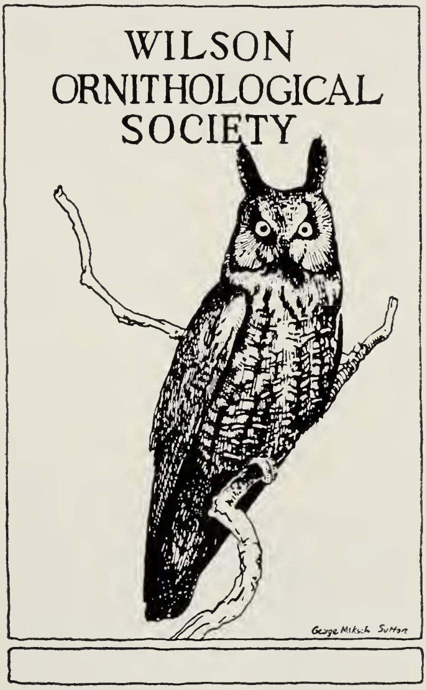

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The following gifts have been recently received. From:

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W. H. Burt—2 pamphlets, 7 reprints
Donald E. Burton—1 journal
Robert S. Butsch—25 reprints
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Delta Wildlife Research Station—4 reprints
L. R. Dice—1 pamphlet
Crawford H. Greenewalt—2 reprints
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Peter H. Klopfer—5 reprints
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H. Morioka—1 reprint

Margaret M. Nice—11 books, 85 journals, 20 pamphlets, 106 reprints
D. F. Owen—3 reprints, 1 journal
O. S. Pettingill, Jr.—2 reprints
Allan R. Phillips—2 reprints
Charles G. Sibley—4 reprints, 1 journal
William E. Southern—1 reprint
Peter Stettenheim—1 translation
Harrison B. Tordoff—1 journal
Robert Sparks Walker—1 book, 3 journals
David K. Wetherbee—1 reprint
University of Wisconsin Agricultural Research Station—2 reprints
Larry Wolf—1 reprint

NEW LIFE MEMBER

M. Albert Linton, of Moorestown, New Jersey, an active member since 1941, has recently become a life member of the Society. Mr. Linton holds B.S. and M.A. degrees from Haverford College, did graduate work at Switzerland's Federal Polytechnic Institute in Zürich, and received an honorary LL.D. from Ohio's Miami University. A former President (20 years) and Chairman of the Board of Directors (5 years) of the Provident Mutual Life Insurance Company of Philadelphia, Mr. Linton has somehow found time to be an "amateur bird watcher for over 50 years," President of the Philadelphia Academy of Sciences, a Fellow of the Delaware Valley Ornithological Club, and a member of the AOU and the Cooper Ornithological Society.

THE STATUS OF WATERFOWL CONSERVATION

A Contribution from the Wilson Ornithological Society
Conservation Committee

The effort to protect waterfowl from excessive hunting and to preserve essential habitat to meet seasonal needs has been moving at an ever-increasing tempo. Recently, attention has been directed toward providing space on which the public may enjoy waterfowl hunting and observation. The objective of this report is an appraisal of accomplishments.

ACKNOWLEDGMENTS

Information used in preparing this report was secured from a variety of sources and people. A note of sincere appreciation is extended to each individual contacted. Space limitations prohibit naming every person who contributed. Personnel providing information represented the following agencies: Alberta and Ontario Departments of Lands and Forests; Manitoba Department of Mines and Natural Resources; Saskatchewan Department of Natural Resources; Canadian Wildlife Service; U.S. Bureau of Sports Fisheries and Wildlife; North Dakota Game and Fish Department; South Dakota Department of Game, Fish and Parks; Minnesota Department of Conservation; Nebraska Game, Forestation, and Parks Commission; Resources For The Future, Inc.; and Ducks Unlimited.

HABITAT MANAGEMENT

Behavioral characteristics of waterfowl dictate that acceptable habitat must be available for breeding, migration, and wintering. Deficiencies in any of the three functional types of habitat, but especially breeding and wintering areas, can depress populations and/or create more complex management problems. However, recognizing that sizable investments have already been made in migration and wintering habitat, the greatest need for habitat expansion now is believed to center on the breeding grounds. Unless a sufficient volume of birds is produced, present and future demands of hunters and nonhunters will not be met, and populations on migration and wintering areas will be disappointing.

Breeding Habitat.—Not all aquatic habitat provides the essential features to satisfy the needs and preferences of waterfowl during the breeding season. The region most productive of ducks and coots is the "Prairie Pothole Region." It extends over an area of 217,000 square miles in south central Canada and the northern Great Plains in the United States (U.S. Fish and Wildlife Service, 1953:3). Included in it are 161,000 square miles in Canada (Alberta, Saskatchewan, and Manitoba) and 56,000 square miles in the United States (North Dakota, South Dakota, and Minnesota).

Specific figures on the number and acreage of wetlands important for breeding waterfowl are unavailable for the entire pothole region. In Canada, wetland inventories are in initial planning or operational stages. Estimates for the U.S. portion in the mid-1950's showed 1,210,000 wetland depressions totaling 4,450,000 acres. Within the 91 key counties in the tri-state area of North Dakota, South Dakota, and Minnesota, an estimated 2,820,000 acres of prime duck and coot production habitat were present. This 91-county area contains the last extensive, top-quality, natural breeding habitat in the United States.

The importance of this pothole area is indicated by waterfowl population figures obtained between 1950–57. Approximately one-half (53 per cent) of the continental duck supply was produced in the North American Prairie Pothole Region (Hawkins *et al.*, 1958). The U.S. portion of this region contributed about 14 per cent of the total production.

Nonpothole type of breeding habitat exists as separate segments in an area upwards of one and one-half million square miles, largely in Canada. These remote and comparatively stable aquatic areas accommodated slightly under 47 per cent of the total breeding duck population in the 1950's. In addition to producing over 80 per cent of the continent's duck supply, Canada also produces the bulk of the coots and geese.

Demands for waterfowl already exceed existing populations. Thus, management's task is to maintain the existing volume of flights and to increase them where possible. In North America, maintenance of the numerous, small, shallow depressions accommodating breeding ducks and coots constitutes the most challenging issue faced by waterfowl managers. The potholes exist in a matrix of soils developed for an agricultural economy. In cropland areas these small wetlands impede tillage with modern machinery and are considered a nuisance. Consequently, land-owners are converting the bothersome wet areas to cropland by draining and filling. This destruction is in an initial stage in Canada. In the United States it is in a final stage. The ducks are caught in a familiar squeeze where the actions of individuals eliminate public resources or values as they develop land to maximize economic returns. Unfortunately, individual choices in land developments usually do not recognize public or national values.

A controversial issue in the United States resolves itself around the fact that technical assistance and cost-sharing are provided by the government to accomplish drainage. The rate of loss of these extremely valuable duck and coot producing areas is accelerated by these incentives.

To date, losses of potholes have exceeded preservation efforts. The magnitude of subtractions are indicated by the following examples. Historically, the prairie pothole area in the U.S. covered 115,000 square miles. Man, largely through drainage, has practically removed all potholes in slightly more than one-half of the area (an estimated 56,000 square miles remained in the early 1950's). Within the remaining portion, federally assisted drainage—not counting locally financed projects—claimed 256,700 acres of prairie duck habitat between 1951 and 1955 (Reuss, 1958:3). During the same period, a total of 3,462 acres of all types of habitat was acquired for waterfowl in the three prairie pothole states by the U.S. Fish and Wildlife Service. In other words, the federal Agricultural Conservation Program removed a little more than 74 times as many acres of wetlands as were acquired by the Federal Government for waterfowl purposes. Farm drainage is continuing. In North Dakota, South Dakota, and Minnesota, drainage increased sharply in 1958 over the average of the three preceding years (Seaton, 1959:391). An estimated 10,000 potholes were drained in this single year. Under existing governmental guidelines, Morgan (1960:8) estimates that eventually 90 per cent of the wet areas of the region will be lost through federally subsidized drainage.

How many years it will take to destroy the remaining breeding habitat is unknown. However, one thing is certain. The technology and horsepower are available to accomplish the task. Drainage and land leveling are now perfected land improvement techniques. Modern machinery has provided landowners with additional time and the means to convert their wet depressions to cropland. For example, one farmer using a three-bottom, 16-inch tractor plow cutting 48 inches and traveling at 3¼ miles per hour, can plow approximately 13 acres in 8 hours of running time. This is about five times the acreage plowed in a day in the 1920's by one man using three horses.

In Canada, both draining and filling of duck breeding habitat, although still in early stages of development, are growing in importance (Hawkins and Jahn, 1960; Moulding, 1960; L. B. Keith, pers. comm., 1960). In certain provinces, governmental assistance is provided for draining and clearing land for crop production (Hopkins, 1952:212).

Various approaches continue to be used to preserve essential duck and coot breeding sites. Some suitable habitat is provided indirectly as small water areas are established, largely to provide livestock with water. In Canada, neither the Canadian Wildlife Service nor the the provincial game branches own any pothole-type habitat. Lack of funds limits their programs. As mentioned previously, some wetland surveys are being planned or have been initiated recently to define more clearly the preservation task.

Two agencies working in Canada have provided duck and coot breeding habitat. Since the Prairie Farm Rehabilitation Act was passed in 1935, the Canadian government has constructed over 56,000 small water areas, primarily to provide water for farm purposes. Secondarily, a small proportion of these areas accommodate breeding ducks. Ducks Unlimited has made some of the most important contributions to the preservation and development of lands for waterfowl. Between initiation of the work in 1938 and 1 March 1960, development has been carried out on 519 projects comprising 788,000 acres of water and having 4,457 miles of shoreline (W. B. Leitch, pers. comm., 1960). Ducks Unlimited owns no land. All projects are established by securing flood easements from landowners.

In the United States, individual landowners carry out practices that add as well as subtract duck breeding habitat. Additions occur primarily as incidental benefits on lands modified to provide water for livestock and the irrigation of crops. In natural grassland areas used mainly for grazing, livestock ponds, in some cases, provide new homes for breeding ducks. However, annual production of ducks per square mile averages 10 to 15 ducklings in the stock pond region of western North Dakota, South Dakota, and eastern Montana, compared to 100 to 150 in good prairie pothole country (U.S. Fish and Wildlife Service, 1953:7). While these additions of duck breeding habitat are of some value, they neither replace the millions of top quality acres already lost, nor do they compensate entirely for the potholes now being destroyed.

Extensive efforts through legislative, educational, and voluntary avenues of approach have been made in the United States to save the potholes from destruction. Attempts to pass bills in the 86th Congress to halt government technical assistance and cost sharing for farm drainage harmful to wildlife, especially breeding waterfowl, failed to make substantial progress. That congressional action is required to change the policy of the Department of Agriculture is clear. Since 1956, Congress has declared that no conservation practice may be dropped by anyone, except the county committees of the Agricultural Stabilization and Conservation Program. This is truly a grass roots type of program. Since the rate of drainage increased between 1956 and 1958, it is evident that in the pothole region the county committees did not abandon or reduce drainage programs.

Another attempt to maintain potholes was advanced in May of 1960. A Memorandum of Agreement between the Bureau of Sport Fisheries and Wildlife, the Soil Conservation Service, and the Agricultural Conservation Program, provides for cooperation between the three agencies in reviewing wildlife values on lands for which farmers have requested cost sharing for drainage in designated pothole counties in Minnesota, North Dakota, and South Dakota. Established procedures permit wildlife technicians to advise the landowners of wildlife values on the lands, alternatives for management, and the existing government programs of land purchase and lease for wildlife. However, it must be clearly recognized that the county committees have final authority for approval or disapproval of cost sharing on drainage applications.

To save a portion of the potholes, government programs of land acquisition have been expanded in recent years. "Save The Wetlands" committees in the Dakotas and Minnesota have energetically brought the story to the public since the mid-1950's and have helped secure limited donations of money for wetland preservation. In these three states, 221,718 acres of waterfowl habitat were purchased between 1940 and 30 June 1960, under the Pittman-Robertson Federal Aid in Wildlife Restoration Act. A little less than 100,000 acres of this total are prime waterfowl breeding habitat. Insufficient funds continue to hamper the state acquisition programs.

An important step to accelerate the federal acquisition program was initiated in 1958. An amendment to the federal Migratory Bird Hunting Stamp Act raised the price of the Duck Stamp from $2.00 to $3.00, and designated that, beginning 1 July 1960, all of the receipts from the sale of stamps, less the cost of printing and distribution, should be spent to acquire lands for waterfowl. Many states, through their Flyway Councils, are enthusiastically urging the Bureau of Sports Fisheries and Wildlife to spend the bulk of the money for preservation of breeding habitat. To date, three federal waterfowl production habitat acquisition stations have been established in North and South Dakota. This program, in its initial phases, consists of securing good quality, duck-producing units through a combination of purchase and easement. A duck production unit consists of a number of temporary water depressions surrounding a more permanent water area required for rearing broods. Availability of experienced personnel now limits expansion of this approach to habitat preservation. Only time will tell how many production units will be saved from drainage. One thing is certain. It will be a tough race, since the rate of drainage has been increasing.

Certain key waterfowl production centers in the nonpothole type habitat are also being threatened by activities of man. Protection of the breeding grounds of the Blue and Snow Geese on the southwest side of Baffin Island became an urgent matter as a result of keen interest recently shown in the mineral resources of that general region (Munro, 1957:10). This area supports one of the world's most important goose colonies, with about 500,000 birds involved. Interest centered around intensive mineral exploration and exploitation of iron ore through open pit mining. Such activities would seriously disturb the geese. Open pit mining would consume space used by the birds and would convert breeding habitat to unsuitable types. The problem has been successfully met by establishing two types of reserved areas. Within a 500-square-mile area containing the heart of the colony of geese, industrial activities and hunting are strictly prohibited. This area is known as the Bowman Bay Game Sanctuary. Surrounding it is the 3,150-square-mile Dewey Soper Bird Sanctuary which serves as a sort of buffer zone. Hunting is prohibited, prospecting may be allowed under permit from the Canadian Wildlife Service, and mining development may be permitted, providing adequate steps are taken to prevent undue disturbance of the geese.

Thus, we see that man is destroying or threatening to destroy a large part of the most productive waterfowl breeding grounds. From goose breeding concentrations in the northern tundra to the more southerly prairie production centers of ducks and coots, individuals or small groups of people are attempting to convert the prime breeding habitat to other land uses. To protect one of the world's largest breeding colonies of geese, regulations have been adopted which restrict individual action for the purpose of aiding the larger public welfare. In our modern society, such procedures are not new.

Some approach, in addition to governmental acquisition, appears necessary to save a large part of the prairie pothole type duck and coot breeding habitat. Farmers now own and occupy the bulk of the area. Soils in the bottom of many potholes are capable of producing crops. In the United States, much of the cropland matrix in which the potholes exist should be converted to grassland to reduce wind and water erosion and provide a more stable agricultural economy (Kimball, 1953; Clawson, Held, and Stoddard, 1960:460). If converted to grazing land, many of the potholes would furnish water for livestock as a part of improved range management. How to bring about this conversion is the challenge now facing citizens. One suggestion is to establish a mixed federal-state-private corporation to buy, develop, and manage grazing land (Clawson, 1958). Time provides the base on which to measure the success of the various attempts used to maintain the essential breeding habitat. But we must recognize that time to preserve the potholes is rapidly decreasing.

Migration and Wintering Habitat.—This discussion of migration and wintering habitat centers on the United States, for it is here that the greatest pressures are on the land at this time. There is no immediate need to consider the status of habitat in Canada and south of the United States in detail. Generally, the status of migration habitat is in a healthy condition in Canada. From the United States-Mexico border to northern South America the majority of the wintering areas, despite some local reductions in carrying capacity, can still accommodate more waterfowl than now use them (Hawkins *et al.*, 1958).

In the United States, maintenance and development of migration and wintering areas for waterfowl are carried out by private interests and governmental agencies. The combination of these efforts contribute toward providing suitable habitat to enhance the distribution and survival of waterfowl and to increase or maintain recreational opportunities.

Private Management. Actions of private interests to benefit waterfowl are much larger in scope than is commonly realized. In the Mississippi Flyway, at least 75 per cent of the nearly 10 million acres of waterfowl habitat under some form of management is privately controlled (Hawkins *et al.*, 1958). In the four states of Illinois, Missouri, Arkansas, and Louisiana, clubs control approximately 3,200,000 acres (Hawkins *et al.*, 1960:17). More than 800 duck clubs control 200,000 acres of land in California (Scheffer, 1959:238). Increased numbers of private landowners in the Pacific Flyway are showing interest in developing and managing lands for waterfowl through plans provided by technicians of the Soil Conservation Service.

Experiences of some of these clubs clearly demonstrate that intensive management aimed at providing preferred feeding and resting areas results in high duck-use. For example, a single duck club in Illinois and another in Arkansas have at one time held close to one-fifth of the Mississippi Flyway's Mallard population (Hawkins *et al.*, 1960:18). While such large concentrations of Mallards reduce the possibilities of having the birds widely distributed, they very vividly demonstrate the capabilities of privately managed areas to accommodate ducks.

Throughout the country, the incentive of securing shooting opportunities has resulted in the management of millions of acres of habitat for waterfowl. In addition, between 1935 and 1 July 1959, a total of 994,000 farm ponds had been constructed with government aid (U.S. Soil Conservation Service, 1960). When the hunting season closes, these private areas benefit ducks and geese. As hunting pressure increases in the future, more acreage will probably be developed by private interests. Such efforts will provide recreational opportunities for people and living space for waterfowl.

Government Management. As in the breeding grounds, conflicting land- and water-use programs are affecting waterfowl migration and wintering habitat. Draining, filling, and flooding have been and are taking place on an extensive scale to modify wetlands for agriculture, navigation, power, industry, and real estate. In this process prime aquatic habitat is destroyed. Studies indicate that approximately one-third of the natural wetlands in this country have been lost (Shaw and Fredine, 1956:7). In natural lakes and streams, aquatic foods, although enhanced in some cases, have generally been reduced by pollution, siltation, and chemical treatments to improve boating and swimming facilities. Conservation organizations are attempting to offset these losses by acquiring lands and working cooperatively with other agencies, such as the Corps of Engineers and Bureau of Reclamation, to mitigate the harmful effects of water development projects and to improve habitat for wildlife.

Federal and state governments started acquiring habitat for waterfowl in the early 1900's. Their efforts were formalized into a specific goal in 1934. A minimum of 12,500,000 acres of land managed primarily for waterfowl was believed needed. With approximately 3,300,000 acres obtained by 1 January 1957, the U.S. Fish and Wildlife Service still has to acquire a little over 4,000,000 acres to reach its share of the objective, or a total of 7,500,000 acres (Select Committee on National Water Resources, 1960:52). Ultimately the Service hopes to have an important waterfowl refuge every 200 miles along the north-south axis of each of the four flyways.

States, with approximately 1,450,000 acres of land for waterfowl, need to secure an additional 3,550,000 acres to meet their minimum objective of 5,000,000 acres. Obtaining the remaining acreage is becoming a more difficult task. There are fewer willing sellers (Jorgensen, 1957:4). Land prices are increasing, and some local governments oppose removal of more land from the tax rolls.

In addition to these acquisition efforts, much has been accomplished in establishing and improving federal policies and programs designed to replace and develop waterfowl habitat as a part of the nation's military and water resources programs. Legislation enacted in 1958 and 1960 advanced the opportunities for developing migration and wintering areas through inter-agency cooperation. One important new feature is that federal construction agencies now have the authority to incorporate fish and wildlife conservation and enhancement features into project planning, including the acquisition of additional lands to benefit fish and wildlife. Possibilities for developing waterfowl habitat under these new provisions are only starting to be realized. Plans on one project, the Army Corps of Engineers' navigation project on the Tombigbee River in Alabama, call for acquisition of land for the new Choctaw National Wildlife Refuge. This is the first instance where land will be purchased for wildlife at the site of a federal public works project, under the terms of the new 1958 legislation. Similar possibilities seem certain in the future. It is expected that reservoirs will double in area from 10,000,000 acres in 1950 to 20,000,000 acres by 2000 (Clawson, Held, and Stoddard, 1960:442). This expansion program deserves close attention. Potentially, tremendous opportunities exist for benefiting waterfowl and for providing public recreational opportunities.

Another cooperative endeavor that could provide aquatic habitat is the small watershed program which was established in 1954. Through cooperative efforts of the Soil Conservation Service, Forest Service, Fish and Wildlife Service, Soil Conservation Districts, and local watershed associations, features benefiting wildlife can be worked into the over-all watershed plan for proper soil and water management. Federal cost sharing is available for project modifications benefiting wildlife. Potentially, benefits to waterfowl could be considerable. However, local sponsoring groups have used the provisions relating to wildlife very little (Select Committee on National Water Resources, 1960:35). In fact, in Minnesota, anticipated losses of existing wildlife habitat would be great within the boundaries of some watershed proposals (Vesall, 1955:4).

A third cooperative measure, established in 1960, provides for development of suitable environments for fish and wildlife on property controlled by the U.S. Armed Forces. Provisions permit state wildlife agencies and administering officers of bases to provide public hunting and fishing on military reservations, using funds from service fees to improve the areas for these activities. Some habitat will be managed for waterfowl.

For a more detailed account of resources programs affecting waterfowl habitat, see the excellent bulletin issued by a select committee of the United States Senate (Select Committee on National Water Resources, 1960).

In summary, progress, although slower than desired, is being made to maintain and develop migration and wintering habitat in the United States. Private interests are managing significant acreages of top quality habitat. Future opportunities for developing migration and wintering habitat appear good, especially in conjunction with federal public works water development projects and on military lands. Nevertheless, under anticipated future intensive use of land and water, losses in suitable acreage are expected to exceed gains. Hope for accommodating large numbers of waterfowl on lesser acreage rests on the fact that the birds will concentrate on specific areas in spring, fall, and winter. Experience definitely shows that on intensively managed areas, large numbers of waterfowl can be accommodated, although the distribution of the birds is more restricted.

POPULATION MANAGEMENT

Waterfowl population management consists primarily of gearing the annual harvest to the yearly surplus and minimizing losses due to causes other than hunting. Objectives of the program include maintaining a widely distributed population of waterfowl at a sufficiently high level to provide both hunters and nonhunters with recreational opportunities on a sustained basis without causing undue hardships to agricultural and other interests. Investigations and management experiences have contributed substantially toward developing the base of information required to satisfy the goals. Some recent advances involving research, regulations, and depredations-control have been especially noteworthy.

Research.—In recent years investigations have covered broad geographic areas through cooperative undertakings. Generally, Canadian and United States federal wildlife agencies have provided leadership and materials. States and provinces, through their Flyway Councils, have contributed manpower, equipment, and funds. Other private organizations, such as Ducks Unlimited, and certain educational institutions, participated in a manner similar to that of the states. The Wildlife Management Institute, North American Wildlife Foundation, and National Wildlife Federation encouraged the investigations and contributed to them. Through combined efforts of these groups, population appraisals, banding, harvest studies, and depredation surveys have been intensified in Canada and the United States. One of the most significant results has been the development of a system to collect wings from ducks bagged by hunters in the United States. Species composition of the kill, age ratios to check on reproductive success, and other characteristics of the kill have been obtained from the wings. Partnership surveys definitely appear to be the most effective means for securing adequate population information over the broad geographic range covered by waterfowl.

Regulations.—One of the important advances in regulations has involved protection of Canvasbacks and Redheads. These over-water nesters were particularly hard hit by drought on the breeding grounds in the late 1950's. Recovery of the emergent aquatic nesting cover in 1960 was, in many areas of the prime breeding range, excellent. With normal water conditions, it is anticipated that nesting cover will be ideal in the spring of 1961. To provide for rapid recovery of Canvasback and Redhead populations, the U.S. Bureau of Sports Fisheries and Wildlife, with support from the Flyway Councils, closed the season on these two species in 1960 in an attempt to return as many of the birds as possible to the breeding grounds in 1961 (Janzen, 1960:2). Another step, which some people believe should already be employed to prevent waste, is to close the key Redhead and Canvasback concentration sites to all waterfowl hunting. This action would eliminate the kill which takes place as a result of the hunter's inability to identify species in flight.

Another significant regulation of 1960 which advanced species management involved the Canada Geese of the Mississippi Valley, specifically those that winter primarily in southern Illinois and adjacent areas. This population is well known for the excessive kill it suffered in the mid-1940's. Attempts are now being made to manage it on a state quota basis to provide maximum sustained public recreational opportunities. To insure a large nucleus of breeders and to permit recovery of the declining flock, a kill quota was established in 1960 for certain counties within the two states where a large portion of the annual harvest takes place. Wisconsin's share was set at 7,000 and Illinois' at 14,000. This action recognizes the fact that the size of a flyway or species population depends upon the sum of the birds in each subpopulation or flock. Regulations aimed at maintaining or increasing separate flocks is definitely a forward step toward improving population management. As long as wintering grounds are adequate, limiting hunting mortality on each of the separate flocks appears to be the most effective way to permit Canada Geese to increase and fully utilize their remote and stable breeding grounds. Sportsmen in Wisconsin and Illinois are to be congratulated for accepting the required restrictive regulations with very few complaints.

Depredations Control.—Grain-eating Mallards and Pintails continue to offend Canadian wheat farmers by consuming and trampling large quantities of grain. Crop losses are substantial in some years. In 1955, estimates indicated that losses totaled $10,500,000 in Saskatchewan (Elkins, 1957:1). These depredations constitute a barrier which threatens to block preservation of the highly productive duck and coot breeding grounds in the agricultural parts of Canada (Leitch, 1960:18). Farmers suffering damage generally consider ducks more a pest than anything else. Unfortunately, all species of ducks suffer from adverse attitudes and activities of farmers caused by two upland feeding species, namely the Mallard and Pintail.

Cooperative investigations have been conducted in Canada during the past few years to determine the characteristics of the depredation problem and to test various control measures. The most important control measure tried was the automatic acetylene exploder, which prevented duck depredations on small parcels of land (Stephen, 1959:1). Trials were conducted in September of 1960 to determine whether or not the exploders would also prevent damage on a large block of cropland.

In addition to these tests, other attempts to deal with the problem have been tried. Scaring and herding techniques have been used. Permits have been issued to shoot in unharvested crop fields. In the Province of Saskatchewan, insurance is available to farmers to protect them against crop losses caused by wildlife. In Manitoba, a feeding program was tried, with some success, near the Delta marshes. These methods have helped meet the problem in some areas. However, additional solutions are required to resolve more fully the conflict between grain-feeding ducks and farmers. What is needed is a preventive or compensatory plan that will operate continuously over a broad geographic area, regardless of weather and road conditions.

In the Pacific Flyway, especially California, crop damage by the Mallard, Pintail, American Widgeon, and coot was severe in some localities. The most effective measure in controlling depredations here was the development of strategically located feeding, watering, and resting areas (Lostetter, 1960:102).

FUTURE NEEDS

The major immediate needs to conserve waterfowl are known. Prairie pothole type breeding habitat must be preserved, especially on the Canadian prairie. Crop depredations must be controlled. Hunting mortality must continue to be regulated in relation to the status of populations, particularly for individual species and manageable flocks.

With the expansion of human population, solutions to these problems will become increasingly more challenging. Greater public understanding and support, adequate financing, and a continuous flow of factual information will be required to permit courageous and imaginative leaders to guide and improve waterfowl management within the anticipated future environmental conditions.

That a large segment of the public does not now recognize the need for immediate action to preserve habitat seems obvious. In the 1959–60 post-hunting season sale of Duck Stamps, only 1,153 stamps were sold up to mid-May 1960. This special sale was held to permit interested citizens to contribute to the essential land acquisition fund. With over two million waterfowl hunters and a much larger group of interested nonhunters, it is apparent that financial support from this special effort was meager. However, public understanding undoubtedly increased somewhat.

Behavioral characteristics of waterfowl help to maintain public apathy. Large concentrations occur during migration and on the wintering grounds. Locally, the birds are abundant. Apparently, what few people realize is that many times they are seeing a large percentage of a given species or manageable flock. Similarly, local shooting success may be high due to exceptional food, water, and hunting conditions. When personal sightseeing and hunting success is high, how many people will purchase an extra Duck Stamp to enlarge the habitat preservation fund? Apparently few.

In addition to supporting programs, the public must clearly recognize the need for changing the broad U.S. Congressional policy encouraging drainage. Technical aids and payments from the government for draining marshes of value to waterfowl should be denied in the Prairie Pothole Region. This action is essential to maintain the type of habitat required to produce a resource that is largely in the public interest.

Because of the magnitude and importance of the breeding habitat and crop depredation problem in Canada, international action is being considered to meet the issues. A Waterfowl Study Committee of the International Association of Game, Fish, and Conservation Commissioners has been evaluating and is continuing to evaluate the need and desirability of establishing an International Waterfowl Advisory Committee or Commission to help resolve the conflicts in land use.

Action on the major waterfowl conservation issues is needed **now.** With proper public support and management, particularly on migration and wintering areas, the numbers of geese, especially Canadas, can very likely be enlarged. Lack of practical solutions to preserve the potholes will result in a reduction in the volume of the duck and coot flight. Extirpation of species is not involved. Rather, the challenge is to maintain a reasonable volume of waterfowl to meet present and expanding future demands of the public.

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LAURENCE R. JAHN, *Wildlife Management Institute, Horicon, Wisconsin, 12 December 1960.*

ORNITHOLOGICAL LITERATURE

Comparative Breeding Behavior of Four Species of North American Herons. By Andrew J. Meyerriecks. Publications of the Nuttall Ornithological Club No. 2, 1960: 6 × 9¼ in., viii + 158 pp., 15 pls., 39 figs., 20 tables. Paper, $2.00; cloth, $3.00. (Order from Massachusetts Audubon Society, Drumlin Farm, South Lincoln, Mass.)

This interesting work is concerned primarily with the hostile and sexual displays of the Green Heron (*Butorides virescens*) and the interactions of birds showing these displays during pair formation. Various maintenance activities are also described as a basis for understanding the origin of the sexual and hostile displays. Pairing behavior of the Green Heron is thoroughly documented and much information is condensed into "ethograms." Comparative information on pairing behavior is given in somewhat less detail for the Great Blue and Great White Herons (*Ardea herodias*), the Reddish Egret (*Dichromanassa rufescens*), and the Snowy Egret (*Leucophoyx thula*). In addition, the presence or absence of 61 behavior patterns found in herons is shown in chart form for all North American herons except the bitterns. One of the real values of this chart is its exposure of the many gaps in the knowledge of our common herons. The author includes a discussion of evolutionary trends in heron behavior as related to sociality, polymorphism, sexual dimorphism and pair formation, coloration of soft-parts, and size and activity.

The primary contribution of this paper is the description of displays and pairing behavior of the Green Heron, based on some 3,000 hours of observation. One can only hope that this study will serve as a backbone for further detailed studies of herons throughout the world comparable to the work being done on many species of gulls. Unfortunately there is still no detailed account of the later breeding behavior in the Green Heron.

The pairing of the Green Heron starts with the attraction of a female to the territory of a male. As reflected by a series of displays, some of them mutual, the hostile tendencies in both birds are gradually overcome by sexual tendencies. The territory of the male is gradually reduced to the nest itself, which is at all times the heart of the territory. The female approaches the nest gradually, and the pair bond is established when the female stands on the nest and both birds express their sexual drive through the Stretch Display, Billing, and Feather Nibbling. Meyerriecks has analyzed this stage of the breeding period in detail and with great clarity.

A number of "ethograms" are presented, showing graphically the actions and reactions of two birds for a particular time interval (usually about an hour—almost three hours in one case). One weakness of the ethograms, and of the entire study, is the lack of definite individual or sex recognition, since color banding was not employed. Sexing was based on "observed behavior and soft-part color."

Commenting on the value of behavior studies for systematics, the author states that "when groups of species are closely related, the ethologist usually has little difficulty in determining those displays which are homologous." Homology, of course, is the criterion by which we must judge the degree of relationship, and the difficulties of interpreting similarities of certain behavior patterns cannot be denied. Meyerriecks mentions the physical similarity between the Stiff-necked Upright Display of the Green Heron and the Aggressive Upright Display of the Great Blue Heron. As he points out, these displays are probably of different origins and therefore not homologous, and they serve different functions. Because of the relatively limited number of distinctive positions which a bird can assume, it is not surprising that certain nonhomologous displays would show fortuitous similarities. It is clear that behavior studies must be thorough and critical to prevent misinterpretation.

Behavior patterns, like anatomical structures, show geographic and individual variation which must be known to allow meaningful comparison with other forms. The author should be applauded for describing variability wherever possible. Thus, he shows that the advertising call of the male Green Heron exhibits geographical variation in pitch and pattern, and he gives a quantitative description of individual variability in the Stretch Display. Whether the geographical variation in call is inherited or learned has yet to be determined.

On the basis of comparative behavior Meyerriecks supports the idea that the Great Blue and Great White Herons are conspecific, and, contrary to Bock (Amer. Mus. Nov. No. 1779, 1956), that *Dichromanassa rufescens* and *Leucophoyx thula* are congeneric.

In criticism of this work I feel that, whereas the section on the Green Heron is firmly based on fact, the section on the other three species is based on relatively few observations. The portion on evolutionary trends is highly speculative and its inclusion is not wholly appropriate. This space might better have been used for critical comparison of the behavior of the four species studied. The drawings illustrating displays are adequate but uninspired, and it is disappointing to find that most of the photographs show maintenance activities rather than displays. Finally, the work might better have been entitled "Comparative *Pairing* Behavior of Four Species of North American Herons."—RICHARD L. ZUSI.

A FIELD GUIDE TO THE BIRDS OF TEXAS. By Roger Tory Peterson. Published for the Texas Game and Fish Commission by Houghton Mifflin Company, Boston, 1960: 4½ × 7½ in., xxxii + 304 pp., 60 full-page plates (36 in color), numerous text figures, 2 maps, 13 pages of silhouettes. Available only from the Texas Game and Fish Commission, Austin. $3.00 postpaid.

No longer must resident and visiting bird students in Texas burden themselves with two or three bird guides. This attractive and colorful book, the most recent in the Peterson field guide series, is a welcome addition to the small list of worth-while works on identification of southwestern birds. Covering 542 species, it is almost as valuable to workers in the neighboring states as in Texas. (A hasty check reveals inclusion of all but 15 or 16 of the regularly occurring birds in southwestern New Mexico and southeastern Arizona.) The volume is so superior to anything else currently available that it is already enjoying widespread use by bird students visiting New Mexico from all parts of the country. All Texas bird students of my acquaintance are busily wearing out their copies and have been doing so for several months. The popularity of the new guide is indicated by the following statement in the 2 May 1960 issue of *Time*: "Without advertising, and despite a sales system that seems designed to discourage all but the most determined customers, the Texas *Field Guide* has sold more than 6,000 copies—better than some bestselling novels." Not until the long-awaited revision of Peterson's "Field Guide to Western Birds" is available will field students leave the Texas Guide home on their shelves.

Peterson has once again demonstrated his ability to condense volumes of information into small quarters. The main problem in preparing any field guide is space; but in this small book, only 14 pages longer than his eastern Guide, 487 species are discussed in the main text. Each is given the familiar concise treatment typical of Peterson's other books, with additional brief comments concerning habitat, nest, and eggs. An additional 55 accidental species and two hybrids are described in an appendix. Subspecies are ignored unless two or more distinctive races occur in Texas. In such cases the forms are discussed under a single species heading in the text. Subspecific names on the plates vary slightly; the two figured forms of Rufous-sided Towhees are labelled "Eastern type" and

"Western type"; the races of Gray-headed Junco are termed "*caniceps form*" and "*dorsalis form*"; the two figured Fox Sparrow subspecies are simply designated "Typical form" and "Western form." The text, however, usually names the races occurring in the state.

Vernacular names are those of the AOU Check-list, 5th edition. Earlier "official" names are given in parentheses as are certain other names used in Richard Pough's "Audubon Bird Guides" or by *Audubon Field Notes* for several years but which never had been sanctioned by the AOU. These appear in quotation marks. The family accounts are somewhat longer than those in other Peterson Guides, including brief remarks on food, habits, and the number of species in the world, in North America, and in Texas.

Some of the plates are the same as those in the author's eastern Field Guide (e.g., terns, waders, rails, waterfowl, hawks, shorebirds, owls, spring warblers, and confusing fall warblers). Two-thirds of them, however, are new, and some of these will be used in the new edition of "A Field Guide to Western Birds." Among the 19 wholly new color plates are particularly good illustrations of flycatchers, vireos, thrushes, and sparrows. To my way of thinking the colorful oriole and tanager plate and the plates of the vireos and streaked sparrows are the best. These, and many others, not only are the finest pictures available for identification purposes but are artistically executed despite being field-guide-type profiles.

Reminiscent of the European Field Guide are the small flight pictures of the Mockingbird, Loggerhead Shrike, and Phainopepla (Plate 45). I have noticed one slip of the brush: on Plate 53 the rump of the Red-faced Warbler should be bright white, not gray.

Some persons would perhaps argue that strict accidentals (and even hypotheticals like Anna's, Costa's, and Allen's Hummingbirds) in Texas should not have been figured in color alongside regularly occurring species. However, in each such case the reader is adequately informed in both picture captions and text of the bird's apparent status. With these cautions I believe their inclusion has made the book more useful. Figuring the stragglers and hypotheticals in color has served the additional purpose of allowing the same plates to be used again in the forthcoming edition of the western Field Guide.

The Golden-crowned Warbler is figured in color but other Mexican species hypothetical in Texas, such as the Clay-colored (Gray's) Robin and Ruddy Ground Dove, are not illustrated. These and the other accidentals are, however, carefully discussed in Appendix I, which lists the details of all records "when the existence of a bird in the state list hangs on a hypothetical sight record." It should be noted that Peterson has wisely excluded very unlikely species (Black Catbird, Abert's Towhee, Short-tailed Hawk, and others) which probably have been erroneously assigned to the Texas list. It is barely possible that at least one of the Sulphur-bellied Flycatchers reported from Texas could actually have been the very similar *Myiodynastes maculatus* which occurs regularly in southern Tamaulipas along with *M. luteiventris.* This possibility is not mentioned, and the statement that no other flycatcher has a streaked breast of course applies to the AOU Check-list area only.

Although the book is written in nontechnical language and with emphasis on the ease of distinguishing species in life, Peterson has nevertheless been cautious and helpful in his statements dealing with certain difficult groups. It will be reassuring to many readers who have despaired over melanistic buteos to learn that "even the seasoned expert gives up on some of the birds he sees," that distinguishing the Olivaceous from the Double-crested Cormorant when the two are not together is "one of the *real problems* of Texas field ornithology," that it is impossible to identify all individual juncos, etc.

Probably it is inevitable that a few minor field problems (such as the beginner's difficulty in distinguishing young Black-throated Sparrows from Sage Sparrows in late summer) would be overlooked or omitted in order to conserve space; but it would be misleading and unfair to dwell on the very few such minor omissions in a volume which covers so much and in such a highly satisfactory manner.

In summary, the book in every way meets the standard of excellence we have learned to expect from Roger Peterson. Any misgivings one may have had about the value of a major field guide to only Texas birds will be dispelled upon using this book in Texas or the adjoining states. It appears to have been a worth-while venture in every respect. —DALE A. ZIMMERMAN.

ZULU JOURNAL: FIELD NOTES OF A NATURALIST IN SOUTH AFRICA. By Raymond B. Cowles. University of California Press, Berkeley and Los Angeles, 1959: 6 × 9¼ in., xiv + 267 pp., photos., map. $6.00.

I cannot praise this book too highly for it is not the usual story of an American naturalist's adventures in a faraway land. Indeed, it is a classic of its kind and should be read by everyone with an interest in the field aspects of biology, in conservation, and in the human problems which beset Africa today.

Dr. Cowles, a Professor of Biology at the University of California in Los Angeles, is a scientist of broad interests with the enviable ability to express himself lucidly. His text is absorbing in content, masterfully composed, and a joy to read. It never strains to be sensational or funny; it is never dependent on pictures, although there are 32 pages of good photographs in the middle of the book.

Born in the Hluhluwe Valley of Natal, South Africa, a son of missionary parents, Dr. Cowles spent his boyhood there and later returned three times, the last in 1953. His many personal impressions and experiences obtained in that country over a span of some fifty years provide the substance of "Zulu Journal." In it he has shifted attention away from the big mammals—so often the dominant elements in accounts of outdoor Africa—and emphasized instead the smaller wildlife. Of these he writes feelingly, with careful attention to form, color, vocal sounds, and behavior. He is constantly heedful of each animal's role in the ecological scheme and has the happy facility of letting the reader share with him the excitement of each observation and discovery. I shall not soon forget his vivid description of the nuptial flight of termites nor his account of how termitaria are utilized by monitor lizards as nesting sites.

There is much about birds that is highly illuminating. This is especially true of the chapter, "Bird Life and the Seasons," which covers a variety of such topics as the parasitic habits of the Lesser Honey Guide, the unique nesting behavior of hornbills, and the clustering of colies and their evident ability to hibernate.

Dr. Cowles is ever mindful of man's relationship to wildlife, both as one element in the fauna and as a potential destroyer, and he voices grave concern lest *Homo sapiens*, through overpopulation and "lack of adequate future subsistence," will bring disaster to both wildlife and himself. The final chapter, "Man," is a penetrating appraisal of Africa's human problems and their impact on that continent's wildlife, today and in the future.

Though Dr. Cowles remarks in his introduction that his book is not a biological treatise, it is nevertheless about biology and beautifully illustrates many a biological principle. Furthermore, it makes Africa seem the challenging place for research that it is and may cause readers to wonder why, to use the author's words, "Europe and its laboratories have an apparently greater appeal for our vacationing sabbatics than Africa with its fascinating possibilities of random discoveries."—OLIN SEWALL PETTINGILL, JR.

Wildlife in America. By Peter Matthiessen. The Viking Press, New York, 1959: 7 × 10 in., 304 pp., 8 col. pls., 16 bl. & wh. pls., over 100 drawings, 1 map. $10.00.

This handsome volume embodies the most eloquent plea for conservation I have ever read. If it could only become required reading for all Congressmen and state legislators, and all appointive officials empowered to promote conservation, our wildlife—what there is left of it—might still have some chance of survival.

"Wildlife in America" is primarily a historical review of our vertebrate animals in the face of the white man's onslaught from early times to the present. It is not pleasant reading, this story of how one species after another has retreated toward extinction, but it is by no means dull, for the author, a talented novelist, writes with facility, force, and color. While being carefully factual in all matters of history, ecology, and biology, he manages to give a stirring account of the greed and shortsightedness that have caused the decline of so many species and to arouse one's dismay and resentment at the apathy of most public officials and citizens toward corrective measures. In order that the animal subjects about which he writes may not be just so many names, he has cleverly worked in numerous commentaries that give them significance and personality—and at the same time excite the reader's interest and sympathy. Mr. Matthiessen's superb text is supplemented substantially by the illustrations—notably the excellent line drawings (averaging one to every other page) by Bob Hines. Practically all species mentioned are pictured. Several chapters in the book deal at some length with the rise of conservation organizations and their bitter struggles, more often lost than won, to stave off the seemingly inexorable trend of species and their habitats toward destruction.

Of great worth as reference material are two appendices, one listing the vertebrate animals north of Mexico that are rare, declining, and extinct, and the other listing chronologically all legislation affecting North American wildlife.

Besides the more than 100 line drawings, the book has eight color plates showing examples of historic work by wildlife illustrators from Catesby to Fuertes, and 16 plates containing black and white reproductions of photographs and early drawings of American wildlife. These embellishments, together with the splendid format, fine quality of paper, and so on, account for the high cost of the book. I hope that eventually an edition at lower cost will be produced so that the book will enjoy a wider sale and its plea for conservation, consequently, a wider readership.—Olin Sewall Pettingill, Jr.

Outdoor Reference Guide. Compiled by Amelia Reynolds Long. The Stackpole Company, Harrisburg, Pennsylvania, 1959: 7 × 10¼ in., 288 pp., 24 full-page photos. $7.50.

This is essentially an abridged encyclopedia for outdoorsmen. Different animals, plants, minerals, "natural wonders" (e.g., Mammoth Cave), weather phenomena, geographical features (e.g., quagmire), and terms used in sports are listed in alphabetical order, followed by brief descriptions or explanations in simple language. In many instances some pertinent fact is given to enliven reader interest. The book is more suitable for browsing than for reference, as it does not attempt thorough coverage. For example, it includes only 11 New-world warblers. Sumptuous in size and attractively bound, "Outdoor Reference Guide" should make a decorative addition to one's living room table or fireside book shelf at the summer cottage.—Olin Sewall Pettingill, Jr.

CHECK-LIST AND BIBLIOGRAPHY ON THE OCCURRENCE OF INSECTS IN BIRDS' NESTS. By Ellis A. Hicks. The Iowa State College Press, Ames [1959]: 6 × 9¼ in., 681 pp. $8.50.

This book has two check-lists, one of insects (18 orders) found in birds' nests and one of birds (26 orders) in whose nests insects have been found. Both lists contain many hundreds of references to a 68-page bibliography. There is also an index to taxonomic groups of insects and birds above species.

The work represents an effort by the author "to assort and consolidate information" gathered from publications pertaining to insects and birds. His task has been prodigious for the specialized information needed has been widely scattered in books and journals the world over. Primarily an entomologist, he has nevertheless had to become conversant with ornithology in order to process his data. That the result of his effort will be helpful to entomologists and ornithologists alike, I have no doubt. I only wish that, besides assorting and consolidating his information, he had also been more discriminating.

Unfortunately many of the insects listed as occurring in birds' nest are neither parasitic on birds nor directly associated with their nests. They are simply insects reported from nests—occupied or long since abandoned—that could just as likely have been found in clumps of dead grass, heaps of forest-floor debris, crotches of trees, tree cavities, or countless other situations. To cite one example: under Robin, *Turdus migratorius*, there are listed such free-living insects as thrips, springtails, midges, and asparagus beetles along with numerous insect parasites. No distinction is indicated. It is left to the user of the book to decide or determine which of these insects properly belong in nests.

In the ornithological check-list many insects are listed as found in nests of *undetermined* bird species and, in numerous instances, of *undetermined* genera, families, and orders. I seriously question the worth of this procedure, particularly since it has necessitated many more pages and thus increased the bulk and cost of the work.

The primary usefulness of the book to ornithologists lies in its accumulation of references to some of the more important literature on insects living in birds' nests as parasites or associates.—OLIN SEWALL PETTINGILL, JR.

This issue of *The Wilson Bulletin* was published on 15 March 1961.

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the AOU Check-list (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited; otherwise, follow the "Style Manual for Biological Journals" (1960. AIBS). Photographs for illustrations should be sharp, have good contrast, and be on 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.

1961 ANNUAL MEETING

The 1961 meeting of the Wilson Ornithological Society will be held from Thursday to Sunday, 8–11 June, at Huntsville, Ontario, Canada. The meetings will be held at Britannia Lodge, in the Muskoka District, under the sponsorship of the Federation of Ontario Naturalists, the Audubon Society of Canada, and the Royal Ontario Museum.

This will be the first annual meeting of the Society held in Canada.

The program plans of Dr. Murray Speirs and his colleagues include a field trip at night to hear wolves howl in response to a recording. Roger Tory Peterson, Second Vice-president of the Wilson Society, will show for the first time in North America his 30-minute film on storks of the world.

More detailed program plans and information regarding best routes, accommodations, etc., will be mailed to members later. Others may receive this material by writing to the Secretary of the Society: Mr. Aaron M. Bagg, Farm Street, Dover, Massachusetts.

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THE WILSON ORNITHOLOGICAL SOCIETY

Founded 3 December 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.

Second Vice-President—Roger Tory Peterson, Neck Road, Old Lyme, Connecticut.

Treasurer—Merrill Wood, Dept. of Zoology and Entomology, Frear Laboratory, Pennsylvania State University, University Park, Pennsylvania.

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

Elected Council Members—Ralph M. Edeburn; Ernest P. Edwards; Harvey I. Fisher.

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

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

THE JOSSELYN VAN TYNE MEMORIAL LIBRARY

The Josselyn Van Tyne Memorial Library of the Wilson Ornithological Society, housed in the University of Michigan Museum of Zoology, was established in concurrence with the University of Michigan in 1930. Until 1947 the Library was maintained entirely by gifts and bequests of books, reprints, and ornithological magazines from members and friends of the Society. Now two members have generously established a fund for the purchase of new books; members and friends are invited to maintain the fund by regular 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 104 periodicals as gifts and in exchange for *The Wilson Bulletin*. With the usual exception of rare books, any item in the Library may be borrowed by members of the Society and will be sent prepaid (by the University of Michigan) to any address in the United States, its possessions, or Canada. Return postage is paid by the borrower. Inquiries and requests by borrowers, as well as gifts of books, pamphlets, reprints, and magazines, should be addressed to "The Josselyn Van Tyne Memorial Library, University of Michigan Museum of Zoology, Ann Arbor, Michigan." Contributions to the New Book Fund should be sent to the Treasurer (small sums in stamps are acceptable). A complete index of the Library's holdings was printed in the September 1952 issue of *The Wilson Bulletin* and newly acquired books will be listed periodically.

THE WILSON BULLETIN

The official organ of The Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Kalamazoo, Michigan. The subscription price, both in the United States and elsewhere, is $4.00 per year, effective in 1959. Single copies, $1.00. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at 50 cents each for 1950 and earlier years, 75 cents each for 1951–1958) and may be ordered from the Treasurer.

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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THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY
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General Notes

Harold Mayfield, *The Kirtland's Warbler*, reviewed by Val Nolan, Jr.; John K. Terres, *The Wonders I See*, reviewed by Harold Mayfield; Donald J. Borror, *Dictionary of Word Roots and Combining Forms*, reviewed by Kenneth C. Parkes; Winston E. Banko, *The Trumpeter Swan: Its History, Habits, and Population in the United States*, reviewed by Robert W. Nero; John K. Terres (editor), *The Audubon Book of True Nature Stories*, reviewed by Olin Sewall Pettingill, Jr.; Richard W. Westwood (editor), *This Is Nature: Thirty Years of the Best From Nature Magazine*, reviewed by Olin Sewall Pettingill, Jr.

Postures of Anhingas: (1) Adult male in usual perching posture; (2–4) wing-waving of male; (5) bowing display of male; (6–7) pointing by male; (8) male in twig-shaking display, female watching; (9) stiff-necked posture of pair formation; (10) bill-rubbing; (11) mock-feeding.

NOTES ON THE BREEDING BEHAVIOR OF THE ANHINGA

Ted T. Allen

Little information has been published on the breeding activities of the Anhinga (*Anhinga anhinga*) in spite of its rather common occurrence in many places in the warmer parts of the United States. The literature on behavior and life history of this species has been limited to accounts of a few isolated observations. The present paper reports some behavior not previously presented in the literature, and it is hoped that this information will be of value in further behavior studies of this species.

These observations were facilitated by the convenient location of a nesting area at Lake Alice, which adjoins the southwestern portion of the University of Florida campus in Gainesville. The easy accessibility of the area, along with the occurrence there of a breeding colony composed of nearly a dozen water bird species, makes it a valuable location for field work, especially in behavior.

Behavior of pair formation was the primary subject of study, although comments have been included on other activities. Behavioral sequences have been generalized from observations of many birds in various stages of reproductive activity at Lake Alice during the breeding season of 1959.

METHOD

All observations were made from the shore or from trees around the lake. Such a study was feasible since many of the nesting birds were close to the shore and in relatively exposed locations. Because of the great disturbance involved to heavily concentrated heron and ibis colonies, which were the subject of another study in progress, no attempt was made to go out into the lake, and therefore no close observations were made on the nests, eggs, or young. Nevertheless, with 10× binoculars and a variable-power telescope, observations could be made on the behavior of birds in the area, most of which seemed undisturbed by quiet human activity.

STATUS AND HABITAT

Most of Lake Alice is actually swamplike with various trees standing dead or growing in shallow water. Less than half the area is strictly open water. Anhingas are permanent residents in the swamp habitat of the lake (Karraker, 1953), but more are present during the breeding season than in the winter. The first territorial and courting behavior was observed on 20 March, and this continued until the study ended in late May.

Lake Alice, in spite of its proximity to concentrated human activity, serves as a nesting place for thousands of water birds of several species. The most abundant of these in 1959 was the White Ibis (*Eudocimus albus*).

In the breeding season of 1952 Karraker (1953:29) estimated the population at 2,500 individuals. Other birds which were numerous, but in lesser concentrations, were as follows:

Glossy Ibis (*Plegadis falcinellus*)
Cattle Egret (*Bubulcus ibis*)
Snowy Egret (*Leucophoyx thula*)
Little Blue Heron (*Florida caerulea*)
Common Gallinule (*Gallinula chloropus*)
Purple Gallinule (*Porphyrula martinica*)
Red-winged Blackbird (*Agelaius phoeniceus*)
Boat-tailed Grackle (*Cassidix mexicanus*)

Anhingas nested in two colonies, both composed of mixtures of all the above species. Karraker (1953:22) estimated the total Anhinga breeding population to be approximately 100 birds, and my estimate in 1959 was about 60, although an accurate census from the shore was quite impossible. In one of the colonies Anhinga nests were located in some dead trees, about 55 feet tall and about 100 feet from the southwest shore of the lake. The nests were located from about 5 to 25 feet above the water and placed no less than 8 feet apart. Anhinga nests in the other colony were located in small red maple (*Acer rubrum*) trees standing within 150 feet of the middle of the south shore of the lake. These nests varied from about 8 to 15 feet above the water, and most of them were located near the tops of the small trees. Usually the nests appeared to be separated from each other by at least 15 feet, but one nest was only about 2 feet below another one in the same tree.

EXTERNAL FEATURES

A male Anhinga in full breeding plumage is mostly black, glossed with green. It has developed a mane, not present in the winter, which is comprised of decomposed black feathers on the hind neck which become grayish brown on the crown and sides of the neck (Brodkorb, 1957). This mane is often erected in sexual displays. The area around the eye is an iridescent blue and green which changes to yellowish on the lores, and the effect of this bright color emphasizes the eye. The greater coverts appear as a patch of silvery feathers on each side when the wings are folded, and the scapulars and tertials are also streaked with silvery.

The female is fawn-colored on the head, neck, and upper breast and has a somewhat smaller and lighter-colored mane than the male. Also present on the female is a black mark beginning on the rictus and extending down into the gular sac. With such marked differences in the appearance of the head, neck, and upper breast of the two sexes, it seems reasonable to assume that sex recognition is at least partly visual. In other details the sexes are generally similar.

PRELIMINARY NEST AND EARLY DISPLAY

In the latter part of March the Anhingas began concentrating in the area, and their early activity was characterized by much shifting about. In mid-March there were a few consecutive days of rainy and cloudy weather, during which time nothing was observed which indicated breeding activity. On 20 March the weather cleared, and there was a rapid initiation of display behavior. Pairing occurred rather rapidly during the following three days, but I had little chance to visit the area during that time. There subsequently was an almost regular occurrence of new birds on the lake, however, and the behavior of these was closely studied.

The male apparently takes over an old nest, if one is available, and establishes his territory there. Bent (1922) reported that the birds return to the same nest each year, but this seems doubtful at Lake Alice, considering the hundreds of birds of several species which might take over old nests or confiscate materials from them. (A Snowy Egret was seen repeatedly pulling sticks out of an old unidentified nest and carrying them to its mate, which was building a nest.) Furthermore, no Anhingas nested within 50 yards of the location of a breeding colony in 1958. Four people, all familiar with the lake, separately informed me of this location. It seems generally known, also, that the Lake Alice colonial birds shift the locations of their nesting sites from year to year. No good explanation for these shifts is available, but they may be influenced by the supply of nesting material, which certainly is subjected to great local reductions during each breeding season.

Male Anhingas did not always take over old nests, although most of the earliest ones apparently did so. Each male which arrived on the area after all old nests were occupied gathered rather long, coarse sticks and arranged them in a flattened clump which I have called the preliminary nest. Only once did I actually see a male carrying sticks to one of these nests, but the regular occurrence of them in previously bare places, and their subsequent occupation by single males, indicates that males built the structures. These nests were later elaborated by the male and female, after pair formation, and were eventually used for nesting. The final arrangement of the nests within the colony was therefore determined by the arrangement of the preliminary nests.

After the male establishes himself on a nest, he begins an invitational display which starts with a wing-waving performance. This behavior is mentioned by Karraker (1953:23) and briefly described by Meanley (1954: 83). The following is a generalized description of the performance. The male stands in the nest or on a nearby branch and raises and lowers each wing separately, still otherwise folded, at the rate of about 3.5 beats per second. While one wing is fully raised the other is held in the normal resting position against the body. As one wing is raised the other is lowered. Each wing is raised upward and slightly outward away from the body so that at its extreme point of movement it forms an angle of about 30° with the long axis of the body. Frontispiece (1) shows a male in a common perching posture, and Front. (2–4) show some of the postures assumed during wing-waving. The neck is sometimes held in an S-curve and sometimes in a tight inverted-U-curve with the head flat against the base of the neck. During wing-waving the mane is sharply erected, and the tail is sometimes raised. The neck often has a thickened appearance caused by its tight retraction and the stretching of the loose flesh on its ventral surface. After a variable period of wing-waving (usually 5–15 seconds), the male makes a deep bow. In doing this the wings are held out from the body, the neck is held in a tight inverted-U-curve, and the tail is erected and spread (Front. [5]). This display usually lasts only about four seconds, during which time the wings are vibrated very slightly but very rapidly. After the bow the male ruffles his wing and back feathers and then resumes wing-waving.

The wing-waving produces a flashing effect of the silvery patches on the wings, and this seems to serve to attract the attention of passing females. The movement certainly made them more noticeable to me, because I was often able to find males which were partially obscured by foliage, only because of these flashing wing patches.

The wing-waving and bowing behaviors occurred at various times during full daylight hours, and no predominance could be seen at any one time of day. Usually, quiescent males began the display when a female came into sight, but most males wing-waved and bowed even when there apparently were no females near.

DISPLAY VARIATIONS AND FEMALE BEHAVIOR

Occasionally in April, and somewhat more often in late May, male Anhingas were seen wing-waving and bowing from bare branches. These birds apparently had not established preliminary nests. They often moved toward any female which came near, whereas the males on preliminary nests in the same area remained on the nests. I never saw a female tolerate such an approaching male, however, and her nearly invariable reaction was to move away. Meanley reported some similar observations on these apparently non-territorial males.

Unattached females made short, wandering flights through the areas where males were displaying, and often they paused for several minutes watching particular males. A female seldom showed any response except some slight stretching and retracting of her neck, and after a time she moved on to another male (or out of sight).

When females began wandering through areas where there were males, both with preliminary nests and without, complex interactions sometimes occurred. The following is an example of one such situation:

> A female was seen giving a slight response (slight neck-stretching and retracting) to a male displaying below her on a preliminary nest, and also to a displaying male on the same branch with her; this latter male was without a nest. The male on her branch moved toward her, but then he suddenly flew off to another female. Very soon he flew back again to the first female, whereupon she flew out of the tree and landed in a bush close to an Anhinga nest in which there were downy young. The female from the nest came hopping across the branches, with wings outspread and bill opened, toward the female which had just landed, and the latter retreated out of the bush. The fleeing female then flew to another bush, closely followed by the male which had previously been on the same branch with her. The new bush had a male in it, however, and he moved out and drove away the male which had followed the female. The remaining male then began to display to the female, but she soon flew out of the bush and out of sight.

PAIR FORMATION

The next type of male display usually occurs when a female approaches, although it may appear mixed with wing-waving and bowing. Sometimes a female will remain near a wing-waving male and react with slight extensions and twistings of her neck. These actions seem to be of low-intensity response and actually appear to be little more than an attempt by the female to change her view of the male. These actions may not constitute the stimulus for the change of display by the male, but when a female begins them, or moves closer, the male begins to stretch his neck and move it in wide sweeping arcs. The most common direction of movement is downward with the neck bending only near the body and the head and bill being held in line with the extended neck (Front. [6–7]). Sometimes the male assumes such postures with the bill pointing directly toward the female and with the mane and tail erected and the gular sac expanded. He usually holds these positions for four or five seconds with only a slight bobbing movement of the head. He then draws back his neck, ruffles his feathers, and extends his neck again. A further variation of this behavior is seen in the slight elevation of the wings (Front. [6]) and sometimes in the grasping of a leafy twig (Front. [8]). Usually the male performs the latter only when the female continues to respond and approaches the male, although once a male without a preliminary nest was seen to perform this action after he had approached a female. While the male grasps the twig he makes vigorous and rapid sideways movements of the posterior part of his head and upper neck, but no male was seen to break off a twig in this manner. Hotchkiss

(1954) reported a male breaking off two willow branches and presenting them to the female, apparently during this same phase of courtship.

By this time some changes in the behavior of the female become obvious. She opens her bill and rapidly vibrates her throat, while the sweeping movements of her head and neck become more pronounced and very similar to those in the male, including the pointing posture. She continues to move closer to the male until her neck appears to be crossed over the neck of the male. The two birds often remain for five seconds or longer with the necks held stiffly straight and crossed, or in positions similar to those shown in Front. (9). Various other stiff-necked sweeping movements are made with the head by both sexes.

Several additional behavioral responses now begin to appear. The male may perform a rapid wing-waving, at least twice as fast as the early invitational type. This occurs interspersed among neck movements, display bows, and feather rufflings. It is common at this stage to see the male with his neck extended nearly vertically and with a flattening of the flesh of the throat laterally, which gives the neck a thickened appearance from the side view. The female then responds with a bowing identical with that of the male, and sometimes they bow in unison. The birds then begin mutual preening and bill-rubbing movements (Front. [10]), and finally the male inserts his bill into the throat of the female in what seems to be mock feeding (Front. [11]). This may precede copulation and may also recur later.

When the mock-feeding performance was first seen, it appeared to be agonistic behavior. This impression was created by the shifting positions of the two birds and by vigorous and rapid side-to-side movements of the head of the male while his bill was inside the throat of the female. It was not possible to observe whether any food material was actually passed between them.

Copulation soon follows after the female steps onto the nest and begins answering the feather ruffles and bows of the male with similar gestures. Sometimes the male walks out on a branch a few feet away from the nest and ruffles his feathers, wing-waves, and bows. The female answers these gestures, and the male hops directly back to the nest and plants both feet on the upper back of the female. She makes little response other than the lowering of her extended neck. The male then grasps the bill of the female and pulls her head upward and backward, and both partially spread their wings and tail. Next the male lowers himself to the female, and copulation occurs, with many movements of the wings and tail of both birds. The duration of copulation is about five seconds.

After the first copulation the pair resumes the posturing which just preceded mating, and the male may again move away from the nest, display, and quickly return to attempt to copulate with the female, not always successfully. This sort of behavior continues for several days following the first copulation, and the pair bond certainly seems to be firmly established since the first mating. Copulation and its associated behavior diminish in intensity and frequency after the first day and are rare by the fourth day.

Since the preceding is largely a generalized account, it does not give details of overlappings and variations of the actions. Some parts of the sequence, such as the initial entrance to the nest by the female, and copulation, were observed only two or three times. I think, nevertheless, that the general pattern was repeated closely enough to allow accurate generalizations.

The recent publication by Meyerriecks (1960) on breeding behavior in herons allows some general comparisons with Anhinga behavior. (The following page references are from Meyerriecks.) A difference was noted in the early stages of pairing. The initially hostile response of a male Green Heron to an approaching female (p. 76) was not seen in the Anhinga, although the neck-stretching displays (Front. [6–7]) were similar to the few hostile attitudes which were observed and could perhaps have evolved from them. Aside from phylogenetic considerations, this type of behavioral difference might be expected on the basis of the easier sex recognition afforded by the more pronounced dimorphism of the Anhinga. Certain similarities were noted between the Stretch Display (p. 43) and Snap Display (p. 33) of the Green Heron to the behavior of the Anhinga shown in Front. (6–9). Feather-nibbling (p. 34) and Billing (p. 51) as well as movement of the male in and out of the nest before and after copulation (p. 52) were very similar in the two species.

NEST BUILDING

The process of finishing the nest is begun soon after pair formation. Sometimes within 20 minutes of the first copulation the male begins to make short trips to surrounding bushes to bring sticks and twigs which the female incorporates into the nest, apparently by wedging them in with thrusts of her bill. There seems to be no set ceremony involved in the transfer of a twig from the male to the female. A female was once seen to open her bill and shake her head from side to side as the male approached with a stick, and she seemed to preen him briefly as he came to the nest. At another time a female was seen to do the neck-extended bow (Front. [7]) just before taking a twig from her mate. All the gathering seems to be done by the male, as Meanley reported, and the female does not help even when her mate is collecting twigs within easy reach of the nest.

Nest building continued for at least three days after pairing in all the birds that were observed, but Meanley reported that nests may be completed in one day. Variability in time taken for nest completion may have been caused by differences in the availability of material, and it may have been influenced by the condition of the preliminary nests. As the female (and sometimes the male) wedges new sticks in among the old ones, the structure becomes considerably enlarged. The completed nests appear to be lined copiously with leafy willow twigs, which show around the rim. The willow of the area is *Salix longipes*, and Anhinga males were seen collecting its branches.

There was good indication that the females stayed at the nest constantly during the first few days after pairing. Complete observations of the pair formation were made at two nests, starting from the solitary wing-waving of the male. After pairing, the female of one was seen in the immediate vicinity of the nest, each time it was observed, for eight days immediately following pairing. Not until the ninth day was she gone. The other was seen on the nest on each of six consecutive days, but no observations were made in the next three days. Once a very wet-appearing male returned to one of these waiting females, and he appeared to feed her. Before the feeding the female performed what appeared to be a display bow with partially opened wings and a spread and erected tail. The male then inserted his bill into her throat and moved his head rapidly from side to side.

The implication from these observations is that the female stays on the nest and is fed by her mate during the first few days after pairing. Even if she occasionally leaves the nest, her presence there is much more nearly permanent than that of the male. The presence of a bird on the nest at all times conceivably could prevent other birds of the colony from taking over the nest or taking its materials.

During the collection of nest material and foraging for food for the young, the birds would usually fly in and out of the nest tree and only occasionally would they climb up out of the water into the tree without flying. Apparently most foraging was being done in the open-water section of the lake or in another lake about one-half mile away. This predominance of flying to and from the nest, instead of swimming and climbing, may be a characteristic behavior for this particular habitat and may not occur in other areas (as indicated to me by Dr. Oscar T. Owre of the University of Miami).

INCUBATION

Incubation is certainly by both sexes as reported by Bent (1922), but no indication was seen that the female does the greater share, as he reported. In my notes there are records of males incubating 13 times and females 16 times. These represent only a small portion of the incubating birds actually observed, however.

No particular ceremony or noteworthy behavior seems to be involved in nest relief. The incubating birds sit usually with mouth opened and throat rapidly and shallowly inflating and deflating, especially during the warmer parts of the day. Incubating birds may also be observed, at intervals of several minutes, to make slight changes in the direction in which they are facing; the total effect of these movements is one of a slow rotation inside the nest.

INTRASPECIFIC RELATIONSHIPS

The general arrangement of the nests within the colonies has already been described. The colonial groupings of nests indicate that territories are small, but there was never enough interaction among the Anhingas to allow determination of territory boundaries. I have seen two males wing-waving in the same bush, but I have twice seen a male chase another one out of the bush where the former was displaying. One of these occurrences was previously cited, and both incidents involved the presence of females, which might have caused an increase in the aggressiveness of the males. Once two males were seen bowing and pointing to each other from a distance of about 15 feet, in a manner exactly like that described for the pointing display in pair formation (Front. [7]). Generally the males showed little response to the presence of other males, and paired males allowed close encroachment by wing-waving males. This sort of tolerance seems necessary for establishment of the compact nesting groups, although the infrequency of territorial interaction is in sharp contrast to the high frequency of border-clashes noted in the early establishment of Green Heron territories (Meyerriecks, 1960:62).

The only observed instance of nest defense was a response to the only observed encroachment upon a nest. This particular trespass, discussed above, seemed accidental.

INTERSPECIFIC RELATIONSHIPS

In both Anhinga colonies there were many nesting ibises and herons. In the colony which was in the maples the concentration was heavy. Some Anhinga nests were in the same bush with White Ibis and heron nests, but in some bushes there were only Anhingas. Once a returning male Anhinga flew into what may have been its preliminary nest or an incomplete ibis nest, in the midst of a group of several White Ibises. This caused considerable shuffling of the ibises, but then the Anhinga stood on the nest and pointed to them with extended head and neck in what apparently was a threat display. His wings were held open, and he made long thrusts with his bill, but the ibises quickly moved out of range. At another time a male Anhinga moved from a bush where he had been displaying to a bush closer to a female. He chased a White Ibis from a nest in this bush and climbed up on the nest to display to the female, which soon flew away.

Twice, however, Anhingas were seen to ignore the close proximity of ibises. Once a White Ibis landed within two feet of a paired male Anhinga without either showing any response to the other. Another male Anhinga, also showing no reaction, was observed sitting in the midst of a group of White Ibises. This ibis was the only species which showed any interaction with the Anhingas.

VOCALIZATIONS

One of the major difficulties with this type of study was the impossibility of studying sounds and calls made by the Anhingas. Audubon described rough, guttural sounds and whistling notes, and Meanley (1954) mentioned notes similar to those of a Screech Owl (*Otus asio*), but I could detect none of these. The distances involved combined with the continuous series of raucous noises from the other inhabitants of the lake made it quite impossible to detect any sounds that could be traced to the Anhingas.

SOARING

During the late winter and early spring particular attention was given to the soaring behavior of the Anhingas to see if it had any relationship to reproductive activity. Bent (1922) quotes a passage from Audubon which mentions "courting on the wing" in Anhingas, which may have been based on the soaring. Many individuals and groups of birds were observed soaring, but there was no indication of any sexual significance.

The birds engaged in soaring as early as 13 February and perhaps all through the winter. The general pattern was for the birds to rise in tight circles, with alternate flapping and gliding, until favorable air currents allowed them to gain altitude without the wing beats. Often the birds would be difficult to follow, even with 10× binoculars, at the height of their ascent. At times I suddenly lost sight of the birds in the sky. Bent (1922) tells of abrupt diving at the end of a soaring flight, and this may account for the disappearances, although I never observed it. At other times birds would droop their wings slightly and lose altitude in a long, slow descent.

The composition of the soaring groups offered no hint of the meaning of the behavior. The groups would usually include both sexes, of varying proportions, and number up to as many as 11 birds. It was not rare, nevertheless, to see a bird circling by itself, and once a male Anhinga soared for about five minutes in close company with a Double-crested Cormorant (*Phalacrocorax auritus*). Although the members of the soaring groups usually circled close together, no interaction could be detected.

SUMMARY

This study was made at Lake Alice in Gainesville, Florida, where Anhingas breed in close association with ibises and various herons. The behavioral sequence of pair formation is generalized from observations of breeding birds during the late winter and spring of 1959.

Anhinga sexual dimorphism is shown by the fawn head and neck of the female compared with the glossy black coloring of these parts in the male. The male has a mane which is conspicuously erected during sexual displays.

The male either takes over an old nest or builds a new "preliminary" nest, on which he stands to wing-wave, ruffle his feathers, and bow. The wing-waving flashes the silvery patches on the wings and probably serves to attract females. Females wander through the area occupied by displaying males and are occasionally pursued by non-territorial males.

If the wing-waving attracts a female, the male begins to change his behavior, employing sweeping movements of the head, rapid wing-waving, and pointing with the bill. The female approaches the nest and begins to answer the gestures of the male with similar ones. Copulation occurs soon after the female steps on the nest. After pairing, the male begins to gather sticks with which he and the female complete the nest. The female probably remains on the nest for several days after pairing, perhaps being fed by the male.

Incubation is by both sexes, and there seems to be no particular ceremony involved in nest relief.

Variability occurs in the defense behavior of territorial males, but reactions seem to be strongest when a female is near. Paired males are very tolerant of wing-waving males, a condition which allows establishment of compact nesting groups.

Anhingas seem to be generally tolerant of the presence of the other species of the colony, although occasional aggressive responses were observed. Herons, ibises, and Anhingas all nest close together, but interaction was observed only between the White Ibis and the Anhinga.

No observations were made on vocalizations of Anhingas. Soaring behavior was observed, but no relationship to reproductive activity was seen.

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SUMMER CREPUSCULAR FLIGHTS OF AMERICAN WOODCOCKS IN CENTRAL MASSACHUSETTS*

William G. Sheldon

The purpose of this paper is to record observations of American Woodcock (*Philohela minor*) during nine summers (1952–60) in central Massachusetts. Active primarily in crepuscular and nocturnal hours, this elusive upland shorebird has presented a challenge to those ornithologists or wildlife biologists seeking knowledge of its life history and ecology. Intensive study of this species by personnel of the Massachusetts Cooperative Wildlife Research Unit for ten years has included exhaustive summer investigations, a season when this species is difficult to find and secretive in habits. The dearth of information on woodcock summer activities during the crucial period of molting and rearing young prompted me to develop methods of gathering critical information. The results are based on 746 woodcock captures with Japanese mist nets. A detailed description of netting techniques appears elsewhere (Sheldon, 1960). Fragmentary and preliminary reports of these summer observations also have appeared elsewhere (Sheldon, 1956*b*).

Search of the literature reveals a paucity of data on the summer behavior of woodcocks. Pettingill (1936) reported that in quest for food during the summer months, woodcocks have been known to use haunts not frequented at other times of the year, such as lawns, cornfields, and vegetable gardens. Similar observations have been made during the course of this study. Mendall and Aldous (1943) suggested that in the heat of the summer and during the critical period of the molt, woodcocks retire to dense thickets where the soil is damp and productive of earthworms. Although most food studies indicate that earthworms form a high percentage of the woodcock diet, findings in this study suggested that other invertebrates play an important part in the woodcock's summer diet.

Evening observations during the summer months revealed a high degree of activity by woodcocks during the evening crepuscular period. Birds observed "trading" across country roads and elsewhere were pursued on the subsequent evenings if their flight direction appeared consistent. These investigations led to the discovery of certain fields where the birds alight. This phenomenon is not unlike descriptions of woodcocks coming into fields to feed for earthworms in their Louisiana wintering grounds. An elder sportsman told me of accompanying a market gunner during the last century when the Massachusetts woodcock season opened in July. He described

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dusk shooting of woodcocks flying to the slope of a dry hill in Essex County. Two small spaniels were used to retrieve the birds.

Exploration revealed four fields thus frequented at widely scattered locations in Quabbin Reservation which comprises 100,000 acres of protected land and water. Three of these were used as study and netting areas. Area 3 was open to the public and unsuitable for effective netting.

DESCRIPTION OF THE AREA

The ground of the frequented fields had little in common vegetatively. Such openings were bordered by trees or shrubs 20 feet or less in height, but grass or shrub cover varied in each area. Whatever the cover might be, there were a few relatively clear patches on the ground. Woodcocks appear to favor areas where they can walk around easily whether feeding or engaged in other activities. The only other feature in which these fields were similar was location in reference to spring breeding areas. All were in or very close to regions where the largest number of singing males was heard in the spring. All were used as singing grounds in the mating season.

Area 1.—One of the two areas where birds alight in Prescott Peninsula in Quabbin Reservation was a small field about ½ acre in size with a ground cover of low bush blueberries (*Vaccinium pennsylvanicum*), scattered sweet fern (*Myrica asplenifolia*), and a few clumps of oak (*Quercus* sp.) and chestnut (*Castanea dentata*) sprouts. There were open areas between the bushes which were the favorite alighting places. It was the site of an old burn, and numerous dead logs and stumps littered the area. These provided an ideal habitat for ants and numerous beetle larvae. The area was surrounded by a predominant growth of gray birch (*Betula populifolia*) up to 20 feet high. Oak-sprout growth was the next most abundant woody plant. Scattered white pines (*Pinus strobus*) up to 60 feet high were found at various distances from the perimeter of the field. The ground was exceedingly dry and well drained. Within 100 yards were two old gravel pits which often contained moist or wet bottoms, and these were occasionally visited by the birds. The field was used by at least one singing male each spring. One of the males was captured and banded in April 1955, but was not netted during the summer.

Area 2, South Side of Quabbin Reservoir.—The second area was almost two acres in size and situated near the top of a high hill. Part of it was an abandoned field with low-bush blueberries and scattered white pines. The favorite alighting area was a bare space of about an acre. Several years ago, machines scraped all the topsoil off the site. Vegetation was sparse and the soil rocky. Numerous ant holes were scattered in the area, but the habitat was not nearly as favorable for insect life as Area 1. The fringe of the field on one side was a red pine (*Pinus resinosa*) plantation.

and on the other, low gray birches, poplars (*Populus tremuloides*), and other scattered hardwoods. The border growth on the whole was higher than that on Area 1. There has always been a high breeding population near this area, and six singing males were heard in the vicinity in the spring. All these males were captured and banded in the springs of 1955 and 1957, but none were netted as repeats in the summers.

Area 3, South Side of Quabbin Reservoir.—This was an abandoned field of several acres in extent. It was filled with scattered clumps of high-bush blueberries (*Vaccinium corymbosum*). Being open to the public, there were well-beaten paths around all the blueberry bushes in July. These relatively bare paths at the base of the bushes were the favorite spots sought by woodcocks each evening. The birds flew from neighboring woods and were seen on occasion to come from at least 300 yards away. There was a minimum of eight "singing" males on this area in the spring of 1955. This would have been a difficult field to net, and netting was not attempted because there was little question that nets would be interfered with by the public.

Area 4.—This field was found in 1958 and netted in 1959. Situated on Mt. Pleasant on Prescott Peninsula in Quabbin Reservation, this site was on the highest point of the peninsula, approximately 1,100 feet above sea level. It was surrounded by old abandoned fields planted to Norway spruces (*Picea abies*), red pines, and larches (*Larix laricina*). Gray birch was scattered about on the periphery. Enough open places remained so that the breeding population within a radius of half a mile had not diminished appreciably for ten years. It was an old hayfield of about two acres in size with an adjoining ½-acre field grown up to sweet fern and grassy spots. Birds alighted all over the area, but avoided the heavy, long-grass hummocks.

"Singing" male woodcocks have used this field and adjoining areas for ten years.

POPULATION COMPOSITION OF NETTED SUMMER BIRDS

Composition of birds captured are depicted in Table 1.

Ages of birds captured before the molt were determined by the color on the tips of the scapular and back feathers as described by Duvall (1956). Some young birds caught early in the summer peeped in the net with the same note of newly hatched chicks. August and September birds could not be aged with certainty during night banding. Sex was determined by bill length and width of outer primaries (Greeley, 1953).

Examination of Table 1 suggests that captured birds may not be representative of the actual sex and age ratios existent in the population. The results reveal that the sex and age groups in order of number of captures were juvenile males, adult females, juvenile females, and adult males. These proportions were relatively consistent from one year to the next. Because

TABLE 1

Sex and Age Ratios in Nearest Whole Percentages of 483 Woodcocks Captured in Massachusetts During Summers 1955–1959

Year	Ad. ♂	Juv. ♂	Ad. ♀	Juv. ♀	Tot. Juv.	Tot. Ad.	Total ♂s	Total ♀s
1955	7(7)*	41(42)	27(28)	25(24)	66(66)	34(35)	49(49)	51(52)
1956	21(28)	32(44)	31(42)	16(22)	49(66)	51(70)	53(72)	47(64)
1957	20(13)	30(19)	36(23)	14(9)	44(28)	56(36)	50(32)	50(32)
1958	14(10)	42(30)	26(19)	18(13)	60(43)	40(29)	55(40)	45(32)
1959	10(11)	35(38)	28(31)	27(30)	38(42)	62(68)	44(49)	56(61)
Totals	14(69)	34(166)	30(143)	20(98)	56(271)	44(212)	50(242)	50(241)

* Figures in parentheses denote numbers of birds.

of this, I doubt that such differences are due to an inadequate sample, but reflect differences in activities of birds according to sex and age.

Reasons for these assumed behavior differences are purely speculative. Adult males may be less active in summer due to a strenuous breeding season extending from late March to early June. Juvenile males may have a greater tendency to move about, a characteristic of many juvenile male vertebrates. Adult females become more active after spending the spring on the ground incubating eggs and rearing young. It is possible evening flights may be serving to develop wing strength for the fall migration.

BEHAVIOR DURING FLIGHTS

Woodcocks were seen flying into the fields one-half hour after sunset at the same light intensity as the beginning of the courtship performance earlier in the year. Usually the flights lasted no longer than 15 minutes, but on one bright moonlight night birds continued to come into one field for 30 minutes. Observations indicate that, after alighting, birds remained in the field from 10 minutes to one-half hour unless flushed. Nets left all night yielded no additional birds.

Birds came in singly as well as in groups of two, three, and four individuals. Figure 1 depicts observations on Netting Area 2 on the evening of 20 June 1959, before netting had started. Twenty-four birds were counted. Only those visible against the evening sky were tabulated. A number of others were heard crossing the field below skyline. Although the figure depicts birds approaching from all points of the compass, the majority came from the western sector and often circled the field and made the final approach from any direction. The pattern of approach depicted was typical of the flights of incoming birds in the other netting areas.

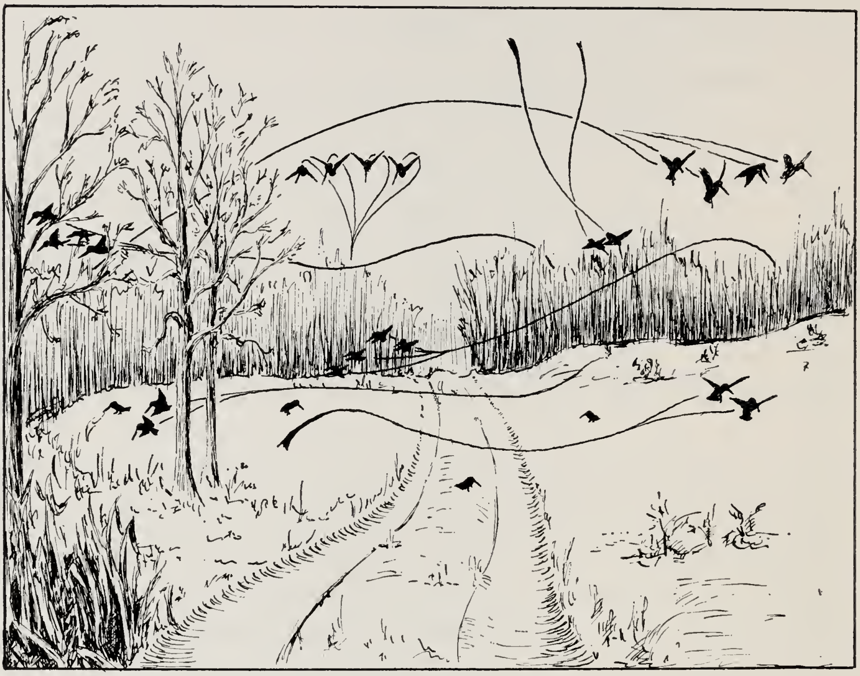

Fig. 1. Woodcock crepuscular flight into open field—Area 2.

Although there is no certain proof, there is no evidence that broods remain intact up to the time the young birds take part in these evening forays. Additional data on this are presented in a later section.

The counts of birds in evening flights when no netting is being conducted may give a rough index of annual abundance if the habitat remains static. Area 1 is in an area of deteriorating woodcock habitat due to vegetative succession. In 1951, there were 63 "singing" grounds known to be occupied in Prescott Peninsula. Censusing the same routes in 1959 indicated only 17 "singing" sites were occupied. Area 2 is on the top of a steeply drained hill which has wet seepages in normal summers. In 1957, the entire hill was dry due to a severe drought. Because of this condition, the birds apparently shifted their diurnal resting areas and used different fields for their crepuscular visits.

From 1952 to 1959 when netting usually took place every evening all summer, records were kept of birds observed and of trap success by weeks and months. It was suspected that the netting and banding operations disrupted normal evening behavior and prompted birds to seek other evening feeding grounds. In 1960, when no nets were set, evening observations of some of the fields were conducted weekly from late June until the end of the first week in August. The evening flights with some variations continued unabated until nets had to be set to capture some live birds for insecticide studies. After six days of netting on two areas, the nets were removed. From the first night of netting the numbers of birds using the fields fell off steadily. In addition to the 1960 observations the largest number of birds observed in a netting area was on 15 August in a season before netting took place.

Variations in counts on Area 1 before netting were approximately 25–43, on Area 2, 10–27, and Area 4, 20–38. Such high counts over a period of time never were recorded while netting was taking place.

Semi-courtship Activities.—The juvenile male birds approaching the fields early in the summer often performed a "courtship" flight high over the field before landing. The performance closely paralleled the flight of adult males in the spring with the exception that the musical chirp song was not given. Occasional irregular *peent's* were heard on the ground. Most of these males were known to be juveniles, since on some occasions they were captured in nets on their descent. Gonads of collected specimens were minute in size, showing no development. These were not sectioned to discover if there were any active spermatozoa.

On 13 July 1955, Dr. William Nutting of the University of Massachusetts Zoology Department was concealed in small bushes and observed the antics of an apparent male and female on the netting ground a few feet away. From a behavioral point of view, his following description of observations is of interest:

> 1. Heard *peent* NE at 8:52 and another weak one at 8:54.
> 2. Several birds in from NNE.
>
> At 8:58, one bird flew in with wing whistle 6½′ from me. He stood and turned SW. Then, I noticed another bird walking in from SW. First bird moved to meet the new one. Bird 1 (hereafter called a *him*) made aggressive head pass toward second (from now on called a *her*). She stopped 2′ from him. He raised his wings, lowered and advanced, raised wings again, lowered and moved; then in several fluttery wing moves came up to female and passed his bill at her midback. She then moved off 3′ NNW. He moved 2½′ NE of her. Both stood still. I heard her give a soft cat wheeze note—followed in a few seconds by another. He turned around and squatted (faced from her). He rose, appeared to peck at ground, then turned facing her. Suddenly he flew in a low arc over her head, wings whistling, to land about 12′ beyond her. She did not change position. In one minute, he flew up with wings whistling and did a semi-courtship flight, directly overhead landing about 50′ to SW. She walked slowly out of sight NW.
>
> I crept toward her and flushed her—her wings fluttered, but didn't whistle. Time, 9:14.

Nutting's description of the behavior of the bird presumed to be a male is similar to the actions of a breeding male preceding copulation. In the course of the Massachusetts studies, hundreds of male birds have been captured on singing grounds with decoys (Sheldon, 1956*a*, *b*), and many notes were accumulated on the behavior of male birds in the presence of a decoy bird or live female. The latter are invariably approached with raised wings and the copulation act is performed with fluttering wings. Similar observations were made in 1960 on 29 June and 20 September.

The "cat wheeze" note attributed to the female was heard several times on the summer alighting fields. When this note is given, it is often loud and startling, entirely unlike other notes given by woodcocks. Birds flushed from the site of these calls appeared large and were presumably females.

Fall or late summer courtship behavior has been reported on several other bird species including several species of ducks, the Yellow Warbler, Baltimore Oriole, and others (Hochbaum, 1944).

Effects of Weather.—Although it has been pointed out that nets have a deterrent effect on birds, observations of activity in different weather conditions in netting years may well have validity.

Careful weather records kept throughout the years of netting showed slight correlation between weather conditions and bird activity. Windy nights with an air movement of more than 5 mph usually yielded poor catches. The motions of the nets were often detected by the birds and thus avoided. Under windy conditions, few birds usually visited the fields. Clear evenings with temperatures ranging from 55–75°F. often produced good catches, but just as often were unproductive. Still, hot, humid evenings following afternoon thunder showers created conditions which were most consistently productive of birds and often stimulated insect activities. Woodcock activity seemed stimulated by quiet evenings with a light drizzle or fog. On the morning of 16 July 1960 half an hour before sunrise, 64 woodcocks were seen on 3½ miles of road during a light rain. Two mornings later no birds were seen over the same route in clear weather.

Factor of Food.—The most important reason for these flights appeared to be dietary in character. Birds landing in the fields fed actively on various species of insects. Table 2 gives the results of the analysis of stomach contents of 15 birds. Some of these birds were collected as they flew into fields. Although earthworms rank second in percentage of volume, there was little more than a trace in the eight birds which were allowed to feed in the fields 10 or 15 minutes before flushing into the net. Direct observations at dusk include woodcocks actively feeding. One bird alighted on a white rock and was observed picking up food items. Examination of the surface of this rock with the aid of a light revealed numbers of a very small ant. Captive woodcocks have been observed chasing flying insects attracted by a light. Presumably, many birds left damp wooded areas where earthworms were found. Seven birds were collected as they flew into nets before alighting

TABLE 2

STOMACH CONTENTS OF 15 WOODCOCKS NETTED IN FIELDS DURING SUMMER EVENINGS IN MASSACHUSETTS

Item	Family	No. of stomachs	Estimated per cent volume
COLEOPTERA			38.7
Ground beetle larvae	Carabidae	2	
Weevils	Curculionidae	1	
Wireworms	Elateridae	13	
Leaf chafer larvae	Scarabaeidae	1	
Short-winged beetle larvae	Staphylinidae	3	
Darkling beetle larvae	Tenebrionidae	5	
DIPTERA			15.3
March fly larvae	Bibionidae	5	
Long-legged fly larvae	Dolichopidae	4	
	Louchaeidae	1	
Snipe flies	Rhagionidae	8	
Stiletto fly larvae	Therevidae	6	
Root-feeding fly larvae	Tipulidae	1	
LEPIDOPTERA			14.7
Noctuid moth caterpillar	Noctuidae	8	
Pupa		1	
Loopers	Geometridae	1	
ANNELIDA			
Earthworms		8	30.0
CHILOPODA			
Centipede		2	.3
CHELICERAE			
Spiders		2	.3
HYMENOPTERA			
Ants		2	.3
VEGETABLE MATTER		6	.2

in the fields. These contained earthworm remains in their stomachs. It may well be that the high protein content of the insects consumed in the fields formed an important part of the summer diet. English workers on icterid species have observed that seeds or fruits eaten during the molting period have a high protein content.

Although the fields were dry and no probing could take place, the prehensile tip of the woodcock bill is well adapted for picking up insects from the ground or even catching a few in the air.

It will be seen from Table 2 that a large variety of fly and beetle larvae were readily consumed. Analysis of these stomachs suggests that woodcocks often consumed earthworms in their diurnal coverts but visited the fields primarily for other types of animal food.

Summer Evening Activity by Months.—The only valid observations on the activity of birds by months are those observations made when no netting or banding was taking place. Most of these observations were made in 1960. Woodcocks alight in these fields in large numbers as late as mid-August at least. Almost as many can be seen in September but fewer alight in the fields. Birds have been netted as late as 10 October and as early as 13 June. When the fields were netted, no birds were observed on several occasions on all areas during August due to the disturbance of banding.

Evidence that Flights Comprise Resident Birds.—The question is posed as to whether the flights were local movements by different groups of birds each evening. In Netting Area 2, 20 per cent of the captures in 1956 and 1958 were repeats. This was solid evidence that many of the same birds took part in the activity more than one evening. The chances of capturing repeats were small, partly since it was seldom that more than 30 per cent of the birds observed each evening were netted and perhaps, more importantly, because of the deterrent effects of the netting and banding activities referred to in an earlier paragraph. Birds in Netting Area 2 came from a relatively concentrated woodcock range. In contrast, Netting Area 1, which has yielded about 400 of all birds captured, produced few repeats. Birds from this area were surrounded by hundreds of acres of woodcock range, and several have been taken as returns several miles away. This field is small, and many other alighting areas must exist. Limited data on returns described in a later paragraph further suggest that we were dealing with resident birds.

Distance between Alighting Fields and Diurnal Cover.—The actual distance individual birds flew in the evening to reach the netting fields is somewhat conjectural. In Netting Area 1, observers posted at intervals provided evidence that many birds coming into the field were first observed coming east over a large hill half a mile from the landing field. In Area 2, observers have recorded many birds travelling toward the field from distances up to at least ⅓ of a mile. There was no single observation of a bird rising from diurnal cover and flying to the field. It probably took a woodcock no longer than two minutes to fly a mile, and there was no way of knowing how far the birds had come when first observed. In one instance, two juvenile males were captured in a funnel trap on the edge of a large alder swamp two miles from the netting field and separated from it by a large hill. Ten days after the first capture, these two birds were again netted, but there was no method of ascertaining their whereabouts between the two capture dates.

TABLE 3

RETURNS OF WOODCOCKS NETTED IN CENTRAL MASSACHUSETTS
DURING SUMMERS 1952–1959

Band no.	Sex	Age when captured	Distance between capture sites in miles	Time lapse between capture sites to nearest year	Method of recapture
553-50260	♀	Juv.	10	2 years	Netted
563-33238	♀	Juv.	0	2 years	Netted
553-50272	♀	Juv.	0	3 years	Netted
563-33297	♀	Juv.	0	1 year	Netted
553-50220	♀	Ad.	3	4 years	Netted
563-33054	♀	Ad.	0	3 years	Netted
563-33110	♀	Ad.	2½	4 years	Netted
563-33160	♀	Ad.	0	2 years	Netted
603-44212	♀	Ad.	0	1 year	Netted
553-50286	♀	Ad.	0	2 years	Netted
523-05229	♀	Ad.	1	1 year	Netted
563-33054	♀	Ad.	0	2 years	Netted
553-50274	♀	Ad.	0	3 years	Netted
563-33295	♀	Ad.	0	1 year	Netted
563-33244	♀	Ad.	0	1 year	Netted
563-33022	♀	Ad.	0	1 year	Netted
563-33242	♂	Juv.	½	1 year	Singing-ground trap
553-50222	♂	Juv.	3	3 years	Netted
563-33213	♂	Juv.	0	3 years	Singing-ground trap
603-44205	♂	Juv.	0	1 year	Netted
603-44225	♂	Juv.	0	1 year	Netted
563-33219	♂	Ad.	⅛	3 years	Singing-ground trap
553-50211	♂	Ad.	1½	1 year	Singing-ground trap
523-07219	♂	Ad.	1	1 year	Singing-ground trap
553-50160	♂	Ad.	1	2 years	Netted
50-301755	♂	Ad.	2	5 years	Netted
563-33266	♂	Ad.	½	1 year	Singing-ground trap
563-33010	♂	Ad.	10	1 year	Singing-ground trap
563-33222	♂	Ad.	⅒	1 year	Singing-ground trap
553-50204	♂	Ad.	0	2 years	Netted
563-33773	♂	Ad.	1	3 mos.	Netted
523-50238	♂	Ad.	1	1 year	Singing-ground trap
553-50162	♂	Ad.	¾	4 mos.	Netted
553-50135	♂	Ad.	1	4 mos.	Netted
563-33243	♂	Juv.	¼	1 year	Singing-ground trap

RETURNS AND RECOVERIES

In this paper, *return* refers to a bird recaptured after a period of at least three months. *Recovery* refers to a bird shot or recovered in a location removed from the study areas. Homing and returns of adult males caught in the spring on their singing grounds were reported earlier (Sheldon, 1956*a*). Table 3 presents the total data on returns of netted birds.

Returns.—Data from Table 3 offer further evidence that netted birds comprised a resident population. There are more return records on adult males than juveniles, because spring singing-ground trapping activities presented greater opportunity for collecting male return records. These data simply suggested the extent of spring and summer range of some of the netted birds. There was one case of a male and another of a female banded one year in Area 1, and captured as a return in Area 2, a distance of 10 miles.

Although the record is meager, these results suggest homing behavior on the part of all age and sex groups. These data show minimum distances from the netting fields that some individual, netted, resident birds have moved at some time in their lives during spring or summer. Not shown in the table is the instance referred to in a previous section of the netting of two juvenile males two miles from an alder swamp where they had been captured ten days previously in a funnel trap. Far more adequate data presented earlier on adult males (Sheldon, 1956*a*) indicate adult males return in subsequent years to the general vicinity of the breeding grounds where first captured.

This table contributes other incidental information. There is evidence that both sexes breed in their first year. Number 50-301755 was first banded as an adult male at least a year old on a singing ground in April of 1951, and subsequently netted five years later in the summer of 1956. Six years longevity appears to be the longest life span recorded for the American Woodcock in the wild.

Recoveries.—Seventeen hunter-recoveries of birds netted and banded during this study were all from southern migration lanes with the exception of two. One juvenile female banded on 16 July 1956, was shot on 1 October 1957, in Peru, Vermont, 65 miles northwest of the original banding location. This bird conceivably could have been a resident of Massachusetts and exhibited a case of vagrant migration. There seems little question that the second bird had forsaken her rearing grounds. This was another female of uncertain age banded on 1 September 1956, and shot 10 October 1957, in Belfast, Maine, 350 miles northeast of the banding location.

WEIGHTS

Weights of known juveniles and adults have varied little from year to year. Figure 2 shows the overlap in weight of the different age and sex groups. By the time juveniles were active enough to take part in evening flights, weight was an unsatisfactory criterion for separating the age groups. Table 4 represents weight changes in three adults and 12 juveniles captured twice at intervals of at least ten days. Weight changes of a few grams are of no significance.

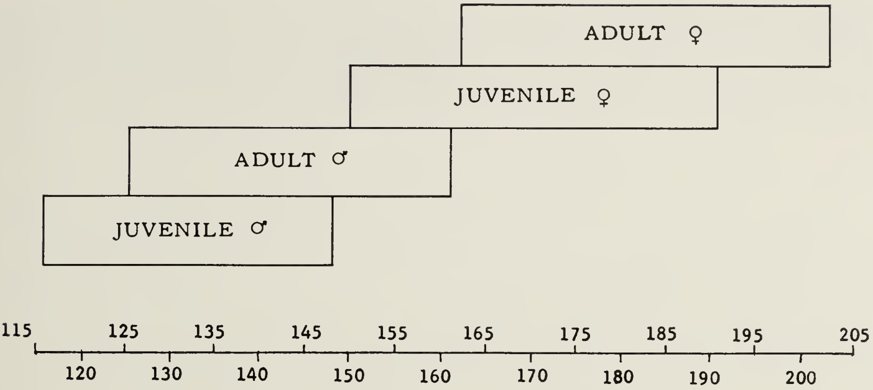

Fig. 2. Weights in grams of 112 woodcocks netted in Massachusetts in the summer of 1956.

Subsequent weighing of a large number of captive birds demonstrated weight fluctuations depending on when the birds had last consumed a meal. Each bird ate approximately 150 grams of earthworms every 24 hours. Because of rapid metabolism and digestion, weights would seldom vary more than 20 or 30 grams. Table 4 offers evidence that juveniles had attained mature growth by the time they engaged in evening flights. If growth had not ceased, much greater changes in weight would have taken place. The greatest gain took place with one adult female and two juvenile females first

Table 4

Changes in Summer Weight (in grams) of 15 Woodcock Captured Twice at Intervals of at Least 10 Days

Sex	Age	Date first caught	Weight when first caught	Date of second capture	Weight on recapture	Weight change
♂	Ad.	25 June '57	127	18 July '57	132	+ 5
♂	Juv.	13 June '57	126	25 June '57	129	+ 3
♂	Juv.	25 June '57	147	12 July '57	150	+ 3
♂	Juv.	23 June '57	121	23 July '57	124	+ 3
♂	Juv.	6 July '56	139	30 July '56	142	+ 3
♂	Juv.	25 June '58	158	23 July '58	155	- 3
♂	Juv.	29 June '58	135	23 July '58	145	+ 10
♀	Ad.	3 July '56	165	28 Aug. '56	184	+ 19
♀	Ad.	30 June '58	165	20 July '58	170	+ 5
♀	Juv.	19 June '57	154	7 July '57	171	+ 17
♀	Juv.	26 June '57	173	12 July '57	187	+ 14
♀	Juv.	13 June '57	184	1 July '57	184	0

caught 3 July 1956, and recaptured the same year in late August or early September. These gains probably represented the beginning of fat accumulation preceding the fall migration. Examination of specimens taken late in the summer revealed the beginning of the growth of fat.

MOLTING

Duvall (1956) has described methods of distinguishing juveniles and adults in the summer, before the former have molted, by plumage characteristics on the back and scapulars. An important finding from summer netting has been a record of the molting sequence for adults and juveniles. This information will be published later. Suffice it to say that because juveniles do not molt their primaries in the first year, a careful study of primary feather wear revealed a method of aging fall-shot woodcocks by examination of one wing (Sheldon, Greeley, and Kupa, 1958). To further apply this technique, large fall wing-samples have been collected from hunters in the northern breeding grounds. Data gathered from this source should greatly augment our knowledge of annual population and production trends. Greeley (1953) has described a method of sexing woodcocks on the basis of outer primary width; so sex as well as age ratios can be calculated from wing collections.

SUMMARY

Seven hundred and forty-six woodcocks captured by Japanese mist nets at dusk in fields provided significant data on summer behavior of this species. The alighting areas varied in size and vegetative composition, but all were situated near the center of spring breeding grounds. The sex and age composition of birds captured showed a preponderance of juvenile males and adult females. Reasons for such age and sex discrepancy are discussed. Factors prompting these evening flights are suggested. Evidence points to food as the most important factor. Behavior of these birds has been described. The alighting grounds were dry and the food consisted primarily of fly, beetle, and moth larvae. Returns suggest homing behavior on the part of all age and sex groups. Molting studies of these summer birds provided the technique for aging and sexing wings of fall-shot birds.

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ENERGY OF BIRDS CONSERVED BY ROOSTING IN CAVITIES

S. CHARLES KENDEIGH

NIGHTTIME is a critical period in the resistance of birds to winter cold at high latitudes because this is generally the coldest time of the day, and is a period when diurnal birds are unable to feed. Numerous notes in the literature describe how birds seek dense vegetation or cavities of various sorts for roosting purposes (Frazier and Nolan, 1959). Shelter obviously gives them protection from the wind and decreases the rate of heat lost from their bodies, but quantitative measurement of the benefits thus obtained has rarely been obtained (Gerstell, 1942).

The present study was stimulated by observing a House Sparrow (*Passer domesticus*) going night after night into a bird nesting box attached to the side of the Vivarium Building on the University of Illinois campus. An attempt was made to determine the difference between the temperature inside the box while the bird was roosting in it at night and the temperature immediately outside the box.

Observations on the roosting of the House Sparrow have been reported by Labitte (1937), Dunsheath and Doncaster (1941), and Swaine (1945), among others. Dunsheath and Doncaster many times observed apparently paired birds roosting together. Swaine reports that the House Sparrow often roosts in its own nests during the winter. He usually found only one bird in a nest at a time, but on four occasions found pairs of birds using the same nest, and on one occasion three birds. I never suspected more than one bird to be using the box in this study, but at different times observed a male and a female at the box at roosting time.

The box was made of ¾-inch pine lumber. Inside dimensions were 6 inches front to back, 4 inches side to side, and 5 inches top to bottom. There was a flat top hinged on one side. An entrance-way with a diameter of 1½ inches was located in the front, ½ inch below the top, and the entire front could be tipped open on a pivot near the top. The box was on the south side of the building approximately 40 feet from the ground. Since it was placed under the rather wide eaves of the roof, it was well protected from precipitation. The box-cavity was about one-half filled with old nesting material, and the nest-cavity, in the rear half of the nesting material, was lined thickly with chicken feathers. The bird presumably roosted in the nest-cavity, but this was not verified.

PROCEDURE

Two thin insulated copper-constantan thermocouples were prepared and when tested against a standardized mercury thermometer gave identical average readings at 22.9° and –13.4°C and a standard deviation for 24 individual readings of ± 0.15°C. One thermocouple was fastened inside the box directly over the nest-cavity with the sensitive junction projecting slightly so as to record the air and not the wall temperature. There was no suspicion that the thermocouple was in a heat stream. The other thermocouple was fastened to the middle of the east side of the box on the outside with the junction projecting into the air. This junction was protected from direct solar radiation at all times of the day.

The two thermocouples at the box were connected to thick copper and constantan leads that extended 200 feet to a Leeds and Northrup recording potentiometer inside the building. The potentiometer registered over a range of –40° to + 160°C with the chart graduated in 2°C intervals. Temperature recordings were interpolated to 0.5°C for analysis. Experience with this potentiometer has shown that while individual readings could be in error by ± 1.0°C, averages were dependable within ± 0.5°C. A daily check on the accuracy of the recording was obtained by the outside and inside thermocouples registering identical temperatures while the bird was absent during the daylight hours. The three thermocouple outlets of this potentiometer were interconnected so that two consecutive readings were taken of the inside box temperature, then one of the outside temperature, each at one-minute intervals, with this cycle being repeated continuously.

RESULTS

Complete 24-hour per day recordings were obtained for 23 days, beginning 20 December 1949, and ending 11 January 1950. The bird entered its roost, on the average, a few minutes after 4:00 PM and left it a few minutes after 7:00 AM, CST. This gave a roosting period of 15 hours per day. On 1 January, the sun sets at 4:38 PM and rises at 7:15 AM.

When the bird first entered the box, inside box temperatures registered higher for a period of one-half to one hour than during most of the night, presumably due to restlessness of the bird (Fig. 1). The temperature record indicates that thereafter the bird was quiet for periods up to two hours or longer during which the box temperature remained uniform. These quiet periods were terminated by short abrupt rises in box temperature, occasionally amounting to over 3°C. These temporary rises in temperature are unexplained, but must have resulted from some activity of the bird. As the outside air temperature fell during the night, the difference between the temperatures inside and outside the box regularly became greater. For one-half to one hour before the bird left in the morning, restlessness, apparently, again brought a higher box temperature, similar to that in the evening after the bird entered. After the bird left the box, the box temperature fell rapidly, but required up to 45 minutes to reach the outside air temperature.

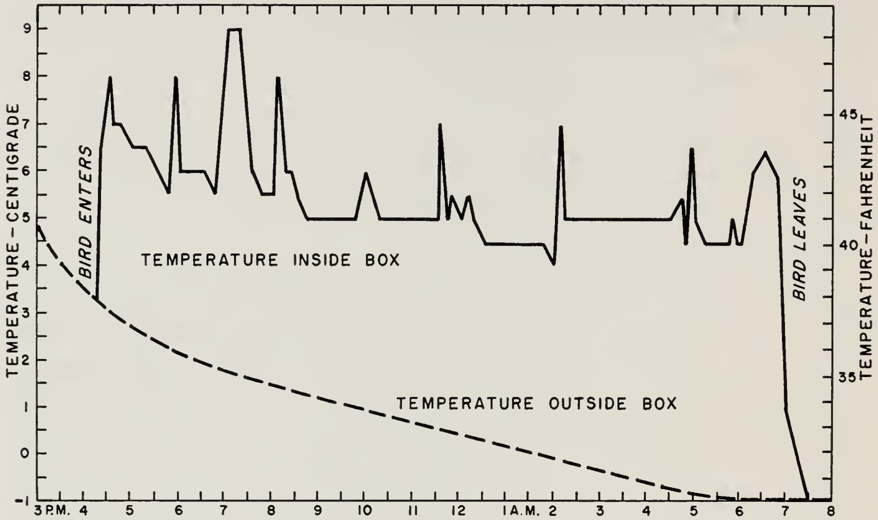

FIG. 1. Temperatures inside and outside the box on a representative night, 10–11 January 1950.

The night of 21–22 December 1949, was unusual in that air temperatures dropped from around 11°C a little before 11:00 PM to –3°C at 8:00 AM, this drop being accompanied by rain (Fig. 2). Inside box temperatures fell from about 13.5°C to + 3°C. Here again it is evident that the difference between the temperatures inside and outside the box was less at the higher than at the lower temperatures.

It is obvious from Fig. 2, but not from Fig. 1, that a pronounced change in the outside air temperature will bring a change in the inside box temperature. In order to show the relation between inside box and outside air temperatures the nightly mean of each of the two temperatures was obtained for each of the 23 days. The means were computed only for the hours 6:00 PM to 6:00 AM, inclusive, in order to avoid the restless periods of the bird after entering and before leaving the box each night. One temperature was read from the chart for each hour on the hour, an average value being recorded if the temperature was fluctuating at the time.

When the differences between the two temperatures are plotted against the temperatures outside the box (Fig. 3), a linear relation is evident ($b = -0.19$°C; $P = < .001$). The same regression line is obtained by plotting the differences between the hourly temperatures rather than the differences between the mean nightly temperatures. The lower the outside air temperature, the greater the difference between outside and inside box

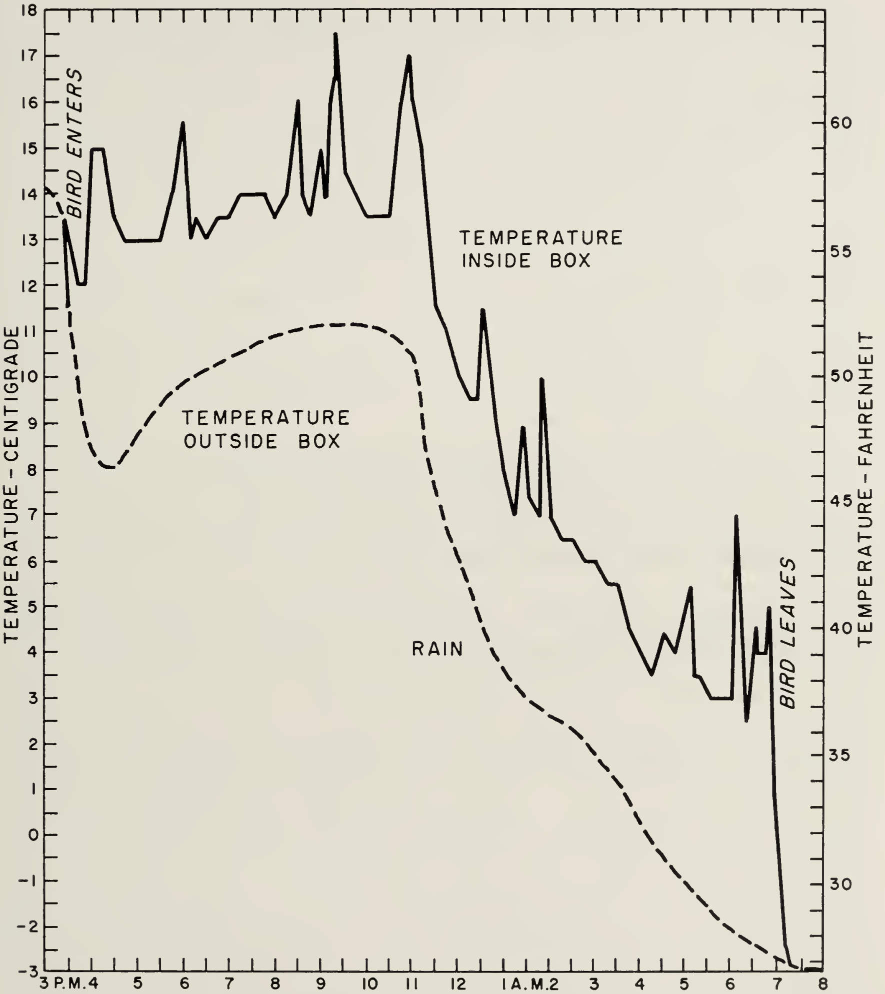

Fig. 2. Temperatures inside and outside the box on an unusual night, 21–22 December 1949.

temperatures, although the increase in the difference does not equal the drop in the air temperature, for instance:

Outside air temperature	+ 17°C	−8°C
Difference	1.5	6.2
Inside box temperature	18.5	−1.8

An extension of the line in the upward direction indicates that the bird would not raise the box temperature at air temperatures of 24.7°C and above. At these higher air temperatures, the resting metabolism of the

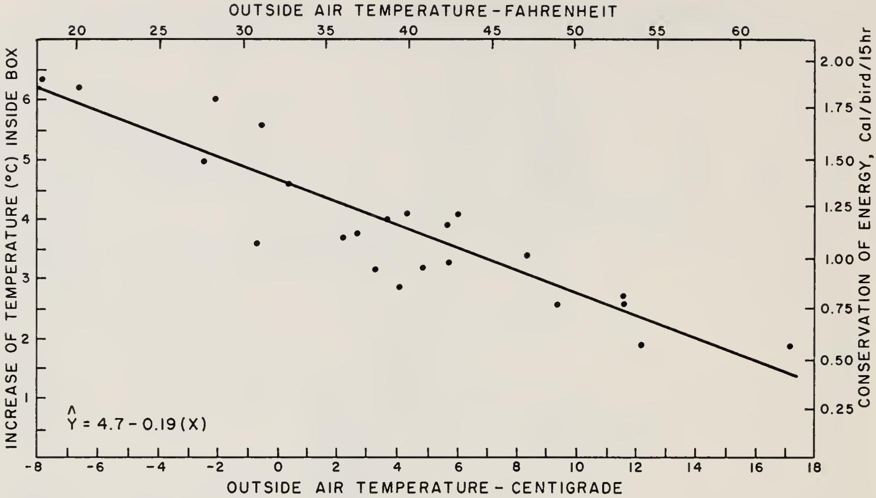

Fig. 3. Relation between box temperatures and outside air temperatures correlated with the amount of energy conserved by the bird.

bird would be so reduced that apparently the low rate of heat loss from the bird would have no measurable effect on the box temperature.

DISCUSSION

Temperature relations inside a well-insulated cavity, like this box, are complicated (Moore, 1945). The resting bird at night probably has an internal body temperature of about 40°C. Skin temperatures beneath the feathers would be about one degree less (Baldwin and Kendeigh, 1932). Conduction of heat along or across the feathers to the outside of the plumage would be very slow, so the temperature on the surface of the plumage would be considerably below the skin temperature. Roosting birds in cold weather commonly fluff out their feathers and place their heads under the scapular feathers. This increase in the thickness of the plumage greatly reduces the rate of heat conduction away from the body. The low surface temperature would greatly diminish the amount of heat radiation from the bird to the walls of the box. Heat conduction from the body and legs of the bird to the nest-material in the box would be very small. Likewise, evaporation of moisture in the respiratory system would account for only a small loss of heat. The principal pathway of heat loss from the bird would doubtless be convectional, partly by the air being warmed by the heat conducted to the surface of the plumage, but to a greater extent by the expiration of heated air from the body in each breathing cycle. This would warm the box cavity until a temperature was reached where the loss of heat from the box to the air balanced the heat loss from the bird to the box. Radiation of heat from the box to the sky during clear weather was doubtless reduced because of the position of the box under the eaves of the roof.

Wood is a poor heat conductor. The temperatures of the inside surface of the walls of the box, although not measured, may have approached the inside air temperature. The temperature of the outside surface of the walls of the box probably approximated the outside air temperature. A temperature gradient must therefore have occurred in the ¾-inch wall, equal approximately to the difference in box and air temperature. Heated air rises and there was doubtless an exchange of warm for cold air through the small entrance-way and the crack between the top lid of the box and the side walls. The insulation of this roost-site was probably better than that of most species but perhaps not as good as for some, as for instance woodpeckers.

The resting or standard metabolism of the House Sparrow at night is lower than it is during the daytime. Seven measurements obtained at night at constant temperatures from −19°C to + 31°C (Kendeigh, 1944) indicate a straight-line relation between resting metabolism and temperature ($b = -0.699$ small calories per gram per hour; $P = < .001$). If we assume the mean weight of House Sparrows in December and January to be 28.5 grams and the roosting period per day to be 15 hours, then for each rise of 1°C in inside box temperature there would be a daily conservation of 0.30 large calories of energy to the bird. These caloric values have been incorporated in Fig. 3. The resting metabolism of the bird in large calories ($\hat{Y}$), when X is temperature, follows the equations:

$$\hat{Y} = \frac{25.6 - 0.699(X - 11.3) \times 28.5 \times 15}{1000} \quad \text{or} \quad \hat{Y} = 3.4 - 0.299X$$

At + 17°C, the raising of the roosting temperature by 1.5°C would conserve 0.45 kcal or only 4.9 per cent of the total required by the resting bird. At −8°C, however, the difference of 6.2°C would mean a saving of 1.86 kcal or 11.1 per cent. Were nightly temperatures to drop to −20°C, an extension of the curvilinear line (Fig. 4) indicates that 12.6 per cent of the total energy required for roosting would be conserved, at −30°C the saving would be 13.4 per cent. The species regularly experiences air temperatures as low as these. An extension of the line in the other direction indicates that no energy would be saved at 24.7°C.

It would certainly appear that roosting in cavities has an advantage at low temperature which increases in extent, but not directly proportionally, with the drop in air temperature. The amount of energy thus conserved may make the difference between survival and death during periods of extreme weather during the winter. Likewise, roosting in cavities may enable a

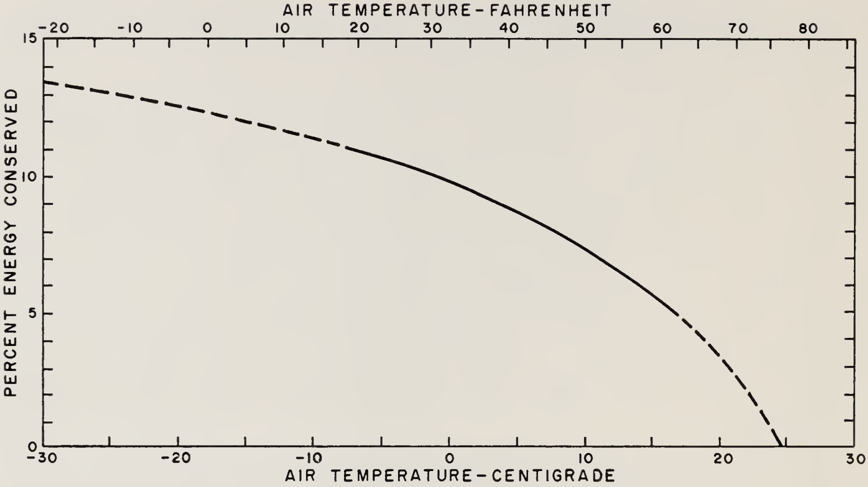

Fig. 4. Relation between per cent of energy conserved by roosting in cavities and air temperature.

species to occur farther north during the winter than it otherwise would. Further studies along these lines should be made with refined techniques.

CONCLUSIONS

1. The temperature inside a box cavity used for overnight roosting by a House Sparrow was higher than the outside air temperature at air temperatures below 24.7°C ($\hat{Y} = 4.7 - 0.19 X$).
2. The difference between temperatures inside and outside the box cavity increased with a drop in temperature ($b = -0.19$°C).
3. The energy conserved by roosting in a cavity compared with roosting in the open varies curvilinearly from zero at + 24.7°C to 13.4 per cent at −30°C.

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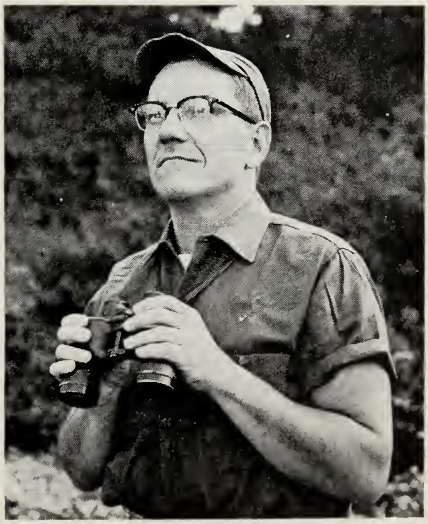
DEPARTMENT OF ZOOLOGY, UNIVERSITY OF ILLINOIS, CHAMPAIGN, 20 SEPTEMBER 1960

NEW LIFE MEMBER

George A. Hall, holder of a Ph.D. from Ohio State University and now Associate Professor of Chemistry at his baccalaureate Alma Mater, West Virginia University, Morgantown, West Virginia, is seriously interested in ornithology and has contributed to the literature of the field. His chief interests are in breeding bird populations, and in geographical and ecological distribution of birds. He has served as a regional editor for *Aududon Field Notes*, and has contributed numerous notes in *The Redstart* and several population studies in *Audubon Field Notes.* Dr. Hall served the Brooks Bird Club as president from 1952 to 1955, and is currently the editor of their journal, *The Redstart.* He is a member of the AOU, the Cooper Ornithological Society, and the Wisconsin Society for Ornithology.



A BOTANICAL ANALYSIS OF KIRTLAND'S WARBLER NESTS

William E. Southern

The Kirtland's Warbler (*Dendroica kirtlandii*) is of special interest to ornithologists because its breeding range is restricted to the distinctive jack-pine (*Pinus banksiana*) plains of the northern part of the Lower Peninsula of Michigan. The 1951 census of this species reported by Mayfield (1953. *Auk*, 70:17–20) indicated that the total population at that time was about 1,000 individuals. The species is most common in four (Crawford, Oscoda, Iosco, and Montmorency) of the 12 counties where nests have been recorded. The breeding range of the species is less than 85 by 100 miles in size. A portion of the data accumulated during this study appeared in H. Mayfield's book, "The Kirtland's Warbler" (1960. Cranbrook Institute of Science). Data so used are indicated in this paper.

Ornithologists have been puzzled by the restriction of the Kirtland's Warbler to a portion of Michigan's jack-pine regions. Mayfield (op. cit.) suggested three interrelated factors as an answer: (1) porous soils, (2) suitable ground cover, and (3) large tracts of young jack pines. In this study I attempted to determine whether or not the materials used in the warbler's nests, since they are obtained from the ground cover, aided in restricting the species to the more open pine forest.

According to Zimmerman (ms) the jack-pine plains may be divided into three parts: (1) the forest—large, fairly dense stands of jack pine; (2) savannas—stands of open, scattered jack pines, and sometimes a few other species; (3) burns—regions in which the stands of large trees have been destroyed and natural reforestation is taking place. The Kirtland's Warbler nests only in savannas and burns. Therefore, only the vegetation of these formations is considered here.

In this study I examined 25 Kirtland's Warbler nests. Twenty of these nests were taken apart and the materials identified, when possible, and weighed. Measurements were recorded; only the 16 nests that contained eggs were used in computing average dimensions since nests that contained young were probably stretched out of shape. During the summer of 1958, I made a botanical study of a section of Kirtland's Warbler habitat in Presque Isle County. Some of the data from that study are included in this paper.

I wish to express my appreciation to Dr. Elzada Clover, Dr. Charles Conrad, Mr. Mason Fenwick, and to Dr. Edward Voss for their assistance in the identification of plant materials. Dr. Voss also made available the University of Michigan Herbarium for comparison of specimens. All of the nests used in this study were from the collections of the University of Michigan Museum of Zoology. Dr. Dale Zimmerman and Mr. Harold Mayfield made available their manuscripts and permitted me to use pertinent information. Dr. Harrison Tordoff made valuable suggestions during the preparation of the manuscript.

The flora of the pine plains is made up of approximately 175 species of higher plants and some 15 species of lichens, mosses, and ferns. In few parts of the dry, sandy, upland pine plains are there luxuriant growths of vegetation. The coverage is much greater in some regions but it is often possible to find sand showing through the ground cover; in some localities fairly large expanses of sand supporting little besides mosses are evident.

The jack pine is the dominant tree of the pine plains but numerous oaks (*Quercus*), occasional aspens (*Populus*), some cherry (*Prunus*), and a few red pines (*Pinus resinosa*) may be interspersed. Red pine plantations are found in some localities. If deciduous trees become too numerous the warblers no longer use the habitat.

The Kirtland's Warbler appears to require an open stand of pines which allows filtered light penetration. This is best offered by stands of jack pines 6 to 15 feet high. Dense "islands" of pines usually exist with openings of herbaceous plants between. Mayfield (op. cit.) stated that the penetration of sunlight increases the life span of the lower branches and thus provides cover nearer the ground and nest. The nest of the warblers may be located on the ground within or at the edge of such an "island." The nests examined were constructed in depressions that ranged from 29 to 41 mm deep in the duff.

All of the nests used in this study were collected in Crawford and Oscoda counties. The vegetation and soil surrounding some of the nests were also collected. These samples indicated that no specific type of vegetation, other than a sizable clump of grass or small shrubs, was consistently used for concealment of the nest. Vegetation was completely arched over some nests thus permitting entrance from only one side.

The average dimensions of the Kirtland's Warbler nests were as follows: Outside diameter, 104 mm by 96 mm; inside diameter, 61 by 56 mm; outside depth, 48 mm; inside depth, 34 mm. The average thickness of the walls was 40 mm, and that of the nest bottom 14 mm. The rim was often asymmetrical and sometimes as much as 15 mm thicker than the rest of the nest wall (Fig. 1). The average weights of the dried nests was 13 grams. The construction varied as to its sturdiness. Some nests were loosely made, others tightly so. A few nests had thin places in the sides through which light passed (see Mayfield, pp. 74 and 75).

There were three recognizable layers in most of the nests (Fig. 1): (1) A loose outer layer made up of coarse stems, leaves, and rootlets of *Carex pensylvanica*, some grasses, leaves, pine needles, and a few short sticks; (2) a middle layer of more tightly woven finer grasses; and (3) the inner layer or lining that was usually of deer hair, mosses, fine twigs, or an unidentified black fiber.

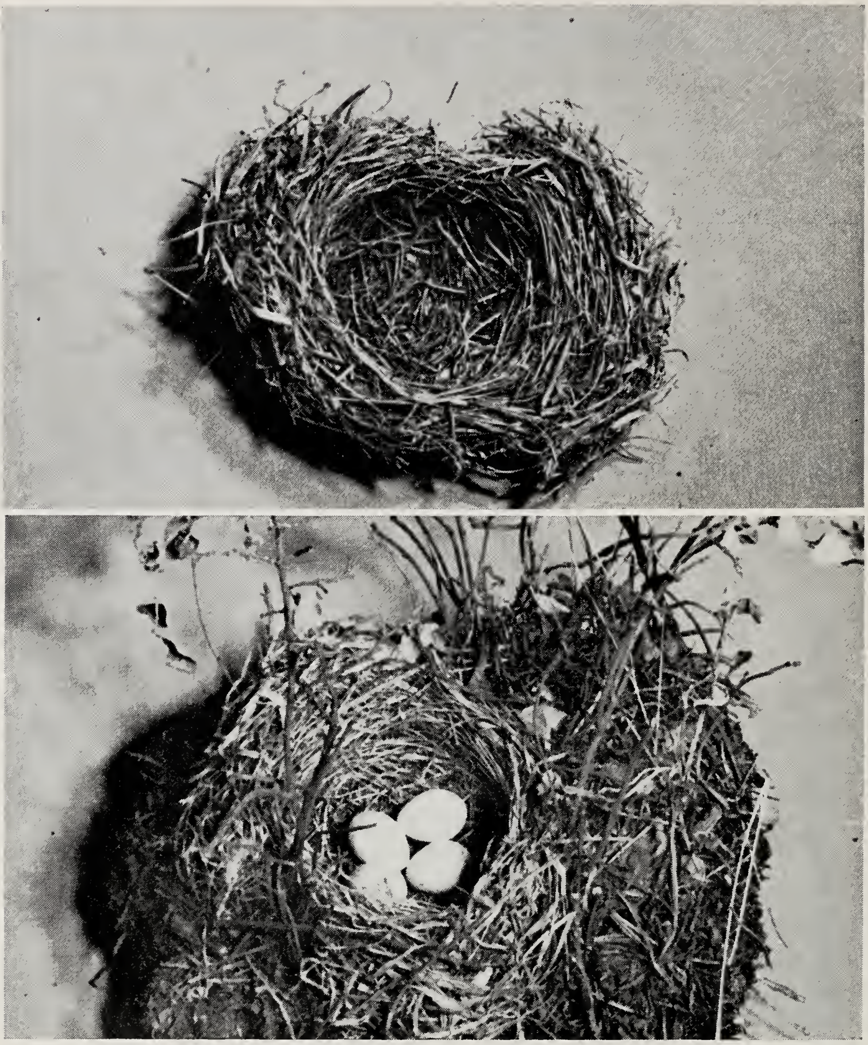


Fig. 1. Rims of nests were asymmetrical, thickened, and composed of coarser material.

At least 29 species of plants were used in the nests. Most of the species used were fairly common within the burns or savannas but none was peculiar to the pine plains.

I placed the materials found in the nests into 11 categories listed below; under each category are the species of plants included, part of the plant used, range of amounts used per nest, average lengths of the pieces, and the percentage of nests containing each type of material. The relative abundance in the region (Zimmerman MS) of each species of plant used by the warblers is also given. A table summarizing the following data appeared in Mayfield's monograph (op. cit.).

Coarse grasses and sedges.—These materials were the bulk of the outside layer of all nests. Amounts ranged from 60 to 97 per cent (av. 56.34 per cent) of the total weight of the nests. Lengths of five leaves selected at random from each of 10 nests ranged from 72 to 170 mm (av. 124 mm). The average width of the pieces was 1.6 mm.

Carex pensylvanica.—Present in 12 nests; the basal tufts were commonly used and perhaps many leaves were present, but positive identification was impossible. Zimmerman gave the constancy (percentage of times found in his quadrats) for burns as 100 per cent, and savannas 94 per cent.

Agropyron sp.—Leaves and stems of this grass were used in at least four nests. It is apparently rare within the pine plains but may be fairly common along roadsides.

Sorghastrum sp.—Leaves and stems present in one nest. Constancy 20 per cent in savannas, 9 per cent in burns. According to Zimmerman, *Sorghastrum* occurs very rarely in forest openings and not at all in shaded woodlands.

Agrostis scabra.—Leaves, stems, and some fruiting bodies used in one nest. Constancy in burns 27.2 per cent, savannas 7.9 per cent.

Eragrostis spectabilis.—Leaves were used in two nests. This grass provided surrounding cover for at least one nest. Zimmerman does not list it for the pine plains.

Andropogon sp.—Leaves and stems used in two nests. Zimmerman found two species on the pine plains, *A. gerardi* and *A. scoparius.* Respectively, their constancies are, burns 54 per cent, interior savannas 50 per cent, peripheral savannas 16.6 per cent; burns 90.9 per cent, and savannas 94.0 per cent.

Fine grasses.—These were the major constituents of the middle layer and, to a lesser extent, the lining of 22 (88 per cent) of the nests. Amounts ranged from a trace to 30 per cent (av. 9.85 per cent) of the total weight of a nest. Fruiting bodies, leaves, and stems were used. Lengths of the stems used ranged from 94 to 178 mm (av. 141 mm).

Deschampsia flexuosa.—Found in five nests. Constancy in burns 27.2 per cent, savannas 18.0 per cent.

Muhlenbergia glomerata.—Identified from three nests. Considered to be rare in the pine plains. Zimmerman collected it in a single Oscoda County savanna.

Agrostis scabra.—Used in middle layer and lining of 11 nests as well as in outer layers as mentioned previously.

Danthonia spicata.—Present in three nests. Constancy 63.6 per cent in burns, 82.0 per cent in savannas.

Poa compressa.—Occurred in five nests. Constancy in burns 63.6 per cent, savannas 32 per cent. Zimmerman also listed *P. pratensis* for one small area of the pine plains.

Oryzopsis asperifolia and *O. pungens.*—One or the other occurred in five nests. The first is considered generally rare by Zimmerman. The latter is much more common; constancy 54.5 per cent in burns and 16 per cent in savannas.

Festuca saximontana.—Identified from three nests. Constancy 9 to 10 per cent in burns and savannas. *F. scabrella* was also listed by Zimmerman and has a very similar constancy. However, it seems to be limited to more open areas. There is still the possibility of confusion of specimen material.

Pine needles.—Needles were found in every nest examined. Although needles were scattered through parts of all layers of some nests, the greatest percentage was usually in the outside layer.

Pinus banksiana.—Needles occurred in 25 (100 per cent) of the nests. Amounts ranged from 0.1 to 9.0 (av. 2.22) per cent of the total weight. Needles were found in all parts of the nests but were most abundant in the outer layer.

Pinus resinosa.—Needles occurred in 5 (20 per cent) of the nests. The amounts ranged from a trace to 1.5 per cent (av. 0.41) of the total weight. The needles were scattered through the outer portions of the nests but never occurred in the middle layer or lining. This species of pine occurred in 14.3 per cent of Zimmerman's quadrats. Zimmerman studied one nest of the Kirtland's Warbler from a stand of *P. resinosa* and found that needles of this species made up 30 per cent of the outer layer of the nest.

MOSSES.—The reddish-brown sporophytes of *Polytrichum piliferum* occurred in the linings of 22 (88 per cent) of the nests studied. Vegetative portions were occasionally found in other layers of the nest. Amounts ranged from a trace to 8.5 per cent (av. 2.55 per cent) of the total weight of the nests.

TWIGS.—Fine brownish stems of *Polygonella articulata* are included under this category. *Polygonella* occurred in 9 (36 per cent) of the nest linings. Amounts ranged from 0.8 to 9.9 (av. 1.8 per cent) of the total weight. On no occasion were both *Polytrichum* and *Polygonella* present in a nest lining. Constancy of *Polygonella* was 9 per cent in burns and 14 per cent in open savannas. It was more common along roadsides. Stem lengths ranged from 56 to 61 mm (av. 58 mm).

Coarser twigs were found in outer portions of 18 (72 per cent) of the nests. Pieces were usually short and dark in color. Diameters ranged to 4 mm. Amounts per nest ranged from 0.1 to 5.7 (av. 1.55) per cent of the total weight. The following woody plants were represented: *Quercus* spp., *Pinus banksiana*, and *Vaccinium angustifolium.* Lengths ranged from 16 to 52 mm (av. 33 mm).

LEAVES.—Leaves of deciduous trees, shrubs, and herbaceous plants occurred in 20 (80 per cent) of the nests. Amounts ranged from a trace to 4.3 (av. 1.27) per cent of the total weight. Small leaves or portions of larger ones were used. Plants represented were *Quercus* spp., *Salix* sp., *Vaccinium angustifolium, Comptonia peregrina, Prunus* sp., *Arctostaphylos uva-ursi*, and *Epigaea repens.*

ROOTLETS.—Relatively unimportant amounts of small rootlets were found in 9 (36 per cent) of the nests. Amounts ranged from a trace to 2.25 (av. 0.41) per cent. Rootlets were present in nest linings. Generally only one or two pieces, if any, were found per nest.

LICHENS.—Small amounts of *Cladonia* spp. ranging from a trace to 1.5 (av. 0.55) per cent occurred in 9 (36 per cent) of the nests studied.

BLACK FIBERS.—Fibers occurred in 8 (32 per cent) of the nests and ranged from 0.69 to 5.7 (av. 1.5) per cent of the total weights. Lengths ranged from 49 to 111 mm (av. 70 mm). The fibers were long, twisted, and had minute side branches. Chemical preparation and microscopic examination showed that each strand was composed of numerous fine fiber-tracheids. The strands could possibly be from a variety of plants. Superficially the material resembled the core from Spanish moss (*Tillandsia usneoides*) which, of course, does not occur in the area. Most of the nests that contained these fibers were from Crawford County. The fibers were used only in nest linings. Usually no hair and few mosses were used when moderate or large quantities of fibers were used.

DEER HAIR.—Hair was the predominant material used in nest linings. Twenty-one nests (84 per cent) contained white deer hair (*Odocoileus virginianus*) in amounts ranging from a trace to 2.9 (av. 1.14) per cent of the total weights. A combination of mosses and hair was most commonly used in the lining. One or two nests contained a few strands of hair from other mammals.

Miscellaneous.—Included under this heading are four types of materials.

One or two small feathers occurred in 3 (12 per cent) of the nests. All were apparently passerine feathers, possibly those of the Kirtland's Warbler.

Wood chips were found in 3 (12 per cent) of the nests. Amounts ranged from 1.5 to 8.8 per cent. One nest contained numerous light, sizable chips, apparently the remains of woodpecker workings.

Equisetum was found in 2 (8 per cent) of the nests. One nest contained a single short piece of the fruiting stalk of *E. fluviatile.* Another nest contained a relatively large amount (by bulk), 7.2 per cent by weight, of the vegetative portions of probably *E. sylvaticum.* These pieces ranged from 69 to 133 mm (av. 104 mm) in length.

Houstonia longifolia appeared in one nest (4 per cent). A small piece of fruiting material was found in the outer layer.

DISCUSSION

As a result of this study it is possible to conclude that nest materials are not distinct limiting factors for the distribution of Kirtland's Warbler. None of the plants identified from nests was restricted to the pine plains. Many probably occur in more dense forest stands and other jack-pine regions not inhabited by Kirtland's Warbler. However, a broader view suggests that the plants most commonly used in nests are characteristic of associations, within the pine plains, preferred by the warblers. Examination of areas that appear suitable, to us, as warbler habitat might actually show an absence of some of these important plants, thus making the area uninhabitable to the birds. This could also be one reason for the nearness of pairs within some areas rather than the birds being dispersed throughout the apparently available habitat. It is also apparent that the importance of particular species of sedges and grasses must be considered, not only with regard to the amounts used in the nests, but with consideration of their abundance in the area. With this in mind we can see that the grasses play an important dual role (1) by providing the bulk of the nest materials, and (2) by providing the major type of concealment for nests. When we consider these two points together it is obvious that the part played by these plants may indeed be important in restricting the warblers to the open, savanna-type or recently burned jack-pine areas.

Although some materials, or species of plants, appeared to be used in very small amounts (by weight) their appreciable bulk contributed significantly to the nest (e.g., deer hair, black fibers, *Equisetum*). Also some small, lightweight materials (e.g., moss sporophytes) probably required more trips by the birds to supply the amounts used in nest linings and their importance should be evaluated with this in mind.

A combination of many factors is probably responsible for the restricted range of Kirtland's Warbler. Eventually we may be able to amass all of the evidence and understand the ecological requirements of the species.

SUMMARY

1. Twenty-five nests of the Kirtland's Warbler were examined; 20 were taken apart and the materials identified, weighed, and measured.
2. The prevalence of "pine islands" is apparently necessary for the presence of breeding Kirtland's Warblers.
3. The nest is located on the ground near jack pines.
4. The nest was composed of three layers of noticeably different materials.
5. Twenty-nine species of plants were identified from nest contents. Most of these were fairly common in the pine plains.
6. The materials used in the nests were placed in 11 categories, and each species of plant is discussed as to the amounts and portions used in the nests, position in the nest, and the constancy of the species in the pine plains.
7. The abundance of sedges and grasses may be important in restricting the warblers to particular portions of the jack-pine plains. There was no indication that any one particular plant affected the distribution of the warblers. However, an association of plants, represented by those found within the nests, may have a definite influence upon the selection of nesting habitat by the warblers.

UNIVERSITY OF MICHIGAN MUSEUM OF ZOOLOGY, ANN ARBOR, MICHIGAN, 9 MARCH 1960

NEW LIFE MEMBER

We welcome Harold D. Mitchell, of Williamsville, New York, as a new life member of the WOS. A graduate of MIT, Mr. Mitchell is a retired sales engineer spending more time now on his special interests in bird distribution and in bird photography. He gives talks before various organizations and illustrates these talks with his own color slides and motion pictures. He has conducted classes for adults at the Buffalo Museum of Science, has published articles in *The Auk* and *The Wilson Bulletin*, and has read papers before the Federation of N.Y. State Bird Clubs and the AOU. Mr. Mitchell is an elective member of the AOU, a former president of the Federation of N.Y. State Bird Clubs, the Buffalo Ornithological Society, and the Buffalo Audubon Society, and a member of the Linnaean Society, Nature Conservancy, and several other similar organizations.

THE GEOGRAPHICAL AND ECOLOGICAL DISTRIBUTION OF THE BLACK SWIFT IN COLORADO

OWEN A. KNORR

THE northern race of the Black Swift (*Cypseloides niger borealis*) remained undescribed until the year 1857, at which time it was reported by Kennerly, a member of the Pacific Northwest Boundary Survey Expedition, who collected a specimen in the Puget Sound region. It seems remarkable that it could have escaped notice for so long. However, history seems to have repeated itself on a more limited geographical scale, for it was not established that the bird is a breeding species in Colorado until 1949.

The breeding range of the northern form of the Black Swift extends from southeastern Alaska southward to southern Mexico, and eastward to much of mountainous Colorado. However, within this vast area, the bird occurs only in isolated colonies due to certain ecological considerations to be discussed later. As far as the winter range is concerned, Bent (1940), who has written the only fairly complete account of the species, states that it is unknown. Whether the bird spends the winter with the resident form in Central America or goes on to South America is still to be determined.

The credit for the initial discovery of the Black Swift in Colorado goes to Frank M. Drew (1881) who collected a specimen along the Animas River a few miles east of the present site of the town of Silverton in San Juan County. He stated that it bred in this locality, but this was an inferential conclusion since he found no nests. This is further borne out by the fact that the nest and egg of the Black Swift were unknown to science until 1901, when A. G. Vrooman found the species nesting along the Pacific Coast west of Santa Cruz, California. Nevertheless, Colorado has been included in the breeding range in the AOU Check-list and elsewhere on this basis up to the present time.

The years following Drew's discovery produced very few Colorado records, some authentic and some doubtful. In 1882, Drew returned to substantially the same locality and collected a series of 10 individuals, publishing some notes on their plumages during that year. Again, in 1885, he published a short paper on the vertical ranges of birds in Colorado giving 14,000 feet as the upper limit for the Black Swift and stating that it breeds between 10,000 and 12,000 feet. Bendire (1895), in his "Life Histories of North American Birds," said that the bird seemed confined to San Juan County and mentioned Anthony's correspondence with him concerning observations of the Black Swift around Silverton in the summer of 1883; he also noted Fisher's observations of swifts of this species about the cliffs near Trinidad in July 1892, although they have not since been seen there.

In 1897, Cooke, in "The Birds of Colorado," merely repeated Drew's and Bendire's statements, managing to confuse the word "saw" with "taken" in the process, as regards Fisher's observations at Trinidad. In the third supplement to his original work, Cooke (1909) mentions that "a female in the collection of George B. Sennett is labelled as taken at Denver, June 26, 1884." Despite all efforts of the staff of the Museum of Natural History at Denver, this specimen has never been located, and Black Swifts have been recorded but once out on the plains—one was found dead near Fort Morgan in Morgan County.

The next reference to the Black Swift in Colorado was by Widmann (1911) who published a list of birds observed in Estes Park, reporting several swifts over Glacier Meadow in July of 1910. This report, along with that of Drew, is interesting in that it provided a concrete location from which to start searching for the actual nesting sites of the swift. One year after Widmann, Sclater (1912) published "A History of the Birds of Colorado," presenting a digest of the work on the Black Swift to date and contributing nothing new. Betts (1913) included the bird in his list of the birds of Boulder County on the basis of Widmann's report of the Black Swift in Estes Park (just outside the county) and some notes by Gale which were unsupported by data. In 1928, Bergtold published a small guide to the birds of Colorado in which he stated that the bird occurs "north and east as far as Golden." This is the first mention of Golden as a locality for the Black Swift, but unfortunately there are no data. This area has been the subject of considerable attention by ornithologists in recent years including three years of intensive field work by me, but the bird does not seem to occur there. Alexander (1937), who revised Betts' list of the birds of Boulder County, permitted the Black Swift to remain on the hypothetical list in the absence of the demonstrated presence of the bird in this area. Niedrach and Rockwell (1939) in their "Birds of Denver and Mountain Parks" repeated Cooke's statement of the specimen in the Sennett collection. In 1940, Bent monographed the species as completely as possible with the data then available, citing all the work done up to that time but contributing no new material so far as Colorado was concerned.

More recently, Knorr and Baily (1950) discovered two nesting colonies in the San Juan mountains of southwestern Colorado during the summer of 1949, taking the first nest and egg for the state. Encouraged by this initial success and fascinated by the bird itself, I undertook the task of determining its geographical distribution in Colorado and the ecological factors of the environment affecting this distribution, restricting the latter to the physiographic and physical aspects. At present, a comprehensive life history of the species is under way, a type of study yet to be done for this bird.

I should like to take this opportunity to acknowledge the assistance given me during the 10 years I have been engaged in this problem. In 1949, the Denver Museum of Natural History, in the persons of Alfred M. Bailey and Robert J. Niedrach, provided the funds for the field expedition which resulted in the initial discovery of nesting Black Swifts in Colorado. The American Museum of Natural History awarded me a grant in 1951 from the Chapman Memorial Fund which permitted continuation of the rather costly field investigations, and for which I am extremely grateful. I am indebted to the staff of the Department of Biology of the University of Colorado, which awarded me a sum from the Gardner-O'Dell Scholarship Fund in 1952 to pursue my field work, and especially to Gordon Alexander, T. Paul Maslin, and Robert W. Pennak whose generous assistance brought the manuscript to its final form. Finally, the Council on Research and Creative Work of the University of Colorado awarded me a Faculty Grant to finish the distributional studies during the summers of 1958 and 1959.

FIELD INVESTIGATIONS

In order to chronicle more completely the search for the Black Swift in Colorado in recent years, it is necessary to go back to 1948. In the summer of that year, John A. Murphy and the late Robert Landberg, staff members of the Denver Museum of Natural History, were sent by the Director to San Juan County. The main purpose of the trip was to secure photographs of the Black Swift to augment the pictorial records of Colorado birds at the museum. Operating out of Silverton as a headquarters, they covered most of the territory between Red Mountain Pass on the north and Molas Divide on the south. Although they spent a number of weeks in this area, the search for the nesting sites of the swifts proved fruitless. Indeed, only a few birds were sighted during the entire period. The reasons for their failure are not clear.

It might be appropriate to mention here that the Black Swift is a very elusive bird. Its marvelous powers of flight make it extremely mobile and prohibit the establishment of any set pattern of comings and goings which often leads the observer to the nests of other species. It often feeds at great altitudes, sometimes appearing as a mere speck through a good 8× glass when directly overhead. When one considers that the bird can be easily confused with the White-throated Swift unless the light is perfect, and that the two species occur together in Colorado, the difficulties in locating a nesting site become apparent. Finally, it must be remembered that the Black Swift is far from common except on its breeding grounds, and in point of numbers of individuals probably stands near the bottom of the list among the breeding Colorado birds.

Since 1937, I had worked from time to time with Robert J. Niedrach, Curator of Birds at the Denver Museum of Natural History, and dean of Rocky Mountain region ornithologists. In the spring of 1949 he suggested that I take up the search for the Black Swift, and consequently plans were laid for a field trip to the San Juans the following summer. A. Lang Baily, a staff member of the Museum, was to accompany me on the trip. Numerous consultations were held and the literature was carefully reviewed for helpful clues. This latter point may have been overlooked by the previously unsuccessful investigators. Gradually, a method of operation evolved. In general, there are three ways to find a bird's nest. First, follow the bird to the nest. With a species as mobile as the Black Swift, this is almost out of the question without the use of hovering equipment. Secondly, be familiar with the type of locale where the bird has nested before, such as a certain species of tree or bush, and look there. Since the literature indicated that one of the keys to the problem was water, especially falling water, this seemed a step in the right direction but the checking of every cascade in San Juan County was also out of the question. Thirdly, one might stumble across the nest accidentally. The method finally adopted combined features of the first two. We decided to station ourselves where swifts had been seen on many previous occasions and to observe their flights. Then we would move in the direction of these flights in progressive stages, and when we were reasonably sure that we were in the general vicinity of the nesting site we would switch to the second method and examine all the likely spots in that vicinity.

We arrived in Silverton on 19 July 1949, and proceeded up the Animas River canyon to the approximate location of Drew's observations of 70 years before. Almost immediately three Black Swifts were observed flying up the canyon. No more were seen that day. The following day we moved up the canyon several miles above the first location and sat down to watch. After several fruitless hours five swifts appeared and proceeded to fly up and down the canyon, feeding at a considerable altitude. They finally disappeared up the canyon. We moved another mile upstream and saw more swifts feeding as before. Darkness concluded the day's observations.

Convinced now that we were on the right track, we decided to explore some of the tributaries of the Animas for possible nesting sites and to watch for any swift activity about them. The Animas Canyon had been heavily glaciated at this point, leaving many hanging valleys from which the tributary streams dropped into the canyon, producing some spectacular waterfalls. The plan was for Baily to ascend the ridge flanking Edith Gulch while I was to proceed up the canyon on foot to the ghost-town of Eureka to see if we were still too far downstream. Upon reaching Eureka I noticed five swifts orbiting the town. I climbed a rooftop for better vision and noticed that periodically they would fly up Niagara Gulch and return. Thinking I could see better from the mine dump across the canyon from the famous old defunct Sunnyside Mill, I climbed it. By this time the five swifts were joined by a sixth which apparently came down Niagara Gulch. Since Niagara was hidden from my view by the shoulder of the mountain, I left the mine dump and proceeded up Niagara Gulch. The ascent was very difficult but it soon became apparent that this was the end of the trail for Drew's swifts since the number of birds now increased to eight or nine and they were continually flying back and forth from the innermost part of the gorge. Upon reaching a point 50 yards below the falls, which have a free drop of almost 100 feet, I saw more than 12 swifts apparently flying to a large rock, which faced the falls, and clinging there. With some maneuvering I managed to assume a semi-reclining position on the side of the gorge 12 feet from the cascade on a slippery ledge. From this position I could observe with binoculars the actions of the swifts. They flew out over the canyon, returned, and circled the cavern at the bottom of the falls. Occasionally they would land on the aforementioned rock. One landed in full view on the side of the cavern. By this time it was getting quite dark and the swifts were coming to roost. Some tried to cling to the side of the chasm near me but my presence seemed to frighten them off. Several passed within a few feet of my head. One clung to the wall about eight feet away and I shone my flashlight on it before it flew away.

The descent was negotiated with considerable difficulty. Niagara Gulch is very steep and filled with a rushing stream. The upper falls are about 1,000 feet above the valley floor and the Gulch itself is over 100 feet deep, almost vertical-sided, and drenched with spray. Moss and some small ferns constitute the plant life. No nests were actually seen, but since the swifts were coming in to roost at darkness, it seemed safe to assume that I was within several hundred feet of the nests, perhaps much closer. The colony was estimated at this time to consist of at least 12 pairs.

On the following day, 22 July, we went up Niagara Gulch to see about the possibilities of reaching the chasm at the bottom of the falls to actually view the nests. This proved impossible without pitons and rope, items of equipment we had not brought along. We tried improvising with old railroad spikes and a sledge, but the spikes would not hold. Hoping to see the nests from the side we climbed the west ridge but the extreme steepness and the rotten character of the rock prevented us from reaching a suitable position. (More recently I was able to reach the face of the nesting rock by a difficult rappel from the top of the east ridge and counted seven nests in as many cavities sprinkled across the face of the rock.)

To ensure the success of our mission, the only line of action open to us was to find another site which would be accessible to simple climbing. We investigated Arraistes, Cunningham, and Cement Creeks all in the vicinity of Silverton without success. We walked down the railroad track along the Animas south of the town for a considerable distance but saw no swifts. While checking the South Fork of the Mineral River we observed two swifts flying up and down the valley and seeming to center about Cataract Gulch. We forded the river and climbed part way up the gulch, noticing that the number of birds had increased. In addition to feeding up and down the valley, occasionally they would swing into the gulch and fly out again. One swift came in and apparently landed just above my position in the gorge. Darkness prevented further observations.

The next morning, 24 July, we returned for more investigation. There are two falls in Cataract Gulch. We planned to examine the lower falls and then

Fig. 1. Typical Black Swift nest site.

go on to the upper falls. Upon reaching the base of the lower falls we flushed a bird from a nesting hole in the rock. By climbing part way up the side of the gulch we were able to see the nest. It was about 15 feet above the pool at the base of the falls on the sheer side of the gulch and about seven feet from the falling water. The pocket in which the nest was located was about one foot wide, 10 inches high, and 10 inches deep. It appeared to have been constructed of moss and mud and the layering indicated several years of use. In the nest was a single white egg. This then was the first nest and egg of the Black Swift to be found in Colorado and vindicated Drew's assumption that the bird bred in Colorado.

We notified the museum in Denver of our discovery and they decided to send John A. Murphy, the staff photographer, to photograph the nest. Meanwhile, we took our own photographs. On the 26th of July we explored the upper falls and found two more nests, one at the base of the falls and one at the top of the falls, and on the next day we collected the nest, egg, and female from the former location (Fig. 1), the first to be taken in Colorado. They are now in the Denver Museum of Natural History collection (DMNH No. 25,551).

Both the Niagara and Cataract Gulch nesting sites were in the Upper Canadian zone about 10,000 feet above sea level. All the nests were in the close proximity of rushing water and were subject to a cold spray, although one was drier than the rest being 20 feet from the water. The egg in the nest which was photographed felt cold to the touch after the incubating bird had been gone for some time but it later developed into a young swift. We judged the colony to be smaller than that at the Niagara location, perhaps only five pairs of swifts.

This concluded the field work for the summer of 1949, but on the trip back to Denver a stop was made in Ouray. I was surprised to see a dozen or more Black Swifts feeding over the town and I made a note to investigate Ouray County the following summer.

Limited funds reduced to a minimum the amount of field work accomplished during the summer of 1950. However, a trip was made through the San Juan Mountains in August, which resulted in the discovery of a new breeding colony in a new locality. This was near Ouray where the swifts had been sighted the year before. Employing the same method used so successfully before, the colony was located on the day of arrival, 24 August, on one of the tributaries of Canyon Creek. It was adjacent to a waterfall and there were approximately 10 pairs in the colony. The elevation was about 7,800 feet.

Recalling the fact that the wintering grounds of the Chimney Swift had remained a mystery until 1944 when some bands were recovered in Peru, and that the winter range of the Black Swift was also unknown, equipment had been brought along to band the swifts. But capturing the birds posed quite a problem. Seth Low, Director of the Bird-banding Division of the United States Fish and Wildlife Service, had informed me that the species had never been banded and he therefore could offer no help as to the matter of traps. A box to place over the nests, insect nets, and cheesecloth were all tried to no avail at both the Cataract Gulch and Ouray locations. Finally it was decided to attempt the banding at night, blinding the birds at the nest and in the roosting spots with a bright flashlight. The Ouray site was chosen for the experiment because of its proximity to the town in case of accident. Just at dusk, the climb up to the top of the gorge was made. The descent of the vertical wall was accomplished by means of a double rappel to a series of ledges and then another rappel to the nesting location. The whole procedure was complicated by darkness, wet rotten rock, and the fact that the nests were in a large chamber which was overhung by the cliff above. A flashlight held by a companion from the opposite side of the gorge illuminated a group of three nests and about six swifts, one of which was a young bird in the nest. The driving of the pitons into the rock and the swinging on the rope to get in under the overhang had not flushed them. Apparently the six-cell flashlight was bright enough to divert them. Four adults and a young bird were placed in a shirt and the descent to the bottom of the gorge was made by finishing the rappel. The birds were banded and since the adults fly as well at night as by day, they were liberated. The young bird was placed back in the nest by my companion whom I belayed back up the wall on the rope which had been left hanging from the last piton. Thus a modest start was made in the plan to band a few swifts each summer in the hope of solving the mystery of their winter whereabouts.

On the return trip a few swifts were observed at dusk near Pagosa Springs in Archuleta County near the southern border of Colorado. The presence of the birds during the breeding season indicated the possibility of a colony in the vicinity and several were found during the summer of 1958.

During the summer of 1951 a field trip was made through the Elk, San Juan, and San Miguel Mountains of west-central and southwestern Colorado with Dr. C. W. T. Penland, Professor of Botany at Colorado College. The trip had a dual purpose: to collect specimens of the genus *Penstemon* which Penland was monographing, and to locate more nesting colonies of the Black Swift. Such a colony was discovered on the west side of McClure's Pass in the Elk Mountains west of the town of Aspen. It was of medium size (about six pairs) and was notable for the fact that the stream consisted mainly of cascades rather than the waterfalls I had come to expect. It was only the first week in August and so the eggs in the nests observed had not yet hatched. The elevation was about 8,500 feet. It was in an area unmapped by the United States Geological Survey and therefore the stream had no official name, although the few human inhabitants of the region refer to it as "West Creek." The finding of this nesting site was important in the project of mapping the geographical distribution of the swift in Colorado since it extended the known breeding range of the swifts in Colorado northward by almost 100 miles.

On the 8th of August the Ouray nesting colony was visited again, and adults were observed either incubating or covering young in the nests discovered the year before. On the 9th and 10th, many swifts were observed in the Mt. Sneffels and Camp Bird Mill area west of Ouray and although no nesting sites were located, the area was thoroughly investigated during the summer of 1952 with good results.

On the 15th of August two large colonies of at least 15 pairs were found on Bridal Veil Creek and another on Ingram Creek within sight of the town of Telluride in San Miguel County at about 10,400 feet. More colonies were suspected in Bridal Veil Basin but time limitations prevented further investigation in the San Miguel Mountains.

The two basic references in the literature concerning the occurrence of the Black Swift in Colorado are the observations of Drew in southwestern Colorado and those of Widmann in north-central Colorado near what is now Rocky Mountain National Park. As the former location had been quite fully exploited I decided to investigate the latter. This proved to be a most vexing problem. Widmann reported that his birds were observed "over Glacier Meadow," in the vicinity of Estes Park in 1911. Park personnel knew of no Glacier Meadow. In fact, they had never seen a Black Swift. Assuming that the present day Glacier Basin was Widmann's meadow, camp was made in this area. Thus began two full weeks of dawn-to-dusk hiking and observation. Most of the area of the Park lying north of Long's Peak and east of the Continental Divide was covered. Swifts were observed at scattered locations throughout the area but they were most numerous in the territory east of Flattop Mountain and Hallett and Taylor Peaks, especially in Moraine Park, Glacier Basin, and along Mill Creek. It should be mentioned here that the character of the terrain in Rocky Mountain National Park is quite different from that of the San Juan Massif. In the Park there is only one main ridge, the Continental Divide, which runs northwest and southeast with the streams draining it at right angles. In the San Juans the mountain range is much wider with ridges and valleys running in all directions. The ridges are higher and the valleys are deeper so that the San Juans resemble the Alps more than most American mountains. Consequently, the swifts tend to fly up and down the valleys rather than over the ridges when travelling to and from the nesting sites. This is not true of the terrain east of the Continental Divide in the Park which tends to be more rolling by comparison. This made it almost impossible to establish any sort of flyways or flight patterns and thwarted the progressive following of the birds which had worked before, since they just seemed to wander over the entire area. The method which finally resulted in solving the problem consisted of plotting the daily swift sightings on a topographic map, and by the middle of the third week a funnel-shaped pattern began to emerge with the apex pointing at Loch Vale. Camp was set up at the bottom of a wet, dripping cliff in the Vale, which seemed a likely spot. The following day three nests were located by binocular from a rise opposite the cliff, two with young and one empty. The elevation was 10,500 feet. By San Juan standards the water was rather meager but there were many excellent damp nesting crannies available.

From the standpoint of the distribution study, this was the most important discovery of four years of field work, moving the breeding range north and east by 200 miles from the original Silverton location.

The summer of 1952 was by far the most successful in the search for the Black Swift in Colorado. The field work was started in Rocky Mountain National Park because it seemed that from the number of swifts observed the previous summer, more nesting colonies should exist than the small one I had found. Operating on the theory that Glacier Basin was not the "Glacier Meadow" mentioned by Widmann, I went back to the literature and found that Widmann had been staying at the Long's Peak Inn when his Black Swift observation was made. A long-time resident of this area provided the information that Glacier Meadow had been renamed Tahosa Valley in later years. This was only four miles to the southeast of Glacier Basin but due east of Long's Peak and in an area not as yet investigated. This clue led to a series of long vigils, watching and waiting for swifts, and after about five days of work a very small colony was found on the Roaring Fork at 11,500 feet on the east slope of Long's Peak, the highest Black Swift colony located at the date of this writing. This was unusual in that timberline is some hundreds of feet lower at this latitude than in the San Juans, and the present colony was situated just at or slightly above timberline. The date of discovery was July 12th but a 100 yard-long snow bank still remained, the lower end of which was a scant 12 feet from the nest, adjacent to a small cascade. An adult was incubating at this time. The nest was kept under observation from time to time and by the 8th of August the young bird was quite visible above the rim of the nest.

Since the stream came over a glacial step on a rather broad front at this point it was necessary to enlist the aid of another person so that the main cascade and another one 70 yards to the south could be kept under observation at the same time. Douglas Alexander of Boulder kindly consented to help, and at least one and possibly more swifts were seen landing in the vicinity of the second cascade at the same time that the adults were clinging to the nest at the first cascade. However, another nest was never found although an abandoned one was observed at the second site. Whether the other birds constituted a family unit and the nest was too cleverly hidden to be located or whether they were part of a floating population coming to roost is open to conjecture. If the latter is true, the word "colonial" as usually applied to the nesting of the Black Swift is open to question.

The final observation was made at this site on the 10th of September in a swirling, early-season snowstorm. The young bird was still in the nest but was seen to be exercising its wings at frequent intervals preparatory to flying away. From the condition of the plumage and the length of the wings it was estimated that the bird had no more than a week left in the nest.

Shortly after the Long's Peak site was discovered, a short trip into the Wild Basin area resulted in the sighting of a considerable number of swifts. Wild Basin is in the extreme southeast corner of Rocky Mountain National Park and in Boulder County, as is the Long's Peak nesting site. A field trip to the San Miguel area prevented further work here but it is felt that future investigation will produce at least one more colony in this region.

Returning to the Ouray County area, five more colonies were discovered during the third week in July. They were located east of the Sneffels ghost-town and were all of small to medium size. One colony was notable in that the volume of water present was extremely small, consisting of only a steady dripping, although roaring Canyon Creek was only several hundred yards away. The elevations of the newly found colonies were all just above or just below 10,500 feet. The old original Ouray site was checked again on the 24th of July, and of four nests visible, three had eggs and the fourth was impossible to observe because of its position.

Just prior to leaving on this last Ouray County trip, a popular article on Colorado was noticed in the *Colorado Wonderland* magazine (1952). In it was a photograph of a series of falls on Dead Horse Creek in the Glenwood Springs area which appeared to be excellent locations for Black Swift colonies. Accordingly, the return from Ouray was routed through this region and the results justified the investigation. Three colonies were discovered, one at each of the falls. Three nests were located at the upper falls, three at the middle falls, and two at the lower. The nests at the upper falls were at least 20 feet from the nearest water although they were subject to considerable spray. However, the birds at the middle and lower falls had to fly through a curtain of falling water to reach their nests, which were located under the lip over which the water rushed. At least one nest was placed within eight inches of this torrent and in order to reach it the birds would fly headlong through a thinner portion of the water curtain, make an abrupt right-angle turn, then fly parallel to the water in the narrow space between the falling water and the rock until reaching the nest, a most remarkable demonstration of aerial agility. These colonies were the lowest to be found in Colorado, the elevation being approximately 7,200 feet above sea level. Although a day's work produced only eight nests, it was felt that the total strength of the three colonies was in the neighborhood of 15 pairs. Those nests permitting direct observation still contained eggs since it was only the 26th of July.

By this time I had found that I could predict the occurrence of swift colonies from photographs or topographic maps with a fair degree of accuracy. By this means, a suitable location was indicated on Clear Creek northwest of the town of Creede in Mineral County. On the 4th of September a large colony was discovered at 10,000 feet with nests flanking both sides of a waterfall. Similarly, another swift area was discovered in the extreme southwest corner of the state. Many swifts were seen in the vicinity of Mystic Falls on the Rio Dolores, but bad weather had become general and no attempt was made to locate the nests.

On the return trip a stop was made in Ouray to investigate Cascade Falls northeast of the town. This is a magnificent cataract with a free fall of over 100 feet when the stream is running heavily. Two nests were observed, both behind the falling water. The upper nest was very high but the lower nest permitted the observation by binocular that the young bird which it contained was still downy. Since it was the 6th of September, this indicated that there may be a considerable spread of time during which nesting is initiated. The remainder of the return trip resulted in the sighting of swifts in an entirely new area, that of Climax and Alma, but time limitations prevented the location of nesting colonies.

During the summer, in a conversation with T. Paul Maslin of the Department of Biology staff, I had described the places in which Black Swifts nest. He recalled a location in the Sangre de Cristo Mountains which seemed to fit the description, a cascade or falls on the eastern slope of the mountains in Wet Mountain Valley. Since this was more than 100 miles away from the nearest swift colony, I decided to visit it next.

On the 12th of September, the day of arrival, a heavy snowstorm hampered field work but on the following day Alvarado Creek was investigated up to about 10,000 feet. At this point a series of cascades came down through a small gorge. One nest was discovered under an overhang on a tiny ledge about 20 feet above the stream level, but it was empty, which might be expected at such a late date. About 35 feet away was an adult roosting niche, a common thing about swift colonies, identified by the droppings. No other nests were found but from the number of birds observed in the air at one time, another colony must have been in the vicinity. However, two occupied nests were found at this site in later years. This discovery was especially significant in that it was the farthest east that the Black Swift had ever been found nesting, being 105 degrees 30 minutes west longitude.

Using field methods similar to those described above, many more swift colonies were discovered in Colorado during the summers of 1953 through 1958. In Boulder County, swifts were sighted over University Camp, Caribou Ranch, Brainard Lake Basin, and Rainbow Lake Basin, all presumably from a colony situated below Arapahoe Glacier. Two more occupied nests were found at the Wet Mountain Valley site. The summer of 1958 was especially productive in closing gaps in the distribution map. Some years before, on a swift-hunting trip to Ouray, I had seen an early photograph in a hotel there of a beautiful "swifty" waterfall in the Black Canyon of the Gunnison River. A trip to the falls disclosed a small colony, the first for this general area. During the same summer three more colonies were found near Vail Pass and two more were located in the Wolf Creek Pass region.

This brought to a close 10 years of field work to determine the geographical and ecological distribution of the bird within the borders of the state. Some 15,000 miles had been traveled by automobile and it was estimated that 120 miles had been covered on foot during the course of the project.

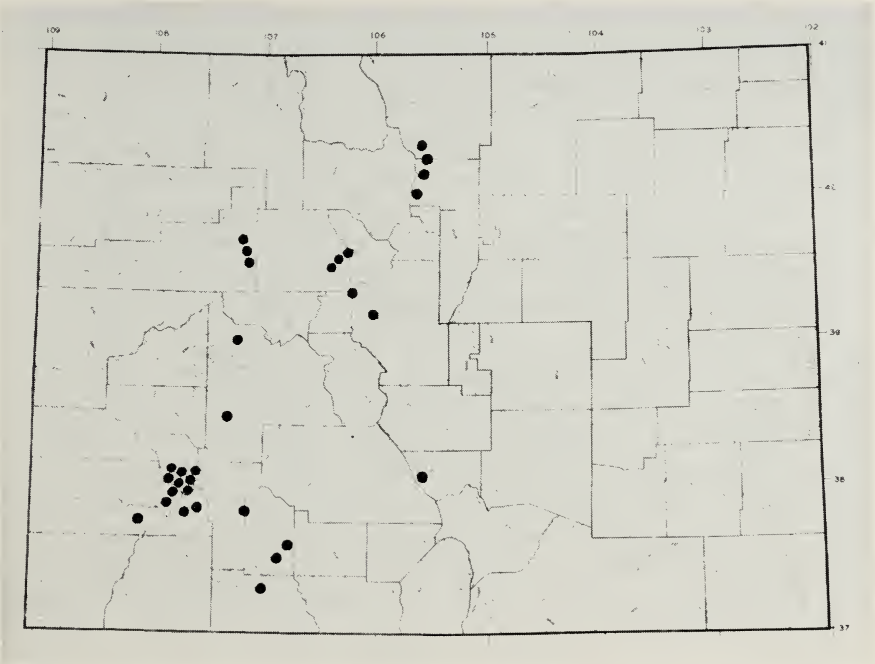


FIG. 2. Locations of active Black Swift breeding colonies and breeding season sightings in Colorado.

DISCUSSION

Geographical Distribution.—As a result of these investigations, 27 active breeding colonies consisting of approximately 80 nests were discovered at scattered locations throughout the Colorado Rockies in the counties of Larimer, Boulder, Eagle, Garfield, Gunnison, Custer, Mineral, San Juan, Ouray, and San Miguel. In addition, sightings were made in areas which should produce nesting colonies upon future field investigation. These were in Boulder, Lake, Park, Archuleta, and Dolores counties. The total area encompassed is approximately 19,500 square miles. It may be seen that the distribution brackets a major portion of the mountainous part of the state (Fig. 2), and there is little doubt that future work will show that the Black Swift will nest anywhere in the Colorado mountains that its ecological requirements are met. The nature of these requirements as established by these investigations is discussed below.

Ecological Requirements.—As the field work proceeded and the notes on the nesting colonies accumulated, an ecological pattern began to emerge. Upon analysis of these data, five physical factors were found to be present to a greater or lesser degree in all the colonies. Furthermore, seemingly suitable locations in which no swifts were present were found to be lacking in one or more of these five requirements. They may be enumerated as follows: the presence of water, high relief as regards the configuration of the terrain, inaccessibility, darkness, and lack of flyway obstructions.

Water.—Without exception, water is present at every nesting site, varying in degree from a rushing torrent to a mere trickle, although the former seems to be preferred. The proximity of the nests to the water also varies, with some as close as eight inches and others as far away as 35 feet. The volume of water and height of free fall seem to control this positioning of nests. The attendant spray at heavily running streams permits the placing of nests at a greater distance from the running water; perhaps the roar of the falling water also plays a part. The moss of which the nests are constructed continues to grow in most cases, emphasizing the role of the spray and damp surroundings. As mentioned before, a curtain of falling water is no barrier to these birds which will fly through it to reach a suitable nesting cranny. The importance of water as a nesting site requirement is indicated in that no swift nests were found on a true intermittent stream. Even in the driest year of observation, the water continued to run at all swift nesting sites. Also attesting to the damp environment of swift colonies are the plant indicators which seem to be such hydrophiles as *Mimulus* and various ferns and mosses.

High relief.—A term borrowed from the cartographer most aptly describes the requirement that the nesting site have a commanding position above the surrounding terrain so that birds flying out from the nests on a horizontal course find themselves automatically at feeding altitude above the adjacent valley. This is to be expected since the bird habitually feeds at high altitudes and is often observed taking airborne insects which are being sucked up by the violent updrafts existing under clouds of vertical development. Some apparently suitable locations fulfilling all the other requirements but situated just at the valley floor are ignored by the swifts. The appreciation of this need for sharp contrast in the terrain surrounding swift colonies greatly simplified the search for nesting sites toward the end of the project.

Inaccessibility.—The requirement that a Black Swift nest be inaccessible to terrestrial marauders appears to be inflexible. No nest was ever found which was accessible to anything without wings. A human being with a rope or ladder is a possible exception, but at most sites this is an extremely hazardous undertaking. The fact that the bird lays only a single egg indicates that its enemies are few. However, the very inaccessibility of the nests operates as a disadvantage at times since at least one young bird has been observed to fall out of the nest to be swept away in the stream.

Darkness.—The sun rarely shines on the nest of a Black Swift. I have never found an occupied nest upon which the sun shone. Furthermore, the gloom of the innermost recesses in the rock is preferred to lighter situations in more exposed places. The young bird invariably faces away from the light while in the nest except when anticipating the return of an adult. However, since there are more Black Swifts at nesting colonies than there are dark crannies which meet all the other nesting requirements, some nests are exposed to more light than others. An interesting borderline case was discovered in the Ouray area where a nest was placed on a sheer wall adjacent to a waterfall. As the season progressed and the sun swung lower in the sky, the sunlight crept closer to the edge of the nest. On the day that the young bird left, the sun had reached the edge of the nest and a few days later, illuminated the inside of it.

Unobstructed flyways.—As a corollary to the requirement of high relief mentioned above, the air immediately in front of a nesting site must be free of obstructions. The birds do not seem to mind flying up and down a narrow, twisting gorge, but they will not fly through a maze of tree branches to reach their nests. Many excellent sites (to the mind of the observer) were found which fulfilled all other requirements but were screened from the front by trees. No swifts were present. On the other hand, no swift colony has been found in which it is necessary for the birds to dodge trees on their way to the nests.

There may be other physical factors present which operate in the choice of nesting sites but the five mentioned above seem to be the obvious ones as established by these investigations. The impossibility of seeing the nests from above, or putting it differently, the protection from weather in the form of precipitation is another physical factor present in all cases but it is not to be ranked with the others. An additional requirement may be sound, since I have never seen, read about, or heard about a Black Swift nest which was not within range of the sound of water in motion, usually violent motion. This need not be merely a tribute to the type of environment required for a mossy nest since many permanently damp and humid crannies can be found quite remote from noisy water and which harbor no swifts. However, sound has not been generally established as an ecological factor for nonhuman animals except perhaps colonial sea birds. Future investigation will probably see the establishment of additional ecological criteria for the Black Swift. A comprehensive life history of the species is presently under way toward this end.

SUMMARY

During the summers of 1949 through 1958, field investigations were carried on to determine the geographical distribution of the Black Swift in Colorado and the ecological factors affecting this distribution. Fifteen thousand miles were traveled by automobile and 120 miles were covered on foot.

Twenty-seven active breeding colonies were located at scattered points in 10 counties

throughout most of the mountainous portion of Colorado. A nest, egg, and associated female were taken, the first to be recorded for Colorado. Additional sightings of the Black Swift were made during the breeding season in five other counties.

Five physical ecological factors were found to be present to a greater or lesser degree in all the colonies: the presence of water, high relief as regards the configuration of the terrain, inaccessibility to terrestrial marauders, darkness, and the lack of flyway obstructions in the vicinity of the nest.

It is believed that the Black Swift will nest anywhere that these ecological requirements are met.

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WEATHER AND FALL MIGRATION OF HAWKS AT CEDAR GROVE, WISCONSIN

Helmut C. Mueller and Daniel D. Berger

The data for this report were obtained during a hawk-trapping and banding program conducted at the Cedar Grove Ornithological Station located on the west shore of Lake Michigan some 45 miles north of Milwaukee, Wisconsin. This area has been known for its spectacular hawk-flights since 1921 (Jung, 1935), and the Milwaukee Public Museum operated a hawk-banding station there for a number of years prior to World War II. Our banding program and migration studies were established in 1950 and are still in progress. The observations reported herein are from the autumns of the years 1952 through 1957.

Evidence of migration is obtained in two ways: (1) by directly observing birds in flight (visible migration) and (2) by noting the fluctuations in numbers of individuals and species in an area. Neither method offers a direct means of determining the factors operative in the inception of migration.

As Brewster (1886) and many others since have emphasized, the weather conditions at the bird's point of departure are important factors in bird migration. Unfortunately, birds have rarely been observed in the process of departing, and inferring the location of departure areas is fraught with difficulties. This is particularly true of analyses based on the presence and numbers of migrants in an area since the direction of arrival is also unknown. A concentration of grounded migrants may be the result of migrating birds encountering unfavorable weather (Bagg et al., 1950; Imhof, 1953; Dennis, 1954). Under other conditions these birds might have passed over unnoticed. Visible migration observations, on the other hand, are almost invariably conducted at localities on a coast, mountain ridge, or other "guiding line." Such observations present a biased picture of the numbers of migrants in an area and may give misleading evidence concerning the migratory direction of the birds.

The literature dealing with relationships of weather and bird migration is varied and extensive. A survey of the earlier works and a brief introduction to modern meteorological concepts can be found in the paper by Bagg et al. (1950).

Modern meteorological analysis is based on the concept of large moving air masses. The surface between two dissimilar air masses is termed a "front." At a given altitude an air mass has approximately the same characteristics throughout its extent, and frontal zones usually have about the same configuration for great distances along the front. Changes in such variables as temperature, wind direction, etc., can largely be attributed to the movements of air masses and fronts. Thus, information of the composition and the movement of air masses is essentially a summary of the temporal and spatial occurrence of most of the meteorological variables likely to be of interest in migration-weather analyses.

Recent investigators of nocturnal migration have correlated the following meteorological factors with the arrival of migration "waves": (1) Air mass and frontal movements (Bagg et al., 1950; Bennett, 1952; Devlin, 1953; Bagg, 1958; Baird et al., 1958; Newman, 1958). (2) Following winds (Robbins, 1949; Bagg et al., 1950; Bergman, 1951; Devlin, 1953 and 1954; Raynor, 1956; Newman, 1958). (3) Temperature (Robbins, 1949; Bergman, 1951). (4) Stable (nonturbulent) air flow (Raynor, 1956). Correlations derived from telescopic observations of birds seen crossing the face of the moon generally agree with those of the students of the arrivals of migration "waves" (Lowery, 1951; Lowery and Newman, 1955).

Only a few attempts have been made in North America to correlate diurnal visible migration with meteorological variables. Hochbaum (1955) correlated major fall waterfowl flights with rising barometer, falling temperature, decreasing humidity, and northwest winds. Ball (1947) found that Red-breasted Nuthatches (*Sitta canadensis*) migrated in periods of clear weather following intervals of inclement conditions. European workers have correlated visible migration with almost all conceivable meteorological factors: e.g., barometric pressure (Griffin and Nisbet, 1953), calm weather (Williamson, 1953), wind direction (Rudebeck, 1950), temperature change (Bergman, 1951), and constant temperature (Ritchie, 1940). Jenkins (1953) correlated migration "waves" of the fall of 1951 for northwest Europe individually with several of these semi-independent variables. In addition, it must be remembered that the physiological and behavioral state of the bird underlies all migration activity and sets the basic seasonal rhythm. Farner (1955) can be consulted for a review of the work concerned with the physiological factors influencing *Zugdisposition.*

A portion of this chaos of interpretations of migration and weather patterns can be attributed to geographical differences in migration patterns, and a part to differences in behavior of the species involved. Hinde (1951) offers an explanation that simultaneously could include several weather factors. He hypothesizes that migration results from the additive effects of both the "internal drive" and the various external factors (law of heterogeneous summation, Tinbergen, 1951:81). Thus, if the internal drive is low, even an optimal combination of external factors may be insufficient to cause migration; when the internal drive is high, any one of several stimuli may suffice. Since the internal rhythm probably varies slightly from year to year, we would expect different responses to any given set of weather conditions (Nisbet, 1957).

An alternative (and, to us, more attractive) view is that the impetus for migration lies entirely in physiological factors and that weather acts simply to aid, permit, halt, or otherwise modify the pattern of migration. The ultimate "cause" of migration undoubtedly lies in the evolutionary adaptation by selection to the breeding cycle and the availability of food, etc. (Baker, 1938; Lack, 1950). Response to a given set of meteorological conditions might be also selected for, if these conditions provide for greater survival of migrants (Nisbet, 1957).

A high correlation between a given meteorological factor and bird migration does not necessarily imply a direct causal relationship. Consider, for example, the following simplified illustration: in autumn migration usually occurs during periods of dropping temperatures and northerly winds. The birds may be responding to the temperature drop or to the effects of temperature on the food supply. Alternatively, the birds may be migrating on northerly winds simply because these following winds aid southerly passage. The correlation with temperature may thus be coincidental, or the temperature drop may serve as a "cue" announcing the onset of northerly (favorable) winds. The above can easily be further confounded by the addition of other meteorological factors.

Hawks, because of their large size and tendency to become concentrated at certain points, are extremely favorable material for a study of weather and migration. Autumn hawk-flights, studied at a number of localities in eastern North America, have been correlated with the following weather conditions: (1) west or northwest winds: Connecticut (Trowbridge, 1895, 1902); Fisher's Island, New York (Ferguson and Ferguson, 1922); Cape May, New Jersey (Stone, 1922, 1937; Allen and Peterson, 1936); Hawk Mountain, Pennsylvania (Broun, 1948, 1951); West Virginia (De Garmo, 1953); Maryland (Robbins, 1956); north shore of Lake Erie (Gunn, 1957); north shore of Lake Superior (Hofslund, 1958). (2) A low-pressure system to the north (Broun, 1951; De Garmo, 1953). (3) Decrease in temperature (Ferguson and Ferguson, 1922; Robbins, 1956). (4) Rising barometer and (5) cold front passage (Robbins, 1956). These weather conditions often occur together, and it is difficult to decide which one or several in combination are finally responsible for initiating a flight.

OBSERVATIONS

A dawn-to-dusk watch was maintained on most of 256 observation days; however, on days with little or no migration the observations often became sporadic. At the worst, observations were made with sufficient frequency to make it exceedingly doubtful that more than a dozen hawks passed by unseen on any observation day. For three of the years (1953, 1954, and 1955), observations were made essentially on every day in the period from 1 September through 25 October. In the other three years, observations

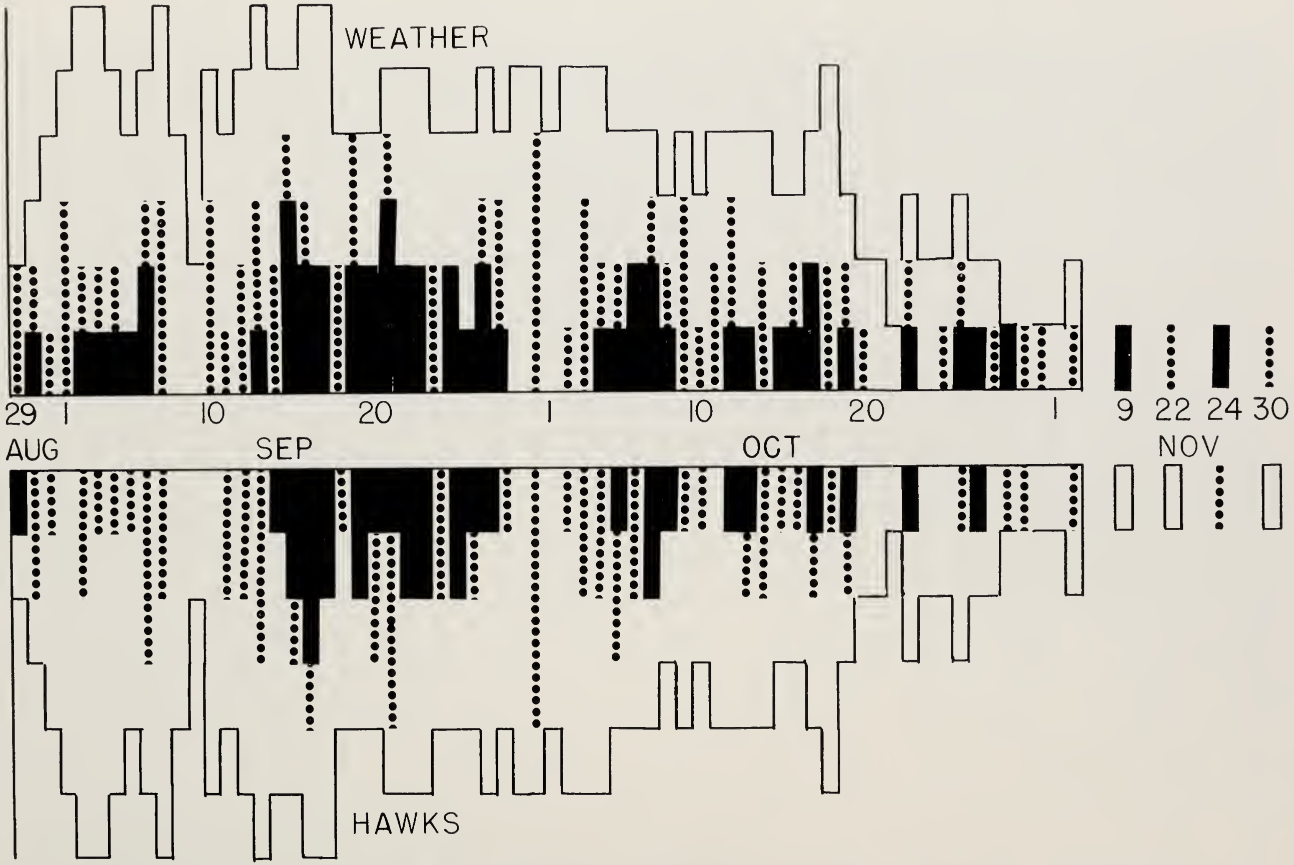

Fig. 1. Relative occurrence of observation, hawk flights, and weather suitable for hawk migration during 1952–1957. Black bars indicate number of days having Class A weather (above the date line) and the number of days having Class I flights (below date line). Similarly, dotted bars indicate Class B weather (above) and Class II flights (below). White bars indicate the number of observation days having unsuitable weather (above) and less than 25 hawks (below).

TABLE 1

NUMBERS OF HAWKS OBSERVED AT CEDAR GROVE IN AUTUMNS OF 1952–1957

Broad-winged Hawk (*Buteo platypterus*)	15,965
Sharp-shinned Hawk (*Accipiter striatus*)	8,524
Red-tailed Hawk (*Buteo jamaicensis*)	1,407
Marsh Hawk (*Circus cyaneus*)	1,115
Pigeon Hawk (*Falco columbarius*)	798
Sparrow Hawk (*Falco sparverius*)	370
Cooper's Hawk (*Accipiter cooperii*)	268
Osprey (*Pandion haliaetus*)	186
Peregrine Falcon (*Falco peregrinus*)	150
Red-shouldered Hawk (*Buteo lineatus*)	72
Rough-legged Hawk (*Buteo lagopus*)	39
Goshawk (*Accipiter gentilis*)	19
Turkey Vulture (*Cathartes aura*)	17
Swainson's Hawk (*Buteo swainsoni*)	7
Bald Eagle (*Haliaetus leucocephalus*)	6
Golden Eagle (*Aquila chrysaetos*)	2
Prairie Falcon (*Falco mexicanus*)	1
Unidentified	115
Total	29,061

were somewhat biased in favor of what we assumed to be good weather. The seasonal distribution of observation through the six years is presented in Fig. 1. Approximately 29,061 Falconiformes of 17 species were recorded. The species totals given in Table 1 are composed for the most part of actual counts, although careful estimates were made on three occasions when flights were too heavy for direct counting (these estimates are indicated in Table 2).

Four species account for more than 90 per cent of the individuals observed and largely determine the characteristics of the fall hawk-flight. Two of these, the Marsh Hawk and the Red-tailed Hawk, are well distributed throughout the entire fall, while the Sharp-shinned Hawk and the Broad-winged Hawk exhibit definite peaks of occurrence. The configuration and principal species components of the fall hawk-flight can be seen in Fig. 2. This illustration presents graphically the average number of hawks (Broad-winged, Sharp-shinned, and all other species totaled) seen per observation day for each calendar date through most of the season.

The meteorological data were taken largely from Weather Bureau publications (*Local Climatological Data* and *Local Climatological Data Supplement*) for Milwaukee, Wisconsin, 45 miles south of the observation point. Local weather publications for Madison, Wisconsin, 95 miles southwest, and for Green Bay, Wisconsin, 80 miles north, were also consulted. *Daily Weather*

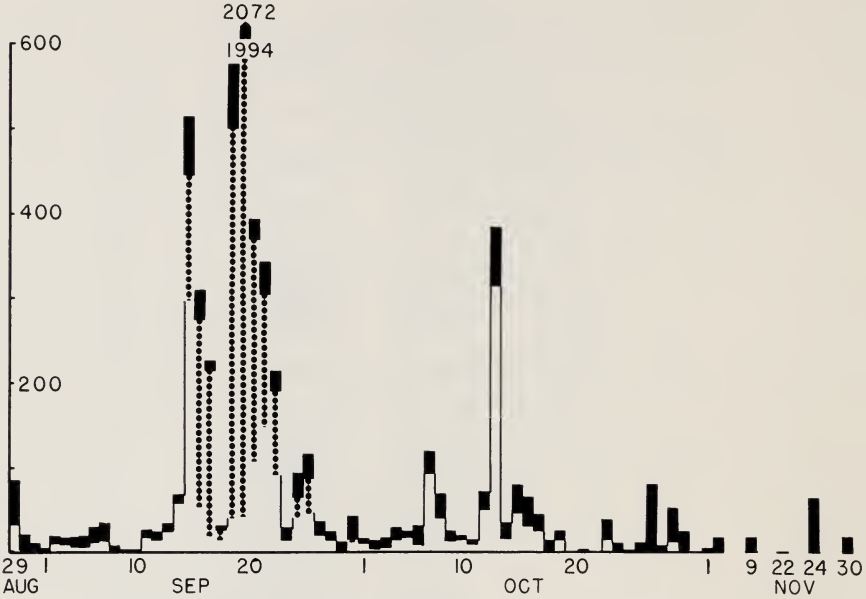

Fig. 2. Average number of hawks seen per observation day. White portion of each bar represents the number of Sharp-shinned Hawks; spotted portion, the number of Broad-winged Hawks; black portion, the number of individuals of all other species.

Maps for each of the observation days were closely examined. *Monthly Weather Review* supplied information on the movements of pressure cells. Although weather conditions were recorded at Cedar Grove, the information was not used in this report because it proved impossible to obtain consistent, accurate data with our meager equipment and varied personnel.

Although the weather conditions concerned with migration are those at the bird's point of departure, the air masses influencing the weather at the *probable* departure points of most of the birds involved in this study (i.e., to the north and west) ordinarily arrive in Wisconsin at about the same time as, or before, the birds. In the absence of more specific information regarding the areas of origin of the migrants passing Cedar Grove it would seem appropriate to restrict the analysis largely to weather conditions near the point of observation.

After a preliminary examination the observation days were placed into two classes on the basis of weather data: (A) days with westerly winds and a 1230-hour (CST) weather map similar to that shown in Fig. 3. On all these days there was a low-pressure area somewhere to the northeast of Wisconsin and high pressure to the southwest. The isobars (lines of equal barometric pressure) crossed Wisconsin on a NW–SE diagonal, and a cold

TABLE 2

LIST OF ALL OBSERVATION DAYS WITH MORE THAN 25 HAWKS AND/OR WESTERLY WINDS AT NOON

Date	No. hawks	(Broad-winged)	Wind at noon	Velocity (mph)	Wind 0600 hr.	Wind prev. day	Temp. drop	No precip.	No overcast	Days since cold front	Barometer
	A. With Class A weather and more than 100 hawks										
20 Sept. 1952	129	+ 7,462*	WNW	11	+	+	+	+	+	3	R
19 Sept. 1952	129	+ 2,000*	WNW	13	+	+	+	+	+	2	R
15 Sept. 1952	1,424	+ 415*	W	21	+	+	+	+	+	1	R
13 Oct. 1955	1,484*		WNW	21	+	+	+	+	+	2	R
17 Sept. 1956	161	+ 1,015	WNW	17	+	–	+	+	+	1	R
16 Sept. 1952	296	+ 782	NW	13	+	+	+	+	+	2	S
21 Sept. 1953	101	+ 801	NW	16	+	+	+	+	+	3	R
22 Sept. 1954	583	+ 285	W	17	+	+	+	+	+	2	R
23 Sept. 1957	433	+ 394	NW	23	+	+	+	+	+	2	S
22 Sept. 1957	328	+ 483	WNW	17	+	+	+	+	+	1	R
15 Sept. 1953	285	+ 349	WNW	14	+	+	+	+	+	0	F
21 Sept. 1954	432	+ 176	WNW	22	+	–	+	+	–	1	F
20 Sept. 1953	61	+ 510	NW	12	+	+	+	–	–	2	F
21 Sept. 1952	87	+ 355	WNW	17	+	+	+	+	+	4	R
26 Sept. 1954	234	+ 159	NW	14	+	+	–	+	+	2	F
16 Sept. 1957	86	+ 195	WNW	20	+	+	+	+	+	1	R
12 Oct. 1955	260		WNW	23	+	–	+	+	+	1	F
7 Oct. 1955	244		WNW	18	+	+	+	–	–	1	F
7 Oct. 1956	243		W	15	+	+	+	+	+	1	R
25 Sept. 1953	139	+ 85	W	21	+	–	+	+	–	0	F
15 Oct. 1954	217		NW	13	+	+	+	+	+	1	R
8 Oct. 1955	204		WSW	18	+	+	+	+	+	2	R
23 Sept. 1956	117	+ 77	WNW	17	+	+	+	+	+	1	R
16 Oct. 1954	173		NW	15	+	+	–	+	+	2	F
27 Oct. 1954	158		WNW	13	+	–	+	+	+	1	R
17 Oct. 1957	145		WNW	21	+	+	+	+	–	1	R
25 Sept. 1954	139		WNW	11	+	+	–	+	+	1	R
19 Sept. 1954	135		W	28	+	–	+	+	+	1	F
27 Sept. 1953	124		WNW	5	+	–	–	+	+	1	R
23 Oct. 1953	102		NW	19	+	+	+	+	+	1	F
19 Oct. 1952	101		NW	19	+	+	–	+	+	1	S
	B. With Class A weather but less than 100 hawks										
6 Oct. 1956	95		WNW	32	+	–	–	+	+	0	F
4 Oct. 1952	87		WNW	14	+	+	–	+	+	0	F
15 Sept. 1957	43	+ 32	W	15	+	–	+	+	–	0	R
4 Sept. 1953	67		NW	11	–	+	+	–	–	0	R
5 Sept. 1953	64		WNW	19	+	+	+	+	+	1	R
24 Nov. 1957	64		NW	20	+	+	+	+	+	0	R
5 Oct. 1952	63		WSW	16	+	+	+	+	+	0	R
28 Sept. 1953	63		WNW	10	+	+	+	+	+	3	F
6 Sept. 1956	61		WNW	21	+	–	+	+	+	2	R
3 Sept. 1952	59		WSW	4	+	+	+	+	+	3	R

* Estimates in part.

(Table 2 continued on next page.)

TABLE 2—*Continued.*

Date	No. hawks	(Broad-winged)	Wind at noon	Velocity (mph)	Wind 0600 hr.	Wind prev. day	Temp. drop	No precip.	No overcast	Days since cold front	Barometer
6 Oct. 1955	58		NNW	7	+	−	+	+	+	0	R
13 Sept. 1957	51		SW	13	+	+	+	+	+	2	R
29 Oct. 1954	51		WNW	20	+	+	+	+	−	0	F
2 Sept. 1952	47		WNW	24	+	+	+	+	+	2	F
2 Nov. 1952	42		WNW	12	+	−	−	+	−	0	F
30 Aug. 1955	35		W	24	+	+	+	+	+	1	F
31 Aug. 1955	30		NW	20	+	+	+	+	+	2	R
6 Sept. 1953	29		NW	2	+	+	−	−	−	2	F
17 Oct. 1954	28		NW	14	+	+	+	+	+	3	R
26 Oct. 1956	25		WNW	23	+	−	+	+	−	0	F
9 Nov. 1957	20		WNW	29	+	+	+	+	+	1	R
27 Sept. 1955	13		WSW	21	−	−	−	−	−	0	F
C. With Class B weather and more than 25 hawks											
14 Sept. 1952	298		SW	20	+	−	+	+	+	0	F
29 Aug. 1954	161		WNW	15	+	−	−	+	+	1	F
30 Sept. 1953	66	+ 19	NW	10	+	+	+	+	+	2	F
18 Sept. 1956	28	+ 44	SSW	16	+	+	+	+	+	2	R
7 Sept. 1953	65		WNW	14	+	+	−	+	+	3	R
9 Oct. 1955	62		SW	17	+	+	−	+	+	3	F
10 Oct. 1955	57		SW	15	−	+	−	+	+	4	R
7 Sept. 1956	57		NW	17	+	+	+	+	+	3	R
30 Oct. 1954	55		NNW	17	+	+	+	+	+	1	R
11 Sept. 1955	55		W	15	−	+	+	+	+	1	R
24 Sept. 1957	47	+ 5	SSW	25	+	+	+	+	+	0	R
5 Oct. 1953	50		WSW	14	+	−	+	+	+	0	F
12 Sept. 1953	49		NNW	17	+	−	+	+	−	1	F
2 Sept. 1954	45		SW	18	+	+	−	+	+	0	F
30 Sept. 1955	43		NW	15	+	+	+	+	−	1	R
6 Sept. 1955	39		WNW	15	+	−	−	+	+	0	F
30 Sept. 1957	37		WSW	21	+	−	+	+	+	0	F
4 Oct. 1954	36		NW	9	−	+	+	−	−	1	R
7 Sept. 1954	36		WNW	15	+	−	+	+	−	2	R
13 Sept. 1953	33		NNW	12	+	+	+	+	+	2	R
16 Sept. 1955	33		SSW	18	+	+	−	+	+	1	F
24 Sept. 1955	32		NW	8	+	+	+	+	+	5	R
14 Oct. 1953	32		WSW	14	+	−	+	+	+	3	F
2 Oct. 1952	31		NW	14	+	+	+	+	−	1	R
3 Oct. 1953	29		WSW	17	−	−	−	−	−	0	F
21 Sept. 1957	27		SW	23	+	−	−	+	−	0	F
30 Aug. 1953	27		WSW	7	+	+	−	+	+	17	F
30 Sept. 1956	26		NW	12	+	−	+	+	+	1	R
D. With a warm-front passage											
14 Oct. 1954	65 (51 reverse)		WSW	23	−	−	+	−	−	0	F
3 Oct. 1954	38 (4 reverse)		SSW	17	+	−	−	−	−	0	F

(Table 2 continued on next page.)

TABLE 2—*Continued.*

Date	No. hawks	(Broad-winged)	Wind at noon	Velocity (mph)	Wind 0600 hr.	Wind prev. day	Temp. drop	No precip.	No overcast	Days since cold front	Barometer
E. With Class B weather but less than 25 hawks											
19 Sept. 1953	23		NW	6	+	+	+	+	+	1	R
9 Oct. 1957	22		NW	17	+	−	−	+	−	1	R
19 Sept. 1955	22		WNW	10	+	+	+	−	−	0	F
3 Sept. 1957	21		SW	26	+	+	+	+	+	0	F
12 Oct. 1952	21		WSW	16	+	+	−	+	+	0	F
30 Nov. 1957	19		W	21	+	−	+	+	+	1	R
18 Sept. 1953	18		SW	20	−	−	−	+	+	0	F
13 Sept. 1956	16		SW	26	−	−	−	+	−	0	F
28 Oct. 1954	15		SW	26	+	+	+	+	+	0	F
23 Oct. 1954	14		WSW	12	+	−	−	+	+	9	R
16 Oct. 1955	14		NW	16	−	−	−	−	−	5	R
28 Sept. 1952	13		SSW	21	+	+	−	+	+	0	F
27 Sept. 1952	12		SSW	18	+	−	−	+	+	2	F
18 Oct. 1952	12		WSW	24	+	−	+	+	+	3	F
15 Sept 1954	11		NNW	5	−	−	+	−	−	7	S
26 Oct. 1952	9		W	12	+	−	−	+	+	2	F
1 Sept. 1952	9		WNW	8	−	−	+	+	−	1	F
14 Sept. 1955	8		WSW	9	−	+	−	+	+	0	F
8 Oct. 1953	8		SSW	17	+	−	−	+	+	2	F
4 Sept. 1955	7		WSW	10	−	+	+	+	+	6	F
10 Sept. 1954	7		NW	12	+	−	+	+	−	2	F
10 Sept. 1955	7		NNW	10	+	+	+	−	+	1	R
12 Oct. 1954	7		SSW	26	+	+	+	+	+	1	F
25 Oct. 1957	6		NNW	16	+	+	+	+	+	1	R
9 Oct. 1954	6		SW	13	+	−	−	+	−	0	F
11 Oct. 1954	6		SW	10	+	−	+	+	+	0	F
18 Oct. 1955	5		NNW	18	−	+	+	−	+	7	R
11 Oct. 1952	5		SW	14	+	−	+	+	+	3	F
1 Sept. 1953	5		SW	16	+	+	−	+	+	18	R
29 Aug. 1953	5		WSW	22	+	+	+	+	+	16	F
12 Sept. 1954	5		SW	12	+	−	+	−	−	4	R
10 Sept. 1952	4		SW	11	+	−	−	+	+	4	F
20 Oct. 1955	2		WSW	12	−	−	−	+	+	0	F
10 Sept. 1956	2		SSW	17	−	−	−	+	−	5	F
1 Sept. 1956	2		SW	17	+	+	+	+	+	1	R
3 Oct. 1952	2		SSW	21	+	+	+	+	+	2	R
19 Oct. 1957	1		NW	5	+	−	+	+	+	3	R
22 Nov. 1957	1		WSW	18	+	+	+	+	+	3	R
31 Oct. 1954	1		W	16	+	+	+	+	+	2	R
F. Without westerly winds at noon but with more than 25 hawks											
17 Sept. 1957		140	ESE	21	+	+	+	+	+	2	R
16 Sept. 1953	8	+ 129	ENE	11	+	+	−	+	+	2	R
13 Sept. 1952	91		SE	13	−	−	−	+	+	7	F
20 Sept. 1954	71		SE	12	+	+	+	+	+	2	R
26 Sept. 1953	70		SSE	18	+	+	+	+	+	1	R
13 Oct. 1954	49		ESE	13	+	+	+	+	+	2	R
12 Sept. 1952	32		ESE	15	−	−	+	+	+	6	F
11 Sept. 1952	31		SE	14	+	+	−	+	+	5	R
18 Oct. 1957	25		N	20	+	+	+	+	+	2	R

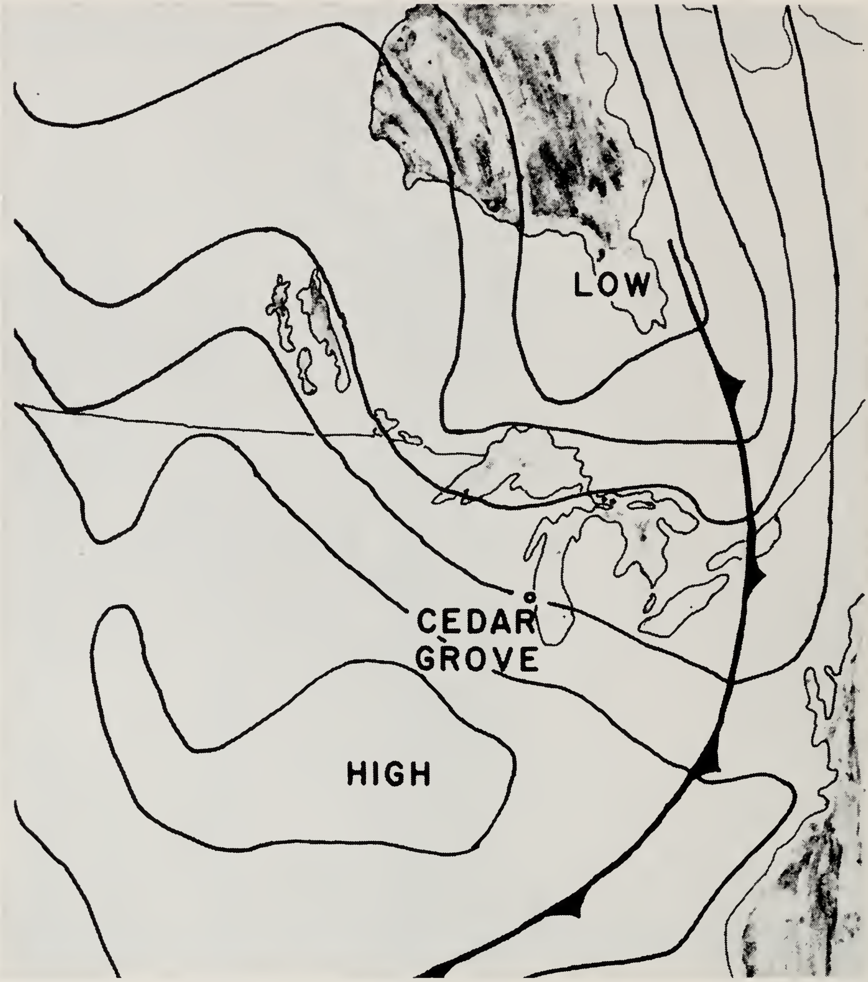

Fig. 3. An example of Class A weather. Drawn from U.S. Weather Map for 1230 hours, 13 October 1955. The line with the eastward-facing points represents a cold front; the other lines are isobars.

front lay somewhere to the south and east. (B) Days with westerly winds (between SSW and NNW) but without the above-mentioned weather map configuration. For purposes of comparing with weather conditions the observation data were grouped into two classes: (I) days on which more than 100 hawks were observed and (II) days with 25 to 100 hawks.

These four data-classes include 131 of the 256 observation days and account for 97 per cent of the hawks observed. Fewer than 25 hawks were observed on each of the remaining 125 days, and the weather was characterized chiefly by the lack of a westerly component in the wind. To simplify the presentation of the data we have chosen to omit herein these days of poor weather and few hawks.

Figure 1 gives an indication of the correlation between flights and weather of the two classes. If the correlation were perfect, the hawk and weather data would tend to appear as mirror images on this graph. While the general correlation is good, there are numerous exceptions which call for further analysis. Table 2 lists all observation days on which at least 25 hawks were seen and/or a westerly wind was blowing. In addition, the occurrence (+) or absence (–) of various meteorological variables is indicated for each of the days. In Table 3 the classes of weather and the classes of hawk-flights are combined to yield four groups of data which are then compared with the per cent occurrence of the various factors influencing migration. These factors are individually discussed in the following section.

CORRELATION OF METEOROLOGICAL FACTORS AND HAWK MIGRATION

It must again be emphasized that migration is strongly influenced by physiological variables which act independently of any short-term fluctuations of the environment. Ninety-one per cent of the Class I flights and 93 per cent of the hawks seen in this study were observed in the period 14 September through 20 October. Before 14 September and after 20 October good weather often fails to produce a good hawk flight; during the period hawks fly even if weather only begins to approach the optimum (see also Table 3, line 1).

Wind direction.—This yields perhaps the best correlation with hawk migration at Cedar Grove. Eighty-three of the 92 Class I and Class II flights occurred on days with westerly winds at noon. In six of the nine exceptions the wind was westerly earlier in the day, and the flight occurred largely before the wind shifted.

Westerly winds apparently cause southward-bound birds to drift eastward until they encounter the shore of Lake Michigan. Since hawks are reluctant to fly out over this 70-mile-wide expanse of water, their easterly drift is arrested, and the birds become concentrated along the lake shore. The lake shore acts as a "guiding" or "leading" line (*Leitlinien* of Geyr von Schweppenburg, 1929). The birds observed moving south over Cedar Grove at any given time will be those which have encountered this guiding line at some point to the north. If we assume that the hawks are more or less randomly scattered on a broad front before they encounter the guiding line, it follows that the longer the period of westerly winds the greater the number of hawks observed at a point on the guiding line. Easterly winds, on the other hand, would drift birds *away* from the lake shore.

TABLE 3

PER CENT OCCURRENCE OF INFLUENCING FACTORS FOR EACH CLASS OF DATA

Weather class	A	A	B	B
No. of hawks	> 100	< 100	> 25	< 25
No. of days	31	22	28	39
Within 14 Sept. to 20 Oct. inclusive.	93	36	65	51
With westerly winds at 0600 hr.	100	91	86	77
With westerly winds previous day.	77	68	61	46
With more than 100 hawks previous day.	35	5	18	3
With noon winds W to NW.	97	91	43	26
With W winds persisting since cold front.	97	91	67	41
With noon winds of velocity > 10 mph.	97	86	86	87
With noon winds of velocity > 15 mph.	68	55	61	54
With temperature drop.	84	77	64	59
Without overcast.	84	68	75	74
Without precipitation.	93	86	93	85
With rising or steady barometer in prev. 24 hours.	68	55	50	41

Good migration days almost invariably have westerly winds from daybreak on, and often the wind is also westerly on the preceding day (Table 3, lines 2 and 3). Exceptionally good flight-days are almost invariably preceded by a few hundred birds on the previous day. More than one-third of all Class I flights occurred the day after another Class I flight (Table 3, line 4). However, the frequent changes which characterize autumn weather rarely permit more than two or three consecutive Class I days.

TABLE 4

CORRELATIONS OF HAWK MIGRATION AND VELOCITY OF THE WESTERLY COMPONENT OF THE WIND

Velocity (mph) of westerly component	Wind direction						
	NNW	NW	WNW	W	WSW	SW	SSW
	A. Total number of hawks observed						
> 20	—	—	1,030	2,233	17	—	—
15–20	—	—	2,797	918	283	52	—
10–15	—	2,395	13,262	139	183	514	—
< 10	224	2,713	218	—	101	77	199
	B. Average number of hawks per observation day						
> 20	—	—	258	558	9	—	—
15–20	—	—	311	306	71	17	—
10–15	—	218	1,020	46	26	64	—
< 10	28	194	55	—	25	13	25

To illustrate the effects of wind drift let us consider a hypothetical hawk with the following characteristics: (1) a constant flight speed of 20 mph, (2) a constant flight direction (directly south), and (3) free drift with the wind. A SSW wind of 20 mph would arrest the southward progress of this hawk 18.5 miles each hour; the net southward speed of the bird would be 1.5 mph. The hawk would require 66.7 hours to move a distance of 100 miles to the south. Eastward drift would amount to 7.7 mph or 514 miles during the time required to move 100 miles southward. Distances of eastward drift for other wind directions (velocity 20 mph), derived similarly, are: SW, 283 miles; WSW, 150 miles; W, 100 miles; WNW, 67 miles; NW, 41 miles; and NNW, 20 miles.

If drift were solely responsible for the hawk migrations observed at Cedar Grove, more birds would probably be seen on SW winds than on NW winds. However, the opposite is true for most migration occurs on days with W or NW winds. Table 4 shows the correlation between wind direction, velocity of the westerly component of the wind and hawks seen per day.

Observations at Duluth, Minnesota (Hofslund, 1958), and on the north shore of Lake Erie (Gunn, 1957) show that the bulk of hawk migration occurs on northerly and westerly winds. The topography and *Leitlinien* in these localities is such that one would expect concentrations of migration on northerly, as well as westerly, winds. The only hawk migration report from the east shore of Lake Michigan known to us was on a northeasterly wind (Smith, 1904).

Since fall hawk migration apparently occurs most frequently on westerly or northerly winds, it is reasonable to suggest that following winds initiate hawk migration. However, westerly and northerly winds are associated with a complex of meteorological factors, and a review of these is necessary before a final judgment can be advanced.

Cold fronts.—The passage of a cold front in the northern United States is characterized by a rather sudden change in most measurable meteorological variables. The temperature falls, the sky rapidly clears, the humidity drops, the barometer reaches a low point and begins to rise, and the wind shifts from southerly to westerly or northerly. In fall, westerly and northwesterly winds are almost invariably associated with a recent cold front passage. Depending on the speed of movement and the paths taken by the large air masses which govern our weather, the wind may swing slowly to southwest after frontal passage, or it may shift clockwise to the south. Thus, southwesterly winds usually occur just before or several days after a cold front. More than 92 per cent of the migrant hawks observed at Cedar Grove passed on 84 days which were characterized by westerly to northwesterly winds following a cold front. Fewer than 4 per cent of the total number of hawks observed passed on 35 days with other westerly winds. Line 6 of

Table 3 gives the per cent of the days of each data-class on which the wind remained westerly or northwesterly after the passage of a cold front. Class A weather, as defined above and illustrated in Fig. 3, implies the recent passage of a cold front. In fact, the existence of westerly winds shortly after the passage of a cold front almost necessitates a weather map similar to that of Fig. 3. Three Class I flights of 35 did not have this weather map configuration, but they did have a recent cold front passage and the migration occurred in the period before a wind shift.

One Class I flight (14 September 1952) occurred in part *before* a cold front passage. The flight came at the end of an extremely atypical period of weather and hawk migration. A cold front approached Wisconsin from the northwest and became stationary just north of Lake Superior in the evening of 8 September 1952. The front remained in approximately the same place until 13 September when it began to move northward as a warm front. A new cold front moved in from the west and passed Cedar Grove at 1430 hours on 14 September. The hawk-flight began on 11 September when 31 birds were observed on a southeast wind! Even though the easterly wind persisted through 13 September, the hawk-flight slowly increased in magnitude: 32 birds on 12 September and 91 birds on 13 September. The flight continued unabated on 14 September when the cold front and an attendant rain squall scarcely interrupted the movement of 298 hawks (one bird was actually observed flying through an intense thundershower). Class A weather prevailed on 15 September, and 1,839 hawks, including a record count of 1,219 Sharp-shinned Hawks, passed over Cedar Grove.

Both the pre-frontal flight of 298 hawks and the smaller flights on the southeast winds of the preceding days are unique to our experience. We propose that the hawks began migrating in Canada with the arrival of the 8 September cold front. The birds continued south after the front halted and began to arrive in east-central Wisconsin on 10 and 11 September. In the region of Green Bay they encountered SSW to WSW winds and were drifted east to the shore of Lake Michigan. Somewhere in the 80 miles between Green Bay and Cedar Grove the wind became SE, but a few birds apparently continued to follow the lake shore at least as far south as Cedar Grove in spite of the easterly winds. On 14 September the winds were SW at both Cedar Grove and Green Bay, and the hawk-flight increased correspondingly.

Warm fronts.—The northward movement of a well-developed warm front in autumn is a rarity in Wisconsin. Only six of the 256 observation days were characterized by such a phenomenon. One of these, 14 October 1954, resulted in the only observed autumn occurrence of a reverse migration of hawks at Cedar Grove. Fifty-one of the 65 hawks seen that day were moving northward. At 0030 hours on this date the weather map showed a warm front about 50 miles south of Cedar Grove. On the 1230-hour weather map the warm front had progressed to the top of the lower peninsula of Michigan, and an eastward-moving cold front had just passed Cedar Grove. The wind was southerly all morning, shifting to westerly at noon, when the cold front passed. All birds were observed in the afternoon. The hawks probably began moving northward after the warm front in the morning but were not drifted against the lake shore until the wind shifted to the west. Once started north they apparently maintained this direction even after the cold front passed. The next day produced a southward migration of 217 hawks.

A second warm-front-date, 3 October 1954, differed considerably in the time of passage and the speed of movement of the front. The 0030-hour weather map showed a warm front a short distance south of Cedar Grove. This front remained essentially stationary and did not pass Cedar Grove until about 1130 hours. Twenty-seven birds moved southward on westerly winds before the warm front passed; four of 11 hawks after the front were moving northward. A cold front passed in the afternoon, and the following day 36 hawks moved southward on a west-northwest wind. Overcast skies persisted on both the above warm-front-days; the remaining four days with warm fronts were characterized by easterly winds and/or partly cloudy skies, and little or no hawk migration was observed.

Drost and Bock (1931) in analyzing cases of reverse fall passerine migration in Europe suggest that overcast skies may have hampered the birds' navigational ability. This idea gains support from the recent works of Kramer (1948, 1952), Kramer and Riese (1952), and Bellrose (1958), demonstrating sun-compass orientation in three orders of birds. It is reasonable to propose that on 14 October the hawks began migration in response to the warm front, and in the absence of orientation clues from the sun they flew northward with the following winds. It must be emphasized that this is not to be taken as an explanation for all reverse migration. Reverse flights often occur on clear days in spring at Cedar Grove. Fall reverse migration, because of its extreme rarity, probably merits some such special discussion as is given above.

Updrafts.—Hawks probably make considerable use of vertical air currents in their migratory passage. It is thus advantageous for the hawks if migration occurs when updrafts are available. In the lower layers of the atmosphere vertical winds are due largely to deflection of horizontal winds (as on the Appalachian ridges) and to heating of air at the surface of the ground. The latter process is at a maximum on clear days when the sun is producing a maximum of heating of the ground and when the overlying air mass is relatively cool. The clear skies and lower air temperatures usually associated with the air mass following the passage of a cold front thus provide optimum conditions for the formation of updrafts.

These updrafts tend to form into organized patterns. Under near-calm conditions these vertical currents take the form of large, columnar, chimney-like updrafts. If a horizontal wind exists, the resulting shear tilts the updrafts downwind, and with increasing wind velocity the columnar structure is disrupted. Laboratory investigations (Phillips and Walker, 1932; Graham, 1934) have shown that within a certain range of horizontal shear the convection patterns are organized into longitudinal "strip-like cells" of alternating updrafts and downdrafts.

Observations of gull-soaring over the North Atlantic (Woodcock, 1942) indicate that similar patterns of thin vertical sheets of rising air apparently occur in the free atmosphere at horizontal wind velocities of approximately 15 to 28 mph when the surface water temperature is at least 4°C higher than that of the overlying air. Woodcock noted that gulls soared in circles when the horizontal wind velocity was less than 15 mph. When the wind velocity ranged between 15 and 28 mph, the gulls soared in straight, narrow lines headed upwind. The rate of ascent was usually greater than that with circle-soaring. No soaring of any kind was observed at winds in excess of 28 mph, suggesting that convection patterns were disrupted or updrafts were of insufficient lateral extent to be useful to the gulls.

The pattern of updrafts over a land surface may be considerably different from that given above. Current theory holds that convection over a terrestrial surface takes the form of discrete bubbles or chains of bubbles of rising air (Ludlam and Scorer, 1953). Further differences would result from the irregularities of topography and varying heat capacity of a land surface. Unfortunately, we were unable to find any information about the organization and structure of updrafts in the atmosphere within a few hundred feet of the soil surface. At higher levels, however, both updrafts of the columnar or bubble form and of the longitudinal-strip type are found (Slater, 1947; Lange, 1940). It is interesting that much of the information available on updraft structure has been gathered by sailplane pilots whose numerous flights of over 100 miles are adequate evidence of the possibilities of soaring flight.

In the absence of information to the contrary, we suggest that updrafts at low altitudes over a land surface are to some degree organized in a form similar to that given by Woodcock (1942). Thus, we expect that longitudinal updraft cells exist over a suitably warm ground surface at horizontal wind velocities between approximately 15 and 28 mph. If the updrafts in these cells are of sufficient strength, a migrating hawk would be able to fly up- or downwind at considerable speed with minimal effort. Cross-wind flight could be sustained by remaining in areas of updraft as long as possible and moving through downdrafts at high speeds.

Thus, the observed correlation of hawk migration with cold fronts and with winds of 15 to 25 mph may be simply a correlation with optimal soaring conditions. The hawk-migration observations of Rudebeck (1950) in Sweden and Holstein (1946) in Denmark also seem to show better correlation with the occurrence of weather conducive to thermal updrafts than with any other meteorological factor.

Wind velocity.—There is an easily discernible difference in the reactions of birds of the genus *Buteo* and those of other hawks in regard to wind velocity. Buteos, particularly the Broad-winged Hawk, characteristically ascend circularly to great heights on a columnar updraft or rising bubble of air, then glide off in a line until a new updraft is encountered. High wind velocities break up the formation of such updrafts and inhibit *Buteo* migration. Optimum wind velocities for these soaring hawks at Cedar Grove range from 10 to 15 mph. The birds undoubtedly will fly at lower wind velocities, but the *Leitlinien* effect is rapidly reduced as wind speed decreases, and no concentrations are formed along the lake shore. The other species of hawks occur in greatest numbers at wind velocities of 15 to 25 mph (Table 3, lines 7 and 8). Winds greater than 30 mph seem to progressively inhibit all hawk migration. The Broad-winged Hawk is listed separately in Table 2 because of the above-mentioned differences in reaction to wind velocity.

Temperature.—Bird-migration might well be related to temperature change, but an uncomplicated analysis of the role of this factor is impossible. Temperature change is markedly effected by a number of seasonally independent factors. Cloud cover, for example, inhibits both nocturnal cooling and diurnal warming, severely damping variations in temperature. Wind disrupts the formation of inversions, and thus prevents extreme nocturnal cooling of low-lying areas. Thus, the influence of a moving air mass on local temperature can be completely masked or markedly exaggerated by various local conditions. The correlations were therefore not so good as conceivably might be expected, but it is possible that no better relationship exists since the aforementioned variations may well confuse the bird as well as the investigator.

Correlations of migration and daily temperature change were attempted for difference in (1) average, (2) maximum, and (3) minimum temperature from the corresponding datum for the previous day. Decrease in minimum temperature yielded the best correlation with migration, and it alone is listed in Tables 2 and 3. Temperature drop is indicated by (+) and increase or no change by (–) in Table 2.

Two seasons (1952 and 1955) were analyzed in regard to short-term temperature changes. The greatest observed drop in temperature in an hour's interval during the 24 hours prior to noon was tabulated for each observation day and compared with the number of hawks observed. A second method, utilizing the temperature change over six-hour intervals, was also attempted.

Table 5

Correlations of Temperature and Migration

Weather class No. of hawks	A > 100	A < 100	B > 25	B < 25
Mean of departure of average daily temp. from normal.	– 2.00	– 2.59	– 0.74	+ 1.82
Mean of departure of minimum daily temp. from average of minimum for previous 5 days.	– 4.84	– 6.79	– 4.68	– 1.19
Mean of departure of average 0030-hr. temp. for Duluth, Wausau, and Escanaba from same datum of prev. day.	– 2.52	– 1.44	–0.88	+ 0.44

Temperature changes between 1200–1800 hours and 1800–2400 hours of the previous day and between 0000–0600 hours and 0600–1200 hours of each observation day were tabulated. Adjustments for the normal daily temperature cycle (warming in forenoon, cooling in evening) were made in the following manner: mean temperatures of 0600, 1200, 1800, and 2400 hours were calculated for each month of observation, and the average change for each six-hour interval was determined. The net temperature change for a six-hour interval on a given day was obtained by subtracting (or adding) the average change. No reasonable correlation was found between hawk migration and these short-term temperature changes.

Finally, we tried to correlate migration with (1) the departure of the average daily temperature from normal for each day, (2) the departure of the minimum daily temperature from the minima for the previous five days, and (3) the departure of the average of 0030-hour (CST) temperatures for Duluth, Minnesota, Wausau, Wisconsin, and Escanaba, Michigan, from the corresponding datum of the previous day. The data for these considerations are given in Table 5. In each case, temperatures averaged two to three degrees lower for days on which more than 100 hawks were observed.

Although hawk-flights usually occurred after a drop in temperature and on days with relatively lower temperatures, the correlations do not appear to be of sufficient magnitude to warrant a migration hypothesis based exclusively on temperature. Trowbridge (1902) came to similar conclusions in his analysis of Connecticut hawk-flights.

Precipitation and overcast.—Table 3 (lines 10 and 11) lists the per cent occurrence of lasting overcast or appreciable precipitation in the morning hours for each class of data. Since the skies usually clear rapidly after a cold front has passed, it is interesting to note that migration occurred on some of the few days on which overcast skies persisted and some precipitation was recorded. Extended heavy rains usually ended migration, but occasional brief showers often hardly interrupted a flight.

Cloudiness reduces insolation of the ground and hence lessens air-ground temperature contrasts. This reduces, but does not necessarily eliminate, the production of updrafts. If the ground is sufficiently warmer than the invading cold air mass, updrafts will result without the aid of insolation.

Barometric pressure trends.—The only barometer-readings readily obtainable for the entire period of this study were those recorded at six-hour intervals in the *Local Climatological Data Supplement* for Milwaukee, Wisconsin. A correlation of these data with hawk counts indicates that hawks migrate more often on rising or stable barometers than when the pressure is decreasing (Table 3, line 12). This relationship is probably secondary and incidental to other factors related to the movement of the cold front. There is no sensory mechanism known by which a bird could determine absolute pressure, and there is no evidence that birds can detect the slight changes in barometric pressure that occur in nature over a period of a few hours. A bird flying from the ground to the tree tops would be subjected to an air pressure change of 0.05 to 0.08 inches of mercury; an atmospheric pressure change of this magnitude rarely occurs in an interval as short as an hour.

Air-mass movements.—A careful study of the origins and paths taken by the centers of both high- and low-pressure cells prior to their entry into the western Great Lakes area yielded no reasonable correlation with migration. The air masses in which migration occurred were almost invariably of "polar" origin, i.e., the origin was in colder, more northern regions. Beyond this restriction, it apparently made little or no difference as to where the air mass originated or as to what path it pursued before it arrived in the upper middle-west.

SUMMARY AND CONCLUSIONS

Daily counts of autumn-migrating hawks were made on 256 days in the years 1952 through 1957 at Cedar Grove, Wisconsin. Most of the migration occurred between 14 September and 20 October. More than 92 per cent of the migration occurred on 84 days characterized by westerly winds and the recent passage of a cold front. Westerly winds serve to concentrate migration along the guiding line formed by the west shore of Lake Michigan.

The fact that correlations of hawk migration with individual factors associated with frontal passage are not so good as correlations with cold fronts per se suggests that these factors act additively in effecting migration. An alternative suggestion is that weather affects migration indirectly in that it acts to modify, not produce, migration. We propose that the relation of fall hawk migration to cold fronts and winds of 15–25 mph is, simply, a correlation with the occurrence of conditions suitable for updraft formation and, hence, with good conditions for soaring and gliding.

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SONG VARIATION IN A POPULATION OF MEXICAN JUNCOS

Peter Marler and Donald Isaac

The variability of bird songs is familiar to all field ornithologists. Geographical variation in particular has received considerable attention partly for its intrinsic interest and partly because its understanding promises to throw some light on the role of reproductive isolating mechanisms in speciation.

However, the problem of describing geographical variation in song is complicated by the excessive variability which we sometimes find within a single population of birds, as in the European Chaffinch, *Fringilla coelebs* (Marler, 1952). An understanding of the extent and significance of this local variation is a prerequisite for analysis on a geographical scale. During an expedition to Mexico in 1958 an ideal opportunity was found for such study in the pine woodlands near El Salto in Durango. Mexican Juncos (*Junco phaeonotus*) are very common there, and the habitat is uniform. It was possible to record songs from a large number of males—67 songs in all from 63 males—within a restricted area of about one square mile. This sample of songs from a single population is much more variable than in other species we have studied such as the Chipping Sparrow and the Brown Towhee (Marler and Isaac, 1960*a, b*). Our intention in this paper is to try to document this variation, both in terms of the over-all characteristics of the song and also with regard to the structure of the component syllables. We thus hope to determine which characteristics persist throughout this variability, providing the basis for whatever species-specific properties the song of the Mexican Junco may have.

METHODS

The songs were recorded in the field with a Magnemite 610 E tape recorder at a tape speed of 15 inches per second with an Altec 633A microphone mounted in a parabolic reflector. A Madison Fielding Micamp was used in the microphone circuit. In the laboratory the tapes were played back on a Viking 75 tape deck modified to operate with a tape speed of 15 inches per second. Analyses were made with a Kay Electric Company Sonagraph and amplitude display unit using the wide band-pass filters and the "high-shape" setting in all cases. The syllable analyses are based on ink tracings made directly from the sonagrams on tracing paper. Figures 1 and 6 are from photographs of tracings of this kind. The recordings were made between 29 June and 3 July 1958, within an area of approximately one square mile within short walking distance of a camp in the pine forests to the northwest of El Salto, in Durango, Mexico. Two or three examples of the songs of each bird were recorded. From each of these samples one example of each song

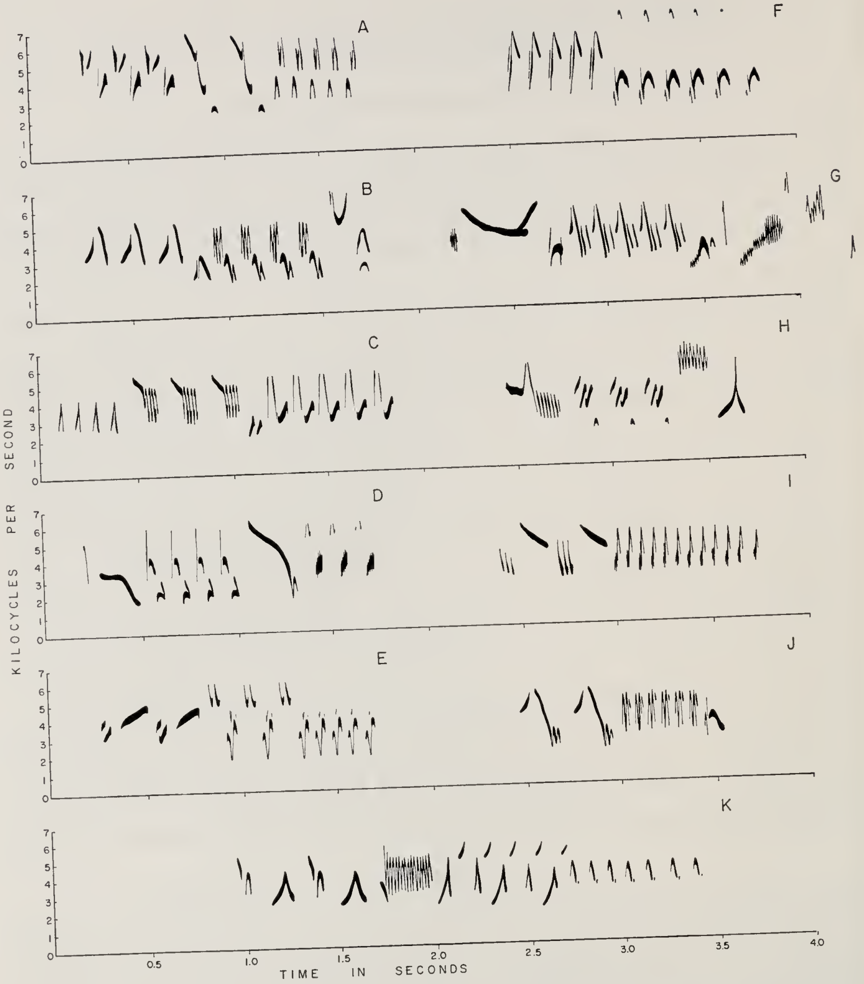


Fig. 1. Sonagrams of songs of 11 individuals selected from recordings made near El Salto, Durango. A–E: These songs represent the most common condition (based on such characteristics as over-all duration, number of syllable types per song, number of trills per song, etc.). F–K: These songs represent extremes as follows: F—few syllable types; G—many syllable types; H—few trill syllables; I—many trill syllables; J—a short song; K—a long song.

pattern recorded was selected for analysis. Data on the frequency and temporal characteristics of the songs were read off on a graduated clip board (see Marler and Isaac, 1960*a*). Unless otherwise stated, the data are presented as arithmetic means plus or minus one standard deviation.

TABLE 1

FREQUENCY OF DIFFERENT TYPES OF SONG,
CLASSIFIED ACCORDING TO POSITION AND NUMBER OF TRILLS AND PHRASES*

	One-trill songs		Two-trill songs		Three-trill songs		
	4	aBc	13	AB	5	ABC	
	3	Ab	12	ABc	2	AbCD	
			9	AbC	2	ABCd	
			7	AbCd	1	ABcD	
			4	aBC	1	AbCDe	
			2	aBcD	1	ABcDe	
			1	aBCd			
Totals	7		48		12		67

* Trills are represented by capital letters, and phrases by small letters.

GENERAL DESCRIPTION OF THE SONG PATTERN

In a sustained bout of singing, a bird delivers one pattern several times with little variation, then switches to another and then returns to the first, and so on. In most cases we have recorded only one song pattern from each bird. Mexican Juncos have a complex song, considerably more elaborate than the simple trill of the Oregon or Slate-colored Juncos. Although the song is about the same duration as in other juncos, it is built from several syllable types instead of just one. Each male has a repertoire of several song patterns, two or three being an average estimate from field observations.

Song analyses of this sort pose a problem in terminology. For sake of clarity in the following descriptions and discussions we have used the terms *note, syllable, trill,* and *phrase.* These terms are useful in this particular case, but may not have any general application. In fact it may be difficult or even impossible to use the same terminology for other types of songs, such as those of some of the more versatile singers (thrushes, etc.). Until such songs are analyzed and a suitable terminology derived, the terms used herein should not be extended beyond their present context.

In the terminology we use for the different parts of the song, as revealed in a sonagram, the basic units are the *notes*, each of which is one continuous vocal utterance. A single note may be modulated in frequency or amplitude in a complicated way, to form quite an elaborate unit. Any break in continuity is regarded as the end of a note. Notes are often arranged in groups to form more or less coherent units, which are the *syllables.* These are not always easy to identify with certainty, except when they are repeated consecutively two or more times, to make a *trill.* When they are not repeated in this fashion, their identification becomes more arbitrary (although the term is still useful).

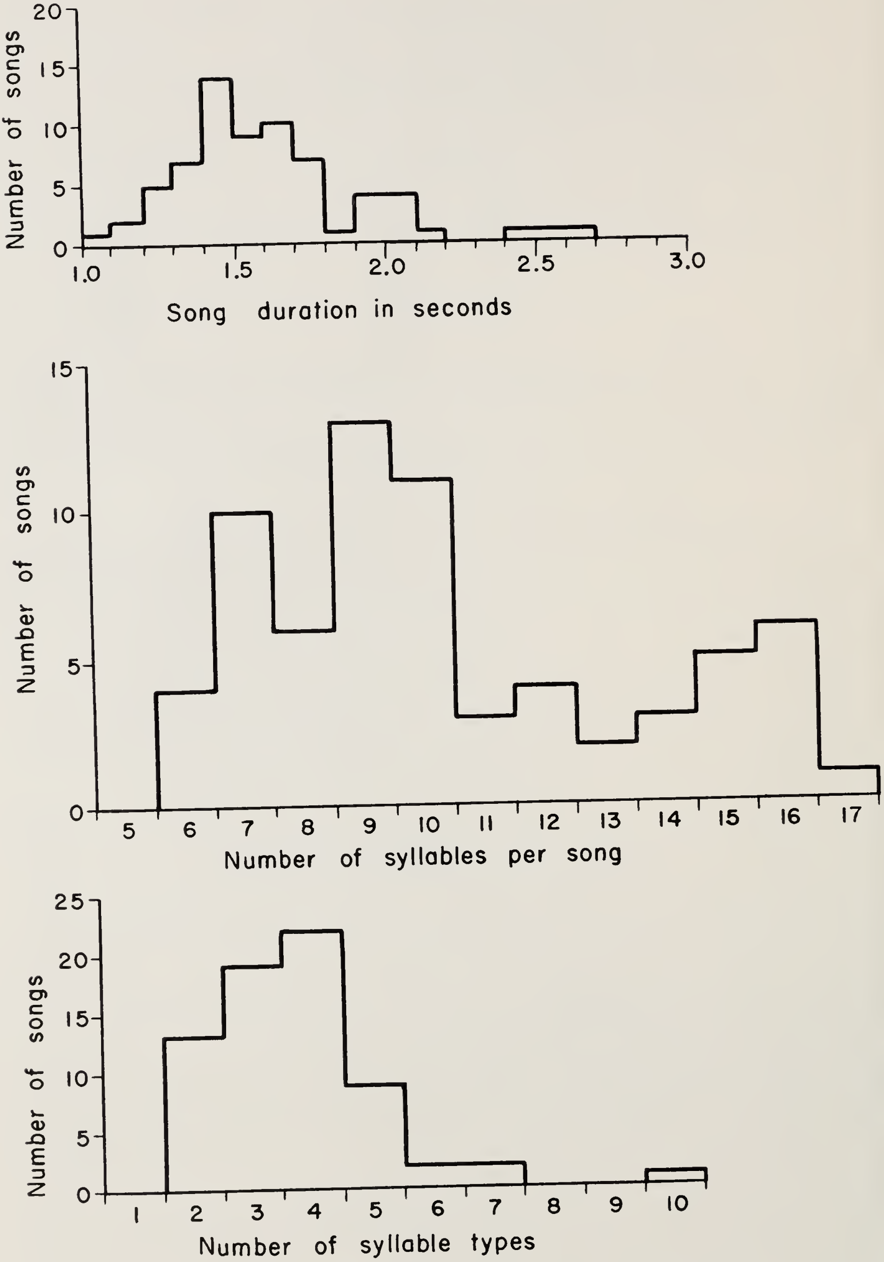


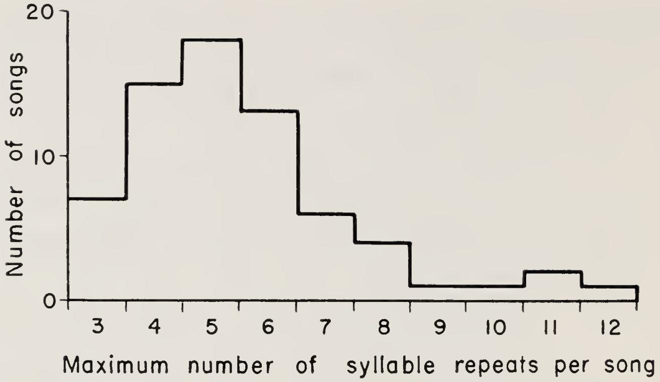
FIG. 2. Frequency distributions of song duration, number of syllables per song, and number of syllable types per song.

Our final subdivision is a *phrase*, one or more such unrepeated, dissimilar syllables which, in these songs, are separated from other phrases by a trill. Using these subdivisions we can make a complete description of the song, beginning with its over-all characteristics, then proceeding to a finer analysis of the structure of individual syllables and notes.

On careful examination we can discern some patterning in the ways in which the syllables are arranged in the songs of different birds. Each song always includes one or more trills. In a few cases there is only one trill sequence (e.g., Fig. 1H), usually two (Fig. 1B), and occasionally three (Fig. 1A). These trills are arranged in many varied ways. The song may begin with a trill (Figs. 1A, B, etc.) or with a phrase (Figs. 1D, G, etc.). Two trills may follow immediately on each other or may be separated by a phrase. And the song may or may not terminate with a trill. The majority of the songs (49) had at least one phrase. Table 1 shows that the number of basic parts in the song can vary through two (16 songs), three (34 songs), four (15 songs), and five parts (2 songs).

The average duration of all songs (Fig. 2) was 1.63 ± 0.29 seconds. Thirty-five unbroken pauses between consecutive songs in the recordings averaged 5.4 ± 1.4 seconds. Thus, at a rough estimate, these birds spend about 23 per cent of their singing time actually in song. The number of syllables in the song also varies, from 6 to 17, with an average of 10.1 ± 2.9 (Fig. 2). In neither respect is this variability excessive, as compared with the Brown Towhee, in which song duration varies similarly, and the number of syllables per song is considerably more variable (10.4 ± 4.5, Marler and Isaac, 1960*b*). As in the towhee, there is a rough correlation between these two measures, shorter songs tending to have fewer syllables than longer ones, but there are many exceptions. One song with 6 syllables, for example, was longer than another with 14 syllables.

There is also a diversity of syllable types in each song (Fig. 2) but the number per song, 3.7 ± 1.4 is relatively consistent. Thus, each song always has at least two syllable types, and rarely has more than five. As pointed out earlier, some of these are given only once in a song, while others are repeated. We can express the amount of repetition in the ratio of the number of syllables to the number of syllable types (Fig. 3). For this sample the value is 2.97 ± 1.05. This is a much lower figure than we would obtain for the Chipping Sparrow or the Brown Towhee, but, nevertheless, the trills are a prominent characteristic of Mexican Junco songs, and merit closer attention. The trills make up the greater proportion of each song, contributing 8.5 ± 2.7 syllables and a duration of 1.24 ± 0.29 seconds, as compared with 0.40 ± 0.25 seconds from 1.7 ± 0.9 phrase syllables. The lower variability of the figures on trills, particularly the duration, emphasizes their importance as a basic characteristic of the song, as compared with the less regular phrases.



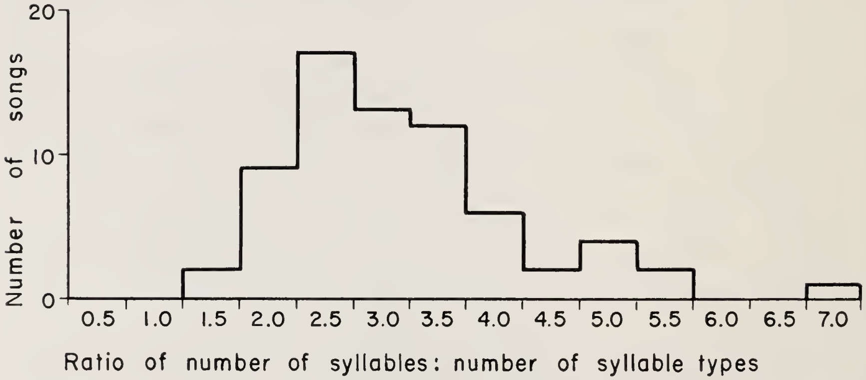


FIG. 3. Frequency distributions of maximum number of syllable repeats per song, and ratio of number of syllables to number of syllable types per song.

An estimate of the number of syllables which make up a trill can be obtained from the maximum number of consecutively repeated syllables in each song (Fig. 3). If we summarize the number of syllables in all of the trills in all songs the average number of syllables per trill is 4.1 ± 2.0, as compared with 1.7 ± 0.9 phrase syllables. The duration of syllables is similar in trills (0.138 ± 0.077 sec) and in phrases (0.135 ± 0.097 sec), the average figures for the songs as a whole being 0.137 ± 0.087 second. In phrases this duration is not related to the number of syllables present. In trills the two characteristics are correlated in an inverse fashion, the trills with most syllables having the shortest syllables. In those with two syllables, the average duration is 0.225 second per syllable; in those with three, 0.158 second; with four, 0.105 second; and so on, down to 0.050 second with

TABLE 2

SUMMARY OF DATA DISCUSSED COMPARATIVELY IN TEXT WITH ADDITION OF STANDARD ERRORS AND 95% CONFIDENCE INTERVALS*

	N	$\bar{X}$	s	$S_{\bar{x}}$	Confidence interval $p = 0.05$
Number of syllables per trill	139	4.1	± 2.0	± 0.17	± 0.33
Number of syllables per phrase	65	1.7	± 0.9	± 0.11	± 0.22
Trill syllable duration in seconds	138	0.138	± 0.077	± 0.0066	± 0.0129
Phrase syllable duration in seconds	111	0.135	± 0.097	± 0.0092	± 0.0182
Trill syllable duration in seconds by number of syllables per trill					
2-syllable trills	34	0.225	± 0.063	± 0.0108	± 0.0220
3-syllable trills	32	0.158	± 0.056	± 0.0098	± 0.0200
4-syllable trills	22	0.105	± 0.061	± 0.0130	± 0.0269
>4-syllable trills	446	0.085	± 0.033	± 0.0049	± 0.0100
Number of syllables per trill by position in song					
First trill	67	3.5	± 1.7	± 0.21	± 0.42
Other trills	72	4.6	± 2.2	± 0.26	± 0.52
Duration in seconds of trills by position in song					
First trill	67	0.67	± 0.16	± 0.020	± 0.040
Other trills	70	0.55	± 0.19	± 0.023	± 0.046
Duration in seconds of trill syllables by position in song					
First position	56	0.188	± 0.073	± 0.0097	± 0.0194
Second position	45	0.103	± 0.055	± 0.0082	± 0.0166
Third position	30	0.105	± 0.074	± 0.0135	± 0.0275
Fourth and Fifth positions	7	0.103	———	———	———
Note types by number of notes per syllable					
Vibrato notes	117	2.0	± 0.8	± 0.07	± 0.14
Non-vibrato notes	378	2.7	± 1.2	± 0.06	± 0.12
Number of notes per syllable					
Trill syllables	138	2.4	± 1.1	± 0.09	± 0.18
Phrase syllables	108	1.5	± 0.8	± 0.07	± 0.15

* N is the sample size; $\bar{X}$, the arithmetic mean; s, the standard deviation of the sample; and $S_{\bar{x}}$, the standard error of the mean. Symbols and calculations are based on Simpson, Roe, and Lewontin (1960).

eight syllables. The differences between two-, three-, and four-syllable trills are the only ones which are statistically significant (Table 2). The same relationship has been described in the trills of the Brown Towhee song (Marler and Isaac, 1960*b*).

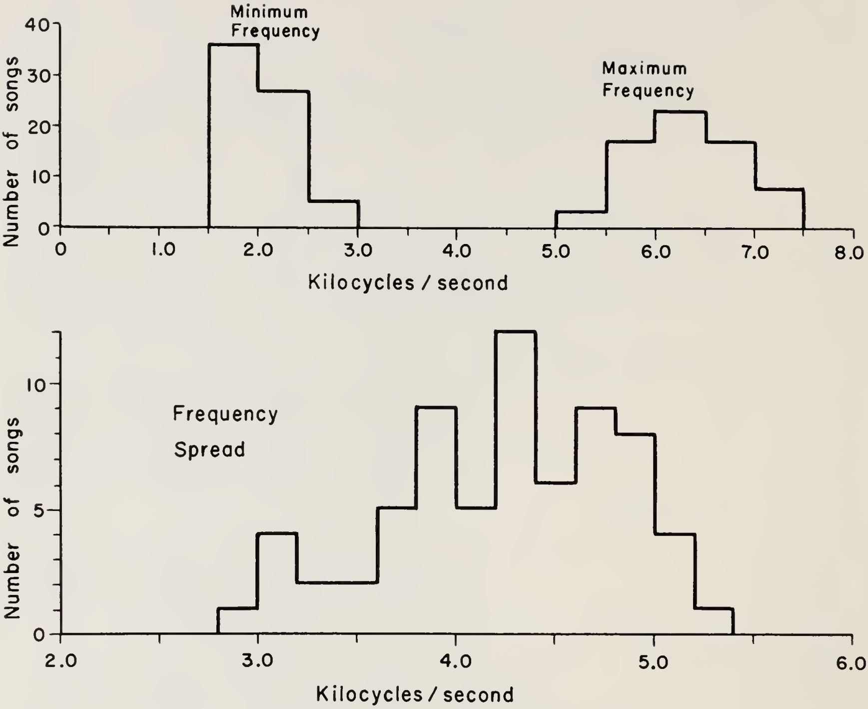


Fig. 4. Distributions of maximum and minimum frequencies per song, and frequency spread per song.

FREQUENCY CHARACTERISTICS

As in the songs of the Chipping Sparrow and the Brown Towhee, the frequency characteristics vary widely (Fig. 4). Once again, the minimum frequency (2.09 ± 0.25 kilocycles per second) is less variable than the maximum (6.39 ± 0.51 kc). The frequency spread which a song may span ranges from 3.0 to 5.4 kc (average 4.30 ± 0.58 kc).

TRENDS THROUGH THE SONG

Thus far we have established certain basic characteristics of Mexican Junco song; its duration, and the number of syllable types, the presence of phrases and of trills. Next we must look for any systematic changes in the course of the song. First, we could find no systematic changes in loudness through the song, as seen in amplitude displays of selected song patterns. In some cases the earlier syllables have the highest amplitude, in other cases, the loudest ones are later in the song. Within a trill the amplitude of the syllables is the same. The position of the trills in the song has already been

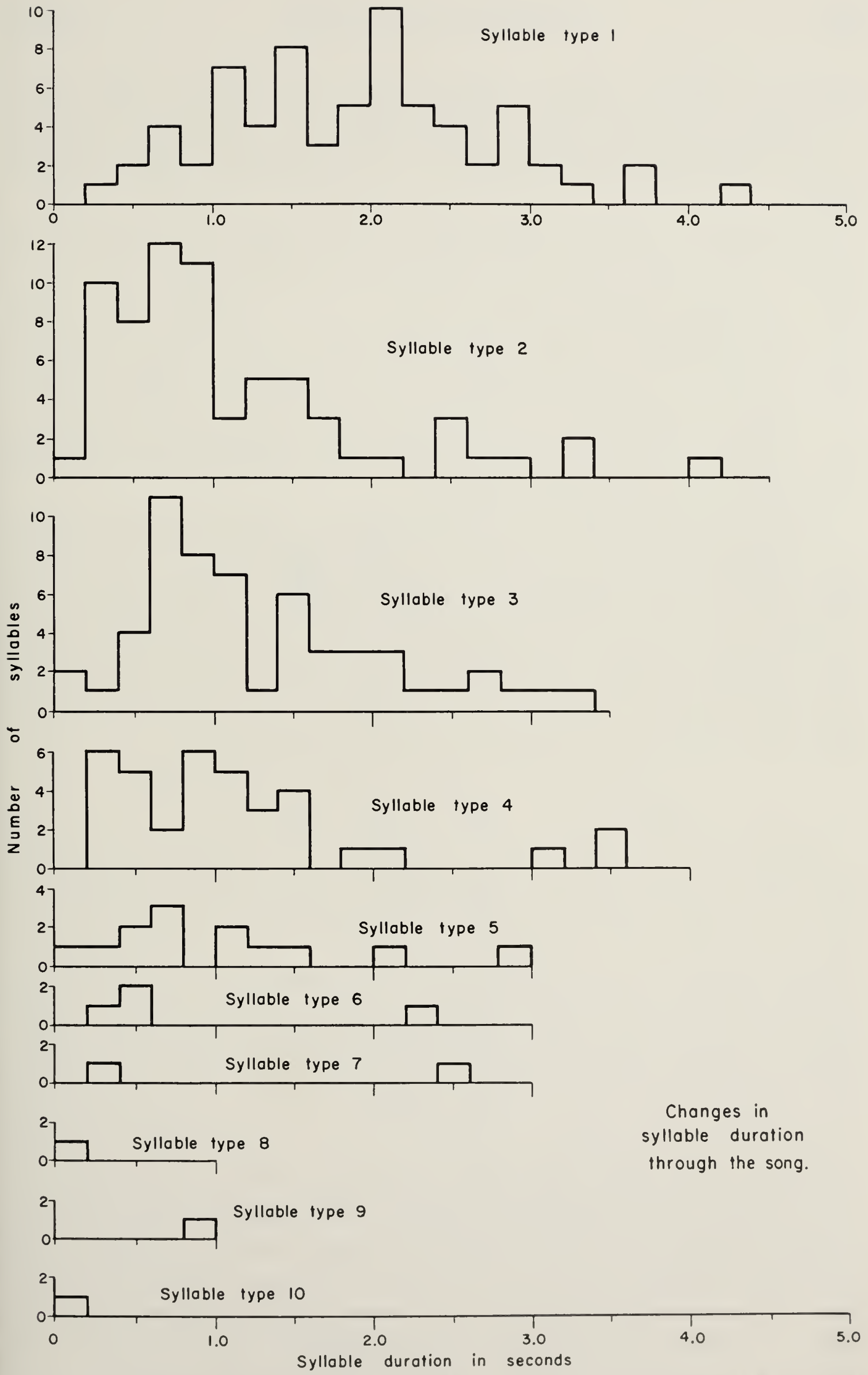


FIG. 5. Frequency distributions of changes in syllable duration by syllable type sequence through the song.

discussed (Table 1). There is usually a trill at the start of a song (in 56 of 67 songs), but apart from this the positions are irregular. Thus, there are often trills in the middle of a song (in 42 of 67 songs) and at the end (in 36 of 67 songs). The phrases are also distributed in rather irregular fashion.

The number of syllables which make up a trill seems to be related to its position in the song. The average figure for the first trill in the song is lower than in other parts of the song (1st trill: 3.5 ± 1.7 syllables; other trills: 4.6 ± 2.2 syllables). In spite of this, the first trill is longer than those which follow (0.67 ± 0.16 sec, as compared with 0.55 ± 0.19 sec for the others). The variability is great, but the differences are statistically significant (Table 2). Another possibility is a consistent change in frequency during the song. We could find none, by referring either to the maximum and minimum frequencies, or to the frequency spread.

Measures were also taken of the duration of the syllables through the song. If the duration of the first example of each syllable type is measured, the first syllable in the song proves to average consistently longer than those which follow (Fig. 5). If we treat phrase and trill syllables separately we can show that the latter are mainly responsible for this trend, those in the first position averaging about twice as long as those in the second, third, and fourth positions (0.19 ± 0.07 sec for the first trill syllable as compared with 0.10 ± 0.06 sec for the second, and so on; see Table 2).

STRUCTURE OF SINGLE SYLLABLES AND NOTES

The analysis so far has failed to account for the impression of extreme variability which the songs of these Mexican Juncos convey. Although the pattern of trills and phrases is varied, it is in the structure of the component notes and syllables that we find the greatest diversity. In an attempt to describe this structure more adequately we took separate tracings of the notes in each syllable type. Various attempts to classify the 497 notes resulted finally in a division into two classes, vibrato and non-vibrato notes. These in turn were subdivided according to the type of frequency inflection: whether rising, falling, steady, rising and then falling, or falling and then rising. A selection of typical examples is presented in Fig. 6 to illustrate the variability of note structure. Only eight of the ten possible classes are shown because two did not occur (non-vibrato: steady; and vibrato: falling and then rising). There were about three times as many non-vibrato as vibrato notes (378:117). Within each group some types are more common than others (Fig. 6, legend) but the diversity is nevertheless the most impressive aspect. There is no particular note type which predominates sufficiently over all other types that it could be said to characterize the song.

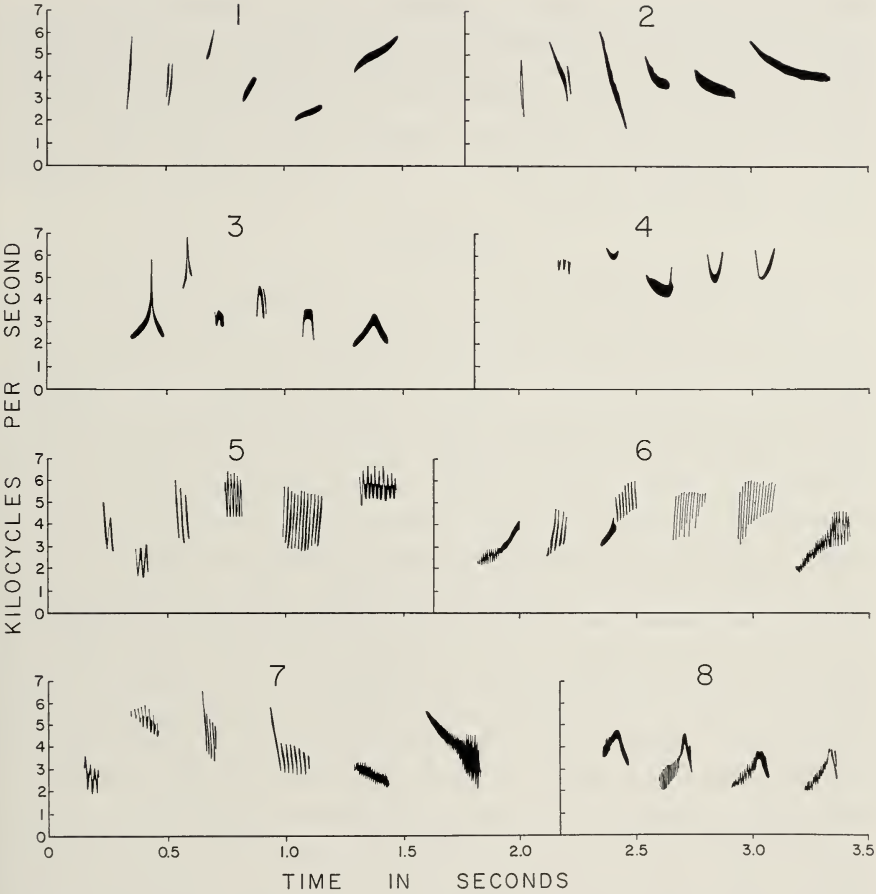


Fig. 6. Note types selected from various songs: The percentage which each note type contributes to the total is given in parentheses. 1 to 4—non-vibrato: (1) upward inflected (17.9), (2) downward inflected (25.2), (3) upward then downward inflected (26.2), (4) downward then upward inflected (6.8). 5 to 8—vibrato: (5) not inflected (10.3), (6) upward inflected (5.2), (7) downward inflected (7.6), (8) upward then downward inflected (0.8).

We also examined the way in which notes are organized into syllables. By recording the number of notes per syllable from which each individual note of the sample had been drawn, we found that vibrato notes come from syllables with fewer notes (2.0 ± 0.8 per syllable) than the non-vibrato notes (2.7 ± 1.2 per syllable, a significant difference: Table 2). Apart from this, each note type is equally likely to occur in a long syllable as in a shorter one. All types are also equally likely to occur at the beginning, middle, or end of the song. Nor is there any difference in the occurrence of note types in the syllables which are formed into trills and those which form phrases. However, the number of notes in trill and phrase syllables differs significantly (1.5 ± 0.8 notes per phrase syllable, 2.4 ± 1.1 per trill syllable; Table 2). There is also a separate relationship with the position of the syllable in the song. It has already been pointed out that syllable duration is greatest at the start of the song (Fig. 6).

DISCUSSION

The variability of Mexican Junco song.—Detailed physical analysis has done little to dispel the initial impression gained by listening to songs of Mexican Juncos in the field. There is a remarkable degree of variability from individual to individual, even within a single population. The properties which the songs of all individuals within this sample tend to have in common, on the average, are: a certain duration, and a selection of from two to five syllable types, with at least two and sometimes three of these repeated several times to form trills, giving a total of about ten syllables per song. Syllables are about 0.14 seconds in duration, although syllables in the first trill are rather longer than those in later trills. The variability of some of the other properties of the song is very striking. The trills are organized in a more regular fashion than the phrases. Nevertheless, the trills may appear in any part of the song, at the beginning, in the middle, or at the end, and the position of the loudest syllables is similarly irregular. The frequency characteristics vary widely, and there is no consistent pattern of frequency change through the song. Above all, there is great variability in the structure of the notes from which the syllables are built up.

Compared with some of the other emberizine finches, there is no doubt that Mexican Junco song is excessively variable in some respects, at least in this part of the range. The variability is probably less extreme than in songs of some of the more versatile singers, such as certain thrushes. Few quantitative studies of variation in bird song have yet been made, so that precise comparisons are difficult. Detailed syllable structure has proved to be variable in several species such as the Rufous-sided Towhee, *Pipilo erythropthalmos* (Borror, 1959*a*), the Brown Towhee, *Pipilo fuscus* (Marler and Isaac, 1960*b*), and the Chipping Sparrow, *Spizella passerina* (Borror, 1959*b*; Marler and Isaac, 1960*a*), and it may be that the Mexican Junco is a typical emberizine in this respect. The much simpler song of the Oregon Junco (*Junco oreganus*) is also variable in syllable structure, even though there is usually only one syllable type per song (Marler, Kreith, and Tamura, in press). Frequency characteristics have proved to be similarly variable in other species.

The variability of the over-all pattern in time is more unusual. The Rufous-sided Towhee has a similar variety of syllable types in each song, but they are arranged in a fairly regular pattern, so that Borror (1959*a*) can speak of an introduction and a trill. The European Chaffinch also has a variety of syllable types in each song, but they are organized into a series of trills, and an end-phrase (Marler, 1952; Thorpe, 1958). There is no such regularity in the way in which trills and phrases are placed in the songs of Mexican Juncos.

Song recognition.—We have suggested elsewhere that variability in bird songs is unlikely to be accidental, but should be related in some way to the function which a song performs (Marler, in press; Marler and Isaac, 1960*b*). It has been argued that specific and individual recognition, both of which can be mediated by bird songs, will encourage different evolutionary trends, toward stereotyped species-specificity in certain characters, and toward individual variability in others. It is thus of some interest to determine which song characters are shared by all members of a population, and which differ from individual to individual. As we have seen, Mexican Junco songs have many characters which vary consistently from individual to individual, and relatively few which are shared by all members of the population. Moreover, those which are shared are rather vague and indefinite in nature, so that we can only characterize the species-specific qualities of the song in an approximate way. We are thus led to ask what qualities are used by the juncos themselves in specific recognition. A final answer can only be given to this question by experiments, which would have to take into account the songs of other birds in the area, with which there might be confusion. The avifauna in the pine woods around El Salto is a simple one, occupying extensive uniform areas. The small number of bird species present may be a factor in determining the lack of highly stereotyped species-specific characters in junco song. This appears to be the case on some small islands, where an increased variability of songs as compared with the mainland populations can sometimes be correlated with the reduced avifauna, which simplifies the problem of specific song recognition (Marler, 1960).

There is an abundance of characters to permit individual recognition by song, even for a human observer. It would be interesting to know the developmental basis of these individual characteristics. Juncos living together in a group sometimes shared resemblances in syllable structure which could have a learned basis or a genetic one. The study of song development in captive-raised birds, which we plan to make in the future, will help us to decide between these two alternatives.

SUMMARY

The songs of 63 male Mexican Juncos living together in the same population, in Durango, Mexico, proved to be very variable in many characteristics. The average duration is 1.63 ± 0.29 seconds. The number of syllable types per song pattern usually

ranges from two to five. Syllables average 0.137 ± 0.087 second in duration, with the first in the song tending to be longer than those which follow. Some syllables are given singly, others are repeated in trills. The position of the trilled parts of the song, of which there are usually two, sometimes one or three, is very variable. The average number of syllables per song is 10.1 ± 2.9. Most of these occur in the trills which make up the greater proportion of the song, and are the most regular component. The frequency characteristics vary widely. There are no systematic changes in loudness or in tempo through the song, except for a tendency for the first trill in the song to have fewer, longer syllables than those which follow. The individual notes from which the syllables are built up have a wide variety of forms. The species-specific qualities of the songs of this population of Mexican Juncos are less definite and stereotyped than in some other emberizine finches.

ACKNOWLEDGMENTS

The expedition to Mexico, on which the songs were recorded, was made possible by a grant from the Associates in Tropical Biogeography, for which we are most grateful. We are indebted to Mrs. Emily Reid, who spent a great deal of time and trouble preparing the figures, and to Mr. W. R. Fish for helpful criticism. And, finally, thanks are due to the National Science Foundation for a research grant, under the auspices of which this work was carried out.

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DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CALIFORNIA, BERKELEY, 21 MARCH 1960

GENERAL NOTES

Dermestids killed when feeding on skeletons of birds killed by organic insecticides.—During the summer of 1959, the Cooperative Wildlife Research Unit at the University of Massachusetts conducted studies on the toxicity of certain organic insecticides using the American Woodcock (*Philohela minor*) as an experimental animal. The insecticides were carefully weighed doses enclosed in gelatin capsules and force-fed individually to birds of known sex, age, and weight. Some of the birds which died were presented to me for the purpose of preparing skeletal specimens to add to our collections. Two birds were roughed out, dried, and placed in separate boxes on clean cotton in the bottom of a five-gallon aquarium which had been used previously for this same purpose, become dirty, and been cleaned with plain hot tap water. A number of adult and older larval stages of the dermestid, *Dermestes maculatus* Deg. (= *D. vulpinus* Fab.), were removed from an active colony and placed on the specimens. The next day most of the beetles were dead. Some were kicking feebly and a few were still able to move about. Every one was dead by the third day. One of the woodcock skeletons was then soaked for two days in several changes of hot water, dried, and beetles placed on it with the same results. Infestation by mites as a cause of the death of the dermestids was clearly ruled out. The insecticide and dosages resulting in the death of these two woodcock were: woodcock No. 12, five doses of Dieldrin (each dose 1.25 mg/kg at daily intervals), and No. 24, a single dose of Dieldrin at 25 mg/kg (killed the bird within three hours after administration).

During the early fall I was called to the home of a friend to receive a sick second-year Herring Gull. As I was holding the gull while talking to Mr. Chisholm, the bird extended its neck slowly and died without a tremor. The symptoms were not at all similar to those of DDT poisoning and, since Mr. Chisholm had mentioned that the bird had some slight respiratory difficulty, I was guessing it had died of aspergillosis. About a month later, I removed the bird from the freezer, roughed it out, and placed it in a box on clean cotton in a five-gallon aquarium with some dermestids. On the following day the majority of the beetles were dead or dying and subsequently every beetle was killed. I do not know whether the aquarium was the same one used for the woodcock. Even if it were, the chances of contamination would appear to be slight, since the cotton was clean, the aquarium used for the woodcock had been thoroughly washed with soap and water and rinsed a number of times, and most of the beetles appeared to remain in the cardboard box containing the skeleton. A quick check in our collection reveals one Robin skeleton which had been brought in with convulsive tremors characteristic of DDT poisoning. This apparently had had no appreciable effect on the dermestids.

The results of these experiences suggest that birds which are found dead or dying should not be placed in vigorous, active colonies of dermestids. They also suggest that, with proper experimental data for background, the dermestid might prove useful in determining whether a bird had died from ingesting lethal quantities of certain organic insecticides. I would like to thank the Wildlife Unit and Mr. Wendell Dodge for providing the specimens and data on the woodcock, and Dr. Marion E. Smith for identification of the dermestids.—L. M. BARTLETT, *Department of Zoology, University of Massachusetts, Amherst, Massachusetts, 24 March 1960.*

Some shorebird records from Mexico.—Among our more interesting observations while in Mexico were those of shorebirds, a group with which Mrs. Coffey and I have spent quite some time. Most species we observed, chiefly of interest as transients, are being reported elsewhere while data on five are given here. Except where noted, all localities are in Veracruz. A favored strip of pits was along the Tampico-Valles highway, starting at Kilometer Post 9, almost to the village of Cacalilao at Km. 33, on the first rise, all in the state of Veracruz. At Km. 17.7 a side road runs south along Laguna Chila (almost dry on recent spring visits).

The Mexican Check-list (Pt. I, Friedmann, Griscom, Moore, 1950. *Pac. Coast Avif.*, 29:91) does not indicate records of the Semipalmated Plover (*Charadrius semipalmatus*) for the state of Veracruz. However, Frederick W. Loetscher, Jr. (1955. *Auk*, 72:26) gives a number of records for the state while Dean Amadon and Don R. Eckelberry (1955. *Condor*, 57:67) found the species, 3 May 1952, at the Bay of Alvarado. Our reports are: Tecolutla, two on 7 December 1949; east of Cacalilao, one on 21 November 1956; the beach, Coatzacoalcos, 50 on 3 December 1956, and on 4 December, eleven there and five near Nanchital. Apparent first reports for Guerrero are ours from near Acapulco; 17 at Pie de la Cuesta, 26 November 1956, and three at Colonia Copacabana, south of Puerto Marqués, the next day.

We know of no previous nesting record of the Snowy Plover (*Charadrius alexandrinus*) from the east coast and, except for Yucatán, but one previous report of the species on this coast. This latter was the four listed for the Tampico Count by L. Irby Davis, et al., 1–2 January 1953 (Edgar Kincaid, Texas Orni. Soc. Newsletter I (11), 9 December 1953). These may have been in Veracruz rather than Tamaulipas. On 4 December 1956, two singles were seen at Coatzacoalcos. Our other records are east of Cacalilao: the pit at Km. 9, and Laguna Chila. On 28 May 1955, two at Km. 9 gave indications of nesting but no nest could be found then or the next day when four were present. Along Laguna Chila on the 29th we saw one, two, and four and found a nest with four eggs which we photographed, along with that of a Black-necked Stilt. The Km. 9 pit was flooded by rain, overnight, and no shorebirds were left there, 30 May. On 31 May 1957, we found two pairs at Km. 9 and four, possibly nesting, at Laguna Chila (one-third dried up).

For the Wilson's Plover (*Charadrius wilsonia*), the Check-list gives only Veracruz (two records) and Yucatán on the east coast. Site of one listed Veracruz specimen is east of Cacalilao where we saw three singles on 11 May 1954, ten on 28 and 29 May 1955, and 20 to 23 (three spots) on 31 May 1957, and 20 April 1958. The 1955 birds acted as if nesting, but the birds were gone 30 May after the water level rose from rain. Amadon and Eckelberry (1955. op. cit.) found this species at the Bay of Alvarado, and Loetscher (1955. op. cit.) found it common at the city of Veracruz.

Sanderling (*Crocethia alba*). Guerrero is omitted under this species in the Check-list. However, Wm. B. Davis (1944. *Condor*, 46:10) reports two collected 14 August 1942, at Laguna Coyuca (near Acapulco) and that the species were "numerous" there. We saw only seven, all at the Colonia Copacabana beach, 27 November 1956.

The Willet (*Catoptrophorus semipalmatus*) was seen but a few times: 7 December 1949, one, south of Tecolutla, and 2 December 1956, ten near Veracruz. East of Cacalilao, we saw one, 29 and 30 May 1955, two singles and a pair on 21 November 1956, and 32 on 20 April 1958.

Another shorebird not credited to Guerrero by the Mexican Check-list is the Black-necked Stilt (*Himantopus mexicanus*). On 25 November 1956, I found two at a small lake north of Chilpancingo and five just southeast of Acapulco. The next day we saw a total of 72 widely scattered between Pie de la Cuesta and the Río Atoyac; then, on the 27th we counted 21 between Puerto Marqués and the new airport for Acapulco.—BEN B. COFFEY, JR., *672 N. Belvedere, Memphis 7, Tennessee, 21 March 1960.*

A Hybrid between the Painted and Varied Buntings.—Following the death in 1945 of the veteran collector, H. H. Kimball, the late Max M. Peet purchased his residual collection, numbering 15,146 bird skins and numerous sets of eggs. Through the generosity of Mrs. Peet, Dr. Peet's collection was donated to the University of Michigan Museum of Zoology. Unfortunately, most of the Kimball birds bear labels with only the sex and date of collection. We do know that he moved from Reserve, Catron County, New Mexico, to Cameron County, Texas, between 25 March and 18 April 1930, and resided in southern Texas through 1944.

Among the birds Kimball collected in southern Texas is an adult male bunting which appears to be a hybrid between the Painted Bunting (*Passerina ciris*) and the Varied Bunting (*P. versicolor*). The bird was taken 9 June 1934, presumably near Los Fresnos, Cameron County, where Kimball lived at the time. (We have another specimen collected on the same date with "Los Fresnos" in Kimball's writing on the label.)

Compared with two adult male Painted Buntings and four adult male Varied Buntings taken in June in Cameron County, the presumed hybrid is more like the Painted Buntings in pattern and general appearance. The underparts are red as in the Painted, but somewhat paler and duller. The top and sides of the head are solid blue as in the Painted, but the color is lighter (near Light Blue-Violet of Ridgway, 1912, Color Standards and Color Nomenclature), but not so pale as the forehead of the Varied. The back is a duller, bluer green than in the Painted (the two tones present being near Peacock Green and Meadow Green of Ridgway) and lacks the golden tones of that species. The green extends less far posteriorly than in the Painted, resembling in extent the mantle of the Varied. The lower back, rump, and upper tail coverts are intermediate in color between the rose-red of the Painted and the blue of the Varied, being between Light Violet and Hortense Violet of Ridgway. The rectrices are also intermediate in color between those of the presumed parental species, being paler and less blue (more violet) than in the Varied. The primary edgings are bluish as in the Varied Bunting, but one left "tertial" has a broad dull green outer web as in the Painted but of a darker and bluer green.

The wing length (chord) of 25 adult male Painted Buntings from southern Texas varies from 68.5 to 74.0 mm (mean, 71.3). Four adult male Varied Buntings from the same area have wing lengths of 65.5, 66.0, 67.0, and 68.0 mm (mean, 66.6). The wing of the hybrid measures 69.0 mm and is thus within the expected range of variation for the southern Texas populations of both species. It is, however, almost exactly intermediate between the means for my two samples. (These populations of the two species do not differ significantly in tail length, and the hybrid, with a tail length of 55.5 mm, agrees with both.)

The Indigo and Lazuli Buntings (*Passerina cyanea* and *P. amoena*) hybridize over a wide area in the Great Plains (Sibley and Short, 1959. *Auk*, 76:443–463). Although the Painted and Varied Buntings are probably less closely related, hybridization between them in southern Texas, where their breeding ranges overlap, is not surprising.—ROBERT W. STORER, *University of Michigan Museum of Zoology, Ann Arbor, Michigan, 31 March 1960.*

Recent brood records for the White-winged Scoter in North Dakota.—White-winged Scoters (*Melanitta deglandi*) were once considered to be locally common as breeders in parts of North Dakota, especially in the Devils Lake region (H. K. Job, 1898. *Osprey*, 3:39; 1899. *Auk*, 16:161–165; 1902. Among the water-fowl, pp. 189–190, Doubleday, Page and Co., New York, N.Y.; A. C. Bent, 1951. Life histories of North American wildfowl [reprint edition], Vol. II, pp. 132–133, Dover Publications, Inc., New York, N.Y.). These observations constituted the most southerly breeding records for the species in North America.

According to my review of the literature, White-winged Scoters became rare as breeding birds in North Dakota between 1900 and 1920. After the observations of Job and Bent, mentioned above, no breeding record is available until 1917, when F. M. Bailey observed half-grown young at Sweetwater Lake, Ramsey County, in late August (original paper not seen; quoted by N. A. Wood, 1923. A preliminary survey of the bird life of North Dakota, pp. 20–21, Misc. Publ. No. 10, Univ. of Mich., Ann Arbor). Wood observed a nest with 12 well-incubated eggs at Stump Lake, Nelson County, on 25 July 1920.

F. W. Cook (1946. *Auk*, 63:251–253) summarized the summer occurrence of White-winged Scoters on National Wildlife Refuges in the north-central United States. Adult birds were recorded on two North Dakota refuges in the summers of 1938, 1940, and 1941. This paper reported the next evidence of breeding by scoters in North Dakota: on 28 July 1936, Seth Low found two White-winged Scoter broods, each containing nine juveniles, on a lake five miles south of Denbigh, McHenry County.

Following this observation no brood records were obtained until 1952, when a female with a brood of nine young was seen at Des Lacs Refuge, Burke County, by Refuge Manager H. Huenecke (1952. *Audubon Field Notes*, 6:287). In 1953, a female with a brood of four young was observed in the same vicinity by Refuge Manager K. D. Dybsetter (1953. *Audubon Field Notes*, 7:314).

On 15 August 1955, while observing waterfowl at the Lostwood National Wildlife Refuge in Burke County, North Dakota, I saw a female White-winged Scoter with a brood of eight ducklings. The ducklings appeared to be about one week old. During a previous visit to this refuge (12 July 1955), I saw two pairs of White-winged Scoters in this same area, a pothole known locally as Knutson's Slough. The female and brood were observed within 100 yards of where the pairs were seen on 12 July.—H. F. Duebbert, *North Dakota Game and Fish Department, Oakes, N. D., 28 March 1960.*

Marsh Hawk and Common Crows feeding simultaneously on roadside-carrion.—At 6:45 AM, shortly after daybreak, on 7 March 1960, one mile north of Lone Elm, Anderson County, Kansas, I observed an adult male Marsh Hawk (*Circus cyaneus*) and three Common Crows (*Corvus brachyrhynchos*) simultaneously feeding on a freshly killed Eastern Cottontail (*Sylvilagus floridanus*). The carcass was lying in the west lane of a hard-surfaced road, and I presumed that the rabbit had been struck and killed by an automobile. All four birds were frightened away from the immediate area by approaching cars, and none returned during the short time that I was examining the eviscerated and well-mutilated rabbit (probably an adult). Crows are commonly observed feeding on roadside-carrion. The Marsh Hawk has also been said (Fisher, 1893. The Hawks and Owls, etc., U.S. Dept. Agric., Division of Ornithology and Mammalogy, Bulletin No. 3) to feed on carrion "when hard pressed." Bent states (1937. Life Histories of North American Birds of Prey, *U.S. Natl. Mus. Bull.* No. 167) that the Marsh Hawk willingly partakes of carrion. Errington and Breckenridge (1936. Food Habits of Marsh Hawks, *Amer. Mid. Nat.*, 17:847) and Randall (1940. Seasonal Food Habits of the Marsh Hawk in Pennsylvania, *Wilson Bull.*, 52:170) have reported that the Marsh Hawk feeds on roadside-carrion. Otherwise, I have found no specific examples on record of the Marsh Hawk feeding on carrion, with the exception of game birds freshly killed by hunters (see Fisher, op. cit.), which birds are carrion in a broad sense of the word. To my knowledge, the Marsh Hawk has never been reported to feed simultaneously with crows. The hawk's feeding on the rabbit and the feeding together of the two species of birds may have resulted from intensified hunger, perhaps effected by recent and severe snowstorms in eastern Kansas.—Charles A. Long, *Museum of Natural History, University of Kansas, Lawrence, 18 March 1960.*

Two observations on the orientation of day migrants heading inland from the Massachusetts coastline.—(1) On 22 September 1959, between 0715 and 1000 (EDT), while driving in a semi-circle around the coast of Cape Cod Bay from Wellfleet Bay past Plymouth to Lincoln, I kept a count of the Blue Jays (*Cyanocitta cristata*) crossing the highway, and estimated their direction by comparing it with the direction of the sun at the time. The observations were nearly continuous except for occasional periods of watching the road and traffic.

From 0715 until about 0800, while still on the Cape (southwest wind, 10 mph), I saw 12 Blue Jays flying singly, heading in directions that lay between south and southeast by south. Between the Cape Cod Canal and Lincoln (light west wind) I saw 36 jays in all, heading in directions varying from southwest by west to west. As soon as I crossed the Cape Cod Canal I saw birds oriented west, and the last group of six birds I saw near Lincoln was headed southwest. I saw four jays headed northeast, between Plymouth and Route 128, and two groups (one of two and one of three) flying northeast, near Lincoln. The directions were accurate to within 10 or 15 degrees, and show that the birds were following different average directions. The birds on the south and east sides of Cape Cod Bay were flying south; those on the west side of the Bay were flying west; those near Lincoln were flying southwest.

If we plot these directions on a map of Cape Cod Bay region, it appears that the Blue Jays near the coast were flying in many directions, but in each case directly away from the water; while those farther inland were taking a single, generally southwest, direction. If the birds on the Cape were merely leaving the coast, they cannot have been aware of the presence of the coast farther south.

(2) On Plum Island on 9 October 1959, a group from the Hatheway School of Conservation and I saw the southward migration of five flocks of Double-crested Cormorants (*Phalacrocorax auritus*) between 1030 and 1300. These flocks numbered between 20 and 45 birds. They were all headed in a direction just west of south, which led them to the coastline. One flock passed over Newburyport Harbor; three others met the coast near the mouth of the Merrimack, and a fourth met the coast near Plum Island Point.

We watched three cormorant flocks come in from over the sea in a regular formation with steady flight, toward the shore, from a point east of the Isles of Shoals, New Hampshire, until they started to pass over the beach. At this point the three flocks broke formation, but the two flocks that we saw near Newburyport Harbor quickly re-formed their V and followed the coastline. The flock of about 45 birds that we saw cross the coast at the southern end of Plum Island broke up and started to circle higher and higher. After the whole group had circled twice, a section of about 15 birds turned from the rest, formed a loose V and moved across the beach in a southwest direction which would carry them inland of Cape Ann. They then shifted their course to the south and continued in a south by west direction out of sight over the land. The larger group continued to circle higher, and was blown gradually offshore by a gentle northwest wind for a period of about 10 minutes until they were at about 3,000 to 5,000 feet up; then they also formed a loose flock and moved to the southwest. They turned again and followed the shore in a southerly direction over Ipswich Bay, but continued on in this southerly direction to pass overland west of Cape Ann.

The cormorants were following a consistent heading across the sea, and as they met the shore, they altered their course as Geyer has suggested for his *Leitlinien* (leading or deflecting lines) (1929. *J. f. Ornith.*, 77:17–32), and the fact that deflection and "indecision" were involved is shown by their milling about.

This course, and these actions, compared with the coastline of New England, and the migration route of Double-crested Cormorants shown in the map in an article by Baird and Nisbet (1959. *Mass. Audubon*, May–June), show that a southwest direction is the primary one for cormorants coming from Maine to cross Massachusetts into Narragansett Bay and Long Island Sound.

On both days on which these diurnal migrations of jays and cormorants were seen, the weather was clear and there was a light wind, southwest and west on 22 September and northwest on 9 October. On both days there was little other evidence of migration, and both days followed several days unsuitable for migration. These two observations point to the compromise between the primary direction and the effect of topography, in the migration of New England birds. These observations show the influence of these deflecting lines, which have led most American students of migration since William Brewster to consider use of topographic features as the primary orientation mechanism in bird migration. Many observations are needed to clarify how diurnal migrants make their way along the New England coast, but at present it is reasonable to accept these observations as further evidence that they use sun orientation together with clues from topography to maintain their primary directions and avoid local dangers.—William H. Drury, Jr., *Drumlin Farm, South Lincoln, Massachusetts. Contribution Number HS-30 from the Hatheway School of Conservation, 25 April 1960.*

Phoebe builds over dead young.—While banding nestlings in the summer of 1959 I observed an unusual nesting of the Eastern Phoebe (*Sayornis phoebe*) about five miles from State College, Pennsylvania. The nest was located just above eye level on a ledge of a rock cliff. When first discovered on 29 May two well-feathered young could be seen—one a Brown-headed Cowbird (*Molothrus ater*) and the other a phoebe. The young were not disturbed. The nest was next visited on 1 June at which time it contained a few loose bits of moss on top of two dead young. Since these two dead young were at an earlier stage of development than those previously observed they must have been hidden beneath the cowbird and phoebe at the time of the earlier visit on 29 May. The adult phoebes were protesting quite near so I decided to check again at a later date. By 8 June about an inch of fresh moss and lining material had been deposited on top of the dead young in the nest, and four eggs had been laid. On 18 June only three eggs could be seen, and on 30 June the nest was empty. The adult phoebes were still in the area on 30 June but showed no interest when I approached the nest. The nest was later collected and examination verified the presence of the two dead young beneath the added layer of nest material.—Dorothy L. Bordner, *926 West Beaver Avenue, State College, Pennsylvania, 12 July 1960.*

A prehistoric record of the Trumpeter Swan from central Pennsylvania.—Sections of the Sheep Rock Site, an Indian rockshelter located approximately 22 miles south of Huntingdon, Huntingdon County, Pennsylvania, were excavated during the summers of 1958 and 1959. Preliminary test pits dug in 1958 revealed quantities of dry organic material such as cordage, fabric, and wood as well as the usual amounts of flint projectile points and chips, bone remains, and other Indian refuse typical of such dry rockshelter sites. The Sheep Rock Site is dated at approximately 1500 A.D. Under the sponsorship of the Pennsylvania Historical and Museum Commission, Harrisburg, more detailed excavations were undertaken for an eight-week period in 1959 and they were directed by John Witthoft and W. Fred Kinsey III, Curator of Anthropology, Pennsylvania State Museum.

The presence of corn and beans in the midden deposits suggests that agriculture was practiced by some of the later groups occupying this site. However, the quantity of vertebrate remains throughout all excavated levels points to the significance of the local fauna as probably the principal source of food for these people. In addition to the large number of bone fragments, which have not yet been completely analyzed, numerous bone artifacts were also encountered. Although several are of particular archaeological interest, the worked ulna and humerus sections of a swan are the most significant from a zoological point of view.

The proximal half of a left ulna and a right humerus of the Trumpeter Swan (*Olor buccinator*) were found in association with materials from these dry middens. Both wing bones were cut off almost exactly at the mid-point of the shaft, and the cut ends then had been beveled inwardly. Possibly these tools (?) were used as some type of gouge or perhaps they served as handles; their polished appearance suggests considerable handling. The ulna was sent to me first by Mr. John E. Guilday, Assistant Curator of Comparative Anatomy, Carnegie Museum, Pittsburgh, and was tentatively identified as *O. buccinator.* Since the locality is considerably out of this swan's known range, it was sent to Dr. Alexander Wetmore, Research Associate, Smithsonian Institution, Washington, who stated (letter of 18/11/59) that "the swan ulna is a good specimen of the Trumpeter Swan of large size." In scraping (or cleaning?) the ulna, the outer edge of the external and internal cotyla, the tip of the olecranon, and a small area immediately posterior to the olecranon on the anconal surface, were removed. The edge of the deltoid crest, internal tuberosity, pneumatic fossa, and bicipital crest of the humerus were also scraped and/or broken away.

The diameter (breadth) of the ulna shaft at the point where it was cut is slightly larger (14 mm. vs. 13 mm.) than the largest adult Trumpeter Swan ulna in the Illinois State Museum collection. In contrast, the breadth of the humerus measured at this point is approximately 1 mm. less (17 mm. vs. 18 mm.) than the humerus of this same swan, thus suggesting the probability that two individuals are represented. Extremely close similarities of anatomical features between the Trumpeter Swan and the Whistling Swan (*Olor columbianus*) often make specific determinations questionable; although this cut humerus is slightly greater in proportion to the largest adult Whistling Swan specimen in the Illinois State Museum collection, it may possibly represent a very large individual of *O. columbianus.*

Apparently there are no authenticated records of the Trumpeter Swan for Pennsylvania, and Indiana is given as the eastern edge of its former breeding range in the fifth (1957) edition of the A.O.U. Check-list of North American Birds (p. 58). Todd (1940. Birds of Western Pennsylvania, p. 67) states that "The Trumpeter Swan (*Cygnus buccinator*) is another species which may have occurred formerly but for which the evidence of occurrence is likewise unsatisfactory." There is one possible record as suggested by Sutton (1928. *Annals Carnegie Mus.*, 18(1):19–239): "Mr. William Foust of Conneaut Lake is said by Mr. Welshons to have taken a Trumpeter Swan at the Lake in November, 1909." Remains of this swan have been reported from Ohio (R. M. Goslin, 1955. *Ohio Jour. Sci.*, 55(6):358–362) and have been found commonly at certain sites in Illinois (P. W. Parmalee, 1958. *Auk*, 75(2):169–176). It is reasonable to assume, therefore, that when this species inhabited eastern North America, occasional migrating or wandering flocks may have occurred in Pennsylvania. This one record (ulna and possibly the humerus) points to the prehistoric occurrence of the Trumpeter Swan in central Pennsylvania; with the excavation of addition faunal materials from various sites and the probable recovery of other swan material, the former occurrence of this species may be definitely established for the state.—PAUL W. PARMALEE, *Illinois State Museum, Springfield, Illinois, 18 December 1959.*

Food competition among closely related sympatric species.—From this viewpoint, the following incident may be of interest. Late in the afternoon of 6 June 1959, a Yellow-billed Cuckoo (*Coccyzus americanus*) and a Black-billed Cuckoo (*Coccyzus erythropthalmus*) were observed feeding on some spiny black caterpillars, about one and a half inches long, which were clustered on many tips of the branches all over a willow tree standing beside a sluggish stream. Both cuckoos used the same techniques. Sometimes they would hop to a branch favorably located below a cluster of caterpillars and then fly up to the cluster, fluttering rather awkwardly until one was captured. At other times they would work out along a limb until a caterpillar could be reached by stretching. In any case, the prey was vigorously worked through the bill from one end to the other several times before swallowing. It seemed that the Black-billed Cuckoo prepared its food more thoroughly than the Yellow-billed. Four instances of conflict were observed; in every case, the Black-billed was the aggressor and the Yellow-billed retreated without resistance to another part of the tree. The Black-billed sang twice, the Yellow-billed was silent throughout. The Black-billed captured 11 caterpillars in an hour and a half, of which nine were eaten in the tree and two were carried off. The Yellow-billed was seen to eat six and, so far as could be determined, never left the tree during the observation period. At least an equal number of caterpillars were dislodged from the tree since the wing-fluttering technique frequently shook loose two or three caterpillars in addition to the one taken. At 9 AM the following morning, a careful examination failed to disclose a single caterpillar. Although it cannot be proven, it seems to be a fair assumption that the cuckoos completed the job during the early hours of the morning, because the only other species present here in June which might have participated, Blue Jays (*Cyanocitta cristata*) and Scarlet Tanagers (*Piranga olivacea*), were not observed in the immediate vicinity during this time. Thus, in interspecific competition, a Black-billed Cuckoo dominated a Yellow-billed Cuckoo where an abundant food supply existed, but the competition did not really interfere with the food supply of the dominated species.—R. O. BENDER, *Cobb's Mill Road, R. D. No. 1, Bridgeton, New Jersey, 6 January 1960.*

LETTER TO THE EDITOR

Further Comments on Variation in Vireo

I would like to take this opportunity to clarify certain misunderstandings which, as A. L. Rand (1961. *Wilson Bull.*, 73: 46–56) points out, seem to have resulted from my paper on "Adaptive variation in the genus *Vireo*" (1958. *Wilson Bull.*, 70: 307–346).

(1) In my paper, I was attempting to show that the effects of selection pressures for large size in the cooler parts of the ranges of species are frequently masked in other regions by additional selection pressures superimposed on the operation of the effect of low temperature. Taking Bergmann's rule for granted, I concentrated on additional factors which conceivably might effect geographical variation in body size and wing length. To make sure that this would not be misunderstood, I introduced my paper with these sentences (1958: 308): "Before continuing, I would like to point out that my conclusions, reported in this paper, on the adaptive significance of variation in body size within the species of *Vireo* and some other New World species *do not invalidate* Bergmann's rule. Rather, I interpret my findings to represent alternate possibilities: First, other selective forces . . . may mask, modify, or interact with the selective action of cold temperature . . ." (Rand, incidentally, does not question my use of the theory of combined operation of additional selective factors; this is evident from the similarity between my comments quoted here and the concluding sentence to his paper (1961: 55), "More than one factor could be in operation at one time, working in different directions, canceling, or modifying each other.") Then, after citing some trends for intraspecific increase in wing length in the Sonoran region, I wrote (1958: 324) that "Finally, I find little evidence for the presence of Bergmann's rule, *per se*, within New World species." This sentence is ambiguous, open to misunderstanding, and seemingly in conflict with my comments elsewhere in the paper. The *per se* referred to the operation of Bergmann's rule without evidence of superimposed, additional selection pressures, and, thus, I feel that Rand is less than precise when he reports (1961: 46) my findings in the words "Hamilton, in 1958, writes that he can find little evidence for the application of Bergmann's rule (wing length and presumably body size being greater in colder climates) within New World species."

The few examples of larger wings and body weights in North American regions of low environmental temperatures, which Rand has listed, do not come to grips with the issue I raised in my paper, namely, that of the possible operation of additional selection pressures on wing length and body size in the southwestern region of North America. Nor do conclusions (Rand, 1961: 54) based on comparisons of the wing lengths and weights of populations from eastern and western United States provide a test for the validity of the aridity effect.

(2) Discussing the aridity effect, Rand states (1961: 54) that "On the basis of longer wing length of populations from the western part of North America, [Hamilton] postulated a greater body weight . . ." I find the first part of this quote puzzling since the aridity effect, as I formulated it, is a speculation (1958: 323) derived from intraspecific increase of wing length *in southwestern North America* (Sonoran region)—made clear by my comparison of these large winged Sonoran populations with conspecific populations from more northerly portions of western North America. A comparison of populations from eastern and western United States appears irrelevant to a critical analysis of the above problem. I present the following comments in complete agreement with Rand's statement (1961: 47), about equating wing length with weight, that "If accepted for

samples of birds of the same species from distant areas with widely different environments, there is danger of falling into grievous error."

To disprove the aridity effect, one would first have to demonstrate that such a tendency for intraspecific increase in wing length *and* body weight in the Sonoran region does not exist. Rand writes (1961: 54) "But, [Hamilton] had no weights." I had planned to delay further in reporting (manuscript in preparation) on the matter until I had adequate material to test the point in several species. The limited data available for *V. solitarius*, however, do support the postulated trend for Mexican increase in size (i.e., if we assume that body weight is a valid indicator of size). For example, consider the variation in three western races of *V. solitarius*: *cassinii*, *pinicolus*, and *repetens*. The distribution of these three breeding segments are, respectively and approximately, western United States, Sonoran Mexico, and southwestern Mexico. For males of the first race, Rand lists (1961: 51) values of 72 mm. and 15 grams; for the second race, there are available nine male specimens (Museum of Vertebrate Zoology: collected during June–July, 1957–1959, in the Sierra del Nido, Chihuahua) with average values of 82.7 mm. (81–85) and 18.0 grams (16.3–20.7); and, for the third race, two male specimens (Texas Cooperative Wildlife Collection) have August values of 81 mm. and 17.2 grams and 81 mm. and 19.2 grams.

How valid an indication of size body weight is, is still uncertain, and when more information about the variation in *V. solitarius* is available, my analysis of the variation may well be superseded. Any explanation, for the present, is hypothetical. For example, one might argue that populations of this species in Sonoran Mexico have longer wings and greater weights resulting from the operation of Bergmann's rule because of occupation of habitats in cooler, montane regions, but, then, this may not be the complete explanation since these populations appear to move south during the winter. One might also argue that populations of the *pinicolus* segment have increased wing lengths as a result of utilization of more open habitats, but, then, their body weights seem also greater than those of conspecific populations to the north in, say, Nevada, or to the northeast in eastern United States (see data for this species cited by Rand, 1961: 51). Finally, one could argue that populations of the *pinicolus* segment appear to have greater wing lengths, simply because the *cassinii* populations have smaller wing lengths in association with reduced body size as an auxiliary adaptation facilitating long-distance migration (for a discussion of such possibilities, see Hamilton, 1961, *Evolution*, 15: *in press*). However, this may not be the complete explanation since the *pinicolus* segment appears to consist of migratory populations which winter farther south in Mexico, where, apparently, occur resident populations of the *repetens* segment. In the light of such considerations, the aridity effect can only remain as previously presented—i.e., a speculation.

(3) Rand writes (1961: 52) that I state "that *Vireo olivaceus* and *V. griseus* show the tendency for insular populations to have 'greater wing length and relatively longer bill length (see Murphy, 1938).'" In reality, I stated (1958: 334) that "The strongly isolated, insular representatives of the Caribbean area show the tendency for insular populations to have greater wing lengths and relatively longer bill lengths (see Murphy, 1938)." The Murphy reference, as Dr. Rand states correctly, refers only to variation in bill length, and I regret not having made it clear that the citation in parenthesis refers only to the immediately preceding item (bill length).

I should like to add that for several years I have believed (without giving the matter much thought one way or the other) in the following theory: that there exists in some groups a tendency for insular populations derived from continents, or for populations of small islands derived from large islands, to acquire slightly greater wing lengths (indicating, presumably, increases in size). For example, if one examines the data for variation in the superspecies *V. olivaceus* and *V. griseus* (Hamilton, 1958: 317, 325), it appears that the Caribbean populations tend to exhibit approximately equal or greater wing lengths than their superspecific counterparts on the adjacent American mainland. (The way Rand (1961: 52) lists my data for these two species prevents observation of this point.) Using my data for these two species, of the values (to the nearest 1.0 mm.) for the 12 Caribbean populations, five are larger, six are intermediate or equal, and one is smaller, when superspecific comparisons are made to the values and ranges of values for the American mainland, lowland populations (from Panama to Florida). The tendency among the vireos of the Caribbean islands to have increased wing length is, to me, unmistakable, provided one makes the comparison with adjacent mainland populations, from which the Caribbean ones are apparently derived.

It would be a good thing if others would take up the problem of the influence of insularity on wing length and size. Mayr and Vaurie (1948. *Evolution*, 2: 253–255, 260) have noted some evidence in the Dicruridae for a tendency of populations or isolates of small islands (12 of 17 cases for *Dicrurus leucophaeus* and *D. hottentottus*) to have greater wing lengths than conspecific populations of adjacent, larger islands. Among the passerine races endemic to Cozumel Island off Quintana Roo (see data of R. A. Paynter, Jr., 1955. The *Ornithogeography of the Yucatán Peninsula*), four seem larger (*Troglodytes musculus beani, Dumetella glabrirostris cozumelana, Cyclarhis gujanensis insularis,* and *Richmondena cardinalis saturata*), five are equal, and two appear smaller, when size comparisons are made to conspecific races on the adjacent mainland. However, absences of such a tendency can also be cited. Lack's data (1947. *Darwin's Finches*) for members of the Geospizidae, when arranged according to size of islands, seem not to show the tendency.

Discussing my data for populations of *Vireo* having breeding distributions in the Caribbean, Rand assumes (1961: 52) that the insular variation is due to "irregularity." He thus believes that my data do not demonstrate a "regularity," even though I reported only about "the tendency." While there can be no doubt that "irregularity" in some way is a component of character variation for any population or isolate, I am not willing to consider this as the only explanation for the variation in wing length of Caribbean vireos. My present stand on the matter (and I have no quantitative evidence for this) is that when continental populations reach small islands, a variety of centripetal selection pressures for specific niche or climatic adaptations may be relaxed, thereby permitting in time more general adaptations to be favored, involving, in some cases, increases in size. However, stringent competition can occur in the depleted or uniform habitats of small islands, and my comments refer mostly to pioneering populations exploiting previously vacant ecological niches and habitats.

(4) In conclusion, when I wrote my 1958 paper, I presented data in an attempt to unify the theories for ecogeographic variation in wing length and size in birds. That attempt leaves, admittedly, much to be desired, as does my current attempt (1961. *Evolution*, 15: *in press*). For example, the evidence for the aridity effect is still sparse and equivocal, and the evidence for the warm-humidity effect (op. cit.) can always be explained away as indicating an absence or reduction in operation of Bergmann's rule. The principal object of these two papers was to stimulate the collecting of new data and to propose new working models and alternate explanations, but not to disprove the work of others.—Terrell H. Hamilton. *Harvard Biological Laboratories, 16 Divinity Avenue, Cambridge 38, Massachusetts, 20 April 1961.*

ORNITHOLOGICAL NEWS

Dr. Oliver L. Austin, Jr., Curator of Birds, The Florida State Museum, has been appointed by the Nuttall Ornithological Club, Chairman of the Bent Life Histories of North American Birds Committee.

The Thirteenth International Ornithological Congress will convene at Cornell University, Ithaca, New York, from 17 to 24 June 1962.

The official announcement and application for membership in the Congress are now ready for distribution. Interested persons who have not already done so should send their names and addresses to the Secretary General as soon as possible.

A small fund has been obtained to provide partial support for the travel of a few persons coming from outside North America. Application forms will be sent to persons requesting them. (Citizens of the United States and Canada are not eligible.)

Before 1 December 1961, all applications for membership, travel grants, and places on the program should be returned to Charles G. Sibley, Secretary General, Fernow Hall, Cornell University, Ithaca, New York, U. S. A.

The Forty-third Annual Meeting of the Wilson Ornithological Society will be held at Purdue University in Lafayette, Indiana, from 6–8 April 1962.

NEW LIFE MEMBER

Hubert R. Doering, of Chicago, Illinois, a new life member of the Society, has been an active member since 1945. An account executive with D'Arcy Advertising Company, Mr. Doering is an amateur ornithologist whose interest began at the age of five when he attempted to hatch Bantam eggs. He then bred show-room poultry in a scientific manner, and now he is interested in population and life history problems, especially of warblers, owls, ducks, and geese. He has published an article on the birds of Bronxville, New York. In addition to being a member of the Wilson Ornithological Society, Mr. Doering is a member of the AOU, the Linnaean Society of N.Y., and numerous local groups.

ORNITHOLOGICAL LITERATURE

The Kirtland's Warbler. By Harold Mayfield. Cranbrook Institute of Science, Bloomfield Hills, Michigan, 1960: 6¼ × 9¼ in., xvi + 242 pp., 8 pls., 9 figs., 44 tables, col. front. by Roger Tory Peterson. $6.00.

This long-awaited and excellent book provides our most complete account of the life of a wood warbler. It has, in addition, independent significance as a study of the history and present ecology of a small relict population of birds, and it will surely play an important part in the efforts of those whose duty it is to save the Kirtland's Warbler (*Dendroica kirtlandii*) from extinction.

Field work began over 30 years ago, when in 1930 Josselyn Van Tyne decided to study the Kirtland's Warbler. Among a number of ornithologists aiding him on occasion was Harold Mayfield, who participated in a trip in 1944 and thereafter collaborated as a full partner in the project until Van Tyne's death in 1957. The bird's breeding grounds were many miles distant from the homes of both investigators; the study required not mere field trips, but expeditions, and there was relatively little opportunity for sustained daily observation of individual birds or nests. To appreciate the difficulties, one might contrast the Kirtland's Warbler with the Song Sparrow (*Melospiza melodia*), for which, as a subject for her classic, Margaret Nice (1943. *Trans. Linn. Soc. N.Y.*, 6:1) listed these advantages: "it is abundant, thus affording many individuals for observation; it is widely distributed (having been available to me [at my homes]); it is easily watched, since it nests at our doorsteps and its territories are small; it readily enters traps, and can be easily reared by hand and kept in captivity." Lacking all of these advantages, Mayfield and Van Tyne nevertheless compiled remarkably voluminous data, and their project has succeeded. Direct evidence was sometimes difficult to accumulate on subjects requiring daily visits to the study area (e.g., duration of incubation, hatching sequence within the clutch, pair stability, and time required for mate replacement); but even on matters of this sort, skillful analysis of fragmentary data has yielded Mayfield much circumstantial evidence to throw light on the direct observations.

There is in the book a natural emphasis on ecology, and the opening chapters on the known history of the Kirtland's Warbler and on the summer and winter habitats are of great interest. So restricted is the species' breeding range in Michigan that no nest has ever been found more than 60 miles from the place in which Norman Wood discovered the first, in 1903. Equally limited is the seral stage of vegetation inhabited: small jack pines (*Pinus banksiana*), springing up in clumps a few years after forest fires, are the dominating feature, for a brief period (typically 10 to 12 years), of the requisite plant association; then the trees become too large, the openings between them close, lower branches are shaded out, and the warbler leaves. There are still further requirements, that the burned-over tract be extensive enough to attract and accommodate the cluster or colony of territories which the males establish, and that the soil be sufficiently porous to drain off surface water before the nests depressed in the ground are injured. Thus, although the jack pine is widely distributed in northern North America, Mayfield believes that the reason the bird breeds only in Michigan is that only there has there been, *continuously*, the required combination of highly specialized conditions. The period of greatest abundance of the Kirtland's Warbler, since it entered the state in the wake of jack pines spreading northward as the Wisconsin glacier retreated, he puts in the 1880's and 1890's. Since that time of forest fires and extensive burning following early timber cutting, numbers of the Kirtland's Warblers declined to fewer than 1,000 in 1951. For the future of the habitat Mayfield finds "no immediate cause for alarm" (p. 28), but a subsequent chapter on population dynamics suggests little reason for optimism about the prospects for the species itself.

Why this narrow restriction as to habitat? The Kirtland's Warbler seems not to be a food specialist, limited by the distribution of organisms comprising its diet. Part of the answer to the question, Mayfield believes, is a high degree of vulnerability to nest predators as the result of an exceptionally long incubation period, 14 days as compared with from 11 to 13 days for other open-nesting parulids. A general unwariness in adults he thinks may put an additional premium on sanctuary, and there is a suggestion that the bird does not prosper against competition. In any event, pine barrens provide greater immunity from predators and isolation from competitors than does deciduous scrub; and it is pointed out that once the species became restricted to jack pines a high precision in orientation may have been an obstacle to potential dispersal into new habitat.

Of that portion of the work, about half of it, devoted to breeding behavior and biology, little summary is needed. The stages of reproduction and of development of the young are treated consecutively, with separate chapters on voice and on weights and plumages. The description of adult behavior surpasses in comprehensiveness any in the literature on parulids, while one seldom sees for a perching bird so detailed an account of intra-family relations and the development of fledglings in the period between nest-leaving and independence. Data on matters of breeding biology have been subjected to rigorous standards of exclusion, and this fact and the meticulous attention to definition of terms and conditions of observation assure the lasting utility of the book as a source.

The longest chapter in the book is devoted to the relations between the warbler and a serious, perhaps the most serious, enemy, the Brown-headed Cowbird (*Molothrus ater*). This material will be an important reference for students of the latter species and of brood parasitism. Although the rate of parasitization of Kirtland's Warbler nests, about 55 per cent, is paralleled or surpassed in the cases of populations of a few other hosts, Mayfield makes a convincing argument that no other *species* is known to suffer comparable pressure. Considering the factor that is ultimately decisive, i.e., loss in net annual production of young, if the Kirtland's Warbler were unmolested by the cowbird, as it probably was until the 1870's, it would bring off 60 per cent more fledglings. This conclusion is supported by analysis of losses, stage by stage, in parasitized nests as compared with nests containing only host eggs. The chapter also contains contributions on the cowbird's selection of nests in which to lay, and on other aspects of its behavior in connection with laying.

The final substantive chapter is a population study. Equally as interesting as the conclusions presented is a novel method of using fragments of data on reproductive success. These data are first presented conventionally, but there is recognition of the error of arriving at hatching or fledging percentages from nests discovered after the incubation or nestling periods have begun; and the sample of nests observed from the laying of the first egg until the fate of the nest was determined was too small to be used. Mayfield is able, however, to determine rates of loss *per day* at each stage of development until fledging and thus to derive the probability of success of nests and eggs in a hypothetical sample. Further, the number of nests and eggs produced by a large sample of pairs can be predicted, and these figures when combined with those on success yield a hypothetical annual rate of production, which proves to be 1.4 fledglings per pair of adult warblers. The complexity of the calculation will be apparent upon consideration that many factors (e.g., probability of renesting, clutch size) are constantly varying as the nesting season advances; and there are other difficulties to be taken into account. I thought the reasoning logical and clear.

Survival of adults is at the rate of about 60 per cent per year, so that the remaining life expectancy of an adult in June is about two years. The conclusion is based on returns of banded birds; there is the usual assumption that the annual mortality rate is unaffected by age. Given the accuracy of the calculated rate of production of fledglings and of that of adult mortality, the rate of survival of fledglings to the following breeding season would have to be 57 per cent to maintain the population. In fact, as Mayfield makes clear, it is most unlikely that so high a percentage of young survives this period. Therefore Kirtland's Warbler numbers may be declining. Undoubtedly there will be more to say on this subject after Mayfield completes his second decennial census of the population, during the present summer.

The book concludes with a list of "Problems for Further Study," which will be useful to future students of the species, but it is one of the merits of the work that his familiarity with the literature and with current problems enables Mayfield to raise many interesting and unanswered questions throughout the report. In this respect he fulfills the functions of a good teacher as well as those of a model.

On points of form and format, the volume can be enthusiastically endorsed. It is well written, attractively bound, and free from errors. The index is a little too general to lead to some subjects with maximum speed and not quite imaginative enough to refer to all pages on which appears material possibly relevant to various indexed words. However, sub-headings within each chapter and summaries at the end compensate for this shortcoming and add much to the convenience of use. In sum, this is a fine and important book, and it deserves hearty recommendation.—VAL NOLAN, JR.

THE WONDERS I SEE. By John K. Terres. With drawings by Walter Ferguson. J. B. Lippincott Company, Philadelphia and New York, 1960: 5¾ × 8¼ in., 256 pp. $5.00.

People who like *Audubon Magazine* may be expected to enjoy this collection of nature sketches—and not surprisingly, since the author of the book was an editor of that magazine for eleven years.

The book consists of 84 selections, nearly half of them about birds. The rest touch on a variety of subjects, particularly insects, mammals, and conservation. Included are original observations, explanations of puzzling questions, retelling of historical events, and personal comment. These jottings range in length from one paragraph to eight pages. They are arranged according to the time of year, and each begins like an entry in a field journal, with date, location, and weather. Since the parts are mostly short and unrelated to the others in sequence, a reader is likely to pick up the book and read it a little at a time rather than continuously from cover to cover.

Examples of items especially interesting to bird students are the following: "Why Don't Birds' Feet Freeze in Winter?" "The Great Lapland Longspur Tragedy," "Why Does the Mockingbird 'Flash' Its Wings?" "How the Cattle Egret Got to America," "When Do Birds First Learn Fear?" "The Mystery of Bird 'Anting,'" "McAtee: Food Analyst of the Birds," and "Where Do Birds Sleep at Night?"

The treatment of subjects is factually accurate but simple enough to be within the comprehension of an interested child. (Words such as "mammalogist" and "gestation" are defined.) A book of this kind intended for recreational reading inevitably will be judged in part for its literary quality, and I think it is fair to say that a person with an ear sensitive to grace and elegance of expression will find passages to criticize. Most readers who share the author's enthusiasm for nature, however, will not be severe in their literary judgments of this work.—Harold Mayfield.

Dictionary of Word Roots and Combining Forms. By Donald J. Borror. N-P Publications, Palo Alto, California, 1960: 5 × 7 in., v + 134 pp. Stapled in stiff paper cover. $2.00.

This modest publication is aimed at "the beginning student [of biology], the medical student, and the taxonomist." The introduction contains general directions for the use of the dictionary, plus a handy set of rules for the pronunciation of scientific names (I have more than once found myself conversing with a colleague who pronounced some scientific name so differently from my own concept of its pronunciation that I failed at first to understand what animal he was discussing, and neither of us certain as to who was correct).

The body of the work is an alphabetical list of word roots, prefixes, and suffixes, mostly derived from Latin and Greek but with a few words that have found their way into scientific nomenclature from other languages—and even from onomatopoeia, as in "phoebe (from its call). The phoebe." There follows a very brief guide to the formation of scientific names of plants and animals, and a list, classified by subject (colors, habitats, structures, etc.), of common combining forms intended as a help in selecting roots for the formation of new names.

This booklet (for it is scarcely more than such) will probably be most useful as an introduction to word meanings for the beginner who does not intend to pursue the subject at any length. There are several more complete publications of this nature, which Borror's book will not replace. I myself use "Composition of Scientific Words," by Roland W. Brown of the U.S. Geological Survey (published by the author, 1956: 882 pp.), which is about as complete a guide to word formation and derivation as one could wish for. Brown's book, unlike Borror's, has the advantage of having the classical roots and English words cross-referenced in the same glossary. Thus, Borror gives "anas (L). A duck." while Brown gives "**anas**, L. duck; *anaticula*, dim., duckling; *anatinus*, of ducks; see **duck**." Under **duck** we find no less than eleven Greek and Latin words which were applied to various kinds of ducks, together with examples of the use of each word or root in a scientific name: "L. *querquedula*, f. a kind of duck: *Querquedula cyanoptera* (cinnamon teal)."

The modest price will permit wide distribution of Borror's little book, but the serious student of nomenclature and the practicing taxonomist with a continuing need to coin new names will wish to own a more complete work.—Kenneth C. Parkes.

The Trumpeter Swan: Its History, Habits, and Population in the United States. By Winston E. Banko. U. S. Department of the Interior, Fish and Wildlife Service, North American Fauna No. 63, 1960: x + 214 pp., 6 × 9⅛ in., front., 54 figs. (including photos., drawings, and maps), 16 tables. Paper covered. $1.00.

This publication will appeal to everyone interested in birds, from bird lovers to professional management personnel. Its wide appeal is due to a broad approach which includes historical, behavioral, and statistical data, all arranged in a logical fashion and presented with extraordinary clarity. An abundance of remarkably fine photographs by Banko and others provide the best illustrations of Trumpeter Swans that I have seen. The text is further enlivened by a series of crisp line-cuts by Shirley A. Briggs. This is a successful monographic treatment of a single species, although the omission of much Canadian data (a separate study by Ron H. Mackay of the Canadian Wildlife Service is in progress) is unfortunate. Still, the status of Trumpeter Swans in Canada is briefly sketched and reference is made to most published Canadian reports. Saskatchewan birders, however, will be disappointed to learn that their province is omitted in the discussion of recent breeding records in Canada (see *Blue Jay*, 1953, 11: 26–27).

The author states in the foreword: "This account includes a historical record of this bird in the United States and Alaska, an outline of its habits and characteristics in its native Rocky Mountain environment, and furnishes information necessary to guide its future." The Trumpeter Swan is introduced as a member of a group of birds (i.e., swans) which have played a prominent role in human history and which have long been admired for their grace and beauty and large size. Their systematic position is also presented. The occurrence of the Trumpeter Swan in North America from the ancient past, through pioneer days and up to 1957, is well documented in a chapter headed: "Distribution and Status." This section includes accounts of the marketing of swan skins by the thousands, an activity which apparently was a major factor in the near extinction of the trumpeter. Strangely, it is evidently not even clear what use was made of these skins! Admirers of Sir John Richardson will be pleased to note from the historical section that he was the first to describe a positive method of differentiating the Trumpeter Swan from the Whistling Swan. The tracheal anatomical difference which he discovered is still the only reliable character. Ecological aspects are considered in the chapter on "Habitat" and include discussions of the former general environments and, specifically, characteristics of the swan's breeding grounds at Red Rock Lakes Refuge. Although it formerly occurred as a breeding species across the continent and throughout several life zones, its ecological niche is shown to be very limited. Both summer and winter habitat requirements are described.

The "Life Cycle" section includes a useful description of the Trumpeter Swan and comparison with the similar Whistling Swan. The difficulty of using bill coloration to separate these species is pointed out. I was surprised to learn that the reddish streak on the bill of the Trumpeter Swan is "confined almost wholly to the basal section of the lower mandible edge . . ." Delacour (1958. The Waterfowl of the World. Vol. 1) states: "The massive bill is wholly black except for a narrow red border to the anterior part of the upper mandible." Peter Scott's accompanying illustration, however, favors Banko's description. According to Banko, not even this character is consistent.

The behavior notes constitute an important contribution to our knowledge of this species. Observations of several displays are described briefly and directly and are illustrated by good photographs. I cannot wholly agree with Banko that analysis of displays "should await that time when extensive recordings of their vocal efforts have been made in synchronization with motion pictures of their various actions." This may be very desirable but in the interim I think it would be useful to proceed as we can. The behavior observations reported by Banko might have been described in more detail and a greater attempt might have been made to relate displays to function. Although there is a considerable discussion of territorialism, the size of the territory is not quite clearly stated, apparently because of the effect of irregular habitat, although maximum area available is reported as from 70 to 150 acres per nesting pair.

Information on the "Life Cycle" also includes breeding data, nesting habits, development of the young, feeding habits and food, and a discussion of limiting factors and longevity. In spite of the lengthy list of mortality factors of natural origin, man may still be considered the most significant limiting factor. However, man's recent activities on behalf of the Trumpeter Swan have clearly been of benefit to the species. Banko estimates the total continental population of Trumpeter Swans now at probably 1,500 or more. A detailed analysis of Trumpeter Swan population dynamics is presented which will be of interest to students of natural populations. The data concern chiefly the population of Red Rock Lakes and Yellowstone Park, both of which were carefully censused annually over a 27-year period. It is shown that a saturation point was reached and that breeding productivity was depressed at this time through a decline in cygnet production. In broader terms the rate of productivity of mated pairs varied inversely with changes in population density. The data to support these conclusions are very clearly presented in table and graphs, but, as the author indicates, the exact mechanism affecting cygnet productivity is not known. Since maximum populations appear to have been attained on the present refuges, Banko concludes that it is highly desirable to keep close check on isolated breeding areas and to make further efforts to establish wild populations in suitable areas within the former known breeding range of the species. He says: "It is the objective of the Bureau [U. S. Fish and Wildlife Service] to maintain the wild population of these rare fowl at an optimum level—the greatest number which can be consistently supported in their natural environment."

An extensive bibliography supports the work and the index appears to have been carefully prepared. Proofreading seems to have been thorough. The U. S. Fish and Wildlife Service and Winston Banko deserve congratulations for this successful exposition of a remarkable species.—ROBERT W. NERO.

THE AUDUBON BOOK OF TRUE NATURE STORIES. Selected and edited by John K. Terres. Thomas Y. Crowell Company, New York, 1958: 6 × 9½ in., x + 294 pp. Illustrated by Walter W. Ferguson. $5.00.

THIS IS NATURE: THIRTY YEARS OF THE BEST FROM *NATURE MAGAZINE*. Selected and edited by Richard W. Westwood. Thomas Y. Crowell Company, New York, 1959: 7 × 10¼ in., x + 214 pp. Illustrated by Walter W. Ferguson. $5.95.

The selections in both of these books are entertainingly informative and just the right length for "pick-up" reading. Those in "The Audubon Book," all from *Audubon Magazine*, deal mostly with birds and mammals, particularly their relationships to human beings, while those in "This is Nature" cover a wider variety of topics ranging from boulders deposited by glaciers, sight and hearing, pollen, and mangroves to turtles, seahorses, prairie dogs, and Snowy Owls. The charm of both books is greatly enhanced by Walter Ferguson's sensitive drawings. "This is Nature" is further embellished with photographs.—OLIN SEWALL PETTINGILL, JR.

This issue of *The Wilson Bulletin* was published on 8 June 1961.

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the AOU Check-list (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited; otherwise, follow the "Style Manual for Biological Journals" (1960. AIBS). Photographs for illustrations should be sharp, have good contrast, and be on 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.

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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.

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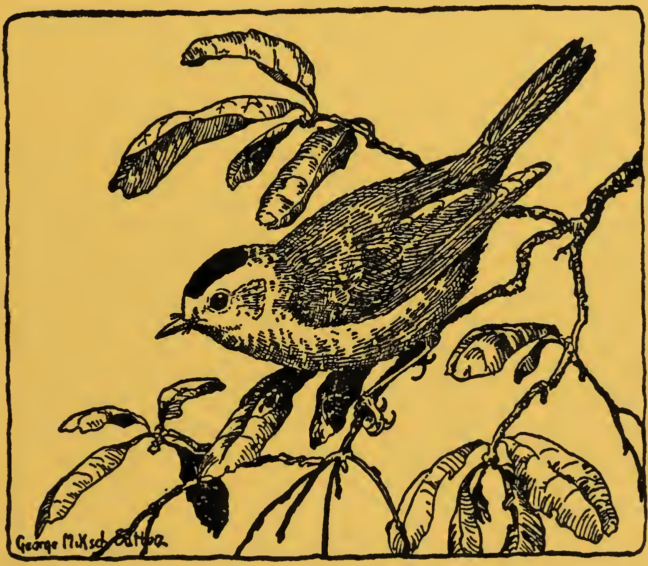

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THE JOSSELYN VAN TYNE MEMORIAL LIBRARY

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THE WILSON BULLETIN

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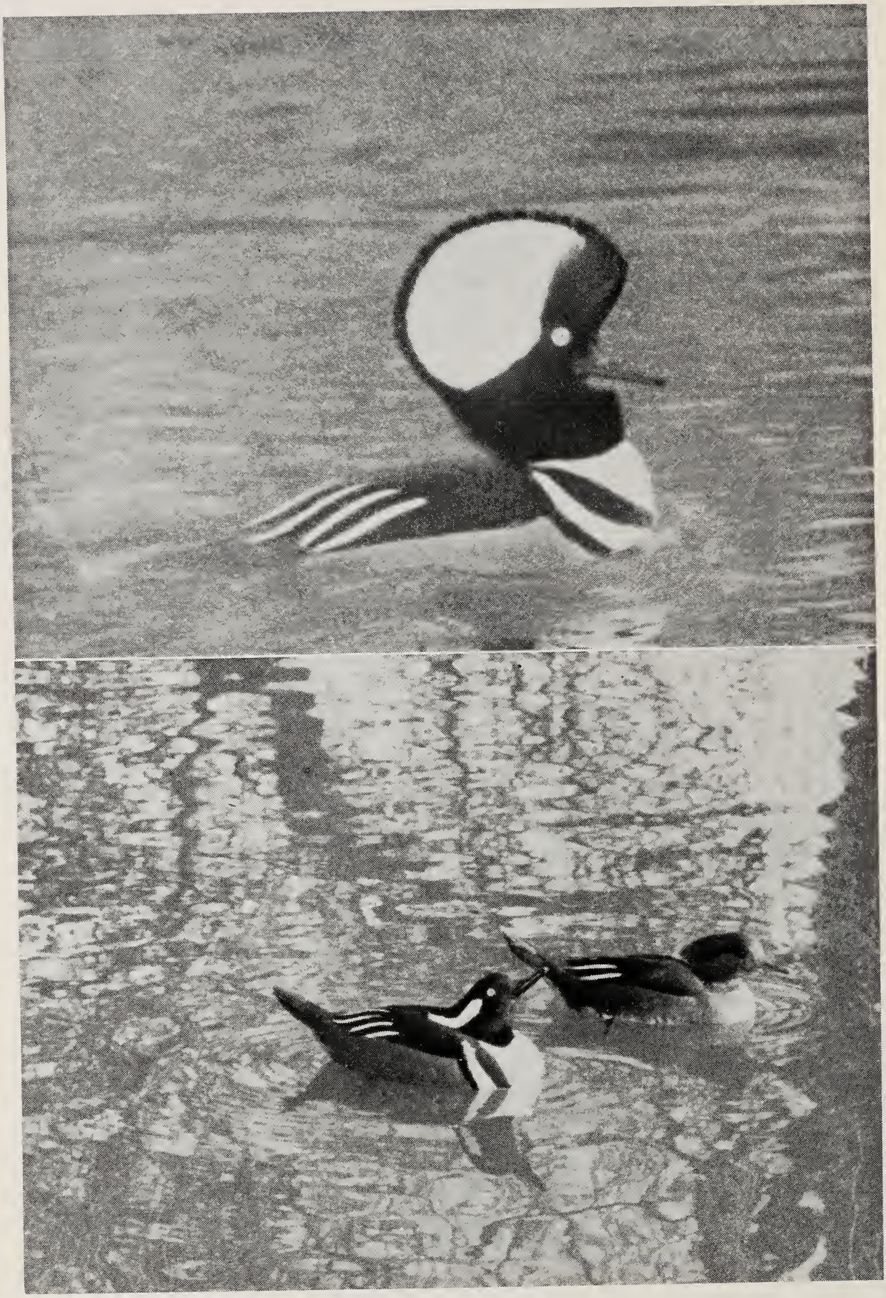

Hooded Merganser behavior.
(Above) Crest-raising by male. (Below) Precopulatory drinking by male.

THE SEXUAL BEHAVIOR AND SYSTEMATIC POSITION OF THE HOODED MERGANSER

Paul A. Johnsgard

It has been over 15 years since Delacour and Mayr (1945) first urged that the mergansers (*Mergus*) and the goldeneye-Bufflehead group (*Bucephala*) be merged into a single tribe (Mergini) rather than being maintained in separate subfamilies (Aythyinae and Merginae). Their reasons for this change were several, and included such points as the similarities in the downy young, female color patterns, occurrence of wild hybrids between the two genera, and tracheal structure. Indeed, except for the shape of the bill in these two groups there is no good means of distinguishing the two subfamilies. As Delacour and Mayr pointed out, bill shape and structure is highly adaptive and should not be used for the erection of major taxonomic categories. However, these two subfamilies are still upheld in the fifth edition of the AOU Check-list.

Delacour and Mayr described the general similarities in the sexual behavior of *Mergus* and *Bucephala*, but no one has yet had the opportunity of critically comparing the behavior of most species in the two groups. Myres (1957, 1959*a*, 1959*b*) reviewed well the behavior of the *Bucephala* species, but was not fortunate enough to compare directly copulatory behavior in this genus and *Mergus*. He has, however, provided detailed descriptions of courtship and copulation in the Common Goldeneye (*B. clangula*), Barrow's Goldeneye (*B. islandica*), and Bufflehead (*B. albeola*). The behavior of the Common Goldeneye has also recently been described by Dane et al. (1959) and Lind (1960). I have been able to observe closely courtship display in all three species of *Bucephala* and in four species of *Mergus*, including the Hooded Merganser (*M. cucullatus*), Smew (*M. albellus*), Red-breasted Merganser (*M. serrator*) and Common Merganser (*M. merganser*), both in the wild (Johnsgard, 1955) and under captive conditions at the Wildfowl Trust, Slimbridge, England. Here I also have observed copulatory behavior in the Common Goldeneye, Barrow's Goldeneye, Hooded Merganser, Smew, and Common Merganser, and have incomplete observations on the Red-breasted Merganser. Although a major summary of my observations on these species and the rest of the Anatidae will be published later, the following observations on the Hooded Merganser are of special interest and have a direct bearing on Delacour and Mayr's (1945) proposed classification.

OBSERVATIONS OF BEHAVIOR

Aside from the notes of Bagg and Eliot (1933), Harper (*in* Phillips, 1926) and Robb (1930), relatively little has been written on the courtship of the Hooded Merganser, and nothing has been noted regarding copulatory behavior. In the Anatidae, behavior associated with copulation is very conservative and thus is extremely useful in judging evolutionary relationships (Myres, 1959*b*, Johnsgard, 1960). The following behavioral patterns associated with courtship, or pair formation, have been observed by me:

Male Courtship. (1) Crest-raising (Front.). This is frequently performed, and may occur without other displays or in combination with them. Crest-raising also occurs in the Bufflehead and, in a less spectacular fashion, in the other species of *Bucephala* and *Mergus.*

(2) Head-shaking (Fig. 1). This is a rapid lateral shaking with crest raised, and is repeated three or four times before the Head-throw display. It serves the same function as does the "Introductory shake" of *Anas*, in that it draws attention to a male that is about to perform an elaborate display. Similar shaking movements occur in the Red-breasted Merganser and the Smew.

(3) Head-throw with Turning-the-back-of-the-head (Fig. 1). This is the most elaborate of the male courtship displays. It is directed to a particular female, to which the displaying male is usually parallel. The head is rapidly brought back to the back with crest erect and a call, a rolling frog-like *Crrrroooooo* is uttered as the head is returned to the normal position and the crest is turned toward the courted female. I have never seen a kick accompany this display. Head-throws also occur in the Common and Barrow's Goldeneyes and in the Smew, but it is doubtful that these displays are all homologous, since Head-throw displays have clearly evolved independently in many genera of ducks (*Anas*, *Aythya*, *Clangula*, *Somateria*, etc.). Sometimes after several Head-shakes the male does not perform a Head-throw but only lifts his head, opens his bill, and utters a hollow *pop.* I know of no similar behavior in any other species.

(4) Pumping (Fig. 1). A frequent and silent display which appears to be aggressive in motivation is an upward and forward stretching of the neck which results in an elliptical movement of the head and bill, as if the bird were reaching for an invisible object. This is often repeated and is sometimes performed simultaneously in both sexes. None of the other *Mergus* species studied have such displays, but the Rotary Pumping of Barrow's Goldeneyes and the Bowsprit Pumping of the Common Goldeneye (see Myres, 1959*a*) are similar in form and also appear to be hostile in motivation.

(5) Upward-stretch. This is a simple Head-shaking stretch with an erect crest. It is often done by displaying males and is clearly ritualized. Similar movements occur in all species of *Bucephala* and *Mergus* observed by me and likewise appear to be ritualized into displays.

(6) Upward-stretch with Wing-flapping. This is like the preceding display but the wings are also flapped several times. This display is found in all the species of *Bucephala* (especially the Bufflehead, in which it is certainly one of the major displays) and also in all the *Mergus* species observed by me.

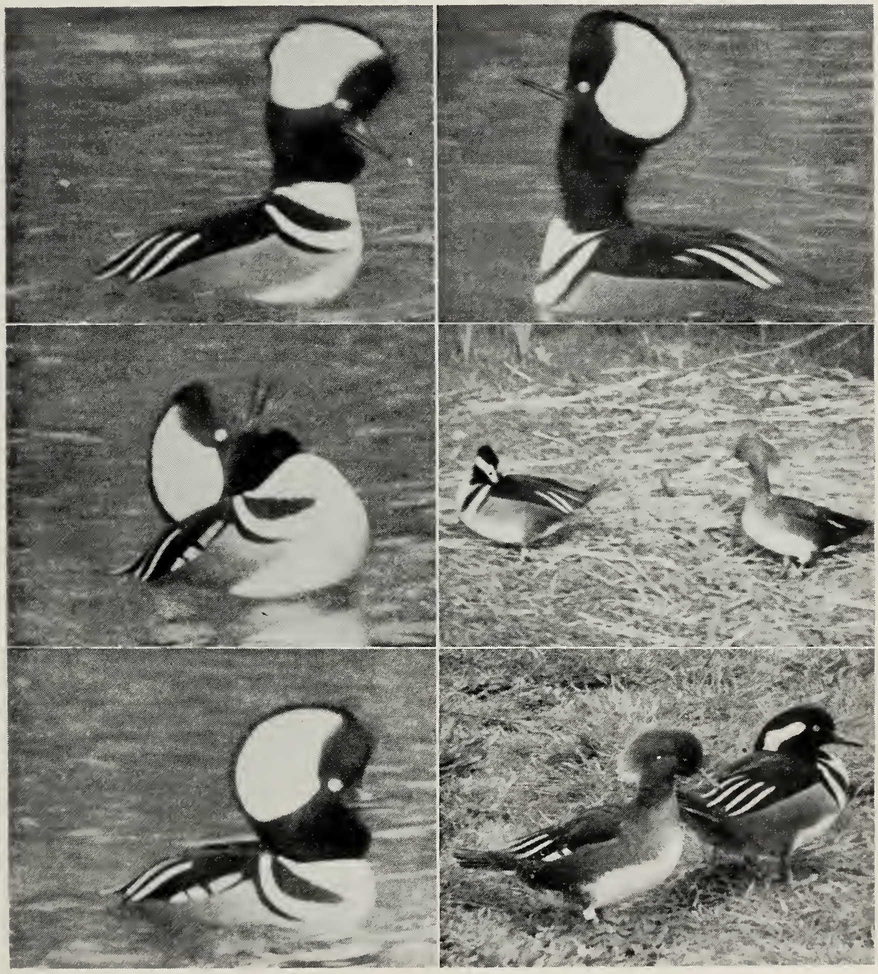

FIG. 1. Courtship displays of Hooded Merganser.

(Upper Left) Head-shaking.
(Center Left) Head-throw.
(Lower Left) Turning-the-back-of-the-head after the Head-throw.
(Upper Right) Pumping.
(Center Right) Male with crest depressed and directed toward female, who is performing "Bobbing" movements.
(Lower Right) Low-intensity "Bobbing" by female.

(7) Drinking (Front.). Ritualized drinking with a depressed crest occurs as a courtship (and precopulatory) display in the Hooded Merganser, the Smew, and to a lesser degree in the other mergansers. In *Bucephala* it is primarily a precopulatory display. In the Hooded Merganser it may be distinguished from normal drinking in that the bill is raised almost to the vertical and the crest is strongly depressed.

(8) Tail-cocking. This display occurs in the Hooded Merganser in association with the following display, which appears to be related to pair-bond maintenance. The male usually swims ahead of the female with his tail cocked at about a 45-degree angle. Similar displays occur in the Smew and in the Common and Red-breasted Mergansers, but I have not seen it in males of *Bucephala.*

(9) Crest-depressed and directed toward female (Fig. 1). This is similar to the Turning-of-the-back-of-the-head display in male *Anas* (Lorenz, 1951–53) and is distinct from the usual head profile of a resting or frightened bird in that the forehead feathers are raised and the crest itself is strongly depressed. A very similar display occurs in the Smew (but in this species the color pattern produced is a black "V" against a white head rather than a white "V" against a black head).

(10) Tertial-lifting. This is a slight and often-repeated lifting of the ornamental tertials while performing displays (8) and (9). I have not observed it in any other species, and am uncertain whether the movement actually has a signal function.

Female Courtship. (1) "Bobbing" (Fig. 1). This is the term used by Hollom (1937) for a display in the female Smew that is obviously homologous to this movement of the Hooded Merganser. It is clearly an especially intensive form of inciting (see Lorenz, 1951–53), in which the female's head moves in a jerky, upward bobbing fashion, with the bill pointed downward, as a hoarse *Gack* is uttered. It is rather rare in the Hooded Merganser, but is very frequent in the Smew. I have also observed this type of inciting in the Red-breasted Merganser, but in the Common Merganser inciting takes a form more like the inciting of pochards (*Aythya*) and dabbling ducks (*Anas*), in that the "bobbing" component is not so conspicuous. Inciting in goldeneyes ("Jiving" of Myres, 1957, 1959*a*) has a markedly different form, but the equivalent behavior of Buffleheads ("Following") is more like the typical *Mergus* type of inciting. The male response in all these species is the same, namely to swim ahead of the inciting female while directing the back of his head toward her.

(2) Pumping. This is identical to Pumping in the male and is usually performed in response to male Pumping in the same way that female goldeneyes respond to Rotary and Bowsprit Pumping by males.

Precopulatory and Postcopulatory Behavior. In *Bucephala* as well as *Mergus*

FIG. 2. Copulatory behavior of Hooded Merganser.

(Upper Left) Water-twitching.
(Center Left) Wing-flapping.
(Lower Left) Preening-behind-the-wing.

(Upper Right) "Tacking" toward female.
(Center Right) Postcopulatory "Rotations."
(Lower Right) Postcopulatory "Steaming."

the female solicits copulation while stretched out prone and stationary on the water after both birds have performed display drinking. Before mounting, males of all species perform repeatedly numerous displays which usually include ritualized drinking, stretching, or preening movements. These have been described by Myres (1957, 1959*a*, 1959*b*) for the Bufflehead and the two goldeneyes, and by Dane et al. (1959) and Lind (1960) for the Common Goldeneye. Copulatory behavior in the Common Merganser has been described by Christoleit (1927), and Hollom (1937) and Lebret (1958) have described the corresponding behavior of the Smew. Adams (1947) and Myres (1959*a*) have provided incomplete descriptions of copulation in the Red-breasted Merganser.

I have seen several sequences of copulatory behavior in the Hooded Merganser which may be summarized as follows: The male swims near the female, frequently performing drinking movements with a depressed crest. The female responds by drinking, and each time lifts her head high and forward, with her crest depressed. After several such mutual drinking displays the female assumes the prone posture, with her head held just over the water and her tail flat on the water surface (as in *Bucephala* and the Common Merganser). The male immediately begins to make rather jerky forward and backward head movements which are less exaggerated than, but otherwise almost exactly like, the "Pouting" behavior of Smews (see Hollom, 1937). (In Smews "Pouting" is a courtship rather than a precopulatory display.) The male frequently makes drinking movements and also occasionally performs an Upward-stretch. Suddenly the male begins to dip his bill and part of his head (Fig. 2) rapidly and repeatedly in the water while shaking the bill (as in the *Bucephala* "Water-twitch" display described by Myres, 1959*a*). After several such shakes (6, 7, and 8 have been counted on three different occasions) the male suddenly stops (at this point a male goldeneye would Preen-behind-the-wing once and "Steam" to the female), performs an Upward-stretch with or without Wing-flapping (three flaps counted on one occasion) (Fig. 2), then settles back in the water and immediately Preens-behind-the-wing (Fig. 2) on the side toward the female (exactly as would a goldeneye), and starts swimming in rapid, jerky, Pouting movements toward the female. He does not Steam directly to the female as a goldeneye would, but rather "Tacks" in a zig-zag course toward her (Fig. 2), alternately presenting (seven times in about 5 feet in one instance) the two sides of his crest to her view, the crest being fully raised and presented to the female's full view with each Tacking movement. In five cases I have seen, this sequence of "Water-twitching—Upward-stretch—Preen-behind-the-wing—Tacking-toward-female" was identical every time, but I am not certain how many times Wing-flapping accompanied the Upward-stretch. As soon as the male reaches the female he attempts to mount her, but in only two times observed by me was he successful.

In each case the male remained mounted for ten seconds or more, and performed on each occasion a single Flick-of-the-wings while mounted (as in goldeneyes). After the male successfully completed treading, he slipped off to one side but retained hold of the female's nape for several seconds, during which the two birds "Rotated" slightly (Fig. 2). In neither case was a complete circle rotated, as usually occurs in goldeneyes (see Myres, 1957; Dane et al., 1959). The male then released the female and "Steamed" directly away from her with crest erect (Fig. 2). In one case the male "Plunged" under the water (as often occurs in Buffleheads after copulation) when he was about 5 feet away from the female. In the other case the male swam about 25 feet away from the female in a straight line, exactly as would a male goldeneye except that no lateral head-turning ("Ticking") was observed. The male then began to bathe. The female started bathing as soon as it was released by the male in both instances.

By comparison, the typical *Mergus* precopulatory behavior consists of the male performing repeated drinking movements, together with Upward-stretches (with or without Wing-flapping) and Preening-dorsally, all of which occur independently. I have not observed any Water-twitching in any of the other species of *Mergus*, and have only observed a Preening-behind-the-wing once in the Smew, but it was not linked to any other behavior and may not have actually been a true display. In *Bucephala* (and the Hooded Merganser) however, the Preen-behind-the-wing is completely ritualized, occurring only once and being firmly linked to the preceding Water-twitching (or "Jabbing") and the following Steaming to the female. Male Smews and Common Mergansers lack such a spectacular approach to the female, but rather repeatedly approach and retreat, until they finally are successful in mounting or the female comes out of the prone posture. During treading I have observed that the Smew repeatedly Flicks-the-wings (five times in one case), but this display (which probably has auditory rather than visual function) did not occur in any of the three Common Merganser copulations I have observed. Neither the Smew nor the Common Merganser exhibits postcopulatory Rotations. Male Smews and Common Mergansers swim away from the female after copulation while Turning-the-back-of-the-head to her.

DISCUSSION

Both in courtship and in copulatory behavior most species of *Mergus* and *Bucephala* share certain patterns and differ in others. However, the Hooded Merganser bridges some of these differences in its courtship, and especially in its copulatory behavior. Precopulatory displays of the Hooded Merganser that are typical of *Bucephala* are the repeated Water-twitching and the subsequent Preen-behind-the-wing. In its linkage of these two displays into a rigid sequence just before approaching the female the Hooded Merganser is more similar to the goldeneyes than is the Bufflehead! Typical *Mergus* precopulatory patterns

TABLE 1

COMPARISON OF PRESUMABLY HOMOLOGOUS BEHAVIOR PATTERNS IN *MERGUS* AND *BUCEPHALA*

	Buffle-head	Common Goldeneye	Barrow's Golden-eye	Hooded Merganser	Smew	Red-breasted Merganser	Common Mer-ganser
MALE COURTSHIP							
Upward-stretch	x	x	x	x	x	x	x
Wing-flapping	X	x	x	x	x	x	x
Crest-raising	X	x	x	X	x	x	x
Head-throw	–	X	x	x	x	–	–
Tail-cocking	–	–	–	x	x	x	x
FEMALE COURTSHIP							
Inciting	x[1]	x[2]	x[2]	x[3]	x[3]	x[3]	x
COPULATORY BEHAVIOR							
Drinking by ♂	?	x	x	x	x	x	x
Drinking by ♀	?	x	x	x	x	x	x
Female prone	x	x	x	x	x	x	x
Upward-stretch (♂)	–	–	–	x	x	x	x
Preen-dorsally (♂)	x	–	–	–	x	x	x
Water-twitch (♂)	x	X	X	x	–	–	?
Preen-behind-wing (♂)	–	X	X	X	?	–	–
Steaming to ♀	–	X	X	x[4]	–	–	–
Flick-of-wings (♂)	x	x	x	x	x	?	–
Steaming from ♀	–	x	x	x	–	–	–

x the behavior pattern was observed
X the behavior pattern was exceptionally well developed
– the behavior pattern is apparently absent
[1] "Following" of Myres
[2] "Jiving" of Myres
[3] "Bobbing" of Hollom
[4] "Tacking"

include the Smew-like Pouting and the Upward-stretch and Wing-flapping. Behavioral patterns it shares with both genera include mutual drinking and the female prone posture. In its approach to the female by Tacking, the male Hooded Merganser is intermediate between the direct and rapid Steaming approach of the goldeneyes and the repeated approach-retreat behavior of the typical mergansers. This "compromise behavior" of Tacking immediately calls to mind the "Zig-zag Dance" (Tinbergen, 1951) of the male Three-spined Stickleback (*Gasterosteus aculeatus*) and the pivoting approach of the male to the female in the Zebra Finch (*Poephila guttata*) described by Morris (1954).

The Hooded Merganser also has a single Flick-of-the-wings during treading which occurs in all *Bucephala* species but which I have only otherwise observed in the Smew among the *Mergus* species. Postcopulatory Rotations are also present, and this behavior is typical of all *Bucephala* species but of neither of the two species of *Mergus* observed by me. Enough evidence is at hand, therefore, to point out the fact that *Bucephala* and *Mergus* share so many complex behavioral patterns in their courtship and copulatory displays that an extremely close evolutionary relationship exists between them (see Table 1). Thus the continued subfamilial separation of these groups that is still adhered to by the AOU Check-list is untenable. Additional evidence for the Hooded Merganser's close relationship to *Bucephala* is provided by the structure of the male's trachea (see Beard, 1951; Johnsgard, 1961). The downy young possess unstreaked cheeks as are typical of *Bucephala* and Smew downy young, rather than the streaked cheeks typical of the other *Mergus* species. The egg-white proteins of the Hooded Merganser exhibit an electrophoretic pattern practically identical to those of the Red-breasted Merganser and *Bucephala* (see Sibley, 1960). The Hooded Merganser is perhaps more closely related to *Bucephala* than is the Smew, which possesses a more *Bucephala*-like bill, which points out the fallacy of regarding bill shape and specialization as a major index to evolutionary relationships.

SUMMARY

The courtship and copulatory behavior patterns of the Hooded Merganser are described, and probable homologies are pointed out with other *Mergus* species and with *Bucephala.* In some of its courtship displays ("Tail-cocking," female "Bobbing") and precopulatory behavior ("Pouting," "Upward-stretch") the Hooded Merganser exhibits typical *Mergus* elements, whereas in others ("Water-twitch" linked to Preen-behind-the-wing, postcopulatory Rotations) it clearly shows affinities with *Bucephala,* and in fact is even more like the goldeneyes in some respects than is the Bufflehead. In still other aspects of display it is intermediate between the typical species of the two genera ("Tacking" toward the female rather than the *Bucephala* "Steaming," or the approach-retreat behavior typical of *Mergus*). The Hooded Merganser thus provides an almost perfect connecting link between *Bucephala* and *Mergus,* and it is concluded that these two groups are no more than generically distinct.

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THE WILDFOWL TRUST, SLIMBRIDGE, GLOS., ENGLAND, 2 MAY 1960 (PRESENT ADDRESS: ZOOLOGY DEPARTMENT, UNIVERSITY OF NEBRASKA, LINCOLN)

REPRODUCTIVE BEHAVIOR OF RED-BELLIED WOODPECKERS

LAWRENCE KILHAM

OBSERVATIONS on a hand-raised pair of Red-bellied Woodpeckers (*Centurus carolinus*) which nested in captivity, and observations on wild birds from 1957 to 1960 form the basis of this paper. I did most of my field work in swampy lands near Seneca, Maryland. Additional observations were made at the Archbold Biological Station, Lake Placid, Florida.

METHODS OF COMMUNICATION

Both sexes of Red-bellied Woodpeckers participate in the vocalizations, drummings, and displays outlined below, but males are the more active performers. My interpretations of these forms of expression are based upon the situations attending their performance on repeated occasions.

Vocalizations.—(a) Breeding call. A musical *kwirr* repeated twice or a number of times in succession—delivered in sets of three in tense situations. The call of the female may have a flatter sound, especially when the members of a pair are answering each other. *Kwirr*'s are seldom given during the fall, but may be heard, in almost explosive fashion, on days of suitable weather in early winter.

(b) Territorial call. A *cha-aa-ah*, shaking the whole body and given the year around, possibly because Red-bellied Woodpeckers have individual territories in the fall and winter in addition to their breeding territories at other seasons. The *cha-aa-ah*, like the *kwirr*, may stimulate responses of the same kind from another individual.

(c) Location and mild excitement. An often-repeated *cha*. A Red-bellied Woodpecker may give this note when disturbed by a human observer.

(d) Intense excitement. Expressed by a triple, high-pitched *kew,kew,kew*.

(e) Conflict. Red-bellied Woodpeckers usually make a loud *chee-wuck,chee-wuck,chee-wuck* when engaged in intraspecific conflicts.

(f) Intimate note. A low *grr,grr*, which may be exchanged by the members of a pair from the first days of courtship until the end of the breeding season. This note is not given by lone individuals, in my experience.

(g) Begging calls of juveniles. Young which have recently left the nest beg with a soft *psee-chew*. The first syllable is high-pitched. They clamor for food in succeeding weeks with a *grr-ick,grr-ick*, which is distinct from, but obviously related to, the *grr,grr* of breeding adults.

(h) The vocalizations of nestling Red-bellied Woodpeckers are as varied as among the young of other genera of woodpeckers (Kilham, 1959*c*). A harsh *chrr* usually accompanies feeding. Further discussion is given below.

Fig. 1. Episode in a conflict observed on 30 January 1960, in which two rival females fought for a male. The intruding female is in the stiff pose expressive of tension as owning female approaches the tree from the left in a floating threat display.

Displays.—(a) The feathers of head and nape are raised when a Red-bellied Woodpecker is excited. This is particularly true of the male whose red feathers, being somewhat long and silky, give him a striking appearance.

(b) Full threat display. Made with wings outstretched at an upward angle of 45 degrees and with tail outspread. The wings may be spread out like a moth's, against the trunk of a tree, in conflicts over holes.

(c) Flight display. A Red-bellied Woodpecker may float through the air toward its landing place with wings held in the position of a full threat display, when engaged in a conflict with a rival (Fig. 1). *Centurus* appears to have no true courtship flight.

(d) Stiff pose. This display gives the woodpecker a rigid, somewhat bowed appearance (Fig. 1). The bowing results from an elevation of the patch of feathers covering the upper back.

(e) Resting motionless. The members of a pair may rest within inches of each other for minutes at a time, and in silence when close to the time of actual nesting. This form of behavior is common to a number of genera of woodpeckers, and Pynnönen (1939) has aptly described it as "*Regungslos-auf-eine-stelle-sitzen.*"

Drumming.—Red-bellied Woodpeckers have two types of drumming. The usual type consists of an even burst of about one second's duration. A second type is similar to the first except that it is preceded by a few well-spaced taps—*da-da-drrrrrr.* I have not discovered any different significance in these two forms of drumming, but I have heard them in the aviary as well as in the field and among the closely related Red-headed Woodpeckers (*Melanerpes erythrocephalus*) (Kilham, 1959*a*). Drumming is a far less frequent method of communication with *Centurus* and *Melanerpes* than among *Dendrocopus, Dryocopus,* and *Colaptes* (Kilham, 1959*b*, *c*, and 1960). The drumming of Red-bellied Woodpeckers appears to serve as an assertion of territorial dominance. It is sometimes associated with conflicts.

Tapping.—Delivered at a regular rate of 2–3 taps per second and with 4–20 taps in each burst. The members of a pair may tap together in mutual tapping. Tapping is closely associated with nest-site selection and maintenance of the pair bond, not only in *Centurus* (Kilham, 1958*a*), but also among other woodpecker genera (Kilham, 1959*a*, *b*, *c*).

EARLY BREEDING BEHAVIOR

Continuing studies of Red-bellied Woodpeckers have enabled me to complete. in some degree, an account of their early breeding behavior presented in a previous report (Kilham, 1958*a*). The additional aspects of behavior are illustrated by the histories of Pairs A and B.

Beginning of breeding season.—Observations on Pair A indicate that male Red-bellied Woodpeckers may stay on their breeding territories the year around and that females, in some instances, may compete for them early in the year.

(a) Territory of Male A.—I observed Male A excavating a nest hole in the dead limb of an elm on 22 February 1959. A subsequent wind storm broke the limb where the excavation had weakened it, but in the fall of the same year I watched Male A excavate a new hole just below the site of the old one. I did not see him in association with any other Red-bellied Woodpecker at this time. On 20 December I saw Male A fly to his excavation and start to tap as a female, making *grr,grr* notes as she flew. alit on the other side of the cavity and joined in mutual tapping. It was of interest that the woodpeckers were using the same hole for actual nesting by 30 April 1960, when I observed them in full copulation on an adjacent limb.

(b) Competition of two females for a male.—On 30 January and again on 6 February 1960, I witnessed prolonged conflicts between two females appearing to be rivals for Male A and the hole he had excavated. Events were similar on both mornings. The females had two centers of their continually renewed conflicts, one being Male A, who called *kwirr, kwirr* from various tree tops but appeared to be indifferent to the actual fighting, and the other, the nest excavation in the elm. The intruding female might fly to either place. What I judged to be Female A would follow closely, hitch up toward her rival, then fly out in any direction in a long circular pursuit. All pursuits appeared to be restricted within the usual limits of the male's territory. The females were silent most of the time, but one might call *chee-wuck, chee-wuck,* and in two instances they clashed in bodily contact. Figure 1 illustrates an episode in the conflict. As Female A flew to the tree in which her rival and the male were resting, she floated the last 10 feet of the way with wings outstretched in a threat display. There were few respites in the conflicts. I watched one going on continuously for two and one-half hours on 6 February. I had observed a similar situation among Yellow-shafted Flickers (*Colaptes auratus*) in which two females contended for a male in mid-winter (Kilham, 1959*b*).

Events leading to actual nesting.—Pair B was well situated for observation because the nest hole was only 20 feet above the ground and remained free of molestation by Starlings (*Sturnus vulgaris*). The activities of the two woodpeckers offered many points of comparison with those of my hand-raised pair, whose breeding behavior is described later.

(a) Mutual tapping and nest-site selection.—On 9 March 1958, Male B called *kwirr* while moving about on the dead stub of a living ash. He pecked at random, as if percussing the underlying wood. There was no sign of an excavation. When I was standing directly below him a little later, he tapped four bursts of about 15 taps each, whereupon his mate flew in and joined in several seconds of mutual tapping. A fresh, shallow excavation appeared on the stub within the next two weeks. Nearly two and one-half months later, on 30 May, I removed two well-feathered young from a nest located at the spot where Pair B had had mutual tapping on 9 March.

(b) Intercommunication during the period of excavation.—The male did most of the excavating. In pauses between bouts of work he often called *kwirr, kwirr* and his mate, who was usually within a range of 150 yards, would answer *cha, cha* or a flat-sounding *kwirr.* Mutual tapping took place periodically. On 29 March, for example, the male was excavating with his body half way in the hole when he dropped down to one side and began to tap. His mate came immediately. The pair then joined in mutual tapping before she flew away. It is probable that the male had been stimulated to tap by seeing that his mate had come close by. On the following day both woodpeckers were away from their excavation when they suddenly flew to it simultaneously and joined in a bout of mutual tapping. Red-headed Woodpeckers may communicate in an analagous fashion during the period of excavation (Kilham, 1959*a*).

(c) Lack of agreement in mated pair.—The nest excavation progressed slowly. It appeared in a variety of ways that the female Red-bellied Woodpecker had a breeding urge less developed than that of her mate in the unusually cold spring of 1958. First, she didn't participate in the work of excavating and second, on 5 April, I witnessed two occasions following bouts of mutual tapping, when both members of the pair held their bodies in a stiff pose expressive of tension, for one can observe the same pose in conflicts between rival males.

(d) The lone male.—The female sometimes left the nesting territory on a long flight over the tree tops to visit, I suspected, a cornfield in the uplands. Her mate, failing to get any response from her at these times made what appeared to human ears to be "frantic" vocalizations. On 12 April, for example, he clung to the entrance of his excavation and called *kwirr, kwirr, kwirr* every three to five seconds for 40 minutes. I then saw a Red-bellied Woodpecker flying in over the leafless tree tops. The male became silent immediately. A few moments later the pair was together at the excavation. I witnessed a similar episode on 20 April in which the male called *kwirr* in sets of three as before, persisted for 15 minutes, then became silent when his mate returned.

(e) Behavior of pair at time of egg-laying.—Egg-laying probably began within a few days of 20 April. This calculation was made not only by reckoning backward from 30 May when I took two advanced fledglings from the nest but also from two concurrent forms of behavior which indicated that the female had finally accepted the nest hole. The behavior patterns were as follows: (1) Both birds remained silent and motionless for eight minutes on 20 April, the male resting inside the nest and his mate on the outside. (2) The female then entered the hole. I then heard *grr, grr* notes. The male was the first to wriggle out the entrance and another silent, motionless period of five minutes followed before the pair flew away.

CONFLICTS OVER NEST HOLES AND TERRITORY

Red-bellied Woodpeckers are territorial during the nesting season. Evidence for this territoriality is difficult to obtain in well-wooded country but two of the conflicts described below took place along a common boundary more or less equidistant between the excavations of two nesting pairs. Three other conflicts occurred close to nest holes. Features characteristic of these conflicts were that when only two individuals were engaged, they were of the same sex and fought in silence, whereas whenever three or four birds representing two pairs were in conflict, a lively combination of vocalizations, drummings, and displays usually took place. The situations observed were as follows:

Territorial conflicts between two females.—On 3 April 1958, Female A flew low over 50 yards of swamp directly at the female of adjacent Pair B. A silent conflict now took place close to the ground. One female would fly at the other, who would dodge around a tree trunk, but on one occasion the two females rose 3 feet into the air, grappling together as they flew. Both withdrew after several minutes. Their battleground was 90 yards from the excavation of Pair A and 70 yards from that of Pair B. The two females had another conflict at the same place 10 days later, so that there was reason to believe that the area represented a boundary separating the territories of the two pairs. Selander and Giller (1959) found a well-defined boundary separating a pair of *Centurus carolinus* from one of *C. aurifrons* in Texas.

Conflict between two rival pairs.—On 12 April 1958, I witnessed a conflict between two pairs of Red-bellied Woodpeckers which went on for one and one-half hours (and probably longer). Pair C owned the disputed nest hole located 60 feet up in a dead elm. A peculiarity of this conflict was that I could identify the attacking male by his aberrant call, a loud *quee-ark*. This abnormality is discussed later. The pattern of the struggle on the morning of 12 April was as follows: The owning male (OM) would bow in and out of his nest hole, his red crest bristling straight backward while the intruding male (IM) approached from a distance calling *queе-ark*. OM would fly at IM. The intruder would then dodge under a limb and raise his wings in a full threat display. As IM was driven farther away he might suddenly dart toward the nest hole. The conflict would then renew itself. Although all four birds of both pairs were occasionally close together in this conflict, it was clear that the main conflict was between the two males. The clashes between the females were mild in intensity. One female, when pursued by the other, might remain away for 10 minutes at a time. During some intervals the two males had prolonged exchanges of their vocalizations, *quee-ark* and *kwirr*. One often drummed in between his calls. *Chee-wuck*, *cha-aa-ah*, and *grr* were other vocalizations heard in this conflict involving both sexes. Pair C retained its nest hole and I watched them feeding young in June.

Intruding male and a mated pair.—On 10 May 1958, I observed coition in Pair D. An IM came close to the nest hole on the same morning and I immediately heard a mixture of *grr* notes and *chee-wuck*'s as the pair faced their visitor. Both males had their crests raised. IM raised his wings in a threat display on two occasions before being driven away by OM, whose mate did not participate in the conflict.

Conflict between two males.—Male A was excavating on 29 March when an intruding male appeared 25 feet away and called *kwirr* a number of times. The two males rested motionless, as if frozen. Male A then flew at IM who averted contact by swinging under a limb. There was no display and no noise. After several such episodes the intruder flew away and Male A backed down to his excavation, holding a bent, stiff pose as he did so.

INCUBATION PERIOD

Red-bellied Woodpeckers become relatively quiet at the onset of egg-laying and the activities of Pair F may serve to illustrate events of the ensuing period. The entrance of Nest F was 20 feet up in the dead top of a living willow. On 18 May 1957, I cut away the wood and wired an aluminum back onto the rear of the nest cavity. There were four eggs at this time. The woodpeckers were incubating a week later, but on 30 May I found the aluminum covered with the muddy paw marks of a raccoon (*Procyon lotor*). The nest contained two eggs and two newly hatched young, all dead. One egg and one nestling were mutilated, as if punctured by the bill of some bird. Observations on the parent birds while they were incubating in the previous period were as follows:

Both birds appeared to be restless when taking turns within their nest on the week-end of 11 May. Egg-laying was presumably in progress at this time. The female would often put her head out, then withdraw it half-way. The male was even more restless, for when guarding the nest he might somersault out of the entrance, call *quee-ark* when he had righted himself, then return inside. He also called in a wide radius about the nest tree at times when the female was in the nest. His loud, aberrant *quee-ark* was easy to distinguish from the *kwirr* of neighboring males. I observed similar restlessness on 18 and 23 May while watching from a thicket 70 yards away. There was no sign of activity at the nest on 26 May. After watching for 20 minutes, I approached and stood below. At this moment the female flew up close to the entrance and I heard the male start tapping on the inside at her approach. She entered the nest after he had flown out. Had I been watching from any distance I would not have heard the tapping response of the male to his mate's arrival. I was to hear this type of tapping many times later on, with my captive pair.

THE NESTLING STAGE

I observed 10 pairs of Red-bellied Woodpeckers while they were feeding their nestlings. The following is a generalized picture of their activities.

Feeding of young.—When the young were recently hatched, one parent stayed with them until the other arrived with food to take its place. Parents usually had many insects protruding from their bills on arrival, and this prey, while small in size in the early nestling period, was larger later on when big beetles, long-legged, gauzy-winged insects, and even butterflies were brought in. The woodpeckers captured most of their prey on tree trunks. On 30 May 1958, for example, I watched the female of Pair A alight on one tree after another, landing low on each trunk and then ascending rapidly. She managed to catch insects even when her bill was already loaded. She then flew to a broken branch where she appeared to store some of her prey, for she returned to the same spot after flying away to feed her young. Parent birds occasionally brought in fruits, carrying two or three nearly one-quarter inch in diameter in their bills at one time. Some of these fruits may have been wild cherries. Parents disappeared inside nest cavities in order to feed the young when they were small. At later times the tails of the old birds projected from entrances as they fed their offspring, and at a still later period the young climbed to the entrance where the parents fed them from outside. Feeding visits varied in frequency with the weather and the time of day. They were apt to be most frequent early on a warm day, as on 18 May 1957, when the two birds of Pair E fed their young 10 times in the 26 minutes after 7 AM. The female made eight of these visits. On 7 June 1958, the male and female of Pair D made two visits each within an eight-minute period.

Greeting ceremonies.—Red-bellied Woodpeckers usually fly directly to their nest holes when carrying food. On 11 May 1957, Male E alit on the bark below the hole and rested quietly for a few seconds. His mate then appeared from within the entrance and made a slight chatter as she flew off. Hungry young ones greet an entering parent with harsh *chrr*'s. These *chrr* notes are not easy to hear and I usually heard them only when standing close to the nest. Adult Red-bellied Woodpeckers were relatively silent when away from their nests gathering food for their young. The vocalizations they made included *kwirr*, *cha*, *cha-aa-ah*, and *kew, kew, kew*; most of these expressing some degree of excitement at such times, for example, as when I stood near the nest tree while a parent bird waited nearby with a bill-full of insects. Males might drum under these circumstances. In the course of 41 feeding visits observed for Pair E, the male started drumming on two occasions when I came close and, from my usual observation post at a greater distance, I witnessed the chatter greeting ceremony of the parents in four of the 41 visits. On most visits the two birds did not encounter each other. I have not heard tapping during the nestling period.

Nest sanitation.—Methods of nest sanitation were not obvious among the Red-bellied Woodpeckers. Parent birds were often making motions with their tongues as they emerged after feeding and I came to believe that they had just swallowed the excreta of their young. I never saw a recognizable fecal sac in their bills at any time. Of six Red-bellied Woodpeckers taken as nestlings, none produced fecal sacs. But two young Flickers, hand-raised under similar circumstances, produced well-formed sacs. Two of the nest cavities, from which I removed well-feathered young, were remarkably clean. The third nest cavity had one-half inch of damp detritus on the bottom, and three nestlings with early pin feathers.

Observations on nestlings.—Woodpecker nests are usually too inaccessible for close study but I was able to observe some features of nestling behavior by removing the young. Three nestlings were taken from a nest on 23 May 1959. Their eyes were beginning to open and they had pin feathers up to one-quarter inch in length. It was apparent at the time of removal, as well as in ensuing weeks, that the three were of different ages in regard to feather growth and behavioral development. The tips of upper mandibles and the protuberant knobs at the corners of the bills of the young were sharply white in color. Young Flickers, among other woodpeckers, have a similar white point at the position of the egg tooth. One may speculate that parent birds, when darkening nest entrances on arrival with food, may be guided to the mouths of their offspring by these white points which disappear only as nestlings become well feathered. The knobs at the corners of the bill are sensitive areas. We found that if we brushed these knobs with a toothpick carrying a morsel of food, the bills of the nestlings would open widely as their necks stretched upward. This begging response could be induced by passing a hand between the birds and a source of light, if the nestlings were on a lighted surface. It seemed likely that the sudden shading was the effective stimulus, for jarring or movement alone had no effect. Results were different in the dark. The nestlings were kept in a dark cabinet, and any scratching on the door or miscellaneous jarring, such as the closing of a nearby refrigerator, was sufficient to elicit a gush of begging cries. These cries were harsh and as steady as if one had turned on a faucet. Once the young had been fed, however, they sank back and made soft, musical *wee-urp*'s which had a contented sound to human ears. The cabinet was equally dark at all times. At night, however, the nestlings would settle down to a low *purp, purp, purp* continuing even after midnight when they were apparently asleep. Nestling Pileated Woodpeckers (*Dryocopus pileatus*) exhibited similar patterns of vocalization (Kilham, 1959*c*).

Young Red-bellied Woodpeckers, when well feathered, developed an urge to scurry away and cower in the darkest place available after being fed and, a little later on when they might have been leaving their nest under natural circumstances, they became wild and pugnacious, as evidenced by attacks on each other as well as on our fingers. This aggressiveness appears to be a specific characteristic of Red-bellied Woodpeckers. I have not encountered it among the young of *Dendrocopus, Dryocopus, Colaptes,* and *Sphyrapicus* raised under similar circumstances.

Time of nest leaving.—I watched two Red-bellied Woodpeckers feeding their young over four week ends from May into June 1958. On 22 June the female fed the last young one in the nest at 7:15 AM. There were no more feeding visits over the next half hour in which the young one perched well out of the entrance, giving a frequent harsh chatter, not only in response to the *kwirr*'s of its parents who were farther down in Creek Wood, but also to the vocalizations of other neighboring Red-bellied Woodpeckers.

PARENTS AND YOUNG AFTER NEST LEAVING

Full foliage in the woods and the comparative quietness of the Red-bellied Woodpeckers after their young had left the nest made it difficult to follow them in summer months. Creek Wood, however, was an open area favorable for observation. Young were raised there in two succeeding years and as juveniles, in each year, they followed their parents about for nearly two and one-half months. These young ones were relatively inactive much of the time, resting while their parents moved up tree trunks or flew into clusters of leaves to catch insects. Adults dismembered large insects before feeding them to their offspring. The begging cries of the juvenile were of two types and were well illustrated by a hand-raised female who would have left her nest at the end of May under natural circumstances. She often fed from my hand. In June her begging note was a high-pitched *psee* or *psee-chew*, but by July her cry under similar circumstances became *grr-ick.* Both of these vocalizations were of help in locating the family groups in Creek Wood. During the summer of 1958 the wood was occupied by an adult male and a juvenile which followed its parent closely at all times. The adult female was attended by the second young one of the family in a similar fashion. These two, however, rarely returned to Creek Wood where the nest had been located. I had reason to suspect that the male had become hostile toward his former mate. On 13 September, for example, he was moving about with his attendant offspring in a peaceful fashion when he suddenly flew to the edge of the wood where I saw the female and her young one. The male had his crest raised, and there was an outburst of vocalizations which included *chee-wuck,chee-wuck, grr-grr,* and *kew,kew,kew.* The female held a stiff pose. After a minute of this confused conflict she flew away followed by her young one. During the same summer I observed another family of Red-bellied Woodpeckers by the canal which appeared to be divided in a similar fashion.

In the summer of 1957, the family which occupied Creek Wood consisted of three offspring, and these juveniles had noisy conflicts among themselves. On 20 July I heard two of them calling *chee-wuck* before grappling together in mid-air. A week later all three juveniles were together on a dead tree. One would perch on the top and the others would fly to replace it with noisy *kwirr*'s and *chee-wuck*'s. This conflict behavior could be interpreted as play.

SECOND NESTINGS

I have had no evidence that Red-bellied Woodpeckers raise more than one brood a year in the vicinity of Seneca, Maryland. Thick foliage, however, makes complete observation difficult in the late spring and summer. The situation appears to be different farther south. Hauser (1959, and personal communication) has had good evidence that a marked male raised a second brood in South Carolina in two successive years, and, while in Florida in mid-June 1960, I observed a pair of Red-bellied Woodpeckers finishing the excavation of a nest hole. The two birds had full copulation on 14 June. On the same day and 300 yards away I watched a juvenile bird for several hours. It appeared to be independent of any parents.

BREEDING BEHAVIOR IN CAPTIVITY

A pair of Red-bellied Woodpeckers, raised in a preceding year, nested successfully in the spring and again in the summer of 1960 in my aviary—a modified indoor garage. The development of their breeding behavior was as follows:

Early breeding behavior.—(a) Fragmentary interest in the fall.—On 22 October 1959, the female tapped vigorously and called *grr,grr* when the male alighted near her. I had witnessed an almost identical episode with a wild pair five days previously, but there was no sustained development of breeding behavior, either in the field or in the aviary, until the beginning of winter.

(b) Female flies to male at dawn.—The female was flying to the male's roost hole at dawn by mid-December and she continued this habit through the next July, except for periods when larger young were in the nest. This visit was in the nature of a greeting. She would tap on the outside of the box and, by 3 January, he was joining her by tapping on the inside at the same time. The male was slow about emerging from his roost hole. He would rest inside for 20 to 30 minutes after the greeting ceremony. I have described this type of behavior at dawn, as observed among wild Red-bellied Woodpeckers, in a separate report (Kilham, 1958*a*). The roosting place of the captive male later became the nest box and his mate developed a constant habit of resting in it for an hour or so every late afternoon.

(c) First breeding calls.—We began to hear *kwirr*'s coming from the aviary on 28 December 1959, and for some weeks the woodpeckers made most of these vocalizations while light was still dim at dawn. We had never heard them give *kwirr*'s in previous months. There were variations in the numbers of the vocalizations given from day to day; on some mornings the woodpeckers were noisy for several hours but on others they were quite silent. On 3 March, for example, a morning of heavy snowfall, our Red-bellied Woodpeckers gave *kwirr*'s in sets of three every four to five minutes after 5:45 AM, although they did not leave their roosting places until nearly 6 AM. On the following morning we heard only one *kwirr* prior to 8 AM. I have described an outburst of breeding behavior among the Red-bellied Woodpeckers of Seneca Swamp on a morning of freshly fallen snow (Kilham, 1958*a*). Whatever meteorological conditions affect avian activity, as judged by the volume of song and other vocalizations, they appeared to influence our indoor birds. Cardinals (*Richmondena cardinalis*), for example, were doing their greatest amount of singing in the yard on mornings when our captive Red-bellied Woodpeckers were calling an unusual number of *kwirr*'s in the aviary. Such correlation was fairly regular during the spring.

Increasing intimacy.—The new forms of behavior outlined below indicated that a closer pair bond developed between the two woodpeckers in the last weeks of March.

(a) Greater association with the nest box.—The male entered the nest box on 24 March when his mate was already on the nest and the pair remained out of sight for a few minutes before she emerged. This togetherness within the nest became of frequent occurrence in succeeding weeks. The male spent increasing periods of time resting on the box during the day and, if his mate came close, he would start to tap or make the *grr,grr* note. The pair engaged in mutual tapping on the box at other times. I observed a new behavior on 3 April when the female, who had been resting on the inside of the nest hole, dropped down and tapped out of sight when her mate alighted on the stub above. Later on the same morning both birds rested, silent and motionless, he within and she on the outside of the cavity. Such episodes became more frequent.

(b) Head-swinging and bill-touching.—It was apparent by early April that the two woodpeckers were meeting on the top of a tall stub, both birds swinging their heads somewhat as the male, with crest raised and calling *grr,grr*, kept trying to touch the female's bill with his own. This performance was of interest in retrospect, for it became the prelude to copulatory behavior on the same stub. Attempts at bill-touching may represent courtship feeding. On 6 April, when the male had carried a small chip of wood to the top of the stub, his mate ran out her tongue to explore it, then seized it and flew off. I observed a closer simulation of parent-young feeding, however, on 24 April. The male was looking out from the nest entrance when the female made repeated attempts to seize his bill within her own. This event occurred five days before the first egg was laid.

COPULATORY BEHAVIOR

I observed full copulation on 12 occasions between 28 April and 6 May. A first egg was laid on 29 April. Inspection of the nest appeared to upset the pair and I did little further inspecting until 8 May, when there were three eggs. The phases of copulatory behavior were as follows:

(a) Initial signs of interest.—The male fluttered on the female's back on 11 April and by 24 April this pseudo-coition was being preceded by reverse mounting on the part of the female.

(b) The full copulations which began on 28 April frequently took place when I turned on the lights in the aviary at about 6:20 AM, but they might occur at almost any time later in the day. The pair nearly always copulated in the same place. This was the top of the tall stub where the two had done their bill-touching in previous weeks.

(c) Preliminaries.—The female flew to the male as if on signal, just preceding most of the copulations. Indications of the male's readiness might consist of his giving a single *kwirr* or simply arriving at the top of the stub. There were no set preliminaries so far as I could determine.

(d) Reverse mounting.—When the female flew to the male, he was usually in a low crouch as if inviting her by the time she arrived (Fig. 2-Left). She would immediately flutter on his back in reverse mounting (Fig. 2-Center). A medley of *grr*'s at this time might alert me to what was going on, even if I were in another room.

(e) Full copulation.—The male mounted the female directly after the reverse mounting. She assumed no special pose. He sometimes waved his wings during the whole process of copulation but usually only briefly and at the start. Once

FIG. 2. Copulatory behavior of Red-bellied Woodpeckers. (Left) Male assumes crouching position as female flies to him. (Center) Female flutters on back of male in reverse mounting. (Right) Final position of full cloacal contact, after male had mounted female and fallen to left.

established on her back, he always fell down to the left. His final position was on his back with his body at right angles to hers so that the tails of the two birds were overlapped in cloacal contact (Fig. 2-Right). Southern (1960) has given a description of similar copulatory behavior among Red-headed Woodpeckers.

(f) Female's drive the more persistent.—The female's sexual drive apparently persisted longer than that of her mate as indicated by the fact that the pair might return to the stub within 10 minutes of full copulation, but only reverse mounting would take place. In addition, reverse mountings continued from 7 May through 11 May, although copulations stopped on 6 May.

INCUBATION AND CARE OF YOUNG

(a) Greeting ceremonies.—The female continued to greet her mate at dawn. He would start tapping at the bottom of the cavity when she appeared but there was no mutual tapping or tapping on the outside of the box during the incubation period. The female might respond to the male by tapping at the bottom of the excavation at other times of day. She would then slip out and leave the nest to him. He did the greatest part of the incubating by day as well as remaining in the nest at night. The pair became increasingly quiet as incubation progressed. On 12 May the female came below the entrance and gave a low *grr-ick, grr-ick*, the first time I had heard her give this vocalization since she had been a juvenile.

(b) Hatching.—Events were similar on 18 May and on 9 July, the dates on which the young of the first and second broods, respectively, began to hatch. The female exhibited a sudden change of behavior. She greeted me in the morning by alighting on my head and pounding my skull (which I interpreted as meaning that she needed some new kind of food and quickly). I brought meal-worms which she prepared with much careful crushing and nibbling. She then carried one to the nest and I could hear *chrr,chrr,chrr* notes as the first hatchling was fed. Hatching took place over the course of two days in the case of both broods.

(c) Guarding, brooding, and feeding the young.—The male remained so close to the young during the first week after hatching that we rarely saw him. He would not move, even when I put a light and mirror into the nest. The female continued to be bold and demanding, taking great numbers of meal-worms from our fingers, which he would not do. This led to a peculiar situation. She would take meal-worms to the nest and either enter in spite of his being there or, more frequently, she would give the food to him at the entrance and he would relay it to the young. This relay system took place in both nestings. It was the reverse of what I have described for another species of hole-nesting bird, the Casqued Hornbill (*Bycanistes subcylindricus*), in which the male always feeds the female at the nest entrance (Kilham, 1956).

(d) Nest sanitation and continued excavation.—The nest remained fresh and

Fig. 3

Fig. 4

Fig. 3. Young Red-bellied Woodpecker on eighth day after hatching in indoor aviary. The position is natural.

Fig. 4. A hand-raised female Red-bellied Woodpecker in threat display, faces a rival female in an adjacent cage.

clean throughout the nesting period and I believe that the parents swallowed the excrements of the young, for they never carried anything away from the nest which we could perceive. It is possible that the male's occasional bouts of excavating provided fresh litter on which the young could rest (Fig. 3).

(e) Young leave the nest.—The three young ones left their nest between the morning and evening of 13 June, 26 days after the onset of hatching. They appeared to leave without any special encouragement from their parents. All three continued to re-enter the nest hole for the next few days. They often made a prolonged, harsh chatter when about in the aviary. These young remained as wild as if they had hatched under field conditions and, since they were unsatisfactory for observation, I had them banded and liberated within three weeks, by which time their parents were already incubating a second clutch of eggs.

(f) Second nesting.—I placed a new nest box in the aviary on 17 June when I noticed a renewal of copulatory behavior. The male did a considerable amount of excavating. I observed full copulation on 25 June, but it had probably taken place before this time, for there were two eggs in the nest on the following day. This was 13 days after the young had left the old nest. The final clutch of four eggs hatched on 9 and 10 July. Due to the lack of a steady supply of meal-worms, three of the young died within a few days. The fourth one remained in good condition until eight days of age, when I cut the nest box in order to photograph it within the nest (Fig. 3). Both parents were suspicious of the nest after I had wired it together. This led to a neglect of the one remaining young, which died.

DRUMMING

The Red-bellied Woodpeckers did little drumming in the course of their breeding activities. Neither of two captive females, one mated and the other unmated, has ever drummed so far as I know. The male of the pair did his first drumming on 11 April, when he was showing his initial interest in copulation, but there were no indications that the drumming had any special relation to either courtship or pair formation. It appeared to serve as a demonstration against rivals. Most of the male's drumming was done at the edge of a window looking out onto a yard where a wild male called *kwirr* many times a day. I was able to precipitate drumming in another way. On 29 May 1960, when the Red-bellied Woodpeckers had been feeding their young for 10 days, I introduced a female Pileated Woodpecker into an adjacent cage. The reaction was immediate. The male Red-bellied made continuous efforts to attack the Pileated Woodpecker through the wire, calling *chee-wuck,chee-wuck* as he did so and making full threat displays. The two birds jabbed at each other, back and forth. When the larger woodpecker finally lost interest and went about her usual activities, the male Red-bellied drummed for over an hour, completely neglecting his young and keeping as close to his adversary as the wire would permit. The female Red-bellied Woodpecker's reaction to a rival was somewhat different. She paid no attention to the Pileated in the above episode and when faced by a female of her own species in the adjacent cage, the two birds engaged in brief bouts of jabbing and threat displays (Fig. 4). These encounters were always silent affairs, unaccompanied by drumming. Evidence is given below that the male Red-bellied probably regarded the Pileated Woodpecker as being a specific rival.

UNUSUAL BEHAVIOR

Unusual behavior, from unusual circumstances, may influence one's interpretation of more usual activities and this is true of the three examples outlined below, which involved wild as well as captive Red-bellied Woodpeckers.

Relations of captive birds to Pileated Woodpecker.—The hand-raised Red-bellied Woodpeckers have lived in association with flickers, sapsuckers (*Sphyrapicus varius*), and Hairy (*Dendrocopus villosus*) and Downy (*D. pubescens*) Woodpeckers but have not responded to these cage-associates in any special way. They have, on the other hand, reacted in a definite fashion to a female Pileated Woodpecker. Thus it was apparent over many months that both the male and the female Red-bellied Woodpeckers regarded the larger bird as a near approach to being a male of their own species. My guess is that the crest of the Pileated served as an exaggerated releasing mechanism. The fact that this bird was the only one in the aviary to have a crest of the same red color and silky texture as that of a male Red-bellied Woodpecker offered some support for this hypothesis. I have described phenomena of a similar nature elsewhere (Kilham, 1959*c*). In this latter situation it was the lone female Pileated Woodpecker which exhibited a vigorous and constant reaction to a female Yellow-bellied Sapsucker. The reactions of the captive male and female Red-bellied Woodpeckers to their larger associate may be outlined as follows:

(a) Reactions of female.—One of our two hand-raised female Red-bellied Woodpeckers has never had a mate. This female began to show an interest in the Pileated Woodpecker when she first assumed adult plumage in the fall of 1958. The attraction has persisted over the course of two breeding seasons, as indicated by the following activities: flying to the Pileated's roost box and tapping at dawn; following the Pileated about and tapping wherever it might be pecking and, in addition, calling *grr, grr* when the larger bird came close. These forms of behavior were similar and comparable to those of the mated female described in a separate section above.

(b) Reactions of the male to the Pileated Woodpecker.—The aggressiveness of the male Red-bellied Woodpecker toward the Pileated, also described above, has persisted for one and one-half years, making it impossible to keep the two birds in the same cage. Whenever I have done so, the Pileated Woodpecker has hidden in its roost box all day. The male has kept it there by perching within a few feet of the entrance, constantly bowing its head and making the vocalizations *cha* or *cha-aa-ah.*

Aberrant breeding call.—The following situation, in which a wild male Red-bellied Woodpecker in Seneca Swamp gave the breeding call of a Red-headed Woodpecker in complete exclusion of that of its own species, may have reflected the relation which appears to exist between *Centurus* and *Melanerpes* (Kilham, 1959*a*). Red-headed Woodpeckers over-winter in the swamp in some years. In 1956–57 they began to give their breeding call, a *quee-ark*, before migrating to breed elsewhere (Kilham, 1958*b*) and on 2 May, after the last of them had left the main swamp, I observed a male Red-bellied Woodpecker calling the same *quee-ark.* The vocalization was in sharp contrast to the *kwirr*'s of neighboring males. I located the nest hole of the *quee-ark*-male three days later and I was able to follow his activities and those of his mate for the next three weeks. The male never called *kwirr* during this or subsequent periods of observation. His other vocalizations were typical of those of his own species. I did not hear him again until 15 December 1957, when the Red-bellied Woodpeckers of Seneca Swamp experienced a short ourburst of breeding behavior. The *quee-ark*-male was still in the same area in which he had nested in May. My next encounter with this individual was 500 yards away when, on 12 May 1958, he and his mate had a prolonged conflict over a nest hole which belonged to the latter birds. I have never heard a male Red-bellied Woodpecker call *quee-ark* since that time.

Attacks of lone female on nesting pairs.—The following incidents parallel those which I have described among breeding Casqued Hornbills (Kilham, 1956). Whether the females of both species of hole-nesting birds were prompted to attack the nests of others of their own kind due to the lack of a mate or to the loss of one, I could not determine. The observations on the Red-bellied Woodpecker were as follows:

I was standing below the nest hole of Pair E on 4 May 1957, when an intruding female (IF) flew to the entrance 15 feet above me. Female E was on the inside, presumably incubating her eggs. The two females jabbed at each other vigorously and small feathers floated down. IF had flown in to renew these attacks four times within a minute when Male E arrived and pecked savagely at the rear of the intruder while his mate engaged her head-on within the entrance. The intruder then took flight with Male E in pursuit. By the next morning IF had transferred her attacks to Pair F. This pair of Red-bellied Woodpeckers had a nest 100 yards from that of Pair E and I watched the conflicts which centered on it from 10:15 until 11:40 AM. They followed a rather constant pattern. Male F would chase the intruder through the surrounding woods to the accompaniment of *cha*'s and *chee-wuck*'s, then return to his nest hole and pop inside. IF would return immediately. Male F would come out to drive her away and another pursuit would follow. Female E took almost no part in the conflicts, even when all three woodpeckers were together in the same tree. It is possible that the IF was attracted by the noise of young within this second nest for at one time she arrived with food in her bill, only to be driven away as abruptly as before.

SUMMARY

Vocalizations, drummings, and displays of Red-bellied Woodpeckers have been studied in relation to their breeding behavior. Observations regarding this behavior may be summarized as follows:

(1) The male takes the initiative in location of a nest hole and seeks the approval of his mate in a ceremony of mutual tapping. He spends more time by the nest hole than she does. The members of a pair, however, remain in contact with each other by an exchange of vocalizations within their nesting territory. If a female leaves her nesting territory, her mate may call incessantly until she returns.

(2) Red-bellied Woodpeckers are pugnacious birds. Described are various types of conflicts centering on issues such as the possession of a nest hole, or on the rivalry for a mate and territorial boundaries.

(3) Acceptance of a nest hole by the female may be delayed until seasonal conditions are favorable. Full acceptance by the female is indicated by the two members of the pair completing the excavation, entering the nest hole together and resting motionless in each other's proximity either within or on the outside of the nest cavity. Copulatory behavior increases in frequency at this time.

(4) The phases of copulatory behavior usually consist in the male assuming a crouching pose as the female flies to him and flutters on his back in reverse mounting. The male then mounts her in full copulation, gradually falling to the left.

(5) Paired Red-bellied Woodpeckers become quiet at the time of egg-laying and incu-

bation. The newly hatched young are brooded by one parent or the other for much of their first week and, as they grow older, they are fed insects of increasing size.

(6) Fecal sacs have not been seen among either wild or captive birds. Parent Red-bellied Woodpeckers apparently keep their nests clean by swallowing the excreta of their young.

(7) The reactions of nestlings were studied by means of hand-raised individuals. Their begging and begging cries were stimulated by sudden shading if they were on a lighted area or by jarring if they were in the dark. The range of their vocalizations was considerable.

(8) A pair of hand-raised Red-bellied Woodpeckers bred in their first year in an indoor aviary. They reared three young in their first nesting and a second nesting was equally successful to the point of hatching but had to be interrupted due to extraneous circumstances.

(9) Copulation, including the preliminary reverse mounting by the female, is described in detail.

(10) Juveniles may leave their parents within a few weeks in the event of a second nesting. Otherwise, they may remain with them for several months until family groups break up in September.

(11) Three examples of unusual behavior are described. One concerned a male Red-bellied Woodpecker which gave the breeding call of a Red-headed Woodpecker to the exclusion of its own; and another, a lone female which attacked the nest holes of two mated pairs. A third situation concerned the peculiar and persistent reactions of male and female hand-raised Red-bellied Woodpeckers to a Pileated Woodpecker kept in the same aviary.

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NESTING SUCCESS CALCULATED FROM EXPOSURE

HAROLD MAYFIELD

In reporting the nesting success of birds, it is customary to give the numbers of nests and eggs in the sample, the number of eggs that hatch, the number of young birds fledged, and various percentages derived from these.

In my analysis of the nesting success of the Kirtland's Warbler (*Dendroica kirtlandii*) I had shortcomings and subtleties in my data that could not be treated satisfactorily by the customary methods. Most serious of these problems was the fact that many of the nests in my sample had not been found until after incubation had begun. That others did not mention such difficulties was not reassuring but rather aroused the suspicion that some of their findings might not be so exact as the cold finality of their figures seemed to imply.

Consequently, I proposed a new way of analyzing data of this kind (Mayfield, 1960. The Kirtland's Warbler. Cranbrook Inst. of Sci., Bloomfield Hills, pp. 182–209). There, however, the method was incidental to the results, and it was complicated at every turn by the effect of Brown-headed Cowbirds (*Molothrus ater*) in the nests with the warblers. So I am offering here a simplified explanation for the benefit of field workers with little training in mathematics.

DIFFICULTIES WITH CUSTOMARY METHODS

In studying the nesting success of birds, we want to know how many of the nests *built* produce fledglings and how many of the eggs *laid* hatch and ultimately become fledglings. In fact, these are the terms customarily used in presenting the results of field work. But I believe that these results are often misleading, because the production is actually calculated from nests and eggs *found*—not the same thing as nests *built* and eggs *laid.*

To illustrate, suppose we were to find a series of nests on the eve of hatching. In this special group the "hatching success" would be nearly 100 per cent, and subsequently the "nest success" and "success of eggs to fledging" would be almost twice as high as if these nests had been discovered at the start of incubation. No such extreme example is likely to occur in field work, but the problem exists to a variable and unknown extent in nearly all studies of birds with concealed nests. Only among birds whose nest sites are under observation before the birds use them, such as those using artificial cavities, are all the records likely to be complete from the very beginning.

Of course, if all nests were discovered with the first wisp of building material and followed through to termination, analysis would present few difficulties and this discussion would be unnecessary. In truth, however, the raw data are not likely to be as tidy as the published summaries would seem to indicate. With open-nesting altricial birds, typically, the field worker finds a few nests during the building stage, a very few during the egg-laying stage, a larger number during the incubation stage, and perhaps the greatest number during the nestling stage. Thus, his records include nests found at every way station of development, and these are somehow lumped together to calculate "success," expressed perhaps as percentages of nests *built* and eggs *laid* although few of the nests were found when just built or when the eggs were just laid.

How serious an error this may be can be seen in another hypothetical example, a little more realistic than the previous one but still simplified enough for easy comprehension without mathematics. Suppose we were to find an equal number of eggs on each day of the incubation period. It is intuitively obvious that the losses observed up to hatching time will be only about half what they would have been if we had found each nest at the start of incubation. That is, many of these nests were well on their way to success when found, or, saying it another way, a good many unsuccessful nests were lost before we got there and thus escaped our attention. Now suppose this series yields a fairly typical apparent "hatching success" of 60 per cent of eggs *found*, or a mortality of 40 per cent of eggs *found*. But, egg mortality occurs mostly through destruction and desertion of entire nests, and we have recognized that nest losses are not adequately represented in our sample. Consequently, the true "success" of the species is very much lower than the apparent success we have calculated from nests found. Similarly, we may wonder if the true success of many open-nesting species is less than the published percentages.

In some studies the discrepancies may not be so great as those in my hypothetical examples, because life-history workers often make a special effort to find nests early. But how can we be sure? Are these factors consistent from one study to another? In one species it may be harder to find nests early than in another. One observer may not be on the nesting ground as early in the season as another. It is unsettling to think that nesting success and mortality reported in studies may be in part an artifact of nest-finding practices.

Indeed, a mortality or survival rate has meaning only if a period of *time* is specified; and, if the period is not stated in units of time, the rate will be assumed to apply to the entire stage of existence under consideration. That is, a mortality or survival rate given for the incubation period is presumed to be based on observation from the very start of incubation.

Yet, if observers throw out all records except those on nests found before the start of incubation, their study samples are likely to become very small (at a serious cost in reliability), and also much useful information may be discarded.

This brings us to another subtlety in quantifying our nesting data. Sometimes observers are unable to follow every nest through to a conclusion and so have fragments of information on nests whose outcomes are unknown. What should they do with these fragments? Cautious individuals may exclude these from their calculations. Yet, to do so, inflates the mortality rates; that is, a nest destroyed quickly is likely to be included because its fate is known, while a nest that endures until after the observer has departed is likely to be disqualified because its outcome is unknown. On the other hand, other individuals, eager to report as many nests as possible, may include these nests, enlarging the sample without enlarging the losses. To do so, understates the mortality. Here is an awkward dilemma: either to include or to exclude nests with outcome unknown threatens to distort the results.

NEST-DAY AS A UNIT OF EXPOSURE

There is a way out of these difficulties. Briefly, it recognizes that the number of nests lost will vary with the number of nests and also with the time span covered by the observations. The combination of these two—nests and time—I call exposure.

A convenient unit of exposure is the nest-day; that is, one nest for one day. Thus, a nest under observation for ten days represents an exposure of ten nest-days, which is equivalent to the exposure of ten nests for one day each, or five nests for two days each, or any combination of nests and days whose product is ten. Thus, the total exposure of a group of nests is the summation of all the days spanned by observation at each nest. (For some calculations greater precision may be offered by a smaller unit, the egg-day; but, for simplicity, I will restrict myself chiefly to the nest-day in this discussion.)

Nests seen only once are not counted because they do not span any period of time. A nest seen on two consecutive days represents an exposure of one nest-day. A nest in existence five days after it was found represents an exposure of five nest-days whether it was visited many times or only at the end of that interval. A nest lost during an interval of several days is arbitrarily assumed to have been lost on the day at the middle of the interval. All days spanned by observation are included even though no change occurs.

Now we can utilize fragments of information and combine them into a meaningful whole. We can calculate the probability of survival looking backward or forward in any period for which we have survival rates, just as the insurance actuary predicts survival at any stage of human life. Also we can combine scanty bits of information from different observers, the only kind of information we are likely to have on certain elusive species for a very long time.

NEST MORTALITY DURING INCUBATION

To illustrate this method of analysis, we may consider my data on the Kirtland's Warbler, examining first the incubation period. My data on 154 nests of the Kirtland's Warbler seen during incubation represent a total exposure of 878 nest-days. It is of interest that 10.3 nest-days is equivalent to the average life of one of these nests during incubation (Mayfield, op. cit.), and therefore if I had been so fortunate as to have had information on all these nests from the very start of incubation up to hatching or termination short of hatching, I would have had nearly twice this exposure. It is worth noting also that if I had included only nests with outcome known, I would have been able to use information from only 113 instead of 154 nests.

In this sample I recorded 35 nests lost (19 destroyed and 16 deserted) in 878 nest-days exposure during incubation. So the mortality rate is 35 /878 = .040 nests lost per nest-day during incubation.

Now, knowing the attrition per nest-day, we can calculate the losses back to the start of incubation even though not many of our nests were observed from the very start. In fact, we can take a sample at any point and calculate the probable number in existence on any earlier or later day within the incubation period.

For example, suppose we have 100 Kirtland's Warbler nests incubating. By tomorrow, we can expect to lose four of these nests; by the following day, 4 per cent of the remainder; and on any succeeding day, 4 per cent of the previous day's remainder. Thus, at first we lose almost four nests each day, but as the sample shrinks, so do the losses. When only 75 nests are left, the losses shrink to three a day. It is like compound interest in reverse; the principal shrinks while the rate remains the same.

Here we assume that the hazards of existence are constant throughout the incubation period. Inspection of my data suggests that this is at least approximately true, although I do not have a sufficiently large number of early and late losses to prove conclusively that they are as likely to occur in one part of incubation as another. This assumption is supported also by the fact that I have been unable to detect any change in the behavior of the bird that would appear to increase the vulnerability of the nest early or late in the incubation period. (If this assumption should need modification in some species—for example, if losses are greater early in incubation—this fact will send even farther astray the customary method of ignoring losses before nests are found; the greater the early losses, the more the results will be distorted by including nests not found at the very start of incubation.)

NEST SURVIVAL DURING INCUBATION

The *losses* are directly proportional to the exposure; so thus far, I have used only the *mortality* rate. For some calculations, however, it is more convenient to use the converse, the survival rate. For example, suppose we have 100 Kirtland's Warbler nests under incubation; then tomorrow, as shown in the previous paragraph, we can expect to have 96 of them left; the following day 96 per cent of 96 ($.96^2 \times 100$); and on each following day 96 per cent of the preceding day's remainder ($.96^3 \times 100$, $.96^4 \times 100$, . . . and so on to the end of incubation). Now, in the Kirtland's Warbler, with an average incubation period of 14 days, the probability of survival for the incubation period is $.96^{14} = .56$. That is, 100 nests at the start of incubation would be expected to shrink to 56 nests at hatching time.

Generalizing and expressing the result in better mathematical form, the probability of survival of nests with a mortality rate r for a period of days d is $(1-r)^d$; or, since $1-r$ is the survival rate S, the probability of survival is S^d.

NEST SURVIVAL DURING NESTLING PERIOD

When young hatch, of course, the hazards of existence for the nest change abruptly. But we can proceed with our calculations in a similar way, using new mortality and survival rates, as follows: I have records on 144 nests of the Kirtland's Warbler observed during the nestling period, with a total exposure of 735 nest-days. In this group, 22 nests were lost, 19 of them destroyed and 3 deserted. (It is interesting to note that the rate of destruction of nests is virtually unchanged from the incubation period but the rate of desertion is much lower.) So the mortality rate for nests during the nestling period was $22/735 = .030$ nests per day, and conversely, the survival rate was .97. Since the young Kirtland's Warbler usually leaves the nest at the age of nine days, the probability of the nest's survival for the nestling period is $.97^9 = .76$.

NEST SURVIVAL FROM START OF INCUBATION TO FLEDGING

These figures drawn from different nest periods and different samples may be combined, through the mathematical principle that the probability of two successive events is the product of their separate probabilities. Hence, the probability that Kirtland's Warbler nests will survive both the incubation and the nestling periods—that is, from the start of incubation to fledging—is $.56 \times .76 = .43$.

EGG SURVIVAL DURING INCUBATION

The Kirtland's Warbler, unmolested by the cowbird, loses very few eggs without loss of the entire nest; so egg survival is virtually equivalent to nest survival during incubation.

To appraise this matter more precisely, it may be calculated from the loss of six individual eggs during an exposure of 3,181 egg-days that the mortality among eggs was .002 eggs per egg-day and that the probability of survival for 14 days was $.998^{14} = .97$. That is, 97 per cent of eggs starting incubation may be expected to be present at hatching time if no nests are lost. Here the loss of individual eggs is so small there is some question if this factor need be included in the analysis. In small samples the imprecision in basic data may not justify such refinement in computation. But, with other species, losses of this kind may be significant, and, for illustrative purposes, this small shrinkage will be treated here along with the other losses.

Combining the two probabilities just calculated, we have .56 (probability of nest survival during incubation) ×.97 (probability that eggs will survive individual loss) = .54 (probability of egg survival during incubation).

NESTLING SURVIVAL DURING HATCHING PERIOD

Before we can link egg survival during incubation to nestling survival in order to get production of fledglings from eggs that start incubation, we need to know the hatching success of the eggs present at hatching time.

Here again our observations are not likely to be as exact as figures seem to imply. Unless every nest is under constant scrutiny—a rare circumstance—it is impossible to be sure exactly how many eggs hatch. For example, a nest containing five eggs one afternoon may contain one egg and three newly hatched young when visited the next morning. What happened to the missing egg? Are we justified in saying it did not hatch? Perhaps it hatched and then was removed by predator or parent.

The parent Kirtland's Warblers remove dead nestlings and damaged eggs promptly. A young bird that pips its shell but does not emerge fairly soon is in danger of removal, as is an egg with shell pierced by bill or claw. Therefore, I have not attempted to separate hatching success from individual survival in the first few hours of life, but consider these two questions under one heading, survival of the hatching period. For this species, it seemed proper to define the hatching period as the two days following the hatching of the first egg in the same nest. (Some Kirtland's Warbler eggs hatch as much as a day later than others in the same nest but never as much as two days later.)

In my sample, among 182 warbler eggs present at hatching time, in nests without cowbird eggs, 142 nestlings were present two days after the first hatched in each nest. So the probability of survival of the hatching period was 142/182 = .78.

The probability of survival of individual birds through the hatching event is quite aside from the hazards of existence for each nest as a whole. Therefore, the two days designated as the hatching period must be considered again when we weigh the hazards causing the loss of whole nests (destruction and desertion) rather than the loss of individuals in a nest that survives.

NESTLING SURVIVAL

In the absence of cowbirds, virtually the only losses of individual Kirtland nestlings (without loss of entire nests) occurs in the first day of life. (I have only one instance of such a nestling lost after the first day and it disappeared on the second day.) Since losses of newly hatched birds were already treated in survival of the hatching period, the probability of survival of nestlings is virtually the same as of nests, which, calculated previously, was .76.

EGG AND NESTLING SURVIVAL FROM START OF INCUBATION TO FLEDGING

Finally, we sum up production for the entire duration of the nest by combining the probabilities for each step, as follows: .54 (probability of egg survival during incubation) × .78 (probability of nestling survival during the hatching period) × .76 (probability of nestling survival to fledging) = .32 (probability that eggs at the start of incubation will produce fledglings).

This figure is approximately the production from eggs *laid*; but, to be perfectly precise, we should be aware that up to five days may elapse between the laying of the first egg in a clutch and the start of incubation. Hence, there is some exposure and loss (not treated here) before the start of incubation. In the species used as an example here, I believe this source of shrinkage much less important than those treated in this paper.

SUMMARY

A field worker analyzing data on nest success may be dealing with a sample in which comparatively few nests were found before the start of incubation. Also, his sample may include some nests for which the outcome was unknown. If such partially complete records are included (or excluded) from his calculations, there is danger of distorting the conclusions. "Percentage of nests *found*" is not the same as "percentage of nests *started*" unless every nest was observed from the very start.

One way of dealing with this problem is to reduce the data to units of *exposure*, which reflects not only the number of nests but also the length of time each was under observation. A convenient measure of exposure is the nest-day (equivalent to one nest for one day). With this approach, all observations covering one or more days each can be incorporated into the sample, even though some of these do not go back to the very beginning and do not carry through to the end. By this method, small fragments of information can be combined into a coherent whole. This may be the only kind of information available for a very long time on many elusive species.

After mortality and survival rates are expressed per nest-day, the probability of survival may be calculated for all or any part of the nesting period. If the survival rate per nest-day is S, the probability of survival of a nest for d days is S^d. The rate during incubation is different from the rate during the nestling period, so these two stages must be treated separately. Also, egg survival must be considered separately from nest survival because of the loss of individual eggs, particularly at hatching time. The probabilities of survival in different stages of nesting may be combined through the mathematical principle that the probability of a succession of events is the product of their separate probabilities.

Each step in these calculations is illustrated with facts from my previously published study of the Kirtland's Warbler, with calculations simplified by considering only those nests in the larger study that were not parasitized by cowbirds.

RIVER ROAD, RFD, WATERVILLE, OHIO, 3 JULY 1961

KERMADEC PETREL IN PENNSYLVANIA

Donald S. Heintzelman

The accidental appearance of a Kermadec Petrel (*Pterodroma neglecta*) at the Lookout at Hawk Mountain Sanctuary in eastern Pennsylvania, on 3 October 1959, adds a new species to the avifauna of North America. Identification of the bird as *P. neglecta* has been made by Dr. Robert Cushman Murphy of the American Museum of Natural History in New York City.

Most appearances of accidentals among oceanic birds can be attributed to the presence of meteorological disturbances passing through the area in which the birds were seen. The usual factor involved is a hurricane. Murphy (1936:53) expresses an opinion regarding hurricanes and accidentals as follows:

> From evidence connected with the "trapping" of birds within the vortex of a cyclonic storm, and with the occasional conveyance of strong-winged species of sea fowl from the eastern equatorial Atlantic to points far in the interior of North America, I am inclined to believe that an ocean bird might be carried along within the so-called "eye" of a hurricane because, when once entrapped, it would tend constantly to rebound away from the periphery of gales, and thus to retreat toward the quieter center.

Dr. Murphy cites the cyclone of August 1933, in which a South Atlantic sea bird and an eastern Atlantic sea bird were carried to New York State and Ontario, Canada, respectively. He continues,

> . . . it seems to me altogether probable that the birds of the two species referred to were actually caught *inside* the swirl of this storm. Under such circumstances, they might be carried along without becoming panicky, without experiencing any sense of difficulty, feeding normally, and tending always to turn inward toward the calm of the slow-moving center when they had flown far enough in one direction to come into heavily wind-whipped waters. The system as a whole, by the way, was moving forward during this period at a rate not exceeding 25 kilometers per hour. Only when the vortex came into close proximity with the land, as I conceive the situation, would the birds thus held in unconscious durance begin to fight the gales, perhaps to be carried into the higher altitudes of the atmosphere and to be buffeted as helpless waifs for long distances overland before being cast out centrifugally, subsequently to fall exhausted.

He then states that he is able only through the above explanation, to comprehend ". . . the transportation of Black-capped Petrels from points east of the Caribbean to the Mississippi Valley, or of Madeira and South Trinidad Petrels from the central or eastern north equatorial Atlantic to Ottawa and Ithaca, respectively." In the case of *P. neglecta*, the subject of this paper, Hurricane Gracie was probably responsible for carrying the bird to Hawk Mountain Sanctuary.

An explanation of Hurricane Gracie, from its beginning to the time it reached the Pennsylvania border will be of interest in determining the pres-

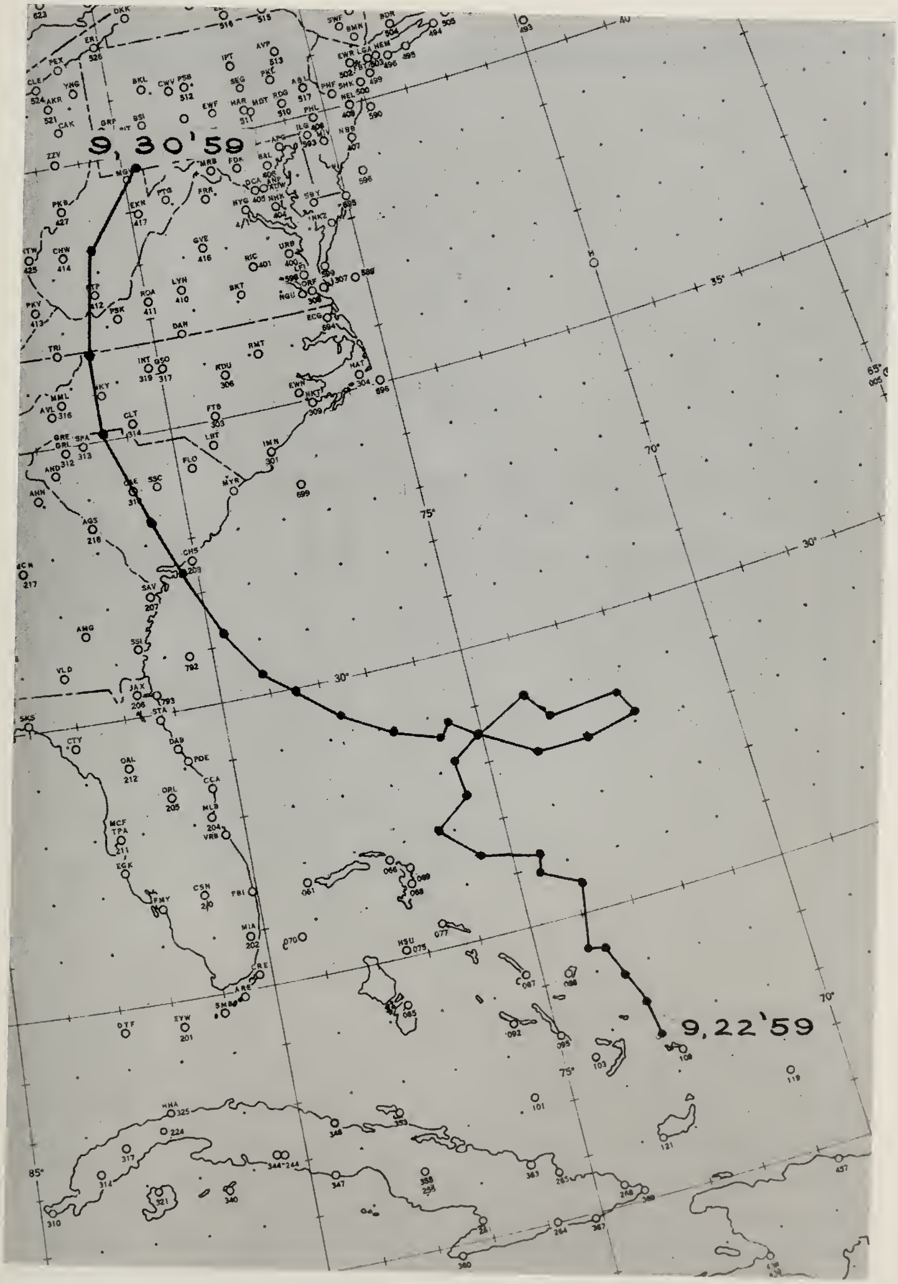

Fig. 1. Map showing the course of Hurricane Gracie from 22 September 1959 to 30 September 1959.

ence of *P. neglecta* far from its normal range. The United States Weather Bureau recorded the storm as a hurricane for the first time on 22 September 1959, in the Bahamas, and it was probably somewhere in that area that the petrel was entrapped. As the storm proceeded north (Fig. 1), it made a loop in the Atlantic Ocean and then proceeded again on its northward course. On the morning of 30 September 1959, eight days after its detection and classification by the Weather Bureau as a hurricane, Gracie entered Pennsylvania. By that evening it was west of Allentown, Pennsylvania, but at that point the velocity of the winds had greatly subsided and the Weather Bureau stopped collecting data on it.

Three days later *P. neglecta* was observed at the Lookout at Hawk Mountain Sanctuary. This is an extremely interesting record because the normal range for the species (Murphy, 1936:705) is the "Sub-tropical Zone of the South Pacific Ocean; breeding at Mas Atierra and Santa Clara Islands of the Juan Fernández group, San Ambrosio, numerous islands of southern Polynesia, and at the Kermadecs and Lord Howe Islands in the western part of the ocean; ranges northward in the eastern Pacific into the northern hemisphere." Murphy (1936:706) quoting Loomis (1918:102) has shown that " . . . the Kermadec Petrel migrates northward in the eastern Pacific to about latitude 15° N., where two examples were collected and others observed by Beck during October, 1906."

Pterodroma neglecta is described (Murphy, 1936) as a dichromatic petrel which occurs in two color phases: black and light brown. A number of intermediates are also found, which range from light specimens with white bellies and very light throats and heads, to very dark specimens which are almost black. White areas on the throat, wings and usually elsewhere are always present, however. The concealed basal portions of the entire plumage are white in all color phases, which produces a mottling even in the darkest phases. All the birds, regardless of color, have the shafts of their primaries, as well as a greater part of the inner web of each primary, largely and conspicuously white. *Pterodroma neglecta* may be distinguished from all other closely related forms, including *P. arminjoniana*, by these characteristics. The whitish base of the rectrices is another distinctive characteristic (Fig. 2). Murphy and Pennoyer (1952:6) give excellent illustrations of wing patterns in the genus *Pterodroma* to which the reader is referred.

The adults in the dark phase (sexes alike) vary in their general color between a grayish brown and a dark brownish black. A white mottled area appears on the throat and also to a lesser degree elsewhere. The quills of the wing and tail, including the white shafts, are as described. Birds in the dark phase have legs which are black, whereas specimens in the intermediate phases are parti-colored.

Fig. 2. A view of the ventral surface of *Pterodroma neglecta* showing the white wing patches, whitish base of the rectrices, and the petrel bill which is shorter than that of the shearwaters. Photo from a 16 mm Kodachrome motion picture.

Pterodroma neglecta was observed for a period of about five minutes (1:00 to 1:05 PM, EST) on 3 October 1959. The weather was very cloudy and the light was quite dim. A Weston exposure meter did not record more than 50 foot-candles. The bird circled the Lookout at varying heights—at times only 40 feet above the approximately 40 observers who were present and saw the bird. I was able to secure 50 feet of 16mm Kodachrome motion pictures showing both the dorsal and the ventral surfaces of the bird as it circled overhead. It was last seen flying in a northwest direction toward the upper Susquehanna River and New York State.

Because of the poor lighting conditions, only 36 feet of film are usable, but they clearly show the conspicuous white wing patches against the dark

FIG. 3. Head and bill of *Puffinus griseus* (left) and *Pterodroma neglecta.* Drawn by Dr. Earl L. Poole from skins in ANSP.

plumage of the body on the ventral surface of the bird. Furthermore, the whitish base of the rectrices may also be seen (Fig. 2).

Since I am unfamiliar with oceanic birds, I sent the film to Dr. Murphy and requested his opinion regarding the identification of the bird. His reply, in part, follows:

> The short strip of motion pictures of your seabird is far more revealing than I had anticipated. It is not a Sooty Shearwater (as one ornithologist suspected). That species has a white wing lining as conspicuous as the Black Duck's. Furthermore, your bird is not a *Puffinus* of any sort. Its bill (see comparison of Figs. 2, 3) and its style of flight show that it is a member of the genus *Pterodroma.*
>
> On geographic grounds, the most likely petrel would be *Pterodroma arminjoniana* from the south Atlantic which has once been taken at Ithaca, New York (Murphy, 1936:53) after a hurricane (see also Allen, 1934:134). Careful examination of the film appears, however, to rule out that species. My final conclusion is that this petrel can be nothing else than *Pterodroma neglecta* in the dark plumage phase. There is no other species that shows the conspicuous white wing patch against a generally black plumage.
>
> Under separate cover I am sending you a systematic paper of my own (Murphy and Pennoyer, 1952) and I call your attention to the diagrams of wing pattern on page 6. These figures and the text will supply the grounds for my conclusion. On the other hand, I suppose that my memory of the living birds influences me quite as much as the facts of description.

My photographs, along with the drawing (Fig. 3) by Dr. Earl L. Poole, which illustrate this paper, serve as another means of comparison between the genera *Puffinus* and *Pterodroma.*

Dr. Murphy has the following opinion regarding records for this bird in North America: "*Pterodroma neglecta* has probably not previously been recorded from the north Atlantic area . . . many members of the genus have turned up as stray birds in odd corners of the world. I believe that *neglecta* has been recorded in the same way from somewhere in Europe." The single record of *P. neglecta* in Europe is a male which was picked up dead in Tarporley (Cheshire), England, on 1 April 1908 (Witherby et al., 1952:63).

The latest edition of the AOU Checklist includes no records for this species in North America. This then is the first record for *Pterodroma neglecta* on the North American Continent.

ACKNOWLEDGMENTS

I would like to express my appreciation to the various members of the Departments of Birds in the Academy of Natural Sciences of Philadelphia, American Museum of Natural History, and Smithsonian Institution who placed series of specimens of various shearwaters and petrels at my disposal for comparison purposes. My sincere appreciation is also due Dr. Earl L. Poole, who examined the manuscript, made several suggestions, and also prepared the drawings of the head and bill of the Sooty Shearwater and the Kermadec Petrel. Finally, my deepest appreciation must be extended to Dr. Robert Cushman Murphy who, on several occasions, critically examined my color motion pictures of the petrel and expressed his opinion as to the identification of the bird..

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629 GREEN STREET, ALLENTOWN, PENNSYLVANIA, 22 JUNE 1961 (ORIGINALLY SUBMITTED 4 MARCH 1960)

NEW LIFE MEMBER

New life member Simon Rositzky, of St. Joseph, Missouri, is interested in ornithology primarily through field work. A graduate of the University of Missouri, Mr. Rositzky is now president of United Department Stores, the father of two teenage daughters, and actively works with Boy Scouts. He was president of the St. Joseph Audubon Society, is a member of the board of directors of the St. Joseph Museum, and is an active member of the National Audubon Society and the American Museum of Natural History.

OCCURRENCE AND TIMING OF EGG TEETH IN BIRDS

GEORGE A. CLARK, JR.

The egg tooth is a small tooth-like protuberance on the distal end of the dorsal surface of the upper mandible at the time of hatching. It is generally believed that the egg tooth functions in cutting through the shell membranes and shell at hatching. In addition to egg teeth on the upper mandible, a number of authors have noted tooth-like modifications of various kinds at the tip of the lower mandible in embryos or newly hatched birds of a variety of families. The objective of this paper is to present an extended review of scattered records of egg teeth as a stimulus and aid for further studies on the morphology, function, development, and evolution of these structures.

In spite of the great significance of hatching in the life of the bird, very little is known of the causal relations involved in the process. Certain correlated events such as respiratory, circulatory, and behavioral changes are known, but in no case have the factors responsible for the timing of hatching been specifically identified. The role of the egg tooth in hatching also needs further study. Fisher (1958) studied the development in the chicken of the hatching muscle which may be important in the functioning of the egg tooth. It has been suggested that the hatching muscle provides a major part of the thrust in breaking through the shell. The egg tooth is possibly unique as a structure functional only at the time of hatching. Many species appear to have characteristic patterns of hatching as shown by the condition of the shells after hatching (Wetherbee, 1959). In the European Quail (*Coturnix coturnix*), for example, the blunt end of the shell is almost entirely cut off with a precise circular incision.

The egg tooth of the upper mandible has been studied in detail for only a very few species. A modern histological study of the egg tooth is that of Kingsbury, Allen, and Rotheram (1953) on the chicken. Detailed comparative studies are needed to determine the homologies of the egg teeth of both upper and lower mandibles within the class Aves. In some groups (e.g., penguins and Falconiformes) the egg tooth of the upper mandible typically remains visible for several weeks posthatching, while in other forms (e.g., many Galliformes) loss of the egg tooth characteristically occurs within a few days posthatching (Table 1). Gardiner (1884) suggested that there is a tendency for nidicolous species to retain the egg tooth longer than do nidifugous ones. The physiological and environmental factors involved in retention or disappearance of egg teeth are virtually unstudied.

Gadow (1891) and others have stated that the egg tooth in birds was first noted by Yarrell (1826), but Anson (1929) reported two earlier observations: Aldrovandi in 1600 and Hunter in 1793 (the latter report not published until 1841). Gadow (1891) stated that the egg tooth is to be found in the embryos of

TABLE 1

TIME OF DISAPPEARANCE OF THE EGG TOOTH IN VARIOUS BIRDS

A. The egg tooth is reduced or disappears before hatching:
   - some Megapodiidae

B. The egg tooth disappears during the first week posthatching:
   - *Hydrobates pelagicus* (Hydrobatidae)
   - *Eudocimus albus* (Threskiornithidae)
   - some Anatidae
   - some Galliformes
   - *Rallus elegans* (Rallidae)
   - some Scolopacidae
   - some Passeriformes

C. The egg tooth disappears after the first week posthatching:
   - some Spheniscidae
   - *Procellaria grisea* (Procellaridae)
   - some Falconiformes
   - some Otididae
   - *Cepphus grylle* (Alcidae)
   - *Turacus hartlaubi* (Musophagidae)
   - *Tyto alba* (Tytonidae)

all birds, but evidence for this opinion was not presented. The data here compiled support Gadow's claim, but the chance of finding species without egg teeth remains. It appears that in most branches of avian phylogeny the egg tooth has been developed or retained as an integral part of the hatching process.

Failure of an observer to find an egg tooth on a newly hatched bird does not necessarily indicate that an egg tooth is absent in that species; absence of an egg tooth in a particular specimen may be an age variation rather than a species-specific character. Within a species there may well be wide variation in the time of disappearance of the egg tooth; precise data are needed on this point.

In reptiles at least two types of egg teeth are known: one a true dentinal structure and the other of integumental origin. Only the latter type of egg tooth is known from birds. Some authors have restricted the term "egg tooth" (*Eizahn*) to egg teeth of dentinal character; such terms as egg callosity (*Eischiele*), "egg caruncle," "shell breaker," or "pipping tooth" are used for the structure found in birds. However, the term "egg tooth" is so widely used for the avian integumental derivative that there seems little to be gained by a change of terminology.

No attempt has been made in this paper to review all the published records of egg teeth. A primary concern has been to find records for as many of the major groups of birds as possible. Many records undoubtedly have been missed. In addition to checking several hundred published articles and books, I have examined study skins and alcoholic specimens at the Yale Peabody Museum of Natural History. Examination of specimens at other large museums would unquestionably yield many additional records of egg teeth.

SYSTEMATIC ACCOUNT

Spheniscidae.—The egg tooth is known for the following species: *Aptenodytes forsteri* (Pycraft, 1907*a*), *Pygoscelis papua* (Murphy, 1936), *P. antarctica* (Parsons, 1932), *Eudyptes chrysocome* (= *E. crestatus*; Lewin, 1903), and *Eudyptula minor* (Grossenheider, 1952).

Struthionidae.—Röse (1892) and Schneider (1949) reported and figured the egg tooth of *Struthio camelus.* Schneider's figures of the newly hatched bird suggest the presence of a well-developed hatching muscle.

Gaviidae.—A study skin of a downy *Gavia immer* bears an egg tooth on the tip of the upper mandible. Stresemann (1927–34) commented that newly hatched loons have a tooth-like callosity on the tip of the lower mandible.

Podicipedidae.—Egg teeth were found on downy study skins of *Colymbus chilensis* and *Aechmophorus occidentalis.* Simmons (1955) observed an egg tooth on the distal quarter of the upper mandible of a downy *Colymbus* (= *Podiceps*) *cristatus.*

Procellariidae.—The white egg tooth of the chick of *Procellaria grisea* disappears between 11 and 22 days posthatching with 17½ days being the average time (Richdale, 1945).

Hydrobatidae.—Davis (1957) noted that in *Hydrobates pelagicus* the white egg tooth is retained to about six days posthatching.

Pelecanoididae.—A prominent white egg tooth on a chick of *Pelecanoides urinatrix* of an estimated age of two days posthatching was observed by Richdale (1943).

Phalacrocoracidae.—Lewis (1929) found that the egg tooth of the upper mandible of *Phalacrocorax auritus* is lost about four days posthatching. The whitish tip of the lower mandible has the appearance of an egg tooth and is retained much longer than the egg tooth of the upper mandible. Boetticher (1928) figured the egg tooth of *P. carbo.*

Ardeidae.—Sushkin (1912) reported and figured the egg tooth of *Ardea cinerea.* Heilmann (1927) also figured the egg tooth of *Ardea.*

Threskiornithidae.—Beebe (1914) reported that the egg tooth of *Guara alba* (= *Eudocimus albus*) is lost about the third day posthatching.

Anatidae.—Yarrell (1826) noted the egg tooth in ducks and geese, especially *Alopochen aegyptiacus.* Heilmann figured the egg tooth of *Somateria.* According to Romanoff (1960), *Anas platyrhynchos*, *Anser anser*, *Cygnus*, and *Mergus* lose the egg tooth a few hours after hatching. Koeche (1958) mentioned the egg tooth in his study of the embryology of *Anas platyrhynchos.* I have observed the egg tooth on the nail of the bill in downy specimens of *Aythya valisineria*, *Netta rufina*, and *Clangula hyemalis.*

Accipitridae.—A prominent white egg tooth present at hatching was lost by three weeks posthatching in *Elanus caeruleus* (Van Someren, 1956). Haverschmidt (1959) found a white egg tooth on a nestling of *Helicolestes hamatus.* Gardiner (1884) figured a tooth-like papilla on the tip of the lower mandible of an embryo of *Milvus milvus.* In *Astur* (= *Accipiter*) *tachiro* a white egg tooth was still present at 12 days posthatching (Van Someren, 1956). Van Someren (1956) found an egg tooth on *Meliërax gabar* at least two and one-half weeks posthatching. In *Aquila chrysaëtos* the egg tooth is very noticeable at hatching (Sumner, 1929). As the bill grows, the egg tooth becomes less and less noticeable; at four weeks posthatching the egg tooth is still visible, though very small. Herrick (1932) reported that the egg tooth persists for over a month posthatching in *Haliaeetus leucocephalus.* I have seen an egg tooth in a downy specimen of *Buteo jamaicensis.*

Pandionidae.—P. L. Ames (pers. comm.) found that the egg tooth remained visible in one young Osprey for at least 28 days posthatching.

Megapodiidae.—A vestigial egg tooth in embryos of *Talegalla jobiensis* and *Leipoa ocellata* has been interpreted as one of several characters indicating that megapodes have evolved from gallinaceous birds which hatched relatively earlier in ontogeny (Clark, 1960, and MS). Friedmann (1931) found no egg tooth in an embryo of *Megapodius pritchardii* shortly prehatching; presumably a vestigial egg tooth could be found earlier in the ontogeny of this species. Megapodes are reported to hatch by kicking their way out of the shell (Clark, 1960).

Phasianidae.—Stoddard (1931) noted an egg tooth on a downy *Colinus virginianus.* The development of the egg tooth in *Coturnix coturnix* has been figured by Padgett and Ivey (1960) and Romanoff (1960; after Weber). In this species the egg tooth is lost by the second day posthatching (Clark, MS). A downy specimen of *Gallus gallus* shows an egg tooth. The egg tooth on the upper mandible first becomes apparent in *Gallus domesticus* embryos at seven days of incubation (Hamilton, 1952; Kingsbury et al., 1953). According to Friedmann (1955), Rosenstadt reported an egg tooth anlage on the lower jaw of the chicken embryo. Yarrell (1826) observed that the chicken has lost the egg tooth of the upper mandible by two to three days posthatching. Friedmann (1955:21) erroneously stated that in *Gallus* embryos the egg tooth of the upper mandible is already present at the time of an oral invagination separating upper and lower jaws. Using the figures of Gardiner (1884), Friedmann misidentified the labial groove by calling it an oral invagination; Hamilton (1952:374–375) has given this correct interpretation of Gardiner's study. In embryos of *Phasianus colchicus* the egg tooth is quite noticeable as early as the ninth day of incubation (Fant, 1957). The egg tooth of the Ring-necked Pheasant remains for one or two days posthatching, rarely longer; sometimes the egg tooth is lost as early as five to six hours after hatching (Westerskov, 1957).

Opisthocomidae.—Beddard (1889) and Parsons (1954) noted the egg tooth in *Opisthocomus.*

Gruidae.—Egg teeth have been observed in newly hatched *Grus americana* (Allen, 1952) and *G. canadensis* (Walkinshaw, 1950).

Psophiidae.—Burckhardt (1901*b*) reported an egg tooth for *Psophia crepitans.*

Rallidae.—The egg tooth is lost in *Rallus elegans* between the fourth and sixth days posthatching (Meanley and Meanley, 1958). Walkinshaw (1937) observed the egg tooth in *Rallus limicola. Gallinula chloropus* is stated to have a tooth-like callosity on lower mandible (Willink, 1899). Steinmetz (1932) noted the egg tooth of *Fulica atra* (Heilmann, 1927, also figured the egg tooth of *Fulica*). Falla (1951) reported an egg tooth in *Notornis.*

Rhynochetidae.—Burckhardt (1901*a*) noted the egg tooth in *Rhinochetos jubatus.*

Otididae.—Romanoff (1960) commented that bustards retain the egg tooth for several weeks posthatching. Willink (1899) found a tooth-like callosity on the tip of the lower mandible of *Otis afra* (= *Afrotis atra*); Willink also noted an egg tooth on the upper mandible.

Haematopodidae.—Among the variety of species with a tooth-like callosity on the lower jaw is *Haematopus ostralegus* (Willink, 1899).

Charadriidae.—Romanoff (1960; after Rezovska) has reported a small egg tooth on the anterior end of the lower mandible of *Vanellus vanellus.*

Scolopacidae.—Willink (1899) found an egg tooth on the anterior end of the lower jaw of *Numenius* and *Limosa aegocephala* (= *L. limosa*). Romanoff (1960) reported that in *Gallinago* (= *Capella*) *gallinago* and *Scolopax rusticola* the egg tooth of the upper mandible is lost a few hours after hatching. Wetherbee (1959) was unable to find an egg tooth in a newly hatched *Philohela minor.*

Recurvirostridae.—Willink (1899) observed an egg tooth on the lower mandible of *Recurvirostra avosetta.*

Burhinidae.—*Oedicnemus crepitans* (= *Burhinus oedicnemus*) has an egg tooth on the lower jaw (Willink, 1899).

Laridae.—Tinbergen (1953) commented on the egg tooth in *Larus argentatus* and showed that typically the initial pipping of the shell is directed vertically, either upward or downward. Kirkman (1931) found that the egg tooth is used in hatching in *Larus ridibundus.* Röse (1892) figured the egg tooth on the upper jaw of *Sterna wilsoni* (= *Chlidonias hybrida*). Willink (1899) found an egg tooth on the lower jaw of *Chlidonias nigra.*

Alcidae.—Winn (1950) observed that in *Cepphus grylle* the egg tooth becomes relatively smaller following hatching; the egg tooth disappears between the 25th and 35th day posthatching. Lockley (1953) figured the egg tooth of the Puffin, *Fratercula arctica.*

Columbidae.—Yarrell (1826) and Wetherbee (1959) have noted the typical egg tooth on the upper mandible of *Columba livia.* The egg tooth on the upper mandible of *Zenaidura macroura* is lost about seven to eight days posthatching (Hanson and Kossack, 1957). Both Hanson and Kossack (1957) and Wetherbee (1959) commented on the egg tooth of the lower mandible of the Mourning Dove; Hanson and Kossack noted that the egg tooth of the lower mandible is still prominent at nine days posthatching. Egg teeth have been reported on both upper and lower mandibles in the following species: *Geopelia cuneata*, *Columbina picui*, *Phaps elegans*, *Geophaps scripta*, *Leptotila rufaxilla*, and *Oreopeleia montana* (Minchin, 1933; Newman, 1908). Newman (1908) thought that *Columba* and *Turtur* lack egg teeth on the lower jaw. The egg tooth on the upper mandible of *Phlogaenas crinigera* (= *Gallicolumba criniger*) was reported by Newman (1909).

Psittacidae.—Pycraft (1907*b*) noted an egg tooth on the upper mandible of a nestling *Calopsittacus novae-hollandiae* (= *Nymphicus hollandicus*). Gardiner (1884) reported an egg tooth on the upper mandible of *Melopsittacus.*

Musophagidae.—In *Turacus hartlaubi* the egg tooth disappears about ten days posthatching (Van Someren, 1956). Moreau (1938) found a very small whitish egg tooth on the upper jaw of a newly hatched chick of *Corythaeola cristata.*

Cuculidae.—Shelford (1900) reported and figured an egg tooth in embryos of *Centropus sinensis.* A relatively small egg tooth is to be found on the upper mandible of *Crotophaga sulcirostris* (Skutch, 1959).

Tytonidae.—Pickwell (1948) noted an egg tooth on *Tyto alba* at 13 days posthatching.

Strigidae.—Heilmann (1927) figured the egg tooth of *Nyctea.*

Trogonidae.—The egg tooth has been noted in *Pharomachrus mocino* (Skutch, 1947).

Bucerotidae.—Shelford (1899) examined a late embryonic stage of *Buceros rhinoceros* and noted that the sharp edge of the extreme tip of the large upper mandible could act as an egg tooth, although no actual egg tooth was observed. On the anterior end of the projecting lower mandible is a small tooth-like papilla.

Capitonidae.—Skutch (1944) commented that egg teeth of nestlings of *Dicrorhynchus* (= *Semnornis*) *frantzii* are less prominent than those of woodpeckers (Picidae). Friedmann (1955) noted a tooth-like protuberance on the upper mandible of a nestling *Megalaima asiatica.*

Indicatoridae.—Ranger (1955) reported an egg tooth at the base of the premaxillary hook in a nestling of *Indicator minor*; Friedmann (1955) suggested that the hooks of both upper and lower mandibles of nestling *Indicator indicator* are formed from anlagen homologous to those forming the egg teeth in other birds.

Ramphastidae.—Van Tyne (1929) observed a well-developed egg tooth in young *Ramphastos sulfuratus* (= *R. brevicarinatus*).

Picidae.—In *Colaptes auratus* Wetherbee (1959) found a white covering on the tips of both jaws; this covering resembled egg teeth in color and texture. Friedmann (1955) observed an egg tooth in each of two nestling specimens of *Colaptes auratus*. Lüdicke (1933) found an anlage of an egg tooth in an embryo of *Picus viridis* at five days of incubation. According to Wetherbee (1959), the Heinroths figured a nestling *Picus viridis* showing the whitish tips of both mandibles. According to Friedmann (1955), the Heinroths also reported an egg tooth on the upper jaw of *Dryocopus martius*. Hoyt (1944) described the whitish tips of each jaw of the nestling *Dryocopus pileatus*; these tips are retained until shortly after the young bird leaves the nest. Hoyt was uncertain whether these whitish tips are forms of egg teeth or whether an actual egg tooth appears earlier and is lost shortly posthatching. Egg teeth on the upper mandible of chicks of *Dendrocopos pubescens* have been reported by Friedmann (1955) and Wetherbee (1959). Friedmann (1955) found an egg tooth on a nestling *Picoïdes tridactylus*.

Corvidae.—P. L. Ames (pers. comm.) has seen an egg tooth on a nestling *Corvus brachyrhynchos*.

Troglodytidae.—Armstrong (1955) reported egg teeth in two species of wrens.

Turdidae.—Lüdicke (1933) found anlagen of egg teeth on both upper and lower jaws in embryos of *Turdus merula*.

Laniidae.—Miller (1931) noted that the egg tooth of *Lanius ludovicianus* was undiminished in size between hatching and four days posthatching. In the fifth and sixth day posthatching the egg tooth was less prominent as a consequence of growth of the remainder of the bill.

Callaeidae.—McKenzie (1951) reported that in *Callaeus cinerea* the egg tooth is retained at least one week posthatching.

Sturnidae.—Romanoff (1960; after both Portmann and Weber) has figured the egg tooth of *Sturnus vulgaris*.

Vireonidae.—Southern (1958) noted a prominent whitish egg tooth in the newly hatched Red-eyed Vireo (*Vireo olivaceus*); by the fourth day posthatching the egg tooth had decreased in size.

Icteridae.—Daniel (1957) found that the egg tooth first appears in embryos of *Agelaius phoeniceus* at the seventh day of incubation; the egg tooth is completely formed by 11½ days of incubation. Daniel also found an anlage of the egg tooth on the lower mandible of *Agelaius*. Friedmann (1929) found the egg tooth still present in *Agelaioides* (= *Molothrus*) *badius* at about five days posthatching; the following day the egg tooth was less distinct. Friedmann also observed an egg tooth in *Molothrus rufo-axillaris*. In *M. bonariensis* the egg tooth is still as prominent at three days posthatching as at hatching; the egg tooth is still present at five days posthatching but on the following day is no longer very distinct (Friedmann, 1929). In *Molothrus ater* the egg tooth is still present on the fifth day posthatching; on the sixth day it is no longer distinct. Friedmann (1929) also found an egg tooth in *Tangavius aeneus* at one day posthatching.

Tersinidae.—Traces of an egg tooth are visible in *Tersina viridis* during the first few days posthatching (Schaefer, 1953).

Ploceidae.—Lüdicke (1933) found an anlage of the egg tooth in the canary embryo at seven days of incubation; he also noted an anlage of the egg tooth on the lower jaw in this form. Weaver (1942) briefly described the egg tooth of *Passer domesticus*; this egg tooth disappears by the fourth day posthatching.

Fringillidae.—Orr (1945) observed an egg tooth in nestlings of *Geospiza.* Woolfenden (1956) recorded the egg tooth present as late as the sixth day posthatching in *Ammospiza.*

ACKNOWLEDGMENTS

I am grateful to Mary A. Heimerdinger and Peter L. Ames for information on the egg teeth of various species. Dr. Philip S. Humphrey generously offered many valuable suggestions. This review was prepared using the facilities of the Department of Zoology and the Peabody Museum of Yale University. Financial support was received from the National Science Foundation G-10735.

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DEPARTMENT OF VERTEBRATE ZOOLOGY, PEABODY MUSEUM OF NATURAL HISTORY, YALE UNIVERSITY, NEW HAVEN, CONNECTICUT, 8 SEPTEMBER 1960

NEW LIFE MEMBER

Walter P. Nickell, an active member of the Society since 1943, is an Associate Naturalist in the Science Education Division of the Cranbrook Institute of Science, Bloomfield Hills, Michigan.

Walt has varied interests in ornithology, but especially is he interested in the migration, life histories, and ecology of birds. He has published approximately 100 papers on these subjects and on others in allied fields of entomology, geology, and mineralogy.

Our new Life Member is also a member of the AOU, Cooper Ornithological Society, Detroit Audubon Society (Pres. 1941–1943), Michigan Audubon Society (Board Member), Massachusetts Audubon Society, National Audubon Society, numerous bird banding organizations, Michigan Botanical Club (Pres. 1947–1949), and others.

GENERAL NOTES

Dorsal apterium present in Bobwhite.—In the only existing discussion of pterylosis in the Odontophorinae, Clark (1898. *Proc. U.S. Natl. Mus.*, 21:641–653) stated that the group is characterized by the lack of a dorsal apterium. Of the five genera represented in Clark's study (*Oreotyx*, *Callipepla*, *Lophortyx*, *Colinus*, and *Cyrtonyx*), only *Lophortyx* was described as possessing a trace of a dorsal apterium. Examination of 175 specimens (170 prepared as flat skins and 5 plucked) disclosed that a dorsal apterium is also present in Bobwhite (*Colinus virginianus*). Located in the dorsal region of the spinal tract, the apterium averaged about 2 cm long and less than 1 cm wide.

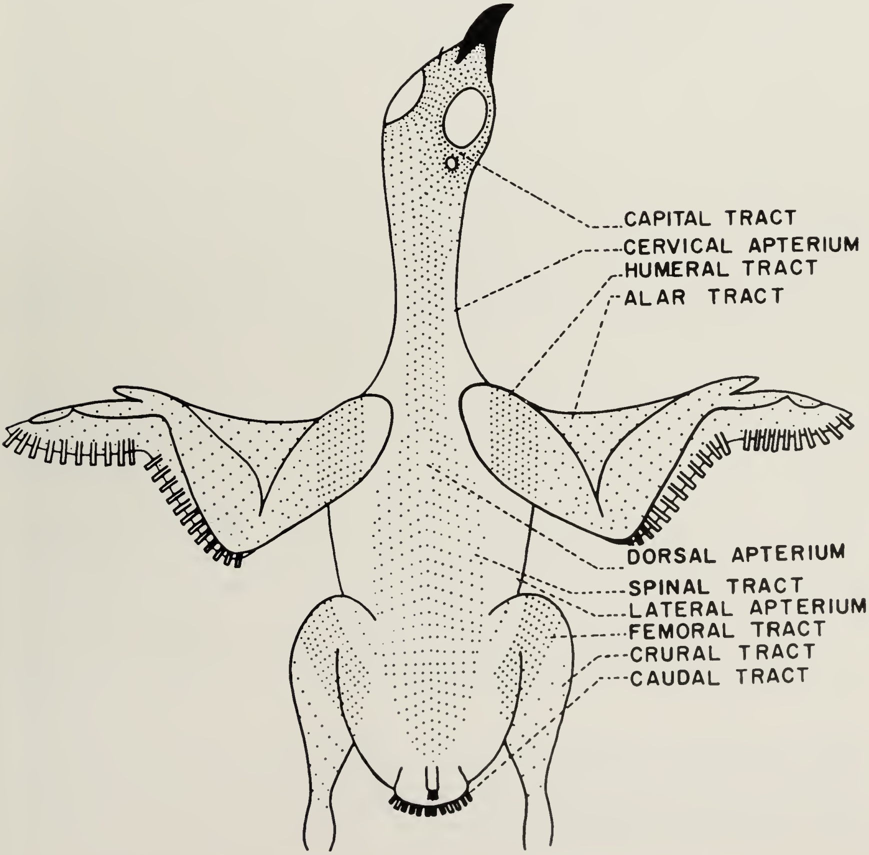

Fig 1. Plucked Bobwhite, dorsal view, illustrating dorsal apterium.

Specimens examined were collected from January to March 1956 in the southern one-third of Illinois. Most were first-winter birds, but those in adult plumage also exhibited the apterium.—Lucy Sharp Brewer, *Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, Illinois, 25 June 1960.*

Copulatory behavior of the Common Loon.—S. T. Olson and W. H. Marshall (1952. The Common Loon in Minnesota. *Occasional Papers:* No. 5, *Minn. Mus. Nat. Hist.*, pp. 27–28) described what they considered to be the courtship of the Common Loon (*Gavia immer*) and stated that copulation had not been observed. They suggested that the act was performed at night. Thus, the following description of copulation is perhaps the first recorded for the species.

On 14 June 1960, I observed two loons at the Crex Meadows Wildlife Area (Grantsburg, Burnett County, Wisconsin) which behaved in a manner similar to that described by Olson and Marshall (op. cit.). While driving along Phantom Lake dike I noticed at a distance what appeared to be a white-capped wave moving irregularly across the lake. As I drove nearer I distinguished the heads of two loons above the churning water. The birds skimmed over the water at varying speeds, striking the surface with powerful wing beats. The pursuing bird was never more than a few feet behind the lead bird. Occasionally the birds gave a great burst of speed lasting for 15 to 20 feet. The first uninterrupted chase covered a meandering course of several hundred feet. After stopping, both loons stood upright, stretched their wings, and dived. After surfacing, one bird started another wing-splashing treck across the water and was soon followed by the second loon. Several other pursuits of shorter length followed. During these the lead bird appeared to be tiring and slowed down. The pursuer seemed less tired and overtook and mounted the lead bird. Togther they submerged like an overweighted object. After about 40 seconds they surfaced at the same location, one still on top of the other. The top bird slipped off immediately and both birds swam about slowly for a few minutes. One or two short, less vigorous, chases occurred and then the birds left for another part of the lake.—William E. Southern, *Department of Biological Sciences, Northern Illinois University, DeKalb, Illinois, 11 July 1960.*

Cattle Egrets in Mexico.—The remarkable spread of the Cattle Egret (*Bubulcus ibis*) northward from South America has been recorded through the islands of the West Indies and in the Gulf and Atlantic coastal areas of the United States. The only previously published reports of this egret from eastern Mexico, a logical route for its dispersal, appear to be of the individuals noted in Quintana Roo near Chetumal on 16 December 1956, and on Cozumel Island, 8 January 1959 (R. Denham, 1959. *Auk*, 76:359–360). The following additional records of its occurrence to the northward in Mexico are of interest. On 13 April 1959, B. L. Monroe, Sr., and B. L. Monroe, Jr., saw nine birds two miles south of Panuco, Veracruz, near the Tamaulipas border. D. M. Lay and D. G. Berret noted seven Cattle Egrets on 22 April 1959, two miles south of Miramar (near Alvaro Obregón), Tabasco. In 1960, D. M. Lay and J. E. Woods observed about 50 birds on 29 February near Huastecas, Tabasco, 18 miles north of Teapa. The following day in the same locality they found 150 Cattle Egrets and collected a specimen. These observers and J. Gee also noted the egrets there on 25 and 30 March. We found a Cattle Egret in a wet field 2.4 miles west of Ciudad Lerdo on the main road between San Andres Tuxtla and Alvarado, Veracruz, on 13 March 1960.—Robert F. Andrle, *Louisiana State University, Baton Rouge 3, Louisiana*, and Harold H. Axtell, *Buffalo Museum of Science, Buffalo 11, New York, 3 August 1960.*

Long-tailed Jaeger in Ohio.—On 20 October 1956, an immature jaeger with an injured wing, found two days earlier near Ashtabula, Ohio, on a road near Lake Erie, was brought to me. It had been kept in a small basement room, where it had apparently consumed very little of the food and water offered it.

I had the feathers of the injured wing clipped, and kept the jaeger in a large box indoors. It was given exercise in the yard every day, and placed in a large tub of water two or three times a day. Although a pan of water was also available, the only observed drinking was done when in the tub. Each day the bird accepted six or seven finger-sized fish or similar-sized strips of larger fish, and about ten pieces of fish-flavored cat food molded to the same size. Such food was taken freely when dangled in front of the bird, but not from the floor unless dropped there by the bird itself. When it ate more than about three pieces at a time (it would take five or six), it would regurgitate the extra pieces with violent effort and pay no further attention to them, or to more food proffered at that time. It seemed to be in vigorous health, frequently tried to fly, and became quite tame, allowing its head to be stroked and not objecting to some handling when shown to visitors.

On 10 November, after about ten minutes in its tub, it was found dead from no obvious cause. Shortly after death it was examined by Drs. Harry C. Oberholser and Owen Davies, and identified as a Long-tailed Jaeger (*Stercorarius longicaudus*). The specimen, apparently the second for Ohio (Trautman and Walker, 1930. *Auk*, 47:242), has been deposited in the University of Cincinnati Museum.—Edwin Novotny, *97 W. 44th St., Ashtabula, Ohio, 8 July 1960.*

Purple Martins nesting in city buildings.—On 29 May 1960, I discovered four pairs of Purple Martins (*Progne subis*) nesting in crevices and cavities of a two-story brick building on the main street of Ottawa, Franklin County, Kansas. The birds were using the building housing the Kramer Drug Store, near the corner of Second and Main streets. The side of this building facing the street has its upper edge (approximately 40 feet high) ornamented with 14 objects resembling one-gallon tin cans suspended on their sides. About one-half of these have one or both ends, or their base attachments, partly or fully broken away, allowing entrance to the interior by the birds. Besides the four pairs of martins, Starlings (*Sternus vulgaris*) and House Sparrows (*Passer domesticus*) were nesting in these ornaments. The martins all appeared to be adults; two pairs behaved as if incubating and another as if feeding young on 2 June, when Richard F. Johnston and I visited Ottawa and observed the birds.

Although several other buildings seemed to possess suitable cavities for martins, no indications of their breeding elsewhere in such crevices were noted by us. Johnston and I questioned an elderly resident of the town about the birds, selecting for this inquiry a gentleman who had three martin houses in his back yard. He was familiar with the birds in question, estimating that they had frequented the Main Street area for 10 to 15 years, although he had never determined where the birds entered the building. Purple Martins nesting in bird houses are common in Ottawa as they are throughout eastern Kansas, and there is no noticeable scarcity of such man-made structures which might cause the birds to use natural cavities.

Allen and Nice (1952. *Amer. Midl. Nat.*, 47:614–616) summarize use of natural cavities for nesting by Purple Martins. In the eastern United States, use of nest sites other than those provided in martin houses has been rare in populated areas and has not been reported since the early part of the 20th century. Use of crevices in city buildings is known in the western United States (for example, Seattle, Washington), but previous to discovery of these Kansan birds, may not be recorded for the eastern half of the country. The use of natural cavities in sparsely populated areas farther east (such as in northern Minnesota and coastal Florida) doubtless still occurs.

The present observations were made while I was a research zoologist at the University of Kansas, Lawrence, Kansas.—John William Hardy, *Department of Zoology, University of California, Los Angeles 24, California, 25 July 1960.*

ORNITHOLOGICAL NEWS

The Wilson Ornithological Society now has a total of 1,561 members categorized as follows (with net gain over last year):

Active	1,233	(10)
Sustaining	144	(7)
Life	180	(12)
Patron	4	(0)

In addition, the Society is filling 228 subscriptions to *The Wilson Bulletin*, and receives 84 publications in exchange for the *Bulletin.*

The University of Georgia announces the awarding of the 1961 Stoddard-Sutton prize to Mr. Herbert W. Kale for his work on the breeding populations of Long-billed Marsh Wrens in Georgia salt marshes. The prize consists of a cash award accruing from the interest on the income received from the sale of the book "Georgia Birds" by T. H. Burleigh. The award honors Herbert L. Stoddard, eminent Georgia ornithologist and conservationist, and George M. Sutton, the artist who prepared the illustrations for the Georgia volume. The purpose of the award is to encourage a student (undergraduate or graduate) at the University who shows promise in original investigation in ornithology or wildlife ecology. Mr. Kale's work with the marsh wrens has also received national recognition in the form of a Frank M. Chapman award granted to aid his continuing work.

TO AUTHORS

All authors submitting manuscripts to *The Wilson Bulletin* are urged to read "Suggestions to Authors" on the inside back cover of this *Bulletin.* The "Style Manual for Biological Journals," which should be followed, was prepared by the Committee on Form and Style of the Conference of Biological Editors. The editorial boards of 78 biological journals have adopted this manual in whole or in part, so as to establish uniform standards in biological publications. The Style Manual was published on a non-profit-making basis. For orders, at $3.00 each, write to: Subscriptions, American Institute of Biological Sciences, 2000 P Street, NW, Washington 6, D. C., USA.

Dr. Jesse M. Shaver, for many years a bulwark of the Wilson Ornithological Society, died on 7 July 1961. Although Dr. Shaver had not been active in the affairs of the Society recently, he served it generously in various offices, culminating in its presidency, which he occupied from 1932 to 1934.

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 15 January 1962. Proposals received prior to that date will be reviewed at the winter meetings of the Foundation's advisory panels and disposition will be made approximately four months following the closing date.

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

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 cases, full details of which will be found in the *Bulletin of Zoological Nomenclature*, Vol. 18, Part 3 published on 16 June 1961:

Validation of the generic name *Pnoepyga* Hodgson, 1844 (Aves). Z.N.(S.)1457;

Designation of a neotype for *Corvus benghalensis* Linnaeus, 1758 (Aves). Z.N.(S.)1465.

Anyone who wishes to comment on these two cases should do so in writing, and in duplicate, as soon as possible, and in any case before 16 December 1961. Each comment should bear the reference number of the case in question. Comments received early enough will be published in the *Bulletin of Zoological Nomenclature.* Those received too late for publication will, if received before 16 December 1961, 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 Museum of Comparative Zoology at Harvard College (Cambridge 38, Mass.) has just reprinted Volume III of the late J. L. Peters' "Check-list of Birds of the World." This volume, long out of print, lists the Columbidae and Psittacidae, and related families. It is available from the Museum for $10.00.

The only other volumes available are V ($7.00), VII ($6.00), and IX ($7.50), but if sufficient interest is indicated, additional volumes may be reprinted.

With the cooperation of specialists throughout the world, work is progressing rapidly toward completing the unpublished volumes. Volume XV, containing the Ploceidae, Sturnidae, Oriolidae, Dicruridae, Paradisaeidae, Corvidae, etc., is in press and should be ready early in 1962. The proposed sequence for the remaining volumes is: X, XII, XIV, XIII, XI, and VIII.

JOSSELYN VAN TYNE MEMORIAL LIBRARY

The following gifts have been recently received. From:

William H. Burt—1 book, 5 reprints
George Chaniot—5 reprints
F. G. Cooch—1 reprint
John T. Emlem—5 reprints
Crawford H. Greenewalt—1 book
Claude W. Hibbard—10 reprints
Institute für Vogelforschung—12 reprints
George H. Kelker—125 reprints
Leon Kelso—5 translations, 3 reprints
S. C. Kendeigh—5 reprints
Aunetta W. Kivi—18 books, 4 journals
Wesley E. Lanyon—6 reprints
Daniel McKinley—1 book, 16 reprints
D. F. Owen—2 reprints
Cecil A. Poole—15 books, 3 pamphlets
Aretas A. Saunders—1 book
Peter Stettenheim—4 translations
Emerson Stringham—1 book, 15 journals, 20 reprints
L. C. Stuart—2 reprints
Mrs. Josselyn Van Tyne—60 books, reprints and pamphlets equivalent to 60 books
Charles Walker—4 books
L. H. Walkinshaw—5 reprints
George J. Wallace—1 pamphlet, 3 reprints
J. Dan Webster—4 reprints
David K. Weterbee—2 reprints
L. R. Wolf—4 books, 8 journals, 25 reprints
James Woodford—4 reprints

STATUS AND PROBLEMS OF NORTH AMERICAN GROUSE

A Contribution from the Wilson Ornithological Society Conservation Committee

North American grouse fall into three overlapping groups: the ptarmigans—Willow (*Lagopus lagopus*), Rock (*L. mutus*), and White-tailed Ptarmigan (*L. leucurus*)—breeding on the arctic tundra, in the far northern brushlands, and above timberline on mountain tops; the forest dwellers, Blue (*Dendragapus obscurus*), Spruce (*Canachites canadensis*), and Ruffed Grouse (*Bonasa umbellus*) ; and lastly, the grouse of prairies and plains, of forest edges and openings, the Greater and Lesser Prairie Chickens (*Tympanuchus cupido* and *T. pallidicinctus*), Sharp-tailed (*Pedioecetes phasianellus*) and Sage Grouse (*Centrocercus urophasianus*). Each group, by the nature of its environment, has been affected differently by the pressures of modern civilization. As a result, population status and the problems of survival differ more from group to group than from species to species within a group.

In this report we will give most attention to those species whose status is least secure. For generalized maps of the distribution of all species except Willow and Rock Ptarmigan, see Aldrich and Duvall (1955).

The ptarmigans are a widespread and successful group. As sources of human food, as distinct from sport hunting, it is likely that since prehistoric times the Willow and Rock Ptarmigan have had greater importance than any other grouse. Because their range is generally thinly populated by man and little changed by his activities, ptarmigan have not been much affected by this levy on their numbers. Sport hunting over their range as a whole has not been a large factor, but hunting is bound to increase in limited areas such as parts of Alaska and those sections in northern Canada near the increasing number of mining centers.

Newfoundland is a special case. There are no other upland game birds there in huntable numbers, although Ruffed and Spruce Grouse have recently been introduced in small numbers. The ptarmigans, and especially the larger and more accessible Willow Ptarmigan, are highly prized for hunting. Willow Ptarmigan appeared to be decreasing at an alarming rate in the early 1950's, especially on the Avalon Peninsula (Wildlife Management Institute, 1955), but by 1960 the population was high again (A. T. Bergerud, 1961, verbal). Studies now in progress may help to explain such fluctuations and to lead to a management program. It now appears that fire plays an important role in the ecology of Willow Ptarmigan: fire encourages *Vaccinium*, a valuable source of food, while the absence of fire allows the successional replacement of *Vaccinium* by *Kalmia*, which has little or no value for ptarmigan (Bergerud, ibid.).

The White-tailed Ptarmigan is the only species resident in the United States. Much of its high mountain range is now, and is likely to remain, relatively undisturbed, and hunting is so difficult that it is not often attempted. In a few places, however, grazing of alpine meadows may have seriously reduced and even eliminated ptarmigan populations. Possible examples occur in Montana in the Whitefish, Bitterroot, Flint Creek, and Anaconda-Pintlar Ranges, and in the Beartooth Plateau-Absaroka Range complex. Ptarmigan are gone from these places where old records—unfortunately not supported by specimens—suggest that they formerly occurred (R. S. Hoffman, 1960, letter). Grazing may have affected ptarmigan habitat in some areas in Washington (F. Zwickel, 1960, letter). Grazing drove ptarmigan almost to extirpation in the mountains of northern New Mexico many years ago (Ligon, 1927) ; they are now seen occasionally only on Costilla Peak, apparently as stragglers from nearby Colorado (J. S. Ligon, 1960, letter).

The Blue Grouse is a thriving species of the Douglas fir (*Pseudotsuga*) region of the far West (Beer, 1943). It is one of the major game birds over much of its range, as in British Columbia, western Alberta, Washington, Oregon, California, Idaho, Montana, Colorado, and Wyoming. In southeastern Alaska it is seldom hunted because of the difficult terrain in which it lives (R. B. Weeden, 1960, letter). In Utah, Nevada, Arizona, and New Mexico it is much less abundant than in the more northern parts of its range. Unlike most mountain dwellers, the Blue Grouse breeds at lower elevations, often as far down as the foothills, and moves to the mountain tops just below timberline for the winter. Most observers speak of the upward movement as beginning in summer (e. g., Wing, 1947; Hoffman, 1956), and Marshall (1946) relates it to the progressively later ripening of fruit at higher altitudes; Bendell (1955) dates the movement on Vancouver Island as beginning as early as late April for cocks and July for hens and young. As a result of this movement, the more easily hunted lower slopes hold only a part of the population by the time hunting seasons normally open, and a large part of the population is by then dispersed over the larger and less accessible winter range. In at least one area in California this upward movement and dispersal does not occur (Hoffman, 1956).

Lumbering and fire in the heavily forested coastal region have increased the primeval breeding range of the Blue Grouse, and the wintering range has been little affected. The net result has been an increase in the Blue Grouse population (J. F. Bendell, 1960, letter). In some places, for example Vancouver Island (Hatter et al., 1956) and parts of western Washington (F. Zwickel, 1960, letter), forest succession after cutting has already gone well beyond the early stages which are best for Blue Grouse. However, future cuttings will probably sustain a long-continuing population at a moderately high level. These same successional factors are also at work in the southern and more eastern parts of the range, but livestock grazing on the lower slopes presents a potential, and in places an actual, threat to breeding habitat. The problem is already recognized. For example, in Washington, B. L. Lauckhart (1960, letter) writes: "Our best blue grouse populations have developed on our department-owned big game winter ranges, where we have purchased the land and eliminated grazing of domestic livestock"; I. O. Buss (1960, letter) adds: "Although blue grouse, ruffed grouse, and Franklin grouse enjoy very good to excellent habitat conditions (status) today, it is entirely possible that the extensive ranges of these birds will be affected significantly when agricultural (particularly grazing) advancement infringes on the breeding range of the foothills of the mountains." Overgrazing appears to be reducing the breeding range of the Blue Grouse in Idaho, where the population has been on the decline for the past two or three decades (E. G. Bizeau, 1960, letter). Montana is currently measuring the effects of grazing on both Blue and Sharp-tailed Grouse (R. L. Eng, 1960, letter).

The Spruce Grouse is one of the most widely distributed North American grouse and one of the least understood. It is generally considered to be a bird of deep climax coniferous forests and swamps, but in parts of Ontario, Michigan, and Minnesota it is found in fair numbers in natural jack pine (*Pinus Banksiana*) stands. J. Hatter (1960, letter) writes of British Columbia: "It is my feeling that a certain amount of fire with the resultant openings in the climax forest does improve conditions for Spruce Grouse." It has the largest range of all grouse in Alaska, where it is a major game bird (Buckley, 1954). It is abundant enough to be hunted in Washington, Idaho, and Montana, although hunting pressure is generally light. In contrast, it occurs infrequently to rarely over much of the eastern part of its range. Scarcity is by no means caused only by the advance of civilization, for there appear to be regions of scarcity and of abundance in wilderness country as well. This is not to say that it has not been affected by civilization, for certainly there has been much loss of habitat and some harassment of remaining populations along the southern part of the eastern half or more of the geographic range. In Ontario south of Lake Nipissing, for example, the species has disappeared from all but a few localities (Lumsden, 1960, letter). Considering the vast range which it still occupies, one cannot call the Spruce Grouse a threatened species; nevertheless, this may be cold comfort for ornithologists in those eastern states where the bird is now rare. A full-scale study of the ecology and population dynamics of the Spruce Grouse is clearly needed, but we do not know of a single current example.

The Ruffed Grouse is the best known of the forest grouse, and the one that lives in closest association with civilized man. Where topography and climate have favored the large-scale conversion of forest to plowland, the Ruffed Grouse has been wholly wiped out over considerable areas, or reduced to small colonies in scattered farm woodlots. This happened as early as 1752 in parts of Pennsylvania (Bartram, quoted in Bump et al., 1947), and has been most conspicuously true in the southern and eastern parts of the range in Ohio, Indiana, Illinois, Kentucky, Tennessee, Iowa, Missouri, and in the southern parts of Ontario, Michigan, Wisconsin, and Minnesota. It has wholly or virtually disappeared from its once fairly large range in Arkansas, and from the smaller areas of former range in Alabama, Georgia, Nebraska, and Kansas (Aldrich and Duvall, 1955). Nor has the process of habitat destruction come to an end. In Ohio about 50,000 acres of agricultural land are currently lost to suburbs and industry each year, with woodlots and other timbered areas being cleared at a corresponding rate as replacement acres for agriculture (T. J. Peterle, 1960, letter).

However, where large stretches of forest have been partially broken up by the introduction of farms, or where such farms have been abandoned and the fields allowed to revert naturally to forest, Ruffed Grouse have been considerably increased over their primeval numbers. Second growth after fires and lumbering have similarly benefited Ruffed Grouse over a geographically enormous area, both by producing interspersion in former monotypes and by turning forest succession back to the younger stages which are far more productive of Ruffed Grouse than mature stands are.

Both destruction and improvement of Ruffed Grouse range are constantly going on, and sometimes the same piece of ground has been affected more than once in historic times. Northern Wisconsin, for example, became much better Ruffed Grouse habitat when the old forests were logged off and replaced by younger stands. Today, however, much of the second-growth forest has passed beyond optimum conditions for Ruffed Grouse and the total population is probably now, or certainly soon will be, smaller than it was at its greatest. And in the earlier settled parts of the country like New England, the second growth itself has been cut, and cut again, with corresponding changes in grouse abundance.

The Ruffed Grouse is superb for sport hunting. On the basis of its wide distribution (coast to coast), total numbers (well into the millions), and annual kill (millions), it takes first place among all the grouse as a sporting bird. Furthermore, habitat management is now practiced, as with other game species in many areas where the population is not endangered, to make a fair population larger in order to improve hunting. There is already available a considerable body of technical knowledge. One of the most important problems still to be solved is how to fit Ruffed Grouse management into forest management. Silvicultural methods are changing and already are very different from those that produced such abundant crops of grouse and deer in the past. Large pine plantations, often established at the expense of vitally important openings, are virtually worthless for wildlife, but are an increasingly large part of modern forestry programs. Group-selection-cutting is aimed at maintaining an essentially closed canopy, and by that very fact tends to discourage both the mixture of plant species and of age classes which Ruffed Grouse must have.

It is not simple to manage a forest so as to produce sustained crops of both timber and wildlife. Wildlife is most abundant in young forests and in forests with a mixture of age classes most of which are young. It follows that almost any cutting will benefit wildlife sooner or later and in some degree. Cuttings are sometimes planned deliberately to benefit deer and Ruffed Grouse. But such glittering generalities as "the best forest management is the best game management," while sometimes true, do an enormous disservice by glossing over the ecological complications and outright contradictions which can be overcome only by direct and forthright action.

It is the grouse of open country and the forest edge—Greater and Lesser Prairie Chickens, Sage Grouse, and the three southern races of the Sharp-tailed Grouse—that are faring worst in modern times.

The Heath Hen, the eastern race of the prairie chicken, became extinct in 1932. The Attwater's Prairie Chicken, the southern race and the southernmost grouse in all the world, is on the verge of extinction. Once common on the coastal prairies of Texas and Louisiana, it is now restricted to scattered, isolated colonies in parts of 11 counties in Texas (P. B. Uzzell, 1960, letter). We estimate the total population at *less than one per cent of its former numbers.* There is no mystery about the cause of this decline: it is the conversion of prairie sod to rice fields and other crops, and the overgrazing of virtually all the remaining grassland. Time is running out. If the Attwater's Prairie Chicken is not to follow the Heath Hen, action will have to be taken at once. This is not just a question of protection against hunting: there has been no open season since 1937, yet the population continues to shrink. Neither is it a question of restocking, for there is no stock to be had; and if there were, could it be expected to fare any better than the wild birds already present? The solution lies in habitat management—in giving back, in some small measure, what has been taken away. If the Attwater's Prairie Chicken is finally lost it will not be through lack of knowledge of what to do, but through lack of doing. What needs to be done has been known for 20 years (Lehmann, 1941).

The Greater Prairie Chicken, with a much larger geographic range, is in better case than the Attwater's, but over much of its range the story is the same. Most of the original range has been plowed or grazed out of existence. Most of the acquired range to the north and west has been destroyed and fragmented through the same causes, as well as by the return of the forest to the new range in the Michigan and Wisconsin cutover. Thus, Greater Prairie Chickens are now gone from their primeval range in Ohio, Kentucky, Arkansas, and Texas. They occur now in Iowa only as occasional stragglers in the northeast and southwest corners (M. E. Stempel, 1960, letter). There are still prairie chickens in Indiana, but the *total population in the spring of 1960 is estimated at 98 birds* (W. B. Barnes, 1960, letter); in Illinois, where there are perhaps 100 small colonies in 25 counties (R. E. Yeatter, 1960, letter); in Missouri, mainly southwest of the Missouri River (D. M. Christisen, 1960, letter); and in eastern Kansas and eastern Oklahoma. Within the acquired range, which once was larger than the presettlement range, prairie chickens remain in about 16 counties in the northeastern Lower Peninsula of Michigan (G. A. Ammann, 1960, letter); in about 16 counties in central and northern Wisconsin; in about 500 square miles in northwest Minnesota (A. B. Erickson, 1960, letter; Farmes, Erickson, and Stenlund, 1960); in a few areas scattered throughout approximately 5,000 square miles of east central North Dakota (M. D. Johnson, 1960, letter); in South Dakota primarily in about 20 per cent (2,000 square miles) of a block of seven counties, plus a few small outlying colonies (D. R. West, 1960, letter); in a broad band totaling some thousands of square miles along the eastern and southern edges of the central Nebraska Sandhills and to some extent within the Sandhills (L. L. Mohler, 1956, letter; M. D. Schwilling, 1960, letter); and in the northeast corner of Colorado, mainly in Yuma County (W. W. Sandfort, 1960, letter). The "millions of prairie chickens in Canada" that one hears about are sharp-tails. It is possible that a few true prairie chickens still persist near the lakes of central Alberta (M. C. Hammond, 1960, letter). One—*one*—was seen in Saskatchewan in 1959 by the one man who cannot be challenged, Roger Tory Peterson (verbal). Manitoba has a few reports of single birds within the last few years but "we do not know of one single flock to date" (R. E. McWhorter, 1960, letter). Ontario's one remaining colony, on Manitoulin Island, is probably disappearing, due to the invasion of sharp-tails (H. C. Lumsden, 1960, letter).

While complete and precise figures are not available, it is not far off to say that about 85 per cent of the presettlement range of the Greater Prairie Chicken has been expropriated and destroyed by being put to other uses. Perhaps the acquired range has fared a little better, but the Greater Prairie Chicken now occupies a range that is no more than about 10 to 20 per cent of the range at the time of its maximum extent. Populations are low over much of the present range, and reports from most areas indicate that habitat continues to disappear and the prairie chickens with it.

There are, however, encouraging signs at long last. Oklahoma is a particularly bright spot. The Greater Prairie Chicken once occurred there over the eastern two-thirds of the state. From about 1900 to 1925–1932 the habitat was severely damaged by plowing and overgrazing, finally accentuated by drought. The population dropped to the lowest level known (estimated at a few thousand birds in 1925) and the occupied range shrank to about 5,000 square miles in the northeast part of the state (Duck and Fletcher, 1945). The drought ended in the 1930's and the grass came back; more important—for drought is a recurring thing—there has been a change in land use which is favorable to prairie chickens. Many ranchers have learned that their lands are not suited to cultivation but will yield the greatest profit as grazing land. Further, range management is changing toward less intensive grazing—"take half and leave half"—again because this is best from the strict economic viewpoint. Under such a grazing regime, prairie chickens also thrive. Not only has the population on the residual range increased, but substantial areas elsewhere in Oklahoma have "come back" to the point where they can again support prairie chickens. A total of 830,000 acres has already been examined and found suitable, and considerably more is probably suitable but not yet appraised. A project under the direction of Karl F. Jacobs has transplanted 586 wild-trapped birds to restoration areas in seven counties over the last five years, in order to re-establish prairie chickens without waiting for natural spread to do the job. The transplantings have in most cases been successful and will be continued (Jacobs, 1959 and letter, 1960).

Kansas and Nebraska are experiencing a similar improvement in the condition of grasslands, and show encouraging gains in prairie chicken populations (D. C. Coleman, 1960, and M. D. Schwilling, 1960, letters). Habitat improvement is less general in the north, however. South Dakota had excellent production in 1958 but a very poor year in 1959 (D. R. West, 1960, letter), while in North Dakota the grasslands in the prairie chicken range are "still depleted" and the small colonies still present are "barely holding their own" (A. T. Klett, 1960, letter).

The importance of the changing trend in range management for cattle cannot be overemphasized. If the scheme of "take half and leave half" is widely adopted and made permanent, the prairie chicken may change from an endangered species to a major game bird in the western parts of its range. The same trend in grassland management strongly implies possible betterment in some areas for the Lesser Prairie Chicken, Sharp-tailed Grouse, Sage Grouse, and Blue Grouse as well as many other kinds of wildlife.

Farther east there are also encouraging developments for prairie chickens. Prairie chicken management is primarily land management; before one can manage land one must have some control over it. A movement to buy land for prairie chickens has started and is gaining momentum. The first piece was bought in Indiana in 1945, when 640 acres were bought with funds raised by the Izaak Walton League plus matching monies from the Pittman-Roberston program. Wisconsin's scatter-pattern plan (Hamerstrom, Mattson, and Hamerstrom, 1957) is moving ahead: from 1954 through 1960 a total of 1,885 acres on the Buena Vista Marsh has been privately purchased and leased to the state (Olson, 1961). These acres were bought by individuals, by the Prairie Chicken Foundation, the Wisconsin Conservation League, and the Wisconsin Society for Ornithology. The state of Wisconsin has bought 560 acres on the adjoining Leola Marsh. Michigan has started scatter-pattern purchase on its Missaukee County area (Ammann, 1957:168–9 and letter, 1960). Missouri started a similar program in 1959 by buying 1,440 acres of native prairie in St. Clair County, to which a series of smaller parcels will be added (C. W. Schwartz, 1960, letter). Illinois is currently raising money for land purchase through its Prairie Chicken Foundation, composed of the Illinois Audubon Society, Illinois Federation of Sportsmen's Clubs, Illinois Division of the Izaak Walton League, and the Illinois Chapter of the Nature Conservancy (R. E. Yeatter, 1960, letter). Twenty areas in northwestern Minnesota, totaling 20,000 acres, have been bought by the state as part of its wetlands program; most were bought primarily for waterfowl but all have prairie chickens on them (A. B. Erickson, 1960, letter). The Fish and Wildlife Service, on its refuges in Nebraska and the Dakotas, has recently started a prairie chicken–sharp-tail management program embracing annual display ground census, attempts to restock prairie chickens on the Sand Lake Refuge (South Dakota), and—most important—a determined effort to modify the pattern of hay mowing and to cut back grazing by permittee livestock (H. K. Nelson, 1960, letter; M. C. Hammond, 1960, letter). The Service is under pressure in some quarters to relax its mowing and grazing restrictions again and is to be commended for continuing its attempt to replenish the sadly depleted stock of prairie chickens on federal refuge lands. Both Illinois and Wyoming have tried introductions of wild stock.

The Lesser Prairie Chicken has a relatively small, horseshoe-shaped range along the east edge of New Mexico, across the panhandle of Oklahoma, the southeastern tip of Colorado, southwestern Kansas, and along both sides of the boundary between western Oklahoma and northeastern Texas. This is primarily grazing country, with little cropland. Overgrazing has been a serious problem, especially in times of drought. The Lesser Prairie Chicken has survived two severe droughts in the last 30 years.

In Kansas the Lesser Prairie Chicken nearly disappeared during the drought of the 1930's but showed considerable recovery by the 1950's (Baker, 1953; Schwilling, 1955); their numbers still seem to be increasing somewhat (D. C. Coleman, 1960, letter). Booming ground counts in Oklahoma (Copelin, 1959 and unpublished reports and letters 1955–1960) show increases from 1957 through 1959 but were still only about half of the high count for the late 1930's. Similar counts in New Mexico show an increase from 1953 through 1958 (L. G. Frary, 1955–1958, unpublished reports). Booming ground counts in Texas show a drop of more than 50 per cent as between 1942 and 1953 on two study areas. Most of this was attributed to the drought of 1952–53. Both areas have been censused each year since 1953, and although one of the two has shown some recovery, neither has reached 50 per cent of the 1942 count (A. S. Jackson, 1960, letter and unpublished reports).

Although Lesser Prairie Chickens are currently on the increase, their range and total numbers are nevertheless much reduced over presettlement days. They are particularly vulnerable at two points. Since they depend on medium and tall grasses in a region of low rainfall, their habitat is very sensitive to overgrazing. Furthermore, low shrubs, particularly shinnery oak (*Quercus havardii*) and sand sagebrush (*Artemesia filifolia*), which are also highly important parts of the habitat, are increasingly being killed with herbicides in the interest of pasture improvement. Although the trend toward moderation in grazing holds a great deal of promise, it is likely that many ranch owners who are progressive enough to adopt the new plan of grazing management would also practice brush removal.

New Mexico was the first to recognize—at least to the point of doing something about it—that the key to the welfare of the Lesser Prairie Chicken lies in the control of grazing. From 1938 to 1951, the state bought 22,844 acres and leased 800 acres for a total of 23,644 acres in 19 tracts, from which livestock has been fenced out. Grass recovery has been slow because of drought and severe damage by overgrazing in the past; nevertheless, these areas are considered to be of major importance in New Mexico's program of Lesser Prairie Chicken management. The U. S. Forest Service administers an area of about 107,000 acres in Morton County, Kansas. This is one of the recently established National Grasslands (U. S. Forest Service, 1960), and it has great potential for Lesser Prairie Chickens. Grazing has already been restricted on National Grasslands in southeastern Colorado (W. W. Sandfort, 1960, letter). On these areas and on New Mexico's Lesser Prairie Chicken restoration areas, where public ownership guarantees land control, it should be possible to work out the details of land management needed for the species, especially details related to tolerable limits of grazing, brush removal, burning, amount of cultivation, if any, which might be beneficial, and to carry forward a long-term gobbling ground census, etc.

The situation for sharp-tails is more complex. Little is known about the three northern races, *phasianus*, *caurus*, and *kennicottii.* It is generally taken for granted that they are getting along all right, for their range has not yet been much influenced by civilization. However, the exploitation of the far north has begun, and the northern birds will be less and less isolated as time goes on.

The southern races already feel the pinch. Two of them, *campestris* and *columbianus*, are in serious trouble. Sharp-tails of the prairie race, *campestris*, are already long gone from Illinois, Iowa, southern Wisconsin, and southern Minnesota. They are still abundant in parts of southwestern Ontario and in the parklands of southern Manitoba and east central Saskatchewan, but in northern Michigan, Minnesota, and Wisconsin—especially Wisconsin—they are rapidly being crowded out of existence. In this part of their earlier range they were found in bogs, blowdowns, and burns within the forest boundary, and in the extensive zone of brushland (also the result of fire) which lay along the edge between forest and prairie. Lumbering followed by fire in the slashings, and pioneer farming in the cutover, enormously expanded the primeval range in all three states for a time; but fire protection, natural forest succession, pine plantations, and modern clean farming within the successful farm communities in the cutover, have all played their part in taking away the new range until there is far less range than there was in the first place. Wisconsin has now planted to pine most of the primeval barrens as well as the abandoned farm fields, and effectively prevents the creation of new openings by its exceptionally efficient fire protection system (Hamerstrom, Hamerstrom, and Mattson, 1952). Michigan will have sharp-tails for a longer time and Minnesota longer still, but without deliberate sharp-tail management all three states will fairly soon find sharp-tails on the rare bird list.

There is much still to be learned about the details of sharp-tail management, but in both Michigan and Wisconsin real progress has been made. The main difficulties in the way of a vigorous program are two: First, sharp-tail openings in the forest, particularly old fields and burns, are often the easiest areas to machine-plant to conifers. Large areas of monotypic plantations are regarded with increasing suspicion by foresters themselves. Nevertheless, in the competition for forest openings—a competition in which subsidies for tree planting play a very important part—sharp-tails are still coming out a poor second best. Secondly, sharp-tail populations are strongly cyclic, and a great many hunters lose interest when populations are low and hard to hunt; this, of course, discourages administrators in charge of public programs. Nevertheless, some lands are now being managed for sharp-tails, especially in Michigan (Ammann, 1957) and Wisconsin (Newman, 1959).

The western race *columbianus* has been hardest hit of all. It is gone from California (A. S. Leopold, 1960, letter), occurs in one small area (if it is still there) in New Mexico, is rare in Utah (about 1,500 birds—J. B. Low, 1960, letter), Nevada, and Oregon; rare or uncommon in Idaho and Washington except for a few counties in which it is still abundant enough to be hunted; and it is sometimes locally fairly abundant but is generally not common in parts of western Colorado, western Wyoming, and extreme western Montana. The only sizable populations left are in British Columbia, particularly in the Peace River, Vanderhoof, and Prince George regions, where land clearing and grain growing are still on a limited enough scale to have benefitted sharp-tails (Hatter et al., 1956). Overgrazing and intensive cultivation have been the primary causes of the decline of this race: see, for example, Buss and Dziedzic (1955). It is not likely that the rich wheatlands of the West will ever be restored to sharp-tail habitat, but changes in grazing practices do offer some hope.

The plains sharp-tail, *jamesi*, has the largest range of all six races and is by all odds the most successful of the three southern sharp-tails. While it has lost ground in the eastern and southernmost parts of its range—in the eastern parts of North Dakota, South Dakota, and Nebraska, and in all its former range in northwest Kansas—and while it has been thinned out over much of its range by overgrazing and cultivation, particularly wheat farming, it still occurs in impressive numbers over large parts of the Dakotas, Nebraska, and eastern Montana. There are fair to good populations in parts of northeastern Colorado and northern Wyoming. In the Prairie Provinces of Canada it reaches numbers little short of fabulous at the highs of the population cycle. Within the limits set by land use (and with a cautious hedge to allow for the influence of the unexplained grouse cycle), reproductive success appears to be high in cool-moist summers and low in hot-dry summers, with two to three cool-moist summers to be expected in each decade in South Dakota, for example (D. R. West, 1960, letter).

There is little deliberate management of the plains sharp-tail other than the regulation of hunting. Actually, little management is needed over the range as a whole, because this grouse is maintaining itself well and lives in a region of rather low human population and hunting pressure. Such general wildlife management practices as the planting of shelterbelts of trees and shrubs in the wheat country, the development of small water areas and their attendant variety in vegetation, and provision of winter food in some areas in the north, all undoubtedly benefit sharp-tails. Moderation of grazing pressure in rangelands would have a wider effect than any management applied directly and specifically for sharp-tails. The most conspicuous example of land management for this race is the program of grassland management which has been started by the Fish and Wildlife Service on the waterfowl refuges in the Dakotas and Nebraska, already mentioned in the section on the Greater Prairie Chicken.

The Sage Grouse has shown dramatic and not fully understood changes in abundance. It was once the leading upland game bird in most western states, but by 1937 had become so scarce over much of its range that it seemed close to extirpation (Patterson, 1950, 1952). Today it is again abundant enough to be a major game bird in a number of states, although both total range and total numbers are much reduced. Thus, the estimated kill in 1959 was 43,811 in Wyoming (D. A. Johnson, 1960, letter), 23,300 in Idaho (E. G. Bizeau, 1960, letter), 23,200 in Montana (R. L. Eng, 1960, letter), 17,304 in Oregon (R. U. Mace, 1960, letter), 15,335 in Colorado (G. E. Rogers, 1961, letter), and 11,738 in Nevada (C. W. Crunden, 1961, letter). By contrast, California hunts Sage Grouse in two to five counties and kills about 2,000–3,000 annually (California Department Fish and Game, 1958); Washington kills only about 2,000 annually (B. L. Lauckhart, 1960, letter); and the estimated kill in 1959 in Utah was "over 1,800" (C. M. Greenhalgh, 1960, letter). The Sage Grouse comes east in small numbers as far as the westernmost counties of North and South Dakota and Nebraska, and its range extends north into a narrow strip along the southern edges of southwestern Saskatchewan and southeastern Alberta. The species disappeared earlier from New Mexico and British Columbia. New Mexico successfully reintroduced Sage Grouse on a small scale by transplantings, and British Columbia is now trying to restock in the same manner.

Sage Grouse are closely dependent upon sagebrush (*Artemesia* spp.) throughout the year, and wholly so in winter. Ranchers consider sagebrush undesirable. They would rather have more grass for their sheep and cattle. Sagebrush eradication programs, subsidized with federal money, are "cleaning up" an ever increasing area and this, added to the overgrazing which has been chronic on much of the remaining Sage Grouse range, seriously affects Sage Grouse populations in many states.

Most of the states within the range of the species have had research studies in progress at one time or another, and several do at the present time. The most informative was that of Patterson (1952) who concluded that: (1) the largest Sage Grouse populations are in those states with the lowest human populations, (2) overgrazing by domestic livestock was the most important factor in the great reduction in numbers of Sage Grouse and other game in the early 1900's, (3) programs to eradicate sagebrush in order to improve grasslands for grazing are ecologically unsound and damage the range for Sage Grouse and other wildlife, and for domestic livestock as well, in the long run, and that (4) reclamation of sagebrush lands for agricultural purposes is the most serious threat to the welfare of Sage Grouse populations.

There are state or federal restoration areas for Sage Grouse in several states, for example, Washington, Oregon, Nevada, and Utah (and probably others). Other management measures which have been tried include the development of water supplies, transplanting of wild stock to speed re-establishment where natural spread was slow, and, of course, regulation of hunting. It has been pointed out in no uncertain terms, however, that regulation of permittee grazing on the public lands of the West is the governing factor (Patterson, 1952). Just as abuses of grazing on public lands caused the great decline of the early 1900's, so did later readjustments toward more reasonable livestock numbers bring about the increase in Sage Grouse which led to the much improved population levels of the present day. The implications for the future management of the Sage Grouse are abundantly clear.

In fact, the tetraonids as a group illustrate remarkably well a fundamental ecological principle: that the welfare of any species is basically determined by the condition of its habitat. Modern man is now one of the major forces, often the most important, in shaping habitats. Ultimately, the preservation or destruction of many species is in our hands.

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ORNITHOLOGICAL LITERATURE

Bird Portraits in Color. Text by Thomas S. Roberts. Revised by Walter J. Breckenridge, Dwain W. Warner, and Robert W. Dickerman. University of Minnesota Press, Minneapolis, 1960: 8½ × 11¼ in., vi + 105 unnumbered pp., 92 col. pls. $5.95.

"Bird Portraits in Color" was in constant demand from the day it was published in 1934. Soon out of print, it was reprinted in 1936 and went out of print again in 1944. Since that time any copy for sale by book dealers commanded a price far exceeding the figure ($3.50 in hard covers) at which it was originally listed. This bit of history bears evidence enough of the book's usefulness. Now, fortunately, "Portraits" has been reprinted a second time and again at a modest price, in this instance through the generous financial support of an admirer of its author, the late Dr. Thomas S. Roberts.

"Portraits" contains all of the 92 plates (by six artists) from Roberts' "The Birds of Minnesota" (University of Minnesota Press, 1932). Depicted are 295 bird species, representing nearly all the species in the United States north of Kentucky and Missouri and east of the Rocky Mountains. Opposite each plate is a page of text, giving information on size, range, plumages and molts, songs and calls, nests, and eggs of the species shown. All the material has been brought up to date by the three revisers. The species on the plates are indexed in the back of the book. Nomenclature follows the fifth edition (1957) of "The AOU Check-list," although in the case of common names, not always strictly. Hyphens are used in many names (e.g., "Golden-eye," "Yellow-legs," etc.), while "Wood Pewee" and "Phoebe" are given for the names of the Eastern Wood Pewee and Eastern Phoebe.

The reprinting of the color plates is exceedingly good; almost all have the same brightness, richness of color, and clarity that they have in "The Birds of Minnesota."—Olin Sewall Pettingill, Jr.

Iceland Summer: Adventures of a Bird Painter. By George Miksch Sutton. Illustrated by the author. University of Oklahoma Press, Norman, 1961: 5¾ × 9¼ in., xviii + 253 pp., 17 full-page illus. (1 col.). $5.95.

It is the irrepressible spirit of youth in George Miksch Sutton which makes all of his books so fascinating. That spirit, coupled with his great knowledge of birds, his wonderful sense of adventure, his never-satisfied curiosity, and above all, his extraordinary ability to paint, all make "Iceland Summer" a most attractive and interesting book.

Dr. Sutton has for a good part of his life been fascinated with the idea of writing a book about arctic birds. Toward this end he has traveled widely in the northern parts of the western hemisphere and he has written much about them. He has not, however, had an opportunity to work in the Old World Arctic, especially Siberia. Therefore, the possibility of a trip to Iceland with Olin Sewall Pettingill, Jr., and his wife seemed the perfect 1958-step in the right direction.

While there he fell in love with the people and the country. He was able to paint a good deal, mostly from live bird models, and—being Dr. Sutton—found all manner of adventures to give zest to the summer project. All of these combined to make "Iceland Summer" a most profitable and entertaining book. It fits into a singular niche in that it is most informative, a pleasure to read, and it offers much of beauty for the eyes to behold. Unlike the usual specialist moving into a new country, Dr. Sutton seems to notice just about everything around him.

He visited most of the important representative habitats, thus his account is well-rounded and quite representative. Mývatn receives special attention since (next to Lake Baikal) it is the most interesting waterfowl lake in the world. Like most ornithologists who have visited Iceland, his emphasis is on the northern, western, and southern (essentially coastal) areas, and, of course, the islands. This is natural because of the available transportation—all stemming from Reykjavík in the southwest corner of the island.

The Icelandic people as a whole are very fond of birds, and it is easy to understand their cordiality to a person like Dr. Sutton who came there full of enthusiasm for his project—for him a business of such transcending interest that nothing seemed to stand in his way. Little wonder then that he had such superb cooperation on all sides. His pleasure began almost at once upon his arrival when he found that many of the special birds he wished to study were present right in the heart of Reykjavík.

He went to great trouble to paint from live specimens rather than follow the easy road of the "deep freeze" technique for keeping specimens. Especially fine among his portraits is that of the Icelandic Falcon which the Icelanders subsequently used on their 25 krónur stamp. Notable also are the paintings of young birds, among the best he has ever done. Anyone who has worked with young birds will especially appreciate the effort and patience it must have taken to obtain and keep them for painting.

Adventure writers would do well to read Dr. Sutton's account of his fall into a ditch while getting into position to study a wagtail's nest. This is dramatically told. For any ornithologist the reading of "Iceland Summer" will be a profitable experience, in fact anyone interested in Icelandic birds will find this book a must.—Rosario Mazzeo.

Birds of Hawaii. By George C. Munro. New edition. Charles E. Tuttle Company, Rutland, Vermont, and Tokyo, Japan, 1961: 6½ × 9⅛ in., 192 pp., 20 col. pls. by Y. Oda, 19 photos. $4.50.

Munro's "Birds of Hawaii" was first published in 1944. (See the review by Dean Amadon in *The Auk*, vol. 61, p. 658, 1944.) Not long thereafter copies became difficult to obtain, owing to loss by fire of most of the stock. This new edition is a photocopy of the original, except for the title page and its reverse side plus the last two pages which give corrections and changes in scientific nomenclature. The color plates, showing over 150 birds, were reproduced by offset from the 1944 book itself. This was the only practical method available to the publishers since the original paintings, as well as the transparencies made from them, had been lost. Despite this unusual procedure, the new plates are remarkably faithful in clarity and color quality.

Besides having good color plates, the new edition has an eye-catching jacket, sturdy binding, and paper of good quality on which printing and halftones are commendably clear. No less attractive than the over-all production is the book's low price.—Olin Sewall Pettingill, Jr.

Birds of North Carolina. By Thomas Gilbert Pearson, Clement Samuel Brimley, and Herbert Hutchinson Brimley. Revised by David L. Wray and Harry T. Davis. North Carolina Department of Agriculture, State Museum Division, Raleigh, 1959: 6½ × 9½ in., xxviii + 434 pp., 47 pls. (24 col.), 97 text figs. $5.00.

This revision of the 1942 edition with the same title contains the following major changes: The deletion of the full-page portraits of the authors; the addition of a preface by the revisers, a map of the state's life zones with descriptive text, accounts of 12 species new to the state, footnotes after most of the other species accounts, a new index replacing the old, and 10 plates (four in color) from Roger Tory Peterson's eastern "Field Guide" (1947 edition).

The revisers did not touch the species accounts, even to amend statements of information which, in the light of recent knowledge, are outmoded. Josselyn Van Tyne, in reviewing the 1942 edition (see *The Wilson Bulletin*, vol. 54, p. 204, 1942) called attention to some of the statements (e.g., the implication that only one nest of the Connecticut Warbler has ever been found; the reference to the cowbirds as "social outcasts" and their young as "selfish"), but they have been retained verbatim. Though the revisers remark (p. xxvi) that the "classification in this edition is changed to conform to the latest A.O.U. Check List," the classification is nevertheless about the same as in the 1942 edition. Subspecies and species are given equal treatment. Little attempt has been made to bring either the technical or vernacular names of species in line with those in the 1957 Check-list. The footnotes to the species accounts are mainly listings or summations of sight observations since 1942. As most of them do not include years and authorities, they are valueless as distributional data. (The records in the untouched species accounts are nearly always meticulously documented.) The bibliography has no entry since 1942.

A few of the plates, including the additional Peterson plates, have been reproduced fairly well, but others have been handled atrociously. The color plates are in many cases badly off register and/or peculiarly granulated, while the black-and-white plates, as well as the majority of text figures, are conspicuously fogged.

Ordinarily the revision of a useful state bird book is sure to reactivate local interest, but this one, even though attractively priced, is so poorly conceived and executed as to impair any such result. Certainly it does not do justice to recent advances in ornithology, either in North Carolina or elsewhere.—Olin Sewall Pettingill, Jr.

Louisiana Birds. By George H. Lowery, Jr. Rev. 2nd Ed. Illustrated by Robert E. Tucker. Louisiana State University Press, Baton Rouge, 1960: 6⅛ × 8¾ in., xxxiv + 567 pp., 40 col. pls., 83 photos (1 col.), 135 figs. and many numbered line drawings. $7.50.

A steady demand for "Louisiana Birds" since its publication in 1955 soon encouraged author and publisher to bring out this revised second edition. (For a review of the first edition, see *The Wilson Bulletin*, vol. 68, pp. 341–342, 1956.) It is a new printing thoroughly updated from cover to cover. The "seasonal charts" of the first edition have been extended to include 387 species—all that have been recorded in the state—and thus represent collectively a check-list of Louisiana birds. The nomenclature has been changed to conform to the 1957 edition of "The AOU Check-list." In every respect, "Louisiana Birds" is a most satisfactory regional work, combining precise instruction about birds in general with local birds in particular, while being highly readable, generously and yet pertinently illustrated, and, withal, laudably compact.—Olin Sewall Pettingill, Jr.

A Gathering of Shore Birds. By Henry Marion Hall. Edited and with additions by Roland C. Clement. Illustrated by John Henry Dick. The Devin-Adair Company, New York, 1960: 7⅛ × 10½ in., xii + 242 pp., many bl. and wh. drawings. $10.00.

This book about an attractive group of birds is well organized and pleasing to the eye. Each of the 57 species of North American shorebirds (i.e., the species "known to breed on the North American continent north of the Panama Canal") is treated in a separate account, headed by a drawing together with common and scientific names of the species concerned, then usually concluded by a statement as to when the species was first described, a list of local names, a digest of field characters, and a description of range. The species accounts (the bulk of the book) are preceded by an introduction to shorebirds in general and followed by condensed listings of shorebirds in other continents, a bibliography, and an index. Jacket, covers, paper, and format are in every respect fine; the pen-and-ink drawings, all by John Henry Dick, are generous in number and beautifully portray not only the vitality and appealing qualities of the bird subjects but also very cleverly allude to special features of their respective environments.

The book, we are told in the introductory matter, "grew out of a series of deft word sketches of shore birds in their haunts" by Dr. Henry Marion Hall, the hunter-turned-conservationist, and some drawings by Mr. Dick. Eventually, in order to "make the book more useful," the publisher enlisted the services of Mr. Roland C. Clement who tried to "bring Dr. Hall's essays up to date in a series of comments on recent changes of status which have occurred, and to interpolate some of the more readable scientific commentaries gleaned from a perusal of an extensive literature. . . ."

The sketches, I find, read nicely and feelingly. As word pictures they can stand on their own and might well have composed a book by themselves. Their weakness in this book is that they are not so much concerned with ornithological facts as they are literary effect, and therefore should not be part of a book that purports to be a work on birds as such.

With these sketches as a basis, Mr. Clement, an erudite ornithologist who writes well himself, has striven mightily to produce a book that will reach and satisfy the widest possible audience. His introduction to shorebirds has the proper tone and substance and thus gets the book off to a good start. The shorter accounts which he has written wholly or in part are praiseworthy. The book's principal shortcomings appear in the longer species accounts—mostly of the well-known and most extensively studied eastern shorebirds—in which Dr. Hall's sketches are allowed to stand as the body of the text without editorial interpolations and corrections. They are inadequate and often erroneous as sources of information and fail to do justice to the abundance of data currently available in various books and journals. Mr. Clement should have edited them much more stringently. Here are a few examples.

The account of the Piping Plover implies that one sex incubates and broods, whereas both sexes do so (see "Notes on the Life History of the Piping Plover" by Wilcox, *Birds of Long Island*, No. 1:1–18, 1939). A recent paper on the same species ("A Twenty Year Banding Study of the Piping Plover" by Wilcox, *Auk*, 76:129–152, 1959) that contained many significant findings is totally ignored. There is no specific information on the breeding habits of the Upland Plover even though there is at least one important study ("The Upland Plover at Faville Grove, Wisconsin" by Buss and Hawkins, *Wilson Bull.*, 51:202–220, 1939) from which appropriate material could have been obtained. The most published-on shorebird in this country, the American Woodcock, is given appalling treatment. Its peculiarly intricate flight song is dismissed in one sentence. The fiction that the parent woodcock carries its young is stated as though it were a proven fact. Neither cited in the text nor listed in the bibliography are the two monographs ("The American Woodcock" by Pettingill, *Mem. Boston Soc. Nat. Hist.*, 9:167–391, 1936; "The Ecology and Management of the American Woodcock" by Mendall and Aldous, Maine Cooperative Wildlife Research Unit, Orono, 1943), or any of the sundry shorter papers on the species, that have been published in recent years. Nowhere in the book is any recognition given to Nethersole-Thompson's "The Greenshank" (Collins, London, 1951) which is undoubtedly the most comprehensive work on a shorebird yet published in the English language. A reference to some of its contents in the accounts of the yellowlegs, to which the Greenshank is closely allied, would have greatly enhanced their otherwise superficial coverage.

If one cares to look for minor errors and inconsistencies, he can easily find them. Tattler is commonly misspelled "Tatler," and the following technical names are misspelled or incorrectly written: Phalaropodidae (p. 20), *Jacana spinosa* (p. 24), *Erolia ferruginea* (p. 159), and *Thinocorus orbigyianus* (p. 226). The plural of plover sometimes has an "s" and sometimes not. The quotation from Elliott Coues (p. 175) comes from his "Field Notes on Birds Observed in Dakota and Montana . . . ," published in 1878, not from his "Birds of the Northwest," published in 1874. The bibliography lists only the latter work with the publication date of 1871. The quotation from W. H. Hudson (p. 182) is from "A Hind in Richmond Park" rather than his "Birds of La Plata."

It is a pity that Mr. Clement or another equally competent ornithologist could not have written the entire book, keeping the text readable for popular consumption while at the same time drawing fully from current knowledge and presenting summations of what has been learned about shorebirds. Before the turn of this century Daniel Giraud Elliot, a distinguished ornithologist wrote a popular book called "North American Shore Birds" (Francis P. Harper, 1895). Its information was drawn from the most authoritative sources at that time. Elliott Coues, another distinguished ornithologist who was a contemporary of Elliot's and unrivaled as a severe critic, praised the book at length in a three-page review (*Auk*, 13:64–67, 1896) and wished the book "all the success it so thoroughly well merits." If one is to measure the progress of American ornithology by comparing Elliot's book with "A Gathering of Shore Birds" published over a half century later, he can only conclude that ornithology has been moving at a snail's pace and that somewhere along the way quality of substance has become immaterial.—OLIN SEWALL PETTINGILL, JR.

ATLAS OF EUROPEAN BIRDS. By K. H. Voous. Thomas Nelson and Sons, New York, 1960: $10\frac{1}{2} \times 14$ in., 284 pp., 355 photos., 419 maps. $15.00.

This work was originally published as "Atlas Van De Europese Vogels" (Elsevier, Amsterdam, 1960). The present edition is not only translated into English by the author himself, but has profited from the criticisms of and additions to the Dutch edition.

The author states that "The Atlas of European Birds consists of three elements: distribution maps, explanatory text, and illustrative photographs. All are directed to clarifying the extent to which the species here described are maintaining themselves in the world or are extending their ranges." Dr. Voous has treated "species" as a zoogeographical concept. The maps are all the same scale and projection and two sizes are used throughout, considerably easing the production problem. Within these limits the author has succeeded admirably in accomplishing his set task.

The small scale precludes any great accuracy, but even on larger-scale maps it would be impossible to achieve an exactly correct range. Not only do ranges change from year to year, but data are seldom available, either at the right time or, in some areas, with any reliance, and may be lacking entirely in other regions. It seems likely that the final maps for printing were done in an "assembly line" method of inking-in the areas from work sheets—possibly by some technician. Surely Voous knows that the upper Mississippi and Missouri rivers do not flow westward to the Pacific and would have noticed this error had he done the final maps. Very few of the species common to both Europe and America breed in the Mississippi Valley and these species—e.g., the Little Tern (*Sterna albifrons*), map 199, p. 152—are properly plotted. The ranges stand very close checking indeed and show that the author did not rely on one general work or description, but must have consulted a large body of recent literature.

Any range maps are extremely vulnerable targets; within his stated aims Dr. Voous has left little at which to shoot. Additions of winter ranges and migration routes would have made the book much more valuable. This is probably asking for more of a very good thing, as winter and migration ranges are much more fluid and more difficult to map—impossible to map to everyone's satisfaction. Disjunct breeding ranges—e.g., the Whimbrel (*Numenius phaeopus*), map 150, and the Marsh Sandpiper (*Tringa stagnatilis*), map 158—may be the result of migration patterns or winter distribution as well as of glaciation patterns as proposed in the text.

There is an inconsistency in the application of the red overlay on the maps; on some maps, Black Sea is covered with the red and on other maps the Sea is left clear. During the press run, perhaps, red spots were added at places where Dr. Voous had no intention of their appearing. In the three copies available to me, such spots were present at least as follows: maps 18, in Brazil; 50, south of Newfoundland; 67, in southern Sweden; 81, in western Africa; 104, in eastern Siberia; 153, in Mongolia; 167, blotch south of the Commander Islands; 173, spot in Southwest Africa, and another south of the Canary Islands; 193, spot on Cape Blanco in Spanish Sahara; 202, one southeast of Ascension Island; 264, one in South Africa; and 389, probably the spot in central Russia.

There are 419 species mapped; these include 189 species which are listed in the 5th edition of the "Check-list of North American Birds." The common names used are those of the British Check-list. The scientific names generally follow European concepts where there is less tendency to use small or monotypic genera. The following is a list of species-groups and pairs considered one species by Voous and of particular interest to North Americans:

Species name used in Atlas	Considered conspecific
Sula [= *Morus*] *bassana*	*M. capensis, M. serrator*
Anas platyrhynchos	*A. diazi, A. fulvigula, A. oustaleti*
Anas crecca	*A. carolinensis*
Anas acuta	*A. eatoni*
Cygnus columbianus	*C. bewickii*
Buteo buteo	*B. jamaicensis*
Elanus caeruleus	*E. leucurus*
Haematopus ostralegus	*H. palliatus*
Tringa [= *Actitis*] *hypoleucos*	*A. macularia*
Himantopus himantopus	*H. mexicanus*
Stercorarius [= *Catharacta*] *skua*	*C. antarctica*
Glaucidium passerinum	*G. gnoma*
Sitta canadensis	*S. whiteheadi, S. kruperi, S. yunnanensis, S. villosa*
Regulus ignicapillus	*R. satrapa*
Lanius excubitor	*L. ludovicianus*
Carduelis [= *Acanthis*] *flammea*	*A. hornemanni*

All of these are according to Voous' expressed zoogeographical concept of species. The relationships are discussed in the text, as are other close relatives and "replacement species." The maps should not be used without reference to the text in which he discusses (sometimes much too briefly) the migration and winter ranges as well as faunal type, habitat, food, and nesting.

Zoogeographical regions used are combinations of those proposed by Sclater and Wallace; climatic zones are based on the scheme presented by the Finnish meteorologist, J. M. Angervo, after Koppen. These are presented on maps in the introductory section plus a world map of January and July isotherms and often referred to in the text. The faunal types used are briefly defined in the same section.

The photographs add much to the attractiveness of the book. The author says "Where possible, they show each species in its characteristic haunts. . . . It has proved impossible to obtain a photograph of every European breeding bird. . . . For some species, the only photographs available do not show the bird in its habitat; nevertheless, these have been included since they mainly show rarely photographed species." Ninety-three species are not pictured at all—an amazing number in this day when the camera reigns supreme. Since so many species have not been photographed in suitable habitat, or at all, the inclusion of several general photographs of the more limited faunal types such as "Chinese–Manchurian" or "Sarmatic," if available, would have been helpful.

The book has remarkably few typographical errors. "Savanna" is apparently spelled throughout minus one "n." The maps of species breeding in North America are questionable generally only in more minute detail. Map 184, p. 147, of the Common Gull (*Larus canus*) indicates that the species breeds in all of Yukon Territory and into northwestern MacKenzie; this apparently was mapped from the word description in the 5th edition of the "Check-list of North American Birds," whereas the bird evidently breeds only in southern Yukon and possibly does not *now* breed in northwestern MacKenzie.

Dr. Voous will evidently be grateful for any additions and corrections which might be made. This edition incorporated changes on 138 maps from information received after publication of the Dutch edition. The work is a must for those interested in zoogeography, ecology, or taxonomy, and will make a handsome addition to the library of anyone interested in birds.—E. M. Reilly, Jr.

The Parasitic Weaverbirds. By Herbert Friedmann. Smithsonian Institution, United States National Museum Bulletin No. 223, 1960: 196 pp., 16 pls. (4 col.). $1.00.

This is Herbert Friedmann's fourth monograph on parasitic breeding habits of birds. His well-known earlier books dealt with three other families that contain parasitic species: the cuckoo, honeyguide, and blackbird families.

The present volume is divided into two main sections. The first discusses the phylogenetic and ethological background for brood parasitism, the antiquity of the habit, and the presumed adaptive value for parasitism of "the remarkable similarities in the color of eggs, in the pattern of nestling mouth markings, and in the nestling plumage of viduines and of their usual foster nest mates." Dr. Friedmann notes that "these similarities are more probably due to community of descent rather than to any convergence developed after the advent of brood parasitism." He also observes that "the parasitic weavers possess no known special structures, habits, or functional gradients that give them particular advantages over their nest mates, but this condition does not mean that they are not adequately equipped for competing with them on equal terms."

The second, and larger, section of the book deals with individual species of parasitic weaverbirds under such headings as "Distribution," "Breeding Season," "Songs and Calls," "Courtship," "Territorial Behavior," "Mating," "Eggs and Egg Laying," "Hosts," "Young out of the Nest," "Food and Feeding Habits," and "Plumages and Molts."

Monographs such as the present volume are invaluable because they summarize available information and point up the vast amount of work still needed on brood parasitism. Not until 1907 was it discovered that parasitism occurs among the weaverbirds. "Of not one of these species is our present knowledge more than partial; of some it is still extremely fragmentary." The author hopes that publication of "The Parasitic Weaverbirds" will "stimulate observers to supply further data and at the same time expedite their work by directing them to the gaps" that he has not been able to close either by his own field work or from the literature, but ornithologists are fortunate, as well, in having Dr. Friedmann's carefully considered conclusions on the broad aspects of brood parasitism among the weaverbirds.—Andrew J. Berger.

XII International Ornithological Congress, Helsinki 5.-12. VI. 1958. Proceedings. Edited by G. Bergman, K. O. Donner, and L. von Haartman. 1960. Vol. 1, pp. 1–436; vol. 2, pp. 437–822, paper bound. (Can be ordered from Zoological Institute, University of Helsinki, Finland.)

These volumes include the Presidential Address of J. Berlioz, the Report of the General Secretary of the Congress, L. von Haartman, the Report of the Standing Committee on Ornithological Nomenclature by F. Salomonsen, and 97 papers (51 in English, 11 in French, and 35 in German). Papers vary from two to 32 pages and provide an international coverage of a multiplicity of ornithological topics. An index of species and genera is provided.

Without attempting to indicate the full spread of subjects included, several papers may be mentioned to show the significant nature of the contributions. On the theme of adaptations, R. W. Storer writes an informative account of the evolution of diving and swimming in different groups of aquatic birds, and G. Kramer, through a study of flight in gulls, develops the thesis that allometric growth is fundamentally adaptive. In the areas of distribution and ecology, H. Johansen presents in succinct form a concept of the nature and origins of the arctic avifauna, S. D. Ripley reports on four species of megapodes inhabiting together the small island of Misool, and A. N. Formozov describes a 10-year study showing close correlations of population size in crossbills and woodpeckers with fluctuating seed production of coniferous trees in Russia and Siberia.

Physiological investigations are reported by A. Wolfson in a discussion of extensive experiments aimed at the elucidation of the role of light and darkness in the regulation of the annual stimulus for spring migration and reproductive cycles, while K. O. Donner writes on the effect of colored oil droplets on the spectral sensitivity of the avian retina. Topics on behavior are of world-wide scope. H. Sick compares courtship in ten species of manakins (Pipridae). R. Drost discusses nocturnal migration over Helgoland as affected by factors such as moonlight, fog, temperature, and wind. F. and F. Hamerstrom contrast the social displays of Black Grouse and Greater Prairie Chickens. Among the papers on paleontology and phylogeny, that of U. Glutz von Blotzheim supports the theory that ratites were derived from an ancestral pro-avian stem prior to its acquisition of flight.

The papers are arranged alphabetically according to author. This is convenient, but threads of continuity achieved in the Congress through grouping of papers into topical sessions are snapped. Had a subject organization been retained, the results would be of easier access to the reader wishing to scan the volumes for advances in particular fields. In all, these two volumes ably carry on the excellent tradition established by the previously published proceedings of the International Ornithological Congresses.—Paul H. Baldwin.

Songs of Fringillidae of Eastern and Central North America. Volume VI 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.

On this record are about 400 songs of 226 individuals representing 43 species of fringillids in eastern and central North America. Probably no other bird-song record has been so effectively devised to satisfy the interests of both the beginning and advanced bird watcher, the critical recording technician, the research ornithologist, and the teacher of ornithology.

Of very special value is the inclusion of more song variations per species than is usual in such records. The average is about nine variations to a species, the maximum being 20 in the case of the Cardinal. Usually the songs have been recorded in different parts of a species' range, thereby demonstrating geographic as well as individual differences. At the same time, most of the recordings give a good concept of "typical" song patterns.

The sequence of species is arranged according to similarities of songs, which have been classified in nine groups. This enables the listener to compare more directly the songs of species with similar melody patterns and other resemblances.

The mechanics of recording have been handled expertly. Tone quality is excellent. Background noises are kept down. For the most part, unusually good judgment has been applied to details of organization, such as the spacing of songs and the length of announcements.

On the jacket is an alphabetical index to species that facilitates finding their songs on the disc by band numbers. There is also a list of species in the order of singing that gives the band numbers, the number of individuals singing, and the number of songs.

Accompanying the record is a three-page mimeographed insert that includes information as to the state or province and the month in which each song was recorded. In some cases a key number provides even more exact locality data. Under "Miscellaneous Notes" a few helpful comments and analytic remarks are supplied. A note at the end states that "a detailed analysis and description of these songs, illustrated by spectrographs, is in preparation." Reprints will be available through the Federation of Ontario Naturalists.

It is hard to find fault with this record. The announcer's three-syllabled pronunciation of "McCown's" will be jarring to some people. Nowhere is there any statement or other satisfactory indication as to exactly what it is that the announcer is enumerating every time he gives a number. Only after much listening and reading can one ultimately figure out just what is being enumerated.

Most of my adverse criticisms are related to the classification of songs. For example, it is not readily apparent why the songs of Blue Grosbeak, Indigo Bunting, and Dickcissel should be described as "a series of loud, unwavering phrases, successive phrases often similar," without requiring excessive elasticity in the concepts "unwavering," "phrase," and "similar." The classification of Baird's Sparrow among the "buzzy songs" leads me to inquire whether musical terminology is really so ambiguous that what is commonly recognized as the musical, tinkling trill of the Baird's Sparrow should also be called "buzzy." Followers of the Aretas Saunders school of thought will not agree that each separate group of notes rendered by a Bachman's Sparrow should be considered an individual "song"; they would call it one "phrase" in a "long-continued song." To me the latter seems the more fitting categorization. The classification assigned to a few other species may be debated, but on the whole the grouping of the songs seems logical.

This record is a long step forward in the production of pleasing and useful recordings of bird sounds. In my opinion, it is superior even to the excellent record of warbler songs by the same authors.—Harold H. Axtell.

The Birds of Finca "la Selva," Costa Rica: A Tropical Wet Forest Locality. By Paul Slud. Bulletin of the American Museum of Natural History, Vol. 121, Art. 2, 1960: pp. 49–148, 5 text figs., 19 pls., 1 table. $2.75.

From the title, one might assume this to be the usual annotated list type of paper based on a series of collected specimens and short-term observations. It is, however, an important attempt at an "ecological classification" of 331 species of birds observed during a year spent on a 1,500-acre plot of tropical forest, in the northeastern Caribbean lowlands of Costa Rica. According to Slud (p. 77), "The way to classify birds ecologically . . . is to place them in their habitat and describe what they do, so that habitat plus behavior add up to niche. . . ." To do this he first analyzes the habitat requirements and the general behavior of all 331 species, comparing and contrasting the species within each family with one another. Then, within a framework of five major habitats (viz., Forest, Second Growth, Tree Plantations, Watercourses, and Aerial) and a varying number of subdivisions of each habitat (e.g., Forest Floor, Understory, Middle Forest, Canopy, and Above the Forest), and at times smaller subdivisions (Terrestrial Species and Semi-terrestrial Species), the 331 species are arranged, giving an "ecological classification." Under each ecological grouping there is a rather comprehensive account of how the various species interact and utilize the habitat.

The paper concludes with a detailed, and convincing, argument for considering the suboscines to be a successful group which thrives in the neotropics, rather than as a group taking refuge there while gradually being replaced by the oscines.—Raymond A. Paynter, Jr.

Birds of the West Indies. By James Bond. Color illustrations by Don R. Eckelberry; line drawings by Earl L. Poole. Houghton Mifflin Company, Boston, 1961: 5¼ × 7¾ in., 256 pp., 8 col. pls., 186 line drawings, 2 end-paper maps. $6.00. (British edition published by Collins, London, 1960; price 35*s.*)

Although not specifically stated, "Birds of the West Indies" is a revision of Bond's "Field Guide to Birds of the West Indies" (1947), which in turn was a revision of his earlier "Birds of the West Indies" (1936). The first book was good, the second better, and the latest excellent. Except for the addition of more colored plates, and the elimination of the dark and fuzzy line-cuts, it is difficult to envision how this evolutionary process can continue.

The most notable change over the 1947 book is the inclusion of eight colored plates illustrating 66 endemic, or the more exotic, West Indian species or subspecies. The depiction of all the West Indian parrots, except for the introduced Guiana Parrotlet (*Forpus passerinus*), is particularly welcome. The portraits are accurate and lively; Eckleberry seems to be the only contemporary artist who can successfully combine these two qualities in field guide illustrations.

Other changes are more subtle but add considerably to the clarity of the book. A brief characterization now precedes each family and the species accounts are more clearly divided into topics (i.e., local names, description, voice, habitat, nidification, and range). The list of birds covered in detail has been reduced by the relegation of the vagrant species to a list at the end of the text. The typography is vastly improved. These changes have resulted in a book which is now attractive, as well as eminently useful.—Raymond A. Paynter, Jr.

Blind Jack. By Stephanie Ryder. Houghton Mifflin Company, Boston, and The Riverside Press, Cambridge, 1961: 5½ × 8½ in., xiv + 145 pp., 9 photos. $3.25.

"Blind Jack" is not only an unusually appealing story but is also a worth-while account of the behavior of one of the more "social" birds (a Jackdaw) that is forced, by blindness, to develop and accept dependence upon a human being. "Jack," it seems, could not have fallen into better hands. Mrs. Ryder displayed an absolutely amazing ability to anticipate and meet the needs of a bird which had been deprived of its most essential sense—sight. For how can a sightless bird find its food and water? Fly without bumping into things? Seek shelter? Jack's owner sensed and met these problems with solutions which resulted in a quite satisfactory adjustment on the part of her patient.

Because of the bird's blindness, the author was able to examine him from a distance of a few inches, thus gaining an unparalleled view of many of his activities, such as the way he preened, or used his tongue in eating. Clearly and carefully she described, in simple terms, such activities as preening, bathing, anting, and the behavior associated with apparent fright, uncertainty, relief, loneliness, and other sensations. Behavior patterns were noted and described, but conclusions were drawn with extreme caution. When more than one interpretation was possible, the author has given it. If there was a possibility of doubt, she says, "At least this was my impression."

Extremely interesting is the account of the ways in which the Jackdaw learned to use his feet to compensate in some way for his visual loss. He made exploratory, reaching motions with them. He grasped his food with them, once he found it. He flew with his feet extended in front of him, tail pointing down, once he had "learned" that this would save him from serious bumps into objects. He used them to climb curtains to a safe and familiar perch on a valance.

Mrs. Ryder truly put herself in Jack's place, time and again, in helping him to overcome difficulties, and in all ways she respected his dignity, and took care to help him to maintain his poise.

I found her style of writing slightly awkward at times, but this is a very minor criticism of a book which will be enjoyed by all students of bird behavior, amateur or professional.—Sally F. Hoyt.

Pirates and Predators: The Piratical and Predatory Habits of Birds. By R. Meinertzhagen. Oliver and Boyd, Edinburgh, 1959: 7½ × 10⅞ in., x + 230 pp., 44 pls. (18 col.). 70*s* (about $9.80).

This, Colonel Meinertzhagen's latest book, is a vast collection of observations on "the manner of hunting" by birds. Although many observations have been drawn from the literature, the majority are the author's, obtained over a period of seventy years in many parts of Europe, Africa, and Asia.

The subject matter is organized in four parts under four main headings. Part 1, "Man, Predators, and Vermin," deals with some of the general aspects and methods of predation. Part 2, "Predators—Amateur," concerns a wide variety of birds not strictly predatory. Part 3, "Predators—Professional," has to do with the falconiform and strigiform birds. Part 4, "Autolycism" (the habit of one organism "making use of" another), presents many notes on birds making use of other birds, man and other mammals, and reptiles and fish.

Writing with terseness and objectivity, Colonel Meinertzhagen minces no words in stating an idea or opinion, however colorful. While his style has commendable virtue, permitting him to reach points quickly, it is apt to leave the reader (my case anyway) yearning for more details. This is especially true in those passages about unusual actions which he has been fortunate to witness. Many times I wanted to know the circumstances and just how the predators and/or prey behaved.

On the whole, the book is a strong defense of predation and a clear exponent of its biological implications. There is no injection of sentimentality, no playing down the high drama and goriness of predatory assaults. Keen admiration is actually demonstrated for most predators, avian or otherwise. One notable exception is man ("the vilest vermin... both vermin and weed—not a nice thought; but then man is not nice").

It is regrettable that a book so replete with noteworthy accounts of predator–prey relationships should be so poorly indexed. Its two concluding pages, titled "Index," give simply an alphabetical listing of the book's subtitles and their page numbers. To determine what the author has written about a particular species, one must go through the book page by page.

"Pirates and Predators" is elegant in both manufacture and format and a great credit to its Scottish publishers, Oliver and Boyd, who have already brought out several fine books on birds. The color plates are excellent reproductions of dynamic paintings by such talented wildlife artists as G. E. Lodge, D. Millais, and C. F. Tunnicliffe. The black and white plates are mostly from striking photographs by R. Austing, Eric Hosking, and other cameramen. All the illustrations are appropriate to the text. No doubt many of the paintings were especially commissioned by the author. For a book embodying so many superior qualities, its price is remarkably modest.—OLIN SEWALL PETTINGILL, JR.

PROCEEDINGS OF THE FIRST PAN-AFRICAN ORNITHOLOGICAL CONGRESS. Supplement No. 3 to *The Ostrich*. South African Ornithological Society, 1959: 7½ × 9¾ in., ix + 445 pp., illus. 26*s* (about $3.65). (Obtainable from S.A.O.S. through Dr. G. J. Broekhuysen, Department of Zoology, University of Cape Town, Rondebosch, C. P., South Africa.)

The First Pan-African Ornithological Congress was conceived after an invitation to the International Ornithological Congress in Basel in 1954 failed to lure that august body to hold its twelfth convention in South Africa. Undaunted by this rebuff, the South African Ornithological Society, with the help of several sister organizations, organized and conducted a highly successful congress in Livingstone, Northern Rhodesia, in July of 1957. About 200 ornithologists from 19 countries attended the sessions including 28 from the United States and three from Canada.

The published proceedings of this congress comprises a substantial volume printed on gloss paper and bound in a heavy textured paper. Line drawings and half-tones are of mediocre quality. Following a few brief introductory chapters, the 55 papers presented at the session are published in their entirety, many of them followed by concise summaries of the discussions they raised. A few of the papers, extending up to 42 pages, were presumably amplified or supplemented for publication. Papers were arranged by subject matter into nine sections: conservation (7), distribution (11), ecology (4), general biology (11), history (2), migration (6), parasitology (2), song (4), and systematics (8).

The series of reports on bird conservation in the various countries and provinces of southern Africa reveals to the American reader a rather unfamiliar picture of protection efforts in a land where hunting for sport is rare, where marketing of game has never been highly organized as it was in early America, and where birds of all sorts are surreptitiously snared for family consumption according to their accessibility and ease of capture. Most of the countries now give blanket protection to all but a rather small list of species which are classified as destructive or which in their continuing abundance have demonstrated a satisfactory resistance to prevailing pressures.

Among the many worthy contributions are: a summary and analysis of the peculiar discontinuous ranges of montane forest birds of southern Africa, by Richard Liversidge; a demonstration of how accumulated deposits of owl pellets have provided data on the faunal composition, population dynamics, and historical changes of small mammals populations, by D. H. S. Davis; discussions of the incidence and significance of color dimorphism in egrets, by P. Milon and J. Berlioz; a consideration of the reproductive cycle of sunbirds near the equator, by J. Chapin; an account of government efforts to control the "swarms" of destructive Quelea finches in South Africa, by T. J. Naude; and a discussion of the effects of day-length changes in the southern hemisphere on transequatorial migrants, by G. J. Van Oordt.

Important papers on life history are presented by G. J. Broekhuysen for the Sugar Bird (*Promerops cafer*), by T. Oatley for several robins of the genus *Cossypha*, and by C. J. Skead for the Penduline Tit (*Anthoscopus minutus*). In this latter species, whole families of up to 18 birds crowd together each night to sleep in remarkable felted nests of spider silk and wool.

Outstanding as a challenge for further field research is an 18-page paper on some aspects of speciation in the birds of Rhodesia and Nyasaland by C. W. Benson, M. P. Stuart Irwin, and C. M. N. White. Over 50 fascinating examples of what are thought to be sibling species, species pairs, geographically separated species pairs, and ecological races are listed and briefly described. This is followed by brief but thought-provoking speculations on speciation factors, isolation factors, and the recent history of the central African avifauna.

This volume constitutes a milestone of progress in the advancement of African ornithology and contains much of interest to ornithologists everywhere.—John T. Emlen, Jr.

Penguin Summer: An Adventure with the Birds of the Falkland Islands. By Eleanor Rice Pettingill. Clarkson N. Potter, Inc., New York, 1960: 6 × 9 in., 197 pp., 68 photos, end-paper maps. $5.00.

When I heard the Pettingills were going to the Falkland Islands, three hundred miles off the tip of South America, to take photographs of penguins for Walt Disney, I thought, "To see penguins! That's one trip I'd like to know *all* about—every detail!"

Now Eleanor Pettingill has written the story in "Penguin Summer" and I am utterly satisfied. Her account of their adventures is so vivid and intimate that as I finish the book I feel I have been taking the trip with them, and I can hardly wait to make it again by re-reading.

Though "Penguin Summer" is filled with information, precise and authentic, on the birds of the Falklands (penguins, of course, but many others too), on the vegetation, the physical aspects of the islands, the social customs and ways of livelihood there, it is never pedantic. It is a delightful, spontaneous story of their project, day by day, from the first vague idea of photographing penguin colonies, to the visit's end.

Every phase of the trip is handled with vivacity and humor, whether Eleanor tells of a formal dinner with the Governor or a rough camping experience where the weather discomforts are almost too actual. The very fact that Sewall Pettingill's accident is not over-emphasized makes it the more harrowing for the sympathetic reader. While both people and birds in the book become real friends, of course the penguins are the heroes of the story, and the descriptions of them are captivating. For instance:

"The penguins were having a party. The birds in the small groups were clicking bills, the way puffins do in the Northern Hemisphere. Two birds would walk up to each other, put their heads together as if exchanging secrets, then click their bills together faster and faster. They were joined by others till there were six or eight in a circle, all leaning toward the center, clicking bills madly. Then suddenly they all raised their heads and walked away."

And— "We watched the penguins going to sea. Although they landed on only one rock, they left from several places. Some walked cautiously down a smooth ledge and waited for the waves to sweep them seaward; most of them, however, climbed in groups up a broken ledge . . . , peeked over, backed up, went forward again, and finally jumped in feet first. . . . If they could have held their beaks with their flippers they would have looked just like the kids in the old swimming hole. But there were some that walked to the edge, took one look, turned around, hopped back to the slanting ledge, and waded in."

If you want to learn of the life cycle of the penguins, or find accurate scientific information about the Falklands; if you'd like to know what diddle-dee and mollymawks and clapmatches are; or if you simply want to go on a fascinating expedition, by all means read "Penguin Summer."—Florence Page Jaques.

PUBLICATION NOTES AND NOTICES

The Caribbean Journal of Science (Vol. 1, No. 1, February 1961) is a new mimeographed publication to be issued quarterly by the Institute of Caribbean Studies. It will report primarily on local and regional studies in botany, zoology, and other sciences in the Caribbean area. Subscriptions ($2.00 in the United States) are payable by check to "University Bookstore, Mayagüez" and should be sent to Dr. W. A. Gordon, Institute of Caribbean Studies, University of Puerto Rico, Mayagüez, P.R.

The Alaska Conservation Society News Bulletin, a mimeographed quarterly now in its second year, should be read by everyone concerned about the state's enormous wildlife problems. Associate Membership ($2.00) is open to non-residents of Alaska and includes a subscription to the *Bulletin*. Checks are payable to the Alaska Conservation Society and should be directed to Box 512, College, Alaska.

Binoculars & Scopes: How to Choose, Use & Photograph Through Them. By Robert J. & Elsa Reichert. Chilton Company, Philadelphia, 1961: 4⅞ × 7¾ in., 128 pp., 55 text figs. $1.95 (paper); $2.95 (cloth).

A carefully detailed, profusely illustrated manual, with a wealth of optical data and helpful suggestions.

Dusky and Swallow-tailed Gulls of the Galapagos Islands. By Alfred M. Bailey. Denver Museum of Natural History, Museum Pictorial No. 15, 1961: 32 pp., 19 photos., 1 map. Paper covered. $1.00.

Another in the Denver Museum's series of handsomely illustrated booklets. Worthwhile information is given on both *Larus fuliginosus* and *Creagrus furcatus.*

A Study of Certain Plant and Animal Interrelations on a Native Prairie in Northwestern Minnesota. By John R. Tester and William H. Marshall. Minnesota Museum of Natural History, Occasional Papers No. 8, 1961: viii + 51 pp., 1 photo., 17 text figs., 14 tables. Available upon request to Minnesota Museum of Natural History, University of Minnesota, Minneapolis 14.

This is based on a field study at the Waubun Prairie Research Area in northwestern Minnesota "to determine the nature of the relations between specific vegetational characteristics of the dominant grasses and litter found on a native prairie and changes in distribution and abundance of certain birds, mammals, and insects . . . during the growing seasons of 1957, 1958, and 1959." The three bird species given special attention are the Bobolink, Savannah Sparrow, and Le Conte's Sparrow.

Bird Mortality in the Dutch Elm Disease Program in Michigan. By George J. Wallace, Walter P. Nickell, and Richard F. Bernard. Cranbrook Institute of Science [Bloomfield Hills, Michigan] Bulletin 41, 1961: 44 pp., 4 tables. $1.00.

The authors "are inclined to question the whole program, as currently conducted, on ecological grounds. Any program which destroys 80 or more species of birds and unknown numbers of beneficial predatory and parasitic insects needs further study."

The Mallard. By John Madson. Conservation Department, Olin Mathieson Chemical Corporation [East Alton, Illinois], 1960: 90 pp., 18 photos. Available upon request.

The contents of this attractive booklet are grouped under five headings: "Life History," "Parasites and Diseases," "Management," "Hunting," and "Man and the Mallard."

ANNUAL REPORT OF THE CONSERVATION COMMITTEE

Rapid expansion of the human population and increasing emphasis on economic growth make it essential that bird conservation problems be kept under constant surveillance and anticipated in advance where possible. Expansion of urban areas, highway construction, and intensive agricultural, industrial, and recreational development are bringing about a modification of the habitat of birds. A sustained effort to appraise the effect of this "new frontier" on bird life and to temper undesirable changes whenever feasible is highly desirable. The ornithologist must show increased aggressiveness if bird conservation is to have meaning in the future. He must assign more research effort to the objective of obtaining increased knowledge of, and solutions to, bird conservation problems, and he must take a greater part in insuring education of the general public and in securing needed legislation.

Using an earlier committee report (Scott, 1958) as a guide, we might examine the bird-conservation problem from a "what to do about it" point of view. The major points of concern separate into the following categories: (1) conservation education, (2) land-use problems, (3) habitat pollution (pesticides, oil, etc.), and (4) control of bird populations. More often than not, the names of birds are added to lists of endangered species and subspecies as a consequence of limitations which may be classified in one or more of the above categories. Vanishing species and subspecies, however, will be discussed in a separate section of this report.

One objective of the conservation committee is to explore and report upon special problems. Two of these reports, one in the area of a land-use problem (Jahn, 1961) and the other on the status of grouse populations (Hamerstrom, 1961), have been presented. We are anticipating additional reports from Charles H. Callison (conservation education), Joseph J. Hickey (pesticides), and Harold Mayfield (Kirtland's Warbler refuge).

The status of research dealing with problems of bird conservation is a cause of concern to the committee. Evidence indicates that there is some apathy among scientists about devoting research time to the solution of problems relating to bird conservation. Additional stimulus may be needed. Although funds for research are available from many sources, funds for use in attacking problems in bird conservation are frequently inadequate. This is a matter which requires thorough appraisal. Perhaps the committee can arrange for an enlightening review.

CONSERVATION EDUCATION

Man tends to be apathetic toward conservation of the apparently unessential natural elements of his environment. Perhaps this is eternally true, and perhaps it is partly a reflection of adaptation to his changing universe. Over the past 200 years the average man in this country has been losing contact with his natural world. It is conceivable that this change from virtual dependence on the wild elements of his environment to an environment of concrete, stainless steel, and supermarkets has had a profound effect on human appreciation of nature. Reduced contact with nature surely lessens appreciation for it and increases apathy which, in turn, keeps even those who are potentially conservation minded from acting, until, in some instances, there is nothing left to appreciate.

The common denominator in all conservation problems is conservation education. The warm feeling which most Americans have for birds must be encouraged; it seems apparent that this can be done most effectively through organized programs of conservation education. In this way intelligent support for bird conservation can be insured.

Many of the notable advances in the conservation of natural resources probably had their initial origin in the classroom. Our grade schools and high schools have made a contribution to the enjoyment and understanding of natural history by the American public, but it is unfortunate that most such training is given indoors. Acquisition of small natural areas to be used as outdoor laboratories by secondary schools has been recommended by some educators as an aid in developing nature appreciation.

A number of organizations not directly connected with public school systems have contributed much to outdoor education. As one example, the Forest Preserve District of Cook County, Illinois, for many years has conducted a program aimed at teaching sound attitudes toward the out-of-doors to children and adults of the Chicago metropolitan region (McCabe, 1952). The more than 45,000 acres of the Forest Preserve are within easy reach of the people of that region. More than 80 per cent of the area can be called "wild" land in that it is kept as nearly as possible as natural woodland and is accessible only by foot trails or bridle paths. Competent naturalists conduct classes from the public schools, or from the Forest Preserve's day-camps in summer, on field trips to woodlands, marshes, or lagoons, where the fundamentals of botany, forestry, and aquatic and terrestrial zoology are explained in understandable terms. Naturalists also give talks in school classrooms on natural history and conservation, and co-operate with teachers colleges in giving instruction to teacher candidates in outdoor education. Both adults and children are reached through radio programs and by weekly nature bulletins sent to 135 newspapers, including the city dailies and about 50 foreign language newspapers, in the Chicago area. This program has been successful beyond expectation in improving outdoor manners and in arousing interest in natural history.

The recent establishment of the Natural Science for Youth Foundation, whose purpose is to stimulate, guide, and assist local communities in the development of natural science centers for children and youth, and also the recent merger of Nature Centers for Young America, Inc., with the National Audubon Society appear to be important steps forward in the field of conservation education. According to Carl W. Buchheister (*Aud. Leader's Cons. Guide*, 2(5), 1 March 1961), President of the National Audubon Society: ". . . it is our purpose to operate the Nature Centers program as one of the major educational extension arms of the Society. It will be coordinated closely with the Society's other educational activities. The staff of NCYA is made up of able, dedicated people.

"With the stimulus and the support that can be given the program by NAS branches and affiliates throughout the nation, we shall look forward to a steady growth in the Nature Center movement. No other device or program appears to hold so much promise of giving millions of urban children an understanding of their affinity with nature, and of their dependence upon the natural resources of America."

The Nature Conservancy plans to embark soon on a "Natural Areas for Schools" program. A preliminary exchange of information between the Audubon Society and the Nature Conservancy indicates that the programs of these two agencies need not compete or overlap. The two organizations will work together to assure coordination. The Nature Conservancy's efforts will be directed toward the acquisition or dedication of areas of land that can be used by schools as outdoor laboratories for natural science classes. The nature centers promoted by the National Audubon Society or by the Natural Science for Youth Foundation will in most instances be larger, with a staff and associated nature museum facilities, and they are intended to serve all the schools and youth groups in an urban community, and, to the degree that they can be accommodated, adult groups as well.

LAND-USE PROBLEMS

The increasing demand for space in which to live and work and the growing demand for the things which can be produced on the land are affecting the bird fauna through altered habitat. Some avian populations may have been favored, and some, such as the prairie chicken in Illinois and Wisconsin, are in danger of regional extirpation. Refuges or modification in land-use practices may be required in specific instances to protect birds. Ornithologists should make every effort to keep informed on species endangered by habitat alteration and to encourage corrective action wherever needed.

Ornithologists and sportsmen have been slow to realize that often they can work effectively together toward important conservation goals, especially where the problem is related to land use. Of the two groups, perhaps the bird people have been the less willing to look for a common ground of interest. The National Audubon Society, however, seems to be taking the initiative in promoting cooperation among different groups of outdoorsmen. Recently, the president of the National Audubon Society took to task both the duck hunters and bird watchers for not protesting vigorously the threatened drainage of Tule Lake National Wildlife Refuge (Buchheister, 1960).

It was encouraging to learn that a memorandum pledging support of conservation programs on military installations was approved during the past year in the Defense and Interior Departments. According to a report by Poole (1960:2), the "agreement stipulates that 'All military installations or facilities which contain suitable land and water areas as determined after consultation with authorized federal or State conservation authorities, shall have an active, progressive program for the management and conservation of fish and wildlife resources consistent with the missions of the installations.' " It is highly probable that this program will be oriented around game animals. It would seem desirable that ornithologists near military reservations make an effort to obtain recognition of nongame bird needs.

In the majority of states in the north-central region, it seems possible to preserve for the future some of the remnant colonies of Greater Prairie Chickens only by establishing a checkerboard pattern of 20-acre or 40-acre refuges in agricultural lands. Such refuges must be kept permanently in grass for nesting cover. This is a major undertaking requiring acquisition and management of considerable acreages of land. In states where the prairie chicken is no longer classed as a game bird, conservation departments have been reluctant to purchase land for refuges except where game species still subject to hunting will also benefit. In Illinois, as in Wisconsin, several conservation agencies are co-operating in attempts to raise funds for a system of prairie chicken refuges in upland farming areas. The Illinois Prairie Chicken Foundation (parent organizations: Illinois Federation of Sportsmen's Clubs, Illinois branches of the National Audubon Society, Izaak Walton League, and Nature Conservancy) has undertaken the task of raising funds by private subscription to purchase refuge land that costs up to $200 an acre, and is exploring other sources of possible financial assistance.

In Wisconsin, where a similar program was initiated in 1954 by the Wisconsin Conservation League and the Wisconsin Society for Ornithology, land acquisition is now proceeding at a steady pace under the auspices of the Prairie Chicken Foundation. These organizations, as well as three private citizens, have now acquired over 1,800 acres at a cost in excess of $40,000; and the scattered blocks of land are leased to the Wisconsin Conservation Department which is managing them intensively.

The Lesser Sandhill Crane has thrived and perhaps increased in numbers during the past decade on relatively undisturbed breeding grounds in Alaska and northern Canada. However, agricultural encroachments upon feeding and concentration areas in Saskatchewan, the Dakotas, and Nebraska, and upon wintering areas in Texas and New Mexico, spell trouble for the species. Pressure for hunting as a means of relieving depredations resulted last year in an "experimental open season" declared by the Secretary of the Interior for certain areas in Texas and New Mexico, a season that Texas couldn't take advantage of because of a state law against crane hunting. In several respects the "experimental season" was unsatisfactory; there was little hunting pressure and the number of birds taken was probably too small a sample to reveal anything definitive about age composition. The experience did reveal a number of questions that need to be answered through research before a management program can be devised for the species. We need to know, for example, the extent to which the birds winter in Mexico, or move into and out of Mexico during the wintering season, and the amount of hunting pressure, if any, sustained in Mexico.

A field investigation in 1960 by the National Audubon Society and the Audubon Society of Canada of the crop-depredations problem in Canada, the Dakotas, and the Southwest, plus observations of the experimental hunting season, has led the two societies to conclude, quite aside from the question of hunting, that the only certain answer to the depredations problem, and a step essential to the future protection of the species, is the acquisition of additional refuge lands for the Sandhill Crane in Saskatchewan, along the flyway, and in the Southwest. Otherwise, the progressive encroachment of farming with attendant demands for "control" will certainly endanger the species.

It seems obvious that cranes, with their low rate of reproduction and restricted habitat, can never sustain more than a small hunting harvest at best. Further, it would seem unwise to permit hunting in areas where the range of the Lesser Sandhill Crane overlaps that of the Greater Sandhill Crane, an endangered form. It would be unthinkable in areas where the Whooping Crane would be endangered. Following the experimental season of last winter, there are already pressures for crane hunting seasons in other western states and in Alaska.

It is gratifying to note that in some instances industrial concerns have shown recognition of conservation needs, especially with respect to the provision of refuge sites. The American Cyanamid Company recently announced the lease of 1,000 acres of land as a wading-bird sanctuary to the Florida Audubon Society. The new refuge has been named the Saddle Creek Bird Sanctuary and will be posted with signs reading, "Florida Audubon Society, American Cyanamid Company Cooperating." This project is especially encouraging because of the marked decline in populations of Common Egrets and Wood Ibises over the past 10 years.

Of major importance in wildlife conservation nationally was the signing on 7 December 1960, by outgoing Secretary of the Interior Fred A. Seaton, of land withdrawal orders establishing three new National Wildlife Ranges in Alaska with a total area of more than 11 million acres. The Arctic National Wildlife Range of approximately 9 million acres in northeast Alaska contains nesting ground for approximately a hundred species of birds, and provides range for grizzly and polar bears, Dall sheep, wolverine, caribou, and other wildlife. The Kuskokwim National Wildlife Range, 1.8 million acres in western Alaska, is one of the most important breeding grounds for migratory birds in North America. The Izembek National Wildlife Refuge, approximately 400,000 acres near the western end of Alaska, is a vital concentration area for migratory waterfowl where large amounts of aquatic food are available. (*Natl. Aud. Soc. News and Views and Leader's Cons. Guide*, 15 December 1960).

The Alaska Conservation Society, in its News Bulletin of January 1961, states editorially that the action establishing the Arctic National Wildlife Range by the former Secretary of the Interior received high praise from Alaskan sportsmen and conservation groups who had long advocated this reserve in northeast Alaska. The action was bitterly condemned, however, by Alaska's Senators Edward L. Bartlett and Ernest H.

Gruening, Representative Ralph J. Rivers, and Governor William A. Egan. Belief was expressed that the new Secretary of the Interior, Stewart L. Udall, would be under strong pressure to rescind the proclamation (*Alaska Cons. Soc. News Bull.* 2(1):3–4, 1961).

Wilderness bills were introduced both in the House and Senate at the beginning of the 87th Congress. Senator Clinton P. Anderson of New Mexico introduced what he described as a "streamlined version of a bill to establish a National Wilderness Preservation system." This bill, S. 174, was referred to the Senate Committee on Interior and Insular Affairs of which Senator Anderson is chairman. The bill was first introduced five years ago. The Senate Committee on Interior and Insular Affairs gave it extensive consideration in hearings, and revisions are said to have met objections of most groups. Senator Anderson stated: "After four years of such constructive revision and in response to an increasing public support and a deep sense of urgency in our realization that we must act promptly or run the risk of losing much of our opportunity, it seems to me we should now proceed to act" (*Nat. Res. Council of Am., Legislative News Service*, Rept. No. 1:7, 13 January 1961).

Amendment of the Migratory Bird Hunting Stamp Act to require all receipts except those for reimbursement to the Post Office to be expended for the lease and acquisition of nesting and refuge areas is beginning to result in acquisition of land. Another step was made in the uphill fight to save waterfowl habitat from encroachment by agriculture when 14,641 acres of Klamath Marsh, Oregon, were purchased by the Department of the Interior. All of the purchase price of $476,401 came from the Migratory Bird Hunting Stamp Act money (*Nat. Res. Council of Am., Executive News Service* 3(9):76, 1960). Progress with acquistion, however, is limited by funds. Doubt was expressed in an earlier report of the Conservation Committee that the amendment of the Stamp Act would provide the necessary acceleration (Scott, 1958:388). Thus it is most encouraging to learn that $150 million for acquisition of waterfowl wetlands is being sought in bills (H.R. 4603 and H.R. 4624) introduced by Congressmen John D. Dingell (Mich.) and Henry S. Reuss (Wis.). The bills would make up to $20 million available annually over a period of 10 years. It should be remembered, however, that unless authority is granted to spend some of the funds in Canada, the bill will not aid in the preservation of the breeding areas that produce most of the ducks in North America.

A gratifying awareness of the serious contradictions in policies of federal agencies and of the need for prompt action to save duck nesting habitat is evident in the excerpt quoted herewith from President John F. Kennedy's conservation program outlined in his message to Congress of 23 February 1961: "I am also hopeful that consistent and coordinated Federal leadership can expand our fish and wildlife opportunities without the present conflicts of agencies and interests: One department paying to have wetlands drained for agricultural purposes while another is purchasing such lands for wildlife or waterfowl refuges—one agency encouraging chemical pesticides that may harm the songbirds and game birds whose preservation is encouraged by another agency—conflicts between private landowners and sportsmen—uncertain responsibility for the watershed and anti-pollution programs that are vital to our fish and wildlife opportunities.

"I am directing the Secretary of the Interior to take the lead, with other Federal and State officials, to end these conflicts and develop a long-range wildlife conservation program—and to accelerate the acquisition of upper Midwest wetlands through the sale of Federal duck stamps" (*Nat. Res. Council of Am., Legislative News Service*, Rept. No. 8:95, 2 March 1961).

HABITAT POLLUTION

The application of extremely toxic pesticides, the accidental dumping of oil into aquatic habitats, the silting of water areas with eroded soil, and general pollution of waterways with industrial and residential wastes present an extremely sensitive problem that must be controlled in some reasonable fashion. Here again, the ornithologist can protect his interests only by aggressively engaging in research on these pollution problems, being alert to conditions in his region, and encouraging needed action.

The 86th Congress voted the usual $2.4 million for the fire-ant spraying program during the fiscal year of 1961; however, the Senate Appropriations Committee, in approving the appropriation, tied on the following string: "The Committee directs that no funds provided herein are to be used to carry out the fire-ant eradication program in any state which does not provide its share of the financing" (*Natl. Aud. Soc., News and Views and Leader's Cons. Guide* 1(4), 1960).

Because large losses of wildlife have been proved beyond doubt to result from similar applications of poison, the conclusions of the National Audubon Society in regard to actions that must be taken to meet the pesticides problem seem sound. They are quoted from the *Natl. Aud. Soc. News and Views and Leader's Cons. Guide* of 1 November 1960:

"1. Research must be stepped up sharply. Research to show what new chemicals will and will not do, in the short run and in the long run, before they are placed on the market or fogged onto the land in government spraying operations. Research also to discover selective chemicals to replace the present broad-spectrum poisons now in common use, and to discover alternative, and safe, biological and cultural controls for economic pests.

"2. New laws are needed to regulate the distribution and sale of chemical pesticides, to regulate their use by public agencies such as the U.S. Department of Agriculture's plant pest control division, and to license and regulate persons engaged in commercial or contract spraying operations.

"3. Educational efforts can alert the public to the dangers involved in the unwise application of poisons that have not been fully studied, and in the excessive or careless use of tested poisons."

Another quotation, from Dr. Samuel A. Graham (1960), Emeritus Professor of Economic Entomology, University of Michigan, deserves careful consideration:

"... the use of insecticides is a necessity for production of foods in the quantity and quality we require. However, numerous widespread projects involving the broadcasting of insecticides that have been endorsed enthusiastically by the public-supported control agencies, are open to question. Apparently the decision to spray or not to spray cannot be safely left to these control agencies. The temptations of empire building are too great. The pros and cons should be weighed by persons with broad training and experience, who can evaluate all available information dispassionately, thus reaching a decision that will be in the best long-term interest of mankind and as nearly unbiased as possible. The viewpoint of forest entomologists on the broadcasting of insecticides deserves special comment because it is the sensible one. It is this: All agree that the application of insecticides over large areas must be regarded as emergency treatment, comparable to extinguishing a fire or removing a man's appendix. Control projects involving the broadcasting of insecticides should not be entered upon lightly."

The National Academy of Sciences-National Research Council designated a committee to investigate problems associated with the chemical control of agricultural pests. A news release from the National Academy of Sciences-National Research Council, dated for release 15 June 1960, stated that the work of the committee would endeavor to:

"1. provide technical advice and guidance to bring about maximum control of crop pests with minimum damage to wildlife,

"2. provide critical evaluation of both the direct and indirect effects of various pest control operations on plants and animals,

"3. stimulate new research where gaps exist, and encourage investigations in progress to obtain factual information as a basis for sound guiding principles and policy determinations, and

"4. foster cooperation among various agencies, organizations, industries, and individuals interested in pest control and those concerned with its effects on fish and wildlife."

The scientists designated to serve on the committee were obviously highly qualified in their fields, but their fields of experience are so closely allied to the problem that some question may be raised as to whether some might not have provided greater service as witnesses than as judges. It is to be hoped that their work will not reflect the potential biases indicated by their backgrounds.

In these times when international good will is so important, the long delay attending ratification of the oil pollution control treaty, officially known as the *International Convention for Prevention of the Pollution of the Sea by Oil*, by the United States has been beyond comprehension. This treaty was drafted seven years ago with U. S. State Department representatives participating. The United States, with about 15 per cent of the world's tanker tonnage, has been the major holdout. The Constitution requires a two-thirds favorable vote of the Senate for approval of international treaties of this kind. Although the Committee on Foreign Relations voted favorably on the treaty on 2 June 1960, the Senate stalled off a vote on this important treaty. On 3 January 1961, the treaty was re-referred to the Committee on Foreign Relations which again voted favorably on it. Finally, on 16 May 1961, the treaty was approved by the Senate. It is our understanding, however, that the treaty will not be formally ratified by the United States internationally until the President and Department of State have obtained legislation to implement it. It is reported that implementing legislation is now under consideration.

CONTROL OF BIRD POPULATIONS

This problem promises to become increasingly important. Concern for bird control reaches spectacular proportions in localities where birds have caused planes to crash. Wherever bird depredations on crops occur there are demands for control measures, and the degree of urgency of such control relates directly to the importance of the crop loss and to the need for increasing food production for livestock and humans. Also, diseases and parasites of livestock and man which find feral hosts among birds stimulate attempts to control birds. The frightening epidemic resulting in 21 human deaths from Eastern Encephalitis in New Jersey in the late summer and fall of 1959 is a case in point, because wild birds were implicated as reservoir hosts. Of the ornithologist's responsibility here, Stamm (1960:5–6) wrote: "Ornithologists must take a much more active role in relating available knowledge to the problems and in developing new approaches. The areas which, at the moment, seem most needful of clarification are (1) the precise trends in bird population density in affected areas during the epidemic season, and (2) the influence of human alteration of habitat on population density. Ornithologists have a special stake in these activities for several reasons. Their knowledge of the host species is essential to solving the EE disease problem. Knowledge gained in studies of this disease will also be applicable to other diseases affecting birds only. Most important, ornithologists must be aware of the details of and basis for possible bird population reduction as a means of epidemic control. Only by direct participation in the basic work can they be assured that harm to bird populations will not result either from overt activity of this sort or potentially even more severe damage as a result of uncritical massive application of chemicals for 'mosquito control.' "

Reports of damage by blackbirds to crops seem to have increased with the spread of the Starling westward. Starlings readily flock with Red-winged Blackbirds, Cowbirds, and other blackbirds, sometimes forming huge roosts. Instances of aerial application of parathion to kill birds in roosts are cited by Dykstra (1960), who states that this matter is of serious concern to the Bureau of Sport Fisheries and Wildlife, partly because of the hazard to humans.

ENDANGERED SPECIES AND SUBSPECIES

At least nine birds native to North America, neighboring islands of the Atlantic Ocean, and American possessions in the Pacific were mentioned during the 1949 meeting of the International Union for the Protection of Nature as on the verge of extermination. Of the seven of these birds on which we have some recent data or opinions, the Eskimo Curlew may be extinct; and the Ivory-billed Woodpecker was down to 12 known birds in Oriente Province, Cuba, by July 1956 (Lamb, 1957*a*). Three others are holding their own, although in low numbers (California Condor, Whooping Crane, and Bermuda Petrel). Two others have staged comebacks (Hawaiian Goose and Laysan Mallard), although the singularly insular condition of the Laysan Mallards continues to render them vulnerable to local catastrophes. Conservation programs are also playing a part in the survival of the California Condor, Whooping Crane, and Bermuda Petrel. There have been no recent reports of the Marianas Mallard or the Marianas Megapode.

There is good reason to feel that management measures must now be taken to preserve such interesting subspecies as the Hawaiian Stilt, whose breeding grounds are being steadily eliminated, and the Hawaiian Duck (or Koloa) if they are to be preserved at all.

It is urgent that action be taken to provide an effective program for the conservation of birdlife in the Virgin Islands, especially the nesting colonies of 17 kinds of sea birds on local cays (leased by the government to private individuals) where the eggs and young birds are reported to be exploited commercially (Lamb, 1957b). By 1957, White-crowned Pigeons had been reduced by excessive hunting and reduction of habitat to a single colony of 300 on St. Croix Island. The United States has shown scant and ineffective interest in the protection of birdlife in the Virgin Islands. On 15 May 1961, the Legislative Assembly of the Virgin Islands passed Bill No. 1395, making legal the "removal or possession of eggs of the birds commonly known as 'Boobies.' " This means the eggs of such birds as Sooty Terns, Bridled Terns, Laughing Gulls, Boobies, and similar species.

In Texas, the Attwater's Prairie Chicken is estimated to number no more than 3,000 individuals, and no management plan has been worked out for their preservation since Lehmann's pioneer study in 1941 (Towell, 1958).

In Florida, the Everglade Kite is about to be extirpated as a native of the United States. In the southeastern states, the Bachman's Warbler appears to be a dying species, and in Sonora, overgrazing is steadily leading to the disappearance of the Masked Bobwhite (Ligon, 1952; Leopold, 1959). This bobwhite apparently has been extirpated in Arizona. The forthcoming attempt by the Arizona-Sonora Desert Museum to stock an area near Tucson with pen-reared Masked Bobwhites will be of much interest. On the Edwards Plateau, where goats now compete for forage with sheep, steers, and deer, a careful census or estimate of the population of the Golden-cheeked Warbler is urgently needed. And our

TABLE 1

AMERICAN RESEARCH PRIORITIES ON RARE AND VANISHING BIRDS

Status	Species	Subspecies
Critical but holding own	Bermuda Petrel Whooping Crane* Hawaiian Goose* California Condor* Cape Sable Sparrow*	Hawaiian Duck Laysan Mallard
Probably in danger	Bachman's Warbler Kirtland's Warbler* Puaiohi (Small Kauai Thrush) Ooaa (Kauai Oo) Kauai Akioloa	Hawaiian Stilt Attwater's Prairie Chicken Masked Bobwhite
Population trend unknown	Golden-cheeked Warbler Nukupuu Maui Parrotbill Noguchi's Woodpecker	

* Birds subjected to adequate ecological study in the last decade.

military occupation of Okinawa should not mean that we assume no responsibility for the preservation of Noguchi's Woodpecker.

In general, an important responsibility for ornithologists in the 1960's is to carry out good ecological studies of at least the species and subspecies listed in Table 1 in order to establish population trends, ascertain limiting factors, and provide sound recommendations for conservation programs.

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WOS Conservation Committee
Thomas G. Scott, *Chairman*
Charles H. Callison
Joseph J. Hickey
Laurence R. Jahn
Johnson A. Neff
Ralph E. Yeatter

PROCEEDINGS OF THE FORTY-SECOND ANNUAL MEETING

AARON M. BAGG, SECRETARY

The Forty-second Annual Meeting of the Wilson Ornithological Society was held at the Britannia Hotel, Huntsville, Ontario, from Thursday, 8 June, to Sunday, 11 June 1961. The meeting was sponsored by The Audubon Society of Canada, The Federation of Ontario Naturalists, and The Royal Ontario Museum. The Local Committee, under the energetic and enthusiastic direction of Dr. J. Murray Speirs, Chairman, made this—the Society's first Canadian meeting—a truly enjoyable and memorable one for the 250 members and guests who attended.

Four sessions were devoted to papers, and two business meetings were held, in the Pavilion of Britannia Hotel, in beautiful surroundings on the Lake of Bays. The meeting opened with an informal reception on Thursday evening, at which the Huntsville Nature Club acted as hosts, and Dr. W. W. H. Gunn presented recordings of warbler songs. The Executive Council also met, Thursday evening, at Britannia Hotel. And there was an evening field trip (repeated on Friday) into Algonquin Park to listen for timber wolves. On Friday evening there was an informal showing of several excellent films. The Annual Dinner was held on Saturday evening at Britannia Hotel, with Harold F. Mayfield presenting the President's Address. This was followed by two outstanding color films by Dr. Roger T. Peterson, *A Gathering of Storks*, and a film by Dr. Peterson made in Africa. The Local Committee had decorated the tables attractively at the dinner, and at each place setting there was a souvenir strip containing color slides of four characteristic birds of the Algonquin Park region in which the meeting was held: Spruce Grouse, Black-backed Three-toed Woodpecker, Gray Jay, and Common Raven.

Early-morning field trips were scheduled for Friday and Saturday. On Sunday, there were field trips into Algonquin Park.

First Business Session

President Mayfield called the meeting to order at 9:00 AM, Friday, 9 June. Welcoming addresses, on behalf of The Audubon Society of Canada, The Federation of Ontario Naturalists, and The Royal Ontario Museum, were made by John A. Livingston, William W. W. H. Gunn, and James Baillie, respectively. President Mayfield responded on behalf of the Society.

The Proceedings of the Forty-first Annual Meeting were approved as published in *The Wilson Bulletin* for September 1960.

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 Purdue University and the Indiana Audubon Society, to the Wilson Society, to hold its 1962 meeting at Purdue University during 5–8 April 1962.
2. The Council voted to accept the invitation of the Charleston Museum, the Charleston Natural History Society, and the Carolina Bird Club, to the Wilson Society, to hold its 1963 meeting at Charleston, S.C., during 2–5 May 1963.
3. The Council voted to look with favor upon, and to explore the possibilities of, an invitation to the Wilson Society to hold its 1964 meeting in Kalamazoo, Michigan, in June 1964.
4. The Council re-elected H. Lewis Batts, Jr., as Editor of *The Wilson Bulletin.*
5. Following the recommendation of the Fuertes Research Grant Committee, the Council

voted a grant of $100.00 to Mrs. Frances Crews James to assist in her study of the birds of Arkansas.

Treasurer's Report

The treasurer, Merrill Wood, submitted the following report on the finances of the Society:

Report of the Treasurer for 1960

General Fund

Balance as shown by last report dated 31 December 1959			$ 4,305.51
RECEIPTS			
Dues:			
Active Memberships	$5,005.84		
Sustaining Memberships	792.00	$5,797.84	
Subscriptions to *The Wilson Bulletin*		995.25	
Sale of back issues of *The Wilson Bulletin*		370.45	
Interest and dividends on savings and investments		1,121.25	
Gifts		20.10	
Miscellaneous		482.37	8,787.26
Total receipts			$13,092.77
DISBURSEMENTS			
The Wilson Bulletin (printing and engraving)		$7,109.47	
The Wilson Bulletin (mailing and maintenance of mailing)		770.95	
Editor's expense		194.56	
Treasurer's expense (printing, postage, safe deposit box)		206.87	
Back issue expense (postage)		52.92	
Committee expense (Memberships and Endowment)		72.43	
Annual Meeting expense		255.31	
Miscellaneous		4.00	
Total disbursements			$ 8,666.51
Balance on hand in First National Bank, State College, Pennsylvania, 31 December 1960			4,426.26

Josselyn Van Tyne Memorial Library Book Fund

Balance as shown by last report dated 31 December 1959		$ 283.41
RECEIPTS		
Sale of duplicates	$ 9.00	
Gifts	46.00	
Total receipts		$ 338.41
DISBURSEMENTS		
Purchase of books	$ 38.25	38.25
Balance on hand in First National Bank, State College, Pennsylvania, 31 December 1960		$ 300.16

Louis Agassiz Fuertes Research Fund

Balance as shown by last report dated 31 December 1959		$ 225.00
RECEIPTS		
Contributions	$ 2.00	2.00
Total receipts		$ 227.00

DISBURSEMENTS		
Award to Mr. Robert T. Lynn	$ 100.00	100.00
Balance on hand in First National Bank, State College, Pennsylvania, 31 December 1960		$ 127.00

Special Publications Fund

Balance as shown by last report dated 31 December 1959		none
RECEIPTS		
Contributions		$ 4.00
DISBURSEMENTS		none
Balance on hand in First National Bank, State College, Pennsylvania, 31 December 1960		$ 4.00

Endowment Fund

Balance in Savings Account as shown by last report, dated 31 December 1959		$ 3,775.98
RECEIPTS		
Life Membership payments	$2,335.00	2,335.00
Stock dividends received (included below)		
5 shares Massachusetts Investors Trust		
Total receipts		$ 6,110.98
DISBURSEMENTS		
Purchase of 12½ shares Fireman's Fund Insurance	$ 674.63	
Purchase of $3,000 Phillips Petroleum 4¼% Bonds due 15 February 1987	3,347.69	
Total disbursements		$ 4,022.32
Balance in Savings Account, First National Bank, State College, Pennsylvania, 31 December 1960		$ 2,088.66
Total		$ 6,110.98
SECURITIES OWNED		
$5,000 U.S. Treas. 4% Notes due 15 May 1963 at 102¼	$5,112.50	
$5,000 U.S. Treas. 4% Bonds due 1 October 1969 at 103	5,150.00	
$3,000 Phillips Petroleum 4¼% Bonds due 15 February 1987 at 115½	3,465.00	
15 shares Kaiser Aluminum & Chemical Co. 4¾% cum. cvt. pfd. at 104½	1,567.50	
396 shares Massachusetts Investors Trust at 13.35	5,286.60	
100 shares Fireman's Fund Insurance at 54	5,400.00	
25 shares Owens-Illinois Glass Co. 4% cum. pfd. at 116¾	2,918.75	
(Securities listed at closing prices 30 December 1960)		
Total securities owned		$28,900.35
Total in Endowment Fund, 31 December 1960		$30,989.01

Respectfully submitted,
/s/ Merrill Wood
Treasurer

Research Grant Committee

Harvey I. Fisher, chairman, reported by letter that the Committee recommended Mrs. Frances Crews James for the Louis Agassiz Fuertes Grant for the current year. Mr. Donald Heintzelman was second choice. The report was accepted and approved.

Membership Committee

Hazel Bradley Lory, chairman, reported by letter as follows:

The membership committee this year has consisted of seventeen members and myself. These members have been supplied with application blanks and leaflets about the Society, also with back numbers of *The Wilson Bulletin* where they had use for them. They have been urged to make personal contacts, to check on College and University Library subscriptions wherever possible, and, in some cases, supplied with names and addresses of people attending last year's annual meeting who were not already members.

Members of the committee wrote to 60 people who attended the 1960 meeting and from them obtained a few new members. We might have gained a few more if we could have had addresses for the 55 other non-members who were registered. I would like to suggest that the membership chairman be supplied with a complete list of those registered at each annual meeting (together with the addresses) soon after each annual meeting. Such a list could then be checked with the most recent membership list and names of prospective members be secured. I have already asked Mrs. Speirs, a member of this committee to see that this is done for the Ontario meeting.

The Head Biologist of the Soil Conservation Service sent in the names of 23 Soil Conservation Service Biologists, saying he thought they should all be interested in joining our Society. I, personally, wrote to these men and a few of them signed up as members.

At last year's council meeting, it was suggested that back numbers of *The Wilson Bulletin* be used to send to prospective members. To that end, I went to Ann Arbor and picked up a supply of recent numbers. I still have a good supply on hand, though many of them have been used in this way.

I wish to extend thanks to all who have helped in this work, not only the members of my committee, but also to the many members outside the committee who are helping by recommending those people they know to be interested.

Library Committee

William A. Lunk, chairman, reported by letter as follows:

The past year, for the Library Committee, has shown continued very satisfactory progress, though without spectacular developments or innovations. It is encouraging to note a continued rise in contributions to the library's collections, when present figures are compared with those of last year.

Our oversupply of certain back issues of *The Wilson Bulletin* has been reduced by the transfer of 500 copies to Mrs. Hazel Lory for use by the Membership Committee. It is to be hoped that this plan will not only alleviate the storage problem, but put the *Bulletin* copies to good use in publicizing our organization and its journal.

Another segment of the late Josselyn Van Tyne's collection, gift from Mrs. Van Tyne, totaling 56 bound volumes and the equivalent of some 56 volumes of reprints and separates, was accepted. The balance, on permanent loan, remains available to members.

Eighty-two other gifts to the library, from 66 individuals and institutions, comprised an additional total of 71 books, 186 journals, 61 pamphlets, 628 reprints, 55 newsletters, and 11 translations. One hundred and seven journals (82 by exchange and 25 as gifts) are currently being received.

Approximately 35 out-of-town loans, of about 140 items, were made during the year. This figure seems low. It does not, of course, reflect the great amount of on-the-spot use being made of the library. Members the country over, however, should be encouraged to make more use of our facilities, both for their research documentation and for their leisure-time reading.

The close association between the Josselyn Van Tyne Memorial Library and that of the Bird Division, Museum of Zoology, University of Michigan, deserves special notice. Without the storage facilities and clerical help provided by the University, it is doubtful whether our library could function. To some extent, and for the benefit of both, holdings of the two libraries are kept complementary (particularly where serials are concerned). Within limits, Bird Division materials are available for Wilson Society loans. Revised shelving arrangements, worked out by Bird Division personnel, have now put nearly all of the Wilson Ornithological Society holdings, exclusive of serials, in a separate room. Special categories, such as bibliography, biography, and regional works, are shelved together for convenient reference. Norman Ford, Technical Aide, is largely responsible for correspondence and for routine library business.

Contributions and proceeds from the sale of duplicates continue to augment the Society's New Book Fund, this being drawn upon from time to time to add important items not otherwise acquired.

Attention of the members is drawn to the availability of reasonably priced items from our duplicate collections, and to the always-present need for donations. Cooperation and assistance in all forms are welcomed.

Second Business Session

The final business session was called to order at 3:15 PM, Saturday, 10 June.

On motion duly made and seconded, the report of the Membership Committee was accepted, and the candidates were elected to membership in the Society.

President Mayfield called upon the editor of the *Bulletin*, H. Lewis Batts, Jr., to speak. Dr. Batts commended the editorial board (Bartholomew, Berger, Gunn, Lunk, Norris, Parkes, Paynter, and Pettingill) for their valued services; he also invited prospective authors to submit manuscripts to the *Bulletin* after consulting the new "Style Manual for Biological Journals," and asked members to offer suggestions about the *Bulletin.*

Maurice Brooks summarized the excellent report of the Conservation Committee. (See pages 312–321.)

Report of the Auditing Committee

Stephen Eaton reported in the absence of David E. Davis, chairman, that the books of the treasurer, Mr. Merrill Wood, had been examined and found in good order. The Auditing Committee "was unanimous in complimenting Mr. Wood on the conscientious work he has done."

On motion duly made and seconded, the report of the Auditing Committee was accepted.

Report of the Resolutions Committee

George Hall, chairman, read the following report:

WHEREAS, The Wilson Ornithological Society at its Forty-second Annual Meeting at Huntsville, Ontario, has enjoyed the cordial hospitality of the sponsoring organizations, of the Huntsville Nature Club, of the Britannia Hotel, and of the Ontario Departments of Lands and Forests and of Travel and Publicity, and has enjoyed the beautiful environment of the meeting place and of Algonquin Provincial Park, and

WHEREAS the Local Committee on Arrangements has unstintingly provided for our comfort, amusement and education,

BE IT RESOLVED that the Members of the Wilson Ornithological Society attending this meeting express to the sponsoring organizations, The Audubon Society of Canada, The Federation of Ontario Naturalists, and the Royal Ontario Museum and to the Huntsville Nature Club, the staff of the Britannia Hotel, and to the Ontario Departments of Lands and Forests and Travel and Publicity, and particularly to the Local Committee on Arrangements, ably chaired by Dr. J. Murray Speirs, their deep appreciation and gratitude for all that has been done to make this meeting so memorable.

WHEREAS the Members of the Wilson Ornithological Society, an international organization are deeply interested in the conservation of North American waterfowl, and

WHEREAS this problem is international in scope,

BE IT RESOLVED that the Society go on record as favoring the authorization by the Congress of the United States of America for the allocation of part of the funds available for the purchase of Wetlands, to the acquisition of waterfowl breeding areas in Canada; and

BE IT FURTHER RESOLVED that the secretary be instructed to make the position of the Society known to the proper Government agencies.

On motion duly made and seconded, the report of the Resolutions Committee was accepted.

Election of Officers

Joseph Howell read the report of the Nominating Committee, which 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, J. Bruce Falls (term expiring 1964).

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, 9 June

1. James Baillie, Royal Ontario Museum. *Ontario's First Naturalists*, slides.
2. Laszlo J. Szijj, University of Toronto. *A Study of Meadowlark Vocalizations in Ontario*, slides, tape.
3. J. Bruce Falls, University of Toronto. *What Makes a Bird's Song Recognizable to Other Members of the Same Species?* slides, tape.
4. Grant Tayler, Algonquin Park, Ontario. *Algonquin Park*, slides.
5. Walter R. Spofford, State University of New York Medical College, Syracuse, New York. *White Epaulettes in Some Appalachian Golden Eagles*, slides.
6. D. J. T. Hussell, Weston, Ontario. *Long Point Bird Observatory*, color film.
7. Walter P. Nickell, Cranbrook Institute of Science, Bloomfield Hills, Michigan. *Net Banding: An Effective Method of Determining Distribution of Northern Migrants in Their Winter Ranges*, slides.
8. Daniel D. Berger and Helmut C. Mueller, Cedar Grove Ornithological Station, Wisconsin, and Frances Hamerstrom, University of Wisconsin. *Banding Snowy Owls in Wisconsin*, slides.
9. James Woodford, Royal Ontario Museum. *Operation Recovery—Great Lakes Region*, slides.

10. Bertram G. Murray, Jr., Douglas College, Rutgers—The State University, New Brunswick, New Jersey. *Fall Hawk Migration along the Coastal Areas of the Northeastern United States,* slides
11. James Baird, Massachusetts Audubon Society. *Summer Weights of Evening Grosbeaks,* slides.
12. James K. Lowther, University of Toronto. *Polymorphism in the White-throated Sparrow,* Zonotrichia albicollis (*Gmelin*), slides.

Saturday, 10 June

13. Norman Duncan Martin, Commonwealth Laboratory, Gore's Landing, Ontario. *Why Do Birds Show Vegetation Preferences?*
14. Louise de Kiriline Lawrence, Rutherglen, Ontario. *The Displays and Courtship of the Yellow-bellied Sapsucker* (Sphyrapicus varius).
15. Heinz Meng, State University College of Education, New Paltz, New York. *The Breeding Behavior of the Goshawk,* color film.
16. Robert W. Storer, Museum of Zoology, The University of Michigan. *Platform Behavior of the Horned, Eared, and Red-necked Grebes,* color film.
17. John L. Zimmerman, University of Illinois. *The Nest Guarding Behavior of the Male Catbird,* slides.
18. Ralph W. Dexter, Kent State University, Kent, Ohio. *Life History of a Thirteen-year-old Chimney Swift,* slides.
19. George Hills Kelker, Utah State University. *A Mathematical Estimation of Species Survival of the Condor, Whooping Crane, and Ivory-billed Woodpecker.*
20. L. M. Bartlett, University of Massachusetts. *Responses of Some Blackbirds to Phenylthiourea,* slides.
21. Glen E. Woolfenden, University of South Florida. *Osteology and the Systematic Position of the Mergansers,* slides.
22. J. Dan Webster, Hanover College, Indiana, and The California Academy of Sciences. *The Systematic Position of the Olive Warbler,* slides.
23. Fred T. Hall, Buffalo Museum of Science. *Birds of the Border,* color film.
24. Lawrence I. Grinnell, Cornell Laboratory of Ornithology, Ithaca, New York. *Australia Outback,* color film.
25. Gordon Bennett, Wildlife Research Station, Algonquin Park, Ontario. *Interrelations of Vector and Host in the Transmission of Some Avian Blood Parasites,* slides.

ATTENDANCE

Members and guests who attended totaled 250 persons. Twenty states, Ontario, Quebec, and Saskatchewan were represented.

From **California:** 1—*Dunmore,* Elizabeth A. Taft.

From **Connecticut:** 6—*Greenwich,* Mr. and Mrs. John C. Schmid; *Old Lyme,* Mr. and Mrs. Roger T. Peterson, Tory C. Peterson; *West Hartford,* E. Alexander Bergstrom.

From **Florida:** 3—*Daytona Beach,* Mr. and Mrs. C. H. Ekdahl; *Tampa,* Glen E. Woolfenden.

From **Georgia:** 1—*Athens,* Philip Kahl.

From **Illinois:** 15—*Blue Island,* Karl E. Bartel; *Champaign,* John L. Zimmerman; *Chicago,* Mrs. Amy G. Baldwin, William J. Beecher, Helen Horton, M. Lehmann, Margaret M. Nice, Paul A. Schulze; *DeKalb,* William E. Southern, James Tate, Jr.; *River Forest,* Mrs. I. B. Wasson, Charles A. Westcott; *Urbana,* Tom C. Jegla, Elden Martin, Ralph E. Yeatter.

From **Indiana:** 2—*Hanover,* J. Dan Webster; *Lafayette,* Russell E. Mumford.

From **Iowa:** 2—*Cedar Rapids,* Lillian Serbousek, Myra G. Willis.

From **Louisiana:** 2—*Thibodaux*, Mrs. Electra D. Levi, Ava R. Tabor.

From **Massachusetts:** 4—*Amherst*, Lawrence M. Bartlett; *Dover*, Mr. and Mrs. Aaron M. Bagg; *Wayland*, James Baird.

From **Michigan:** 26—*Albion*, Danny Dillery, Dean G. Dillery, Clara Dixon; *Ann Arbor*, Mr. and Mrs. Ralph Branch, Haven H. Spencer, Robert W. Storer, Harrison B. Tordoff; *Bloomfield Hills*, Walter P. Nickell; *Dearborn*, Mr. and Mrs. Joseph T. Woolfenden; *Grand Rapids*, Spencer Holmes, Bob Murray; *Grayling*, Mr. and Mrs. Fenn Holden; *Kalamazoo*, H. Lewis Batts, Jr., Judy Centa, Judy Cooper, Monica Ann Evans, Richard Koerker, Theodore List, Tracy Newkirk, James Spaulding; *Leonard*, Mrs. Don S. Miller; *Marquette*, Mrs. Mary Spear Ross; *Warren*, Sergej Postupalsky.

From **New Jersey:** 16—*Audubon*, Mr. and Mrs. Clarence E. Stasz, James Stasz; *Bound Brook*, Bertram G. Murray; *Clifton*, Joseph R. Jehl, Jr.; *Jamesburg*, Jeff Swineboard; *Maplewood*, Ann Chamberlain, Mrs. Richard R. Chamberlain; *Mountainside*, Mr. and Mrs. Albert Schnitzer; *New Brunswick*, Thomas C. Crebbs, Jr.; *Ramsey*, Mrs. Eleanor E. Dater; *Spotswood*, Mr. and Mrs. Stanley S. Dickerson; *Upper Montclair*, Charles W. Lincoln; *Westfield*, Norman B. Pilling.

From **New York:** 15—*Albany*, Mrs. Dayton Stoner; *Allegany*, Mr. and Mrs. Stephen W. Eaton, David Krieg; *Buffalo*, Harold H. Axtell, Fred T. Hall, G. John Lehrer, Richard C. Rosche, Edwin L. Seeber, Mr. and Mrs. Edward C. Ulrich; *Canton*, Robert G. Wolk; *Hornell*, Mr. and Mrs. William M. Groesbeck; *Ithaca*, Lawrence I. Grinnell, Barbara Ann Lund; *Long Island*, Lester L. Short, Jr.; *New Paltz*, Dr. and Mrs. Heinz Meng; *Olean*, Rev. Patrick D. D. Connor; *Syracuse*, Walter R. Spofford; *Williamsville*, Mr. and Mrs. H. D. Mitchell.

From **Ohio:** 21—*Ashtabula*, Howard E. Blakeslee; *Cincinnati*, Emerson Kemsies, Mr. and Mrs. Howard P. Walding, Jr.; *Cleveland*, Helen M. Focke, Adela Gaede, Eugene S. Morton, Mildred Stewart; *Columbus*, W. Todd Furniss; *Cuyahoga Falls*, J. Neil Henderson; *Dayton*, Kenneth L. Meyers; *Kent*, Mr. and Mrs. Ralph W. Dexter; *Lakewood*, Mr. and Mrs. William A. Klamm; *Madison*, Mrs. Bernice Dodge, Howard Walding; *Painesville*, Mrs. Robert V. D. Booth; *Toledo*, Dr. Miriam Bell, Robert Crofts; *Waterville*, Harold Mayfield.

From **Pennsylvania:** 10—*Allport*, Elsie Erickson; *Chester Springs*, Phillips B. Street; *Philadelphia*, C. Chandler Ross; *Pittsburgh*, Dr. and Mrs. Kenneth C. Parkes: *State College*, Mr. and Mrs. Earl R. Bordner, Dorothy Bordner; *University Park*, Dr. and Mrs. Merrill Wood.

From **South Dakota:** 2—*Sioux Falls*, Mr. and Mrs. J. Scott Findley.

From **Tennessee:** 3—*Knoxville*, Mr. and Mrs. J. C. Howell; *Nashville*, Amelia R. Laskey.

From **Utah:** 1—*Logan*, George H. Kelker.

From **Vermont:** 3—*Bennington*, Thomas H. Foster; *South Londonderry*, Mr. and Mrs. James R. Downs.

From **West Virginia:** 4—*Morgantown*, Mr. and Mrs. Maurice Brooks, George A. Hall, Earl N. McCue.

From **Wisconsin:** 10—*Beloit*, Carl Welty; *Cedar Grove*, Daniel D. Berger; *Madison*, Mr. and Mrs. Helmut C. Mueller, Mr. and Mrs. Richard Penneng; *Plainfield*, Elva Hamerstrom, F. N. Hamerstrom, Frances Hamerstrom; *West Bend*, Marvin E. Vore.

From **Ontario:** 89—*Collingwood*, A. J. Mitchener; *Don Mills*, Mr. and Mrs. John Livingston, Dr. and Mrs. J. Bruce Falls; *Dorset*, L. F. Hess, W. A. Morris; *Ft. William*, Mr. and Mrs. Jack Murrie; *Gore's Landing*, N. D. Martin; *Guelph*, Mr. and Mrs. Alex Cringan; *Hamilton*, Eric W. Bastin, Robert H. Curry, George W. North; *Huntsville*, Mr. and Mrs. Phil Bailey, Mrs. Fred Brook, Abbott Conway, Sr., Abbott Conway, Jr., Isabella Conway, Paul Conway, Mr. and Mrs. Jack M. Heron, Bessie McAlpine, Ambrey C. May, Ken Perrin, Dr. and Mrs. Ross Rogers, Mr. and Mrs. Ted Rogers, R. J. Rutter, Bessie Waters; *Kingston*, Mr. and Mrs. C. D. Quilliam; *Kirkland Lake*, Mr. and Mrs. Frederick Helleiner, Gertrude McClanahan; *North Bay*, Hazel Petty; *Ottawa*, Michael Spencer; *Pickering*, Dr. and Mrs. J. Murray Speirs; *Port Credit*, Mr. and Mrs. Harry McDougall; *Port Hope*, Albert B. Schultz, Jr.; *Rutherglen*, Louise de Kiriline Lawrence; *South Porcupine*, Mr. and Mrs. R. S. Raymer; *Sudbury*, W. Ross Lowe; *Toronto*, Dr. and Mrs. James L. Baillie, D. H. Baldwin, Find Bay, Mr. and Mrs. Fred Bodsworth, Mr. and Mrs. W. T. Clarke, George Francis, Greta Ford, Ronald L. Gaschen, Rosemary Gaymer, Dr. and Mrs. W. H. Gunn, Sylvian Hahn, Ida Hanson, Mr. and Mrs. P. A. Hardy, Mrs. J. D. Ketchum, James K. Lowther, Mr. and Mrs. R. McCleary, Mr. and Mrs. Robert L. MacMillan, Margaret D. Marsh, John A. Parker, John Sherrin, William W. Smith, Mr. and Mrs. Donald Sutherland, Laszlo J. Szijj, Mr. and Mrs. H. D. Wilkins, James Woodford; *Uxbridge*, Mr. and Mrs. W. H. Carrick; *Weston*, Clive E. Goodwin, D. J. T. Hussell; *Whitney*, G. E. Tayler; *Willowdale*, Hugh M. Halliday.

From **Quebec:** 4—*Montreal*, R. W. Stevenson; *Westmount*, John P. S. Mackenzie, Hon. Justice and Mrs. G. H. Montgomery, W. H. Rawlings.

From **Saskatchewan:** 1—*Regina*, Robert W. Nero.

No Address: Mrs. Gordon Hill.

This issue of *The Wilson Bulletin* was published on 1 September 1961.

Suggestions to Authors

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the AOU Check-list (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited; otherwise, follow the "Style Manual for Biological Journals" (1960. AIBS). Photographs for illustrations should be sharp, have good contrast, and be on 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.

THE 1962 ANNUAL MEETING OF THE
WILSON ORNITHOLOGICAL SOCIETY
will be held on
the Campus of Purdue University at
Lafayette, Indiana
on 6–8 April

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The Wilson Ornithological Society

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The Wilson Bulletin

The official organ of The Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Kalamazoo, Michigan. The subscription price, both in the United States and elsewhere, is $4.00 per year, effective in 1959. Single copies, $1.00. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at 50 cents each for 1950 and earlier years, 75 cents each for 1951–1958) and may be ordered from the Treasurer.

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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THE WILSON BULLETIN

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CONTENTS

General Notes

PINNATED BITTERN (*Botaurus pinnatus*) and male ALTAMIRA YELLOWTHROAT (*Geothlypis flavovelata*). Watercolor by Walter J. Breckenridge.

A NEW SUBSPECIES OF THE PINNATED BITTERN

Robert W. Dickerman

The Pinnated Bittern (*Botaurus pinnatus*) was first reported from Mexico from Laguna Chacanbacab, Quintana Roo by Paynter (1955). He observed at least ten bitterns each day spent in the field in that vicinity and collected two. These bitterns are apparently common on the coastal plain of Tabasco. I observed at least 15 in the marshes along the rivers in the region of Cantemo on 9 May 1955. One was collected that date, and two more were collected near Villahermosa on 17 May. Delwyn G. Berrett of Louisiana State University collected a juvenile on 9 April 1959, 18 miles northeast of Teapa. He reported (in litt.) that he saw several others. At a marsh four miles northwest of Tecolutla, in northern Veracruz (cf. Dickerman and Warner, p. 336) on 1 June 1959, I flushed a bittern. It was light-colored, and realizing the late date for a migrant, I collected the bird and immediately recognized that it was the same species as the Tabasco specimens. The seven specimens from Mexico prove to be an unnamed form which may be known as:

Botaurus pinnatus caribaeus, new subspecies.

Type: adult female, No. 34984, University of Kansas Museum of Natural History; Cantemo, Tabasco, Mexico; collected 9 May 1955 by Robert W. Dickerman (original No. 5906).

Characters: Differs from the nominate race in being lighter in color; streakings on the throat and flanks somewhat reduced; general tone of underparts creamy white in contrast to the buffy tan of *pinnatus*; undertail coverts and inside of thighs nearer white; dorsally, feather edges and barrings lighter, more buffy to cream, less deeply tan and ochraceous. There is a tendency for the black areas of the feathers to be somewhat reduced compared to *pinnatus*. The culmen averages longer. (For measurements see Table 1.)

SPECIMENS EXAMINED

Botaurus pinnatus caribaeus—Quintana Roo: Laguna Chacanbacab (2). Tabasco: Cantemo (1) ; 3 mi S of Villahermosa (2) ; 18 mi NE of Teapa (1). Veracruz: 5 mi NW of Tecolutla (1).

Botaurus pinnatus pinnatus—Nicaragua: Greytown (1). Colombia: Jamundi (1) ; Bogotá region (1) ; Guabinas, Río Cauca (1). Venezuela: Aragua, Lake Valencia (1) ; Mérida, Capaz (1) ; Mt. Auyan-tepui (1). Trinidad: Caroni Swamp (3). British Guiana: Annai (2), Buxton (2). Brazil: Primeri Cruz (1) ; Tanary, Rio Tapajoz (1). Paraguay: 195–200 km W of Pto. C'do. (Puerto Casado, 85 mi NNW of Concepción) (1) ; Orloff (1). Argentina: Barrancas al Sud (Prov. B. Aires) (1), Concepción, Tucuman (1) ; Mocovi (1).

Table 1

Measurements of *Botaurus pinnatus* in Millimeters

	No. of specimens	Wing		Culmen		Tarsus		Tail	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
caribaeus									
♂	2	291–301		94–95		103–108		106–107	
♀	4	272–281	276.5	84–89	86.4	97–104	100.5	96–102	99.0
Trinidad									
♂	3	301–309	306.3	90–92	90.6	101–105	103.7	107–117	113.7
pinnatus									
♂	8	267–336[1]	306.3	68–93	86.1	83–108	103.1	97–118	108.2
♀	8	275–350[2]	289.6	78–87	82.8	90–117	98.5	99–132	108.3

[1] Wing measurements of *pinnatus* include only six individuals of each sex.

[2] The upper measurements in each character are for a bird taken at Tucuman, Argentina. The next largest individual measurements for wing, tarsus, and tail are respectively 291, 105, and 108.

Remarks

The seven specimens of *caribaeus* show considerable variation. The darkest specimen, a female (KU 34983) from Tabasco, approaches a male of the nominate race from Brazil (MCZ 173069) in dorsal coloration, although it is differentiated by the racial characters given above. Ventrally this Tabasco specimen is pale, characteristic of *caribaeus*, although the lower neck and upper breast streakings are darker and more chestnut than any other specimen of this race. The palest *caribaeus* is a somewhat worn-plumaged female from Tabasco (KU 34984), although the specimen from Tecolutla, Veracruz (MNH 14152), a female in nearly fresh plumage, is almost as pale. Feather wear greatly affects the over-all dorsal coloration; in advanced stages of wear, the light borders of feathers may be entirely eroded away, leaving only the blackish central areas.

The specimen taken by Berrett is a juvenile. Its outer primaries are sheathed, and it is in body molt. The juvenal plumage is similar in pattern, but is slightly more buffy than the adult plumage. There may be heavier barring in the auricular region of adults than in immatures or juveniles. It appears that the characters attributed to adults and immatures by Sharpe and Ogilvie-Grant (1898: 263) might be reversed, the younger birds being lighter in coloration.

There is a slight size difference between the sexes of *Botaurus pinnatus* which is apparently not mentioned in the literature. (See Table 1 for measurments.) A second sexual character is a distinct banding or mottling throughout the central rectrices in the female. The mottlings are buffy to ochraceous in contrast to the nearly unicolor slaty-black central rectrices of the male, in which only the edges of the feathers may be clouded with the lighter color.

Three specimens, all males from the island of Trinidad, may represent an undescribed race. They differ from all of the other specimens at hand by having much heavier barring of the neck frills, the black bars usually being wider than the light bars. Unfortunately, two of the three specimens are soiled and grease burned, so over-all comparisons cannot be made. The culmen and tail measurements of these specimens average larger.

ACKNOWLEDGMENTS

For the loan of specimens I wish to acknowledge the consideration of the curators of the following institutions: The Academy of Natural Sciences, Philadelphia; American Museum of Natural History; Chicago Natural History Museum; Museum of Comparative Zoology, Harvard College; Museum of Natural Science, Louisiana State University; Museum of Zoology, University of Michigan; Peabody Museum of Natural History, Yale University; United States National Museum; and University of Kansas Museum of Natural History. I am particularly grateful to Richard Johnston and the University of Kansas Museum of Natural History for the loan of three Tabasco specimens. George H. Lowery of the Louisiana State University kindly loaned the juvenile specimen.

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Paynter, R. A., Jr.
1955 The ornithogeography of the Yucatan Peninsula. *Peabody Mus. of Nat. Hist. Yale Univ. Bull.*, 9.
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1898 Catalogue of the Birds in the British Museum, Vol. 26.

UNIVERSITY OF MINNESOTA MUSEUM OF NATURAL HISTORY, MINNEAPOLIS, MINNESOTA, 11 DECEMBER 1959

DISTRIBUTION RECORDS FROM TECOLUTLA, VERACRUZ, WITH THE FIRST RECORD OF *PORZANA FLAVIVENTER* FOR MEXICO

Robert W. Dickerman and Dwain W. Warner

The coastal plain of the state of Veracruz, Mexico has probably been traversed by more ornithologists than any other portion of the country. The recent Distributional Checklist of the Birds of Mexico (Friedmann et al., 1950, and Miller et al., 1957) included all records from the region, and Loetscher (1955) summarized the records of North American migrants from Veracruz. On 26 and 27 April and 1 and 2 June 1958, while accompanied by Bruce J. Hayward, Dickerman visited a small fresh-water marsh located about 4.5 miles northwest of Tecolutla. He revisited the marsh briefly on 6 November 1958 with Warner and John R. Tester. During these short visits, 25 specimens of 10 species were prepared. The collection includes two forms new to Mexico, and extends the ranges of three other species formerly known in Mexico only from the states of Chiapas and Quintana Roo. Four species not recorded before in Veracruz were collected or observed.

The marsh is located three to four miles behind the beach dunes along the coast. It is one mile north of the Tecolutla-Poza Rica highway from which it is not visible. The part of the marsh visited was 40 to 60 acres in extent, but the marsh must vary greatly in size with variations in water level. On the inland side of the marsh are low rolling hills partly heavily vegetated with tropical lowland forest and partly cleared for farming. Springs from the base of the hills feed the marsh. Immediately against the base of the hills is a stand of several acres of cattails and bulrushes. Spreading outward from this are extensive marsh meadows of shorter grasses, *Equisetum*, *Pontederia*, and other emergent aquatics, with several ponds scattered about close to the cattails or in depressions elsewhere.

A large shallow pond which was present on the south side of the dense cattails on the April visit provided a resting area for numbers of Black-bellied Tree Ducks, Blue-winged Teal, and a few other ducks. Its muddy edges were used as feeding areas for shore birds and American Coots. Several deeper smaller ponds were found farther out in the marsh. These varied in depth from one to four feet. They contained white water lilies and water hyacinth and were bordered by taller stands of *Pontederia,* bulrushes, and other emergent aquatics. The open marshy meadow was dissected by ditches and deep wagon ruts which were often obscured by dense plant growth, causing frequent soakings of the investigators. A few shrubby trees, mostly *Acacia*, grew on the higher areas of the marsh.

The growth of vegetation and fluctuations of water level made work in the marsh increasingly difficult as the season progressed. On the first visit the grasses were about eight to twelve inches tall; on 1 June all of the vegetation had increased greatly in density and there were no open areas of water. The marsh was barely penetrated on the November visit due to the great difficulty in wading through knee-deep water with dense tangles of tough trailing stolons from the grasses.

The following annotated list includes only species whose status was found to differ from that in the references cited above, or where previous records are scarce. All specimens were collected by Dickerman unless otherwise noted. Taxonomic comments on *Pardirallus* and *Laterallus* are based on his examination of specimens in certain collections mentioned in the acknowledgments. The Pinnated Bittern (*Botaurus pinnatus*) from this collection is discussed by Dickerman elsewhere in this issue (pp. 333–335).

White Pelican (*Pelecanus erythrorhynchus*).—Seventy-five seen over the marsh on 26 April and a flock of about 200 flew over the town of Tecolutla on the coast on 2 June. The latest previous date for the species in Veracruz is 16 April.

American Bittern (*Botaurus lentiginosus*).—Three were seen on 27 April, two on 2 June, and one on 6 November. One seen on 27 April and one on 2 June were crippled; the former was collected. On 6 November, Warner shot an odd appearing bird flying over a nearby field that proved to be an oil-stained bittern of this species. The region is one of extensive oil fields.

Virginia Rail (*Rallus limicola*).—Two were flushed from the deep grass on 26 and 27 April.

Spotted Rail (*Pardirallus maculatus*).—Bruce Hayward and Dickerman first entered the edge of the marsh about 8:30 AM on 26 April. They were almost immediately attracted by a sound not at all unlike very muffled "pumpings" of the American Bittern. The calls came from a stand of a large *Carex* that was taller than the surrounding flooded grassy meadow. Approaching closer and closer, and even standing at the edge of this small clump, nothing could be seen but the sounds continued. Finally rushing into the taller plants, Dickerman flushed a large rail at his feet, and shot it before it had flown far. It was a Spotted Rail. He heard one or two others calling, and, within an hour's tramping had flushed two others, one of which he was able to collect. On 1 June Dickerman flushed one pair and one or two single birds, and on 2 June another pair and one or two more single birds were flushed. A third specimen was collected on 1 June. On 6 November, two or three birds were flushed, but could not be collected.

The soft parts of the first bird (unsexed) taken 26 April were recorded in the field. The "feet were pale orange-red, near 'old rose.' The bill was pale yellowish-green, with a Chinese red spot near the base of the lower mandible. Iris red." The bill of the female taken the same day was noted to be similar in color but slightly darker. All three birds had moderate to heavy fat; the first, shot at close range, was not sexed or weighed. The female weighed 161 grams; a male taken on 1 June weighed 211 grams. These two birds in the flesh measured: length 298 and 322, and extent 410 and 430 mm., respectively.

The Spotted Rail was previously known in Mexico only from the region of Tuxtla Gutiérrez, and Ocozocoautla Chiapas (del Toro, 1958). The race *insolitus* is known only from the type specimen from Ycacos Lagoon, British Honduras and from Chiapas. The Tecolutla birds were compared with the type of *insolitus* at the Museum of Comparative

Zoology and were found not to differ from it in any significant way. The type is a worn bird taken in June 1907, and may show some foxing. The deep chocolate brown edgings of *insolitus* are even more pronounced in the less worn Tecolutla specimens. *Insolitus* shares with *inoptatus* the character of having white spots instead of long streaks on the inner remiges, upper wing coverts, and tertials as in *maculatus.* Within each of the races there is great variability in the width of the ventral white barring and size of the white spots on the dorsal parts. Some individuals have the black bars of the ventral surface so reduced as to give the appearance of having nearly white throats and bellies. The relation of this variation to age and sex, if any, is unknown.

Sora (*Porzana carolina*).—Except for the following species, Soras were the commonest rail in the marsh. On the first visit, 26 and 27 April, about ten were seen. Two were seen and one was heard calling on 2 June, a late date for spring migrants. One or two were seen during the few minutes spent in the marsh on 6 November.

Yellow-breasted Rail (*Porzana flaviventer woodi*).—This diminutive species was the commonest rail in the marsh. It was encountered on every visit to the marsh except the last one on 6 November. During morning and evening collecting periods on 26 April, and in the morning of the following day, at least nine of these little rails were seen and three were collected. During the visits in late afternoon on 1 June and early morning on 2 June, 30 were estimated to have been seen, six of which were collected. The birds were seen only as they flushed and fluttered weakly over the grass before dropping back into the dense vegetation. From the manner in which the birds flushed, Dickerman gained the impression that they were high up in the somewhat matted grasses a foot or more above the water. As many as three were seen flying at the same time.

The race *woodi* was described by van Rossem (1934) from two specimens taken at Lake Olomoga, El Salvador. He separated *woodi* from the Antillean races *hendersoni* and *gossii* on the following basis: crown (of males) paler, pectoral region whiter, median upper parts browner, less blackish, dorsal white markings narrower and less extensive, black loreal streak narrower (1 mm. wide). In comparing the nine Tecolutla birds, the topotype of *woodi,* and a specimen from 7 miles W. of San Carlos, San Juan River, Nicaragua taken 2 (?) May 1917, with eleven *gossii* and five *hendersoni,* we find that none of the above characters as described is of value in separating *woodi* from the Antillean races. We are unable to find characters to separate the Mexican birds from the topotype or the Nicaragua specimen. Hence, the mainland population as a whole and *hendersoni* are separated from *gossii* only by size (Table 1). Three specimens of *hendersoni* at hand, all in relatively little worn plumage (13 February, 11 March, and no date), are easily separable from all specimens of *woodi* and *gossii* by being lighter, more sandy buff, and less ocheraceous on all light edges of wing feathers. One *woodi,* a worn and faded specimen in heavy molt, is paler, but remains less sandy than the three *hendersoni.* Two worn *hendersoni* (13 June and 15 July) are lighter in color when compared feather area by feather area to worn *woodi* and *gossii.* We can find no color difference of value in separating *gossii* and *woodi.*

The northern races are separated from the South American forms as described by previous authors, and by size (Table 1). No significant geographic variation was found among the 29 specimens of the race *flaviventer* at hand.

Four males of *woodi* weighed 25.0 to 28.8 (average 26.5) grams. Five females of *woodi* weighed 24.0 to 28.3 (average 25.3) grams.

The immature plumages of *Porzana flaviventer* have not been described. One bird in post-juvenal molt, a female No. 13278 in the H. B. Conover Collection (Chicago Natural History Museum) from 170 Km. W. Puerto Casado, Paraguay, has the barring on the flanks continuing to the tips of the ocheraceous-buff feathers of the sides of the breast.

TABLE 1

MEASUREMENTS OF *Porzana flaviventer* IN MILLIMETERS

	No.	Wing Cord		Tarsus		Culmen	
		Range	Mean	Range	Mean	Range	Mean
gossii[1]	16	63.5–71	67.6	20 –24	22.7	16 –18	17.2
	11	65–74	68.5	20 –24.5	22.5	15.5–17.5	16.3
hendersoni	2	62, 63		20.8, 22.4		15.7, 16.6	
	3	61–64	62.7	22.0–22.6	22.36	15.2–16.0	15.56
woodi	5	61–63	62.0	21.0–22.7	21.82	15.0–17.0	16.27
	6	63–66	63.9	21.6–22.6	22.13	14.5–15.9	15.23
flaviventer	14	64–73	69.0	22.0–25.6	23.68	15.1–17.0	16.33
	13	66–79	70.7	20.6–24.8	22.80	14.4–15.6	14.92

[1] Measurements for *gossii* taken from Ridgway and Friedmann (1941: 146).

A second specimen from the same locality taken on 2 March (Conover Coll. 96143), still retains minute bars of black on some of the breast feathers. Several of the Tecolutla birds taken on both visits were in heavy body molt.

Black Rail (*Laterallus jamaicensis jamaicensis*).—A male in rather worn plumage was collected on 2 June. Its testes were slightly enlarged, measuring 6 × 4 mm. right, and 5 × 4 mm. left. Its measurements are: wing 68 mm., tarsus 2.15 mm., culmen 14.4 mm., middle toe without claw 22.1 mm. In the flesh its length measured 162 mm., its extent 240 mm., and it weighed 32.8 grams. It was moderately fat and was in general molt. Moreno (1953) assembled the sparse material available from the West Indies and failed to find valid characters to separate the named eastern races.

Golden Plover (*Pluvialis dominica*).—A female was taken from a flock of mixed shore birds on the shallow open pond on 27 April. It presumably belongs to the eastern race, although its measurements made before skeletonizing are not determinate, being: wing 174 mm., tail 67 mm. The flock of shore birds included Greater and Lesser Yellow-legs, Pectoral and Least Sandpipers, one Common Snipe, two Upland Plovers, and at least two Long-billed Dowitchers.

Stilt Sandpiper (*Micropalama himantopus*).—Four or five were present in the above group of mixed shore birds. Two were collected, and are apparently the first specimens of the species taken in Veracruz.

Caspian Tern (*Hydroprogne caspia*).—On 26 April, Bruce Hayward and Dickerman saw about 15 sitting on a sandy spit at the mouth of the Río Tecolutla in company with about 25 Laughing Gulls and 30 Sandwich Terns.

Mourning Dove (*Zenaidura macroura*).—During 26 and 27 April several hundred Mourning Doves were seen lining power lines and fences and feeding in flocks in pastures.

Swallows (Hirundinidae).—The evening of 25 April when Hayward and Dickerman arrived in the Tecolutla area they saw many hundreds of migrating swallows. The following two days they were also present in these large numbers. Bank and Barn Swallows each formed about half of the assemblage, with but a very occasional Tree, Rough-winged, and Cliff Swallow seen. One Barn Swallow was seen on 2 June.

Long-billed Marsh Wren (*Telmatodytes palustris*).—Three specimens were collected and eight or more Long-billed Marsh Wrens were seen 26 and 27 April. They tended to be secretive, and some appeared to be in heavy molt. The three specimens, all females, had moderate fat to excessive fat, and weighed 10.9, 11.3, and 11.8 grams. The oviduct on the heaviest was very slightly enlarged. None was seen on 2 June.

Altamira Yellowthroat (*Geothlypis flavovelata*) (see frontispiece).—An adult male was taken 27 April, and a pair of very worn birds was preserved in formalin on 2 June. During the earlier visit this species was greatly outnumbered by migrants of the "Common" Yellowthroat (*Geothlypis trichas*). On 2 June little attention was accorded this group and Dickerman did not notice if the "*trichas*" type was present in the marsh. This extends the range of *G. flavovelata* 130 miles southeastward from its known range in the vicinity of Tampico, Tamaulipas.

Swamp Sparrow (*Melospiza georgiana*).—One was seen 27 April by Dickerman. This apparently adds a new species to the state's list.

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UNIVERSITY OF MINNESOTA MUSEUM OF NATURAL HISTORY, MINNEAPOLIS, MINNESOTA, 11 DECEMBER 1959

INTERSPECIES FLOCKING OF BIRDS OF MONTANE FOREST IN OAXACA, MEXICO

Lester L. Short, Jr.

Foraging bird flocks containing several to many species are frequent during the non-breeding period in most of the world. I observed such flocks while participating in a Cornell University field expedition to Mexico, during August 1954. The observations were made from 26 to 29 August in pine–oak woodland at an elevation of about 9,300 feet in the vicinity of La Cumbre, 5 miles northeast of Cerro San Felipe, Oaxaca (see Sibley, 1950, pp. 152–154 for a description of this area). A number of foraging flocks were encountered, but only those watched for a period exceeding five minutes are mentioned below.

OBSERVATIONS

On 26 August two small foraging flocks were observed about one mile north of La Cumbre. Both flocks moved through the area of observation within seven minutes. The birds paid no attention to me as far as I could determine. Both flocks were composed of Gray-barred Wrens (*Campylorhynchus megalopterus*) and Spotted-crowned Woodhewers (*Lepidocolaptes affinis*), while a single male Hairy Woodpecker (*Dendrocopos villosus*) was also present in one flock. The wrens outnumbered the woodhewers by about three to one in both flocks (8:3 and 11:4). The constantly calling wrens generally foraged at middle elevations in the oaks, especially along the smaller branches. Occasional individuals flew to the ground to retrieve fallen food. The woodhewers foraged mainly on the trunks and major limbs of the trees.

One flock was observed near camp on 27 August. Only wrens were seen in this flock numbering about 20 birds, although individuals of other species may have been present, escaping detection in the dense foliage and undergrowth.

A large flock was observed in a small valley between La Cumbre and Cerro San Felipe on the morning of 28 August. The bulk of this flock was comprised of about 30 Gray-barred Wrens, a dozen Dwarf Jays (*Cyanocitta nana*), and eight Spotted-crowned Woodhewers. A pair of Mountain Trogons (*Trogon mexicanus*) (both collected later, see below) moved with the flock, perching quietly and not feeding. Two Steller's Jays (*Cyanocitta stelleri*) were also present in the flock. Wrens and jays called constantly, though not very loudly. The notes of the Dwarf Jay were similar to the "conversational" notes of the Blue Jay (*C. cristata*). At distances of 50 yards or more from the flock normal calls of all species were inaudible. In 15 minutes the flock moved 200 yards up the valley.

During the afternoon a small flock of Gray-barred Wrens (6–8) and Dwarf Jays (2) was noted about a mile north of the area in which the larger morning flock was observed. No trace of the latter flock was found late in the afternoon in the area in which it had been early in the day.

On 29 August three flocks were encountered one mile east–northeast of the valley in which the large flock of the previous day was seen. One of these was a small flock of about 20 birds, including Gray-barred Wrens (10–12), Dwarf Jays (4), and Spotted-crowned Woodhewers (4). The birds of this flock seemed more wary than others encountered, with vocalizations lower and more sporadic than in other flocks.

A second flock encountered about one-half mile north of the first contained a larger number of individuals and species. Species in this flock were Gray-barred Wrens (about 20), Dwarf Jays (5–6), Steller's Jays (2), Red-shafted Flickers (*Colaptes auratus*) (4), Spotted-crowned Woodhewers (4–5), one Hairy Woodpecker, and several Chestnut-capped Brush-finches (*Atlapetes brunnei-nucha*). The brush-finches were with the flock for the entire 20 minutes of observation, moving some 200 yards uphill in the pine–oak forest. Individuals were noisy (particularly wrens and jays), although most of the notes carried little. Diversity in foraging habits was exhibited with brush-finches on the ground, flickers mostly on the ground, the Hairy Woodpecker and woodhewers on the trunks and lower branches, and jays and wrens in the foliage. Dwarf Jays seemed more deliberate in their movements than the Steller's Jays, although the latter may have been more excited due to my presence. The wrens fed well up in the foliage, rarely descending into the undergrowth.

Over a hill to the west a larger flock was observed for several hours. It contained Gray-barred Wrens (35–40), Dwarf Jays (10–12), Spotted-crowned Woodhewers (10–12), Strong-billed Woodhewers (*Xiphocolaptes promeropirhynchus*) (2), one Mountain Trogon, several flickers, two Hairy Woodpeckers, Chestnut-capped Brush-finches (5), and Collared Towhees (*Pipilo ocai*) (3). Wrens and Dwarf Jays seemed to initiate forward movement of the flock. The flock moved along a hill to the north, across a ravine and then westward, covering about a mile while observed. The Strong-billed Woodhewers were wary, and disappeared about 20 minutes after I appeared. Collared Towhees were seen in only one area, and were with the flock for but a short time. Brush-finches were present constantly, but I could not determine whether or not the same individuals were involved. One interspecific encounter was noted, that being between a Gray-barred Wren which had flown to the ground after a food particle it had dropped and a brush-finch feeding close by. The latter was attracted to the fallen particle, but was driven off by the wren. Encounters between or among wrens were frequent, but these were generally hidden by the foliage.

The following specimens were collected from foraging flocks near Cerro San Felipe:

Trogon mexicanus.—Male and female (Cornell Univ. Collection Nos. 26372 and 26371). Probably a pair as the two were closely associated. Taken 28 August from the largest flock observed. Gonads of both less than two millimeters.

Lepidocolaptes affinis.—Male and female (C.U. Nos. 26364 and 26363). Secured 28 August, one from an interspecies flock and one feeding alone. Both were adults, the male with testes under 2 millimeters and the female with a slightly enlarged ovary (5 mm.).

Cyanocitta nana ("*Cyanolyca*" *nana*; see Amadon, 1944; 6).—Adult female (C.U. No. 28363). Obtained on 27 August. Ovary slightly enlarged (5 mm.). The primary molt was in progress.

Campylorhynchus megalopterus.—Juvenile (sex ?, C.U. No. 26388). Collected on 26 August.

DISCUSSION

Aggregations of birds similar to those encountered in Oaxaca have been variously called parties, flocks, groups, bands, companies, assemblages, associations, and aggregations. It seems appropriate to use the term "flock" for such an association. A flock may be intraspecific or interspecific. There may be several types of flock activity, such as foraging or migrating, which can be used to further define the phenomenon. The Mexican flocks noted above may be designated interspecific foraging flocks.

Observations on flocks in Oaxaca tend to support certain points which have been noted by previous authors. Mitchell (1957) reported the rapid movement of foraging flocks in southeastern Brazil, noting that species with very different feeding methods keep pace with the general movement of the flock. Stanford (1947) has noted that Burmese birds which feed deliberately are able, nevertheless, to keep up with faster moving species in foraging flocks. Further observations on these movements are desirable. Miller (1922), Wing (1946), and Davis (1946) have stressed the importance of calls in keeping the flocks together. It seems evident that the constant calling of individuals in the Cerro San Felipe flocks served such a function, because the fog and general darkness of the pine–oak woodland on the slopes of the mountain often rendered the birds inconspicuous, if not undetectable.

The species found in the Mexican foraging flocks may be categorized as nucleus species, regular attendant species, irregular attendant species, and accidental species (modified from Rand, 1954, and Winterbottom, 1949). (See also Davis, 1946.) Although arbitrary to a considerable degree, these terms are useful. Nucleus species are those which are essential to flock formaiton and maintenance. Individuals of nucleus species are among the most numerous birds in the flock, if not the most numerous. These may occur in intraspecific foraging flocks. Regular attendant species are those occurring regularly in interspecies foraging flocks, but which are not essential to flock formation and maintenance. They usually occur in fairly large numbers. Irregular attendant species are found less commonly and in smaller numbers, but are an active part of the flock when they do occur. Accidental species are those not actually moving with the flock for long periods, but which feed locally with the flock. Species encountered in interspecific foraging flocks in Oaxaca can be categorized as follows (general foraging areas indicated in parentheses):

I. Nucleus Species
  1. Gray-barred Wren (middle, upper and lower arboreal).
II. Regular Attendant Species
  1. Dwarf Jay (upper, middle arboreal).
  2. Spotted-crowned Woodhewer (middle lower arboreal).
III. Irregular Attendant Species
  1. Mountain Trogon (upper, middle arboreal).
  2. Steller's Jay (upper, middle arboreal).
  3. Red-shafted Flicker (terrestrial).
  4. Hairy Woodpecker (upper, middle, lower arboreal).
  5. Strong-billed Woodhewer (lower, middle arboreal).
IV. Accidental Species
  1. Collared Towhee (undergrowth).
  2. Chestnut-capped Brush-finch (undergrowth).

There is considerable disagreement concerning the relative importance (i.e., biological advantage) of flocking behavior exhibited by species participating in foraging flocks. The advantage of protection offered to individuals in such flocks has been pointed out by Miller (1922), Hindwood (1937), Allee (1938), Mitchell (1957), and others, but Winterbottom (1949) was skeptical about the protective value of flocking, and Rand (1954) considered it unimportant. There are two means by which individuals in a foraging flock may achieve greater protection than while foraging alone. One is due to the increase in the number of "receptor systems" (individuals) available for detecting potential predators. The other is by the "confusion effect" (Allee, 1938) or distraction of predators due to the presence of numbers of prey making it difficult for any predator to select and seize one individual from the flock. The value of the presence of more individuals to detect predators is self-evident. However, there is a possibility that this advantage may be overweighed by the increased attraction of predators to flocks due to the concentration of activity and vocalizations associated with them. The importance of the "confusion effect" is demonstrated by Miller's (1922) observation of the distraction of a predator (Sharp-shinned Hawk) upon encountering a foraging flock (of bush-tits). This observation suggests that selection may favor the avoidance of such flocks by predators.

Mutual aid in finding food is considered by some authors (e.g., Swynnerton, 1915; Gannon, 1934; Rand, 1954) to be a primary factor in the formation of foraging flocks. The discovery of a large food supply by one bird may attract others, enabling the sharing of food. This sharing probably involves a decrease in aggressiveness on the part of the discoverer of a food source as it feeds, the bird allowing closer approach by other individuals as its hunger diminishes. Another passive type of mutual aid is afforded members of foraging flocks by the movement of individuals occasionally causing insects in their paths to fly up, allowing their capture by other birds. This type of mutual "aid" would benefit species which chase after insects, but would not benefit species with other habits, as noted by Winterbottom (1943).

Probably of greater importance than protection or mutual aid is the efficiency gained by the foraging of birds in a given area in flocks, rather than individually. The rapid movement of the flock and the spacing of individuals within it (by birds maintaining individual distances, see discussion by Emlen, 1952) lessen the chance of one bird foraging in an area which has previously been worked over by another individual. The speed with which a flock moves may be adjusted rather precisely to provide an optimum period of feeding in each area with a minimum of wasted effort due to individuals moving into areas previously subjected to foraging. If this is so, small flocks with fewer individuals should progress more slowly than larger ones. Further observations are needed to determine whether or not this is true. At any rate, the spacing of individuals in foraging flocks, and the speed with which they move seem to insure a minimum of duplication of effort. Species which form intraspecific foraging flocks probably become the nucleus species of interspecific flocks because they have evolved habits and movements which by their nature lend themselves to use in regulation of the foraging activities of other species as well. Miller (1922: 126) aptly expresses the importance of feeding efficiency in foraging flocks as follows: "The flock represents the most economical method by which a given number of individuals can occupy a given foraging range." He points out the conservation of time and energy offered by this method, and also emphasizes the importance of individuals in such flocks crossing paths less frequently than they would if foraging individually.

Gregariousness has been stressed as the most important reason for flocking by Gannon (1934) and Sedgwick (1949). While there is little doubt that gregariousness or individuals' motivation to associate actually functions to form and maintain the flock, it is evident that such gregariousness is the means by which selection has brought about flock formation, answering the "how" of flocking rather than the "why." The "why" of foraging flocks may be answered by the biological advantages accruing to individuals participating in such flocks. These advantages include an increase in feeding efficiency, an increase in protection from predators and mutual aid in locating food.

SUMMARY

Observations on several interspecific foraging flocks encountered during late summer in the highlands of Oaxaca, Mexico, are reported. Information is presented on species comprising the flocks and on flock movements. Some details of habits and calls of species involved are included. Categories of species observed in the flocks are nucleus species, regular attendant species, irregular attendant species, and accidental species. Advantages afforded individuals in foraging flocks are a greater feeding efficiency, protection from predators, and mutual aid in finding food. Flock formation and maintenance are due to the tendency of individuals to associate, i.e., the gregariousness characteristic of the species involved.

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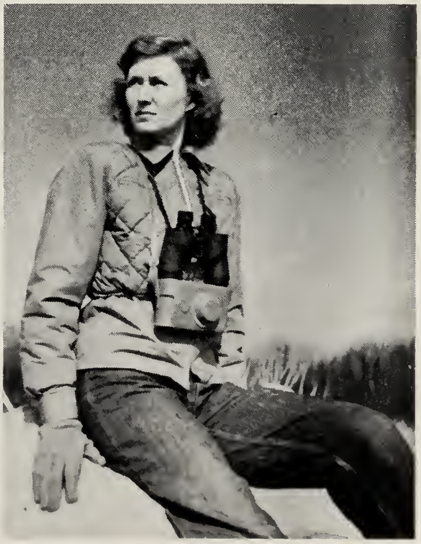
DEPARTMENT OF BIOLOGY, ADELPHI COLLEGE, GARDEN CITY, NEW YORK, 16 DECEMBER 1960 (ORIGINALLY SUBMITTED 12 SEPTEMBER 1960)

NEW LIFE MEMBER



Mrs. M. Stuart Roesler (Carol Stevenson), of Cos Cob, Connecticut, has been an active member of the Society since 1949, and is interested in warblers, bird behavior, life histories, and migration and the effects of weather upon it. She is a Life Member of the AOU, a member of the National Audubon Society, the Wilderness Society, the Sierra Club, and many others. Her hobbies include botany, wildflower photography, and painting landscapes with water colors. Between her two children, both married, one is an avid bird enthusiast.

COMPARATIVE NOTES ON THE LIFE HISTORY OF THE CAROLINA CHICKADEE[1]

Richard Brewer

A knowledge of the life histories of closely related organisms is basic to understanding their ecological and evolutionary relationships. The Carolina and Black-capped Chickadees (*Parus carolinensis* Audubon and *P. atricapillus* Linnaeus) are sibling species occupying essentially allopatric breeding ranges. Where their ranges are contiguous in western Illinois and eastern Missouri, interbreeding apparently occurs, with the production of a zone in which a large proportion of the birds may be hybrids. This paper presents information on certain aspects of the life history of the Carolina Chickadee, along with comparative material on the Black-capped Chickadee and on a population occurring at the line of contact between these two species.

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PROCEDURE

Field work was conducted from October 1954 to November 1959. Although some supplemental observations were made in Indiana, Michigan, Missouri, North Carolina, Tennessee, and Texas, the principal areas of investigation were the following counties of Illinois: Bond, Champaign, Clinton, Coles, Cumberland, Douglas, Effingham, Fayette, Jackson, Piatt, Randolph, Shelby, Washington, and Williamson. Observations of the population believed to be composed partly of hybrid birds were confined to the areas along the Kaskaskia River around Vandalia (Fayette County), Illinois, and (observations on vocalizations only) areas in St. Louis and Jefferson Counties, Missouri. Specifically, the area in Illinois included in observations of what will be referred to as the Vandalia population was from the level of Wrights Corner south to near the level of Vernon (i.e., from Sec. 28, T. 8 N., R. 2 E. of the St. Elmo quadrangle to Sec. 34, T. 5 N., R. 1 W. of the Vandalia quadrangle).

Only a few birds, all in the breeding season, were marked. Marking was by means of colored airplane dope applied to the tail feathers. Individual recognition of members of mated pairs was usually possible without marking,

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[1] Based on a doctoral thesis in the Dept. of Zoology, Univ. of Ill., Urbana.

through differences in appearance. Attentiveness data were gathered directly, without use of mechanical recording devices. To allow direct observation of the nest, five nest stubs, including both species and the Vandalia population, were treated in the method described by Odum (1941*a*): a small, square panel was sawed out of the front of the stub and wired in place. It could be removed and replaced for brief observations of eggs or nestlings.

One brood of Carolina Chickadees (on 3 June 1958) and one of Black-capped Chickadees (on 18 June 1958) were brought into the laboratory after sawing off the nest stubs containing them. Each brood was about 13 days past hatching. The stubs were placed in adjacent flight cages. The Carolina Chickadees were left in their own nest stub until they fledged; the Black-capped Chickadees were placed in the by-then-deserted Carolina nest stub for ease of observation. The Carolina Chickadees were hand-fed from the time they were brought in until they were able to feed independently. The Black-capped Chickadees were hand-fed only on the day of collection; after that, one parent which had been trapped with the young but separated from them was introduced into the flight cage and allowed to resume feeding. The food provided was mealworms (*Tenebrio* sp.) and hamburger.

FLOCK FORMATION AND WINTER BEHAVIOR

Within two to three weeks after fledging, young chickadees become independent of their parents. At this time, young from various family groups may form loose aggregations. These aggregations wander about more extensively than during the period of dependence, when the family group stays in a small area on or near the breeding territory. The adults tend to confine their activities to areas on or near their territory for a time but later join or are joined by other birds and begin to move over a larger area.

Dixon (1959), working with Carolina Chickadees in Texas, reported that this species formed small winter flocks with a home range of about 10 acres (Dixon, in litt.). Organization of the flock was hierarchical with resident pairs dominant. Contrasting the situation he observed with conditions reported for the Black-capped Chickadee (Butts, 1931; Odum, 1941*a*, 1941*b*, 1942*a*), Dixon suggested that Carolina Chickadees may possess a stronger pair bond, be less mobile, and form smaller flocks. It seems possible that these apparent differences may be responses to climate and food supply based on traits that are common to the two species. It is clear that in both species winter dominance is related to breeding-season territoriality, dominant birds tending to have breeding territories included in the winter home range (Dixon, 1959; Odum, 1942*b*; Hamerstrom, 1942). There is no obvious difference in strength of the pair bond, inasmuch as both species tend to pair for life (see "Pair Formation"). Probably flock size, as well as the degree of constancy of flock composition, varies with many factors both of the birds themselves and of the environment. For example, Johnston (1942) has pointed out the tendency of Black-capped Chickadee flocks to disperse at temperatures above 25°C. In Illinois, where both species may be found at the same latitudes, mean flock size (considering any group of chickadees encountered in the winter as a flock) for 21 Carolina Chickadee flocks was 3.3 birds (S.E. = 0.253), and for 16 Black-capped Chickadee flocks it was also 3.3 (S.E. = 0.034). Obviously, no significant difference exists between the two means. Mean size for eight flocks of the Vandalia population was 3.8 (S.E. = 0.558), which is not significantly different from either parental species. In Illinois, both species appear fairly regularly in twosomes. Laskey (1957) has stated for Carolina Chickadees in Tennessee that these twosomes may be either a mated pair, adult and young, or two young birds.

The winter home range found by Dixon in Texas is small, but Nice (1933) calculated that one pair of Carolina Chickadees in Ohio had a home range of about 35 acres in one winter. This is about the same size at that found for Black-capped Chickadees in New York and Michigan (Butts, 1931; Odum, 1942*b*; Batts, 1957). The observation of Batts that home ranges tend to increase in size as the winter progresses suggests that food may be an important factor in determining their size. If this is true, smaller home ranges in the southern United States might be expected.

In both species of Chickadees (Odum, 1942*a*; Hamerstrom, 1942; Dixon, in litt.), well-defined uni-directional dominance orders are present. Dixon found that in the small flocks on his study areas the relationship was linear, but in the larger assemblages studied by Odum and Hamerstrom, deviations from complete linearity were observed.

Chickadees are often encountered in feeding parties composed of a number of species. These parties often include migrant warblers and vireos in the autumn and spring, and Odum (1942*a*) believed that aggregations with these species are held together by definite social bonds. The parties tend to move as groups, and call notes, particularly alarm notes of chickadees (and titmice) tend to have some integrating action on the other species. From autumn to spring, certain winter and permanent resident birds are frequently associated with chickadees. In Illinois, Tufted Titmice are the most constant associates of chickadees when they form interspecific feeding parties (Table 1). White-breasted Nuthatches, Golden-crowned Kinglets, Brown Creepers, Red-bellied Woodpeckers, and Downy Woodpeckers are also fairly frequent associates.

The temporary nature of these parties, resulting partly from differences between the species in vegetational requirements and in rates of travel, has been commented on by several writers (e.g., Odum, 1942*a*; Fitch, 1958). Butts (1927) stated that Black-capped Chickadees spent about one-sixth of their time in company with White-breasted Nuthatches.

TABLE 1

OCCURRENCE OF VARIOUS BIRD SPECIES IN 24 FEEDING PARTIES WITH BLACK-CAPPED CHICKADEES, 8 FEEDING PARTIES WITH CAROLINA CHICKADEES, AND 5 FEEDING PARTIES WITH CHICKADEES OF THE VANDALIA POPULATION[1]

Species	Carolina Chickadee		Black-capped Chickadee		Vandalia Population	
	No.	Per cent	No.	Per cent	No.	Per cent
Tufted Titmouse (*Parus bicolor*)	8	100	20	83	3	60
Downy Woodpecker (*Dendrocopos pubescens*)	5	62	11	46	2	40
Golden-crowned Kinglet (*Regulus satrapa*)	3	38	1	4	2	40
White-breasted Nuthatch (*Sitta carolinensis*)	2	25	17	71	4	80
Red-bellied Woodpecker (*Centurus carolinus*)	2	25	8	33	2	40
Brown Creeper (*Certhia familiaris*)	2	25	7	29	3	60
Red-breasted Nuthatch (*Sitta canadensis*)	1	12	—	—	—	—
American Goldfinch (*Spinus tristis*)	1	12	—	—	—	—
Hairy Woodpecker (*Dendrocopos villosus*)	—	—	5	21	—	—
Cardinal (*Richmondena cardinalis*)	—	—	1	4	—	—
Purple Finch (*Carpodacus purpureus*)	—	—	1	4	—	—
Yellow-shafted Flicker (*Colaptes auratus*)	—	—	—	—	1	20

[1] The sample for Black-capped Chickadee includes 15 parties from Johnston (1941).

Fighting. Intraspecific and, when it occurs, interspecific aggressiveness in Carolina and Black-capped Chickadees, whether associated with feeding, territoriality, or other actions, appears to consist of vocalizations, supplanting attacks, chasing, and actual combat. Aggressive vocalizations are discussed in a later section. Combat generally occurs in the air when a bird resists a supplanting attack or a chase. Combat is similar in the two species and resembles that described by Hinde (1952) in the Great Tit (*Parus major*). The two birds face each other with bodies upright, flail with their wings, and strike with beak and claws. The birds may fall to the ground, and one may withdraw or there may be further supplanting, chasing, or combat.

The variety of aggressive displays reported by Hinde (1952) for the Great Tit either are absent or difficult to detect in the two chickadees. Something resembling the wings-raised and head-forward postures are occasionally seen, and Odum (1942*a*) used what seems to be the head-forward posture as one of his criteria of dominance. These displays seem not to be very specific; for example, a wounded bird may give what appears to be the head-forward posture to a collector who has cornered the bird in order to dispatch it. It may be that displays as distinct and frequent as were observed by Hinde are merely given more rapidly or are less conspicuous in the smaller chickadees; perhaps study of motion pictures would supply the answer.

PAIR FORMATION

Considerable evidence exists that members of a pair of chickadees remain together after nesting and, if both survive, nest together the following season (*P. carolinensis*: Nice, 1933, Dixon, in litt.; *P. atricapillus*: Baldwin, 1935, Harding, 1942, Odum, 1942*b*). Pair formation, and probably re-affirmation of the pair bond, appears to begin in the flock during early spring. The process seemingly is a gradual one, similar in its general outlines to that described by Hinde (1952) for the Great Tit. Males begin to exhibit increased aggressive behavior. Some birds, presumably females coming into reproductive condition, begin avoiding attacks rather than meeting them or flying, as is the case with other females and males.

Some other elements may be present in the formation of the pair bond. Although Odum (1941*a*) stated that one of the functions of the whistled song is to attract females, I have no definite evidence that it has any role in pair formation. Long flights in which the female follows the male are frequent during the period of separation of pairs from the flock and may have some role in forging the pair bond. It is not clear whether hole inspection and excavation have any part in pair formation. If they do, they come into play only after the two birds have been associated for a time. The following typical example of hole inspection was observed on 1 April 1956, in the Carolina Chickadee, but does not differ appreciably from the same action in Black-capped Chickadees or birds of the Vandalia population. Two birds had been observed feeding 3–20 feet apart for 15 minutes. One flew to a hole in a dead willow (*Salix nigra*).

> It looked inside the hole by perching on the side of the trunk, then flew nervously about, perching on vines of poison ivy (*Rhus radicans*) near the hole. It looked inside several times. In about one minute the second chickadee flew up, looked inside the hole and then flew in headfirst. After a few seconds it came out and both flew approximately 60 yards to a soft maple (*Acer saccharinum*) and commenced feeding. About two minutes later one bird came back and looked inside and went in for six to ten seconds. Then it came out and moved away.

Presumably, the first bird was the male and the second was the female.

Once the pair has been formed, the two birds typically continue to range widely, spending most of their time feeding as before. Stumps possessing or suitable for a cavity are inspected and some desultory excavation may be begun. If another pair or another adult is met, a fight may ensue. There is excited calling, supplanting attacks, chasing, and sometimes combat. Fights during this period are more vigorous than at other seasons. Often, the loud vocalizations attract one or more additional pairs. Fitch (1958) has recorded instances in the Black-capped Chickadee in which eight birds were involved. After several minutes the birds drift apart, but the same actions may be repeated in the same areas (perhaps those most suitable for nesting) several times during a day.

NEST-SITE SELECTION, TERRITORIALITY, EXCAVATION, AND NEST BUILDING

As has been suggested, nest sites are chosen after inspection of several possible locations. Excavation, and even nest-building, may be begun at several sites before the pair concentrates on the cavity in which the eggs will eventually be laid. Some of the sites investigated may be unsuitable. Hinde (1952) has pointed out the adaptive value of being able not only to occupy the best possible sites but also to occupy inferior sites if more suitable ones are unavailable.

If a pair (and perhaps if only one member of the pair) survives from one year to the next, it often shows a tendency to nest in the same cavity, or at least in the same tree it used previously (*P. carolinensis*: Tanner, 1952; *P. atricapillus*: Boyles, 1922; Butts, 1931).

Excavation seems identical in the Carolina and Black-capped Chickadees. Both birds of the pair excavate, often working alternately. The bird not excavating may feed, rest near-by, or sing if it is the male. The female spends much longer periods in the cavity than does the male. At first, the excavating bird perches on the side of the stub. Later it perches on the rim of the hole and, as the hole deepens, goes inside. In the early stages, the bird usually pounds loose several chips and then rears up and discards them with shakes of the head. When the hole is deeper, there is a tendency for the bird to fly some distance (generally 5–20 feet) before discarding the chips. During any one period of a few hours, the perch used for this purpose is the same, but it is changed from time to time. There appears to be an alternation of attentive and inattentive periods during excavation.

A noticeable difference existed in excavation as practiced by the Vandalia birds. At five cavities where I observed excavation for a total of more than 50 minutes, only one bird excavated, and in four instances, it was the female.

In all three populations, occupancy of cavities other than those excavated by the birds themselves is rare. When a pair does make use of a suitable preexisting cavity, some excavation is nearly always performed, even though this may produce no noticeable improvement in the cavity. Observing that Black-capped Chickadees rarely nest in nest-boxes, Drury (1958) prepared boxes in which the cavity was filled with peat and sawdust. Five of 11 of these boxes were utilized, whereas none of 25 standard boxes in similar situations was occupied. It is conceivable that excavation is some essential part of courtship, necessary for reaching or maintaining the psychological conditions required for mating. Inasmuch as chickadees do sometimes make use of nest-boxes in which excavation is impossible, the need for excavation may not be absolute or else can be satisfied by excavating at other sites which are not suitable for actual nesting.

The stub used for nesting is usually around 165–200 centimeters in height and 11–13 centimeters in diameter where the hole is placed. Trees with the inner portion softened by decay but with outer layers of wood or bark still firm are usually chosen. The particular species chosen depends on what species satisfy these requirements in any particular geographical region, but willows (*Salix* spp.), pines (*Pinus* spp.), cottonwoods and poplars (*Populus* spp.), and fruit trees of the genera *Pyrus* and *Prunus* are widespread choices.

Excavation may be followed immediately by lining of the cavity, or a period of several days (at least 16 at one nest of the Vandalia population) may ensue during which the cavity is rarely visited. Desultory excavation having no appreciable effect on the size of the cavity may be carried on during this period and also during the early stages of nest-building.

Four measurements were taken of nest cavities as follows: maximum entrance height and width, diameter of cavity at nest level, and depth of cavity from top of entrance hole. These measurements were similar for the three populations except for height of entrance hole (Table 2). The difference of seven millimeters between the larger holes of Black-capped Chickadees and the smaller holes of Carolina Chickadees was significant with a *P* value of less than 0.01. Height of entrance hole in the Vandalia population was intermediate but nearer the size characteristic of the Carolina Chickadee.

During nest-building the female may spend occasional periods merely sitting in the cavity, often in such a position as to look out. This habit may be carried over to some degree into the egg-laying period. In Illinois, nests

TABLE 2

DIMENSIONS (IN MILLIMETERS) OF NESTING CAVITIES OF BACK-CAPPED AND CAROLINA CHICKADEES AND CHICKADEES OF THE VANDALIA POPULATION

Measurement	Carolina Chickadee		Black-capped Chickadee		Vandalia Population	
	No.	Mean ± S.E.	No.	Mean ± S.E.	No.	Mean ± S.E.
Height of entrance hole	3	40.2 ± 0.1	3	47.3 ± 1.4	5	42.0 ± 1.4
Width of entrance hole	3	44.7 ± 5.4	3	41.4 ± 2.7	6	36.7 ± 1.6
Diameter of cavity	2	65.2	4	64.8 ± 3.4	2	81.8
Depth of cavity	3	179.0±18.0	4	199.0 ± 9.0	4	221.0±20.2

are most often made of a layer of moss overlain by fine bark strips and lined with fur. The materials are gathered in approximately the same order. A female of the Vandalia population stripped bark from a small branch of a box elder (*Acer negundo*), starting at the base of the branch and working to the tip and then going back on the underside.

The male often accompanies the female as she gathers nesting material but normally gathers no material himself and, although he may enter the cavity occasionally, does not assist in building the nest. Once in the Black-capped Chickadee, I observed a male pick up some fur and transfer it to his mate, and Brackbill (in litt.) observed a male Carolina Chickadee approach the nest with nesting material in its bill, but these are unusual occurrences.

Territorial boundaries appear to be established during the period from the beginning of excavation to egg laying. Odum (1941*a*) has suggested that territorial defense is an outgrowth of the antagonism of paired birds to other chickadees. Chickadees do not regularly proclaim territories, and territorial use of the whistled song usually occurs only in the early stages of marking out the territory or when an intruder or neighboring bird comes into the territory or near its boundaries. Under these circumstances, vocal duels lasting for several minutes may occur. If close-distance conflicts take place, they appear about the same as fights in any other season. Both sexes may engage in territorial defense, although the male generally takes the initiative. Territorial defense is almost exclusively intraspecific, except that evidence from the contact zone at Vandalia suggests that a pair defends its territory against all other chickadees—Black-capped, Carolina, or hybrid. Available evidence suggests a mean territorial size of about 3.5–4.0 acres, with considerable variation.

MATING AND EGG LAYING

Except that little time is spent around the nest, the behavior of chickadee pairs during egg laying is similar to that during nest building. A pair of Carolina Chickadees either in the egg-laying period or the period of relative inactivity that sometimes follows nest-building was observed from 10:20 AM to 12:20 PM, on 18 April 1957. They fed close together during this time. The female gave the beg call that solicits feeding by the male continually but was fed only about four times. Copulation occurred about noon. The female was near the edge of a riverbottom forest, the male farther in the interior. The male gave a four-noted song and the female flew near him. They perched near one another about 30 feet up and the female shivered her wings. The male appeared to feed the female who continued shivering her wings and flew a few feet to another tree. There, she shivered her wings and spread her wings and tail. The male flew up and perched about three inches from the female and shivered his wings. He called *deedle-up*, flew behind to the female's left, and mounted briefly. The male and then the female flew off rapidly and resumed feeding.

Copulation apparently is similar in the two species. The following description of copulation between two birds of the Vandalia population adds some details to that already given, but does not noticeably differ from it. The observation was made near the end of the nest-building period.

> 7:55 AM. Female giving *dee-deet-dit* (begging note) about 40 feet up in dead tree. Male giving *fee-bee-febay* and variations. Female shivering wings and flew . . . (to a perch near) male who was perched 22–25 feet up on a small branch of willow. She shivered wings and gave the begging note. Male flew beside her, mounted from left, turned tail over her right side and copulation apparently took place. Female's vent was noticeably expanded or extruded. Male flew off a few feet. Female continued shivering wings a few seconds. Her crown feathers were erect. She stretched wings, shivered briefly, then flew off to west. Male likewise flew west.

Copulation, as well as courtship feeding, probably begins during nest building.

Eggs are laid one a day in the morning, in one case just before the female emerged from the cavity. The female spends the night in the cavity, leaving about sunrise and usually in response to signal songs from the male.

Nesting material, mainly fur, is added to the nest throughout egg-laying. This fur apparently is used to form the flap which typically covers the eggs during this period. The flap appears to be a built-up rear portion of the nest lining which is turned forward over the eggs. The flap may serve two purposes: it conceals the eggs, perhaps making the nest appear empty to a predator, and it may insulate the eggs so that development is not initiated by the female's roosting in the cavity.

Clutch size. Of 63 complete clutches for the Carolina Chickadee, from literature, correspondence, and my own observations, the modal size was 6 eggs (34.9 per cent). Five eggs comprised 31.8 per cent of the clutches, and the range was 3–9. For the Black-capped Chickadee, modal clutch size was 8 eggs (32.3 per cent of 96 clutches), with 29.2 per cent of all clutches possessing 7 eggs. The range was 2–13. A geographical trend was evident in clutch size, however, with each species having larger clutches at higher latitudes. At the same latitude, Carolina Chickadees produced larger clutches than did Black-capped Chickadees. Modal clutch size for four nests of the Vandalia population was 7 (range 6–8), which is nearer the size to be expected for Carolina Chickadees at this latitude.

INCUBATION

Carolina and Black-capped Chickadees. The regular rhythm of sitting characteristic of incubation begins with the laying of the last (or next to last?) egg. At the same time, the flap formerly covering the eggs is no longer used. In both species only the female incubates. The incubation period for Carolina

TABLE 3

CHARACTERISTICS OF ATTENTIVENESS DURING INCUBATION IN BLACK-CAPPED AND CAROLINA CHICKADEES AND CHICKADEES OF THE VANDALIA POPULATION

Characteristic	Carolina Chickadee	Black-capped Chickadee	Vandalia Population
Minutes observed	843.0	1277.5[1]	568.0
Percentage attentiveness	77.2	77.5[1]	68.0
Length of attentive period			
Number	33	10	13
Mean ± S.E. (minutes)	16.5 ± 2.45	18.0 ± 3.62	18.8 ± 2.31
Length of inattentive periods			
Number	35	11	20
Mean ± S.E. (minutes)	5.2 ± 0.66	7.0 ± 1.07	8.0 ± 0.85
Feedings of ♀ on nest by ♂ per hour of attentiveness	2.2	2.8	0.6

[1] Includes data from New York.

Chickadees has been reported as 11 days (Bent, 1946), 12 days (Tanner, 1952), just over 13 days, and just over 14 days (Laskey, in litt.). Odum (1942*c*) has described a case in which infertile eggs were incubated for 24 days. Odum (1941*b*) summarized published incubation period data for Black-capped Chickadees as from 11 to 13 days; in the one example he actually observed, it was 13 days, 6 hours.

As indicated by Table 3, attentiveness in incubation is similar in the two species. Percentage attentiveness figures, based on my own observations in Illinois plus those of Odum (1941*b*) for the Black-capped Chickadee (about 960 minutes of observation for New York) and of Brackbill (in litt.) for the Carolina Chickadee (780 minutes in Maryland) indicate that the percentage of time spent incubating is about 75. Attentive periods for the Carolina Chickadee in Illinois and Maryland averaged 16.5 minutes, inattentive periods 5.2 minutes. These figures are similar to those obtained for the Black-capped Chickadee in Illinois. In New York (Odum, 1941*b*) attentive periods of the Black-capped Chickadee averaged 24 minutes, inattentive periods 7.8 minutes. These differences of a considerably longer attentive period and somewhat longer inattentive period are what one would expect considering the probable differences in temperature between the two latitudes (see Kendeigh, 1952).

When the male approaches the nest, he typically gives a soft version of his whistled song. There is a tendency for the last note of the song to be omitted when thus used as a signal. Sometimes the male merely gives soft *dee-dee-dee* notes. The female may respond by coming to the entrance or by flying out, or she may make no apparent response. Odum (1942*a*) found that the female

Black-capped Chickadee sometimes gave a soft twitter in response to the male's signal, but I have not detected this answering call in either species.

If called off the nest by the male, the female generally flies to him and begins posturing and giving the beg call. She is usually fed once and the two then fly off. The female often takes the lead in this flight. Once off the nest, the female keeps up a constant begging and is fed repeatedly. While the male is searching for food, she also forages for herself, particularly near the end of an inattentive period.

Often the female does not leave the nest, and then the male usually flies to the cavity and feeds her. He may, however, stay close by and continue calling or merely go away. Whether or not the female ends her attentive period seems to depend partly on the length of time she has been sitting. Occasionally, the female will end an attentive period without the male's presence.

The male may or may not accompany the female when she returns to the nest. The female usually returns in a direct, rapid flight, giving faint *sip* notes. She may perch briefly near the nesting stub or fly straight to it.

Disturbance of a female on the nest may elicit the so-called snake display, which consists of a lunge forward by the bird accompanied by a forced expiration of air causing a kind of hiss. Pickens (1928) has thoroughly described the display, which seems identical in the two species. Some individuals do not give the display, and as Odum (1941*c*) has pointed out for the Black-capped Chickadee, such birds are usually much easier to flush from the nest. Sibley (1955) suggested that the act is a defense against predators. Reactions of other birds, especially House Wrens (*Troglodytes aedon*) upon looking into cavities containing incubating chickadees indicate that the display may also function against competitors for nest sites. The response seems to be to a foreign object entering the nest hole. The display is given, at least to humans, throughout the periods of excavation, nest-building, egg-laying, incubation, and probably brooding. Young birds in the nest give a similar display.

The most usual cause of singing in the female appears to be disturbance at the nest. When a female has been flushed from the nest, she is often hesitant about re-entering and may fly about for several minutes singing. This may be a form of displacement activity or irrelevant behavior. It is conceivable, however, that the songs function as a signal to the male. Sometimes when the female persists in refusing to re-enter the cavity, the male will fly up and look in or even enter the cavity briefly. Usually the female then enters fairly readily, as though the action by the male had a reassuring effect. Another apparent example of displacement activity seen after disturbance at the nest is the bringing of nesting materials, even though nest-building may have been completed several days previously.

The Vandalia population. Although the general outlines of incubation behavior given for the Carolina and Black-capped Chickadees also hold true for the Vandalia population, several apparent abnormalities were observed. The one incubation period accurately determined was 14 days, 3 hours, and 33 minutes (± 1 hr., 22 min.). This is longer than all except the longest of incubation periods reported for the parental species. Attentiveness figures showed certain differences compared with the parental species (Table 3). Percentage attentiveness seemed somewhat low, and attentive periods seemed short and inattentive periods long. All of these apparent abnormalities, however, could be merely responses to high temperatures at the rather southerly location. A striking difference, not apparently related to temperature, appeared in the frequency with which the male fed the female on the nest. At all nests except one, the male never visited the nest and often appeared not to know exactly where it was. Repeatedly, males would arrive in the general vicinity of the nest with food and sit for several minutes giving nest signals while the female continued incubation. I know of only one instance in either of the parental species in which the male failed to feed the female on the nest (Black-capped Chickadee: Odum, 1941*a*).

Perhaps the most noticeably abnormal behavior was that shown by a pair in which the female began what was apparently normal incubation with the laying of the first or second egg. Observations totaling 410 minutes were made on the first, second, third, and fifth days of egg-laying (since seven eggs were laid, incubation would have been expected to begin on the sixth or seventh day). As has been mentioned earlier, the two criteria for the beginning of incubation are the absence of a flap covering the eggs and the presence of a regular rhythm of sitting by the female. No flap was used at this nest at any time. On 26 April 1958, the date of laying of the second egg, a percentage attentiveness figure of 39.5 was recorded. The following day, the female spent 85.6 per cent of 90 minutes on the nest, and on the day the fifth egg was laid, she spent 68.4 per cent of 160 minutes on the nest.

The same nest showed other abnormalities: the pair abandoned after 20 days of incubation (i.e., 14 days after the laying of the last egg). Of the seven eggs, three contained no embryo, one contained a good-sized embryo still several days from hatching, and the others contained much smaller embryos ranging down to a small amorphous mass.

HATCHING AND PARENTAL CARE OF NESTLINGS

In two nests of the Carolina Chickadee observed by Laskey (in litt.) hatching of the complete clutch took somewhat more than 24 hours. Two clutches of the Black-capped Chickadee observed by Odum (1941*b*) took from 12 to 24 hours. Hatching of one complete clutch of seven eggs at Vandalia took

TABLE 4

CHARACTERISTICS OF ATTENTIVENESS DURING NEST LIFE OF YOUNG BLACK-CAPPED AND CAROLINA CHICKADEES AND CHICKADEES OF THE VANDALIA POPULATION[1]

Characteristic	Population	Days after hatching			
		1–4	5–8	9–12	13–16
Minutes Observed	Carolina Chickadee	308	300	300	211
	Black-capped Chickadee	205	—	198	175
	Vandalia population	330	89	423	45
Percentage attentiveness (brooding)	Carolina Chickadee	55.2	25.0	11.7	0.0
	Black-capped Chickadee	71.5	—	9.3	0.0
	Vandalia population	56.2	0.0	7.9	0.0
Mean length attentive period (minutes)	Carolina Chickadee	11.4 (3.0–25.5)	5.3 (2.5–11.5)	8.9 (2.5–15.0)	—
	Black-capped Chickadee	10.5 (1.0–8.0)	—	6.2 (4.0–11.0)	—
	Vandalia population	11.1 (3.0–79+)	—	3.0 (1.0–7.0)	—
Mean length inattentive period (minutes)	Carolina Chickadee	8.2 (3.0–13.8)	16.4 (5.0–33.)	21.0 (3.0–79+)	—
	Black-capped Chickadee	6.6 (2.0–7.5)	—	24.8 (18.0–24+)	—
	Vandalia population	13.6 (1.0–24.0)	—	17.2 (2.5–87+)	—
Feedings by parents per young per hour	Carolina Chickadee	2.6	2.5	2.8	3.8
	Black-capped Chickadee	1.7	—	2.7	—
	Vandalia population	1.4	2.6	2.5	3.7
Percentage of feedings by ♀	Carolina Chickadee	18	25	45	53
	Black-capped Chickadee	24	—	50	—
	Vandalia population	30	—	60	—
Fecal sacs removed per young per hour	Carolina Chickadee	0.07	0.5	0.5	—
	Black-capped Chickadee	0.08	—	0.5	—
	Vandalia population	0.01	0.5	0.5	0.7

[1] Data are for Illinois except for 333 minutes of observation of Carolina Chickadee from District of Columbia (Brackbill, in litt.). Ranges are in parentheses.

19 hours, 33 minutes (± 6 hours, 20 minutes). Hatching apparently occurs at any time of the day or night. I have not determined what disposition is made of eggshells, but they are not allowed to remain in the nest. Infertile eggs, however, are not removed.

Attentiveness continues about the same as in incubation for the first three days after hatching (Table 4). Then there is a rapid decline, and about the 11th day brooding is completely discontinued. The rate at which nestlings are fed increases during nest life. As has been pointed out for the Great Tit (Betts, 1955), the feeding rate, based on visits to the nest by the parents, is not a completely accurate reflection of the amount of food the young receive because more than one item is sometimes brought and the average size of food items increases during nestling life.

Feeding may be almost entirely by the male during the first few days after hatching. The male brings food to the female during her attentive periods and feeds the young directly during inattentive periods. During the early days after hatching the female almost never returns to the cavity with food during an inattentive period, although she may bring food when she arrives to resume brooding. The male rarely feeds the female off the nest after young are present, although she begs frequently during the first few days. When the two meet near the nest with food, there is mutual wing-shivering which is more pronounced in the female. In this situation the male feeds first, the female flying to the hole immediately upon his departure. By the time the female terminates brooding, the sexes share about equally in feeding duties, and by the end of nestling life the female is performing the greater part of the chore.

Fecal sacs are removed by both parents, although there is some indication that this function is performed more often by the male. Often a bird will perch at the hole for several seconds after having fed, evidently waiting for the young to defecate. There is an increase in the frequency of production of fecal sacs with increasing age of the young. That the adults may eat the fecal sacs during the first day or two after hatching is suggested by the extremely low rate of removal during that period. When carrying a fecal sac, the adult appears to take a longer, more direct flight away from the nest than is otherwise the case. It perches higher than the average feeding height and deposits the sac on a limb. Near the end of nestling life, when feedings are very frequent, there may be some tendency for fecal sacs to accumulate in the nest.

Parental care of nestlings by birds of the Vandalia population seemed identical to that practiced by the two parental species. This fact is remarkable in view of the anomalous behavior in incubation. For example, one might expect that since the male did not feed the female on the nest (except in one pair), he might also neglect the young. This did not happen, the male assuming an apparently normal share of the duty.

Length of nest life appears to be about 16 days (Laskey, in litt.; Bent, 1946; Odum, 1941*c*). The time required for a brood to leave the nest has been reported as 40 minutes for seven Black-capped Chickadees (Odum, 1941*b*). Four Carolina Chickadees in the laboratory fledged in a period of 100 minutes. In both species, fledging generally takes place in the morning.

Hatching success (eggs hatched per eggs laid) is on the order of 95 per cent for the Carolina and Black-capped Chickadees, and fledging success (birds fledged per eggs laid) is between 70 and 90 per cent. For the Vandalia population, hatching success was no more than 65 per cent, fledging success no more than 43 per cent. Both of these figures are significantly lower than those for the parental species. The low rate of successful reproduction resulted from infertility and retarded development of eggs, destruction by House Wrens, and destruction by an unknown predator.

BEHAVIOR AND DEVELOPMENT OF NESTLINGS

No systematic observations were made during early nest life. The scattered data obtained suggest no differences from early development of the Black-capped Chickadee as reported by Odum (1941*b*, 1943) and Johnston (1941). The following comments pertain to a brood of four Carolina Chickadees hand-reared in the laboratory from the thirteenth day on.

13th day. By this time the young are well-grown and well-feathered, with only a few traces of down. They beg by gaping and calling the usual beg call of females and fledged young rather than the high-pitched twitter of younger nestlings. The sight of the wiggling mealworm evokes the beg; however, the young also beg when they are hungry and we are not close by. The young are not dextrous with the worms and cannot swallow them unless the worms are put well down in the mouth, headfirst. The young make no effort to get out of the nest through an opening cut on a level with it. There is a rotation in feeding through the actions of the young. Birds which are not hungry do not beg, and the hungrier birds are more active in moving to the top of the nest. Defecation occurs shortly after feeding, although not after each feeding. The young bird puts its head down and its tail up pointing toward the entrance (or at least away from the center of the nest) and expels a gelatinous sac which is white with a black-brown inner tip. After being fed to satiation, the young sleep. The young sometimes hiss at the movement of an object toward them. This response is present at least as early as the tenth day.

14th day. Three of the young now feed actively, lunging at the forceps. Any tapping or jarring of the nest causes the birds to assume a crouched, immobile posture. They also do this when removed from the nest. This freezing reaction apparently begins about the seventh day and occurs in response to stimuli which previously would have produced begging. Begging behavior, besides being elicited by the sight of a worm, also is elicited by pressure. When the observer felt in the nest, trying to remove a bird, the ones not being sought begged vigorously. The young birds also now beg at the sight of the forceps even if the forceps contain no worm. After a freezing reaction, if one bird resumes begging, all start in. Usually after being fed until full, they sleep. They may, however, preen, apparently using the preen gland.

15th day. Fecal sacs are now decidedly less gelatinous. Each bird ate about 80 mealworms on this day and discharged 10–14 fecal sacs. These are usually discharged one to a feeding period, immediately after the 1st or 2nd mealworm. The birds now usually beg only when the observer is in the cage. The sound of an airplane overhead induces freezing, as does also the sounds of people close by and replacing the cover over the cut opening in the stub. Some wing-flapping occurred on this day, and there was some interest in looking out of the hole. After the last feeding at 7:30 PM, one bird jumped out of the cut opening, hung on the side of the stub, and discharged a fecal sac. The bird was returned to the cavity and remained there.

16th day. 7:50 AM. The bird marked with blue flew out. It flew at the highest part of the cage, finally coming down at 8:15 to accept one worm. By 9:10 another bird was out. Yellow, the third bird, came to the opening several times, then backed into the cavity and shivered its wings. Finally, at 9:25, it flew out. Red, the fourth bird, perched on the rim of the opening, gradually getting farther and farther outside. It looked from side to side and begged. After five minutes of this, it flew out a short distance, climbed up the wire walls of the cage and then began flying around as the others were doing. One or more of the birds when perched on the wire side walls or ceiling hung upside down, bat-like, perhaps because of weakness of leg muscles. By 10:30, feces were no longer enclosed in sacs at all. Jarring of their perch, now that the birds were out of the nest, no longer produced a freezing response.

Observations of caged Black-capped Chickadees over the same period of development detected no appreciable differences in the two species.

PARENTAL CARE AND BEHAVIOR OF FLEDGLINGS

When young birds have just fledged, the adults lead them away from the vicinity of the nest. The young may be taken to a distant part of the territory or even off it. The family group is subject to attacks from pairs which are still nesting, but the nesting pairs seem not to be particularly successful in their efforts to drive the family groups away.

The adults seem to direct the movements of the young, perhaps by the use of whistled songs. At least, singing by both parents is frequent during the early fledgling period. When the group is disturbed by humans, the pair, particularly the male, scolds vigorously. Odum (1941*b*) has described an injury-feigning display, similar to that of shore birds, performed by parent Black-capped Chickadees when the young gave the distress call. I have not seen this display in either species. The begging posture and notes of the young are identical to those of the adult female during the early part of the nesting cycle. Disturbances cause the adults to interrupt feeding of the young.

Within a week after fledging, young are able to forage for themselves to some degree. They may be fed by the parents for another two weeks or so before the family group breaks up.

The following comments are based on observations of four hand-reared Carolina Chickadees, but appear to apply equally well to a brood of Black-capped Chickadees which were studied in the laboratory during the same period of development.

1st day (day of fledging; 16 days after hatching). The young spend considerable time preening. It is difficult to induce begging. One bird took a piece of hamburger too big to swallow and put it under its foot in the manner of an adult. The birds drank water after being set on the rim of the container. By 6:57 PM all were asleep. Three slept sitting normally on a perch, but with breast feathers well-fluffed and head bent down. The fourth slept with its head under its wing from top and back in the manner of an adult.

2nd day. General behavior was similar to the first day, but begging was more frequent. Mean weight 9.7 grams (9.5–10.1).

3rd day. One bird grasped a piece of food too large for it strongly in one foot and proceeded to eat it. Some of the birds will come to the observer for food. Some will pick up and eat small mealworms laid down beside them. None of the birds can land well on perches yet. Mean weight 10.0 grams (9.6–10.4).

4th day. All were much wilder this day, perhaps because of the calls and actions of the adult Black-capped Chickadee in the adjoining cage. One young bird often begged from another, even though the second may have had no food. The birds appeared curious, pecking at their perches, their own or another bird's feet, or their plumage.

6th day. Mean weight 9.8 grams (9.7–10.1).

7th day. This day all birds would fly down to pick up worms they had dropped. Also they would feed themselves from the container of worms when the observer was not present. Two birds gave a kind of *sotto voce* call, resembling somewhat the song of a White-eyed or Warbling Vireo (*Vireo griseus* or *V. gilvus*), but soft and not whistle-like. Begging is less frequent and also there is little sleeping during the day.

10th day. One bird gave the *dee-dee-dee* general call note for the first time. This occurred when the observer had removed one of the two remaining birds to a different cage. Sun-bathing was observed in one bird.

In both species I have found instances of what appeared to be re-nesting following some kind of interference with the first nesting. I have never found good evidence of second broods in either species. Odum (1942*b*) in two seasons in New York detected one second brood in 10 nesting pairs of Black-capped Chickadees in a season cooler than usual and three second broods in 13 nesting pairs in a season warmer than usual. It seems clear that second broods are infrequent in both species.

TIMING OF REPRODUCTIVE EVENTS

The date of laying of the first egg was obtained from my own observations, literature, and correspondence. In nearly every case, this date had to be established indirectly by allowing one day for each egg laid, 13 days for incubation, and 16 days for nest life. Approximations of first-egg dates were made from the following kinds of information: daily schedule of laying, date of fresh complete clutch, date of hatching, and date of leaving nest. The sample for Carolina Chickadees included 42 dates from 29.0 to 39.8° N. Lat., that for Black-capped Chickadees 27 dates from 39.8 to 46.0° N. Lat. The data were so variable that no firm conclusions could be reached, other than that both species tended to begin laying 3½–4½ days later for each degree of latitude northward. Using the best data from 38.5–40.5° N. Lat., the date for laying of the first egg ranged from 24 April to 15 May for Carolina Chickadees (N = 6) and 14 April to 20 May for Black-capped Chickadees (N = 9).

Estimates of timing of other events in nesting can be obtained for either species as follows: excavation and nest building begins about 20 days previous to laying of the first egg; hatching occurs about 13 days after laying of the last egg; young leave the nest about 29 days after laying of the last egg; and young reach independence 45–55 days after laying of the last egg.

The mean date of laying of the first egg for seven pairs of birds of the

Vandalia population (about 39° N. Lat.) was 19 April (median 25 April, range 8 April–2 May; six records for 1958, one for 1959). The earliest date of observed excavation was 27 March, the latest 17 April.

MISCELLANEOUS ACTIVITIES

Other than those already considered, activities engaged in by chickadees involve feeding, roosting, preening, resting, drinking, bathing, sun-bathing, and avoidance and scolding of enemies. Some of these are discussed elsewhere in this paper. In this section only preening, bathing, and sun-bathing will be considered.

Preening appears not to differ appreciably in the three populations. The following observation was of a bird of the Vandalia population:

> (The bird) wiped bill, then preened around neck, letting wings lie rather limp. Then preened right wing, then scratched right side of head, leg coming up behind wing. Then preened right side of tail, spreading and raising it and pulling it to the right. Then preened around preen gland. These actions were then repeated on the left side in approximately the same order. Bird would wipe bill on limb occasionally. Bird then defecated and moved to a lower branch. It went through many of the same motions, scratching even more vigorously, then also preened around ventral apterium. Bird faced east, was in open, but was not in direct sun (there being none).

Less extended observations of the bathing of Carolina Chickadees suggest that the actions are similar to those noted for the Black-capped Chickadee on 19 November 1958:

> A chickadee which had been looking for food flew to ground at river's edge, then flew to edge of water and, sitting in it, bathed. It stayed for about one minute and bathed by bending over and shaking head back and forth, at the same time spreading wings. Would pause several seconds between each bend-over. Finally flew up, fluffed feathers, flew further and began to preen.

Odum (1942*b*) has stated that in winter, when there was no open water, birds were observed "snow-bathing." The birds would fly down to where the sun shone on the snow and would flutter around on the moist surface. There are no reported instances of snow-bathing in the Carolina Chickadee, perhaps because open water is nearly always present and snow rather infrequent over most of the range of this species.

Sun-bathing appears not to be previously reported in Black-capped and Carolina Chickadees, but it occurs in both. I have seen it only in young birds, from five days after fledging to one or two months. The four examples of sun-bathing observed, two in each species, all occurred on sunny days following one or more cloudy ones. The following description is for the Black-capped Chickadee, but the actions seem identical in the Carolina Chickadee.

On 26 June 1958 the bird perched at the top of cage about 1:00 PM in sun, spread one wing, then spread the other, then as it sat there, other feathers were ruffled and the head slowly fell forward (beak pointing down). At maximum intensity, the wings were spread, plumage lax, and right eye pointing toward sun.

VOCALIZATIONS

The following discussion is based on Odum's (1942*b*) analysis of the Black-capped Chickadee.

Whistled song. This vocalization is similar in the two species, consisting of high-pitched clear whistles. The whistled song of the Carolina Chickadee is typically four-noted, *fee-bee-febay.* Nearly always when the song is heard at close quarters, the first and third notes are lisped, so that *tsee-bee-tsebay* is perhaps a closer rendering. Other transcriptions of it are *sufee-subee* (Bent, 1946) and *se-bee-se-bu* (Tanner, 1952). The song is generally stated to be higher pitched than that of the Black-capped Chickadee, but I am not sure that this is true. Saunders (*in* Bent, 1946) observed that the second and fourth notes of the song are pitched about the same as the two notes of the Black-capped Chickadee, B and A or A and G in the highest octave of the piano, with the first and third notes higher or lower. A frequent version in Illinois is B-B flat-B-A. The quality of the song, particularly the first and third notes, differs from that of the Black-capped Chickadee in being thinner, lisped, and more tremulous. The phrasing is characteristic, with one or both of the first two notes drawn out and the last two rapidly given.

Variations include three-noted songs which sound like *fee-bee-feep* and six- or more-noted songs, which may be *fee-be-fee-be-fee-be* or *febay-febay-febay.* These are given as occasional variants by birds which also sing the four-noted song. On the Big Muddy River south of Murphysboro (Jackson County), Illinois, many or all of the birds sing *fee-be-febzz,* the last syllable being much more buzzy or burred than is usually the case.

In Black-capped Chickadees, the song is characteristically two-noted, *fee-bee,* pitched B-A or A-G. A variation of this song is three-noted, *fee-be-bee* or *fee-bee-ee* (Odum, 1942*b*). Dawson and Bowles (1909) stated that *P. a. occidentalis,* in contrast to *P. a. septentrionalis,* sang a three- or four-noted song pitched C-C-C or C-C-C-A. Lumley (1934), in reporting a similar song, felt that it resulted from individuals imitating the song of the Mountain Chickadee (*P. gambeli*). Bagg (1958) reported what appears to be a local variation, in which birds of Martha's Vineyard sang a monotonal two- or three-noted song. A similar song has been reported from the Gaspé Peninsula (Bagg, 1958) and in Ontario (Lawrence, in litt.).

In the area around Vandalia, five apparent classes exist with regard to whistled songs: those which give only Carolina songs, those which give only Black-capped songs, those which give only songs outside the normal range of variation of either species, those which give both unusual and Carolina songs, and those which give both unusual and Black-capped songs. Most of the unusual songs were of the general type *fee-be-deekee-deekee,* usually pitched B-A-BB-BB in the highest octave of the piano. Variations were frequent, including omission of the first portion (*deek-ee-deek-ee-deek-ee*), variations in length of the second portion, and changes in inflection or phrasing (*fee-be-tswee-tswee, fee-be-deekit-deekit, fee-bee-deet-dee, see-bee see-beeseebee, fee-be-deup-deup*). These vocalizations were given both by birds that gave only unusual whistled songs as well as those which gave Carolina or Black-capped songs. A second unusual song type may have been restricted to those which gave only unusual songs or those giving both unusual and Black-capped. This was of the general form *fee-fee-deet-dee,* usually pitched G flat-G flat-B-B or B-B-A-A. Two other unusual types of whistled songs were *swee-towee-towee* (and variations) and *fee-a-be-fe-be.* Neither of these was encountered more than a few times.

In the contact zone of eastern Missouri, most of the vocalizations were of the *fee-bee-deekee-deekee* type. A variation of this, *fee-deet-dee* or *fee-sbee-sbee-sbee,* rarely heard at Vandalia was fairly frequent. Another type, not heard at Vandalia, was given by two birds in Missouri and could be written as *fee-bee-bay.* It consisted of three notes each on a different pitch and given in no apparent order (high, medium, low; medium, low, high; etc.). It is possible that this may be a normal but rare vocalization of the Carolina Chickadee, for Saunders (*in* Bent, 1946) recorded it in that species. It is interesting that this song apparently duplicates one of the normal whistled songs of the Mountain Chickadee (see Saunders *in* Bent, 1946).

The whistled song is generally given by the male. Juveniles may sing about the time of the post-juvenal molt. The annual trend in frequency of the whistled song suggests a connection with reproduction. The song is rarely given from October through January, but there is a sharp increase in February. The peak frequency is reached sometime in April—somewhere near the period of egg-laying—in Illinois. There is a gradual decline to October, with perhaps a slight recrudescence in late August or early September. Functions of the whistled song appear to be proclamation and defense of territory and maintenance of contact between members of a pair. In the second function, it appears to be used at greater distances than the general call note.

Signal song. The signal song is like the regular song, but much softer, of a rather ventriloqual quality, and often reduced by one note. It functions in announcing to the female the approach of the male to the nest. Signal songs of males of the Vandalia population tended to be soft, shortened versions of the *fee-be-deekee-deekee* whistled-song type (Examples: *fee-bee-deet-dee, fee-ee- deek-ee, fee-deek-ee*).

General call note. The general call note is the *chicka-dee-dee-dee* call which gives the birds their name. Considerable variation exists in the number of *dee*'s and in the presence, absence, or repetition of the *chicka* portion. A high, hard *ditdit-didit,* somewhat resembling a call of the Downy Woodpecker, appears to be a variation of the general call note without special significance. Tanner (1952) has stated that the general call note is higher-pitched, thinner, and more rapidly given in the Carolina Chickadee, but I am often unable to distinguish the species on this basis. The call is used by both sexes to announce the position of the calling bird to its mate or, in winter, to other members of the flock.

Fighting and dominance notes. I have not been able to separate clearly the fighting note and the dominance note of Odum (1942*a*) for either species. The first Odum has described as a sputtery, high-pitched, beady *chick-a-dee* or *chit-chit-chit* given during spring conflicts between pairs and during the chasing and fighting phases of territorial defense. The second was described as a throaty *che-lup* or *che-up-che* which is given most often by aggressive males. The note was said to be a vocal threat used when birds come close together or one bird chases another.

As nearly as I can tell, a kind of falsetto *chick-a-deep* or *chick-a-deep-chick-a-deep* has been my rendition of the note that would correspond to the fighting note. A note I usually rendered as *deedle-up* appears to be the equivalent of the dominance note. These notes are similar and a variety of intermediates seem to exist. All of the notes are clearly related to aggressiveness. The connection between aggressiveness and courtship may be suggested by the fact that a male Carolina Chickadee gave the *deedle-up* note just before treading its mate.

Begging note. My most accurate transcription of this call is *che-che-weweweup.* The call is variable and difficult to syllabify. The note is given by young from just before fledging throughout their period of dependence and by the female of mated pairs from nest building through incubation and somewhat beyond. At full intensity, the begging bird crouches and shivers its wings rapidly.

In most cases, there appeared to be no difference in this call between the three populations. The female of one pair of Black-capped Chickadees, however, began about the ninth day of incubation to give a beg call which I recorded as *chee-chip.* This is similar to the version of the begging note reported by Odum (1942*a*): *tee-ship* or *tee-chip-she.* Other female Black-capped Chickadees gave the *che-che-weweweup* call throughout incubation.

Other notes. Odum (1942*a*) also recognized for the Black-capped Chickadee a scolding note, an alarm note, a contact note, a flight note, a warning note, and the hissing note of the snake display, all of which I have heard in the Carolina Chickadee or in both species. All seem identical in form and function in the two species and in the Vandalia population. Other notes listed by Odum, I have either not heard or failed to recognize in the Carolina Chickadee. Additional notes heard by me which appear not to be distinguished by Odum are the following: a *ticket-ticket* or *dickit-dickit-dickit* which appears to be used by both species before or after flock movements; the *sotto voce* song of young Carolina Chickadees fledged eight days.

DAILY ACTIVITY

The awakening time of chickadees of all three populations seems closely related to sunrise in females throughout the year and in both sexes during the winter. During the breeding season, however, males seem to awaken and become active 30 or more minutes before sunrise. The time of roosting is variable, with earlier roosting with respect to sunset being the rule in winter and perhaps early spring and on cloudy days. Roosting may be latest when a pair is feeding young in the nest. I have at that time found female Black-capped Chickadees active 16 minutes after sunset. By the time the female is roosting in the nest cavity, the male has begun retiring later as well as arising earlier than the female. The early morning period often is one of relatively frequent singing on the part of the male, but the twilight period is nearly silent. In Illinois, the period of activity for the male is about 15 hours during May and about 9 hours during January. For the female, it is somewhat more than 14 hours during May and about 9 hours during January.

WEIGHT

In an analysis of weights of the two species of chickadees, four trends are noticeable. First, both species show a trend of increased weight from south to north. For example, the mean weight of male Black-capped Chickadees in Ohio (41.5° N. Lat.) from April to September appears to be about 11 grams (Baldwin and Kendeigh, 1938), whereas during the same period in Ontario (46° N. Lat.) males weigh more than 12 grams (Lawrence, 1958). A similar comparison can be made for Carolina Chickadees using weights from Illinois (Table 5) at an average latitude of about 38.5° N. Lat. where males in the winter average about 10.5 grams and females about 9.6 grams and weights from Ohio (Nice, 1933) where males average 11.2 and females 10.1 grams. At the same latitude, Black-capped Chickadees appear to be slightly heavier than Carolina Chickadees.

Within a species, males are considerably heavier than females (Table 5; see also Odum, 1943; Hartman, 1955; and Norris and Johnston, 1958). This difference diminishes during the egg-laying season. A fourth trend is seasonal, with birds being heavier in winter and spring, lighter in summer and fall (Lawrence, 1958; Odum, 1943).

TABLE 5

WEIGHTS (IN GRAMS) OF CAROLINA CHICKADEES IN ILLINOIS (AVERAGE LATITUDE ABOUT 38.5°N.)

Month	Males		Females	
	Number	Mean ± S.E.	Number	Mean ± S.E.
January	5	10.8 ± 0.25	6	9.7 ± 0.25
February	4	10.7 ± 0.43	4	10.1 ± 0.32
March	4	10.4 ± 0.34	4	10.1 ± 0.34
June	—	——	1	10.0
November	2	10.0	5	8.9 ± 0.38
December	3	10.1 ± 0.02	8	9.7 ± 0.18

Besides varying with species, latitude, sex, and season, weight in the Black-capped Chickadee also varies with time of day, according to the data of Lawrence (1958).

SUMMARY

The life history of the Carolina Chickadee was studied from October 1954 to November 1959. During the same period observations were made on Black-capped Chickadees and a population believed to be composed at least partly of hybrid birds. Most of the field work was in Illinois, with that for the presumed hybrid population confined mainly to the contact zone near Vandalia.

The three populations were found to be similar or identical in most respects. In winter, chickadees of all three populations tend to occur in flocks, the mean size of which is three to four birds in Illinois. Home range size appears to be related to food supply and is on the order of 35 acres at the latitude of central Illinois. Chickadee flocks tend to occur in temporary feeding parties. In spring and fall these parties may include migrant warblers and vireos; in winter, the most frequent associates of chickadees are Tufted Titmice, Downy Woodpeckers, Golden-crowned Kinglets, and White-breasted Nuthatches.

Pair formation apparently begins in the flock and is a gradual process. Members of a nesting pair tend to remain together during the winter and, if both survive, to nest together the following season. Excavation and even nest-building may be begun at several locations before the pair finally concentrates on the site which is actually used. Carolina and Black-capped Chickadees almost invariably excavate their own cavity, with both sexes participating. In the Vandalia population, excavation appeared nearly confined to the female. Nests in Illinois are usually of moss overlain by fine bark strips and lined with fur. Gathering of nesting materials and nest building is almost entirely by the female. Eggs are laid one each day in the morning. A geographical trend in clutch size exists, with Carolina Chickadees tending to have larger clutches at any given latitude than Black-capped Chickadees. Date of laying of first egg also varies geographically, tending to be 3½–4½ days later for each degree of latitude northward.

Incubation is by the female and is begun with laying of the last or next to last egg. The incubation period appears to be about 13 days. Attentiveness is about 75 per cent for the Carolina and Black-capped Chickadees. Attentive periods in Illinois average about 15–20 minutes in length, inattentive periods 5–8. In the two species, the incubating female is fed by the male about two to three times per hour of attentiveness. During

inattentive periods the female gives a begging display and is fed repeatedly by the male. Among apparent abnormalities observed in the Vandalia population were a nearly complete lack of on-the-nest feedings of the female by the male, initiation of incubation with the laying of the first or second egg (in one pair), and a low rate of hatching and fledging of young.

Hatching of the complete clutch in all three populations requires about 12–24 hours. The percentage of time spent brooding is about the same as that spent incubating for the first three days after hatching; then there is a rapid decline until brooding is completely discontinued about the 11th day. At first, feeding of nestlings is almost entirely by the male, but by the end of nest life, the female has assumed the greater share of this duty. Length of nest life is about 16 days. Development of young Carolina and Black-capped Chickadees studied in the laboratory from the 13th day on seemed essentially identical, as did the behavior of fledglings during the first 10 days after leaving the nest. By about 7 days after leaving the nest, young are able to forage for themselves to some degree, but may remain with the parents for another two weeks before the family group breaks up.

The two species have an extensive and similar vocabulary. Small differences exist in the whistled song, the signal song, and to some degree the general call note. Many birds of the Vandalia population gave whistled songs and signal songs far outside the normal range of variation of the two parental species.

Miscellaneous activities, such as preening, bathing, and sun-bathing, appear to be similar or identical in the three populations. The pattern of daily activity is similar, with awakening time related fairly closely to sunrise in the female. The male tends to arise earlier and retire later than the female in the breeding season. Within each species, weight varies with latitude, sex, season, and time of day. With other conditions equal, Carolina Chickadees appear to weigh slightly less than do Black-capped Chickadees.

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DEPARTMENT OF BIOLOGY, WESTERN MICHIGAN UNIVERSITY, KALAMAZOO, MICHIGAN, 10 JANUARY 1961

NEW LIFE MEMBER

G. Stuart Keith, Associate, Department of Birds, American Museum of Natural History, is the newest Life Member of the Society. Mr. Keith received his Master of Arts Honors Degree in Classics at Oxford in 1955. His chief ornithological interests are in behavior, systematics, photography, and conservation. His two papers have recently appeared in Natural History Magazine ("The Dances of the Japanese Crane") and in Tori Magazine ("Winter Birds of Hokkaido, Japan"). He is also a member of the London Natural History Society, the Tori Society of Japan, the International Council for Bird Preservation, the AOU, and is at present a Director of the Alberta Wildlife Foundation.

The achievement of which Mr. Keith is most proud is his breaking of Roger Peterson's record for the greatest number of birds seen in North America in a single year. Dr. Peterson saw 572 species in 1953, and Mr. Keith saw 594 in 1956.

TAXONOMIC RELATIONSHIPS AMONG THE AMERICAN REDSTARTS

KENNETH C. PARKES

In recent years certain bird taxonomists have indulged in what might be described as a veritable orgy of genus-lumping. Small genera, particularly monotypic genera, *must*, it seems, be somehow combined with one another, or shoehorned into larger genera (see, for example, the footnote on *Uropsila*, Paynter, 1960:430). To some extent this is a healthy trend, as many bird families are undeniably oversplit. Much of the recent lumping, however, has a fundamental shortcoming; the authors make little or no effort to re-evaluate the composition of the currently accepted genera before simply emptying the contents of two bureau drawers into one. It is possible, indeed probable, that some of our genera as they now stand are composite and artificial, not reflecting actual relationships. The answer to such problems is not simple lumping, but rather redefinition of genera, with the generic lines drawn in different places.

An excellent example is provided by the case history of the North American forest thrushes. Ridgway (1907:19, 35) pointed out many years ago the close relationship between the thrushes generally placed in the two genera *Hylocichla* and *Catharus*. Ripley (1952), in a paper which advocated merging a number of genera of thrushes, formally proposed the lumping of *Hylocichla* and *Catharus* under the latter name, but without any analytical study of the species currently placed in these two genera. This proposition had already been made in several unpublished theses dealing with regional avifaunas (Loetscher, 1941:664; Phillips, 1946:309; Parkes, 1952:384), also as a straight lumping of the two genera. After Ripley's paper appeared, several other authors, still without any additional study, jumped on the bandwagon and used *Catharus* for the five North American species. It remained for Dilger (1956*a*, 1956*b*) to illustrate the dangers of uncritical lumping by showing conclusively that "*Hylocichla*" as used by all previous authors was a composite assemblage, containing four species congeneric with *Catharus* and a superficially similar species (*mustelina*) barely separable from *Turdus*. The possibility of a parallel case in the family Parulidae will be suggested in the present paper.

Many taxonomists are of the opinion that too many genera of wood warblers are admitted in current check-lists. This viewpoint was strongly expressed by Griscom (1957*a*:11), who stated, in reference to the large number of monotypic genera now recognized in the Parulidae, that "something relatively radical should clearly be done." He attempted to rectify this situation himself (Griscom, 1957*b*), reducing the number of genera of

Parulidae by eleven, although only five of the lumped genera were monotypic. An additional six monotypic genera apparently defined all his attempts to combine them in some fashion.

One of Griscom's generic combinations included the birds to which Americans have long misapplied the name "redstart" (which, like "robin" and "oriole," properly belongs to an Old World group). These are currently divided between the two genera *Setophaga* (two species) and *Myioborus* (nine species). Griscom reverted to an earlier classification by combining these two groups (under the older name *Setophaga*), pointing out quite correctly that the only characters hitherto used to separate them have been relatively insignificant differences of proportion (Ridgway, 1902:722, 730). I should like to propose here that in the redstarts, as in the forest thrushes, simple lumping may not best reflect the true relationships.

It appears to me that the genus *Setophaga* as now understood is a composite. I believe that the American Redstart, *S. ruticilla* (type species of the genus), is not only generically distinct from *Myioborus* (*contra* Griscom), but not even particularly closely related to the latter group of species. On the other hand, the Painted Redstart, *picta*, always placed in *Setophaga* with the northern bird, might better be included in *Myioborus*, from which it differs chiefly in having a white area on the wing. Presently available evidence for such a recombination includes the following points:

(1) Sexual dimorphism in plumage color is striking in the American Redstart, absent in the Painted Redstart and in *Myioborus*.

(2) The sooty juvenal plumage of the Painted Redstart resembles the homologous plumages of *Myioborus* much more closely than it does the juvenal plumage of the American Redstart. In addition, the juvenal plumage of the latter species is of exceptionally short duration; in a captive individual the first prebasic ("post-juvenal") molt was well under way at 22 days of age (Petrides, 1943). Specimens illustrating this molt are very rare in collections, although the American Redstart is an abundant species. On the other hand, as well illustrated by museum skins, young Painted Redstarts and *Myioborus* are fully grown before the first body feathers of the first basic plumage appear.

(3) The definitive plumage pattern of the Painted Redstart is very similar to that of some species of *Myioborus*; the American Redstart has in common only the large amount of black in the male (Fig. 1).

(4) Both sexes of the Painted Redstart and of *Myioborus* attain their definitive plumage immediately following the juvenal plumage, whereas males of the American Redstart do not assume their definitive plumage until the second year.

(5) The Painted Redstart is a Central American species that barely reaches

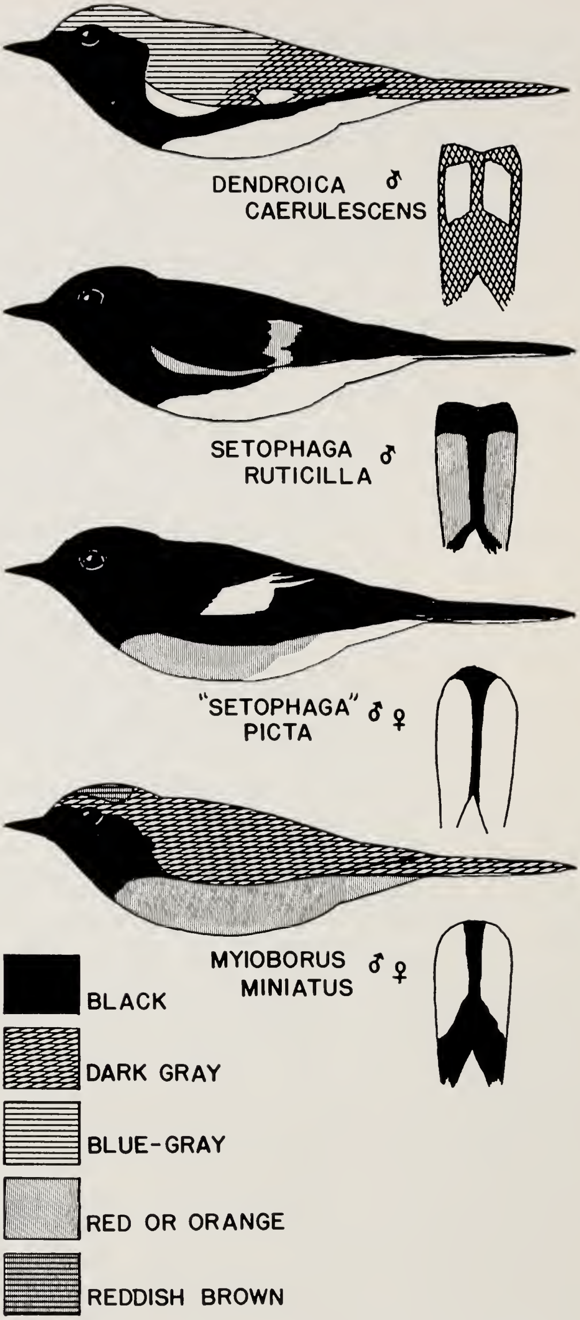

Fig. 1. Definitive plumage patterns of some male wood warblers (diagrammatic). Drawing by William C. Dilger.

southwestern United States, conforming in general distribution with *Myioborus*; the distribution of *Setophaga ruticilla* is decidedly northern.

(6) The American Redstart always nests in trees or bushes, usually 10 to 20 feet up, varying between several inches and about 70 feet. On the other hand, only one exceptional nest of the Painted Redstart has been reported as off the ground, the situations and materials ordinarily chosen by this species being precisely like those described for *Myioborus* (Bent, 1953; Skutch, 1954).

(7) The "advertising" song of the American Redstart is short and wheezy, much like those of some species of *Dendroica*; that of the Painted Redstart is described as loud, ringing, wonderfully rich and mellow, the sort of adjectives also applied to the songs of *Myioborus* (see Skutch, in Bent, 1953:687).

It is true that some of the differences between the American and Painted Redstarts cited above are those usually to be found in northern versus tropical wood warblers in general; in particular, the ground-nesting habit and lack of sexual dimorphism are typical of (but not universal in) tropical Parulidae. However, the total evidence thus far listed certainly suggests that the Painted Redstart is more closely related to *Myioborus* than to *Setophaga ruticilla.* If the differences exhibited by the American Redstart are to be brushed off as secondary developments by a northern representative of a tropical group, it would represent a unique distributional situation in the Parulidae. Other genera that include both northern and tropical species (*Vermivora, Dendroica*) are predominately northern in distribution, with relatively few tropical representatives. An apparent exception is *Geothlypis*, but in that genus the northern representative *trichas* differs little from the tropical forms, which all display the "northern" character of sexual dimorphism. The genus *Parula* includes only a single widely distributed superspecies consisting of two or three species, the northern form closely resembling the tropical species.

The resemblances between the American Redstart and the Painted Redstart are predominantly in those characters directly associated with the flycatching habit (for instance, broad bill and elongated rictal bristles), and can be attributed to convergence. The American Redstart would thus represent an independently evolved flycatching-adapted offshoot of a group of wood warblers other than that which gave rise to *Myioborus* and the Painted Redstart. It is my opinion that *Setophaga ruticilla* finds its closest living relatives in the predominantly North American genus *Dendroica.* Its nest and its vocalizations are strongly reminiscent of those of such species of *Dendroica* as the Yellow Warbler, *D. petechia.* The color and pattern of both the juvenal and definitive plumages of *ruticilla* find near counterparts in *Dendroica.* I call particular attention to the resemblance of both sexes of *Setophaga ruticilla* to the Black-throated Blue Warbler, *Dendroica caerulescens.* Saturation to black of the dorsal pigmentation of males of the latter species (already suggested in the race *cairnsi*) plus the addition of orange to the white spots on tail, wings, and sides of breast, would produce a passable redstart pattern (Fig. 1). I certainly do not wish to imply that I believe the American Redstart to be an offshoot of the Black-throated Blue Warbler, but merely to show that the plumage pattern of the former, at first glance so distinctive, is not incompatible with a *Dendroica* or *Dendroica*-like ancestry.

In summary, then, I suggest that the genus *Setophaga* as presently understood is an artificial one, the resemblance between the two species being due to convergence. One species, the Painted Redstart, is probably best placed in *Myioborus*; the American Redstart may be allowed to stand in a monotypic genus, but placed near *Dendroica.*

These conjectures, of course, are not represented as being the last word. However, since some of the ideas incorporated in the present paper were presented at the symposium on Parulidae organized by George M. Sutton at the 1959 meeting of the Wilson Ornithological Society, other workers have begun to turn up evidence bearing on redstart relationships. I am indebted to Stephen W. Eaton for calling my attention to the findings of Osterhaus (1960), who compared the pelvic skeletal appendages of five genera of wood warblers. She found virtually no difference between those of *Setophaga ruticilla* and *Dendroica virens,* although these two species differ in feeding habits. Of perhaps even greater significance, the agonistic behavior of the American Redstart has been found to be strikingly similar to at least one species of *Dendroica,* the Chestnut-sided Warbler (*D. pensylvanica*) (Millicent S. Ficken, pers. comm.). I shall certainly not be surprised if additional studies, based on a variety of anatomical, behavioral, distributional and other data, confirm the relationships suggested here.

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CARNEGIE MUSEUM, PITTSBURGH 13, PENNSYLVANIA, 31 AUGUST 1961

GENERAL NOTES

Colors of Stomach Linings of Certain Passerines.—In the fall of 1957 I examined several hundred bird specimens which had been killed in nocturnal migration at a television tower near Aiken, Aiken County, South Carolina. From these birds various kinds of mensural data were obtained, including quantitative estimates of color of stomach (gizzard) linings of 90 specimens representing 39 passerine species. None of the stomachs contained food. The stomach linings, which were flattened, stretched somewhat, and blotted until almost dry, were compared with color tabs on Munsell charts (Munsell Color Co., Inc., Baltimore). Color determinations were made in terms of hue (the name of a color, as red, yellow-red, yellow, etc.), value (the amount of light in a color), and chroma (the degree of strength, or intensity, in a color). A particular color reading (such as that for a Black-and-white Warbler) is as follows: 5 YR 4.7/6, the three numerical values referring, respectively, to hue, value, and chroma. Quantitative readings such as this, involving three color dimensions, were converted into color names through use of overlay charts based on the Munsell system (Kelly and Judd, 1955. The ISCC-NBS Method of Designating Colors and a Dictionary of Color Names, Natl. Bureau of Standards Circular 553). Names applying to the specimens in question appear in Tables 1 and 2. Here the sequence of names is based on the sequence of hues, which range from "R" or reddish hues to "Y" or yellowish ones in the first table, and from "P" or purplish hues to "YR" or yellow-red ones in the second. For full descriptions of the Munsell color system, see Cooper (1941. Munsell Manual of Color, Munsell Color Co., Inc., Baltimore) or Kelly and Judd (op. cit.). For an example of a study in which this system is employed, see Bowers (*Syst. Zool.*, 5: 147 – 160 + 182, 1956).

The data on stomach-lining color for members of the wood warbler family, Parulidae, and the family of sparrowlike birds, Fringillidae (Table 1), are rather similar as far as range of hues is concerned. The hue class containing the greatest number of determinations for the parulids is in the neighborhood of 4YR, where the red component is a little greater than the yellow component. For this group the most prevalent color is "strong brown," with "brownish orange" ranking second. In the sample of fringillids the yellow component tends to exceed the red, the hue class having the greatest number of determinations being approximately 8 YR. Here "strong yellowish brown" is the most frequent color, with "brownish orange," again, ranking second. Considerable intraspecific variability is suggested by the tables. It is possible that some of the stomach linings were stained by previously ingested food, but it is doubtful that this contributed appreciably to the variability in either the warblers or the sparrows.

A much greater amplitude of hue readings was obtained from the several passerine species included in Table 2. Intraspecific variability again is marked. Whether the distinctly purplish colors found in the Catbird and the species of thrush are natural or are due to food staining is uncertain. There was no evidence of staining of other parts of the alimentary tract. In Table 2, as in Table 1, it is evident that much larger series of colorimetric readings of this sort will be necessary before one can ascertain whether some of the interspecific differences are statistically significant. Large series for particular species would also reveal whether hues, values, and chromas exhibit normal distributions. If the distributions should prove normal, it would seem that food-staining effects would be of little or no consequence. If they should prove non-normal (as suggested by the three color readings from Swainson's Thrushes, one being light brown and two grayish purple), food staining might be part of the explanation. At this point, however, we cannot rule out the possibility that stomach-lining color variation (and perhaps even dichromatism) is genetically determined. Other questions suggest themselves. For ex-

TABLE 1

COLORS OF STOMACH LININGS OF PARULIDS AND FRINGILLIDS

Color names	Moderate reddish brown	Dark reddish brown	Strong brown	Light yellowish pink	Deep orange	Brownish orange	Moderate brown	Moderate orange	Dark orange yellow	Strong yellowish brown	Moderate orange yellow	Dark yellowish brown	Moderate olive brown	Light olive brown	Dark grayish yellow
Mean hue readings	(10.0 R)	(2.5 YR)	(4.1 YR)	(4.8 YR)	(5.0 YR)	(5.1 YR)	(5.8 YR)	(7.5 YR)	(8.4 YR)	(8.9 YR)	(10.0 YR)	(10.0 YR)	(1.7 Y)	(2.5 Y)	(2.5 Y)
PARULIDAE															
Black-and-white Warbler						*†									
Tennessee Warbler	*												*		
Orange-crowned Warbler			*												
Nashville Warbler										*					
Parula Warbler			*												
Cape May Warbler		*													
Black-throated Blue Warbler			*									*			
Myrtle Warbler			(2)			*							*		
Black-throated Green Warbler			*												
Chestnut-sided Warbler			*												
Bay-breasted Warbler			*				*								
Blackpoll Warbler			(2)												
Prairie Warbler			*												
Ovenbird			(2)			*	*								
Connecticut Warbler						*									
Yellowthroat			*		*	*	*								
Hooded Warbler			*												
Canada Warbler						(2)									
American Redstart			(2)												
FRINGILLIDAE															
Cardinal										*					
Indigo Bunting										(2)					
Grasshopper Sparrow				(2)		*		*	*					*	
Henslow's Sparrow			*			*									
Vesper Sparrow			*												
Slate-colored Junco										*	*				
Chipping Sparrow										(2)					
Field Sparrow						*			*	(3)					*
Swamp Sparrow			*			*				(2)			*		
Song Sparrow						*			*	(3)					

† In Tables 1 and 2, asterisks indicate single records; numbers, more than one record.

Table 2

Colors of Stomach Linings of Several Passerine Species

Mean hue readings	(7.5 P)	(8.3 P)	(10.0 P)	(5.4 RP)	(10.0 RP)	(3.8 R)	(7.5 R)	(10.0 R)	(5.0 YR)	(5.0 YR)	(5.8 YR)	(10.0 YR)
Color names	Dark purple	Grayish purple; dark grayish purple	Dark reddish purple	Dark purplish red	Blackish purple	Grayish red; dark grayish red	Dark grayish reddish brown	Light reddish brown; moderate reddish brown	Strong orange; brownish orange	Light brown	Strong brown	Moderate yellowish brown
Traill's Flycatcher											*	
Least Flycatcher								*				
Catbird			*	*			*					
Wood Thrush		*										
Hermit Thrush						(2)		*	(2)		(2)	*
Swainson's Thrush		(2)								*		
Gray-cheeked Thrush	*											
Ruby-crowned Kinglet					*							*
Solitary Vireo									(2)			
Red-eyed Vireo				*							*	

ample, are there groups of birds in which plumage color and stomach-lining color tend to show concordance or positive correlation? No such correlation is suggested by data here tabulated.

In the Munsell system, color values range from very dark (1 = almost black) to very light (9 = almost white), with gradations (2 through 8) in between. Thus, the higher the value, the lighter the color. Values of stomach-lining colors of the parulid group range from 3 to 5.3, averaging 4.1. Values for the fringillids are a little higher, ranging from 3.3 to 6.7 and averaging 5. Those for the mixed group of passerines, mostly thrushes, range from 0.7 to 5.7, averaging 3.7. The fact that dark colors are rather more prevalent in the last-mentioned group is indicated not only by these figures but also by the color names in Table 2. As to chroma or brightness, the duller colors in the Munsell system are designated by smaller numbers (2, 4, etc.), the brighter by larger numbers (up to 12 or 14 for certain hues). Chromas for the series of parulids range from 3 to 10, averaging 6.3. Those for the fringillids extend from 3 to 9, averaging 7.4. Hence they tend to be a little brighter than the chromas for the warblers. Chromas for the mixed group of passerines range from 1 to 11; they average 4.7, tending to be duller than those for either the warblers or the sparrows. In this mixed group low chroma readings (from 1 to 3) pertain to the more or less dark purplish colors.

To sum up: stomach-lining colors of samples of the Parulidae (34 specimens of 19 species) and Fringillidae (32 specimens of 10 species) were appraised quantitatively with the aid of Munsell Color Charts. There was marked intraspecific variability. The parulids tended toward "strong brown," the fringillids toward "strong yellowish brown." The parulids' colors averaged a little darker and duller than those of the fringillids. Several thrushes and other passerines had purplish stomach linings, these averaging darker and duller than those of either the warblers or the sparrows. Several questions (for example: Are food-staining effects important?) are raised by this preliminary study. —Robert A. Norris, *University of Georgia Ecological Studies, AEC Savannah River Plant area, Aiken, South Carolina. Present address: 427 Eureka Street, San Francisco 14, California, 28 October 1960.*

Purple Sandpiper in Michigan.—The Purple Sandpiper (*Erolia maritima*) has apparently not been taken in Michigan. In Wisconsin (Schorger, *Passenger Pigeon*, 1948 : 147) only two specimens have been recorded; in Illinois, two specimens (7 November 1871 and June 1895) seem to be all that have been taken; and in Indiana there is as yet no specimen, but movies have been taken of one individual along Lake Michigan at Michigan City by C. T. Clark (Keller, *Ind. Aud. Quarterly*, 1958 : 18). The earliest sight record at the Michigan City breakwater was 12 November (1950), and the latest, 6 February (1954).

Margaret D. Elliott (*Jack-Pine Warbler*, 1949 : 60–61) gave several sight records for Pere Marquette Park, Lake Michigan, Muskegon, Michigan, December 1939; 15 December 1940; 18 December 1942; 23 December 1944; and 17 December 1947; then on 9 January 1949. On 26 December 1954, G. M. Wickstrom and Peter Hovingh, Jr., observed another, and Wickstrom observed others on 2 January 1955 and 7 April 1957 at Muskegon. On 1 January 1960, William Freeman observed two at Muskegon, and on 3 January 1960, Freeman, Clara Walkinshaw, and I observed two which flew immediately up the Muskegon Lake–Lake Michigan channel out of sight.

Clara Walkinshaw and I returned the morning of 10 December 1960 to the same spot and almost immediately found and collected a Purple Sandpiper from a small pile of rocks along the Lake Michigan shore. The bird proved to be a female. Her weight was 70.9 grams. The wing measured 130 mm.; tail, 67 mm.; tarsus, 23.1 mm.; exposed culmen, 33.2 mm. The legs and feet were strong yellowish, as was the tomium. The eye was very dark. The specimen is now in the University of Michigan Museum of Zoology. —Lawrence H. Walkinshaw, *819 North Ave., Battle Creek, Michigan, 20 December 1960.*

Flamingo in Michigan.—On 16 August 1959, a report came that a flamingo was located on the farms of Arah Pullman and Frank Tillman in Sections 21 and 28, Burlington Township, Calhoun County, Michigan (T4S, R7W). We made several trips to see this bird and found that it was apparently an American Flamingo (*Phoenicopterus ruber*) from its general rich pink color. It was a full-winged bird, and on the morning of 19 August it flew about a mile from us then returned to feed again in typical flamingo fashion, swinging its bill back and forth in the shallow water. This bird remained into late September then disappeared.

The area where it fed regularly was a pit from which marl had been removed. It had areas of both shallow and deep water, but the bird fed and roosted in the shallow areas. —William A. Dyer, *Union City, Michigan*, and Lawrence H. Walkinshaw, *819 North Ave., Battle Creek, Michigan, 9 November 1960.*

Observation of White-necked Raven on Galveston Island, Texas.—On 3 April 1960, Victor L. Emanuel, Steve Williams, Trevor B. Feltner, Dudley Deaver, and I observed a White-necked Raven (*Corvus cryptoleucus*) on Galveston Island. The bird was found four miles west of the intersection of Termini Road and Stewart Road, on the western end of the island.

We were proceeding west on Stewart Road at 2:15 PM and passed a black bird which was standing on the left shoulder of the road. Expecting a Common Crow (*C. brachyrhynchos*), which is unusual on the island, we stopped approximately 50 yards beyond. Feltner and Deaver were following and stopped closer to the bird. As the cars came to a halt the bird flushed and spiraled upward in the strong wind coming from the Gulf of Mexico. At this time the bird was 150 yards from the Gulf.

All five members of the party were able to study the bird for several minutes through 8 × 40 and 9 × 35 binoculars and spotting scopes. The bird was the size of a Common Crow but the broad tail and large beak separated it from this species. The tail was decidedly broader in the middle than at the tip. As the bird flew upward and toward the southwest, it alternately flapped and soared. This flight pattern continued until we lost sight of the bird approximately four minutes after it had been discovered.

We did not hear the bird call and were not able to see the white on the bases of the feathers of the neck, but a combination of characteristics involving size, flight pattern, tail, and beak left no doubt that it was a White-necked Raven—the first record for the Upper Gulf Coast of Texas.

There are several spring records of this species for the vicinity of Rockport, on the Central Coast of Texas.—CARL H. AIKEN III, *3767 Georgetown, Houston 5, Texas, 26 August 1960.*

Age variation and time of migration in Swainson's and Gray-cheeked Thrushes.—On 8 October 1959, Harold Wing found a total of 268 birds of 29 species dead near a TV transmitting tower at Onondaga, Ingham County, Michigan. These birds were given in the flesh to the University of Michigan Museum of Zoology. They all appeared to have been freshly killed, presumably by flying into the tower when attracted by red lights at night (Cochran and Graber, 1958. *Wilson Bull.*, 70:378–380). The bulk of this more or less random sample of nocturnal migrants consisted of 73 Swainson's Thrushes (*Hylocichla ustulata*) and 99 Gray-cheeked Thrushes (*H. minima*). Measuring wing lengths, tail lengths, and bill lengths and comparing the birds with identified specimens in the Museum of Zoology collection indicated that they represented the subspecies usually occurring in Michigan, *H. u. swainsoni* and *H. m. minima.*

Published U.S. Weather Bureau data and weather records from airports at Battle Creek, Lansing, Jackson, Willow Run, and Detroit, all stations within 100 miles of Onondaga, indicated a low ceiling with fog or drizzle at Onondaga beginning between 2300 and midnight on the night of 7–8 October and continuing for several hours. The absence of recognizable, undigested food remains in gizzards of all but four birds (beetle elytra and ants' wings in Gray-cheeked Thrushes) may have indicated that these diurnal and crepuscular feeders were not killed until at least a few hours after sunset, allowing time for digestion. Probably more generalizations about time of migration during the hours of the night in passerines have been drawn from observations of *Hylocichla* thrushes than from any other North American genus. Ball (1952. *Peabody Mus. Nat. Hist. Bull. No.* 7) and Graber and Cochran (1959. *Wilson Bull.*, 71:220–235) heard more call notes in the predawn hours than at other times, but this may mean that thrushes call more at that time, rather than that more thrushes are actually flying at that time (Lowery and Newman, 1955. *In* "Recent Studies in Avian Biology," pp. 238–263; Vleugel, 1960. *Auk*, 77:10–18). Lowery (1951. *Univ. Kansas Publ. Mus. Nat. Hist.*, 3:361–472) observed by watching the face of the moon that the peak of numbers of small migrants came between 2300 and midnight. Probably most thrushes killed at Onondaga were killed during the hour that the ceiling dropped from 2,000 feet to 700 feet (Lansing data), the hour before midnight. The fog and drizzle after midnight noted for Lansing and Jackson stations north and south of Onondaga probably grounded most low-flying night migrants. The weather records and empty gizzards suggest that *Hylocichla* thrushes do follow the peak of migration at about 2300 as observed by Lowery.

At Southfield, Oakland County, Michigan, I looked for dead birds at two TV transmitting towers on the morning of 8 October but found only one, a male Golden-crowned Kinglet (*Regulus calendula*). Southfield is within 30 miles of the Willow Run and Detroit Metropolitan Airports; hourly weather records from these stations show the drop in ceiling to have occurred during the night between midnight and 0200. The peak of migation for the night may have been over by that time, although differences in night migration routes across the state might also account for the difference in the number of migrants killed.

It is generally recognized that the single layer of bone forming the skull of newly fledged passerines is strengthened during the first year of life by the formation of a second, connected layer of bone. In the House Sparrow (*Passer domesticus*) this ossifying, or double layering, process is complete after about 180 days (Nero, 1951. *Wilson Bull.*, 63:84–88). In the thrushes the last area to become double layered (except for persistent, clear oval "windows" along the midline above the foramen magnum) was an oval area on either side of the midline in the posterior half of the frontal region. In thrushes this last area to ossify is slightly posterior to the corresponding site in House Sparrows. The sample of *Hylocichla* thrushes indicated that some individuals do not develop the complete double layering within a year and possibly never fully ossify. Two skeletons of *H. ustulata* collected in April in Costa Rica (UMMZ 153,287 and UMMZ 153,288) had oval, single-layered areas in these locations. Another skeleton (UMMZ 72,241) taken in Michigan in May had unossified areas 5.0 by 2.8 mm. in these locations. Finally, four *H. ustulata* in the present 8 October sample had a pair of oval, single-layered areas symmetrically located near the posterior margin of the frontal area; these were about 2 by 3 mm. No other thrush skulls in the sample were over three-fourths double-layered in the dorsal aspect of the skull. There was no visible bursa in one of the four thrushes, although I did find a bursa in 8 of 11 immatures; I did not examine the other three birds with nearly-ossified skulls for presence of a bursa. The plumage of the four was adult; I found no spotted or streaked coverts, and under the microscope the upper and lower wing coverts were close-webbed, adult feathers rather than loose-webbed, juvenal feathers. These adult characteristics together with the series of the three incompletely ossified, spring-collected thrushes indicate that some individuals do not ossify completely within a year.

The degree of retention of juvenal feathers was even more variable in thrushes. Banders (e.g., Middleton, 1958. *Ebba News*, 21:65–66) have systematically identified *Hylocichla* thrushes with no spotted or streaked juvenal wing coverts (usually retained at the postjuvenal, premigratory fall molt) as adults, following Dwight's (1900. *Ann. N.Y. Acad. Sci.*, 13:73–360) description of molt sequences. Dwight recognized the presence of "precocious individuals," but generalized that in both thrush species the postjuvenal molt involves "the body plumage, the lesser coverts and not the rest of the wings nor the tail." The TV tower sample indicated a variability among first-year birds. Not all immatures had spotted wing coverts, and those that did (most did) had different numbers of juvenal feathers retained. Using the characters of the presence of spotted, streaked, or otherwise marked or loose-webbed upper coverts and body feathers and degree of wear of flight feathers, I was able to age correctly all adult (10 male, 19 female) *H. ustulata*, but only 18 of 20 first-year males and 15 of 22 first-year females. Similarly I aged correctly all adult (29 male, 24 female) *H. minima*, but only 13 of 17 first-year males and 25 of 26 first-year females. I repeated these attempts with the same results. Others in the Museum of Zoology had the same experience with this sample. Because of this considerable variation in retention of juvenal plumage, it would be desirable for banders to check age by skull ossification on live birds as described by Miller (1946. *Bird-banding*, 17:33–35) as well as by plumage.

I would like to thank N. L. Ford, F. B. Gill, H. B. Tordoff, and L. L. Wolf for advice in this study. The article was written while I was attending the University of California with support from the National Science Foundation.—ROBERT B. PAYNE, *University of Michigan Museum of Zoology, Ann Arbor, Michigan, 2 October 1960.*

Foot-stirring in the Green Heron.—Dr. A. J. Meyerriecks' article on Foot-stirring behavior in Herons (1959. *Wilson Bull.*, 71:153–158) describes this method of feeding in three North American herons (Snowy Egret, Reddish Egret, Louisiana Heron). A comparative behavior chart ("A summary of existing knowledge of the displays and related activities of ten North American Herons") in his more recent publication, "Comparative Breeding Behavior of Four Species of North American Herons" (*Publ. of Nuttall Ornith. Club*, No. 2), lists only these same three species as known to engage in this type of feeding behavior. On page 8 in this publication, he relates that the feeding behavior of the Green Heron (*Butorides virescens*) is primarily of two types: Stand and Wait, and Wade or Walk slowly. In the light of these two articles the following observation may be of interest.

In the summer of 1954, while taking 16 mm films of Killdeer and Spotted Sandpipers in the shallow water of Fall Creek behind my home in Etna, New York, I noticed a Green Heron perched on a stone just above the surface of the water. With the 150 mm lens I was able to get a fairly large image, and started the camera as the heron stepped off the rock into the water. I recorded it on film as he stirred the water several times with his right foot, and shortly thereafter seized and ate what appeared to be a crustacean. Dr. Meyerriecks reports to me (pers. comm.) that an extensive search of the literature has failed to turn up a published reference to foot-stirring in the Green Heron, nor has he observed it himself in many hundreds of hours of watching this species. The little section of film footage I made is included in a lecture film of mine which has been shown to many audiences. Evidently this type of feeding behavior, while far rarer than other types, does occur at times in the Green Heron.—SALLY F. HOYT, *Laboratory of Ornithology, Cornell University, Ithaca, New York, 29 July 1960.*

Nest-building movements performed by juvenal Song Sparrow.—There have been several accounts recently in the literature of nest-building movements performed by juvenal birds. Dilger described such an activity in a juvenal Swainson's Thrush (*Hylocichla ustulata*) (1956. *Wilson Bull.*, 68:157–158). I have recently observed a similar performance in a fringillid.

On 10 September 1960, I watched a juvenal Song Sparrow (*Melospiza melodia*) feeding on the ground under my window. In a flower bed which was soft from rains, and where the soil was mixed with husks of sunflower seeds so that it was light and porous, my dog had left several rather deep footprints. The immature sparrow settled itself in one of these footprints and performed somwhat awkward but very recognizable nest-building movements, kicking back with the feet and pressing the breast against the side of the depression in a "smoothing" motion. The bird also picked up a small piece of dried grass and tucked it beneath the body.

This observation lends support to Dilger's statement that "the innate releasing mechanisms responsible for reacting to nest-building stimuli must be present at an early age."—Sally F. Hoyt, *Laboratory of Ornithology, Cornell University, Ithaca, New York, 19 October 1960.*

Notes on nesting of the Caracara.—Bent (1938. *U.S. Nat. Mus. Bull.*, 170 (2):127–135) listed the range of the Caracara (*Caracara cheriway*) in central Texas as Sheffield, San Angelo, Mason, Waco, and probably Houston. While working in Brazoria County, Texas, I had occasion to observe the nesting success of this interesting bird each year from 1955 through 1959. The location of the nesting site was 1 mile south of Danberry, Brazoria County, Texas. Danberry is 43 miles south of Houston. The general agriculture of the area is rice farming and cattle grazing.

The birds were seen each year close to the same nesting site in late January. They are known to nest earlier in Florida and south Texas. However, waterfowl hunting is common in this area and shooting may keep these shy birds away until the waterfowl season closes.

The nest was located about 15 feet high in a clump of live oak trees (*Quercus virginiana*), a common nesting plant for the caracara. The clump of trees was in an open pasture surrounded by rice fields. Its location enabled the birds to view the surrounding country with ease. The birds were observed at a distance, for they flush while the intruder is some distance away. Only the sentinel bird would be seen during the period they were incubating. The family group was seen in June but the nest itself was not examined during the nesting season because the landowner had asked that it not be disturbed.

Because the family group remained together in the general vicinity of the nest for some time after the young left it, the nesting success was easy to determine. Two young were raised each year in 1955, 1956, 1957, and 1959. Only one young bird was raised in 1958. The family could be seen until late June or July. It would then leave the area and would not be seen again until the nesting pair returned in January of the following year. The young evidently left the area for good, for none of them was seen again.—Olan W. Dillon, Jr., *Soil Conservation Service, Ithaca, New York, 1 November 1960.*

Distraction display of the Common Gallinule.—Common Gallinules (*Gallinula chloropus*) at Lake Alice, University of Florida Campus, Gainesville, Florida, most commonly build platform nests on small floating islands, but sometimes build floating nests in water pennywort (*Hydrocotyle umbellata*). Alexander Sprunt, Jr. (Bent, 1926. *U.S. Nat. Mus. Bull.*, 135: 349 pp.) describes the reaction of incubating birds to his presence at the nest: ". . . the adults within a few feet of me while photographing the nest and examining the eggs. . . ." He comments on the "utter unconcern on the part of the bird. Walking about . . . picking up food . . . within 6 and 8 feet . . . they stroll about as if there was no enemy . . . within miles." Although this behavior is well recorded, I have not seen it at Lake Alice.

Two types of behavior are exhibited by Common Gallinules when they are flushed from their nests at Lake Alice. Most of the birds walk or spatter rapidly away from the immediate nest site and do not return until the intruder leaves. Some individuals exhibit an unusual distraction display from nearby floating pennywort or in very shallow water. They retreat 20 to 30 feet from the nest, face the intruder, half extend both wings, and stamp their feet alternately on the water. The alternate stamping of the feet results in much splashing and in general creates a noisy disturbance. The wing extension more than doubles the bird's apparent bulk. *Kuk* calls are given during the display and while the bird moves about between displays. One bird which was observed daily during the 1960 season performed on low, horizontal limbs of nearby willow (*Salix* sp.) when a combination of pennywort growth and high water level made the display impossible at its usual locale. The display lost much of its effectiveness, but the slapping on the bark was still distinctly audible at more than 30 feet. Some stamping was done using alternate feet, but the bird appeared to have some difficulty maintaining its perch, and most of the stamping was done repetitively with one foot. Although this stamping was done with the right foot, it was probably because the left foot was at a slightly higher elevation rather than because of any "footedness" on the part of the bird.

These observations clarify a discrepancy in the literature. Bent leaves the impression that incubating birds respond by moving a very few feet away and otherwise ignoring the intruder. Miller (1946. *Cassinia,* 36:14) describes what must be this same distraction display, ". . . jumped about excitedly. She splashed and displayed upon the water and pecked frequently at the duck weed which covered her. Her cries . . . attracted her mate. . . . He behaved just as excitedly, as he jumped up and down on the water feigning a broken wing." Miller labels this injury feigning. Gullion (1952. *Wilson Bull.,* 64:83–93) refers to Miller's work. He concludes that the elements of this display closely resemble churning and swanning by the American Coot (*Fulica americana*). Churning is a displacement activity in which the coot backpaddles so rapidly that it lifts its body out of the water. Swanning, partial extension and arching of the wings, is used in nest defense. Swanning in the American Coot resembles wing extension in the Common Gallinule. Stamping in the gallinule is not the same thing as churning in the coot. These coot and gallinule displays do have some elements in common, but they play different roles in the behavior patterns of these two birds. Gullion was correct in questioning the classification of these gallinule displays by Miller as injury feigning. The gallinule's partial wing extension crudely resembles the familiar broken-wing feint, but apparently only serves the function of increasing apparent bulk. The total display makes the adult bird more conspicuous, and it should be considered a distraction display.—Donald A. Jenni, *Department of Biology, University of Florida, Gainesville, Florida, 2 November 1960.*

A Hoary Redpoll specimen for New Jersey.—During the winter of 1959–1960, there was a major invasion of Common Redpolls (*Acanthis flammea*) in the northeast, the fourth such occurrence in the United States in the past 14 years (*Audubon Field Notes,* 14:284). Hoary Redpolls (*A. hornemanni*) were frequently reported in the flocks of Common Redpolls, several "lighter" redpolls being reported from the New York City region and Hunterdon County, New Jersey.

On 1 April 1960, I noticed one pale individual in a flock of 14 redpolls at a feeding station in West Englewood, Bergen County, New Jersey. It was frequently involved in threat displays and chase flights with other members of the flock. The bird was taken as a specimen and subsequently identified as *Acanthis hornemanni exilipes* by Harrison B. Tordoff. The specimen has been deposited in The University of Michigan Museum of

Zoology (UMMZ 155,143). It was a male with small testes and a moderate amount of body fat. Slight molt was noted on the back and on the throat. The wing measured 71.2 mm., the exposed culmen 6.1 mm.

This appears to be the first specimen record for New Jersey and the only recent specimen for the New York City region — one was taken in the Bronx in 1888 by Dwight (Cruickshank, "Birds Around New York City," 1942:441).—FRANK B. GILL, *The University of Michigan Museum of Zoology, Ann Arbor, Michigan, 3 November 1960.*

Three new birds for the Mississippi list.—I can find no reference reporting the Black-necked Stilt (*Himantopus mexicanus*), Mottled Duck (*Anas fulvigula maculosa*), or Cattle Egret (*Bubulcus ibis*) as having been collected in Mississippi. Recent collection of these three species seems noteworthy.

CATTLE EGRET.—On 29 May 1960 I found two of these egrets in a cow pasture near the coast 4 miles east of Pascagoula (Jackson County). One was collected. During the summer, several others of this species were seen at various points along Mississippi's coast. Sterling G. Clawson, Mississippi Game and Fish Commission Biologist, took a young specimen at Claiborne (Hancock County) on 8 September 1960.

MOTTLED DUCK.—The fresh and brackish marshes of western Hancock County held a sizable population of these ducks during the summer of 1960. I saw the species there on numerous occasions and took a specimen near Claiborne on 9 September when 23 were seen.

BLACK-NECKED STILT.—I saw this species once during the fall of 1960. On 24 September I took a specimen from a group of seven found feeding on mud flats at Bayou Casotte in Jackson County, a few miles east of Pascagoula. The AOU Check-list (Fifth Edition, 1957) lists Mississippi among the states in which the Black-necked Stilt occurs casually in migration.

The specimens were deposited in the museum of the Mississippi Game and Fish Commission.—LOVETT E. WILLIAMS, JR., *CGC Gentian, General Delivery, Galveston, Texas, 28 November 1960.*

Flock feeding behavior in migrant Bonaparte's Gulls.—On 12 November 1960, we observed a flock of 75–100 Bonaparte's Gulls (*Larus philadelphia*), including only four immatures, feeding at a hot-water outlet of the Consumer's Power Company near Erie, Monroe County, Michigan. After we watched this flock for several minutes, we noted a definite feeding pattern.

The feeding area was about 100 yards long and 10 yards wide. The birds moved south into the wind along the long axis of the feeding area. When a bird reached the end of the area, it would veer lateral to, or up and over the feeding flock and return to the northern end of the area, whereupon it would resume feeding. The lateral routes were used more frequently than the overhead route. A returning bird could re-enter the feeding flock at any point, although the majority entered within the first 20 yards of the run.

Additional observations of the flock revealed that there were two smaller circular feeding routes within the large one. Upon reaching the center of the feeding area, a small percentage of the birds would return to the beginning, thus covering only half of the total feeding area. A similar half-route was established in the southern half of the feeding area.

The number of dives an individual made in one trip ranged from 2 to 17, the greatest number being made by those birds which covered the entire 100 yards. The birds dived into the water from 2 to 5 feet above the surface. An actively feeding individual would dive consistently from the same height, enter the water at approximately a 60-degree angle and completely submerge. Upon surfacing (headed in the same direction), it would fly to a suitable height from which it would dive again. If a gull caught a fish, it left the flock, usually with two or three other gulls in pursuit. The flock was silent except when a fish was caught. The great individual variation in this general feeding pattern seemed to depend on the intensity of the individual's feeding behavior.

The next weekend, 19 November, Wolf made the following observations of Bonaparte's Gulls in the same area. The foraging flock of gulls fluctuated between 2 and 25 birds. No definite feeding pattern of the sort observed the previous week was noted. The birds were feeding close to the mouth of the hot-water outlet and fished mainly at the periphery of the strong current. The feeding area was almost circular with a diameter of about 20 yards. The birds flew rather irregularly about the area, occasionally veering to avoid a collision.

The birds did not dive directly into the water, but maneuvered to the surface from a height of 5 to 15 feet. No birds were seen to submerge completely. The only food which we noted being taken by the gulls was small fish. The gulls seemed to be catching more fish per unit of time than in the previous week.

A possible explanation for the differences in feeding behavior on the two days might be found in the fact that fish are discharged with the water at the outlet. The water is drawn up from the lake and used to cool generators in the power plant. Some of the discharged fish are brought close to the surface by the churning action of the water in the immediate vicinity of the outlet. Thus on 19 November the birds feeding on the edges of the turbulent water did not have to submerge to obtain a morsel. The small number of feeding individuals probably did not necessitate an organized feeding pattern. On 12 November, however, the gulls may have been feeding on a school of fish, which in turn were feeding on the morsels discharged at the outlet. Since the pieces of food would be sinking in the more slowly moving water, the gulls would have to submerge to catch the fish. The school of fish would be a rich, localized food source, which would be best exploited by a large flock of gulls if they fed in an organized manner. The efficiency of this organized flock was less than that of the birds observed on 19 November because submergence, which was less often used than picking morsels off the surface of the water, is less efficient. Diving and complete submergence has been noted for a number of species of gulls (Tinbergen, 1953. "The Herring Gull's World," p. 36).

Organized flock feeding behavior has been described only infrequently. Bartholomew (1942. *Condor*, 44:13) describes the organized fishing behavior of flocks of Double-crested Cormorants (*Phalacrocorax auritus*) on San Francisco Bay. Hailman (1960. *Raven*, 21:109) describes feeding by a flock of Ring-billed Gulls (*Larus delawarensis*) following a plow in Virginia. Inasmuch as the most recently plowed soil is the richest food source, the rotation of the flock facilitates a more efficient exploitation of the exposed grubs, larvae, etc. A similar "leap-frog" feeding behavior was described by Meyerriecks (1960. *Natural History*, 69 [7]:51–52) for the Cattle Egret (*Bubulcus ibis*). —LARRY L. WOLF and FRANK B. GILL, *University of Michigan Museum of Zoology, Ann Arbor, Michigan, 22 December 1960.*

Range extensions of herons in the Northeastern United States.—The rapid northward expansion of several species of Ardeidae has rendered obsolete the range descriptions in the AOU Check-list. Following is a list of these species and their northern breeding limits in New Jersey, New York, and New England, as of the summer of 1960.

Little Blue Heron (*Florida caerulea*).—*AOU Check-list Status*: "Breeds . . . on the Atlantic coast from Massachusetts (Marshfield, casually) to southern Florida."

1960 Status: New Jersey.—"Nests locally in the southern part of the state" (Fables, 1955: 18). The farthest north that this species has been reported to breed in New Jersey is at Brigantine, Atlantic County (Forward, *fide* Potter, 1957:394), and at Island Beach, Ocean County (*fide* Potter, 1951:284). New York.—During the late 1920's, when the general increase of "white herons" due to protection became evident north of the breeding range, the Little Blue Heron was the most frequently noted of the three in the New York City area. This species was "occasionally encountered in flocks of over one hundred. The largest concentration occurred on the Newark Marshes on September 3, 1930, when 329 birds were counted" (Cruickshank, 1942: 71–72). By the mid-1940's it had become the rarest of the three (Bull, 1958: 9). Today such numbers of Little Blues are unheard of in the area.

The situation in regard to the Snowy Egret (*Leucophoyx thula*), on the other hand, is the reverse. During the period when the Little Blue Heron occurred in flocks of one hundred or more, the largest flock of Snowy Egrets reported about New York numbered 12 (Cruickshank, 1942: 70). When the Little Blue Heron became scarce, the Snowy Egret became common and became a locally numerous nester on Long Island.

Therefore, when, on 15 July 1956 Alperin, Buckley, Bull, Phelan, Smith, and I found as many as four to six adult Little Blues, one pied bird, and four to six white birds in the Tobay Beach, Long Island, Nassau County, heron colony, we were greatly surprised. These birds were found among 6 pairs of Green Herons (*Butorides virescens*), 15 pairs of Common Egrets (*Casmerodius albus*), 80 to 90 pairs of Snowy Egrets, 20 pairs of Black-crowned Night Herons (*Nycticorax nycticorax*), and 40 pairs of Yellow-crowned Night Herons (*Nyctanassa violacea*). However, no positive evidence that the Little Blues were breeding was found. The white birds appeared to be birds of the year, but they were fully grown and flying, and the possibility of post-breeding wanderers from the south could not be ruled out.

Access to young and nests was also extremely difficult, for the herons were nesting in almost impenetrable tangles of cherries (*Prunus* sp.), cat brier (*Smilax* sp.), bayberry (*Myrica cerifera*), and an especially luxurious growth of posion ivy (*Rhus radicans*), reaching 6 to 7 feet in height.

Positive evidence of breeding of the Little Blue Heron in New York State was not obtained until two years later, when, on 18 July 1958, in the same colony, John L. Bull observed an adult feeding young (Elliott, 1958: 95). The second and only other definite breeding of the Little Blue Heron in New York was in a heron colony on Canarsie Pol, an island in Jamaica Bay, Kings County, which is within the city limits of New York. This colony was discovered by Ernest J. Restivo and me on 16 July 1960. Among 6 pairs of Green Herons, 25 pairs of Common Egrets, 90 pairs of Snowy Egrets, and 12 pairs of Black-crowned Night Herons, was at least one pair of Little Blue Herons. The Little Blues acted as if they were breeding, and a search produced one flightless young bird, out of the nest, fully feathered, with the primaries only about 2 inches out of their sheaths. These feathers were edged in dark gray, characteristic of the young of this species. One primary was taken for documentation of the record, and the bird was banded.

Although only two adult Little Blue Herons were seen, it is believed that two pairs were present. When I was in the area where the young Little Blue Heron was found, only one adult flew about, croaking. The other Little Blue Heron was observed at a distance sitting on a bush, as if on a nest.

The color of the soft parts of the young Little Blue Heron is given here because of the scarcity of such descriptions in the literature. Bill: dark blue changing to black toward the tip. Legs and feet: bright greenish-yellow. Iris: light grayish-blue.

New England.—North of New Jersey the only other definite breeding records are two from Marshfield, Plymouth County, Massachusetts—1940 and 1941 (Hagar, 1941: 568–569) and the two from New York here mentioned.

Common Egret.—*AOU Check-list Status*: "Breeds from southwestern New Jersey (Salem and Gloucester counties) south . . ." *1960 Status:* New Jersey.—"Breeds locally as far as Sandy Hook, Monmouth Co." (Fables, 1955: 18). This species has been breeding at Sandy Hook, at least since 1952 (Stout, *fide* Nichols, 1952: 274). New York.—Nests only on Long Island, where it "breeds very locally" (Bull, 1958: 9). The first definite breeding for the state was from Fisher's Island, Suffolk County, during 1953 (Ferguson, in litt.). This remains the farthest north and east this species breeds in New York. The 15 pairs at the Tobay colony and the 25 pairs at Canarsie Pol are the two largest breeding concentrations north of Brigantine, New Jersey, where 75 pairs were recorded in 1957 (Forward, *fide* Potter, 1957: 394). New England.—Discovered breeding at South Hanson, Plymouth County, Massachusetts in 1954 (Griscom and Snyder, 1955: 31). This species has since been discovered nesting at Manchester, Essex County, Massachusetts in 1956 (*fide* Baird and Emery, 1956: 370).

Snowy Egret.—*AOU Check-list Status*: "Breeds from southern New Jersey (Cape May County) . . ." *1960 Status*: New Jersey.—"A local breeder as far north as Island Beach, Ocean county" (Fables, 1955: 18). First found breeding at Island Beach in 1951 (*fide* Potter, 1951: 284). As many as 2,000 birds in the Stone Harbor colony, Cape May County, on 9 July 1959 (Potter, 1959: 422). New York.—Breeds only on Long Island where it breeds "chiefly on the south shore . . . in several places" (Bull, 1958: 9). The 100 pairs in the Tobay colony (Guthrie, *fide* Elliott, 1958: 95), and the 90 pairs at Canarsie Pol are the largest breeding concentrations recorded north of Stone Harbor, New Jersey. First recorded breeding in New York in 1949, at Oak Beach, Suffolk County (Elliott, *fide* Nichols, 1949: 229). New England.—One breeding record for Massachusetts—1955 at Quivet Neck, Cape Cod, Barnstable County (Le Baron, *fide* Morgan and Emery, 1955: 365).

Louisiana Heron (*Hydranassa tricolor*).—*AOU Check-list Status*: "Breeds from coastal Maryland (Worcester County) south . . ." *1960 Status*: New Jersey.—First found breeding at Stone Harbor in 1948 (Wright, *fide* Potter, 1948: 200). This species "has shown a considerable increase since 1954. H. H. Mills counted 210 birds in three colonies in 1958. Rare north of Stone Harbor" (Fables, 1959, p. 4). The farthest north this species has been reported breeding in New Jersey is at Brigantine, where two pairs were found in 1957 (Forward, *fide* Potter, 1957: 394). New York.—The increase in New Jersey has been reflected in New York. This species has been recorded annually on Long Island since 1952, with a maximum count of six, and has been suspected of nesting in the Tobay colony since 1956 but no positive proof of breeding was ever found. There is only one definite breeding record for the state—Jamaica Bay Wildlife Refuge, Long Island, Queens County, 1955 (Meyerriecks, 1957:184). New England.—No breeding records, but several sight observations of wandering birds.

Yellow-crowned Night Heron.—The present breeding range of this species in the Northeast is essentially as outlined in the AOU Check-list. The large numbers breeding in the Tobay colony, with 40 pairs the largest concentration (during 1956), deserves special mention. As far as can be determined from the available literature, this species is usually considered as a rare and local breeder—at least in the northern part of its breeding range. The largest concentration in any one colony usually numbers only several pairs.

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PETER W. POST, *575 West 183 St., New York 33, New York, 18 August 1960.*

Migration of Blue Jays at Madison, Wisconsin.—The morning of 24 April 1960, while walking from Picnic Point to Second Point on Lake Mendota, I noticed small flocks of Blue Jays (*Cyanocitta cristata*) drifting northward through the woods. On arriving at Picnic Point I observed jays leaving the conifers and circling higher and higher until they were barely visible to the naked eye, then flying northward. Due to the swirling about of the birds, I could not make an accurate count, but a conservative estimate of the number would be 75. The exodus took place at 11:05, daylight saving. Not all of the jays left as some could still be heard calling in the conifers. At the time that the jays were circling a Sharp-shinned Hawk appeared and also circled. The jays, from all appearances were completely ignored. On returning to Picnic Point I met Alex Dzubin and mentioned the migration to him. The following day he told me that on reaching the neck of Picnic Point, a flock of 19 jays came past going in the direction of Second Point.

A regular spring migration occurs at Madison, principally during the last week in April and the first two weeks of May. Usually the jays are in small flocks. In open country they are to be seen flying at a height of about 200 feet. When woods are encountered they drop down and continue their journey through the tree tops. The flight of jays mentioned by Doolittle (1919. A Strange Blue Jay Flight. *Auk*, 36:572) represented a normal migration. The above is the only case in which I have seen jays tower before moving north. Circling and attaining altitude has been described by Tyrrell (1934. Bird Notes from Whitefish Point, Michigan. *Auk*, 51:21–26) for jays crossing Lake Superior. Brewster (1937. The Birds of Lake Umbagog Region of Maine. *Bull. Mus. Comp. Zoöl.*, 66(3):502) at Lake Umbagog noticed jays spiral to a height of 2,000 feet before flying southwest. The distance from Second Point to Fox Bluff on the north shore of Lake Mendota is approximately 1.7 miles. Even this expanse of water appears sufficient to stimulate the jays to migrate at a high altitude.

There are few observations on the manner by which birds gain altitude when they start their migration across a body of water. Taverner and Swales (1907. The Birds of Point Pelee, *Wilson Bull.*, 19:133–53), in spite of their unusual opportunity, are not specific on how Blue Jays and other birds left Point Pelee. Some species circle while others rise at an angle. I have seen Eastern Kingbirds leave Madeline Island in Lake Superior, and they rose at an angle. James Baird has informed me (in litt.) that at Block Island and Narragansett Bay, Massachusetts, swallows and Eastern Kingbirds did not circle, and this seemed to hold for the sparrows and warblers. Robins on the other hand gained great heights by circling.—A. W. SCHORGER, *College of Agriculture, University of Wisconsin, Madison 6, Wisconsin, 12 November 1960.*

Porcupine Quills in a Ruffed Grouse.—On 22 October 1960, Walter J. Frautschi of Madison shot a Ruffed Grouse (*Bonasa umbellus*) at Pine Lake, Oneida County, Wisconsin. When the bird was carved at the table, eight porcupine quills up to one inch in length were found in one side of the breast. The wounds had healed over completely. The porcupine is mentioned (G. Bump et al. 1947. The Ruffed Grouse, p. 14) as an enemy of this grouse but it must be an uncommon one. There is one account of its eating the eggs (Anon. 1933. Porcupine Eats Grouse Eggs. *Pa. Game News* 4(3):5). The female Ruffed Grouse is at times a bold defender of its nest and young. Though the bird was not sexed, it is logical to assume that it was a female that dashed at its potential enemy and was struck by the tail of the porcupine.—A. W. SCHORGER, *College of Agriculture, University of Wisconsin, Madison 6, Wisconsin, 12 November 1960.*

Yellow Warblers in conifers.—On 2 July 1960, at Marshall Point, near Port Clyde, Knox County, Maine (on the mainland about 10 miles south of Rockland), I found a number of Yellow Warblers (*Dendroica petechia*) in white spruce (*Picea glauca*) 20 to 30 feet high. Between 12 and 14 July 1960, I found over 100 of these birds in white spruce on Matinicus Island, Maine; and at the north end of this isle on 13 July I also found several well into a dense forest, over 100 acres in extent, of red spruce (*P. rubens*) 60 to 70 feet high. The same day Harry Edgcomb found them not only in white and red spruce but also in hemlock (*Tsuga canadensis*) near the southwest end of the island. Matinicus is one of a number of islands 20 to 25 miles south southwest of Rockland and just south of Penobscot Bay. Originally covered with conifers, probably mostly red spruce, Matinicus has been inhabited by white men for over 200 years. One-half to two-thirds of its 700-odd acres is now fairly open, with a goodly crop of bushy white spruce beginning to cover many areas. In these, Yellow Warblers were very common, Harry Edgcomb and I agreeing that, including young, about 700 (or 1 per acre) were on the island. The warblers were still on the island 8 September 1960, but were gone the next day.

The only Yellow Warbler nest I have seen on Matinicus was in an apple bush 3 feet up in a clump of white spruce, just above the beach at Condon Cove, on the east side of the island. Mrs. Robert P. Booth said that four young had been in the nest on 16 July 1958, but we found it deserted the next afternoon.

This warbler, widespread over the entire country and breeding in its various forms in almost every state, is so confined to deciduous growth that I have been able in an extensive search of the literature to find but one reference to its being in conifers. There (Dawson, 1923. Birds of California. Students' Ed., I:464) it is said "the nest of the Yellow Warbler is found in suitable territory at any height, in alders, willows, apple trees, or even fir saplings."

I can suggest as an explanation only a tremendous crowding of this warbler from its normal habitat, peculiar in view of the cold June of 1959 in Maine. However, at least one late nesting was noted by Mrs. Judson Lord at Warren, Knox Co., Maine (Hebard, 1960. The Land Birds of Penobscot Bay, p. 22. Portland Soc. Nat. Hist.), and perhaps such late nestings in 1959 were unusually successful. Certainly all warblers loving deciduous growth, such as the Yellow, Chestnut-sided, Yellowthroat, and Redstart were unusually common in at least most of Maine in 1960 (H. L. Mendall, pers. comm.; Hebard, pers. obs.).

Observation of Yellow Warblers in conifers is all the more surprising when they seem generally confined to deciduous growth in winter (Bent, 1953. *U. S. Natl. Mus. Bull.* 203:176–177, quoting Skutch). However, some warblers, such as the spruce-loving Cape May (*D. tigrina*), are found in deciduous growth on fall migration and in winter (Bent, op. cit.: 221). Likewise, finding Yellow Warblers in deep woods is surprising. Brewster, at wooded Lake Umbagog, had but six observations dating from 1871 to 1907 (Griscom, 1938. *Mus. Comp. Zool., Bull.*, 66(4):570).—Frederick V. Hebard, *1500 Walnut Street Building, Philadelphia 2, Pennsylvania, 23 December 1960.*

ORNITHOLOGICAL NEWS

The 1962 Annual Meeting of the Wilson Ornithological Society will be held on the campus of Purdue University at Lafayette, Indiana, on 6–8 April. Plan now to attend.

Louis Agassiz Fuertes Research Grant

This grant, established in 1947, is devoted to the encouragement and stimulation of young ornithologists. One particular desire is the development of research interests among amateur ornithologists. Any kind of ornithological research may be aided. Recipients of grants need not be associated with academic organizations. Each proposal is considered primarily on the basis of possible contributions to ornithological knowledge.

An anonymous donor gave $500 to found the fund; later donors have provided some $600. The Council of the Wilson Ornithological Society has added funds as necessary to provide at least one $100 grant annually.

Although grantees are not required to publish their studies in the *Wilson Bulletin*, it is hoped that they will submit their manuscripts to the Editor of the *Bulletin* for consideration.

Since its inception the Fuertes Research Grant has been awarded to 16 persons, many of whom have continued their research work. The recipients are listed below.

1948—Leonard R. Mewaldt, Life history of Clark's Nutcracker.
1949—Stephen W. Eaton, A comparative study of the genus *Seiurus*.
1950—Henry E. Childs, Population dynamics and life history of the Brown Towhee.
    Byron E. Harrell, Ecology of the Rancho del Cielo, Tamaulipas, Mexico.
    Arnold J. Petersen, Reproductive cycle in the Bank Swallow.
    Harrison B. Tordoff, Comparative osteology of the subfamilies of the Fringillidae.
1951—Howard L. Cogswell, Territory size and its relation to vegetation, structure and density among birds of the chaparral.
1952—Robert W. Nero, Territorial and sexual behavior in the Red-wing.
1953—no award.
1954—William C. Dilger, The isolating mechanisms and relationships of the thrush genus *Hylocichla*.
1955—Robert G. Wolk, Analysis of reproductive behavior in the Black Skimmer.
1956—John B. Millar, An investigation of possible factors involved in the initiation of migration.
    Lester L. Short, Jr., Hybridization and isolating mechanisms in North American flickers.
1957—Millicent (Mrs. Robert L.) Ficken, Comparative study of the behavior of the Canada Warbler and the American Redstart.
1958—Harold D. Mahan, Studies of growth and temperature regulation in the Red-wing.
1959—no award.
1960—Robert T. Lynn, The comparative behavior of the Carolina Wren and Bewick's Wren.
1961—Frances (Mrs. Douglas A.) James, Compilation on the distribution and abundance of Arkansas birds.

Application forms may be obtained from Harvey I. Fisher, Southern Illinois University, Carbondale, Illinois. Completed applications must be received by 1 March 1962.

Several thousand eggs collected over a period of about forty years by the late Frank M. Phelps of Elyria, Ohio, have been presented to the University of Massachusetts by Mrs.

Phelps. The collection, to be known as the Frank M. Phelps Memorial Egg Collection, will be catalogued in the Zoology Museum and will be available for study at the University. It is anticipated that this will form the nucleus of a growing collection and other such gifts will be appreciated.

With the co-operation of the Audubon Society of Missouri, Daniel McKinley is preparing a biography of Otto Widmann. Anyone having photographs, personal memories, or letters to or from Widmann or knowing of their whereabouts is urged to correspond with Mr. McKinley, Lake Erie College, Biology Department, Painesville, Ohio.

A Committee on Student Participation has been formed, with Professor S. Charles Kendeigh as Chairman, to receive applications from young ornithologists for financial support to enable them to attend the XIII International Ornithological Congress in Ithaca, New York, 17–24 June 1962. The funds provided for this Committee are being raised by private donation, and it is not certain at this time how large a sum will be available. The Committee will presumably be able to make grants only to graduate students.

Applications must be submitted to Prof. Kendeigh, Vivarium Building, University of Illinois, Wright and Healy Streets, Champaign, Illinois, before 1 April 1962.

Checks of donations for the work of the Committee should be made payable to the American Ornithologists' Union and should be mailed to the Treasurer (Prof. Charles G. Sibley, Fernow Hall, Cornell University, Ithaca, New York) with instructions that the money is to be used for this purpose.

It is the hope of this Committee that serious young students of ornithology will take advantage of the unique opportunity to attend an International Congress and to meet the world's leading ornithologists in person.

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 15 January 1962. Proposals received prior to that date will be reviewed at the spring meeting of the Foundation's advisory panels and disposition will be made approximately four months following the closing date. Proposals received after the 15 January 1962 deadline will be reviewed following the summer closing date of 15 May 1962.

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

SOME EFFECTS OF INSECTICIDES ON TERRESTRIAL BIRDLIFE IN THE MIDDLE WEST

A Contribution from the Wilson Ornithological Society Conservation Committee

The object of this paper is to present an ecological review of the presently known effects of insecticides upon bird populations in terrestrial habitats in Wisconsin and (to a lesser extent) in the neighboring states of Michigan and Illinois. The omission of aquatic phenomena in this report has one serious drawback that the reader should recognize at the start: Very little attention in this paper is given to destruction of aquatic insects and fish-food organisms in routine forest spraying (Hoffmann and Merkel, 1948; Hoffmann, Townes, Swift, and Sailer, 1949; Hoffmann and Drooz, 1953) or to the heavy losses of invertebrate animals when marshland has been sprayed for mosquito control (Springer and Webster, 1949, 1951) or to the delayed effects on fish (Surber, 1948; Herald, 1949). These phenomena presumably have an effect on bird populations, although this effect is seldom measured; but they involve aquatic birdlife for the most part, they have seldom been studied in the Middle West, and they are outside the scope of the present review.

I am much indebted to a great many patient colleagues in other institutions, as well as at the University of Wisconsin, who critically read an early draft of the present paper. Without the availability of Rudd and Genelly's (1956) fine monograph on the relationship of pesticides to wildlife, the writing of this paper would have been doubly difficult. The present review is a slightly condensed version of a multilithed report which the State of Wisconsin distributed in limited numbers early in 1961 as part of a study carried out by the Governor's Special Committee on Chemicals and Health Hazards.

ECOLOGICAL CHARGES OF WILDLIFE CONSERVATIONISTS

FEARS REGARDING DIRECT MORTALITY

Many conservationists believe that the direct mortality sustained by wildlife is steadily increasing as the gross tonnage of insecticides sold each year continues to mount. Allied to this widespread feeling is awareness that insects develop resistance to certain insecticides and that society is faced with the prospect of more and more poisons of higher and higher toxicity. Statistics annually compiled by the Commodity Stabilization Service (Shepard, 1956; Shepard, Mahan, and Graham, 1959, 1960) to some extent bear this out. From 1952–53 to 1958–59, domestic "disappearance" of DDT (domestic use plus some export shipments by formulators) increased only 12 per cent (from 62.5 to 78.7 million lb.). At the same time, six much more toxic chlorinated hydrocarbons increased 115 per cent (from 34.1 to 73.3 million lb.). Wildlife hazard is, however, much more closely related to manner of use than to volume. Thus, applications of aldrin or heptachlor (at 1 lb./acre, for soil-insect pests) involve almost one-half of all the crop acres treated with insecticides in Illinois and Wisconsin (Mills, 1956; Dicke, 1960). Here the chemicals must be disked into the soil at once, since delays of even 1 hour can affect the results (Mills, 1955). It is unlikely that birdlife is appreciably affected by this method of application. Occasional delays in coverage of the insecticide are reported, however, in Illinois (Bigger and Blanchard, 1959); and, in the opinion of A. W. Schorger (pers. comm.), the three birds most likely to be exposed to the chemical in the Middle West are Herring Gulls (*Larus argentatus*), Ring-billed Gulls (*L. delawarensis*), and Pectoral Sandpipers (*Erolia* *melanotos*). We have no evidence, however, that any unusual mortality among these species is taking place; and it is my judgment that the wildlife hazard involved in this particular use of insecticides must be very small. The difficulties of generalizing from the toxicity of an insecticide, from the total volume used, and from application rates are always compounded by the place of application—since some landscapes have high densities of birdlife (forest edges, wetlands, and well-landscaped suburbs) while others support almost no birds at the time insecticides are applied to them (plowed cornfields, potato fields, and the like).

It seems wisest, therefore, to avoid sweeping generalizations about the over-all effect of pesticides upon wildlife until one can evaluate particular programs of insect control where the individual variables are better understood and where less extrapolation from known facts is necessary. Even here, however, it is rather difficult to get good data on the magnitude of everyday control programs; and—partly as a result—public attention has tended to focus on the spectacular emergency projects.

Forest-insect Control

Forest-insect control is of great interest to sportsmen, since the ungrazed 195 million acres of forested land today provide major opportunities for hunting and fishing in the United States. In 1957, the forested area subjected to aerial applications of insecticides in this country was 10.3 million acres (Shepard et al., 1959). As it is not necessary to protect every branch of every tree (as in Dutch elm disease operations), forest-insect control here is chiefly confined at the present time to single applications of DDT at 1 lb./acre. These do not seem to affect mammals (Stickel, 1946, 1951; Adams, Hanavan, Hosley, and Johnston, 1949); their direct effect on birdlife is negligible (Kozlik, 1946; Kendeigh, 1947; Adams et al., 1949); and at the present time, they are not known to damage the general arthropod fauna seriously, but in this latter connection many forest types having a variety of canopy densities still remain to be studied with a precise, statistically adequate method (Hoffmann et al., 1949; Hartenstein, 1960).

Barker (1958) found that June and July applications of 1.5 and 1.1 lb. of DDT per acre can be concentrated sufficiently by earthworms to kill Robins (*Turdus migratorius*) during the following spring. Although this study involved a nonforested area, there is, therefore, a possibility that the earthworm-feeding Woodcock (*Philohela minor*) may similarly be affected by forest spraying. In northern New Brunswick, where (as of 1959) applications of 0.5–1 lb. of DDT per acre have been annually repeated for as many as 5 years, Wright (1960) has found a marked reduction in the reproductive success of Woodcock. This finding represents the first field evidence of a phenomenon previously produced under laboratory conditions; the evidence is, however, circumstantial and should be followed up by chemical analyses of the northern birds that are involved. Pesticide usage in Canada differs from that carried out against forest-insect defoliators in the United States: (1) Applications of DDT in New Brunswick are now reduced to 0.5 lb./acre; and (2) 55.5 per cent of the sprayed area there has been treated twice, 28.3 per cent three times, and 2.5 per cent four times (Webb, 1959). As far as I can learn, these replications are very rare in the Middle West. In Wisconsin's forests, treatment in two successive years seems to have occurred only on a few small pine plantations during the past decade.

The European pine shoot moth is a local pest that has recently reached the Middle West and now occupies the Lower Peninsula of Michigan as well as southern and eastern Wisconsin (Benjamin, Smith, and Bachman, 1959). This species can be controlled only with very heavy applications of DDT—some of which go up to 10 lb./acre (Miller and Haynes, 1958). These treatments are carried out by Christmas-tree operators (chiefly in Michigan), and only local bird populations are probably affected. The insect does relatively little damage to white pines or to pine plantations over 15 ft. in height; and its further spread in the Middle West is restricted by its inability to over-winter at –18°F. (Benjamin et al., 1959). Although no evaluations of the wildlife effects of shoot moth spraying have been carried out, the wildlife-conservation problem here seems to be essentially a limited one.

Agricultural-insect Control

Agricultural-insect control has been only slightly studied by wildlife ecologists. There is, of course, a great deal of regional variation in the distribution of insect pests and a parallel variation in the use of insecticides. In 1955, farmers in Illinois used insecticides on 1,531,000 acres—mostly for corn borers and soil insects (Mills, 1956). In Wisconsin, the crop acreage in 1959 was about 295,000 (Dicke, 1960). On the whole, it has been very difficult for an ecologist to get these statistics for each state and to form some preliminary idea of the magnitude of the bird mortality that may or may not be taking place. Dicke's (1960) statistical data for Wisconsin are among the very best that lend themselves to an ecological review, and my preliminary estimates of the bird mortality taking place in that state in 1959 (Table 1) must be regarded as working hypotheses rather than conclusions based on rigorously established facts. These hypotheses really rest on comparative toxicological studies of laboratory animals (as summarized by Rudd and Genelly, 1956, and Negerbon, 1959) and on field studies of the effects of DDT on forest birdlife where experimental application rates have reached 3–5 lb./per acre (Hotchkiss and Pough, 1946; Robbins and Stewart, 1949; Mitchell, Blagbrough, and Van Etten, 1953).

It is virtually impossible at this time to make any estimate of the late-summer effects of agricultural insecticides on wildlife. In the fall and winter, when the cornfields of the Middle West are highly important feeding areas for both game species and for songbirds, insecticides do not appear to have any negative effects on these animals . . . and in their contribution to high yields, it can be said that insecticides have helped Midwestern farmers to tolerate the wastage in mechanically picked corn that is now so important to Canada Geese (*Branta canadensis*), Mallards (*Anas platyrhynchos*), and Ring-necked Pheasants (*Phasianus colchicus*) in this region.

In general, it seems to me quite possible that modern orchards have lost most of their birdlife. Unpublished summer-transect data from Illinois indicate that this may not be true in that state (Graber, pers. comm.). Most of the orchard-wildlife-loss reports elsewhere on the continent come from British Columbia, Washington, and California (Rudd and Genelly, 1956) where DDT and TEPP seem to be the insecticides most frequently involved when the observations were carried out. Songbird mortality from parathion is said to be frequent in citrus groves, but the extent of such loss is not known (Rudd and Genelly, 1956). No conclusive research has been carried out on such very important variables as the size of the orchard area that is sprayed and on the chronological aspects of spraying as they relate to the nesting cycles of both game and songbirds.

Among wildlife conservationists, there exists some fear that agricultural insecticides tend to increase toxicological hazards for migratory birds which—quite apart from their avoidance of cropland during the breeding season—are often found on farm fields during the migratory and wintering periods of their annual cycle. Only fragmentary data on the presence of insecticidal residues in the tissues of such birds are currently available to test this hypothesis in a critical and conclusive fashion. Pending the finality of such tests, I believe that three facts mitigate against the hypothesis being true in the Middle West: (1) The organic phosphates used during the plant-growing season have too short

TABLE 1

PRELIMINARY ESTIMATES OF THE EFFECT OF AGRICULTURAL AND FOREST INSECTICIDES ON WISCONSIN BIRDLIFE

Crop	Per cent Treated in Wis.[6]	No. of 1,000 Acres[1] Treated	Principal Insecticide Used on Crop[1]	Total Lb. per Acre[1,2]	Bird Populations[3]		Estimated Mortality to Birds Present[5]
					Nesting	Feeding[4]	
FIELD CROPS							
Forage	1.2	50	Malathion or parathion	0.25 or 0.5	Fair (48)	Good	None or slight?
Field corn	3.6	100	Aldrin or heptachlor[6]	1	V. low (3)	Good	None
Sweet corn	11.7	12	DDT	3.0(2)	None?	Good	–?–
Soybeans	1.0	1	DDT	1	Low?	–?–	None
Peas	7.0	6.5	Parathion	0.67(2)	Low	Low	Slight?
Small grains	0.7	20	Parathion or malathion	0.25 or 0.5	Low (10)	Low	None or slight?
Tobacco	33.0	4.6	Aldrin or heptachlor[6]	2	None	None	——
VEGETABLES							
Cabbage	95.6	5.5	Endrin	1(2)	None	Poor	——
			Parathion + toxaphene	1.5 + 4.5 (3)	None	Poor	——
Carrots	50.0	0.9	DDT	8(4)	None	None	——
Onions	75.0	2.1	Ethion[6]	1	None	None	——
Cucumbers	25.0	4	DDT	0.5–1 (1–2)	None	None	——
Potatoes	95.0	42.8	DDT + toxaphene[7]	6.8 + 9 (8–9)	None	None	——
FRUIT CROPS							
Apples	100	10	Dieldrin Lead arsenate DDT TDE	0.25 30(5) 10(5) 8(4)	High	High	98%
Cherries	100	10	DDT Malathion or parathion Methoxychlor Dieldrin	3 4.5 or 1.5(2) 3 0.25	High?	High	98%
Cranberries	100	4.5	Parathion	0.3(2)	Low	Low	None
Strawberries	100	1.5	Parathion or malathion Methoxychlor TDE	0.5 or 1.5 1 1	Low	High	Slight
PULP, TIMBER							
Forests[8]	1.0	20.4	DDT	1	Good (225)	Good	None
Planting	11.3	6[9]	Aldrin[6]	0.4[10]	Low	Low	None

[1] From Dicke (1960) except as noted below; treated acres represent 1959 data.
[2] The total number of treatments per growing season is given in parentheses.
[3] Subjectively estimated (with help from R. A. McCabe and A. W. Schorger, Univ. of Wis.) for pre-insecticide conditions. Some actual densities for SCS-planned farms in Ohio (Dambach and Good, 1940) are shown in parentheses as pairs per 100 acres.
[4] Excludes late summer, fall, and winter.
[5] Crudely estimated; based in part on summary by Rudd and Genelly (1956).
[6] Soil treatments to which birds are not generally exposed.
[7] The switchover to systemic phorate in 1961 (Dicke, 1960) should not change the mortality estimates. Total lb./acre calculated for nine applications.
[8] Four-year average (1956–59) calculated from Benjamin's (1960) compilation.
[9] State-wide estimate by S. W. Welsh, Wisconsin Conservation Dept. (pers. comm.).
[10] Estimated by R. W. Shenefelt, Dept. Entomology, Univ. of Wis. (pers. comm.).

Table 2

Summary of Major Uses of Insecticides in Rural Wisconsin in 1959[1]

Crop Treated	Acres Treated	Lbs. Insecticide Used	Lb./Acre	Est. Bird Loss
Field crops	194,000	168,000	0.87	None to slight
Vegetables	55,300	726,000	13.13	None
Fruit crops				
Apples, cherries	20,000	572,500	28.63	Very considerable
Others	6,000	5,900	0.98	None to slight
Forests	26,400	22,800	0.87	None
Totals and means	321,800	1,495,200	4.64	Over-all: slight

[1] Insecticide treatment for outbreaks of migratory insects is variable and cuts across all crops. In 1960 about 20,000 acres were treated for grasshopper control, about 44 per cent with malathion, and 38 per cent with aldrin (Dicke, 1960).

a residual life to be available to migrating birds in fall or winter; (2) the aldrin, dieldrin, or heptachlor used for soil insects is disked into the soil and hence is unavailable for direct ingestion by birds in this region; and (3) most of these field-foraging birds are hunting for seeds rather than for insects during the fall and winter.

The use of malathion and parathion on alfalfa takes place in July and does not involve the first cut of this forage crop. The year's second growth of alfalfa rarely is attractive to nesting birds (R. A. McCabe, pers. comm.). It does attract feeding birds from nearby fields. As far as I can determine from Rudd and Genelly's (1956) excellent review, applications of these organic phosphates at such low concentrations may well have only a slight effect on birdlife.

For Wisconsin, the serious bird mortality on crop and orchard land seems to be confined to about 20,000 acres—an area representing less than 0.06 per cent of the 35,011,200 acres in the state. Although almost 1.5 million lb. of insecticides are used in this state's agricultural and forestry operations (Table 2), the over-all direct effect on the state's birdlife seems to be slight.

Dutch-elm-disease Control

Dutch-elm-disease control has been rapidly expanded within the past decade as this disease moved into the Middle West where street elms are extensively planted in many residential areas on former prairies and farmlands. The disease was first identified in Cincinnati and Cleveland in 1930, in Detroit in 1950, in Chicago in 1954, in Wisconsin in 1956, and in Iowa in 1957. As a very preliminary guess, one might say that the threatened street elms in this region may number about 1.5 to 2 million trees. The dollar value of these is hard to assess and probably exceeds the net cost of removing a dead tree. Taken at $250 per tree, these street elms could well represent a resource totaling 375–500 million dollars. Whatever the true value of this resource really is, one may conclude that the problem facing state and municipal authorities is indeed an immense one that demands our most earnest thinking.

Variations in DED-control techniques can be arbitrarily classified into three types that are of particular interest to the ornithologist. Each importantly depends on sanitation (tree trimming, clean-up of elm wood piles, etc.). Each has its own (known or suspected) wildlife effects; and almost every possible gradation between the three has been used during the past decade.

Sanitation.—The first and apparently the oldest of these types involves sanitation alone. Some of the cities relying on this technique are quite large, like Buffalo (185 thousand public and private elms, with a disease loss averaging 0.4 per cent per year from 1953 through 1956 according to Matthysse, 1958). These cities—as far as I know—are all in the East. The tree trimming probably has at least a slight depressing effect on local bird populations, but this has never been measured. [The Chickadees (*Parus atricapillus*), woodpeckers (*Dendrocopos pubescens* and *D. villosus*), and Nuthatch (*Sitta carolinensis*) populations—which are most likely to be affected—could be in part restored by erection of artificial nest boxes.] This program was used in 1959–60 at Shorewood, Wisconsin; but no community in the Middle West seems to have relied on it exclusively from the start. In New York State, where the disease was discovered in 1930, Matthysse (1958) recommends that sanitation receive the main emphasis and that DDT be used for high-value, healthy elms. Such a system presumably has wildlife effects that will be somewhat intermediate between the sanitation type and the DDT programs described below.

DDT.—In the Middle West, control of DED is principally carried out with application rates of DDT that have been roughly estimated by George (1959) as running 5–10 lb./acre, but we in Wisconsin have calculated local treatments as high as 17.2 and 23.6 lb./acre (Hickey and Hunt, 1960*a*). There are four variables affecting these rates: the height of the tree, the number of elms per acre, the use of mist-blowers vs. hydraulic equipment, and the application technique of the machine operator. Elm losses in 12 Illinois communities using this technique were less than 1 per cent per year from 1956 through 1959 (Neely, Carter, and Compana, 1960). All the published reports of bird mortality associated with routine DED control during the past decade are restricted to Michigan, Illinois, and Wisconsin where this use of DDT is quite common and where it has tended to be introduced in full-scale programs of spraying.

In Michigan, at least 18 residential communities are now known to have sustained bird mortality as a result of these programs; breeding-bird mortalities on the order of 90 per cent or more have been recorded; and 94 species of birds are known or are suspected to have died from DDT poisoning (Mehner and Wallace, 1959; Wallace, 1960*a*, 1960*b*; and Wallace, Nickell, and Bernard, 1961).

In Wisconsin, where the picture has been almost identical, minor differences in the mortality reports can be attributed to pressure exerted on operators by the State to finish spraying operations earlier in the spring. When elms on the University of Wisconsin campus were sprayed with DDT for the first time, Robin mortality on 61.2 acres was found to run at least 86 per cent (Hickey and Hunt, 1960*b*). After the second season of spraying, this figure was at least 85 per cent (Hunt, unpubl.). Careful census work in six residential areas that had been sprayed with DDT for 3 years in southern Wisconsin disclosed that their breeding-bird populations were 31–90 per cent lower than the average for five unsprayed residential areas (Hunt, 1960). Although these study areas were not randomly selected and therefore not indicative of average conditions, the indicated bird mortality due to DDT was significantly correlated with the number of elm trees sprayed per acre (Hickey and Hunt, 1960*a*). Where sprayed street elms numbered about 10 per acre, the drop in the breeding-bird population apparently was on the order of 90 per cent after 3 years of spraying. Where all the elms of an area (rather than just the street elms) are sprayed, densities of 3.1–4.8 trees per acre have been associated with Robin mortalities of an equally high magnitude (Wallace et al., 1961; Hickey and Hunt, 1960*a*).

At Shorewood, Wisconsin, Hunt (1960 and pers. comm.) could detect no difference between the bird population of an area mist-sprayed that spring and one mist-sprayed the previous fall. Bird-mortality differences attributable to other variables (like mist-spraying vs. hydraulic spraying, height of trees, etc.) have not been studied.

All the bird-mortality reports in the Middle West point to a consistent pattern when a full-scale use of DDT is launched to control this disease: The direct mortality is largely confined to April, May, and June. It seems to involve mostly breeding birds in Wisconsin; but a delayed spraying program (late April or early May) in a late cold spring can cause heavy mortality among wood warblers and other foliage gleaners (Wallace et al., 1961). The bird mortality is spectacular and easily observed during the first spring after spraying; it is still conspicuous but much less noticeable in the second spring; it almost escapes public notice by the third spring—when the bird population has been fully depressed. At this point, spring census work in three Wisconsin municipalities has shown that a mortality of 36 per cent was still occurring within a 6-week period during the nesting season (Hickey and Hunt, 1960*a*). The fatal ingress of birds into sprayed areas during the breeding season has been noted in both Michigan (Wallace, 1960*b*; Wallace et al., 1961) and Wisconsin (Hickey and Hunt, unpubl.) and apparently represents a drain on the songbird populations of nearby unsprayed terrain. About one-half of the bird mortality involves Robins. Although none of these urban-dwelling species is, in my opinion, in any danger of extinction at this time, the bird populations affected by this program have a high sentimental value because they enter so intimately into the daily lives of so many people.

It is impossible at this time to estimate with any accuracy how many birds have been fatally involved in this heavy use of DDT. Wallace's (1959) estimate of "millions" of Robins killed by DDT in DED programs is in turn based on an over-all estimate of 2 million acres of elms treated in the United States (George, 1959). In Wisconsin, we have been impressed with the fact that at least one Robin was apparently lost for every four elms sprayed on Hunt's (1960) study areas. Thus, if 1.5–2 million trees approximate the number now being sprayed with DDT in the Middle West, then about 375–500 thousand Robins may be initially lost when DDT is used to protect elms, and some lesser but unknown number is then lost each subsequent year as new birds move into the sprayed areas. Since the numbers involving other species of birds should be roughly equivalent to the number of Robins (Hunt, ibid.), it is possible that the initial loss in urban birdlife due to this type of DED control is on the order of ¾ to 1 million birds in this region. These estimates are very crude ones involving (1) a very risky extrapolation of Wisconsin mortality records to a much larger geographic area in which DDT is being used to control elm bark beetles, and (2) a very crude assumption regarding the number of trees being sprayed. Whatever the true extent of the loss really is, one may at least conclude that the wildlife-conservation problem here is very large.

Methoxychlor.—A third system of DED control involves the usual sanitation plus the use of methoxychlor (Whitten, 1958; Norris, 1961). This chemical has a very low toxicity to warm-blooded animals (Negerbon, 1959). When DDT is fed for 5 days to captive Robins, 50 per cent of the birds will die at a daily dosage of 110 mg./kg.; whereas a similar diet of methoxychlor at 3750 mg./kg. has failed to kill any of the birds (Hickey, Sacho, and Hunt, unpubl. MS). Usage of this insecticide in DED control has been restricted in the past partly by the price of the chemical and partly by uncertainties about its effectiveness in this program. After much research on the control of DED, Norris (1961) recommends the use of methoxychlor as a 12 per cent emulsion spray applied by mistblower in early spring before the emergence of buds. It is now being used by two communities in Illinois (Neely et al., 1960) and three in Wisconsin.

Conclusions on DED Control.—The use of DDT to control DED is clearly a threat to an important component of the birdlife in the Middle West. It is a relatively inexpensive chemical to purchase and a relatively convenient one to apply; but its use should be vigorously condemned where elm trees that are to be sprayed reach moderately high densities in this region. Conservationists should, however, recognize that the substitution of methoxychlor for DDT that has been applied in the past does not at once remove the DDT now in the soil . . . and that Robin mortality will continue until local earthworms no longer carry concentrations of DDT that are lethal to the birds eating them. Although at the present time there are no studies of the wildlife effects of methoxychlor under operational conditions, it appears that the tremendous urban elm population of the Middle West and its associated birdlife can both be preserved by vigorous tree-sanitation programs, with methoxychlor spraying carried out in spring on (a) the more valuable trees and (b) in those areas where elms have a relatively high density per acre.

Federal-state Programs

Federal eradication and suppression programs have in recent years been confined to imported insect pests. Co-operatively organized by the federal and state departments of agriculture, these programs have involved very large acreages, have taken on considerable importance in the public eye, and are bound to increase in the Middle West as more and more ocean-going vessels take advantage of the St. Lawrence Seaway and as more and more air terminals like O'Hare Field in this region receive aircraft direct from Europe (Simmonds, 1959). The wildlife-conservation problems, which are quite complex and varied, are illustrated in three examples:

Gypsy Moths.—The long history of efforts to eradicate this species in the eastern United States has recently been reviewed by Worrell (1960). This moth was found in Michigan in 1954, its previous western boundary having been eastern Pennsylvania. From 1954 to 1959 inclusive, 249,798 acres in Michigan were treated in an attempt to wipe out this pocket of distribution. These treatments, which involved 1 lb. of DDT per acre, should not importantly affect forest-dwelling birds, but the effects of 1 lb./acre on the birdlife of open terrain appear to be inadequately studied.

Japanese Beetles.—These insects have been steadily moving westward, and suppression measures have been taken in Michigan, Indiana, Kentucky, Illinois, Iowa, and Missouri. Up to 1960, these six states treated 96,000 acres in co-operation with the U.S. Department of Agriculture. The usual chemicals employed are granular aldrin, dieldrin or heptachlor, applied at 2–3 lb./acre. These hydrocarbons are far more toxic than DDT at such levels, and the wildlife losses have been considerable.

At Sheldon, Illinois, resident Meadowlarks (*Sturnella magna*), Robins, Brown Thrashers (*Toxostoma rufum*), Starlings (*Sturnus vulgaris*), Grackles (*Quisculus quiscula*), and Pheasants were virtually eliminated; so too were muskrats (*Ondatra zibethicus*), rabbits (*Sylvilagus floridanus*), and ground squirrels (*Citellus franklinii* and *C. tridecemlineatus*) (Scott, Willis, and Ellis, 1959). At Blue Island, Illinois, over 300 dead and dying birds were picked up in a 2-month period; 37 of these were banded birds (Bartel, 1960). Bartel's banding data suggest that the songbird mortality in his area was on the order of 80 per cent; his personal estimates, based on other criteria, were slightly higher. Among the curious side effects at Sheldon was a 160 per cent increase in the number of corn borers (Luckmann, 1960).

The reaction of the public to this federal-state program has been one of steadily increasing apprehension and emotion. This is not surprising since the program has gradually expanded to include urban and suburban areas. Although the mortality at Sheldon was thoroughly documented by a research team from the Illinois State Natural History Survey Division (Scott et al., 1959) and the wildlife losses labeled as "severe," an Illinois control official was asserting in 1960 that the Survey had found "no . . . serious damage being done to wildlife" (letter, 7 January 1960, S. J. Stanard to F. W. Zebell).

There is, of course, a subtle and important distinction between the words "serious" and "severe," but this is usually lost on the public, which is often far more informed about direct songbird losses than control authorities realize. The net effect of such statements is to inflame public opinion and to lower public confidence in control or eradication programs. Rightly or wrongly, the entire program is now challenged . . . and some highly technical questions are subjected to debate.

These questions involve such matters as the choice of insecticide, application rates, and extent of the area to be treated. Why did Illinois drop dieldrin and switch in 1960 to aldrin—one of the most toxic of all agricultural chemicals to game birds (Post, 1952; Dahlen and Haugen, 1954; DeWitt, 1955)? And if Illinois was really successful in treating 74,615 acres from 1954 through the spring of 1960, why were 38,914 still scheduled for treatment in the fall of 1960? These are questions which an enlightened citizenry is entitled to ask but not always able to judge. In the modern technological world, we still want the technical efficiency of managerial government with the traditional responsibilities of public servants in a democracy. What appears to be lacking in insect-control machinery of some states is an administrative realization of the emotional impact of modern insecticides on the public mind, an alertness to all the questions that are puzzling conservation-minded people, a willingness to admit that wildlife losses are taking place under certain conditions, and a sense of responsibility to show exactly how these losses are being kept to a minimum and why these losses are justified. When these are lacking, public fears regarding an entrenched bureaucracy are bound to mount.

One may conclude from this rather brief review that eradication and suppression programs require well-defined coordination of state conservation and state agriculture departments; and that there is a pressing need for alert extension teaching when a state prepares to co-operate with the federal government in a program of this type.

The Fire-ant Program.—This will long remain a classic example of how an insect problem can be mishandled at the administrative level. Amid all the furor, charges and counter-charges, it seems obvious that the U.S. Department of Agriculture did not clear its plans in advance with the Department of Interior and with the state conservation departments that were subsequently involved. Much less clear are three fundamental hypotheses on which the program has been based: (1) that the fire ant is indeed a costly pest, (2) that the initial application rates were selected on the basis of adequate research, and (3) that the Department's program can indeed eradicate the imported fire ant in the United States.

There seems to be little doubt that the wildlife losses associated with this program in its early stages (when dieldrin and heptachlor were used at 2 lb./acre) must have been very great (Baker, 1958; Clawson and Baker, 1959; Glasgow, 1958; Lay, 1958; Rosene, 1958); but it should be borne in mind that the insecticides were not being applied to a solid block of "27 million" acres and that the bird populations affected may regain their former levels in a period far shorter than some conservationists have predicted. One prominent game manager has said that it will take 25 years for Bobwhite Quail (*Colinus virginianus*) to recover from the fire-ant program. This view is, in my opinion, far too pessimistic. The Bobwhite has a high breeding potential, and it should be able to come back within 5 years after disappearance of the toxicant. The degree to which this period may vary is discussed below under Population-recovery Rates.

DeWitt, Menzie, Adomaitis, and Reichel (1960) have found that Woodcock are now incorporating dieldrin or heptachlor epoxide into their tissues soon after they arrive on the wintering grounds. Because the chlorinated hydrocarbons have a tendency to build up in a bird's gonads, some impairment of this species' reproductive efficiency is possible. The actual degree of probability is, however, unknown at this time. It does seem safe to conclude that the complex operations of the fire-ant program should be of interest and concern to sportsmen as far north as Minnesota, Wisconsin, and Michigan. This is especially true since DDT may now be depressing the reproductive success of Woodcock in New Brunswick where chemical residues from the fire-ant program are also beginning to appear in the tissues of this species (Wright, 1960). If the basic hypotheses of USDA regarding the fire-ant program are all true, then the wildlife loss may simply be a part of the price that society has to pay in the long run. If any one of the three hypotheses is false, then the USDA plant-pest machinery surely is in need of modification.

General Conclusions on Federal Programs.—The most impressive aspects of the recent federal programs are—from the wildlife ecologist's point of view—the vast acreages they can involve and the extreme wildlife hazard they develop when aldrin, dieldrin, or heptachlor are applied in a granular form at 2–3 lb./acre. When two such variables occur simultaneously, there will always exist the possibility that a species limited in distribution [like Kirtland's Warbler (*Dendroica kirtlandii*) in Michigan, the Golden-cheeked Warbler (*D. chrysoparia*) in Texas, and the Dusky Seaside Sparrow (*Ammospiza nigrescens*) in Florida] will be exposed to a federal program at a time when its repopulation rate is unequal to the occasion. Hence federal emergency programs will always contain an element of danger in the eyes of wildlife conservationists.

There are few conclusions that one may draw from these federally sponsored programs and the activities of state agencies co-operating in them. In general, the control agencies have been slow to admit that their programs can and do cause locally severe bird mortality, and conservation groups have been equally slow to realize that the affected bird populations will generally recover within a few years' time after disappearance of the toxicant. Amid all the public unrest, there is (1) a mounting apprehension that avian species with critically low populations may be irreparably reduced before conservation agencies are aware that a control program is underway and (2) an increasing suspicion that an entrenched federal bureaucracy is seeking to perpetuate or increase its empire (Cottam, 1958). This latter view, while often quite unfair to the dedicated public servants in government agencies, is not uncommon in other areas of our society; but a careful evaluation of such a hypothesis is quite outside the scope of the present review. What emerge from the abundant literature on this subject are (1) a growing realization that inadequate provisions exist in the federal government for collecting all the information and making it available to decision makers on major insect-control programs (Worrell, 1960), (2) an increasing awareness that state fish and game departments have no contact with the U.S. Department of Agriculture (Popham, 1960:60), and (3) a mounting conviction that decisions affecting the welfare of wildlife should not be left entirely in the hands of regulatory entomologists at either the federal or state level (Turner, 1959).

Mosquito Control

Although the broad ecological effects of mosquito control received much attention when DDT was first introduced (Erickson, 1947; Bishop, 1947; Tarzwell, 1947, 1950; Scudder and Tarzwell, 1950), wildlife biologists have not evaluated many developments in this program that have taken place within the past decade in the United States. By 1952, mosquitoes in some parts of the country were exhibiting a high level of resistance to all the chlorinated hydrocarbons, and mosquito-abatement districts were turning to organic phosphates like EPN, chlorthion, malathion, and parathion (Grieb, 1957). In various countries, physiological resistance to the chlorinated hydrocarbons had been confirmed in more than 20 species by 1959, and in more than 37 by 1960; and in California some resistance to malathion and parathion is now reported (Communicable Disease Center, 1960, 1961). The organophosphus compounds differ greatly in their toxicity to warm-blooded vertebrates, but none of them have been studied as they are used in mosquito-control programs. A national survey of mosquito-control agencies in January 1956 showed DDT to be the compound still most commonly relied upon, with substantial use reported for BHC, malathion, pyrethrum, and dieldrin (Ginsburg, 1956). Although Illinois now spends over $800,000 annually in 17 mosquito-abatement districts covering nearly 1,000 sq. miles (Lopp, 1958; Boulahanis, 1959), the Middle West does not have—for the most part—the highly organized mosquito-control agencies found on both the West and East coasts, and DDT still appears to be the insecticide most commonly used in this region to control mosquitoes.

Adult-mosquito Control.—According to Quarterman (1957), there are no such things as standardized formulations and application rates in this program; these vary throughout the United States according to the species of mosquito involved, the ecology of the area to be treated, annual changes in the weather, and differing opinions of the operators. In the United States, DDT is used most commonly as a 5 per cent solution in fuel oil, applied at approximately 0.5 lb. per acre (ibid.). This application rate is considerably higher than that currently being recommended for adult mosquito control in Wisconsin (E. H. Fisher, pers. comm.). Couch (1946) has reported the disappearance of insect-eating songbirds when a lowland forest in Illinois was sprayed at monthly intervals with DDT at 0.5 lb./acre. In this case, the spraying did not begin until August 8 (when the nesting season was almost completed), and there is a strong possibility that local songbirds reacted to depleted food supplies by moving off the sprayed area. (During the nesting season, their movement would be more localized, and—if the application was more frequent than monthly—some loss of reproductive efficiency might take place.) In another Illinois study, applications of DDT mist at 1 lb. per acre were begun on 23 June in a mixed prairie and forest and on 22 July on a wooded river bank (Ross and Tietz, 1949). Although the birdlife was reported as not visibly affected, any such effects would be very difficult to measure; and there was clearly a change in the insect food supplies available to birds.

It is difficult to estimate the bird mortality taking place at Maple Bluff, Wisconsin, where some 20 mosquito-fogging operations in the entire village averaged 0.18 lb. DDT/acre in 1960 and where each acre got 3.5 lb. of DDT during the entire mosquito-fogging season (Dicke, 1960). Although this total amount of the insecticide should be sufficient to set up the lethal earthworm-chain reaction for Robins, discovered by Barker (1958), the Robin mortality in this community was spectacular shortly after the area was first subjected to DDT to control Dutch elm disease (Hickey and Hunt, 1960*b*). This loss could scarcely have resulted if mosquito control had seriously depressed the breeding-bird population in previous years. Wallace (in litt.) has encountered DDT-stricken birds following a mosquito-control operation in Michigan. If Midwestern adult-mosquito control techniques are as variable as Quarterman (1957) says they are nationally, local variation in bird mortality due to this program surely is possible. In Illinois, where mosquito-control work dates back to 1921, the area included in organized abatement districts now represents about 1.67 per cent of the total acreage in the state (Boulahanis, 1959). In Wisconsin, local fogging for adult mosquitoes is being carried out far more frequently than entomologists feel is necessary (R. J. Dicke and E. H. Fisher, pers. comm.).

Adult-mosquito control in the Middle West appears to have a variable, rather uncertain, and quite possibly minor effect on birdlife. Wherever possible, it should be (1) localized, (2) carried with minimum application rates, (3) authorized only when conditions really require it, and (4) delayed until the conclusion of the breeding-bird season.

Mosquito Larviciding.—Elsewhere in the United States, modern larviciding has long been regarded as having rather little effect on birdlife. Good control of Culicine and Anophaline mosquito larvae was initially obtained with DDT repeatedly applied at 0.1–0.25 lb./acre (West and Campbell, 1952). In South Carolina, 12 routine larvicidal treatments by airplane from 28 May to 5 September at 0.1 lb. DDT/acre are reported to have reduced mosquitoes, deer flies, and sand flies in numbers, but to have no observable over-all effect on other terrestrial insect populations (Scudder and Tarzwell, 1950). Repeated applications in South Carolina also had no known effect on birdlife in terrestrial habitats (Erickson, 1947). Dicke's (1960) report of 0.5 lb. DDT/acre being used from 1 to 21 times per season for larval-mosquito control at Madison, Wisconsin, carries the implication (I think) that insect food for some birds may be reduced. In this instance, however, the larviciding is carried out on "high grass" and temporary water, and (it should be stressed) permanent marshes in this area are avoided. The effects (if any) on birds in this city seem likely to be confined to a few species like Song Sparrows (*Melospiza melodia*), Vesper Sparrows (*Pooecetes gramineus*), and Meadowlarks; since only 2.6 per cent of the city's area is involved, the over-all effect on Madison's birdlife is likely to be slight. Until additional data are gathered on the actual larviciding techniques of other communities, the wildlife effects of this program will remain unknown. The relative rarity of aircraft applications in the Middle West and the emphasis on treatment of temporary pools of water, rather than permanent ones, seem to me to reduce the potential hazard of mosquito-larval control to wildlife in this region. In other states, residual larvicides are now being applied at rates that certainly should be investigated by wildlife ecologists: DDT at 3–10 lb./acre, heptachlor at 5 lb./acre, and malathion at 3 lb./acre (Communicable Disease Center, 1961).

Research Needs.—The ecology of modern mosquito control in the Middle West is in many ways little known. Information is needed to determine the variation in amount of DDT now used by governmental agencies, by government contractors, and by private landowners for both larval- and adult-mosquito control. It is needed also to determine not only the size and shape of the areas now being subjected to DDT but also the density of wildlife populations exposed in each habitat. It is further needed to clarify both the short-term and the long-term effects of frequent spraying on key populations of other insects that are important to high-density bird populations.

OTHER FEARS

Impairment of Reproductive Success.—In the laboratory, pheasants and quail chronically exposed to a diet containing sublethal amounts of chlorinated hydrocarbons have suffered a marked reduction in reproductive efficiency (DeWitt, 1955; Genelly and Rudd, 1956). This has led wildlife conservationists to fear that many birds may survive a sublethal exposure to insecticides but still suffer a marked loss of eggs or surviving young as a result. This is an extremely difficult phenomenon to detect and verify in the field, but Wright (1960) has obtained circumstantial evidence that Woodcock are thus affected by spruce budworm spraying in New Brunswick. Depressed reproductive success in the Wild Turkey (*Meleagris gallopavo*) has also been reported 1 year after fire-ant eradication in Wilcox County, Alabama (Clawson, quoted by DeWitt and George, 1960). Genelly and Rudd (1956) suggest that the phenomenon may occur in pheasants that attempt to nest in commercial orchards where 40–60 lb. of DDT may be applied annually on each acre. It does not, of course, follow that the diet and exposure of wild birds are similar to that of the captive birds alluded to in the above experiments. What exists as a possibility has frequently been taken by conservationists to be a probability. It is extremely difficult to recommend or to recognize what is the conservative position that society should take in this matter. Among the facts that research workers could furnish to clear up this confusion are chemical analyses of the insecticide content of the gonads of birds killed each spring at TV towers in the northern tier of states. These birds presumably represent randomized samples of bird populations. If the gonads and other organs proved to have no traces of insecticides, the argument that the particular species sampled tend to pick up critically important amounts of DDT during their migratory and wintering periods would tend to collapse. If insecticides were present, the amounts found would then have to be correlated with those known in the laboratory to impair reproductive efficiency.

Disruption of Food Chains.—The destruction of food resources brought about by insecticides is potentially a major hazard to birdlife, as many writers have pointed out. This danger is a function of a great many variables:

(1) the size, shape, and ecological characteristics of the area treated (small or narrow areas are least hazardous; self-contained aquatic areas are apt to hold the toxicant longest);
(2) the toxicity and residual life of the chemical used;
(3) the rate, manner, and frequency of application;
(4) interspecific and seasonal differences in the mobility of animals (swallows can readily forage elsewhere; but during the nesting season some birds are confined to areas less than 1 acre in size); and
(5) the life-history characteristics of the food organisms involved (some populations recover rapidly from contact with an insecticide, others much more slowly; earthworms can concentrate the toxicant).

There is no doubt that food supplies of some birds are quite radically changed by insecticides; but the actual effects on bird-population levels, reproductive success, and life expectancy have not been measured. This entire phenomenon requires further study in those treated areas where birdlife exists in moderately to fairly high densities. In the Middle West, the problem is restricted by the tendency of farmers to use insecticides on cropland where fence rows have virtually disappeared and where the breeding-bird population is now quite low. Attempts to work out the effect of an insecticidal treatment on a whole ecological system have seldom been carried out. This type of research requires highly organized team work, and it is beset by sampling problems that are often quite difficult to resolve.

Delayed and Long-term Effects.—The persisting effects of insecticidal treatments vary widely. Some chemicals are, of course, deliberately selected in control projects for their short residual life, while others may be applied at rates sufficient to have an insecticidal effect for as long as 3 years. As this latter effect was initially incorporated into the fire-ant program, the spring die-off of songbirds 1 year later (Baker et al., quoted by DeWitt and George, 1960) was not unexpected. Barker's (1958) finding that Robins began to die 1 year after foliar spraying of DDT throws new light on this general problem. This research, which incriminated the earthworm as the carrier, has obvious implications in Woodcock ecology; but the phenomenon has yet to be repeated under controlled experimental conditions.

After 10 years, experimental turf plots in Ohio have contained 11–18 per cent of the DDT originally applied to them, the rate of disappearance being inversely proportional to the initial concentration (Lichtenstein, 1957). Among application rates studied in this experiment, turf receiving 12.5 lb./acre in 1945 still contained 1.4 lb./acre in its upper 6-in. layer in 1955. The application rate used here on turf only once was considerably less than the 23.6 lb./acre and the 17.2 lb./acre that Hickey and Hunt (1960*a*) have calculated for DDT used on trees on University of Wisconsin and Shorewood (Wis.) study areas in 1959. Although soil type and other factors also influence the persistence of an insecticide in the soil (Lichtenstein, 1958; Lichtenstein and Schulz, 1959), it seems possible that Robins (which apparently constitute one-half of the nesting suburban songbirds in the Middle West) may be affected for some time after DDT is no longer used in these communities. At the present time, however, there are no adequate data correlating the amount of DDT applied to a tree during the dormant season and the amount of this insecticide that falls to the turf below.

GENERAL COMMENTS

BIOLOGICAL VS. CHEMICAL CONTROLS

Following Koebele's dramatic success in controlling cottony-cushion scale, there has been a continuous effort to find parasites, predators, and diseases that would control other insect pests (Martin, 1940). According to Clausen (1952), at least 30 major insect pests have been fully controlled by this method in one or more countries; and substantial reductions appear to have been brought about in the infestations of a much larger number. These successes have not been easily attained. At least 40 species were tested in California before black scale could be crossed off the list of serious citrus pests. The U.S. Bureau of Entomology's search for an effective enemy of the gypsy moth began in 1905 and lasted with some interruptions until the 1920's. Although some success has been reported in this particular search (Hawley, 1952), the gypsy moth was the subject of large-scale spraying in 1956–58. Of about 390 insect predators and parasites introduced and deliberately colonized in the continental United States, only 24 per cent are now established (Clausen, 1956). In general, climatic factors have greatly complicated the biological control of insects. Chemical control has one signal advantage in the eyes of entomologists; it can be counted upon to work in a wide variety of climates.

Companies like Roehm & Haas, Merck, Bioferm, and Stauffer are all reported to be active in the development of biological mechanisms to control insects. Much of the industrial approach appears to be confined to *Bacillus thuringiensis* to kill moth worms. The USDA is, of course, active in this field. Its recent eradication of the screw-worm fly in the Southeast now seems to be assured, and must be ranked among the great triumphs of modern technology. The recent synthesis of the sexual attractant of the gypsy moth (USDA news releases 964-60 and 2953-60) marks another important breakthrough. The department, however, has had virtually the same research budget for the past 10 years (under $5,000,000 annually). Since the biggest impetus for the development of biological controls should be here, and since inflation has certainly affected this budget throughout the decade, one may wonder about the encouragement now being given to research on biological mechanisms in the United States. It has been said that "the research program in economic entomology is out of balance" (Smith, 1946) and, with some notable exceptions, biological control methods in the United States are not being exploited on a wide scale (Steinhaus, 1960). The possibilities for biological control still remain encouraging (Pickett, 1959; Simmonds, 1959). If wildlife-conservation organizations really want to see this research increased, they may well have to go to their representatives in the Congress and actively work for an increase in the USDA appropriation for this type of work.

One of the most confusing aspects of Japanese beetle programs to the layman centers around the concept that a proven biological control (type-A milky spore disease) is being neglected in favor of the chemical approach in the Middle West. This view neglects the known life-history facts of the bacterium and the persisting difficulty of propagating *Bacillum popilliae* under artificial conditions prior to its sale to governmental agencies and to the general public. At the present time, the speed with which milky spore disease can be built up in a new locality directly depends upon the density of Japanese beetle grubs that are present (Hawley, 1952). This speed does not seem to be a function of closely related white grub populations, although the bacterium has been found in some June beetles. In short, milky spore disease represents an effective control of well-established Japanese beetles; but it is not known to be a barrier to geographic extensions of the species' range, and it has no place at this time in an eradication program. A state like Wisconsin, which has already had its first occurrence of this pest, cannot build up a milky spore population in advance of its host.

POPULATION-RECOVERY RATES

Among the intellectual factors contributing to our present confusion regarding insecticides, little attention seems to have been given to the rates or periods of time required by birds to repopulate heavily sprayed areas. Aside from food-chain and reproductive phenomena about which relatively little is yet known, the insecticide-wildlife relationship roughly breaks down into three types: (1) little or no wildlife mortality where the insecticide is lightly applied and then only as a one-shot affair; (2) considerable mortality where a highly toxic chemical is applied only once as an eradication measure (real or alleged); and (3) considerable mortality where insecticides are repeatedly applied in fairly high concentrations. Forest-insect work in the U.S. is an example of the first; Japanese-beetle and the initial fire-ant programs are examples of the second; Dutch-elm-disease control (and possibly orchard spraying) are examples of the third. The response of bird populations to these latter two types is the subject of research that is only now getting underway; but some generalized remarks on avian repopulation phenomena can be made at this time.

As Mills (1959) has pointed out, population-recovery rates for a given species will obviously vary (1) from year to year, according to the weather, (2) with the reproductive capacity of each species, (3) with its mobility, (4) with the level to which the species has been reduced, (5) with the existence of nearby habitat carrying good densities of the same species, (6) with the size of the tract to be repopulated, (7) with the persistence of the insecticide that has been used, and (8) with the relative toxicity of this chemical or its breakdown products.

It is a truism in both physics and biology that nature abhors a vacuum. Whenever an insecticide has depleted a bird population, new birds will move in to take advantage of the vacated habitat. This can be counted on to take place in Type 2 programs like eradication and in Type 3 programs like annual DED control. In Type 3, nearby unsprayed habitats will annually feed birds into the sprayed area, which thus serves as a death trap. During the breeding season of 1959, Wallace et al. (1961) had a high count of 22 Robins on the Michigan State University campus; but a total of 45 Robins were picked up or reliably reported there as dead or dying. Ingress here is clearly indicated.

Under conditions of catastrophe not involving an insecticide, a breeding-bird population like that of the Eastern Bluebird (*Sialia sialis*) may take up to 10 years to return to its former density over an area as large as New England (Forbush, 1929:419–420), but in areas as small as 40 acres, the recovery may be effected in a matter of weeks (Stewart and Aldrich, 1951; Hensley and Cope, 1951). There are no facts available that cover all the eight variables listed above; but, other things being equal, rapid recovery is apparently the normal thing in common, healthy, and vigorous species of birds (Griscom, 1941). This is a consideration that wildlife conservationists often fail to take into account in the evaluation of insecticidal programs carried out as eradication measures.

NATIONAL POLICY AND INSECTICIDE-WILDLIFE RELATIONSHIPS

From the present review of the effect of insecticides on both migratory and non-migratory birdlife, it is obvious that—despite all the unknowns still to be resolved—certain uses of insecticides do have broad, lethal effects on bird populations. These effects cannot be traced to carelessness in the field, or to accidents, or to instances of outright experimentation. National policy in respect to these phenomena is still in a state of evolution. I think it can be safely said that the United States has no formal and consistent policy regarding the protection that Americans are to give all forms of birdlife. It does have a body of presidential proclamations, congressional acts, and administrative decisions that, within the past 60 years, have to some extent formalized public attitudes and governmental responsibilities. The proclamation approach, extensively used by Theodore Roosevelt, did much to set aside portions of the public domain as parks, as reservations for colonial-nesting birds, and as game reserves. The congressional approach, made possible by the 1916 treaty with Great Britain, removed most migratory birds from the game list. Although this technique involved the elementary use of prohibition, it was a landmark in the development of a national policy regarding birdlife. In recent decades, the Congress has been most active in expanding the federal government's responsibilities toward migratory game birds, but congressional thinking on nongame birds has largely been restricted to budgetary support of federal research projects on such aspects of conservation as wildlife diseases and the effects of pesticides. Thus the research character of the U.S. Fish and Wildlife Service has—quite apart from the waterfowl problem—been the focus of a slowly developing national policy with respect to birdlife. The administrative decisions that have crystalized national policy on nongame birds have been many. The U.S. Fish and Wildlife Service has exercised a major responsibility for the Whooping Crane (*Grus americana*), and the U.S. Forest Service has done the same for the California Condor (*Gymnogyps californianus*). Secretary Seaton's decision not to allow mineral exploration in Condor terrain was an important landmark in the evolution of national policy; State Department pressure, sparked by an official protest from Canada, was even sufficient to modify activities of the military establishment in order to preserve the wintering grounds of the Whooping Crane.

Administrative recognition of the importance of pesticide research developed at the federal level during the 1930's when Cottam, Uhler, and Bourn investigated the ecological effects of mosquito control on the Atlantic Coast. Service studies were greatly expanded in the 1940's when DDT became generally available for public use. Research administrative leadership was, in effect, formally approved by the Congress. In 1960 the Congress went beyond the requests of the executive branch of the government in further expanding the Fish and Wildlife Service budget for research on pesticides.

Thus national policy with respect to songbirds is continuing to evolve; but its outlines are still vague and contradictory: Without a special permit, you cannot pick up and take home a road-killed Baltimore Oriole (*Icterus galbula*); you can generally with impunity, however, cut down a tree containing an oriole nest full of young. You cannot shoot a Snowy Egret (*Leucophoyx thula*), but you can drain off a marsh on which a whole colony of egret nestlings may depend for food. You cannot shoot a Robin, but you can kill it with an insecticide. In general, national policy holds that the economic interests of man supersede the survival interests of animals, but the federal government appears to exercise at least a research responsibility to mitigate the impact of economic developments upon the wildlife of the country. That our society does make exceptions to the overwhelming rule of economics is evident in our perpetuation of parks that have great sentimental or aesthetic value in spite of their tremendous worth as real estate. (Central Park on Manhattan Island is one example.) Americans may be quite pragmatic; but they are also sentimental . . . and some unconscious development of a wildlife ethic is taking place.

In public-health matters in the United States, national policy places the finger of guilt on a new food chemical until industry has demonstrated its innocence—and the innocence of its breakdown products. In the pesticide-wildlife field, the chemicals are—in effect—nearly always deemed officially to be innocent until proven otherwise. There is no organized system set up for testing the wildlife effects of new pesticides prior to, or even after, they are placed on the market; nor is there any agreement yet as to how this responsibility is to be shouldered. To some extent, the Congress has looked more and more to the Fish and Wildlife Service to plug this gap. It is hardly possible that the Service can ever do this alone, but the magnitude of the entire problem is not yet clear. Most states, for instance, do not even have statistics regarding the total amount of various insecticides used within their borders for agriculture.

THE DECISION-MAKING PROCESS

Decisions on the use of insecticides in this region are made by landowners, municipalities, counties, states, and the federal government. The degree to which wildlife-conservation interests participate in these decisions varies greatly.

At the landowner's level where farmers, gardeners, and suburbanites are so much involved, wildlife-conservation thinking seldom seems to enter into the decision-making process. In general and at the moment when these decisions are made, the public does not have ready access to information on the wildlife effects of the various application rates that are possible.

This situation may prove to be more and more hazardous to suburban wildlife. (Its public-health aspects are outside the scope of this review.) There is nothing at this time to prevent a landowner from oversaturating his property with DDT to control adult mosquitoes (although 0.1 lb. per acre may suffice), and the resulting hazard to nesting birds then becomes a function of the number of properties that are blocked in during the course of this process. (Excessively frequent use of DDT is, of course, one way to build up resistant strains of mosquitoes. At the present time, no such strains are known in the Middle West, and any contemporary prediction of their future appearance is complicated by the essentially local character of adult-mosquito control in this region.) The use of chlordane to kill crab grass is another potential hazard to suburban wildlife, but no ecological research has been carried out on this technique and its side effects, especially those on local Robins.

The private ownership of large blocks of forest land involves an entirely different pattern of decision making. Here there is always the possibility that either the state or both the state and the federal government will recognize the insect outbreak as a public danger and carry out a control program in which subsidies toward the landowner's share in the spraying are an important consideration. Quite apart from any state regulations regarding a permit to spray, economic interest thus dictates that technically trained foresters and entomologists enter into the decisions regarding the use of insecticides on privately owned forest land.

In general, wildlife interests have had in the past only a minor role in decision making at the municipal level. An April cut-off date for Dutch-elm-disease spraying in Wisconsin (jointly set up by the state conservation commission, the state board of health, and the state department of agriculture) may well have reduced the hazard to May migrants; these were conspicuously affected by late spraying operations in Michigan in the spring of 1956 (Wallace et al., 1961). Public interest in the matter seems to have encouraged three municipalities in Wisconsin and two in Illinois to substitute methoxychlor for DDT in spring. Thus, the weight of public opinion in some states is somewhat in advance of regulations set up by a state pesticide review committee. This occurs despite a frequent failure of government authorities to acquaint the public with the wildlife hazards of insect-control programs. Proposals to create or strengthen a state pesticide-review board or committee have recently been the subject of legislative consideration in Michigan, Illinois, and Wisconsin. Review boards may indeed be helpful in some states where control agencies have consistently refrained from consulting with conservation departments, but their authority is often restricted (as in Connecticut, to aerial application; or in Wisconsin, to forest and noncrop spraying). The wisdom of their decisions will also be limited by the paucity of research data that are available (as on the effects of mosquito-control operations on urban birdlife). Co-ordination of government agencies now having quite separate functions is clearly a current need. Each state could also profit by some long-range planning jointly carried out by agronomists, plant pathologists, pollution experts, public-health authorities, entomologists, foresters, and fish and wildlife biologists.

At the federal level in the United States during the 1940's, close co-operation in research featured the many efforts of the old Bureau of Entomology and Plant Quarantine (in the Department of Agriculture) and the Fish and Wildlife Service (in the Department of Interior) to understand the complex side effects of DDT. This co-operation seems to have gradually disappeared, and at least until 1961 the present Agricultural Research Service did not enjoy a close working relationship with the Bureau of Sport Fisheries and Wildlife in the Interior Department. During the past decade, when ARS was able to set up large-scale programs involving granular applications of aldrin, dieldrin, or heptachlor, the absence of an efficient interdepartmental memorandum of agreement significantly contributed to public controversy. Such an agreement was worked out during the past year; but as late as 1960 ARS flatly refused to deal with state fish and game departments, as Congressman Dingle brought out in a public hearing (Popham, 1960:60). Although it is true that most game populations will recover after a heavy application of (say) aldrin has disappeared, no written-out arrangements exist to enable a state conservation department to plan locally closed hunting seasons and to inform sportsmen why such steps are necessary. This conflict of interests in the United States has a parallel in Canada where spruce budworm spraying appears to be threatening local populations of salmon. There, however, a federal interdepartmental review committee represents the agencies responsible for forest, fish, and wildlife resources (Preble, 1960), and co-ordinated efforts to resolve a difficult problem have now led to a new use of DDT at ¼ lb. per acre (Webb, 1960).

WILDLIFE-CONSERVATION NEEDS

If society is to succeed in minimizing the impact of insect control upon wildlife populations, it will have to delegate specific authority for certain jobs, co-ordinate the technical knowledge now available, and find the funds to use the full potential of scientific research in resolving the problems, both real and alleged, that now face our developing technology.

Virtually all of the ecologists who have reviewed the over-all pesticide-wildlife problem emphasize the lack of factual information on this phenomenon, and they point out specific areas that require research (Rudd and Genelly, 1955, 1956; George, 1957; Leedy, 1959). These research needs are critical and require no itemization here, although the need for a team approach cannot be over-emphasized. Ecologists, however, are not political scientists, and their papers deliberately avoid recommendations that have political overtones (using politics in the best meaning). This has left a serious gap in conservation thinking. I feel no better equipped than my colleagues to fill this gap, and I would prefer to delineate needs rather than recommendations. These needs involve both federal and state responsibilities. They appear to apply to the Middle West as well as to other parts of the United States.

NATIONAL NEEDS

(1) As new insecticides continue to come into the market, the responsibility will have to be fixed for determining their general wildlife toxicity and hazard. This means an expanded budget for either industrial, federal, or federally sponsored research. It also means a national board of review and some expansion of our present labeling system. It does not mean a Miller-like amendment which arbitrarily eliminates the agricultural use of compounds that exceed some established tolerance. It does mean that new insecticides should be identified as to their probable effect on a limited number of wildlife species under certain specified conditions. There is a widespread feeling among wildlife conservationists that the Congress should place the responsibility for this research on the manufacturer who releases a new economic poison on the market. To some extent, the Congress has already done so (George, 1957): the Federal Insecticide, Fungicide, and Rodenticide Act states that every manufacturer must plainly mark his insecticide with an appropriate statement of precautions to prevent injury to man and domestic animals, fish and wildlife. Under this legislation, the U.S. Department of Agriculture is given discretionary responsibility in the registering of new compounds. The system is not effective, as wildlife conservationists see it, and a realistic appraisal is now needed. This appraisal could well be carried out by the new Committee on Pest Control and Wildlife Relationships that has been set up by the National Academy of Sciences and the National Research Council.

(2) Some parallel system should be worked out to cover the more toxic compounds that now are widely used. Field studies are needed not only on the short-term, wildlife-mortality effects, but also on repopulation rates, long-term reproductive effects, and food systems. This expansion of ecological investigations will surely require an increased budget for the U.S. Fish and Wildlife Service. Where elaborate facilities (like pens and cage equipment for toxicological studies) are required, the Service will do well to carry out the research itself. Where field investigations are needed under a variety of conditions, the Service will have to set up research contracts with agricultural experiment stations, its own co-operative wildlife research units, and other colleges and universities. This possibility is further discussed under (6) below.

(3) The Agricultural Research Service of USDA should get budgetary encouragement to expand its research work on insect-control methods that will affect pest targets without disrupting entire food-chains and affecting wildlife populations.

(4) The National Science Foundation and other agencies encourage and subsidize intensive studies of food-chains as they are affected by our most widely used pesticides. These are difficult investigations to carry out, involving (as they do) teams of specialists capable of working together on both vertebrate and invertebrate animal populations. A co-ordinating committee of the National Research Council or the Ecological Society of America is probably needed to encourage and integrate this type of work which,

at least initially, could be restricted to natural areas and a few very typical types of pesticidal usage.

STATE NEEDS

(5) State legislatures should inaugurate statistical systems that will clearly show the extent to which the more important insecticides are being used within their borders. These statistics should include the crops and land uses involved, the chemicals and rates of application used in each type, the method and frequency of application, and approximate acreages. Some provision should be made for testing the accuracy of the data so compiled. California's present system is often regarded as an appropriate model; but Dicke's (1960) compilation of Wisconsin statistics is the only summary that I have seen clearly picturing the use of agricultural insecticides in a given state—in terms that are meaningful to ecologists and conservationists. These statistics need only be compiled about once every 5 years in order to show trends. They could well be made a responsibility of each state department of agriculture.

(6) Agricultural experiment stations should co-ordinate their research on the actual application rates that are being employed for the major poisons in each region, giving attention not only to immediate but also long-term wildlife effects. Wildlife ecologists attempting to carry out research on insecticides in Illinois, Michigan, and Wisconsin frequently report that they are restricted by a lack of state funds to carry out their investigations. Special federal subsidies provided by the Congress are certainly needed to conduct this work on migratory birds, but studies of pesticidal effects on non-migratory game should be financed by each state.

(7) Agricultural extension specialists should assume a greater responsibility in explaining federal and state insecticidal programs to the general public both urban and rural. They should be prepared to explain the reasons for these programs, to predict what wildlife losses are expected, and to show how efforts are being made to reduce these to a minimum. This is not a criticism of the Agricultural Extension Service, but rather a vote of confidence that it can fill a gap that now exists. The confused state of public opinion is to some extent the result of overspecialization in both research and control operations. If the Service is willing to help its men to train themselves along broad ecological lines, it can do much to educate the public on the complex, interlocking problems that it is facing. In many state conservation departments, extension specialists can also greatly contribute to the solution of this problem.

(8) In states where interdepartmental liaison is traditionally poor, legislatively created boards of review may be required to permit the state conservation department (and also the department of health) to participate in decisions on mass-spraying programs. Connecticut's regulatory committee is a much-quoted example, but its powers surely require expansion. My review did not go into this aspect of the problem.

(9) Legislative Reference Bureaus (or their equivalent) should have standing pesticide advisory committees to (a) inform each legislature of new pesticide developments that may affect not only public health but also the wildlife resources of the state, (b) review state trends in pesticide usage every 5 years, and (c) recommend practical procedures in the control of pesticidal use that are appropriate. In some states, as in California, legislation may require the licensing of trained personnel for the application of the more toxic chemicals now on the market. At the federal level, the National Research Council has recently established an advisory committee on pesticide-wildlife relationships. Its counterpart almost surely is needed at the state level, too.

SUMMARY

In the Middle West, few data are available on the acreages now sprayed for mosquitoes, on the variations in application rates, and on the long-term effects of this type of control. Large-scale, orchard-insect control is potentially more hazardous to wildlife, but is equally unstudied in this connection. Forest-insect pests now appear, with one possible Canadian exception, to be controlled with little or no apparent loss of birdlife. Dutch-elm-disease control has had very serious urban wildlife effects in the Middle West, but the substitution of methoxychlor for DDT in the spring promises relief from this problem. Programs of the U.S. Department of Agriculture to suppress Japanese beetles in this region and to eradicate fire ants in the South have been associated with marked effects on songbird and gamebird populations; it appears likely that most of these populations will recover within a few years after disappearance of the insecticide, but federal programs will remain a threat to bird species of limited distribution. Agricultural use of insecticides has not been adequately studied for its effect on wildlife, but severe bird mortality on cropland treated in Wisconsin may be mostly confined to about 20,000 acres where apples and cherries are grown.

Reproductive efficiency has been markedly lowered as the result of sublethal ingestion of chlorinated hydrocarbons by laboratory birds; and this has led conservationists to fear that many wild bird populations may be insidiously depressed by modern insecticides. It is also feared that the disruption of food chains may also be hampering birdlife today. Both hypotheses are quite difficult to test in the field, although reproductive failures in Woodcock and Wild Turkey are now reported to be associated with use of insecticides in New Brunswick and the South. In general, control agencies have displayed some slowness in admitting the effect of insecticides on birdlife, and conservationists have been equally slow to admit the population-recovery potential of bird species killed off in emergency insect-eradication programs.

National policy regarding nongame birds has been gradually developing throughout the present century. At the present time, the U.S. Congress is interested in lessening the impact of modern insecticides on wildlife, but no satisfactory system has evolved to identify the wildlife hazards of new insecticides that come on the market, and state conservation agencies do not participate in all the major insect-control decisions of the U.S. Department of Agriculture. Research on biological control in America is not being fully exploited in the United States, and budgetary encouragement of the Agricultural Research Service along these lines could be pushed by conservationists. Intensive ecological research on food-chain systems could also be expanded with federal funds that are now available, but some responsibility to encourage and organize this difficult work will have to be assumed by the National Research Council or a similar agency.

State governments should inaugurate statistical systems on pesticides, co-ordinate research by agricultural experiment stations on the field use of the major poisons, expand extension teaching in this field, integrate interdepartmental interests and goals, and create standing advisory committees to anticipate new problems.

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JOSEPH J. HICKEY, *Department of Forestry and Wildlife Management, University of Wisconsin, Madison 6, Wisconsin, 1 September 1961.*

ORNITHOLOGICAL LITERATURE

The Book of Bird Life: A Study of Birds in Their Native Haunts. By Arthur A. Allen. Second edition. D. Van Nostrand Company, Inc., Princeton, New Jersey, 1961: 6 × 9¼ in., xxii + 396 pp., 53 col. photos., 200 figs. (incl. many bl. and wh. photos and 76 paintings in bl. and wh. by William C. Dilger). Trade edition, $9.75; text edition, $7.50.

Witmer Stone, in his review of the first edition of "The Book of Bird Life" (see *The Auk*, vol. 47, pp. 432–433, 1930), wrote: "Dr. Allen's ability to transmit clearly to others his knowledge of birds through the medium of pen and camera make this book particularly valuable both as a text book and as a reference work in the home." Dr. Stone's remarks hold for this new edition. In my opinion, it sustains the reputation of the earlier edition as the best general introduction to ornithology.

Dr. Allen states in his introduction that "The book never was intended as an all-inclusive text and the omissions will be quite conspicuous to the technically-trained ornithologist. On the other hand, those who are interested chiefly in extending and interpreting their own observations and who need a readable introduction to general ornithology may find this new edition helpful."

There are three major, beneficial changes in the edition. The first is a new chapter on ethology. The last half, on instinct and intelligence in birds, was taken from Chapter 11 of the first edition and nicely rounds out an extremely valuable and interesting account of bird behavior.

The second change is in Chapter 2 on classification. Two new figures diagrammatically illustrate relationships of orders and families in accordance with Wetmore's (1951) system of classification. Dr. Dilger's paintings, representing the North American families, are exceptionally well done. Each shows a typical head (with neck) and tarsus and, in many cases, a distant view of the bird in its habitat. With these illustrations the chapter presents a concise summation of North American bird classification. Reproductions of some of the author's colored pictures of warblers are misplaced here and break up the sequence of Dilger's paintings between Tyrannidae and Alaudidae. In my copy some of the plates are off register and the colors have been poorly reproduced.

A third change is in the section called "Suggested Readings" which is designed to expand various topics covered in the text. This has been brought up to date and appears at the back of the book arranged under various subject headings such as "Anatomy," "Banding and Bird Behavior," etc. One important source which unfortunately missed inclusion is Marshall's "Biology and Comparative Physiology of Birds."

The rest of the book remains little changed except where obvious errors have been corrected (e.g., Ostriches in Europe and Asia instead of Europe and North America, p. 7) and where outmoded examples occurred. One statement that was not revised on p. 72 reads: "One would not expect the live oaks and cabbage palms of Florida to shelter the same birds as the hemlocks and *chestnuts* of New York. . . ." Some statements in the section on ecology might be questioned by specialists of the subject, particularly the statement that "a forest of trees is a poor place for birds." But these statements of the author tend to stir up the critical mind, as no doubt they were intended.

One particularly distressing thing about the copy at hand is that several of the color photographs of birds are poorly reproduced and sandwiched into places far from where they illustrate the text. A more direct reference in the text to these plates would help the reader.

It is apparent that there has been lack of communication between author and publisher in working out production details. One is also inclined to question the ethics of a trade edition selling for $9.75 (price listed in the "Cummulative Book Index") and a text edition (not as well advertized) for $7.50, the only apparent difference being in the jacket.

All in all, this second edition, like its predecessor, is a fine contribution to ornithology from one of America's foremost teachers.—STEPHEN W. EATON.

BIRDS OF ANAKTUVUK PASS, KOBUK, AND OLD CROW: A STUDY IN ARCTIC ADAPTATION. By Laurence Irving. Smithsonian Institution, United States National Museum Bulletin No. 217; 1960: x+409 pp., 13 pls., 36 figs., 19 tables, several line drawings. $2.00.

Lately there has been an increase in the experimental approach to the ecology of homoiothermal ("warm-blooded") animals. Most of these new studies have concentrated on some limited feature such as temperature regulation, metabolism, and water loss. In ecological literature the faunal listing is common, and the experimentalists have overlooked this form. But one experimentally based fauna is now available. This is Laurence Irving's book on the birds of Arctic Alaska, which shows how a group of species maintain themselves in a cold environment.

The book first surveys, in separate chapters, the distribution of birds in three northern Alaska localities: Anaktuvuk Pass, Kobuk, and Old Crow. Each chapter contains a description of the region and a commentary on each of the species found. Included is valuable information rarely presented in avifaunal studies—for example, six-year records of arrival dates for the birds of Anaktuvuk Pass. In gathering these data and others, Dr. Irving has greatly profited from the activity and perceptivity of the resident Eskimos and Indians. Occasionally the species accounts give interesting fragments of native folklore.

In later chapters the book takes up a discussion of migration, residence of birds in the Arctic, the influence of Arctic environment on migration and nesting, and the bioenergetics of Arctic birds. Dr. Irving suggests that extreme environmental conditions regulate the physiology and behavior of Arctic birds. Much of the book's importance lies in these chapters for it is here that the author (an experimentalist himself) gives an excellent synthesis of field and laboratory observations and at the same time provides a fine summation of current knowledge on the adaptation of warm-blooded animals to a cold climate.

Well organized and written in an easy style, the book is highly recommended to anyone interested in the ecology of animals.—BRIAN K. MCNAB.

A FIELD GUIDE TO WESTERN BIRDS. By Roger Tory Peterson. Houghton Mifflin Company, Boston, 1961: 4½ × 7½ in., xxvi + 366 pp., 60 pls. (36 col.). $4.95.

Twenty years after the appearance of the first field guide to western birds a second revised edition has appeared (publication date: 31 March 1961). Not only has it been completely rewritten, but it is enlarged and vastly improved. It is amazing how much more information has been included, yet the size is seemingly not much larger. It is still a convenient "pocket-sized" book, handy for field use. This edition has 126 more pages than the first. As an incidental feature it is sponsored by the National Audubon Society and the National Wildlife Federation.

The biggest innovation is that it includes the birds occurring in the Hawaiian Islands. Accordingly the book is arranged in two parts, Part I being concerned with the birds of North America west of the 100th Meridian and Part II with those of the Hawaiian Islands. In addition there are two appendixes, one on accidental and marginal species in western North America and the other on casual and accidental species in the Hawaiian Islands. An attractive feature pertains to the inside covers. In front there are 30 roadside silhouettes and at the rear 24 shore silhouettes. A complete index terminates the book.

Mention of the index brings up the matter of names. The ones used are those of the fifth edition (1957) of "The AOU Check-list," but in the index and species accounts names are given in parentheses that were in use in the fourth edition (1931) of the Check-list and which have now been changed—e.g., Dunlin (Red-backed Sandpiper). Obsolete or little-used vernacular names are not listed except for an occasional one that has wide popular use, even though it has not been officially sanctioned—e.g., "Winter Chippy" for Tree Sparrow. In these instances the common name appears in quotes. Both common and scientific names are listed in the index where the page number in boldface, following the common English name of the species, refers to the page on which the illustration is found. Unlike the earlier edition virtually no attention is paid to subspecies, which with few exceptions cannot be distinguished in the field, and which do not properly belong in a popular field guide. Occasionally there is reference to two types like the Solitary Vireo on plate 49 (p. 246) which shows the so-called typical form and a plumbeous form.

The illustrations are all new for this book although a few have been borrowed from the eastern and Texas guides, and there are more color plates. Of the 60 plates, 36 are in full color, which is six times as many color plates as in the first edition. Black and white illustrations are used (e.g., hawks in flight and gulls) when they afford more aid in field identification than color. However, in some instances groups are shown both in black and white and color. The color plates are superb. The color reproduction is much better than before and thus every figure approaches "true to life" conditions. Impressing me as particularly fine examples are plates 59 and 60 (pp. 310 and 311) on native and introduced Hawaiian land birds. In the latter even the orange colored variant of the male house finch is shown. I wish the author had devised a way to include in color plate 16 (p. 67), showing the hawks, two western species, namely the Prairie Falcon and the Aplomado Falcon, even though each is shown in black and white on plate 17 (p. 74). I would like to have had included a color plate of the owls, yet I realize there were limitations of what could be included and the publishers are to be congratulated on keeping the cost down to a reasonable figure. The colored illustration of the Gray-headed Chickadee (*Parus cinctus*) (plate 45, p. 214) of Eurasia, which occurs in northwestern North America, is the first I have seen of this interesting form. The plates are nicely spaced throughout the book and so are fairly close to the families and species accounts. The several illustrations per plate are for the most part representatives of the same family. Beneath each bird on the plate is printed its name and on the opposite page the kinds are listed and under each the principal diagnostic characters are given. Many of these features are further emphasized by short lines extending from the particular marking shown on the colored figure. It was called to my attention by Clayton White that one figure has partially incorrect coloring, namely the male Ladder-backed Woodpecker on plate 40, opposite p. 167. It should have a black tail in the center, not green as shown. In the colored plates different colored backgrounds are very effective (*cf.* pp. 67, 98, 151, 198, 263). Two plates impressed me as a bit overcrowded, namely the woodpeckers, plate 40, p. 167 and the finches, plate 55, p. 274, yet it is advantageous to have the similar kinds grouped together. A very utilitarian feature is a system of cross references between figures and textual material. Under each species account there is a page reference to the colored illustration, while on the page facing the plate, where the kinds are listed, there is a page reference to the descriptive material.

As pertains to the text, the summaries of family features are improved and strengthened. For the species accounts there is more factual data than before. The plan is to give in capital boldface letters the common name. Under this in italics is the specific name followed by an indication of the size of the bird and the page reference to the illustration in color and/or black and white. Field marks (formerly description) come next with the most distinctive features italicized. A very useful addition is a section on similar species with the distinguishing features briefly noted. Then comes voice and where found (formerly range). Both breeding and winter occurrence are noted. Then there are two new entries on habitat and nest. The data are remarkably thorough throughout and up-to-date. For instance, information is included on the rediscovery on the island of Kauai by Frank Richardson in 1960, of several of the Drepanids feared to be extinct (see *The Condor*, vol. 63, p. 179, 1961). I like the notation of different opinions in cases of doubtful taxonomic position, e.g., the Blue Goose (p. 37), the Wrentit (p. 218), Brown-throated Wren (p. 220), and the placement of the subfamily Carduelinae either in the Ploceidae (p. 264) or the Fringillidae (p. 278), as well as different concepts as to the number of species in the family, e.g., Sylviidae (p. 234), Laniidae (p. 239), Parulidae (p. 245), and Thraupidae (p. 276). Throughout there are many added helpful notations like the frequent occurrence of rust staining on the heads of Snow Geese and Sandhill Cranes.

The author went to great lengths to insure accuracy of his distributional data both in the main body of the text and the appendixes and after carefully going through the literature himself, he submitted the write-ups to many regional ornithologists. It is remarkable how complete and accurate the data are. However, one slight omission was called to my attention by Robert Sundell, that the Roseate Spoonbill (p. 339) is also casual in Arizona, there being several sight records and a published photograph of a specimen (*The Condor*, vol. 46, pp. 19–20, 1944).

Western ornithologists and bird finders have long awaited this second edition of "A Field Guide To Western Birds" by Roger Tory Peterson. With the appearance in recent years of the fifth edition of "The AOU Check-list," several state publications on birds, and now this revised field guide, the way is cleared for a new era of accentuated study and pleasure with standardized names and improved tools.—William H. Behle.

Dawn in a Duck Blind: A Guide to the Calls of Waterfowl. By Peter Paul Kellogg and Arthur A. Allen. Cornell University Records, Ithaca, New York, 1960: 10-inch vinylite record, 33⅓ r.p.m. $5.95.

This record will be of particular value to the ornithologist and waterfowler wishing to hear certain waterfowl calls which they might never hear in a lifetime afield.

The spring display notes of the Common Goldeneye, the high-pitched squeak of the drake Blue-winged Teal, the low chattering goldfinch-like notes of drake Wood Ducks, and the sonorous calls of the Trumpeter Swam are rarely heard. Few observers in interior America have seen Oldsquaws, let alone heard their melodious calls so familiar to the waterfowlers of the New England coast. Yet the calls of these and other waterfowl may be readily heard from the comfort of an arm chair because this record simulates a morning in what could be called a unique duck blind. The blind is unique because of the geographic range of the species represented and because of the seasonal nature of many calls. Only the most cosmopolitan hunter would ever be exposed to all the waterfowl voices presented.

Some of the species represented are provincial in their occurrence, as exemplified by the Fish Crow, Common Loon, Oldsquaw, and Trumpeter Swan. Other species such as the Pied-billed Grebe, Redhead, Canvasback, and Common Goldeneye rarely call during the fall; the calls presented are to be heard mainly during the spring.

The calls of several important ducks are not given (e.g., Green-winged Teal, Gadwall, Shoveler), but calls of several species (Mallard, American Widgeon, Pintail, Redhead, American Coot) are presented three or more times. The value of such prosaic calls as those of the Killdeer and Ring-billed Gull is questionable to those interested in "A Guide to the Calls of Waterfowl," the subtitle of the record.

Most species of ducks have several calls but usually only the principal call of each species is given. The rarely heard notes of the drake Wood Duck are presented, yet the characteristic alarm call of the hen Wood Duck is not. The record has a good repertoire of Mallard calls and a special band of three series of Mallard calls which duck hunters could emulate in decoying this species.

The rendition of most calls is good, but the clamor of Snow Geese is so loud that it obscures many of their characteristic barking notes.

This record will be enjoyed by all who thrill to the particular wildness conveyed by waterfowl conversation in the air, in the marsh, and on the water. It is of value to the duck hunter interested in perfecting his technique in decoying Mallards and Black Ducks. As a guide to the calls of waterfowl, it is somewhat disappointing because the extent of its coverage is incomplete.—FRANK C. BELLROSE.

HUMMINGBIRDS. By Crawford H. Greenewalt. Doubleday & Company, Inc., New York, 1960: 8¾ × 11¾ in., xvi + 250 + xvii–xxi pp., 69 col. pls., numerous bl. and wh. drawings. $25.00.

"Hummingbirds" is a really thrilling presentation of a series of 75 superb color photographs of 58 species of this very challenging group of birds. It is indeed a rare pleasure to thumb through page after page of exquisite, life-sized, color prints of these iridescent avian jewels. One feels that each one encountered must surely be the best. The quality, although varying somewhat, certainly holds up well throughout the entire series. The short paragraphs of explanation of each plate are not profound statements of factual data regarding the birds depicted, but in most cases give intimate, often amusing, details about the circumstances under which the pictures were taken. One, for instance, states "This bird and her mate were photographed in the garden of Mr. and Mrs. Wm. Phelps, Jr. in Caracas, where Mr. Phelps was kind enough to provide sugar solution for the birds and an occasional gin and tonic for the photographer."

Crawford Hallock Greenewalt, the author, is president of the DuPont Chemical Company and a highly capable chemical engineer and executive, but both ornithologically and photographically he is an amateur. One might feel that this "amateur" status would give encouragement to other amateur photographers but, when the chapter dealing with his equipment is read, one finds that the word is hardly applicable in its ordinary sense in this case. As the writer states in this chapter, the account does not contain "do it yourself" directions. Not that Mr. Greenewalt is selfish or exclusive about his methods—he is not. The point is, how many camera fans are in a position to design and build electronic flash equipment of such special nature as to produce 30/1,000,000th-second exposures? If a continuous light were to burn as brightly, he states, it would require 5,000, not watts, but kilowatts of power. The gear weighs about 250 pounds. An extensively modified Hasselblad camera was used. Surprisingly enough, a telephoto lens was not found necessary; nor did it have a large, high speed lens, only *f* 5.6. Actual exposures were usually made by the birds themselves tripping an electronic eye. Numerous anecdotes about how pictures were or were not secured sustain the interest even in this technical chapter. His collector's use of blow pipes and flyrods for catching hummers unharmed might well be suggestions for bird banders.

Although the major feature of the book is the series of superb photographs, Chapter One gives a very informative and entertaining discussion of hummingbird "Behavior and Characteristics." Two other chapters delve deeply into the subjects of "Flight" and

"Feathers, Color and Iridescence." The latter chapter is an attempt to make understandable a very complicated subject with opinions differing, perhaps, as to whether he has succeeded. Barbules, rami, and pennula become laths, poles, and hooks and eyes (all well illustrated) to explain feather structure as resembling a venetian blind. Some preliminary basic discussions on the nature of light introduce the complications of structural color in feathers. The subjects of refraction, dispersion, and interference colors are handled in such a way as to give a lucid basis for understanding iridescence. Even the electron microscope is drawn upon to examine the feather structures, and masses of measurements are handled with electronic computers to bring the experimental results and the theories together in explaining the hummingbird's gorgeous colors.

In the chapter on "Flight" one will find a number of new facts on hummingbird flight, as well as flight in general. He points out, for instance, that in this highly specialized flier the humerus and the radius and ulna bones of the wing are so shortened and incorporated in the muscle mass of the body as to eliminate the flexing of the wrist and elbow joints in flight. This closely parallels the situation where in the highly specialized swimmer, the loon, the proximal bone (femur) of the leg is likewise bound into the body muscles, thus limiting swimming movements to the distal leg joint only. The hummer's wing being "all hand" eliminates the partial folding of the wing on the up beat, thus rendering the aerodynamics of its flight quite different from that of other birds. The surprising fact is brought out that a Ruby-throated Hummingbird's wing beats at 53 strokes per second (plus or minus three beats) regardless of the bird's flight speed. Another surprise is his statement that "at a given wing length or weight hummingbirds beat their wings less rapidly than ordinary birds." Not only do the interesting facts and his lucid manner of presenting them make for good reading but the ingenious techniques devised to gain new information are fascinating. For example, Mr. Greenewalt lured the birds to a sugar-water feeder, then placed the feeder in the throat of a wind tunnel in order to use a stationary camera in taking high speed movies of the bird as it neared its maximum speed. He has compared and contrasted flight data on insects and birds of many different types and even ventures, with tongue in cheek, to determine how large the wings of an angel would have to be!

The decorative sketches scattered at strategic places throughout the text, and those illustrating the technical chapters, are the work of Mr. Dale Astle. They are direct copies of high speed photos, to be sure, but they are executed with a delicate pencil technique that shows a beautiful appreciation of the structure as well as the texture of the subject.

The price ($25.00), which puts this beyond the reach of many people, might draw some criticism. However, the writer's aim is extreme excellence in the focal sharpness and color rendition of his exquisite subjects and anything but the best of reproduction of the plates would be a definite retreat from his high ideals. The fine color plates, without question, merit equal quality in the accompanying text and format—hence the price.

The American Museum of Natural History and Doubleday and Company, as well as the author, are to be congratulated on a really fine book.—W. J. Breckenridge.

Postcranial Osteology of the Waterfowl. By Glen E. Woolfenden. Bulletin of the Florida State Museum (Gainesville), Vol. 6, No. 1, 1961: 129 pp., 6 figs., 2 tables. $1.60.

Dr. Woolfenden recommends the following changes in the classification of the Anatidae: "*Anseranas* is placed in a monotypic family; *Stictonetta* is removed from the Anatini and placed tentatively in the Dendrocygnini of the Anserinae; *Cereopsis* is removed from the Tadornini to a monotypic tribe of the Anserinae; *Plectropterus* is moved from the Cairinini to the Tadornini; *Tachyeres* is moved from the Tadornini to the Anatini; the tribe Cairinini is merged with the Anatini; *Merganetta* is moved from the Anatini to a monotypic tribe; *Rhodonessa* is moved from the Anatini to the Aythyini; the tribe Somateriini is merged with the Mergini. The following genera are resurrected: *Olor*, *Nesochen*, *Callonetta*, *Pteronetta*, *Metopiana*, *Mergellus*, *Lophodytes*, and *Nomonyx*, and, tentatively, *Asarcornis* and *Salvadorina*."

This study was based on the examination of 432 skeletons representing 105 of the 167 species of waterfowl recognized by James L. Peters. From one to 25 skeletons of these species were studied. The "relative taxonomic usefulness" of 10 postcranial bones was analyzed: humerus, carpometacarpus, coracoid, sternum, tarsometatarsus, femur, tibiotarsus, scapula, pelvis, and furculum.

Descriptive osteological studies of a family or order of birds are always welcome additions to the literature. I believe, however, that taxonomists should adopt Dr. Woolfenden's "diagnostic" characters with considerable caution when attempting to understand the evolutionary history of, and closeness of relationship among, the waterfowl. Without intending to detract from the value of the osteological study itself, it should be pointed out that little thought was given to the functional significance of the osteological characters cited as diagnostic features for the various genera. Although there must be a genetic factor involved in the growth and conformity of bones, ridges, crests, tuberosities, and other bone features are, as far as we know, directly related to the forces exerted on the bones by muscles and/or ligaments. It may be a statement of fact that "the pneumatic fossa is greatly reduced" or that the capital shaft ridge "is situated more medially" but I fail to see any basis for asserting, for example, that "*the structure of the humerus shows* Anseranas *to be a primitive anatid*, and completely justifies its removal from the Anatinae" (italics mine).

Let us consider also one of the bones of the lower limb: "The tarsometatarsus is the best taxonomic element of the leg. The many articulating surfaces partly account for its usefulness. As with other leg bones, adaptive modifications frequently obscure the more basic features" (page 79). Here, again, the articulating surfaces of the bone are directly related to the function of the limb. What are the "more basic features" that are obscured by adaptive modification?

One can say that Dr. Woolfenden has presented diagnostic features of the skeletons (only one or two for some 70 species examined) of a large number of anatids, but I am skeptical of the significance of these data by themselves in attempting to ascertain the course of evolutionary processes among the Anatidae.—ANDREW J. BERGER.

INSTRUCTIONS TO YOUNG ORNITHOLOGISTS. II. BIRD BEHAVIOUR. By Derek Goodwin. Museum Press Limited, London, 1961: 5½ × 8¾ in., 123 pp. 17 photos., 11 figs. 12*s* 6*d* (about $1.75).

This highly readable small book might well be entitled "Instructions to *Beginning* Ornithologists," for the information and suggestions contained therein are useful for any student, regardless of age. The introductory chapter on instinct and learning covers this sometimes touchy subject carefully and adequately in the light of present knowledge. Succeeding chapters concern food-finding, escaping predators, reproductive behavior, social life, preening, bathing, and anting. Currently accepted behavioral terms are used and well defined.

Black and white photographs illustrate some of the aspects of behavior outlined in the text, and these are supplemented by simple, clear, line drawings. One wishes there were even more of these. The specific examples which are given to illustrate basic principles of behavior naturally concern British species and the suggested "useful references" are likewise British, but this should serve to lead the American reader into possibly heretofore unknown fields.

The author points out many unanswered questions and many gaps in our knowledge and observations. These suggestions in themselves are helpful as guides to study, and, in addition, stimulate thought along other lines of investigation not covered here. The presentation is not didactic. The author suggests, inquires, theorizes—and makes it clear that he is only theorizing. This is a worthwhile addition to the library of any ornithologist or student of animal behavior, be he young or old, beginning or advanced. —Sally F. Hoyt.

The Bird Watcher's Guide. By Henry Hill Collins, Jr. Golden Press, Inc., New York, 1961: 6¼ × 9 in., 125 pp., many photos. (majority in col.); several paintings (7 by James Gordon Irving, 1 by Arthur Singer; end-paper illus. of flyways uncredited). $3.95.

Another bird-watching book has been put on the market. This one differs more from J. J. Hickey's "A Guide to Bird Watching" (Oxford University Press, 1943) than the similarity of title might lead one to expect. Textually, it is much skimpier, as its two-page index (Hickey's has 12 pages) indicates. The poverty of text, however, is more than made up for by its color pictures. These, taken from such sources as the National Audubon Society and the Fish and Wildlife Service, add greatly to the color of the book, as they must to its price. It would be interesting to know how the illustrations were selected. Why, for example, was almost half a page devoted to a color picture of a cowbird, accompanied by the legend, "In many places the brown-headed cowbird would be a 'common' bird for a Big Day list"? This is entirely true, but, except for filling space, is it any more necessary than the instruction on page 97 that when one wishes to photograph gulls following a boat, one should "take the picture from the stern"?

With the exception of the illustrations, which are present on all but eight of the 123 text pages (the publisher counts the outside of the cover as page one), Collins' book follows the pattern of other available guides. This is to be expected, for unless an author were to strike out in a new direction, there are not many ways of advising about the size and weight of binoculars, the use of a telescope, or the plants which often attract birds. Collins has followed the beaten path, as a run-down of his table of contents shows. Starting with "Becoming a Bird-watcher," he has short chapters on equipment, identification, location, voice, "bird golf," lists and censuses, means of attracting birds, and, with a bow to conservation, ends with three pages listing bird clubs. Here his information is inadequate, at least for the two Illinois organizations with which I am acquainted. Neither one could be reached through his list.

The price of "The Bird Watcher's Guide" is high, for the market at which it appears to be aimed. Nevertheless, it should be a useful beginning book, and a good present to give to a boy or girl who is showing signs of interest in birds. Its color illustrations, its clear type, and its heavy paper should make it an attractive gift for any young person.—Ormsby Annan.

Ornithological Books in the Yale University Library Including the Library of William Robertson Coe. Compiled by S. Dillon Ripley and Lynette L. Scribner. Yale University Press, 1961: 7¼ × 10½ in., [x] + 338 pp., 3 unnumbered pls. $6.00.

This is essentially a catalogue of the extensive ornithological collections in the Yale Library. An introduction by Dr. Ripley explains, among other things, that the book "attempts where possible to point out certain details and facts about less known volumes," that it has a section listing bibliographies which include bird items and another section on falconry, that it has no entries after 1955, that it does not list works in journals and monograph series, and that certain books have been omitted.

Conspicuously missing in the introduction or elsewhere in the book is an explanation of methods, abbreviations, and symbols used in describing the works. One who consults the book must figure out for himself just what the compilers have attempted to show. Authors' names have been given in full, regardless of how they appeared on the title pages, with one evident exception. For some reason, known only to the compilers, appelations such as "Jr.," "II," etc., have been arbitrarily dropped. (This reviewer, whose name happens to be one thus treated, considers Junior to be an integral part of his name, not a terminal flourish!) The reason seems all the more puzzling when one notes that the names of certain European authors have been unnecessarily lengthened by including titles of noble and royal rank. The size of each book is indicated by one dimension only—and in centimeters. Unless a person is familiar with the work, he has no way of knowing with certainty that the figure refers to height, and his problem is compounded by the fact that he normally thinks of book sizes in inches.

The fact that the book has two special sections—on bibliographies and on falconry—is mentioned only in the text of the introduction (and in the case of falconry, again on the jacket). Both should have been prominently indicated somewhere in the front matter, preferably on the title page. As it is, without reading the introduction, one can easily overlook them because they are in the back of the book.

Following many of the book descriptions are brief though nonetheless helpful comments as to contents. These greatly augment the catalogue's value.

The book was made possible through the generosity of the late Mr. Coe, the arduous task of the compilers, and the encouragement and help of several other persons. To them we are grateful, because we now have an invaluable reference tool and a welcome companion to the classic works by John T. Zimmer ("Catalogue of the Edward E. Ayer Ornithological Library," 1926, Field Museum of Natural History, Chicago), and Casey A. Wood ("An Introduction to the Literature of Vertebrate Zoology," 1931, Oxford, London). —Olin Sewall Pettingill, Jr.

Sea Birds. By Charles Vaucher and translated by James Hogarth. Oliver and Boyd, Edinburgh, 1960: 8¾ × 11⅜ in., 254 pp., 255 photos. (15 col.). £5. 5*s* (about $14.10).

A translation of "Oiseaux de Mer" (published by Delachaux et Niestlé in Paris), this book is primarily an album of photographs with complementary text. In all respects it is a superior work, combining, as George Waterston has well said in its introduction, "all the artistry of good typography, magnificent plates, and well-written text." It should be a worthy addition to any collection of fine books.

The photographs were taken in Scandinavia and Britain, in such places as Tvärminne in Finland, Bass Rock and Tentsmuir in Scotland, and the Farne Islands off the coast of Northumberland. Quality and reproduction of the photographs leave nothing to be desired. Many have been reproduced one to a page and the others rarely more than two to a page; all except those in color are bled. From them one receives an exhilaration of intimacy, as if he were standing before the subjects. In the selection of the photographs, no attempt was made to give all bird species equal coverage. The Fulmar, Shag, Gannet, and Common Puffin, for example, are generously illustrated whereas the Black Guillemot is represented once. Along with the sea-bird pictures are those of three shorebirds (Oystercatcher, Ringed Plover, and Turnstone) and the Rock Pipit. Monotony of composition from plate to plate is avoided successfully by varying the views from close-up to medium-distant to distant, and these are interspersed with seascapes that vividly show physical features together with the capricious moods of water, sky, and wind. Legends accompanying the photographs identify the species, usually without comment. Through some strange mix-up, the color photograph on page 117 and the one in black and white on page 132 are labelled, respectively, Lesser Black-backed Gull and Great Black-backed Gull. Each picture shows an adult sitting on what is obviously the *same* nest. The species in both cases is undoubtedly the Great Black-backed Gull.

The text, though somewhat incidental to the illustrations, is plain in style, evenly written, and straightforward, giving the kind of information the average reader will want to know about the birds depicted and the places where they nest. The bulk of the text comprises general accounts of the species featured by pictures, followed by a section, "Descriptive Summaries," that gives, for the same species, the common names in French, German, and Italian, a description of adult, juvenile, and nestling plumages, measurements of length and "wing-span," facts concerned with breeding (habitat; shape, color, and measurements of eggs; and incubation data), and distribution.—Olin Sewall Pettingill, Jr.

A Key to Florida Birds. By Henry M. Stevenson. Peninsular Publishing Co., Tallahassee, Florida, 1960: 6⅛ × 9⅛ in., viii + 158 pp., 6 figs. Paper covered; spiral bound. $4.00.

This work, for students at the college and university level, has a series of dichotomous keys to orders, families, and species of Florida birds, followed by sections titled "Descriptions and Status of Florida Birds," "Collecting and Preserving Birds," "Glossary and Measurements," and an index. Keys and descriptions have to do only with species whose occurrence in Florida is substantiated by at least two records. The keys are designed for the identification of specimens in the hand. Great care has been taken to base the keys on the more apparent morphological characters and on precise, easily determined measurements (millimeters for smaller dimensions) and ratios so that the specimens, if museum skins, need not be excessively mauled by students and consequently damaged. The description and status of each species are in separate paragraphs. The first gives common and scientific names, total length, coloration of plumage or plumages to be seen in Florida, and peculiarities of form, if any; the second gives seasonal status in the state. Directions for skinning and preparing museum skins are illustrated by four instructive photographs. All in all, the work has a wider application than its title implies and should be highly useful in any ornithology course given in the Florida area.

The text has been painstakingly prepared; errors are very few. (A mimeographed list of corrections and omissions is available from the author upon request.) Its convenience as a study tool, however, is impaired in two places. *The keys.* There are no page numbers in the key to orders and families that will refer the user to the keys to species. If he identifies his specimen, for instance, as a fringillid, he must then, to identify the species, search for the key to species of Fringillidae by thumbing through succeeding pages or looking it up in the index. And further, if he wishes to corroborate his identification of species by checking on its description, he must again go through the same procedure because the page number of the description is not given in the key. *The section on descriptions and status.* Here the user cannot see at first glance where the treatment of one species ends and the next begins because the spacing between the two paragraphs *in* the treatment is the same as *between* one treatment and the next, and the common name of the species at the start of each treatment is in the body of the first paragraph and printed in the same type. Double spacing between treatments only, and boldface type for common names, would be distinct improvements.—Olin Sewall Pettingill, Jr.

The Christopher Happoldt Journal: His European Tour with the Rev. John Bachman (June–December, 1838). Edited by Claude Henry Neuffer. The Charleston Museum, Charleston, South Carolina, 1960: 5½ × 8¾ in., 128 pp., 4 pls. $5.00.

It is always a pleasure to read of a long hidden manuscript coming to light, and one responds with friendly interest not only to the discoverer but also to the person who had the foresight to preserve it. "The Christopher Happoldt Journal" was saved first by the daughter and then by the granddaughter of Christopher Happoldt, Mrs. John B. Ross of Washington, D.C. It is fitting that Dr. Happoldt's descendants should have preserved this record of their distinguished forebear. Through Mrs. Ross and the Charleston Museum, Professor Neuffer was permitted to publish it.

Dr. Happoldt (1823–1878), a naturalist of Charleston, South Carolina, made an outstanding reputation in medical research and was editor of the *Charleston Medical Journal and Review.* This publication reached three hundred subscribers and earned well-deserved praise from readers in Europe where Dr. Happoldt had trained in medicine. Its success spurred the Doctor to more intensive research. Dr. Happoldt's long association with the clergyman and naturalist, Dr. John Bachman (1790–1874), was another contributing factor to his complete satisfaction with his work. But as Professor Neuffer says, "Dr. Happoldt had given 'hostages to fortune' " and at thirty-five felt it incumbent upon himself to concur in his wife's wish to return to her girlhood home in North Carolina where she apparently needed a manager for the family's plantation.

Professor Neuffer conveys skillfully the Doctor's deep reluctance to renounce the work he loved so well: to abandon the *Charleston Medical Journal*; to curtail the time for medical research, in order to direct wisely the business interests of the plantation.

In three years the whole picture of the South had changed. The Confederacy seceded from the Union and the War between the States was raging through the land. Happoldt as surgeon in the Infantry was ordered back to Charleston to defend the city, but in 1863 he was taken prisoner and so remained until the war was over. He came out of the war without serious injury, but the glamour of the plantation system, which he only dimly understood, was gone, and he resumed the role of the country doctor of Burke County. No doubt he yearned to serve his fellow man with deeds of greater valor, and the fight against yellow fever, which had broken out, looked like his opportunity to return to research. So he plunged first into Memphis, Tennessee, and then into Vicksburg, Mississippi, where the dread disease engulfed him in the general tragedy. Thus fighting to save others, Happoldt died there in 1878, only fifty-five years of age.

The foregoing comments relate to the first part of the book which Professor Neuffer calls "A Biographical Sketch of Christopher Happoldt." In order to keep the Happoldt elements of the book together I mention next the Happoldt "Journal" which occupies most of the latter half of the text. The reader is informed in the book's preface that the Journal is a record of John Bachman's six months of European travel in 1838, during which young Happoldt, aged fourteen years, was invited to accompany him as a companion and assistant. The faithful entries made by Christopher each day, while sometimes rather trivial, are in the main very worthwhile for they furnish the facts of each day's itinerary with hotels, prices, the centers of sightseeing interest, and impressions of the general public. Occasionally he refers to some of Dr. Bachman's museum visits and mentions the names of various professors and curators, for Bachman was already collaborating on "The Quadrupeds" with Audubon. The story is often lightened with quaint, precocious commentaries on public behavior and he evinces surprising perception in his estimate of the different national qualities of English, French, and German character. It is clear also that young Happoldt had a rather mature tact by which he saved Dr. Bachman unnecessary annoyance and trouble. Although the Journal is much over a hundred years old, it could be enjoyed by boys of today.

It was a pleasant surprise to find Professor Neuffer's biography of John Bachman included between two sections of the Happoldt story. Bachman is another case of a fine naturalist skilled in birds, mammals, and general natural history being thrown into shadow by the luminescent John James Audubon. It is well that Director Milby Burton of the Charleston Museum mentions the unrewarded career of Bachman despite his many contributions to Audubon's knowledge which Audubon duly recognized, although he scarcely realized their importance.

The families of these two men were so closely knit by the marriage of two of Bachman's daughters with the two Audubon sons that they could well take each other for granted, but it is time that Bachman be disengaged from his relatives by marriage and receive his correct position in the scientific world, even though posthumously.

It is clear as one reads the biography of Bachman that Audubon dominated whatever the two naturalists engaged in cooperatively. It is also equally clear that Bachman was intent upon the most accurate and scientific methods of describing the quadrupeds. For this necessary work he begged Audubon to visit museums while he was still in England in order to get the measurements of the mammals of America, these details being essential to every species description. Audubon, on the other hand, was keen primarily on getting their combined work into print, much to the annoyance of his hard working collaborator who rose at 4:30 AM in order to spend three hours each morning on the text of the Quadrupeds. When at last it was completed and released in 1846 it was pronounced by Louis Agassiz "a classic" without any equal in Europe. Bachman was quietly pleased and took courage but the dilatory habits of the Audubons were wearing.

Although of German and Swiss ancestry, John Bachman was born in Duchess County, New York, and lived in the North for twenty-four years. His allegiance was always with the South and when he came to St. John's Lutheran Church of Charleston, the city was glad to have him develop it as he saw fit. Bachman kept his pastorage until 1871, weathering the War between the States, but he never ceased to miss his able colleague, Christopher Happoldt, as a worker in his parish.

Professor Neuffer has produced a much needed and well documented biography of John Bachman but, in its present form, it would seem to be in danger of being overlooked by those who really need it. Certainly Bachman's name should appear in the title of the book.—ELSA GUERDRUM ALLEN.

FUGITIVE REACTIONS IN AVIAN BEHAVIOUR. By Martin Markgren. Acta Vertebratica (Nordiska Museet and Skansen, Stockholm), Vol. 2, No. 1, 1960: 160 pp. Paper covered. 25 Swedish kronor (about $4.88).

For many years the author has been making field observations on a variety of flight responses in a number of Fennoscandian bird species. This paper is an attempt to show how a diversity of avoidance and other movements made by birds fit his definition of "fugitive reaction," a rubric apparently blanketing most bird activities.

The paper is divided into two parts, each with numerous subsections. Part I, "Escape Behaviour," has four chapters, the longest one dealing with a variety of predator-prey interactions; Part II, "Fugitive Behaviour," consists of one chapter which is largely devoted to a discussion of numerous aspects of bird migration as they relate to the author's main theme. Two appendixes, which take up fifty pages, list field observations made from 1947–59.

My over-all impression is that the author has tried to cover too much ground. A crude analogy which came to mind after I had finished reading the paper was that of a man who entered a vineyard, sampled a few choice grapes, then left feeling that he had consumed the entire crop. Many of the subjects are merely touched upon, seemingly as afterthoughts; others are not treated in detail even though some dogmatic statements are made and broad generalizations are drawn. The style is irritatingly discursive; too often we are told of experiments to be tried in the future or of other works in press; some usage is archaic ("Regnum Animale," p. 26, for example) ; the literature cited is heavily Scandinavian; and the extreme subdivision of each section is often distracting and confusing. Finally, the price seems a bit unreasonable for a publication with a stiff paper cover.

The author has gathered many interesting and significant field observations, but I think he was mistaken in trying to interpret all flight as "fugitive reaction." Many of the difficulties in style undoubtedly accrued as a result of his decision to publish in English rather than Swedish.—Andrew J. Meyerriecks.

PUBLICATION NOTES AND NOTICES

Directory to the Bird-life of Kansas. By Richard F. Johnston. Museum of Natural History, University of Kansas, Mis. Publ. No. 23, 1960: 69 pp., 1 fig. Paper covered. Available upon request.

This is essentially a check-list, with pertinent information on the natural history of the 379 species in the state. Terms and methods used in presenting each species are meticulously explained in the introduction. A most useful feature is a reference at the end of many species accounts to a more comprehensive treatise on the natural history of the species concerned.

An Annotated Bibliography on the Uses of Statistics in Ecology—A Search of 31 Periodicals. By Vincent Schultz. United States Atomic Energy Commission, Office of Technical Information, Oak Ridge, Tennessee, 1961: viii + 315 pp. Paper covered. $3.00. Available from the Office of Technical Services, Department of Commerce, Washington 25, D.C.

Data on "wildlife" (i.e., birds and mammals) have been obtained from *The Auk*, *California Fish and Game*, *The Condor*, *C. S. I. R. O. Wildlife Research*, *Danish Review of Game Biology*, *Ecological Monographs*, *Ecology*, *Forest Science*, *Journal of Animal Ecology*, *Journal of Mammalogy*, *Journal of Wildlife Management*, *Journal of the Fisheries Research Board of Canada*, *New York Fish and Game Journal*, *Transactions of the North American Wildlife Conference*, and *The Wilson Bulletin.*

Among the recently published "paperback" editions of books in the field of natural history are the following:

Audubon and His Journals. By Maria R. Audubon with Zoological and Other Notes by Elliott Coues. Volumes 1 and 2. Dover Publications, Inc., New York. $4.00.

The Heart of Thoreau's Journals. Edited by Odell Shepard. Dover Publications, Inc., New York. $1.45.

King Solomon's Ring: New Light on Animal Ways. By Konrad Z. Lorenz. Thomas Y. Crowell Company, New York. $1.95.

Bio-Acoustics Bulletin, edited by William R. Fish, is a new quarterly publication of the Laboratory of Ornithology at Cornell University. Now in its first year (Vol. 1, No. 1, January–March, 1961), the *Bulletin* is designed to interest, advise, and assist persons in natural-sound recording. Copies of the three issues so far published are available from the Laboratory of Ornithology at 50¢ each.

LETTER TO THE EDITOR

I would like to make a public disclaimer of the drawings purporting to be my work on the dust jacket of the American edition of Bond's "Birds of the West Indies." Comparison of the plates within the book with the copies on the cover will make clear my desire to explain that the latter were rendered by a jacket designer for Houghton Mifflin Co. without my knowledge or consent.

This was not the case with the British edition published by Wm. Collins Sons & Co., Ltd., London.

Sincerely,
Don R. Eckelberry

INDEX TO VOLUME 73, 1961

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. Names of new forms described in this volume are printed in **boldface** type.

This issue of *The Wilson Bulletin* was published on 22 December 1961.

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the AOU Check-list (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited; otherwise, follow the "Style Manual for Biological Journals" (1960. AIBS). Photographs for illustrations should be sharp, have good contrast, and be on 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
44th	1963	Charleston, South Carolina