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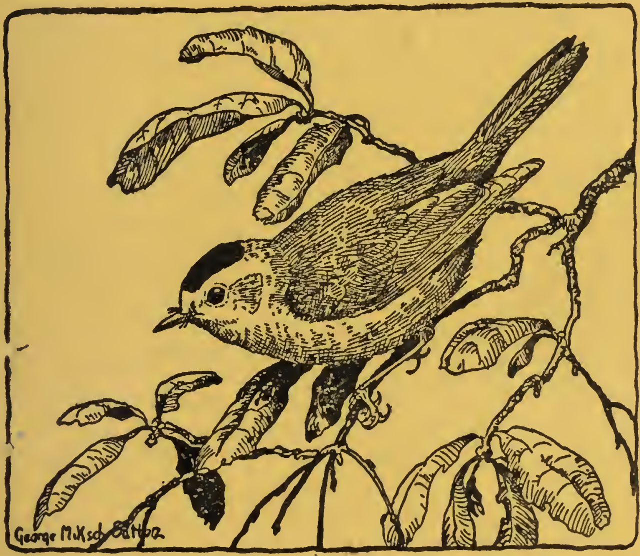

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EXPERIMENTS ON WINTER TERRITORIALITY OF THE AMERICAN KESTREL, *FALCO SPARVERIUS*

BY TOM J. CADE

Despite some salutary criticism (Lehrman, 1953) levied at the excessive use of hypothetical systems by the "ethologists," it seems that the methodology of these investigators offers possibilities for sound research into fields of animal behavior that have as yet been little explored by American scientists. For instance, Howell and Bartholomew (1952; 1954) have recently employed some of the ethologists' techniques in a meaningful way without resorting to the construction of elaborate hypotheses or becoming embroiled in a tortuous vocabulary. I refer, of course, to methods of *experimenting* with wild animals in the natural environment and, especially, to the introduction and manipulation of stuffed dummies, of various sorts of models, and captive, live animals into social situations involving wild creatures (see Tinbergen, 1948).

In the fall of 1952 I became interested in exploring the possibilities of using captives and stuffed dummies as aids to a comparative behavioral study of the long-winged hawks, genus *Falco,* on which I have been working for the past several years. Previously I had carried out a few cursory experiments with Peregrines (*Falco peregrinus*) and Gyrfalcons (*Falco rusticolus*) in Alaska with results indicating the desirability of a more thorough investigation than I could conduct in the wilderness areas where these two species were studied. I chose the American Kestrel (*Falco sparverius*) as the species for study because it is the commonest and most approachable falcon of southern California. I knew from casual observations that individuals of this species take up winter territories, and this was the aspect of behavior that I wanted to study.

It will be noted that I use the common name 'American Kestrel' in preference to the name 'Sparrow Hawk' for this falcon. The latter name was first applied to *Falco sparverius* in ignorance. Because it has had a long history of prior use for a true hawk, *Accipiter nisus,* the adoption of this name for our American falcon has been a constant source of confusion in the literature, especially when Latin names do not accompany the vernacular ones. The name 'American Kestrel' relates our species to its closest congener, *Falco tinnunculus,* and is more desirable from the standpoint of esthetics and conservation. Peterson (1947) makes a notable appeal for changing the common names of our North American falcons.

STUDY AREAS

Most of the experiments, and most of the observations on which the next section of the paper is based, were carried out in residential areas of Glendale, Hollywood, and West Los Angeles, California. Kestrels occurring in these districts were using vacant city lots for their winter hunting territories, and the experiments were conducted on these areas. A few experiments also were carried out in rural districts in the vicinity of Castaic, Los Angeles County, California, and on the Mojave Desert between Gorman and Lancaster. No differences were apparent in the behavior of urban and rural kestrels under comparable experimental conditions, but the rural kestrels were wilder and more difficult to work with.

ANNUAL CYCLE OF BEHAVIOR

Before discussing the actual experiments, it will be well to have in mind a brief sketch of the annual cycle of social organization in a kestrel population. There are no definitive studies on this subject, and the statements that I offer are based on my own casual observations over a number of years prior to 1952, and on intensive, year-around studies of 20 kestrels beginning in January, 1953, and continuing to the present.

Courtship.—In southern California mating behavior of most kestrels begins in January, although a few birds may be seen courting and engaging in copulatory behavior in late December. A few kestrels do not begin courtship until late February. Paired birds engage in a long pre-nesting association which is characterized by aerial displays (chiefly by the males), by social hunting by the pair, by courtship-feeding of the female, by mutual preening and billing, by characteristic chittering vocalizations, and by frequent acts of copulation throughout practically the entire period. Copulations become more and more frequent as egg-laying approaches (as many as six in half an hour have been counted) and end within a day after the last egg has been laid. This phase of the breeding cycle usually lasts twelve to fourteen weeks but can be prolonged considerably by a late spring, as was the case in 1954.

Although the pair bond in kestrels is strong, promiscuity is frequent on the part of both sexes. During the courting period adult kestrels appear to be more sociable toward each other than at any other time of the year, and the members of two or more pairs are not infrequently found together on the same area. (See Childs and Mossman (1952) for an account of such an occurrence.)

In one case closely observed by me, this sociability seemed to be directed only toward certain individuals. After a pair under observation had initial territorial conflicts with an intruding pair on their hunting and courting area, and after the female of the territory-holding pair had established complete dominance over both intruders *by fighting*, the new birds were permitted to share the lot, and promiscuous matings were observed among these four birds. However, other stray kestrels that came to this lot were driven away by both the original and new pairs. The second pair finally took up a separate nesting territory near the end of the courting period, and the original pair was left in sole possession of the lot.

Occasionally during the courting period one finds an extra bird or two, usually a female, associating with an established pair. In January and February of 1954, a lot near the University of California campus was shared by two pairs and four unattached females. Territorial clashes were never seen.

Nesting.—In April or May a nesting site is occupied, usually near the hunting and courting area, but the only area defended during the nesting period is the immediate vicinity of the nest. Encroachments onto the former hunting area do not elicit attack. The eggs hatch in about 29 or 30 days (see Nice, 1954), and the young occupy the nest for about five weeks. The fledged young remain with their parents as a family unit in the vicinity of the nest for a variable time ranging from two weeks to a month or more. During most of this time the young continue to be fed by the parents to some extent. During the late summer the young finally are driven off by their parents, if they have not already strayed away on their own.

Social hunting groups.—Under favorable conditions, the siblings then form a social hunting group and occupy a given area for the rest of the summer. Several broods may band together, and I have seen as many as twenty juvenal kestrels hunting over a single field of 200 to 300 acres. I know of no instance where such an area has been defended by any of the juveniles.

Apparently the juveniles of all North American species of falcons form these hunting groups during the immediate post-nesting period. I have observed such groups of juvenal Peregrines and Gyrfalcons in Arctic Alaska, and twice in interior Alaska I encountered mixed hunting groups of juvenal Sharp-shinned Hawks (*Accipiter striatus*) and Merlins (*Falco columbarius*). Morlan W. Nelson, who is an accomplished falconer and a keen observer of wild falcons, first brought this phenomenon to my attention. He has observed it for a number of years among juvenal Prairie Falcons (*Falco mexicanus*) in Idaho. Mr. Nelson calls the area occupied by such a group the "hunting rendezvous". This social group is maintained until broken up by migration or, in the case of the kestrel at least, by aggressive territory-seeking adults coming into the area in the fall.

The only information concerning the onset of territorial behavior in first-year kestrels is provided by one male that was color-marked as a juvenile and observed continually from July to the following May. Territoriality was first demonstrated experimentally on January 28 by the release of a trapped kestrel in his area. Previously, such releases had not elicited attack.

The winter period.—In southern California most resident kestrels maintain a permanent pair bond, occupying the same area throughout the year. Some local pairs break up in the fall, and the mates occupy separately-defended areas during the winter. Often their territories are adjacent and near their former nesting sites. A few breeding pairs in southern California leave the vicinity of their nests in the fall and are not seen again until late December or January. How far they move is not known.

The resident population is augmented in the fall and winter by migratory birds from the north and from the higher summer ranges in the mountains. The resident kestrels of urban districts usually constitute no more than one-fourth to one-half the maximal winter population, although the number of immigrants varies a great deal from year to year.

For the purposes of this study, winter territorial behavior is defined as the active defense of a hunting area by a pair or by an individual following the disintegration of the family groups. Most resident pairs begin to show such behavior in the last weeks of August. In migratory birds it begins with their impingements upon the territories of the resident kestrels. Active defense of a hunting area usually ends with the onset of the breeding cycle, and marked territoriality is not again seen until the nesting site is chosen.

Procedure and Methods

In October, 1952, I began systematically recording the occurrence of kestrels in the study areas, locating territorial birds for later experimentation. By the end of the month it was apparent that many individuals consistently occupied the same lots. Birds that appeared to be the same individuals could be found on the same lots—usually on the same perches—at about the same time each day. Different perches, and sometimes different lots, were used at different times of the day. (After nearly three years of observation on individual birds, I can say that the constancy of individual patterns of daily activity is one of the most noticeable aspects of kestrel behavior. Miller's (1954) description of the roosting schedule of a female in this area is an excellent case in point.)

Trapping.—In order to make sure that I was observing the same individuals, I trapped some of the kestrels and color-marked them. Three types of traps were used with about equal success. One was a simplified version of the automatic bow-net recently described by Tordoff (1954). The other two were copies of ancient Persian traps used by falconers. The *balchatri* consists of a wire holding cage for live bait, over the top surface of which are attached slip nooses of lightweight nylon fishing leader. When a kestrel flies down and strikes the cage, his feet become entangled in the nooses. The *dhogaza* is a lightweight net held vertically between two poles. The edge of the net is laced with a continuous line, the ends of which are attached to the upper ends of the poles. A hawk flying into this net in quest of the staked-out bait pulls the corners of the net loose from their fastenings, and it sacks around the bird. (See Meredith, 1943:442–447, for a complete description and diagrams of this trap.)

Marking.—Since October, 1952, I have trapped and banded forty kestrels. Some of these were color-marked with an acetone-base lacquer (airplane dope) on the dorsal surface of their central rectrices; others were marked by attaching colored jesses (leather leg straps) around their tarsi. The latter method is more satisfactory because the jesses remain intact for a longer time than the painted feathers, which are molted after one year.

A number of these marked birds were experimented with before they were trapped. Subsequent to their being trapped, most of them showed marked alterations in their responses to the same stimulus. Untrapped kestrels did not show such alterations even after many repetitions of the same stimulus. It was soon concluded that trapped birds did not give reliable results in most cases; therefore, all comparable experiments had to be carried out on untrapped birds.

Materials.—A male and a female were trapped and held in captivity for use in the experiments. These birds are referred to hereafter as the "lure-male," the "lure-female," or, collectively, as the "lure-birds." Another male and a female were secured for stuffed mounts. The male was prepared in the normal sitting posture; the female in the copulatory position with up-tilted tail. These birds are referred to hereafter as the "dummy-male," the "dummy-female," or as the "dummies."

The experiments reported below were carried out during the months of November and December, 1952, January, February, March, September, November, and December, 1953, and August, October, November, and December, 1954. The objective was to determine what kinds of response could be elicited from territorial kestrels during the winter by various presentations of the experimental objects on their hunting areas.

EXPERIMENTS WITH LIVE DECOYS

In the experiments involving the lure-birds, the procedure first used in 1952 was as follows: one of the lure-birds was tethered to a pyramidal, cloth-screened perch two feet in height from base to apex (Fig. 1). The lure-bird was tied on a short leash so that it could not touch the ground. If it attempted to fly away, it simply fell against the cloth screen on the side of the perch, a position from which it could easily right itself. When a wild kestrel was sighted, the lure-bird was placed on the perch at a certain estimated distance from the territorial bird. Then the observer retreated, usually to a car or behind some concealing object, such a billboard, to observe. Subsequently this procedure was abandoned for the simpler one of staking the lure-bird on the ground at the end of a four-foot leash.

A great variety of responses was produced by the lure-birds, ranging from apparent indifference to violent and persistent attacks characterized by bodily contact between the wild bird and the lure-bird. Some descriptions of experiments from my field notes will serve to illustrate the kinds of aggressive action elicited.

Fig. 1. Lure-male on the pyramidal perch near Gorman, California, December, 1952.

On November 13, 1952, at 8:20 a.m., a female that I had been observing for several weeks was sighted on her hunting area. She was perched on a telephone wire at the back of a lot about 50 × 50 yards in extent. The lure-male was set on his perch approximately 20 yards from the female. As I was walking away from the lure-male in plain view of the female and before I was more than 10 yards distant, the female suddenly launched forth into a diagonal dive straight at the lure-male, passing just a few inches above his head. She made a sharp turn and alighted on the ground about two feet from the base of the lure-male's perch. Then she jumped up and hovered just over the lure-male's head for several seconds, finally flying back to the telephone wire, where she perched and screamed for a short time. Still screaming, she flew to a guy-wire on a telephone pole where she perched about fifteen feet directly above the lure-male. From this point she attacked again, striking the lure-male with her talons and knocking him off his perch. The female flew back to the guy-wire and then repeated her attack, knocking the lure-male off his perch a second time. At the end of this attack, she landed on the ground and sat looking at the lure-male, screaming for several seconds. After this action she flew back to the guy-wire. Again she dived and knocked the lure-male off his perch. By this time the action had been going on for five minutes, and I intervened to prevent injury to the lure-male. There were, however, no cuts or other signs of injury on his body. (I might add at this point that throughout these experiments the lure-birds frequently received blows as severe as the ones described here, but they were never injured in any way, and both were released in perfect condition at the end of the experiments.)

On the same day, at 8:55 a.m., I placed the lure-male in the territory of a male that I had been observing for several weeks. This territory consisted of a vacant lot about 300 × 400 yards in extent with three oak trees growing in it. The male used one of the oaks frequently for a perch and feeding station. At the beginning of this experiment, he was perched on top of a telephone pole on the north side of the lot. The lure-male was set out 100 yards away. There was no action for one or two minutes, the wild male appearing not to have seen the lure-male, which sat still. Presently the wild male flew from his perch and attacked a flock of four Killdeers (*Charadrius vociferus*) that were on the ground about thirty yards from him. He chased these birds out of the lot and disappeared from sight. At 9:00 a.m., I saw this same kestrel flying toward the lot from an unnoticed perch on the side of a hill to the east. He headed straight for the lure-male and hit him solidly with his talons on the first pass. He landed on the ground about three feet from the lure-male and screamed continually for several seconds. Then he began walking around the lure-male in a circle, drooping his inside wing so that the tips of the primaries dragged on the ground. This appeared to be some sort of threat-display. (Other males and females under similar circumstances have shown this same behavior.) After several seconds the male flew into the air again and, making a wide circle, he came in high over the lure-male, 'stooped', and knocked the lure-male off the perch. While the lure-male was dangling over the side of the perch, the wild male alighted on the apex and sat there screaming. Each time the lure-male tried to right himself, the wild male knocked him back down with a blow from one foot while maintaining his stance on the perch with the other. Occasionally the wild male jumped up and hovered two or three feet above the perch, at which times the lure-male would right himself only to be knocked down promptly by the wild male. After ten minutes had elapsed, I intervened, and the wild male flew to his perch in the oak tree.

On December 8, 1952, I set the lure-male in the area of a wintering pair, at 9:05 a.m. Both wild birds immediately started circling in the air over the lure-male, screaming. In less than one minute the wild male started stooping at the lure-male and striking him with closed fists. The female continued to fly about in an excited manner higher up. She did not stoop at the lure-male. Forty minutes later, when I moved in to retrieve the lure-male, these birds had not lessened the intensity of their actions, except for brief pauses.

On October 17, 1954, at 8:42 a.m., I set the lure-female on the ground in the territory of a resident female. The wild female was 35 yards away. She watched the lure-female intently for a few seconds and bobbed her head up and down. At 8:45 a.m. the wild female flew toward the lure-female, dropped to the ground, and caught an insect about 10 yards away from her. She flew back to her perch on a fence and ate the insect. There was no further action for ten minutes, after which the lure-female was removed.

The same day, at 9:56 a.m., I set the lure female in the area of a wintering female. The wild female was 50 yards away. Immediately she flew down and struck the lure-female a blow with her closed feet. She circled around once more and landed on the ground two feet away from the lure-female. Then she charged in and grabbed the lure-female by her legs, pinning her to the ground on her back. The wild female held the lure-female in this position for several seconds and then flew into the air screaming. She repeated variations of this attack for ten minutes, when I intervened.

Discussion

These five accounts give an idea of the variability of the responses elicited by the lure-birds. Actually no two birds reacted with an identical pattern of behavior, but for the purpose of presenting the data quantitatively, it is convenient to group the results into three categories. Some birds remained on their perches, continued hunting activities, or in other ways showed no change in their behavior when the lure-birds were presented on their areas. Others screamed and dived at the lure-birds, always staying above them and never coming into bodily contact. The most aggressive birds not only screamed and dived at the lure-birds but also actually struck them with their feet in the air or landed on the ground and grappled their legs, pinning them down.

Tables 1 and 2 summarize the data in these three categories of behavior. Inspection of these tables reveals no differences among the four experimental groups in their responses to the lure-male, but there is a marked difference between the males and the females in their responses to the lure-female. Only one-third of the single males actually came into bodily contact with the lure-female in comparison to about three-fifths of the females which did. None of the paired males hit the lure-female, but four-fifths of the paired females did. The difference between the frequencies of all highly aggressive males and all highly aggressive females of table 2 gives a chi square value greater than that required for P to equal the one per cent level of significance.

TABLE 1

RESPONSES OF FREE-LIVING KESTRELS TO THE LURE-MALE

Experimental Groups	Types of Attack			Totals
	Striking and Grappling with feet	"Stooping" without bodily contact	None	
Single Males	8	3	3	14
Paired Males	10	1	3	14
Paired Females	8	4	2	14
Single Females	11	4	4	19

TABLE 2

RESPONSES OF FREE-LIVING KESTRELS TO THE LURE-FEMALE

Experimental Groups	Types of Attack			Totals
	Striking and Grappling with feet	"Stooping" without bodily contact	None	
Single Males	4	4	4	12
Paired Males	0	5	5	10
Paired Females	8	2	0	10
Single Females	9	4	3	16

Experiments Involving Mounted Models

Usually the dummies were set out in the territories on a six-foot rod that was stuck into the ground, but in a few instances they were placed on the ground or on fence posts, and in one case in the top of a pepper tree (*Schinus molle*).

The experiments with the dummies produced a much smaller number of responses. The dummy-male was presented to seven single males, four single females, and one resident pair. None of these birds showed any reaction to the dummy-male. The dummy-female was presented to eight single males, three single females, and two resident pairs. The dummy-female elicited responses three times. One of the females that had been strongly aggressive toward the lure-male during a previous experiment stooped over the dummy-female when it was placed on the ground. On a subsequent day when the dummy-female was set up on the six-foot pole, the same female dived at the dummy and hit it several times in five minutes.

On February 7, 1953, about 4:30 p.m., a male and a female were observed in courting display on a lot that had been the female's hunting area for the past three and one-half months. The female flew out of the area at my approach, but the male remained. I placed the dummy-female in the uppermost branches of a pepper tree growing in the lot. In the meantime the male was flying high overhead. As soon as I retired to watch, the male flew down and hovered just above the dummy-female for several seconds and then flew away.

Experiments with Models and Lure Birds

The experiments involving combined presentations of the lure-male and the dummies revealed some interesting aspects of behavior. In these experiments three different males that had previously shown strong aggressive actions toward the lure-male were used. In the first experiment, in which the lure-male was first presented singly and the dummy-male then substituted for it immediately afterward, the wild male again initiated violent attacks on the lure-male. When the dummy was substituted, the wild male continued attacking it just as vigorously as before and continued to do so for nearly ten minutes, until scared away by a pedestrian.

In the second experiment, the wild male also attacked the lure-male when it was set out alone, but when the dummy-female was presented simultaneously above the lure-male on the six-foot rod, the attacks were switched to her, and these continued in excess of ten minutes. During this time the wild male did not attack the lure-male once, but the dummy-female was hit so hard that its head fell off.

The other experiment of this series occurred by chance. The dummy-male had been set out 100 yards from a resident male, and there had been no action for about five minutes. Then the lure-male suddenly began screaming the common *killy-killy* cry from his perch inside my car. The resident male immediately answered with a corresponding call and flew directly at the dummy-male, striking it roughly with his talons on the first stoop. Prior to this action there had been no indication that the wild male was aware of the presence of the dummy-male. The lure-male continued to scream at intervals for about five minutes, and during this time the dummy-male was struck many times by the wild male, which displayed even greater aggressiveness than he had shown toward the lure-male in previous experiments.

Discussion

Comparing the results obtained with the lure-birds to those obtained with the dummies, one can say that movement or "aliveness" is a stronger releaser of territorial aggressiveness in kestrels than are form or plumage pattern. This conclusion is also supported by field observations. If a stray kestrel flies quietly into the territory of another bird, and then sits still in a low, inconspicuous place and does not attempt to hunt, the resident bird frequently will not attempt to drive it away; but if the intruder flies about over another bird's territory or attempts to hunt there, it is nearly always attacked.

The last experiment described in the foregoing section shows strikingly the effect of vocalizations on the aggressive behavior of territorial kestrels. Field observations indicate that the *killy-killy* cry is used by resident kestrels to advertise their presence, and frequently this vocalization alone is enough to cause an intruder to leave the area. If an intruder vocalizes, the resident will attack at once.

The differences in the reactions of males and the reactions of females to the lure-female reflects a fundamental aspect of the social behavior of this species. In any social situation involving a pair of kestrels, the male is nearly always subordinate to the female. The female has first right to food taken by herself or by the male. If the male does not present his food to the female, she may take it from him, in which case he does not offer resistance. However, the female does not often enforce her dominance for the food except in the breeding season. The female has first right to favorite perches and roosts. The female accepts or rejects the male in the initial pair-formation, and she releases and controls copulatory behavior. The male inspects a number of nesting sites, but it is the female that chooses the one in which the eggs are laid.

Sherman (1913) is apparently the only one who has recorded detailed observations on the nest-life of the American Kestrel. She presents some evidence to show that this fundamental difference between the sexes first appears when the birds are nestlings. After the young which she was observing were old enough to feed themselves, the females always ate first and took the most, gaining weight faster than the males. If a hand or a stick was thrust into the nest the males reared back on their tails and opened their beaks, but the females struck out with their feet. I have applied this same test to fledgling Peregrines, Gyrfalcons, and Prairie Falcons and, while the results are not invariable, in general, the same relationship holds for these species. Sherman (1913:410) says, "This yielding of their lawful share of food by the males may have its origin in their disposition in mature life to give the food they bring to their mates." I am inclined to think the statement should be reversed —that the bringing of food to the female and the courtship-feeding of mature life are developments from the social tendencies of nestling life.

It becomes important to learn how much the behavior of males toward their mates is modified by the social milieu of nestling life. For instance, would a brood of all males produce individuals showing the same submissiveness to females that a mixed brood would produce?

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SUMMARY

Winter territoriality is a prominent feature in the behavioral cycle of the American Kestrel (*Falco sparverius*). It functions primarily to maintain an adequate hunting ground for the individual. Experiments employing a captive, adult male, a captive female, a stuffed dummy-female, and a stuffed dummy-male were carried out to study this behavior. The reactions of wild kestrels toward the experimental objects placed in their territories ranged from apparent indifference to the most violent and persistent kinds of attack. There was no measurable difference between the reactions of males and females to the captive male, a majority of both sexes being highly aggressive; females also attacked the captive female as frequently as they did the captive male, but males showed a marked decrease in the frequency of their attacks on the captive female, especially of attacks resulting in bodily contact. This difference between the sexes is the reflection of a masculine submissiveness which has its earliest manifestations during nestling life. A comparison of the results produced by the live captives and the dummies indicates that movements and vocalizations are stronger releasers of aggressive behavior than are form or pattern *per se*.

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AN APPARATUS FOR MEASURING KINETICS IN AVIAN SKULLS

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In 1867 Huxley distinguished several basic types of construction in the ventral parts of birds' skulls. The structure of these types is in part responsible for the degree of movement (kinetics) at the frontonasal hinge. Despite this early recognition of the mechanism and the possibility of movement, the concept of kinetics here was not extensively explored until the work of Moller (1931), Kripp (1933-1935), and especially Engels (1940). Hofer (1945) dealt with the problem in a functional and quantitative way. Beecher (1951*a*) carried this approach farther. Additional work by Hofer (1950), Beecher (1950, 1951*b*, 1953) and Fiedler (1951) has shown the importance of kinetics, as part of the functional jaw mechanism, in long-term adaptive changes of evolutionary significance.

The studies cited above have, for the most part, been subjective and qualitative. This has caused some concern in our laboratory. We could not find in the literature any measure of the accuracy of judging the degree of kinetics in the skull of a species or any evidence of statistical reliability and variation within a species. Where the kinetic attributes of two different species have been compared, there were no statistical data to support hypotheses of significant or insignificant differences between the two. It would seem that the criteria of variation, reliability, and significance must be established before it is possible to interpret the kinetics in terms of function or adaptive significance.

We failed to see how accurate quantitative data could be obtained following the methods of observation employed by the authors listed. We could find no description of any apparatus that would produce consistent and accurate measurements which could be compared from species to species. This statement is not to be construed as a criticism of these workers; several were interested only in the qualitative, and those who gave quantitative data generally used them as approximations only.

An apparatus was designed to produce quantitative data on this problem and to eliminate, as far as possible, the subjective aspects of past work. This equipment is illustrated in Figure 1.

Description of the Apparatus

The machine is constructed of brass. Therefore the apparatus is sturdy but not great in weight, enabling easy transport to and from the field. This light weight makes necessary the use of a C-clamp (not illustrated) to secure the apparatus to the edge of a table or desk during use.

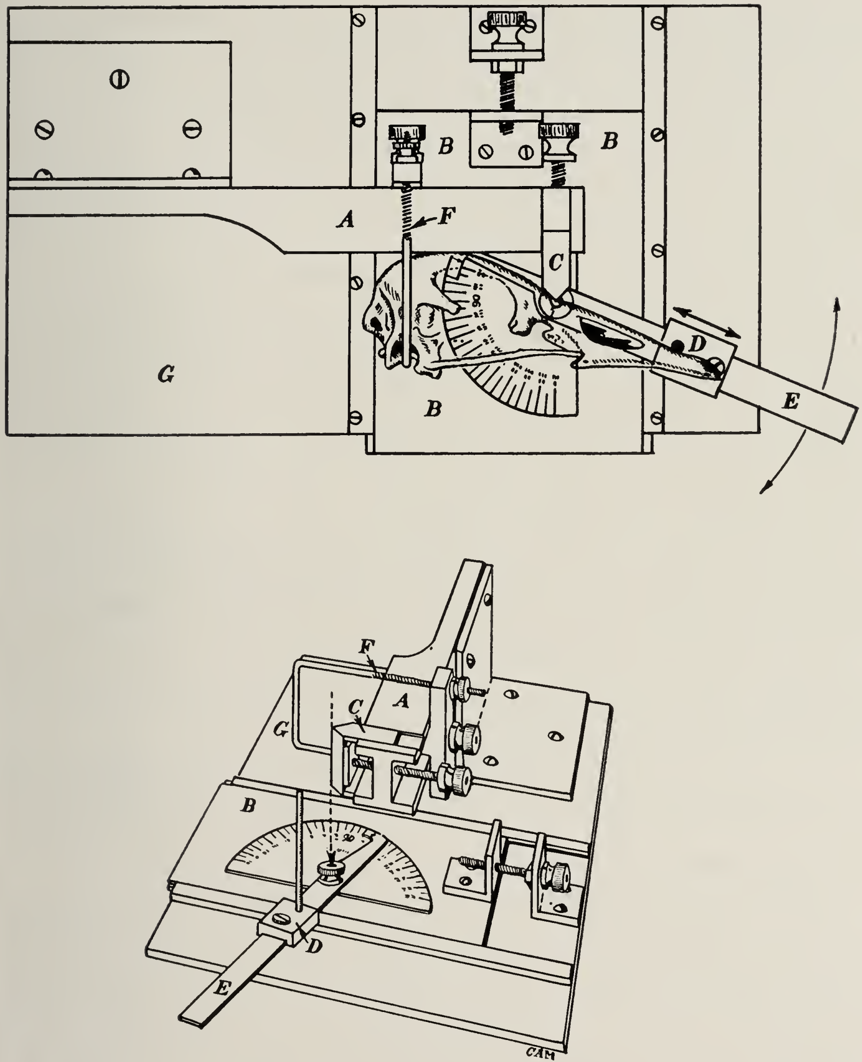

Fig. 1. An apparatus for measuring the kinetics in the frontonasal hinge of the avian skull. Upper figure: top view. Lower figure: oblique end view. See text for details of operation.

Beam A is elevated from base plate G by a wide L-bar. The part of beam A which is free of attachment to the L-bar has been machined into an I-beam. The purpose of the I-construction is to make possible the fixing of clamp F at any point along the length of beam A. It also provides a rest for the convex dorsal surface of the cranium. The edges of the I provide a sturdy contact for the curved cranial surfaces and eliminate dorso-ventral rocking.

The adjustable knife edge C is located at the free end of beam A. By means of a screw, threaded through the beam, the knife edge may be moved closer to or farther from the beam, accommodating high- or low-vaulted skulls. The base of the knife edge slides in grooves on the upper and lower surfaces of beam A, thereby maintaining the knife edge perpendicular to the axis of the beam. The knife blade is of a length that the entire width of the frontonasal hinge will rest on it. This eliminates dorso-ventral rocking and allows equal distribution of force at the pivot of the system.

The base of clamp F which fits into the posterior depression of the I-beam provides strong and uniform attachment to the beam. Both ends of the rod portion of the clamp are threaded and fitted with thumb nuts. The nuts are tightened for coarse adjustment of the sides of the clamp, but a set-screw threaded into the base of the clamp provides the fine adjustment. The set-screw draws the entire clamp tight against the I-beam.

A protractor of 180 degrees is soldered to a sheet of brass—the sliding protractor plae B. The protractor plate is held to base plate G and is guided in its movement, which is perpendicular to the axis of the beam, by grooved guide bars attached to the base plate. The exact movement of the protractor plate is accomplished by the set-screw shown at the top of the drawing. This adjustment is necessary to insure that the center point of the protractor is directly below the knife edge.

The protractor arm E is fitted with an adjustable vertical extension D. The vertical extension is clamped to the protractor arm. The extension arm may be moved along the length of the protractor arm to adapt for bills of different lengths.

Certain principles in the construction and use of this apparatus merit brief mention. Only two subjective aspects remain. The scale must be read and the hand must be used to manipulate the upper bill. The error in reading the scale is minor; the calibration is in full degrees and so is the reading. The force used to press the tip of the bill upward is a thumb or finger. This pressure might be considered an inconsistently variable feature, but several factors reduce the possible error. With repetition, the user becomes accustomed to the amounts of pressure to be used with the skulls of different species. Then too, in all the species we have thus far dissected, there are ligaments which limit upward motion in the bill. As the bill is pushed upward there is a sudden stop when the ligament is fully extended. We have found, in those forms possessing a basipterygoid process, that the movement between the articular surfaces of this process and of the pterygoid is limited to approximately one-half the length of the articular surfaces. That is, if the two surfaces are opposite each other when the upper bill is retracted, only half their lengths will be articulating when the ligament halts the movement. Thus, if this fact has been determined for a species, the skull prepared in the usual way for museums may be used. Pressure is exerted on the tip of the upper jaw until the articular surfaces are in the proper position.

A second important feature of the apparatus is its rigidity. All parts are firmly attached, and the bird's head or skull is clamped tightly. The frontonasal hinge, knife edge, and center of arc of protractor are strictly aligned. The clamp and the length of the knife edge prevent any rolling of the skull.

Deflection of the protractor results from pressure on the vertical, fixed arm. No subjective sighting from point to point is necessary.

Parts of the apparatus adjustable for heads and skulls of different sizes are as follows:

1. beam (A)—inserts with smaller grooves may be used for measuring small skulls.
2. knife edge (C).
3. clamp (F)—different lengths and shapes.
4. sliding protractor plate (B).
5. sliding vertical arm (D) on protractor arm (E).

Use of the Machine

1. Adjust the holding-rod of the clamp to grasp the skull immediately anterior to the opisthotic processes. In this position the skull may be held firmly without interference with movable bones.

2. Move the clamp and skull to make the knife edge and frontonasal hinge adjacent.

3. Adjust the knife edge so that when the frontonasal hinge contacts the knife edge the ventral edge of the skull is approximately parallel to the edge of the base plate.

4. Move the protractor center-point by moving plate B so that the center of the protractor arc is aligned with the knife edge. (The skull is tipped forward so that this alignment can be made.)

5. Move the frontonasal hinge into position against the knife edge and adjust the skull in the clamp by use of the set-screw. The correct seating of the skull in the I-beam should be checked; the final adjustment of the clamp must hold the skull tightly.

6. Move the vertical extension arm along the protractor arm so that the extension will conveniently meet the dorsal edge of the upper bill. Use of any point on the bill will produce the same angle, but we chose for the area of contact a point in the distal one-fourth of the bill length.

7. Move the protractor arm so that the vertical extension touches the dor-

sal surface of the bill. The number of degrees indicated on the protractor is the zero reading.

8. Force is applied with a thumb or finger on the ventral surface of the tip of the upper bill until resistance is met. When the orbito-pterygo-palatal ligament is in place, this point of resistance is very definite. A second reading of the protractor is made.

9. The final protractor reading minus the zero reading is the number of degrees that the upper bill has moved.

In the long series of skulls that have been measured in this and other unpublished work, it was found that sufficient accuracy could be obtained by holding the skull in place in the apparatus with a thumb on the basisphenoid plate and fingers grasping the I-beam. This elimination of the adjustment of the clamp permitted more speed in the use of the machine.

RELIABILITY

One of the most important features in the use of any apparatus is constancy in results obtained. That is, what is the error in continuous or discontinuous use when all factors are equal? To test this, one of us measured the kinetics in the head of one Canada Goose, *Branta canadensis interior*, on different days within a period of one month. The head was preserved in embalming fluid with ligaments intact, but the muscles were removed. The head was removed from the apparatus and replaced before each test. The data from this series follow:

Number of trials=66
Mean=17.7 ± .11 degrees
Standard deviation=0.86 degrees
Observed range=16—19 degrees
Theoretical range (M ± 3 standard deviations)=15.1—20.3 degrees
Coefficient of variation=4.9

This information indicates that the mean would lie between 17.4 and 18.0 in 99 of every 100 measurements, no matter how many tests were made. This would be an error of about 3.5% of the minimal mean or, calculated as a part of the observed mean, an error of less than 2% on either side of the observed mean. The error here is that of the machine and its single user.

For the apparatus to be of universal practicability the results should be duplicable by different workers. In a test of this, each of us, independently, measured the kinetics in the same head of a Canada Goose. The head was in the same state of preservation as the head in the first test. The head used in the first test was not used here because we thought there might be some loosening of articulations and stretching of ligaments with prolonged use of materials hardened in a preservative. The data of the second test follow:

	Observer 1	*Observer 2*
Number of trials	51	51
Mean in degrees	16.0±.16	15.5±.16
Standard deviation	1.17	1.16
Observed range	14–19	13–18
Theoretical range	12.5–19.5	12.0–19.0
Coefficient of variation	7.3	7.5

In each of these series the error on either side of the mean is about 3%. However, the important point here is that the variation between the means of the two series is only 3%. This indicates that different workers can use the machine and obtain comparable results.

SUMMARY

An apparatus was designed to measure the degree of movement (kinetics) in the frontonasal hinge of the avian skull. Several tests demonstrated that the device produced reliable and consistent figures when operated over a period of time by one observer or when used by two different workers.

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THE HAIRY WOODPECKER IN CENTRAL AMERICA

BY ALEXANDER F. SKUTCH

The Hairy Woodpecker (*Dendrocopos villosus*), familiar to nearly every observant person who frequents the woods and fields of temperate North America, is found in the highlands of the warmer parts of the continent as far south as western Panamá. The forms of the species that breed in the mountains of Central America are distinct from those resident farther north, yet all are so similar in plumage and voice that the naturalist who knows any race of the Hairy Woodpecker will at once greet a member of any other race as an old friend. Only after the first warmth of recognition has passed will he begin to think about the differences between the southern bird and its northern relatives. The Central American forms are smaller than the more boreal forms and have the under parts, and sometimes also the white central band along the back, more or less strongly tinged with brown.

In both Guatemala and Costa Rica Hairy Woodpeckers occupy a broad altitudinal belt extending from about 4,000 to at least 11,000 feet above sea-level. At the lowermost of the elevations mentioned they appear to occur only where the mountain slopes are exposed to the prevailing winds and hence unusually cool and humid for the altitude. In the valleys and on the more sheltered slopes they are rarely met lower than 6,000 feet. Near Vara Blanca, on the northern or windward slope of the Cordillera Central of Costa Rica, an excessively humid region exposed to the full sweep of the northeast trade-winds and subject to long-continued storms of wind-driven mist and rain, I found Hairy Woodpeckers abundant at 5,500 feet. Here they dwelt among heavy sub-tropical rain-forests where the towering trees were burdened with an amazing profusion of epiphytic plants of many kinds. These woodpeckers were found in company with Quetzals (*Pharomachrus mocino*), Blue-throated Toucanets (*Aulacorhynchus caeruleogularis*), Prong-billed Barbets (*Semnornis frantzii*), Black-faced Andean Solitaires (*Myadestes ralloides*), and Irazú Grosbeaks (*Pheucticus chrysopeplus*). They usually slept and nested in holes in decaying trees about the edges of the forest or in fire-killed stubs standing in recent clearings. At higher altitudes in Costa Rica Hairy Woodpeckers inhabit heavy forest dominated by huge oaks, and higher still they live amidst the stunted trees near timberline.

In the Guatemalan highlands Hairy Woodpeckers are at home in woodlands of oak and other broad-leafed trees, or among forests composed largely of pine, as well as in the remnants of the magnificent stands of cypress on the high mountain tops. On the plateau of the Sierra Cuchumatanes in the Department of Huehuetenango, I found them on the lightly wooded ridges that rose above the level alpine meadows. Here they were greatly interested in the pine trees, which at the time of my visit in September, 1934, had been killed in large numbers by some sort of blight. In the neighborhood of 11,000 feet above sea-level they were far less in evidence than were the Guatemalan Flickers (*Colaptes cafer mexicanoides*).

As to the Hairy Woodpecker's way of earning a living, there is little to be written about the southernmost representatives of the species that has not been said a dozen times over for the northern races. They are everywhere the same industrious peckers into dead and dying trees. In Guatemala I watched a female tearing apart old pine cones in search of insect larvae that lurked beneath the scales. There at the higher altitudes the Hairy Woodpeckers roam about the woodlands in the motley flocks of resident and wintering wood warblers, vireos, flycatchers, and other small birds. For some months after the young become independent of parental care, each woodpecker appears to avoid the company of others of its kind, and it is rare to find more than one of them in a flock of other birds. By late November or December, however, they have mated and travel in pairs, either in the mixed flocks or without the company of birds of other kinds.

In voice, too, the Hairy Woodpeckers of Central America resemble their northern relatives. Their most common utterances are a sharp *bip*; a longer, fuller, stronger *beep*; and a rapidly-given, high and clear *bic-bic-bic-bic-bic*— a variant of the picarian rolled note or *churr*. Both males and females beat rapid, rolling tattoos upon resounding dead wood. At Vara Blanca I first heard this drumming about the middle of February.

Sleeping Habits

At Vara Blanca I found ten dormitories of Hairy Woodpeckers. These woodpeckers invariably slept alone; but in August two females, probably young birds, occupied lodgings only ten feet apart in the same low stub in a pasture. The doorway of the lower was only as high as my head. From early August until the following February or March, another female slept fifteen feet up in a rustic post that supported a telegraph wire beside a muddy mountain road. Tame and confident, she was not frightened from her low dormitory by travellers passing before her doorway. Her tenancy of over six months was terminated only by the fall of the decayed pole. Other Hairy Woodpeckers that slept in low holes were equally fearless, and would at times enter while I stood watching at a distance of only three or four paces. Indeed, in these mountain fastnesses still scarcely invaded by man, the birds as a whole were easier to approach and to watch than I have ever found them elsewhere.

A male Hairy Woodpecker occupied the same hole in a high stub at the forest's edge from September until at least the end of the following January;

in February the stub fell. Although I found seven dormitories of female Hairy Woodpeckers and only three of males, the two newest cavities were occupied by males; and the only hole that I actually saw being made, before the start of preparations for egg-laying, was carved out and used for sleeping by a male. Some of the chambers in which the females roosted were very old and dilapidated, with chinks in the walls. The males of the Red-crowned Woodpecker (*Centurus rubricapillus*) also carve holes for sleeping at seasons when I have not known the females to interest themselves in this activity, and they sleep habitually in dormitories sounder than those occupied by the females. Like other members of the family, these Hairy Woodpeckers retired early, especially on rainy evenings, and became active late in the morning.

SETTLEMENT OF DISPUTES

Most kinds of woodpeckers are 'territorial' birds, and it is rare to find two nests of the same species in sight of each other. But as a rule the boundaries between territories are agreed upon by methods that elude the bird-watcher. Once, however, I witnessed a dispute between two male Hairy Woodpeckers, which apparently were endeavoring to settle some difference over boundaries or conflicting claims to land. The scene of this debate on April 18, 1938, was the pasture below the cottage which I occupied at Vara Blanca. Here there were a number of dead trunks close together, and fallen dead branches, portions of which rose above the herbage that covered the ground. The two antagonists clung to a thick branch, or to the side of a trunk near its base, a foot or two apart, and thrust forward their heads until body, neck, head, and bill all lay very nearly in a straight line. In this posture they twitched their bodies rapidly up, down, and sideways, a performance which they continued together for a few seconds; and when one ceased the other did likewise.

Then they would prance about, or come as near to prancing as is possible on a surface that is vertical or almost so, both at the same time, for a period of several seconds. Next, perhaps, one would fly over the other and cling to the trunk an equal distance on the other side of his opponent; and, with the relative positions of the actors reversed, the play would proceed much as before. After a while, tiring of these antics, the two woodpeckers would rest for a minute or two, only a foot or two apart. Then one of the twain would fly to a nearby trunk or branch, and soon the other would follow. As the second came near the first, the latter would sometimes spread his wings in a defensive attitude, prettily displaying the black and white bars on the lower surfaces. Here on this new stage the play continued in the same fashion. Only rarely did one bird actually come into contact with the other as the two pranced about and flew over each other; and then they barely touched, in the lightest and most inoffensive manner.

Thus the mimic warfare moved from one trunk or branch to another, then back again to the first, always keeping near the ground and rarely rising so much as ten feet above it. Perfect silence was preserved by the contestants, who seemed quite oblivious of my watching so close to them. For nearly an hour this elaborate play continued, with alternate periods of activity and motionless repose, while the two protagonists clung possibly a foot apart in amicable truce. Surely, two opponents who rested so quietly almost within each other's reach could not have been bitter enemies! At last they wearied of this monotonous game and went off to attend to other business. Like so many of the conflicts of birds, theirs had been of a purely formal nature, and was not attended by the loss of so much as a single feather on either side.

Nest-Building

Above Tecpán in the Guatemalan highlands, at an altitude of nearly 9,000 feet, I found the members of a pair of Hairy Woodpeckers working alternately at a newly begun hole, evidently destined to contain eggs. This occurred on February 7, 1933, at the height of the dry season. On March 21, in the same locality, I discovered another hole which apparently already held nestlings. At Vara Blanca, Costa Rica, the first preparations for nesting were noted on March 3, 1938, when I watched a pair just beginning to carve a hole. This was never completed, possibly because they found the wood too hard toward the center of the trunk; but a neighboring pair was incubating by March 28. This was at the driest time of the year in an excessively rainy region which had no real dry season. The Hairy Woodpeckers in both Guatemala and Costa Rica nest earlier than the majority of the birds which surround them, although not so early in the year as some other woodpeckers.

The seven nest cavities that I have seen in Central America were in dead trunks or posts, either in the woodland or in clearings not far beyond it. In height they ranged from 11 to about 60 feet above the ground. The lowest was in a telegraph pole beside a mountain road—not the one in which the female slept but in the same line. Another was about 15 feet up in a dead stub in a pasture; the highest, at 60 feet, was also in a dead tree in a pasture.

Male and female work alternately at carving out the nest-cavity. Sometimes each continues the task rather steadily for 25 or 30 minutes, but often the period of labor is considerably shorter. When the mate arrives to take over the chiselling, the one which has been at work flies promptly away to forage at a distance, instead of lingering close by while the other works, in the manner of trogons, puffbirds, jacamars, barbets, and motmots. One pair which I watched carving a hole in April, to replace another they had lost, dawdled at their task through the early morning, but at about ten o'clock set to in earnest and continued until noon. Another pair also toiled hard through the middle of the day. The loosened chips were always dropped to the ground beneath the doorway, never carried away This orifice is from 1⅜ to 1½ inches in diameter.

INCUBATION

Upon its completion, one of the two Hairy Woodpecker nests accessible to me was stolen from the woodpeckers by a pair of Blue-throated Toucanets. After enlarging the doorway, the toucanets began nesting in this cavity. The other woodpecker nest within reach of a ladder (11 feet up in the telegraph pole), contained three white eggs when found on April 16. This is the only Hairy Woodpecker's set from Central America of which I have knowledge. During the day male and female incubated alternately; by night the male alone occupied the nest. One morning at dawn I saw the female come to replace her mate on the eggs; but he, not caring to leave so early, repulsed her with pecks from the doorway. He lingered in the nest for 34 minutes longer, or until 6:14 a.m. when, hearing the female call *bip* in a neighboring tree, he flew forth. Seven minutes later she entered to incubate.

THE YOUNG

In the nest in the telegraph pole only a single egg hatched, on April 24. The pieces of empty shell remained at least two days in the nest. The nestling was perfectly naked and had tightly closed eyes. Like other woodpeckers, it bore at each corner of the mouth a prominent white knob, the pair of which apparently help to guide the parents when delivering food in the dimly lighted cavity. The little one was fed by both parents with food carried in the bill, from which at times parts of insects projected and were easily seen. Both took turns at brooding the nestling during the day, but the male alone kept it company through the night. When the nestling was six days old its pin feathers began to sprout. At the age of 17 days it was partly feathered and already displayed a patch of red on the head. When three weeks of age it was well clothed with plumage and rather closely resembled its father.

By his tenth day the young woodpecker had become quite vociferous and cried much in a high-pitched voice when a parent visited his nest. By the time he was feathered he delivered with rapid repetitions a sharp, clear, metallic note, and also uttered the churred call of the adults. When 26 days old he began to look out through the doorway and call for food with a sharp *bip* or a rapid series of such notes, only slightly weaker than the corresponding notes of the adults. The parents now passed food to him while they clung outside. Except at meal-time, he was now less noisy than he had been a few days earlier. Both parents removed the droppings and kept the nest perfectly clean for at least 17 days after the nestling hatched. But about the time the youngster became clothed with feathers they relaxed their attention to the sanitation of the nest, which rapidly became foul on the bottom. Before the young woodpecker departed, the waste matter had accumulated to a depth almost sufficient to bury an unhatched egg that still remained in the nest.

This young Hairy Woodpecker flew from the nest on May 22, at the age of 28 days. While I watched that afternoon, his father from old habit came to the post with a long larva dangling from his bill. Not finding the youngster at home, he called and, receiving an answer from the neighboring thicket, flew off in that direction with the food. Neither the father nor the fledgling came that evening to sleep in the nest-cavity, which thenceforth remained deserted.

From the nest 60 feet up in the tall dead trunk standing in the pasture, I watched the last fledgling, a male, make his exit at eleven o'clock on May 8. He flew very well and descended to a small yos tree that stood down the slope from the nest. Here he climbed about and pecked at the bark just as though he had been long accustomed to these activities. Both he and his brother wore red patches on the head, brighter than those of their father, whose plumage was worn. (Although both youngsters were apparently males, the tendency of young woodpeckers of both sexes to resemble the adult male rather than the adult female, casts some doubt upon this point.) Later that afternoon I found the family, consisting of the parents and these two fledglings, at the edge of the woods about a hundred yards from the nest. Because of the low cloud-mist and the drizzle that fell from it, I could see little of them; and it was hopeless to try to follow their movements. But I watched the empty nest. At six o'clock the father flew up alone and entered it. The youngsters apparently remained out in the rain, which was now falling steadily.

Late in the afternoon of the third day after these young woodpeckers left the nest, I again found them with their parents on a dead trunk near the nest-tree. The youngsters hammered at the decaying wood and picked up particles which apparently were not good to eat, for they were dropped. But at least they already tried to find food for themselves, only three days after sallying from the nest. They flew back and forth between the trunks with surprising speed. I decided to try once more to learn where they passed the night.

At 5:45 p.m., when the sky was dark with clouds and a drizzle fell, the mother of the family entered a hole in the top of a living guarumo (*Cecropia*) tree. These trees have slender trunks with a wide central hollow, often inhabited by ants; and although I had often seen woodpecker holes in both living and dead trees of this genus, I had never before known any use to be made of them by the woodpeckers. They are apparently rarely if ever occupied as nests, but this Hairy Woodpecker showed me that they sometimes serve as dormitories.

Then the father vanished, evidently to sleep in the nest-cavity, as he had done three nights earlier; but this opened on the side of the trunk facing away from me and I could not see him enter. The two fledglings continued to climb over the trunks in the slow rain and the waning light. Although there were numerous old and unoccupied holes made by woodpeckers and barbets in these trunks, one of them in the guarumo tree directly below that into which the mother had retired, the youngsters took no notice of them. I lost sight of one of the young woodpeckers while keeping my eyes upon the other. As the light failed, he ascended to the top of a tall tree and climbed restlessly over its branches, pecking here and there, and taking special interest in a shallow hollow in the midst of a small cushion of moss. Still, he did not sleep in this. At length he settled down, clinging upright to an upright bough, just beneath a horizontal branch that grew out from it. These branches were themselves thin, but the moss that enveloped them afforded the young woodpecker a degree of shelter from the raindrops that fell vertically. But he was unprotected on three sides and exposed to all the winds that blew that stormy night. Meanwhile his parents slept not far off in their snug quarters. They showed exactly the same indifference as to how their youngsters passed the night that I had found earlier in Red-crowned Woodpeckers. What a contrast between this neglect and the careful attention which Golden-naped Woodpeckers (*Tripsurus chrysauchen;* see Skutch, 1948. *Auk*, 65:225–260) and Olivaceous Piculets (*Picumnus olivaceus;* Skutch, 1948. *Ibis,* 90:433–449) give to their fledglings' comfort for the night!

SUMMARY

The Hairy Woodpecker is resident in the highlands of Central America, chiefly between 4,000 and 11,000 feet above sea-level. In the Guatemalan mountains a single woodpecker is often to be found in a mixed flock of small birds in the late summer and autumn, but before the end of the year these woodpeckers have mated and travel in pairs.

Ten dormitory holes were found in Costa Rica. Adults, except males attending nestlings, always slept alone. Some of the females occupied chambers which were very old and dilapidated. The males used newer holes, and the only sleeping cavity actually found under construction was the work of a male.

A dispute between two males was settled by much displaying and posturing but no actual fighting.

In February or early March the woodpeckers begin to prepare their nest chambers, which are carved by both sexes working alternately. One hole was no sooner finished than a pair of Blue-throated Toucanets took it from the woodpeckers.

Laying begins about March, and one set of three eggs was examined. Male and female alternate incubating the eggs by day but the male alone attends them through the night. He also broods the nestlings by night.

Both parents feed the nestlings on insects and larvae brought in the bill rather than regurgitated as with some other woodpeckers. For the first 17 days or more one nest cavity was kept perfectly clean, both parents carrying away the droppings. But after the nestling was feathered, the sanitation of this nest was neglected.

A lone nestling flew from the nest when 28 days old. Neither this bird nor a parent returned to sleep in the low nest cavity. After two other young woodpeckers left a very high nest, the father returned to roost in this cavity; the mother retired at nightfall into a neighboring hole, but the youngsters were left out in the rain.

San Isidro del General, Costa Rica, May 5, 1954

COMMENTS ON SOME RECENT STUDIES OF SONG BIRD PHYLOGENY

BY ERNST MAYR

THE classification of the families and orders of birds, particularly that of the song birds, was until recently one of the most neglected branches of ornithology. For fifty or seventy years little progress had been made in this field except for the occasional reassignment of a doubtful genus or for a reshuffling of the sequence of families. In recent years a newly awakened interest in bird anatomy has led to studies which have resulted in a number of stimulating publications. Two of these have been selected for discussion here. A critical evaluation of the methods and principles underlying such studies is urgently needed in order to point out potential pitfalls to other investigators engaged in similar work.

TORDOFF'S STUDIES OF THE BONY PALATE

The objective of Tordoff's (1954*a*) study is specific and his method straightforward. It starts from the well-known work of Sushkin, who divided the finches into a number of subfamilies (Cardinalinae, Emberizinae, Carduelinae, etc.), each diagnosed by characters of the horny and bony palates. Tordoff attempts to ascertain whether these subdivisions are well founded, whether some of them are more closely related to each other than to others (in fact, whether "the finches" are a natural group), which other families are closely related to the finch group, and where some of the genera that have not previously been assigned to any of the subfamilies belong. To answer these questions he studied the bony palate in representatives of about 175 genera of finches and related families. The number of differences in the palate which are not largely determined by functional needs is small. The principal object of such a study, in fact, is to find out which of the similarities are functional adaptations and which are due to common descent. As far as the palates of finches are concerned, Tordoff decides that the presence or absence of palato-maxillaries is the most crucial character, in conjunction with the conformation of the pre-palatine bars. On the basis of these characters, Tordoff concludes that the finches consist of two unrelated assemblages, the carduelines (goldfinches, purple finches, etc.) on the one hand, and all the remaining ones (true finches, buntings, cardinals, etc.) on the other. (The term "bunting" throughout this discussion refers to any emberizine finch, including the American "sparrows," towhees, and juncos. The members of the genus *Passerina*, called buntings in America, belong to the subfamily of cardinals.)

Tordoff presents good evidence to indicate that the Carduelinae are related to the weaver finches (Estrildinae). By a happy coincidence, Prof. H. Steiner of Zürich was working concurrently on a similar problem. He reached the same conclusion independently on the basis of a study of the Estrildinae (work presented at the International Ornithological Congress at Basel in June, 1954). Steiner showed that the "Ploceidae" of textbooks are, like the finches and as suspected previously by Chapin, an artificial group, consisting of true weavers and the unrelated weaver finches. Tordoff and Steiner find that the association of Carduelinae and Estrildinae is supported not only by anatomical, but also by life-history data.

Tordoff finds characters of the bony palate of the chaffinch genus *Fringilla* which seem to him to justify its exclusion from the cardueline complex and its association with the Emberizinae. This taxonomic disposition of *Fringilla* is not entirely satisfactory. There is in the chaffinch a cardueline resemblance in plumage coloration and bill structure, in the gape color of nestlings (similar to that in *Coccothraustes*), and in nest structure (finely woven). *Fringilla* also differs from the usual emberizine pattern in the color of the eggs. Sushkin (1925:256) believed that the characters of horny and bony palates indicated relationship of the chaffinch with the Carduelinae. It would seem far better not to combine *Fringilla* with the buntings but to retain for this genus a separate subfamily. Tordoff is right in keeping it separate from the carduelines, from which it differs not only in the stated osteological characters but also in the apparent absence of a crop.

Tordoff's findings concerning the cardinals, buntings (as defined above), and tanagers are as follows: No sharp line can be drawn between emberizids and tanagers, as far as skull structure is concerned. This parallels the findings of the bird skin taxonomist, who had long been in doubt as to where to place certain genera. By drawing an arbitrary line between genera with free and those with fused palato-maxillaries, a sharp separation can be made between cardinals and buntings. Yet this forces one to assign quite a few genera to a different subfamily from that in which they had been placed on the basis of plumage characteristics. Regardless of possible shifts of genera on the basis of other characters, the essential fact of the very close relationship of the New World finches and the tanagers is well established. (Tordoff found no characters which would justify separating Darwin's finches from the subfamily of buntings.) It is likewise clear that the Icteridae, Parulidae, and Vireonidae belong to the same general assemblage of families.

What is still in doubt is the direction of evolution. At first sight it would seem simplest to accept as ancestral a type with an unspecialized bill (such as that found in certain tanagers and vireos) and to derive from it the two specialized finch types (cardinals and buntings), as well as the various more extremely specialized insectivorous and nectar-feeding types. This solution is rejected by Tordoff because it would require the repeated independent origin of fully-developed, functional palato-maxillaries, as well as an explanation for the occurrence of fused palato-maxillaries in groups where they seem to have, at present, no functional significance. As a consequence, Tordoff postulates that some cardinal-like finches were the ancestors of all New World nine-primaried song birds (including icterids, vireos, wood warblers and honey-creepers), which subsequently lost free palato-maxillaries. This is a tenable hypothesis, and yet it raises so many awkward phylogenetic problems that one should keep an open mind concerning an alternative hypothesis. The fact that many thick-billed seed-eaters (Ploceidae, Carduelinae) lack the palato-maxillaries indicates that such a structure is not a functional necessity and develops only where there is a predisposition for it. Perhaps this potentiality has an embryological cause (a separate ossification center?). The textbooks of comparative anatomy and paleontology list literally hundreds of instances where a potentiality in a group is realized independently a number of times. This does not constitute polyphyletic origin because the character is in each case produced by essentially the same gene complex. Perhaps the fused palato-maxillaries condition is a rudimentary trait and not an indication of obsolescence. It is difficult, in the absence of fossils, to decide which way to read such a morphological series. The rich development of insects during the Cretaceous makes it hard to believe that the principal insect-eating birds of North America would have evolved so late, and as descendants of finches, at that!

Tordoff's study is an important contribution to our knowledge of the structure and relationships of passerine birds. The evidence is clearly presented throughout, and where it causes difficulties, this is not glossed over, but discussed in detail. The 77 drawings of bony palates permit a rapid check of the characteristics discussed, even if one does not have access to specimens. It is improbable that the author's modest warning will prove justified: "Further studies of structures other than the bony palate may show that many conclusions expressed here must be modified." Rather, it seems that Tordoff's essential conclusions are sound and will be substantiated further.

Beecher's Studies of Jaw Musculature

Far more ambitious than Tordoff's investigation of the bony palate of finches is Beecher's work of the past several years, devoted primarily to the arrangement of the jaw muscles of birds. It has resulted in the publication of a series of papers culminating in a new phylogeny of the song birds (Beecher, 1953). Beecher's concepts of the phylogeny and classification of the song birds differ so drastically from previous theories and arrangements that a critical analysis of his findings and interpretations seems to be in order. This has already been done in part by Tordoff (1954*b*), with particular reference to Beecher's conclusions regarding the New World nine-primaried oscines. Yet, in view of the growing interest in bird anatomy, I feel that there is need for a broader evaluation and, in particular, an *analysis of the principles* by which Beecher has interpreted his findings.

The broad basis and the importance of Beecher's work is indicated by the fact that he dissected the jaw muscles of nearly one thousand specimens belonging to more than six hundred species. On the strength of his anatomical findings he suggests a new placement for many genera, subfamilies, and families, leading in many instances to a considerable improvement of avian classification. His argument (1951*b*) that the Coerebidae are a polyphyletic group consisting of superficially similar flower-visiting wood warblers and tanagers seems convincing and is consistent with the plumage characters and palatal structure of the respective genera. Worthy of special attention are his suggestions (1953:281) of placing *Oxylabes*, *Prunella*, *Thamnornis*, and *Zeledonia* with the Saxicolinae, the Mimidae near the thrushes (p. 282) rather than the wrens, *Tylas* and *Hypositta* with the Vangidae (p. 298) and the Vangidae near the Prionopidae (p. 298), while separating the monarch flycatchers (Monarchinae) from the true flycatchers (Muscicapinae).

Especially valuable features of Beecher's studies are the utilization of a new set of characters (the jaw muscles) and his presentation of numerous semidiagrammatic drawings which permit other workers to make their own interpretations of his data. (It is difficult to evaluate how diagrammatic these drawings are. Some of the jaw muscles are interlaced in a rather intricate manner, and in some of my own dissections I have been unable to establish the clear patterns shown in Beecher's diagrams. This may be due to lack of aptitude on my part.)

It is possible, if not probable, that interpretations very different from those of Beecher might be made. Indeed, the past history of phylogenetic researches reveals how often different authors have come to diametrically opposite conclusions on the basis of the same evidence. Evidently, this field is full of intellectual pitfalls. Before accepting Beecher's drastic proposals, let us first see on what assumptions they are founded. Although most of these are only tacit in Beecher's publications, they so clearly underlie his reasoning and interpretations that it does not seem unfair to clarify the discussion by stating them succinctly.

ASSUMPTION 1.—*An established morphological series equals a phylogenetic* *series; simple structures are primitive, and more complex structures are derived from them secondarily; morphological trends are irreversible.*

This tripartite assumption applied to the jaw muscles of song birds leads Beecher to the following conclusions: Since the parallel-fiber type of muscle (with a terminal attachment of tendons) is morphologically simpler than the pinnate type in which fibers are attached laterally to a longitudinal central tendon, the higher the proportion of parallel-type jaw muscles, the more primitive the species. Therefore, the families of song birds can be arranged in a series or several series according to the increasing proportion of pinnate jaw muscles. This morphological series equals a phylogenetic series. Beecher's entire new arrangement of the song birds rests essentially on this basis.

I believe that this basic assumption, as well as the taxonomic conclusions drawn from it, are wrong. In groups like the mammals and the reptiles, in which there is good fossil material available, it has been shown again and again that a morphological series is not necessarily a phylogenetic series. In fact it is of almost regular occurrence that a structure begins in a simple condition, becomes complex later in its evolution, but is eventually again simplified. The more important a structure is functionally, the more plastic it will be in evolution.

Specifically, there is no evidence whatsoever that a high proportion of parallel jaw muscles is an indication that a given genus of song birds is primitive.

Unfortunately not much is known about the relative frequency of parallel (longitudinal) and pinnate jaw muscles among the lower vertebrates or in the older orders of birds, but this much is certain, that pinnate muscles are an ancient invention. They occur where heavy traction is needed between two bones that are in close proximity. Thus they have a clear functional significance. Since functional characters, especially those connected with feeding habits, are known in many instances to have reversed the direction of their evolution, it is highly presumptive that the development of jaw muscles in birds has also done so at times. It is highly probable that many of the ancestral song birds fed on a mixed diet and had a generalized equipment of parallel and pinnate jaw muscles, and that from this primitive condition there have been various specializations either in the direction of more parallel muscles or toward more pinnate muscles and probably back again in many cases. If this is true, then a modern pattern of jaw musculature consisting almost exclusively of parallel muscles is as specialized as the reverse. It might be added, incidentally, that it is quite impossible to draw a sharp line between parallel and pinnate muscles—intermediate stages occur frequently.

Beecher seems to have been influenced in his reasoning by "Dollo's Law" of the irreversibility of evolution. Although this law is valid as far as the broad history of the earth is concerned, it is by no means always true when single organs or evolutionary trends are concerned. Indeed, evolution often is reversible, particularly when strong selection pressures exist and genetic systems are essentially the same, as in close relatives. (For a discussion and further references, see Huxley, 1942:501–503 and Simpson, 1953:310–312.) The application of "Dollo's Law" to such a plastic structure as the jaw muscles within such a closely knit assemblage as the song birds is certainly misleading.

Assumption 2.—*The pattern of jaw muscles is constant within a given family; function does not vitally affect muscle pattern; similarity of muscle pattern therefore proves close relationship.*

Beecher is aware of potential objections to this assumption and cites therefore the family Icteridae, with its varied feeding habits. He dissected all of the more divergent genera without finding any major deviation from the basic pattern of the jaw muscles (Beecher 1951*a*). Yet, this point is not convincing. To begin with, the bills of the Icteridae are not sufficiently different in form and function to prove that adaptive radiation could not induce shifts in muscle pattern within a family. Indeed, if Tordoff (1954*a*) is right in stating that the Dickcissel (*Spiza*) is a cardinal, rather than an icterid as demanded by the muscle pattern, the basic premise is weakened considerably.

Furthermore, every student of the higher categories knows that a given character may be highly constant in one group and highly variable in another. Perhaps the muscle pattern is relatively constant among members of the Icteridae, but quite variable within the other families? Beecher himself cites abundant evidence to prove that this is indeed the case. He proposes (1953:278): "A major phylogenetic division of oscinine families . . . largely on the basis of the parallel or pinnate character of adductor slip *M7b* [*M. adductor mandibulae externus medialis*]." Yet, scattered through his account are numerous examples of variation in this muscle, as well as in "*M7a*" (*externus superficialis*), within a single family. For instance, in 25 per cent (two out of eight) of the vireos, *M7b* is not parallel, in spite of the fact that the functional difference is very slight; *M7b* is parallel in *Motacilla citreola* but pinnate in the remaining motacillids; it is usually pinnate in the wood warblers (Parulidae) but is parallel in the broad-billed genera *Setophaga*, *Myioborus*, and *Basileuterus*. These do not appear to be the most primitive genera of wood warblers, Beecher's assertion to the contrary notwithstanding! In the family group diagnosed (p. 278) as having a pinnate *M7b* are several families, such an tanagers, cardinals, and Carduelinae in which it is stated in the text: "*M7* (not *M7b*) pinnate." The muscle pattern is highly diverse in the Honey-eaters (Meliphagidae, p. 301) and the Hawaiian Honeycreepers (Drepaniidae, p. 312), so that these families surely would have to be broken up if muscle patterns were decisive. Tanagers and carduele line finches intergrade imperceptibly in their muscle patterns, but are not closely related on the basis of other criteria. Here, obviously, parallelism is involved, as also in the case of the finch-like Drepaniidae with their extraordinary resemblance to carduelines. The embarrassing frequency of a parallel *M7b* in groups that "should" have it pinnate induces Beecher to say with respect to the wren-creeper-titmouse assemblage (p. 315): "*M7b* might be considered parallel but not in the same sense as in Sylvioidea." In what sense then, one might ask (since Beecher's attempt at an answer in subsequent sentences is no solution)?

A close study of the variation in these muscles shows how closely they are correlated with function. One can establish quite a consistent functional series from the weak-billed insect-eaters through the stronger-billed shrike-flycatchers and shrikes to nectar-, fruit-, and seed-adapted or omnivorous groups. These latter "are in every way more complex, with increased pinnate musculature, stronger bills, more intricate palate relief, a tendency toward double ectethmoid foramina . . ." (Beecher, 1953:278). Only there is, contrary to Beecher's contention, no evidence that this functional-morphological series is a phylogenetic series. Beecher admits the artificiality of groups like "finches," "shrikes," and "flycatchers," based on the form of the external bill, but precisely the same criticism can be raised against the use of internal functional characters. Pinnate muscles are clearly correlated with powerful biting action and heavy jaws or other functional adaptations (nectar-feeders), in contrast to the largely parallel jaw muscles of the thin-billed groups. Even Beecher seems occasionally unable to escape the force of the evidence which shows that the jaw muscles, like all other functional characters associated with food intake, may be subject to rapid evolutionary changes and convergences, hence to polyphyletic groupings. He admits for certain slender-billed babblers (Timaliidae) that (p. 313) "in them the pinnate character of *M7b* has virtually disappeared as it has in many honey-eaters and in the true wrens."

ASSUMPTION 3.—*A valid phylogeny and classification of the oscines can be erected on the basis of a single character, the pattern of variation of the jaw muscles.*

In spite of his protestations to the contrary, Beecher (1953:276) cannot escape the fact that he has built the imposing structure of a new phylogeny of higher passerine birds essentially on a single character, namely on a few variations in a set of seven jaw muscles. There is so little potential variation among the functionally possible patterns of these muscles that much similarity is quite inevitable. Other characters cited by Beecher, such as the sculpture of the horny palate, and the shape of the tongue and that of the bill, are functionally so closely correlated with each other, and with the jaw muscles, that they certainly cannot be regarded as four independent characters. From the point of view of selection pressure they are a single-character complex, even though some basic potentialities may not be affected (for example, bifid vs. trifid tongue).

Additional characters used by Beecher, such as the formation of the ectethmoid foramen and the shape of the lacrimals, do not seem to contribute much to our understanding of oscinine relationships beyond showing that some families differ from each other in these characters. The character of plumage coloration must be singled out for a more detailed discussion. In recent decades plumage characters have been found to be conservative in many birds, and it is quite in order for Beecher to utilize plumage patterns. In so doing, however, he makes questionable suggestions, for example (p. 284), that close relationship between swallows and starlings is corroborated by the fact that in both groups streaked plumage occurs in both immatures and adults, as well as iridescent black plumage in adults. The widespread occurrence of such patterns of plumage in other orders and in other passerine families clearly renders the character useless taxonomically. Equally questionable are the suggestions (p. 288) that the bare nape of bulbuls may be "associated with" the naked nape of certain birds of paradise and that the long nape "hairs" of bulbuls may be the forerunners of the specialized plumes of the paradiseids and hence endorse their relationship! Likewise Beecher's statement (p. 289) that the variable black and white plumage of the bulbul *Microscelis madagascariensis* suggests that of the Corvidae is not convincing.

It would seem advisable to use color pattern as a clue to relationship only when it can be evaluated carefully. A color character which is maintained without or against selection pressure, is highly valuable phylogenetically. For instance, the white spots in the tail feathers of the crag martins ("*Ptyonoprogne*") of Eurasia and Africa indicate their close relationship with *Hirundo*, an association which is also supported by voice and by nest structure. The sandy coloration of the desert-living *Ptyonoprogne*, however, is a character that has developed under high selection pressure and is of low phylogenetic value. A cryptic general coloration of sandy brown with a disruptive pattern of dark shaft streaks occurs in so many non-passerine and passerine families of grassland birds that it is obviously of no use as an indicator of relationship. Nevertheless this color pattern is used by Beecher to support his association of larks, pipits, and cisticolas (1953:314). White bellies, or black breast bands likewise are so widespread among birds that they are virtually useless as phylogenetic clues.

It has become almost axiomatic in modern taxonomy to accept that classification as the best which is based on the greatest number of characters. But quantity alone is not decisive. Such characters must also be weighed. It is often stated that taxonomy is an art. This is to some extent true. The art consists in the proper weighing of characters. The validity of many recent classifications has been greatly strengthened by the generous reference to habits and other biological characteristics. Unfortunately, even biological characters are not immune from convergence. This is evident from the occurrence of domed or pendant nests in many unrelated groups of birds or the "teetering" of spotted sandpipers and wagtails. Such characters are of value nevertheless when used in combination with others, particularly in order to place an ambiguous species or genus. They are of very dubious value when used to support the association of otherwise dissimilar families, such as the true wrens (Troglodytidae) and the Australian warblers (Malurinae) because both have the habit of "carrying the tail over the back" (Beecher, 1953:317).

ASSUMPTION 4.—*A phylogenetic tree can be devised on the basis of a morphological progression of contemporary families.*

This basic flaw in Beecher's philosophy of phylogeny has by implication already been exposed in part above (see Assumption 1). Tordoff (1954*b*) points out that it induces Beecher to push the origin of living families of birds, such as the vireos, back to the Cretaceous. At that, Beecher derives the vireos through the monarch flycatchers from the grass warblers, which therefore ought to be much older still!! Although specialized families often seem to have a higher evolutionary rate than more primitive ones, there is no evidence available that would favor Beecher's extreme interpretation. Indeed it seems improper to use the term phylogenetic tree for a morphological series as presented on his fig. 18 (p. 324). Phylogenies can be established only by unequivocal evidence from comparative anatomy or by fossil finds. It is much safer to use a neutral term, such as "dendrogram" (Mayr, Linsley, and Usinger, 1953:58), for a diagram of hypothetical descent based exclusively on the comparison of living forms. In view of the mounting evidence for frequent evolutionary reversal and convergences in adaptive characters, it is quite inadmissible to apply the term "phylogenetic tree" to a diagram that portrays merely morphological sequences.

This plea for caution should not be misunderstood by evolutionists. If one believes in evolution (and which biologist does not?), one is justified in proposing hypotheses concerning the probable relationships of families and genera, and concerning the probable characteristics of their common ancestors. However, one should at no point confuse fact with hypothesis. This is for two reasons particularly important with respect to birds, the almost complete lack of crucial connecting links in the fossil material that is so far available, and the anatomical uniformity of birds, particularly the song birds. The case is not quite hopeless, since morphological assignments have often been confirmed by ethological findings (such as the relationship of sandgrouse to pigeons, and penguins to tubinares). Yet it is advisable to exercise great caution and to weigh carefully the phylogenetic versus functional significance of each character.

My final criticism is raised on grounds of logic. As pointed out previously by Tordoff (1954*b*), Beecher frequently indulges in circular reasoning. One example relating to the age and distribution of the "stem" groups has already been discussed. An additional example follows: Beecher states that seed-eating song birds and shrikes (super-family Timalioidea) have a pinnate *M7b*. Seemingly this functional adaptation is associated with the food habits of shrikes and finches. Beecher then concludes (1953:278) that his sylvioid assemblage with parallel *M7b* was unable to develop shrikes or finches and that the ability of the timalioid groups to do so constitutes a major point of distinction between the two superfamilies. The logic of this is vulnerable, to say the least, since the arrangement of the fibers of *M7b* is Beecher's fundamental criterion of distinction between the two groups. He has made certain that no members of the Sylvioidea has a pinnate *M7b* by placing all groups in which this muscle is pinnate in the Timalioidea! He cannot justifiably argue then that the Sylvioidea lack the ability to evolve a pinnate *M7b* since the distinction is an artifact.

* * *

As a consequence of having made the various assumptions listed above, Beecher proposes a phylogeny of song birds which is unsatisfactory in many respects. There are numerous indications that Beecher has placed unrelated forms together merely because they have become specialized or de-specialized in a similar manner. Some of the instances, such as bringing together the tanagers and the cardueline finches or placing the Indigo Bunting and its relatives in the Emberizinae, have been criticized previously by Tordoff (1954*b*). I would like to cite some other proposals of Beecher's which to me seem highly dubious: The derivation of the larks from the Cisticolinae; placing *Hemipus* with the monarch flycatchers and *Tephrodornis* with the Prionopinae; associating the parrot-bills with the larks, while making the unsupported claim (p. 314) that "The parrot-bills are basically similar to larks and pipits in . . . bill"; wide separation of *Remiz* (p. 319) from the flowerpeckers; inclusion of *Rhipidura* with the monarch flycatchers, and deriving *Pachycephala* and the vireos from the monarchs; the separation of *Aegithalos* (p. 315) and *Aegithaliscus* (p. 319); the placing of Carduelinae and Estrildinae at opposite ends of the system (fig. 18); and the establishment of certain phylogenetic series, such as that of Monarchinae — Cisticolinae — Troglodytidae — Certhiidae — Sittidae — Paridae.

CONCLUSIONS

It is evident from the above discussion that Beecher's attempt to establish a new phylogeny of the oscinine birds, based primarily on the morphology of the jaw muscles, is not an unqualified success. He has shown numerous variations in the jaw muscles, many of them previously unknown, thus making a distinct contribution to descriptive avian anatomy. Yet, it seems to me that his basic contention, namely that the stated anatomical differences support the postulated phylogenetic sequence, remains unproven. Indeed, the close correlation established by Beecher between pattern of jaw muscles and habits suggests strongly that the specific development of these muscles is functionally conditioned. This does not deprive these muscles of all phylogenetic significance, because closely related genera will have a larger number of similar potentialities than will distantly related genera. Yet this evidence must be used with much caution.

The papers of Tordoff and of Beecher have shown that the song birds are not nearly so uniform anatomically as was formerly believed and that the study of previously neglected structures may shed new light on function and relationship. It is to be hoped that the newly awakened interest in bird anatomy and bird phylogeny will result in many other stimulating contributions. Let the students in this field, however, be aware of the great logical difficulties of the subject and of the many intellectual booby traps into which the unwary may stumble.

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Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, November 17, 1954

OBSERVATIONS ON THE SUMMER TANAGER IN NORTHEASTERN KANSAS

BY HENRY S. FITCH AND VIRGINIA R. FITCH

The Summer Tanager (*Piranga rubra*), a characteristic inhabitant of deciduous forests of the eastern United States, reaches its western limits in Kansas. The records for this state are concentrated near the eastern edge. Specimens in the University of Kansas Museum of Natural History were collected in Doniphan County (Geary, August 24), Wyandotte County (Bonner Springs, May 11), Douglas County (Lawrence, April, May, August and September), Miami County (Pigeon Lake, May 31), Labette County (10 mi. SW Oswego, July 6, 12 and 19), and Montgomery County (4 mi. N Caney, August 7 and 10). W. S. Long (unpublished thesis, Univ. Kansas Library, 1935) gives nesting records from Doniphan County and Kansas City. Nearly all these localities fall within the Deciduous Forest Formation as mapped by Braun (1950. "Deciduous Forests of Eastern North America"), and the others are closely adjacent to it.

On the University of Kansas Natural History Reservation, 5½ miles NNE Lawrence, this tanager is regularly present in summer as a breeding species. The earliest recorded dates for three different years were April 27, 1951, April 26, 1952, and April 28, 1953. These dates probably approximate the time of arrival and each year the tanagers were seen and heard frequently throughout the month of May.

Spatial Relations of Pairs

In May and June, 1952, singing males were recorded at seven well-separated locations on the 590-acre Reservation. In 1953 singing males were heard in six different locations, four of which corresponded well with the 1952 locations (see Fig. 1). Several pairs were seen repeatedly at about the same places. No encounters between members of different pairs ever were seen and the territories were so well spaced that, from the trees used as singing stations, songs of neighboring males never were audible. A minimum breeding population of at least six or seven pairs must have been present on the Reservation each year. Since some parts of the area were visited infrequently, and no systematic attempts at census were made, several additional pairs may have been present.

In every instance, pairs had their territories or headquarters in thick second-growth deciduous woods of elm (*Ulmus americana*), oaks (*Quercus Muehlenbergii, Q. velutina*) and hickory (mainly *Hicoria ovata*). However, the male of a pair that stayed near the Reservation buildings and another male seen and heard frequently did most of their singing in large honey locusts

(*Gleditsia triacanthos*) that were in fields near woodland edge. The woodland areas of more xeric aspect, notably south slopes dominated by such species as osage orange (*Maclura pomifera*), honey locust, and hackberry (*Celtis occidentalis*), were used little or not at all by the tanagers.

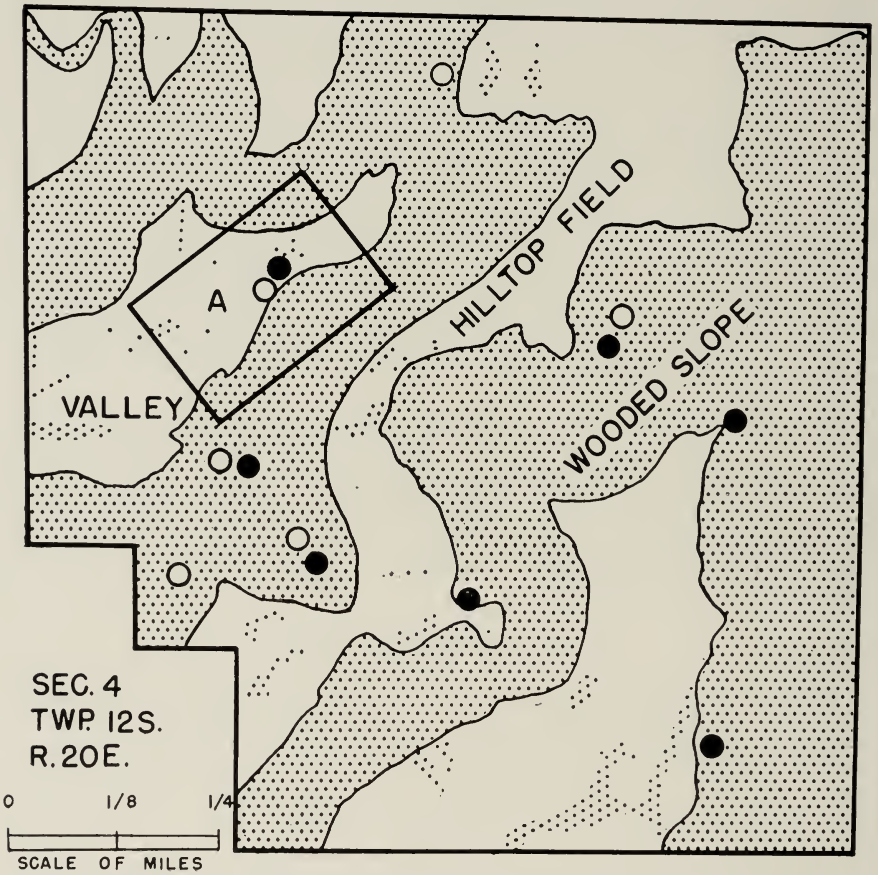


Fig. 1. Map of University of Kansas Natural History Reservation showing locations where pairs or singing males of summer tanagers were recorded in 1952 (solid circles), and in 1953 (open circles).

Pre-nesting Behavior

Tanagers tended to stay in tree canopies, where they were inconspicuous and were usually unnoticed except when the distinctive clicking notes or song called attention to them. They were less wary than most other passerines in this locality, however, and often permitted approach to within 30 to 40 feet.

They sometimes exhibited curiosity, and flew nearer, with tail and crown feathers elevated, uttering clicking notes.

In early May, members of pairs were seen together on many occasions. The clicking notes seem to serve to keep each member of a pair informed of the other's whereabouts. In 1952 and 1953 a pair made its headquarters near the residence building at the Reservation, facilitating observations. History of this pair evidently was similar for the two years, but our records are far more complete for 1953 (see Fig. 2). In that year singing was heard in the last three days of April and frequently in early May.

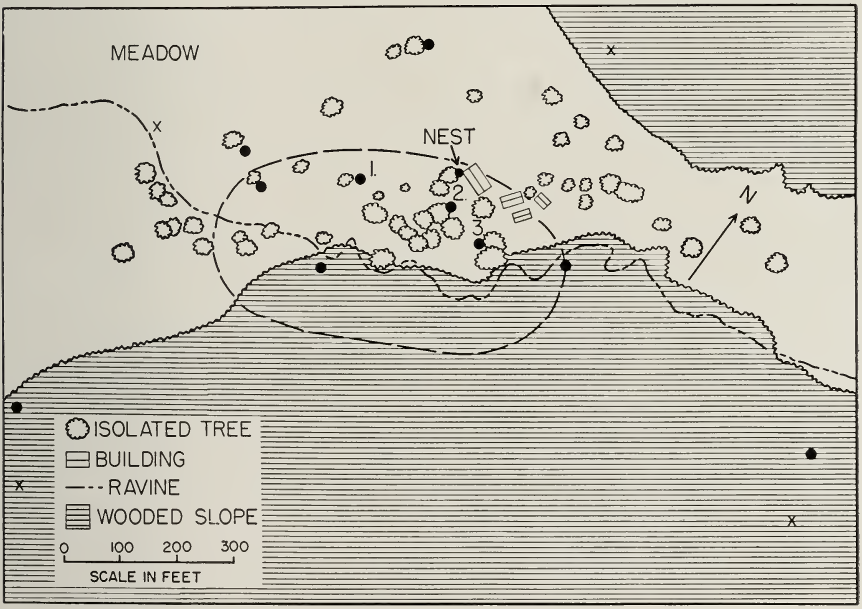


Fig. 2. Map of area shown in Fig. 1A, the area occupied by a nesting pair of summer tanagers in 1953. Dots show male's singing stations, with those most often used numbered in order of preference. Broken line encloses area within which the pair usually stayed. Outlying points occasionally visited by one or both members of the pair are shown by crosses, or by dots if singing male was recorded.

Throughout the season, frequent sudden and spirited pursuits of the female by the male were observed. The female, closely followed by the male, would fly rapidly and erratically, usually for a distance of several hundred feet. Often she was chased beyond the limits of the area to which that pair's activities usually were confined. Usually the course led into thick trees where the outcome could not be seen. Pursuits usually ended suddenly, the birds resuming their routine activities. On some occasions the male followed the female slowly from tree to tree, both uttering clicking calls.

NEST BUILDING

On the morning of May 11, the female was twice observed at a certain spot screened by thick foliage in the fork of an elm branch near one corner of the house. She was seen coming there again several times in the following week. On the afternoon of May 18, she was observed again, this time carrying stems to the nest site at this same place, in a horizontal crotch approximately 8½ feet above the ground. She was seen to fly to the ground nearby and find stems. On the morning of May 19, hasty inspection disclosed that as yet only a few stems had been deposited in the crotch. In the next few days additional material gradually was incorporated into the nest. On May 20, between 7:00 and 7:30 a.m., both members of the pairs made several trips to the nest. Only the female carried material. The male's function seemed to be to stand guard as she worked. Once when the female returned to the nest, a pair of Black-capped Chickadees (*Parus atricapillus*) were within a few feet of it and she drove them away by flying at them several times before depositing her load. Ordinarily she spent several minutes at the nest incorporating each load of material. From May 21 to 24, activity in building was greater than it had been previously, and the nest grew at a relatively rapid rate. Sometimes a round trip was made in as little as five minutes. The female ordinarily spent several minutes on the nest or beside it after her arrival with a load. At this stage she usually searched for nesting material along a ravine at the edge of the woods approximately 200 feet from the nest.

INCUBATION

On May 29 one egg was found in the nest, and on May 30 a second had been laid. On the morning of June 1, the clutch of four eggs was complete and the female had begun incubating. She permitted an observer to climb within four feet before she left. On June 5, at 9:00 a.m., the eggs were found to be uncovered. A few minutes later the female was heard nearby giving clicking notes and food calls, whereupon the male appeared and chased her several hundred feet south across the ravine and back again to the nest.

The eggs were observed daily during their incubation. On June 11 at 2:00 p.m. the female was sitting on the rim of the nest watching intently, while the male was perched a few feet away. Late in the afternoon we checked the eggs and found them all unhatched. On the following morning the male delivered food to the female as she sat on the nest. At 8:15 we checked the eggs and found that two had hatched. The third probably hatched later this same day, as it was found to have hatched on the following morning when the nest was next examined. Thus the incubation period was approximately eleven days. The fourth egg did not hatch, and it still remained in the nest when the young were fledged.

THE NEST

The nest was removed for study after the young were fledged. It was wedged in a 40° horizontal fork of the limb. Each branch was just under an inch in diameter. When removed from its support, the nest had a hole on one side which had been filled by the branch. The nest was 110 mm. outside and 75 mm. inside in greatest diameters, with minimum diameters of 83 mm. outside and 62 mm. inside. Depth was 35 mm. to the bottom of the bowl and 55 mm. to the bottom of the nest. The nest consisted of dried herbaceous vegetation of the previous year's crop and there were three main layers. The basal layer consisted chiefly of the panicles of white vervain (*Verbena urticifolia*). There were at least 41 of these, mostly 1 mm. to 1.5 mm. in greatest diameter and three to five inches long, each with several branches and with numerous minute protuberances where the inflorescences were based. These roughened and branched stems tended to adhere to each other and to the elm limb. Those deposited for the nest foundation were wedged into place adhering to the rough bark of the elm limb and providing a base for the support of additional material. A second layer, not entirely distinct from the basal layer and firmly woven into it, consisted of longer, more flexible stems of grasses, nearly all Japanese chess (*Bromus japonicus*), some with roots or empty seed heads, or both, still attached. These stems were mostly a little less than 1 mm. in diameter and up to two feet long, and 46 of them were counted. Material of the two outer layers was so tightly bound together that separate pieces were removed with difficulty and, as some breakage was unavoidable in the process of dismemberment, the exact number of units could not be determined. Binding material consisted chiefly of the shredded fibers of the stems themselves. Spider web had been included also, the tough, sticky strands of a large araneid, probably *Neoscona* sp. The web may have been gathered separately or may have been already attached to the stems. The inner layer lining the nest bowl was a mat of fine grass stems, mainly or entirely muhly grass (*Muhlenbergia Schreberi*) 0.5 mm. or less in diameter, and three to eight inches long. A total of 215 of these stems was counted. They were laid down in all directions and were woven and bound together much less tightly than the material of the outer layers. Material of the outer layer weighed 1.7 gm., that of the middle layer 1.8 gm., and that of the inner layer 2.7 gm.

CARE OF THE NESTLINGS

Both parents participated in feeding the young. A partial record of their activities on June 15 is recorded below.

9:29 a.m. Male delivered food to young.
9:30 Female delivered food and brooded briefly.
9:47 Male delivered food.
10:08 Female delivered food and brooded until 10:27.
10:30 Male delivered food and stayed at the nest for approximately one minute.
10:55 Both parents approached the nest and the male perched on a telephone wire fifty feet from it while the female delivered food and brooded.
4:06 p.m. Female delivered food and sat on edge of the nest until 4:20.
4:57 Male delivered food and stayed at nest until 4:59.

5:05 Male delivered food and left.
5:15 Female delivered food and left.
5:20 Male returned briefly to feed young.
5:27 Female delivered food.
5:47 Female came to nest and brooded until 5:54.

On June 16, a Red-bellied Woodpecker (*Centurus carolinus*) was seen several times in the tree near the nest, and was driven away at least once by the male tanager.

DEVELOPMENT OF THE NESTLINGS

At hatching the young were pink-skinned and well covered with buffy gray down. The edges of their bills were bright yellow. Their development was phenomenally rapid. Although attempts to measure these living young were not wholly satisfactory, the trend of growth is shown by the figures in Table 1. All measurements are to the nearest millimeter. For most of the samples, only one or two of the three young were measured, as it was deemed inadvisable to remove all from the nest simultaneously. The young were not recognized individually for several days after hatching, and the records on consecutive days may have been based on different nestlings which differed somewhat in their development. Deviations from the general trend of growth are due in part to this factor.

TABLE 1

GROWTH IN YOUNG SUMMER TANAGERS FROM HATCHING TO FLEDGING

Date	Number measured	Total length, mm.	Body length	Tarsus	Hind toe	Culmen	Gape	Weight, grams
June 12	1	—	24	8	5	7	9	4.2
June 13	1	42	—	8	6	7	13	5.2
June 14	2	52	30	11	7	6	14	8.7
June 15	2	56	34	13	9	8	13	11.4
June 16	—	—	—	—	—	—	—	—
June 17	2	74	44	19	11	10	14	17.3
June 18	2	79	45	19	11	10	14	17.1
June 19	3	87	46	19	12	11	13	17.3
June 20	2	93	48	19	13	11	14	17.8
June 21	—	—	—	—	—	—	—	—
June 22	1	96	50	18	13	11	14	18.2

On June 15, the three-day old nestlings had their eyes open but were sluggish and indifferent. Quills of the remiges had grown to 11.5 mm. Two days later these remiges had grown to 25 mm., and the feathers were beginning to emerge from their sheaths in the most advanced nestling. The young clung tenaciously to the nest lining and were removed with difficulty on this date. On June 18, at an age of six days, one nestling squeaked in protest when removed from the nest. When placed on the top of a laboratory desk, it hopped about, chirping, its activity contrasting with the quiescence of all the nestlings on earlier dates. The slightly smaller nest mate was still quiescent, however. When both were returned to the nest, the active one raised itself onto the nest rim.

At 5:00 a.m. the following morning we were aroused by high-pitched, penetrating squeaks in the neighborhood of the nest and ran outside, thinking a predator was raiding it. The disturbance had ceased abruptly, but a Red-bellied Woodpecker was nearby in the tree. A few minutes later, looking through the window, we saw one of the nestlings hoist itself onto the nest rim. After a pause, it edged along unsteadily, out on the adjacent limb for several inches. It was maintaining a precarious balance with feeble fluttering, in what appeared to be an absurdly premature excursion. It made its way back along the branch but it continued without a pause past the nest. When it had progressed some inches farther, the nestling suddenly lost its balance and, fluttering frantically, gradually swung around to the lower side of the limb. There it hung upside down for a few seconds before it dropped to the ground, having the good fortune to fall in high brome grass where it was uninjured. Another nestling was found to have left the nest earlier the same morning, and it was located concealed in the grass a few feet away. The adults were making frequent trips with food which was delivered mainly to the single nestling remaining in the nest. However, within half an hour, this third nestling went through the same procedure already described, edging out onto a limb, then losing its balance and dropping into the grass.

To facilitate further observations, all three young were then gathered and placed in an open cardboard carton on the ground under the nest. The adults brought food regularly. The female was seen to make four trips between noon and 1:00 p.m. Once she left carrying a fecal pellet, but many other feces accumulated in the box, where the young were kept throughout the day.

Though still feeble and undeveloped for life in the open, the young had changed strikingly since the preceding day. The ends of the primary feather vanes were exposed to a length of 15 to 20 mm., and bodies were beginning to acquire a feather covering, especially on the breasts. The tail feathers had scarcely grown out at all.

On June 20, after being kept indoors overnight, the young were placed in the box beneath the nest soon after daybreak. At 6:00 a.m. shrill chirping similar to that heard on the preceding morning attracted our attention and hastening to the window, we saw a Fox Squirrel (*Sciurus niger*) approaching the box. Both parents were fluttering beside it and scolding. The squirrel, alarmed at our presence, fled to the shelter of the tree trunk and did not return. Through the day the female continued to feed the young confined in the carton, and several times she was seen to carry away fecal pellets. Late in the afternoon two young were missing from the carton. They were located by their chirping in the grass about five feet apart and both were returned. However, within a few minutes, one was seen to hop out a second time. It hopped and fluttered through the grass for about fifteen feet to the base of a large elm tree. Clinging to the rough bark, and vigorously fluttering its stubby wings, it walked up the vertical trunk for nearly four feet, then dropped back to the ground. It made several more similarly futile attempts to climb into the tree, while the female fluttered beside it, calling as if in encouragement. All the fledglings had made conspicuous gains in strength and vigor since the preceding day. By dusk only the most retarded one remained in the box, and again it was kept indoors overnight. At 4:45 a.m. it was put out beneath the nest. The female came and fed it at 5:00 a.m. At 5:30 she came again with food and, perching on the edge of the carton, she called to the young bird, causing it to flutter up beside her, thus escaping from its confinement. Several times during the day we retrieved it for further observation and confined it in other cages with higher sides open on top. Each time it escaped. Throughout the day young could be heard calling in the grass, chiefly within a 30-foot radius of the nest. They had become more wary and ceased to call whenever a person approached.

Behavior of Fledglings

On June 22 at 8:00 a.m. the female was seen to come to the trunk of the nest tree and feed one of the young which was perched on a twig five feet above the ground. When an observer approached, this fledgling "froze" in a bittern-like stance with bill pointing upward. When the observer came within reach, the fledgling flushed and flew 60 feet to a twig of another tree, maintaining its level. In attempting to alight, it lost balance and flew off in a new direction for 30 feet, then dropped into the grass. There it was found again frozen in the bittern-like stance observed previously. It did not flush from this low, concealed perch and it allowed itself to be grasped. Then it struggled and called with a high *sgwee ee rr* repeated several times. The sound caused the female to fly down scolding. For the several minutes that it was confined in a cage, the fledgling fluttered in vigorous attempts to escape and frequently uttered the two-syllabled hunger call *zhürri,* louder than it had called previously while in the open. Some of the exposed vanes of the primary feathers were as much as 28 mm. in length, and the rectrices had grown to lengths up to 6 mm. The fledgling was now well feathered. The dorsal feathers were dark gray with yellowish edges, and the breast feathers were pale gray with dark streaks. Down was evident only on the head. The bill was mainly olive, with yellow at the tip and at the corners of the mouth.

Within the next two days the young shifted away from the vicinity of the nest tree to thick woods beside and beyond a ravine 200 feet farther south. They were not seen again at close range, but the family group was glimpsed in the tree tops from time to time. On July 10 and 11, for instance, a fledgling was seen to follow the female, giving food calls, while the male was nearby. As the tanagers were staying in the tree tops and were difficult to follow, or even to see, we were unable to determine how many fledglings remained but seemingly there were at least two.

Activities in Late Summer

The young were not definitely recorded after July 11, and may have dispersed from the parental territory at about this time. The adults were seen and heard frequently in their territory throughout July. The male's song was one of the most prominent of bird voices in late July and early August. His song began in morning twilight, often while Whip-poor-wills (*Caprimulgus vociferus*), Barred Owls (*Strix varia*), and Horned Owls (*Bubo virginianus*) were still calling, and he resumed singing from time to time throughout the day. On August 10 singing was heard frequently. On subsequent days song was no longer to be heard, although the clicking calls of tanagers were heard on August 14, 25, and 28.

Similarly in 1952, singing ceased abruptly in our absence between July 27 and August 11, although brief snatches of song were heard on August 21 and September 7. At least some of the tanagers remain in this area throughout most of September. There are specimens in the University of Kansas Museum of Natural History collected on the 14th, 15th, and 25th of that month. On September 27, 1953, a male was seen in a walnut tree near the house, giving the clicking call notes. Twice in the quarter hour that it was watched, it was seen to catch large black wasps (*Polistes fuscatus*) abundant in the vicinity. These were eaten after much pecking and battering.

Summary

There are many records of the Summer Tanager for Douglas County, Kansas, and scattered records for other parts of extreme eastern Kansas. Several pairs breed in the vicinity of the University of Kansas Natural History Reservation every year. Tanagers arrive approximately the last week of April.

In one pair observed in 1953, nest-building extended over a little more than two weeks and was done entirely by the female. Incubation lasted eleven days. From a clutch of four eggs, three hatched and all the nestlings were fledged. At an age of one week all three young left the nest, one at a time, and fell to the ground. At this age, although nearing adult size, the young were still remarkably undeveloped, feeble, and nearly helpless, depending almost entirely on concealment in ground vegetation. After spending three days hiding in the grass near the nest site, the young became sufficiently strong and well feathered to fly into nearby trees. Soon they moved away from the nest site but remained in the parents' territory for nearly three weeks longer. Tanagers remain in the general area through August and September. Singing ceased abruptly after August 10. For the remainder of the season tanagers were usually silent and inconspicuous.

Natural History Reservation, University of Kansas, Lawrence, Kansas, February 1, 1954

A STUDY OF PURPLE FINCH WINTER WEIGHTS

BY FRED D. BARTLESON, JR. AND OVE F. JENSEN

THIS paper is a report on the data collected by Mrs. Jensen during the winter stay of Purple Finches (*Carpodacus purpureus*) at her banding station in Chapel Hill, North Carolina, from December 16, 1946, to April 12, 1947. During this time over 1300 weights of 494 individual Purple Finches were recorded. Each bird was banded and weighed when trapped, and time of trapping was recorded. It was thought that it might be interesting to compare the results of this study to the findings of Baldwin and Kendeigh (1938), who analyzed the weights of a large number of birds of various species, but recorded only 11 weights of the Purple Finch.

The authors wish to express their appreciation to Drs. Howard T. Odum and Pierce Brodkorb, of the University of Florida, for advice in the methods of collecting data and suggestions in the preparation of this paper.

SEX AND AGE DIFFERENCES

The data on weights were analyzed to make comparisons between males and females and between adults and immature birds. All weights were valued equally whether or not more than one weight came from a single individual, regardless of temperature and other factors. Since the plumage of adult females is indistinguishable from the first winter plumage (Dwight, 1900), it was not surprising to find that nearly two-thirds of the banded birds were brown females and immature males. Pink males made up only one third of the sample. The weights of the females and immatures were plotted against their frequencies on a graph. This was "fitted" to a normal curve (formula from Simpson and Roe, 1939) and tested by chi-square in order to determine whether or not the populations were homogeneous. The curve obtained was normal and bell shaped, with no indication of bimodality. The calculated "P" value or probability that the actual data differed from the bell shaped curve was about 0.60, which strongly suggests that the weights of the immature and adult female Purple Finches are, for all practical purposes, the same.

The weights of the males then were analyzed and were found to have no significant differences in mean, standard deviation and variation from the weights of females and immatures (Table 1). Since no differences in the weights of any of these three groups could be found, the groups will be considered as one in the remainder of this study. Although the weights of these groups of birds were apparently the same during the period studied, it is quite possible that the males and females differ significantly during the breed-

TABLE 1

WINTER WEIGHTS OF PURPLE FINCHES (IN GRAMS)

Sex	No.	Extreme	Mean	σ	"t"	P.	V.
Females and First-year Males	906	21.0–32.0	26.06	1.752	.1045	.92	.067
Adult Males	394	19.5–31.0	26.01	1.687			.065

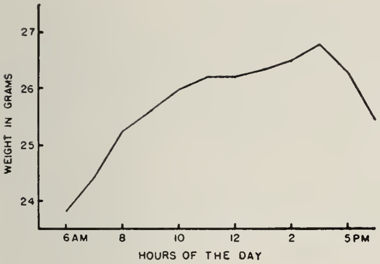
σ—standard deviation of means. "t"—calculated significance of differences of means. P.—probability. V.—coefficient of variation. (Formulae from Simpson and Roe, 1939)

ing season, and the immatures most certainly differ from the adults for at least the first few months after hatching.

HOURLY VARIATION

As an expected result of utilization of food and defecation at night, the early morning weights of these finches were comparatively low. The rate of increase in weights was rapid for the first few morning hours and then slowed down until about noon (Fig. 1). This phenomenon was also noted in Goldfinches (*Spinus tristis*) by Stewart (1937). Another increase in Purple Finch weights was noted in the early afternoon hours. By a little after 3:00 p.m. the Purple Finches had reached their maximum mean weight of 26.8 grams. This is a gain of 3.5 grams from the average for 6:00 a.m. or an increase of 13.5 per cent of the average daily weight. Nice (1937) found that the highest weights in Song Sparrows (*Melospiza melodia*) were reached somewhat later in the afternoon. After 3:00 p.m., there was a sudden drop in the mean, amounting to 1.4 grams within the next two hours. The remaining 2.1 grams were lost sometime during the night. Even though the lowest weight may be reached before 6:00 a.m., the rate of weight loss certainly must be rapid.

The main difference between our results and those of Baldwin and Kendeigh (1938:429) is that, whereas they found the maximum weight in the late afternoon or early evening, we found it occurring in mid-afternoon. The differences here may possibly be attributed to the relatively shorter length of day during the winter, or to the fact that the great majority of Purple Finches were observed to stop feeding in the middle of the afternoon and to leave the station area sooner than other species.



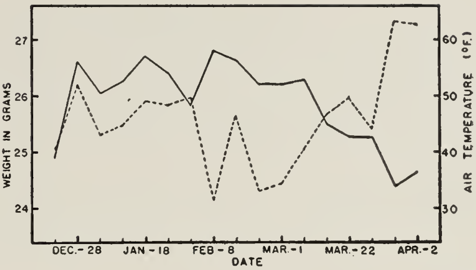


Fig. 1.—Hourly variations in mean weight of Purple Finches.

Fig. 2—Weekly variations in air temperature (Fahrenheit) and body weight of Purple Finches. Broken line indicates temperature. Unbroken line indicates weight.

Weekly Variation

In examining the variations of weight during weekly periods, it was seen that there tends to be an increase in weight from the last of December to early February. After this time, the birds became progressively lighter until they left the area sometime in the first two weeks of April. There are two weeks which do not fit this trend. The first was the last week in December, in which the body weight was nearly a gram higher than would be expected. There were only ten records for this period, which might account for the discrepancy. The second period which did not show the expected result was the first week in February. During this period, when it probably should have been the highest, the weight was about a gram lower than expected. The cause of error here was probably not due to the number of weights (73) recorded. In this particular week the daily temperatures were relatively high in comparison to those recorded during the rest of the period of the study, often reaching 75° F. This would tend to support the view held by Baldwin and Kendeigh (*op. cit.*:449) that at high temperatures the body weight of birds decreases.

From the work of Wolfson (1945) on Oregon Juncos (*Junco oreganus*) and Odum (1949) and Odum and Perkinson (1951) on White-throated Sparrows (*Zonotrichia albicollis*), one would think that the Purple Finches would have tended to gain weight, due to fat deposition, in preparation for their spring migration. This does not appear to have been the case in the Purple Finches studied. The lowest average weights were recorded during the last two weeks preceding migration. However, it is quite possible that the birds left the station just before migration and put on weight elsewhere, or added the weight very suddenly.

CORRELATION OF WEIGHT AND TEMPERATURE

The temperature data for the Chapel Hill area, which were received through the courtesy of the United States Weather Bureau, were plotted on the same graph with body weights. The results appear quite confusing (Fig. 2). Data from the first few weeks show an almost perfect positive correlation. For every increase or decrease in air temperature there was a corresponding increase or decrease in body weight. The data for the remainder of the period of this study, however, show both positive and negative correlations intermittently.

In order to see if there were any association between the temperatures and weights observed, a contingency table was devised and tested by chi-square. The resultant X^2 value obtained was 588.1, with four degrees of freedom. The differences between the observed and expected frequencies, therefore, could not have arisen by chance. Thus, it follows that there is significant association between the weights and temperatures.

A coefficient of correlation ("r") test was used then to determine just what this association was. An "r" value of plus or minus 1.0 indicates complete positive or negative correlation, as the case may be, whereas an "r" value of zero indicates that there is absolutely no correlation. The "r" value found in this case was –.543. To answer the question, "could this deviation of 'r' from zero have arisen from chance?", a significance of difference test was used. The "t" value of 22.8 obtained necessitates the conclusion that the difference between the coefficient of correlation value obtained and zero is significant. Thus, there is an inverse, or negative, correlation between body weight in Purple Finches and air temperature.

SUMMARY

(1) The winter weights of 1300 Purple Finches at Chapel Hill, North Carolina, were compared with previous work on weight variation in passerines. (2) Over the period of study, no significant differences in weight among adult males, adult females, and immature birds were found. (3) The highest hourly weight occurred shortly after 3:00 p.m. (4) Average weekly variation in weight showed an increase from the last of December to the first week in February, and then a gradual decrease until the finches left the area in their spring migration. (5) An inverse, or negative, correlation was found between air temperature and body weight.

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GENERAL NOTES

Records of Swainson's Warbler in southern Illinois.— Swainson's Warbler (*Limnothylpis swainsonii*) is typically associated with extensive southern bottomlands and shallow swamplands, particularly where there are large cane brakes, *Arundinaria gigantea* (Walt.) Chapm. Although southern Illinois is at the northern limit of such habitat, there are a few places along the rivers and creeks that harbor fairly good growths of cane. In these areas Swainson's Warbler has been recorded occasionally, although the records are extremely few and irregular. The few published observations are as follows: Wabash County in April (Ridgway, 1878. *Bull. Nutt. Orn. Club,* 4:163); Perry County in June (Gross, 1908. *Auk,* 25:225); Alexander County in May and Johnson County in June (Howell, 1910. *Auk,* 27:216); near Cairo, Alexander County, in September (Ammann, 1939. *Wilson Bull.,* 51:185). These were the only published records of the warbler for southern Illinois until mention of some of the following observations appeared in *Audubon Field Notes* (1951. 5:292; 1952. 6:292). No published observations of Swainson's Warbler were made in southern Illinois over an extended period in summer prior to 1951.

On April 29, 1951, Richard Brewer and I discovered a singing male Swainson's Warbler in the extensive Cave Valley cane brake, two miles north of Pomona in Jackson County. With further searching during the following weeks, we found the male singing on May 15 and June 16, but otherwise were unable to discover any clue to its status. On July 1 we observed a Swainson's Warbler at close range in an upland forest adjacent to the swamp. The bird was excited by our presence, as if perhaps concerned for the safety of a nest or young birds. It carried insects in its bill and fluttered on the ground almost to our feet, but, although we searched carefully, we were unable to discover a nest. No further observations were made of the species in 1951. Observations of Swainson's Warbler in 1952 were made on May 4 and 20, and on July 4; all were of a singing bird or birds, obviously not excited by the observer's presence. Other duties prevented our searching for the possible nest during the remainder of 1952. In 1953, drought conditions caused the swamp to go nearly dry, so that repeated search for Swainson's Warbler yielded only one late May observation and no summer records. In 1954, moisture conditions returned to near normal, and with this condition Swainson's Warbler again appeared in the Cave Valley swamp in summer. Brewer and I heard a singing male on June 13, and I observed an individual on June 19. We both watched a singing male on July 3 as it fed or gathered food on the ground in the swamp. The preceding observations definitely establish Swainson's Warbler as a summer resident in Illinois. Furthermore, the actions of the bird or birds observed in suitable breeding habitat would seem to indicate nesting activities. It is hoped that these records will assist in ultimately clarifying the status of Swainson's Warbler in Illinois.—JOHN WILLIAM HARDY, *Department of Zoology, Southern Illinois University, Carbondale, Illinois, August 2, 1954.*

Tail winds and migration.— The *Wilson Bulletin*, vol. 66, no. 2, June, 1954, contains several articles dealing with the relationship of weather, particularly of wind direction, to bird migration; and there have been a number of other recent articles on this general subject in several journals. There seems to be general agreement among most authors that birds tend to drift with the wind, something like aerial plankton, but there seems also to be a general tendency to assume that the wind blows from the same direction at all levels. This is by no means the case; and a couple of observations on the Preston Laboratories' grounds in Western Pennsylvania seem to show that birds of many species can find and use a limited stratum of air that is moving in the direction in which they want to go, even though at other levels there may be strong crosswinds or even headwinds. How the birds discover these critical levels is not obvious. It may be that they observe the drift of insects or clouds or true aerial plankton, or possibly they find the levels in some cases by accident or by observing other birds which have discovered the right level.

On September 27, 1953, at 10:15 a.m. I looked up and saw, at a height above ground of about 2,000 feet, an Osprey (*Pandion haliaetus*) headed south with the speed of an express train and without the slightest motion of its wings. At this I was very much surprised, because at the ground level the wind around my face was blowing strongly from the south, while at really high levels (say 10,000 feet), the few wispy clouds were scurrying east on a strong west wind. The bird had scarcely passed when I saw three Purple Martins (*Progne subis*) hawking where the Osprey had been and apparently migrating south too. A few moments later some wisps of cloud appeared at the same altitude, and, although they dissipated almost at once, they lasted long enough to show that at this level the wind was in fact blowing strongly from the north. The birds had discovered this condition and were making use of it. In the course of the next hour, the clouds thickened a great deal, and it was evident that at levels no higher than 5,000 feet above ground the wind was from the west. Thus the north wind was confined to a rather shallow stratum, and below this the wind would have opposed the birds, or at least would not have assisted them. The increasing cloudiness indicated that some change in the weather, and in the atmospheric circulation, was brewing and that the favorable stratum was not merely shallow in space but most likely fleeting in time.

On May 24, 1954, the early wind was from the north, but later in the day a dead calm prevailed. Around 3:00 a.m., May 25, a thunderstorm passed through, presumably a line-squall on a "front," and at 7:45 a.m., the ground wind was from the south, although at cloud level, several thousand feet up, the wind was from the west and was strong.

A mass migration of warblers and other birds rode the south wind and our woods were full of them, but by 8:15 a.m. the warblers had passed through, leaving behind numbers of Red-eyed Vireos (*Vireo olivaceus*) and Wood Pewees (*Contopus virens*) (the first of the season in each case). Several other species of summer residents seemed to increase in numbers suddenly at the same time. At 9:15 a.m. the ground wind was no longer from the south, but from the west, and was strong. The migration was confined to the south wind, and this wind was confined in space to a shallow stratum near the ground, and in time (at the laboratory) to a few hours, certainly not extending longer than from about 3:00 a.m. (time of the thunderstorm) to 8:00 or 9:00 a.m., and perhaps much less.

The following comments, from a private letter from Mr. Henry Rockwood, Meteorologist-in-Charge, U.S. Weather Bureau, Pittsburgh, have been condensed slightly without changing their sense.

"Wind direction is chiefly a function of the pressure patterns in the atmosphere, which at the surface (neighborhood of ground level) tend to be rather complex. As we go aloft, the pressure patterns tend to become increasingly simpler. This means that wind direction is not the same throughout the atmosphere, but varies with altitude. One of the simpler variations is a clockwise shift with height, which indicates the advection of a warmer airmass into the area. At other times the shift is counterclockwise with height, which means the advection of a cooler air mass.

"Because of the complexity of pressure patterns mentioned above, it is possible for a rather strong low pressure center moving eastward across the Great Lakes to induce a surface flow at Pittsburgh from south to southwest. At intermediate levels though, the low center may be slightly farther west and more V shaped so that winds will be more northerly or northwesterly. At much higher levels low pressure may not be apparent at all and winds at those levels could well be from the west.

"The duration of a particular pattern is chiefly a matter of a rate of movement of the pressure systems and may last for a few hours at the least to a day or more. It might well be that migrating birds, consciously or unconsciously, seek out the optimum level for their direction of flight."

Although only two occasions are reported above when a particularly striking set of circumstances was obvious, it seems likely that many more would be observed if they were carefully watched for.—F. W. Preston, *Preston Laboratories, Butler, Pennsylvania, August 13, 1954.*

An avifauna from the Pleistocene of central Kansas.— The avifauna described here is the result of ten years of intermittent collecting of vertebrate remains from a Pleistocene deposit in the NE¼ sec. 14, T.18S., R.3 W. (Kentuck locality of Hibbard, 1952. *Univ. Kansas Paleont. Contr., Vert., Art.* 2:6), McPherson County, Kansas, by members of the Kansas Geological Survey, Museum of Natural History, and Department of Anatomy, University of Kansas. I wish to acknowledge the critical advice of Dr. H. B. Tordoff, University of Kansas, and the use of comparative material in the University of Kansas Museum of Natural History and the National Museum, Washington.

The specimens, all in the University of Kansas Museum of Natural History, represent the following species:

FAMILY ANATIDAE

Anas carolinensis Gmelin, Green-winged Teal. Nos. 9908 and 9909, distal ends of right humerus.

Lophodytes cucullatus (Linnaeus), Hooded Merganser. No. 9910, proximal end of left carpometacarpus. No. 9911, shaft and distal end of left carpometacarpus.

FAMILY SCOLOPACIDAE

Bartramia longicauda (Bechstein), Upland Plover. No. 9912, left coracoid.

Numenius borealis (Forster), Eskimo Curlew. No. 7428, humeral end of right coracoid.

FAMILY ICTERIDAE

Euphagus cyanocephalus (Wagler), Brewer Blackbird. No. 7354, humeral end of left coracoid. This specimen and no. 7428, listed above, were reported (as unidentified birds) by Hibbard (*loc. cit.*).

To my knowledge, this is the first record of *Numenius borealis* as a fossil. The remaining four species are known from late Pleistocene deposits, to wit: *Anas carolinensis*, Florida (Wetmore, 1931. *Smithsonian Misc. Coll.*, 85:21), Oregon (Howard, 1946. *Carnegie Inst. Wash. Publ.*, 551:191), California (Howard, 1949. *Condor*, 51:21 — a tentative identification), and Nevada (Howard, 1952. *Bull. So. Calif. Acad. Sci.*, 51:54); *Lophodytes cucullatus*, Florida (Wetmore, 1931. *op. cit.*:23) and Oklahoma (Lunk, 1952. *Condor*, 54:317); *Bartramia longicauda*, Kansas (Downs, 1954. *Condor*, 56:211); and *Euphagus cyanocephalus*, Oregon (Howard, 1946. *op. cit.*:192). Fragments, closely resembling parts of *Anas carolinensis*, have been reported from the lower Pliocene of Texas (Compton, 1934. *Condor*, 36:41) and lower Pliocene of Nevada (Miller, in Merriam, 1916. *Univ. Calif. Publ., Bull. Dept. Geol. Sci.*, 9:173). Judging by the result of Wetmore's (1944. *Univ. Kansas Sci. Bull.*, 30:92–94) study of *Anas bunkeri* from the Blancan of Kansas, it is probable that these specimens from the Pliocene of Texas and Nevada would prove to be different from the existing species if more material were available for study.

The age of this avifauna is probably late middle Pleistocene or early upper Pleistocene. Hibbard (1952. *op. cit.*:11) regarded the stream deposit from which the Kentuck assemblage was collected to be younger than beds containing the Borchers faunule of Meade County, Kansas. Some of the mammals in the assemblage suggest an age roughly near that of the Cragin Quarry faunule and other fossils from the Kingsdown, or lower Sanborn, formation. The bird bones listed here provide no evidence of having been associated with the fossils of pre-Borchers age that Hibbard thinks were redeposited with the younger post-Borchers fossils to make the Kentuck assemblage. In any event, without better faunules for correlation it is enough to say that the deposits containing this avifauna are probably late Yarmouthian or Illinoian in age.

This collection is of interest because there is nothing in it to show that there have been any great and profound changes in the avifauna of the High Plains since the end of the middle Pleistocene. The five species have been inhabitants or migrants in the High Plains within historic times. The similarity of all seven of the fragments to the corresponding parts of Recent species increases the probability, in my opinion, that the species had attained, or were near, their present form by mid-Pleistocene time. With a collection as small as this one such a view would not exclude the presence of now extinct species or the possibility that slight morphological differences existed.—Edwin C. Galbreath, *Department of Anatomy, University of Kansas, Lawrence, Kansas, August 6, 1954.*

An early seasonal record of the Swallow-tailed Kite in Florida.— A Swallow-tailed Kite (*Elanoides forficatus*) was seen by the writer on February 6, 1954, flying over Payne's Prairie four miles south of Gainesville, Alachua County, Florida. The bird was sighted about 8:00 a.m. and was watched through 7 × 50 glasses for about 40 minutes as it circled overhead. The bird then flew southeast. According to the weather station at the University of Florida, at Gainesville, the temperature was 47° F. at 8:30 a.m. The weather was clear following a heavy frost and there was a slight wind from the northwest.

The species is a rare summer resident in this area, and as far as can be ascertained, this is the earliest record of its occurrence in Florida. Howell (1932. "Florida Bird Life," p. 164) gives the earliest record as February 28, 1920, at St. Marks, or the "last week in February, 1876" at Panasoffkee Lake.—Thomas W. Hicks, *University of Florida, Gainesville, Florida, August 10, 1954.*

Red Phalarope in Ohio.— On May 1, 1953, while flying through a rapidly moving storm system near Columbus, Ohio, our crew noticed clouds of dust blowing along at 8,000 feet above sea level. Later we learned that the system had caused dust storms in the Great Plains and tornadoes in Macon, Georgia, and other places as it moved eastward.

An hour before sunset on the next day, I found a Red Phalarope (*Phalaropus fulicarius*) swimming on a small pond in the Game Preserve in Area C, Wright-Patterson Air Force Base, Dayton, Ohio. The bird was busily snapping up black "flies" which were numerous within three inches of the surface of the water. The bird must have been starving, for it paid little attention to my family and nearby fishermen as it darted after the insects. It came within 25 feet of me as I watched with 8 × 30 binoculars. The yellow, dark-tipped bill was diagnostic. The bird was apparently a female midway between winter and spring plumage. It had a gray back, almost black crown and nape, and cinnamon-red mottling on the breast.

The bird was rediscovered in a different part of the pond the next day by Lt. George DeCoursey, and it was seen by Dr. Richard Reinhardt, Mr. Carl Horst, and Mr. Bert Smith, now president of the Dayton Audubon Society. The phalarope stayed on the pond for five days. On the afternoon of May 6 the bird was photographed in fair light with still and movie cameras. Two hundred feet of black and white 35 mm. movie film and several good stills in color were taken with telephoto lenses. At this time the plumage seemed richer and the bird less tame. Occasionally, as it was swimming and spinning after black "flies," it would leap after them and flutter several feet across the water. This was our last observation.

Correspondence with Dr. Donald J. Borror of Ohio State University reveals that there is apparently no previous spring record for the state of Ohio and that none of the fall records for central Ohio has been from the Dayton area.—GERALD T. ROGERS, *Wright-Patterson Air Force Base, Ohio, August 26, 1954.*

Blue Jay anting with hot chocolate and soap suds.—A hand-raised Blue Jay (*Cyanocitta cristata*) obtained June 17, 1950, at the estimated age of two weeks and kept until March 23, 1951, anted upon her first encounter with ants. (We assumed her sex because of the very small wing measurement—82.5 mm.) On September 17 she picked up a small ant and at once wiped it on her primaries, at the same time twisting her tail to one side. Later there was a suggestion of anting with some other small insects. On October 22 I gave her four small ants. She immediately anted with each one, rubbing them on both primaries and rectrices, in the mean time nearly falling from her perch. This was the last of her experiences with ants while with us.

On January 6 she helped herself to my daughter's hot chocolate. After each sip she spread out her wings and wiped her primaries from one to three times, doing this 14 times in succession. During the next two days I tried her on tea and coffee (both unsweetened), and again on hot chocolate. She took a few sips of each, but failed to ant.

On January 26 she was in the sink after the dishes had been washed, pecking around and sipping up drops of water. Twice she held out her wings and wiped under them.

A month later she watched my daughter making herself a cup of hot chocolate; she approached and helped herself, anting after each of 27 sips, wiping her bill on her primaries two or three times after each sip, usually on each wing alternately. She twisted her tail to one side, but did not ant on it. Finally she took two good drinks, anting after the second.

On March 13 she was perched on the edge of the dishpan that was half full of soapy, warm water. She took a sip and at once anted, doing this five times in succession. She then hopped into the water, but came out immediately, as it was rather too deep for a bath.

Many substitute objects have been reported as stimulating anting, but to my knowledge hot chocolate and dish water are new to the list. It seems evident that there is something in the taste of ants and various other substances that releases this curious behavior.—MARGARET M. NICE, *5725 Harper Avenue, Chicago 37, Illinois, September 2, 1954.*

Cabot's Sandwich Tern in New Jersey.—Although Cabot's Tern (*Thalasseus sandvicensis*) has been taken in New Jersey (Stone, 1937. Bird Studies at Old Cape May, 2:590), records of its occurrence so far north are, curiously, even fewer than for the much more southerly-distributed Sooty Tern (*Sterna fuscata*). Hence the following observation seems worthy of record.

Scrutiny of a resting flock of Laridae at Beach Haven Inlet, New Jersey, on September 1, 1954, revealed the long, rather slender, jet-black, distinctly yellow-tipped bill of a Cabot's Tern. First recognized at some distance through 12 × 50 binoculars, it permitted approach to within 25 feet. At that distance, in perfect light, its other characteristics, familiar to me from many previous meetings much farther south, could be readily checked. Apparently an adult in post-nuptial plumage, its forehead was white, its black nape noticeably crested, and its legs and feet black. Its size was slightly larger and its underparts were somewhat whiter than those of adjacent Common Terns (*Sterna hirundo*). Keeping an eye on the rarity, I beckoned to two nearby bird-students, Charles Atherton and William Evans, both of whom obtained very satisfactory views of the tern before we watched it fly toward the south, whence it had presumably been blown, a day or two before by Hurricane "Carol."

Three Royal Terns (*Thalasseus maximus*) carefully identified that day at the same locality may have been storm-blown also.—Frederick W. Loetscher, Jr., *Department of Biology, Centre College, Danville, Kentucky, September 17, 1954.*

Yellow-throated Warbler breeding along the Delaware River, Hunterdon County, New Jersey.—During mid-June, 1954, Mr. Vincent Abraitys of Sergentsville, New Jersey, located a singing Yellow-throated Warbler (*Dendroica dominica*) on an island in the Delaware River at Raven Rock. For two weeks following he made frequent trips to the area, finding the singing bird each time. It appeared to be keeping within a limited territory, which suggested to Abraitys the possibility of a nest.

On June 27, accompanied by Mr. Abraitys and Mr. Henry Barlow, I visited the island for the purpose of making a thorough search. We located the singing male without difficulty. It sang briefly from the top of a tall sycamore and then flew to another stand of sycamores near the center of the island. There we found a second bird.

Both of the warblers were very active, foraging among the leaves on the terminal branches of the sycamores and occasionally pursuing a flying insect. After obtaining a beakful, each would fly to an adjacent tree and disappear into the foliage of a grapevine. Although we searched carefully, neither the 10X binoculars nor the greater power of a 20X scope availed us to discover either nest or young in that impenetrable greenery.

We kept the feeding birds under observation and, within a few minutes, we noticed that they were no longer going to the grapevine but to a large sycamore some distance away. A careful study of that tree disclosed two young birds perched on a horizontal limb about fifty feet above the ground. While we watched, they were visited and fed by the parents.

The young warblers were fully fledged and appeared quite able to take care of themselves. Between parental visits they were active and their rapid movements and the thickness of the foliage of the trees made it difficult to observe them for more than a moment at a time. We could discern no differences in plumage between the adults and young other than the absence of the yellow throat on the latter.

Bent (1953. *U.S. Nat. Mus. Bull.* 203:358) does not include New Jersey within the breeding range of the Yellow-throated Warbler. So far as I know this species has not heretofore been reported breeding in this state.—Howard Drinkwater, *Old Road, Whitehouse, New Jersey, July 5, 1954.*

Juvenile Cowbird attended by Parula Warblers.—In Bent (1953. *U. S. Nat. Mus. Bull.* 203:145) it is indicated that, although instances are known, the Parula Warbler (*Parula americana*) is very seldom parasitized by the Cowbird (*Molothrus ater*). In view of this, the following observations may be of interest.

At about eleven o'clock in the morning of June 30, 1954, I was investigating the edge of a wet deciduous woodland near College Park, Maryland, when I discovered a fully-fledged young Cowbird being attended by a pair of Parula Warblers. Observation was continued for about ten minutes with 7 × 35 binoculars from distances of twenty to thirty feet. The Cowbird was on the ground at first, but it became somewhat alarmed at my approach, and flew unsteadily into the small trees at the forest edge. It uttered begging calls continually and solicited food from the warblers, as well as from an American Robin (*Turdus migratorius*) which seemed interested but did not feed the Cowbird. I clearly saw only the female warbler actually feed the latter, but the male remained near, apparently somewhat disturbed both by me and by the robin. He may have fed the Cowbird, but several of the acts of feeding were accomplished so quickly that I could not be sure which warbler performed them.

A short time later I saw a group of four adult Cowbirds (two males, two females) feeding on the ground about one hundred yards away.—Frank G. Anderson, *4608 Fordham Road, College Park, Maryland, July 6, 1954.*

Aquatic snails found attached to feathers of White-faced Glossy Ibis.—Several aquatic gastropods were discovered adhering to the feathers of a White-faced Glossy Ibis (*Plegadis mexicana*), by Edwin B. Davidoff while he was brushing the specimen for ectoparasites. The bird was collected two miles south of Orr's Ranch, Skull Valley, Tooele County, Utah, on May 25, 1954, by Mr. John Bushman. All of the snails were immature, making identification possible to genus only. Represented were *Physa, Lymnaea* and *Helisoma*, genera belonging to three distinct families of basommatophorous Pulmonata.

The importance of such observations lies in the valuable data they may furnish relative to possible avian dispersal of various mollusks. For example, Baker (1945. The Molluscan Family Planorbidae, Univ. Ill. Press, pp. 39–40) has pointed out the close similarity of migration routes and the distribution of some planorboid snails in the West Indian region, concluding that ". . . the populating of many if not all of the islands of the West Indies with planorboid and other fresh-water mollusks has been brought about through the agency of migrating birds." Some such similar mode of dispersal must be in operation to account for the distribution of aquatic mollusks in the widely separated bodies of water in the Bonneville Basin desert region.

It has long been known that various mollusks may become attached accidentally to the bodies of various other organisms, several excellent examples from the earlier literature having been cited by Kew (1893. "The Dispersal of Shells," Kegan Paul, Trench, Trubner & Co., Ltd.). Subsequent observations, several of which relate to attachment to birds, have appeared from time to time (citations in writer's file available upon request). I would like to reiterate here Baker's plea to ornithologists, sportsmen and others who have occasion to examine the bodies of birds to save any mollusks they may find and to turn these specimens over to a malacologist for study.—Ernest J. Roscoe, *Zoology Department, University of Utah, Salt Lake City, Utah, September 14, 1954.*

1955 ANNUAL MEETING

Members are reminded that the Thirty-sixth Annual Meeting of the Wilson Ornithological Club will be held at Stillwater, Oklahoma, April 7–10.

LOUIS AGASSIZ FUERTES RESEARCH GRANT

The deadline for applications for this grant has been extended to April 20, 1955. Application forms for this award of $100, established to promote ornithological research, may be obtained from Dr. Kenneth C. Parkes, Carnegie Museum, Pittsburgh 13, Pennsylvania.

ORNITHOLOGICAL NEWS

Some years ago Arthur Cleveland Bent, who died on December 30, 1954, arranged with James Lee Peters, at that time President of the Nuttall Ornithological Club, to have that organization agree to sponsor preparation of the remaining Life Histories of North American Birds should such action prove necessary. More recently, Mr. Bent had the Nuttall Club appoint Wendell Taber as Chairman with a free hand to choose his own committee. In May, 1954, Mr. Bent turned his work over to the Committee. Members are: Mrs. A. C. Bent, Alfred O. Gross, William G. F. Harris, Frederick C. Lincoln, Robert A. Norris, Christopher M. Packard, Lawrence H. Walkinshaw and Wendell Taber, Chairman. Contributions of material and photographs will be welcomed as before and may be sent to the most convenient member of the Committee.

It is hoped the volume on the Icteridae will go to the printer in the spring of 1955.

Of interest to bird banders is the appearance of a new publication, *The Ring*. The objective of this private publication is the international exchange of information on bird-ringing systems and other items of interest to workers in this field. The price of the first number is three shillings. The editor of *The Ring*, Dr. W. Rydzewski, 1 Altyre Rd., Croydon, Surrey, England, invites correspondence from bird banders in this country.

The 100-page gazetteer which appeared in part of 4 of James P. Chapin's "Birds of the Belgian Congo" is available as a separate with protective cover, priced at $1.00. Orders may be placed with the Department of Birds, American Museum of Natural History, New York 24, N.Y.

The Aves section of the *Zoological Record* covering ornithological literature for 1953 was issued in November, 1954. Ornithologists owe a debt of gratitude to Lt. Col. W. P. C. Tenison for his careful preparation of this valuable research reference. A standing order for this publication may be placed with the Zoological Society of London and the bill can be paid by foreign postal money order. The list price, seven shillings and sixpence, is equivalent to $1.00.

THE WILSON ORNITHOLOGICAL CLUB LIBRARY

The following gifts have been received recently. From:

P. H. Baldwin—1 reprint
Ralph Beebe—1 book
A. J. Berger—6 reprints
G. Reeves Butchart—1 book
Powell Cottrille—1 book
William H. Drury, Jr.—1 reprint
Karl W. Haller—12 books
F. Haverschmidt—4 reprints
Philip S. Humphrey—7 reprints
Mrs. Dinah H. Kahn—34 magazines
S. Charles Kendeigh—7 reprints
Amelia R. Laskey—3 reprints
Rosario Mazzeo—1 book
Margaret M. Nice—5 reprints
Fred M. Packard—2 books, 157 reprints, 384 magazines
Williams H. Phelps—4 reprints
William F. Rapp, Jr.—26 reprints
W. E. Scott—15 pamphlets
Arthur E. Staebler—1 pamphlet
Paul A. Stewart—1 reprint
A. W. Stokes—1 reprint
Robert W. Storer—2 reprints
Richard M. Straw—6 reprints
Harrison B. Tordoff—33 reprints
University of Utah—10 reprints
J. Van Tyne—1 book
Mr. and Mrs. C. R. Wagner—4 magazines
Harriet B. Woolfenden—2 books

THE MEMBERSHIP COMMITTEE

The Membership Committee listed below consists largely of members from the general region of the annual meeting. Your chairman has found it profitable to emphasize the recruiting of new members each year in a different area, that of the annual meeting. We still expect each member to be alert in helping to build our membership. As a means of bolstering individual effort, the Treasurer mailed with the dues notices an application form rather than a nomination form. However, any of the members of the committee listed here will be happy to receive nominations.

Ben B. Coffey, Jr.
672 N. Belvedere
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Ralph M. Edeburn, Chairman
Marshall College
Huntington, West Virginia

ORNITHOLOGICAL LITERATURE

A Guide to Bird Finding West of the Mississippi. By Olin Sewall Pettingill, Jr. Oxford University Press, 1953: 4¼ × 7⅜ in., xxiv + 709 pp., 36 pen-and-ink sketches by George Miksch Sutton. $6.00.

The Pettingill guides to bird finding are earning a place alongside the Peterson guides to identification as indispensable equipment for the field student in the United States. This volume covers the states west of the Mississippi River (including Minnesota and Louisiana), picking up where the Eastern guide, issued in 1951, left off.

It is truly an ornithological geography of the Western states. Although, first of all, it provides a directory of places to see birds in the wild, it provides also much other information of regional interest—about zoos, museums, bird clubs, and available literature.

This guide is intended primarily to help people traveling to an unfamiliar part of the country, but it is much more than a mere directory. All readers will find useful facts in it, particularly in the introductory portion of the chapter on each state, where there is a discussion of the climate, topography, and plants as they affect the bird life of the region. This information about the Western states is not gathered into any other work to my knowledge. For this alone, the guide will earn a place on many library shelves. There are other items of information that could not easily be found elsewhere. Such an item is that about a 20–acre patch of virgin prairie, never plowed or grazed, near Cherokee, Iowa.

In this work there are many evidences of thoughtful consideration for the problems of the traveler. Localities are discussed under the name of the nearest city or village listed in the Rand McNally road map of the state. Highway directions are given in detail, down to the last unmarked lane. Other suggestions cover overnight accommodations, special clothing needed, and tips on the pronunciation of difficult Spanish and Indian names.

This work is a notable achievement of cooperative effort. It could not have been written from the experience nor even from the reading of one man alone. It is a compendium of the knowledge, much of it previously unpublished, of more than 300 cooperators who are intimately acquainted with their own areas.—Harold F. Mayfield.

A Field Guide to the Birds of Britain and Europe. By Roger Tory Peterson, Guy Mountfort and P. A. D. Hollom. Wm. Collins Sons and Company, London; and Houghton Mifflin Company, Boston, 1954: 4½ × 7¼ in., xxxiv + 318 pp., illustrated by Roger Peterson with 40 color plates, 24 half-tone black-and-white plates, 32 line drawings in the text and 2 end-papers; 368 line distribution maps by P. A. D. Hollom. At time of writing, Swedish, Dutch, German, and Swiss (in French) editions also available. Price of U.S. edition, $5.00.

This new book confines within the tiny space of some 26 cubic inches the most important published contribution to the advance of European field ornithology since field ornithology assumed its position as a science (and art) in its own right. Mountfort (Secretary of the British Ornithologists' Union) has contributed the main part of the text, Hollom (an editor of *British Birds* and editor of Witherby's *Popular Handbook of British Birds*) the material on geographical distribution and maps, and Peterson the plates and planning, as well as an important part of the text. All three authors have, as this reviewer has witnessed, worked together in a tight collaboration involving ruthless cross-criticism; and the result is nearly perfect.

As the author of a series of field-recognition books the reviewer is well aware how eagerly some critics can hurl themselves upon the details of text and illustrations and make a great show of correcting the proofs at the expense of an appreciation of the book as a whole. In the case of *A Field Guide to the Birds of Britain and Europe* such pedants can make (and have made) a poor showing, pushing Hollom's map-areas a few miles here or there, infrequently modifying Mountfort's choice of field-marks or voice-transliterations, occasionally trying to catch the great Peterson in some slight error or exaggeration in depiction. The bag of such fair game has been incredibly low; for the book is a triumph of accuracy. But, beyond this, it is a triumph of presentation and planning, and performs the service for which it was designed better than the most particular and demanding customer could ever have expected.

The area covered by this book is all Europe west of Long. 30° E. Within this area are found 452 'basic' species, and a little over 100 others that are now extinct or have occurred less than 20 times. This compares interestingly with the 440 species and 74 accidentals in Peterson's Eastern (U.S.) Field Guide; the small extra number of European species are carried by four more color plates. None of the accidentals in the European Field Guide is figured, but no less than 1172 individuals or details of the 452 others are drawn or painted. Peterson has never done his unique type of recognition portraits more beautifully or lucidly; clearly he has learned the European birds so quickly and accurately (in several long seasons in the field) that he has been able to improve, difficult as this may seem, even on the quality of the revised edition of his *A Field Guide to the Birds* (1947).

In general treatment the book follows the plan of the Eastern Field Guide, save that under each species a section on *Habitat* replaces the section on *Range* which is nearly always covered by a map. Dutch, German, Swedish, French and American vernacular names are given. There is a very helpful introductory chapter on 'How to Identify Birds', another on 'The Problem of Subspecies', a personal check-list, a good description of the accidentals, and a well-arranged index. Praise is due Messrs. Collins, at whose Glasgow press the book was printed, and to Messrs. Gilchrist of Leeds, England, who made the color and half-tone blocks, which are specially good; it is no fault of theirs that in a few copies one or two plates may be found to be printed off-register.

It is not often that a bird book can be recommended as a universal 'must'—but such is *A Field Guide to the Birds of Britain and Europe.* The visitor to Europe will be only half a bird-watcher without it. We in Britain know few stay-at-home North Americans, but if there are such persons they can scarcely be wise to overlook a new Peterson Field Guide; and this one covers very many species on the A. O. U. Check-List.

Many must note with wry sympathy the dedication—"to our long-suffering wives." JAMES FISHER.

LIFE HISTORIES OF NORTH AMERICAN WOOD WARBLERS. By Arthur Cleveland Bent. U.S. National Museum. Bull. 203. Washington, D.C., 1953: xi + 734 pp., 83 halftone plates. $4.50

This is the nineteenth in Mr. Bent's series of bulletins dealing with the life histories of North American birds. Since the previous eighteen have been reviewed in ornithological journals throughout the world, a reviewer of the present volume may well wonder what remains to be said.

The wood warblers constitute an exclusively New World family, of exceptional interest to students of evolution and speciation. Almost every habitat, from rain forest to desert, has its peculiarly-adapted warbler species. Wood warblers breed from the tropics to the arctic. Many a student traces his awakening interest in birds to his first good view of the flashing colors of a warbler.

Like other volumes in the series, this one aims to be complete insofar as our present knowledge allows. Mr. Bent concludes his introduction with this sentence, "If the reader fails to find in these pages anything that he knows about the birds, he can only blame himself for failing to send the information to—*The Author*." Subject to fairly long delays in printing after the manuscript was finished, this perfectionist aim is rather well met. The student who does know facts about wood warblers which do not appear in the present pages is quite likely to find that these things have been learned (or published) since 1945, when Mr. Bent's manuscript was completed.

Since "monumental" has seemed to so many other reviewers the apt adjective for Mr. Bent's work, it should perhaps be repeated in describing this volume. To a bird student who dwells outside New England, however, certain questions are likely to occur, and certain disagreements appear. Although Mr. Bent has utilized the special knowledge of some bird students outside the Northeast, would it not have been better to have assigned to western ornithologists the preparation of appropriate life histories? As in past volumes, the late Dr. Winsor M. Tyler and Dr. A. O. Gross have contributed complete life histories. Edward von S. Dingle, Alexander Sprunt, Jr., and Josselyn Van Tyne, all non-New England bird students, have each contributed two life histories of species concerning which they have special knowledge. Might not the volume have benefited from a wider use of such authors?

It is everlastingly to the credit of New England bird students that they were pioneers in ornithological exploration. Their voluminous, and often charming, writings reduced certain other sections of the country to a state of "ornithological illiteracy." In short, they were too good and too thorough for many of the rest of us. The inevitable result of this, however, is that certain life histories have, for outside readers at least, a kind of New England parochialism. Many warbler species migrate through, and breed in, vast areas outside the Northeast, and it is certainly true that they do not always behave in other areas as they do in New England.

A good number of species, both of northern and southern associations, are peripheral in New England, and thus are likely to exhibit those aberrations of behavior which are common to animals (and plants) in zones of ecological tension. Students familiar with species near the centers of their abundance will often fail to recognize the limitations of behavior which older New England authors place upon them.

There is a very human tendency to place undue emphasis upon the *first* good ornithological writing dealing with any area or any species. Thus, in years gone by when Eastern college students spent summer vacations in the South, they often returned with ornithological information which was entirely new and highly valuable. Now it is quite obvious that a few weeks' residence in an unexplored area did not make these observers "experts" on local bird life, but we have gone on quoting them at great length just as though they were. This is manifestly unfair to resident students who have to their credit many years of observation in a particular area. The explorers continue to be quoted, simply because they were first, while the real local authority is overlooked because he came on the scene later. As history this is good, but it tends to distort the picture of our knowledge of a bird. In many cases we have learned new things; in others the birds themselves have adjusted to new environments.

By this time a good many readers may be ready to dismiss this as the captious comment of a reviewer who must say something after all the complimentary things have been said. It is not so meant. Our wood warblers are not regional, not national, but international. If New Englanders have done the best writing about them, other sections may only hope that they will in time catch up.—MAURICE BROOKS.

SHEARWATERS. By R. M. Lockley. Devin-Adair Company, New York, 1954:238 pages, 20 pages of illustrations. $4.00.

This is not a new book, but the American edition seems to have appeared more than a decade after its publication in England.

In 1929, when the author and his wife established a residence on the lonely Welsh island of Skokholm, little was known about the life history of the Manx shearwater (*Puffinus puffinus*), of which some ten thousand nested on the island's 242 acres. At that date even the incubation period of the species was grossly underestimated in the literature.

The Lockleys settled in the island's ancient farmhouse, ran sheep as a livelihood, and tirelessly studied the shearwaters for twelve years before this book was first issued. They began with simple observations statistically recorded throughout the seasons, next carried out extensive ringing or banding, later conducted homing experiments that have become famous, and, finally, made voyages to the northernmost and southernmost breeding stations of the Manx shearwater. Throughout the work they welcomed and sought collaboration from anyone capable of aiding them. Skokholm even became a memorable port-of-call, in 1934, for participants in the Eighth International Ornithological Congress.

The results of Lockley's work are already familiar to students of oceanic birds from successive reports that he has published in scientific journals. This book is a faithful summary of the findings up to 1942 (the research has continued since), as well as a colorful and charming account of island life and its pageant of weather, vegetation, and a multiplicity of birds and other creatures.

For ornithological field work it would be hard to find a better model of sound methodology than "Shearwaters." Step by step the author describes his procedure and draws inescapable conclusions. There is a minimum of speculation, and Lockley is as scrupulous as Darwin in weighing every alternative hypothesis that might stem from the same evidence. The book establishes the essential pattern of life history not only of its subject species but also of all other Procellariiformes, from storm petrels to albatrosses. Their prolonged breeding seasons, stylized emotional behavior, equal share of labor by the two parents, means of family recognition, lengthy period of growth (125 days from egg to fledgling in the Manx shearwater), the abandonment and subsequent nocturnal flight of the young, the extraordinary extent of the feeding flights, the length of life, and the amazing and still not fully explained homing feats from distant localities, totally unknown to the birds, are set forth here in classic fashion.—ROBERT CUSHMAN MURPHY.

This number of *The Wilson Bulletin* was published on March 28, 1955.

EDITOR OF THE WILSON BULLETIN

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SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the color-plate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

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STILLWATER, OKLAHOMA
FRIDAY, APRIL 8, TO SUNDAY, APRIL 10, 1955

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GREAT CURASSOW OR *FAISÁN REAL*

(*Crax rubra*)

Adult male in breeding condition. Painted in the field from a specimen collected March 2, 1938, along the Río Sabinas, near the village of Gómez Farías, Tamaulipas, México, by George Miksch Sutton. This plate, which first appeared in Sutton's *Mexican Birds* (copyright 1951), is here used by courtesy of the University of Oklahoma Press.

GREAT CURASSOW

BY GEORGE MIKSCH SUTTON

SIXTY-SOME kilometers south of Victoria, Tamaulipas, the Mexico City highway crosses a beautiful stream, the Río Sabinas. West of the bridge a few miles rises the first foothill of the great Sierra Madre Oriental. The foothill is heavily forested; but the careful observer will note, well up the slope, a patch of naked, red-tinted rock, and at about the same level, a little to the north, a white cloud which seems to be caught in the trees. Under this cloud-banner—or, indeed, in it, for it clings to the slope much of the time—grow huge "*jobo*-plum" trees (probably *Spondias mombin*) whose uppermost branches bear thousands of yellow-orange "plums" in March and April. On this fruit feeds a remarkable bird, the Great Curassow (*Crax rubra*). The lofty trees are a favorite haunt of another cracid, the Crested Guan (*Penelope purpurascens*), and off to the north and east a few miles, in brushy, comparatively dry "mesa country," lives a third big galliform bird, the Wild Turkey (*Meleagris gallopavo*). These forms have survived principally because so few people living thereabouts have owned firearms. They probably will continue to survive, despite the proximity of the highway, if the traffic will be good enough to keep on moving.

The Río Sabinas is near the north edge of the Great Curassow's range. The species inhabits heavy tropical woodland southward through Middle America and western Colombia as far as western Ecuador (Peters, 1934. "Check List of Birds of the World," 2:12). A small race is endemic to Cozumel Island, off the coast of Yucatán. In southern Tamaulipas, where *Crax rubra* is found up to at least 3300 feet elevation, the bird is known as the *Faisán Real* (Royal Pheasant). In some parts of México, and in Guatemala, it is called the *Pahuil* (Salvin and Godman, 1897. "Biologia Centrali-Americana," Aves, 3:272), a name which strikes me as being a local version of *Pavo real*, the name used in Panamá (Aldrich and Bole, 1937. *Sci. Publ. Cleveland Mus. Nat. Hist.*, 7:53). Wetmore (1943. *Proc. U. S. Nat. Mus.*, 93:243) states than in one area of southern Veracruz the bird's name is *Cholín.*

The adult male Great Curassow is black with white belly, flanks, and under tail coverts. The black is faintly glossed with dark green and blue. The stiff, narrow crest feathers, each strongly recurved at the tip, give the head a fantastically tousled appearance when the bird is excited. The heavy bill is ornamented at the base with a yellow knob which swells and brightens at the height of the courtship season. The iris is dark brown. Young males are female-like in color for a time just after the post-natal molt, but they become boldly black and white long before reaching full size. A young male in my collection, taken by Paul S. Martin in southwestern Tamaulipas on March 26, 1949, is much like an adult male except that it is decidedly small, its crest feathers are only slightly recurved, it has no bill-knob (label comments indicates that the cere was "bright yellow"), the feathers of the chin and throat are dull white basally, and there are a few brown- and gray-edged feathers among the greenish black feathers of the chest and upper belly.

In several adult male Tamaulipas specimens which I have handled in the flesh, the bill-knob has been large and almost spherical. The male shown in Sturgis (1928. "Field Book of the Birds of the Panama Canal Zone," opp. p. 26) has no bill-knob whatsoever, so either the bird was young or the photograph was taken at some season other than the breeding season.

The adult female is brown, without white on the belly and crissum, but with crest even more bizarre than that of the male in that it is black and white. The color of the upper parts is highly variable. Concerning this variability Sclater and Salvin (*Proc. Zool. Soc. London,* 1870:514) say: "In some specimens the wings are wholly red, in others much banded with black and cinnamomeous; in some specimens also the tail-bands are very slight, and almost evanescent. The upper portion of the back varies from black to chestnut." Friedmann (1946. *U. S. Nat. Mus. Bull.* 50, part 10:15) calls attention to the interesting fact that all specimens of the barred-backed "*chapmani* Nelson" form known to him have come from Campeche and Yucatán.

The sound produced by the male Great Curassow during courtship is simple but impressive. It has the muffled quality of a distant explosion. The individual whose portrait we present here produced a sound which I have set down as *oomh* (Sutton, 1951. "Mexican Birds," pp. 164–165). I use the word *sound* rather than *callnote* because I do not know to what extent the *oomh* is really vocal. The neck-skin of a courting male which I collected along the Río Sabinas on March 15, 1941, was thick and flabby, the muscular subcutaneous tissues being supplied with a considerable network of blood vessels. Such apparatus clearly indicates that the explosive quality of the *oomh* might result from a sudden releasing or powerful expulsion of a neckful of air. Salvin and Godman (*loc. cit.*) liken this sound to "the distant roaring of the 'tiger'." Cries of parent birds, excited over possible danger to their young, include "screams, peculiar grunts, and wails" (Sutton and Pettingill, 1942. *Auk,* 59:11).

All species of the family Cracidae are known to be arboreal, but the Great Curassows I have observed in southern Tamaulipas have certainly spent less time in trees than the Crested Guans of the same areas. Salvin and Godman (*loc. cit.*) say that in the morning and evening *Crax rubra* is "usually found perched upon trees and feeding on fruit, but during the day [it] spends its time chiefly on the ground scratching in the leaves for food . . ." As for

Penelope purpurascens, I have only very rarely seen it on the ground; *Crax rubra* I have seen on the ground several times, notably on March 21, 1941, when a female, near her nest or accompanied by small young, ran back and forth through the brush calling *kwut, kwut,* and giving a thin, penetrating squeal. Dickey and van Rossem (1938. *Field Mus. Nat. Hist. Zool. Ser.* 23: 147), writing of El Salvador, tell of surprising a dozen females and young which, instead of taking wing, all trotted into cover of the swamp in the manner of turkeys. These authors describe the flight of *Crax ruba as* "alternate flapping and sailing," the wing-beats as "powerful and rather slow."

The Great Curassow's nest is an unsubstantial, unshapely, disproportionately small structure of leaves, twigs, or a mixture of the two, placed in deep woods, but not very far from the ground. A nest found by the Cornell University-Carleton College Expedition near Gómez Farías, Tamaulipas, on March 17, 1941, was in a "vine-covered clump of slender trees . . . twenty feet from the ground. Here the female was incubating. From far up the slope we could see her dark tail and tousled crest" (Sutton and Pettingill, *loc. cit.*). The eggs, which are large, white, and rounded rather than pointed, usually number two.

The newly hatched chick, which I have never seen, has been figured by Heinroth (1931. *Journ. für Ornith.*, 79, opp. p. 282) as warm grayish buff, with white chin, throat, and belly, marked with black or deep chestnut on the head, neck, back and wings. Eggs are often taken from the nests by the Mexicans and hatched under domestic hens. The chicks grow up tame. I have seen two such pets, fully matured, walking sedately about in front of a fine home on the outskirts of Monterrey, Nuevo León.

R. I. Pocock (1908. *Avicultural Mag.*, 7:23–30) reports the breeding in captivity (in England) of a pair of Great Curassows. The nest, of willow twigs, was built solely by the male. The young, which were remarkably precocial, were fed by the female.

For many years I have been puzzled by the beautiful Fuertes drawing of a curassow illustrating his famous paper on the voices of tropical birds (1918. *Bird-Lore,* 16:427). When I first became acquainted with *Crax rubra* in southwestern Tamaulipas, I thought that Fuertes's drawing of the Colombian bird represented a male *rubra* with undeveloped bill-knob. I now feel quite sure that his model was an adult *Crax nigra,* probably a female, since the only specimen of *nigra* listed by Chapman (1907. *Bull. Amer. Mus. Nat. Hist.,* 36:194) is a female from Buena Vista, Colombia, the very locality at which Fuertes reported hearing a "Black Curassow."

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF OKLAHOMA, NORMAN, OKLAHOMA,
FEBRUARY 20, 1955

VARIATION IN RELATIVE HEART SIZE OF CERTAIN PASSERINES WITH INCREASE IN ALTITUDE

BY ROBERT A. NORRIS AND FRANCIS S. L. WILLIAMSON

RENSCH (1931) has attempted to show that in certain passerines (*Dicaeum igniferum*, *Acmonorhynchus annae*, and *Cinnyris jugularis ornata*) from tropical regions the ratio of heart weight to body weight, or "heart ratio," increases markedly with increase in altitude. Although Rensch's data and conclusions were accepted by Stresemann (1927–1934), Moreau (1944) maintained that whereas such a trend might be expected on physiological grounds, the evidence presented by Rensch was unsatisfactory. Because Rensch had only small series of specimens and had not fully explained the method by which his data were obtained, Moreau expressed the need of standardized procedure by listing and briefly discussing possible sources of error. These sources included differences in age, sex, or physiological condition of specimens; in time of day of collection (birds weighing more in the afternoon than in the early morning); in lapse of time between collecting and weighing (the longer the time, the greater the weight loss through desiccation); in method of collecting (if shot, loss in body weight possibly resulting from loss of blood); and in preparation of hearts for weighing. Moreau also pointed out the need of larger series, statistical treatment of data, and investigation of intrapopulation variation as a necessary preliminary to comparison of populations at different altitudes. While Moreau's critique in general seems valid, we believe nevertheless that Rensch's data, albeit scanty, do provide a rough reflection of an actual pattern of increasing heart ratio in birds with increasing altitude.

Even before the appearance of Rensch's paper, Clark (1927:79,80) made the generalization that "animals living in cold climates appear to have higher heart ratios than similar animals living in warmer climates." Clark's evidence was based on reports by Strohl and by Hesse who dealt with ptarmigan (two species of *Lagopus*), House Sparrows (*Passer domesticus*), and squirrels (*Sciurus vulgaris*), comparing high-latitude or high-altitude forms with their counterparts from warmer regions. As these findings suggest and as Moreau (*op. cit.*) readily granted, an increase in heart size relative to body size at high altitude might be expected not only because of cooler temperatures but also because of the more rarified air. The following data on twelve species of passerine birds from a Temperate Zone region provide further evidence for the relationship between heart ratio and altitude (Fig. 1).

METHODS

Most of the specimens furnishing ratio values used in Figure 1 were taken with shotguns, placed in paper cones, and weighed within a few hours. The birds were weighed to the nearest 0.1 grams on a double-beam balance; the hearts, to the nearest 0.01 grams on a triple-beam balance. It was found through testing that weights of hearts freshly excised and prepared (which included cutting off stumps of blood vessels and removal of blood or clots from the auricles) were not significantly different from weights of the *same* hearts preserved in 10 per cent formalin and later re-weighed. Specifically, among 84 hearts of Scrub Jays (*Aphelocoma coerulescens*) and Steller Jays (*Cyanocitta stelleri*) so treated, there was a mean weight loss of 1.56 per cent in the preserved hearts. Hearts in formalin were therefore considered comparable to ones freshly weighed. All the high-altitude data included in the present report pertain to weights of formalin-fixed hearts (all removed from solution, carefully trimmed, washed out, gently blotted, and weighed by the senior author). No attempt was made to correct for possible weight loss of the order of 1 or 2 per cent. All the lower-altitude data pertain to fresh-heart weights (again prepared and weighed by the same person in a standard way). The high-altitude specimens were obtained in the White Mountains of extreme east-central California and adjacent Nevada by the junior author, who accompanied a collecting expedition led by W. C. Russell and sponsored by the Museum of Vertebrate Zoology. The hearts of passerines taken at elevations from 6750 to 10,500 feet were excised and labeled individually (being pierced with insect pins bearing heavy-paper tabs for field catalog numbers). Thus, hearts could later be associated with individual specimens and their corresponding body weights.

Most of the specimens of lower-altitude populations represented in Figure 1 were obtained at elevations between 100 and 800 feet, usually in Alameda, Contra Costa, or Marin counties in central-coastal California. Exceptions are (1) the "lower-altitude" specimens of *Cyanocitta stelleri*, which were shot in Tuolumne County, California, at approximately 2000 feet, and (2) the Yellow throats (*Geothlypis trichas*) and Chipping Sparrows (*Spizella passerina*), of which the lowland samples came from southern Georgia. It should be added that the lowland Fox Sparrows (*Passerella iliaca*) were wintering birds from near Berkeley, California. While it is possible that these Fox Sparrows represent breeding stock from high altitudes, it is not likely that they do. With these exceptions, the highland and lowland samples were both taken shortly before or during the breeding season and are both essentially Californian, coming from high Sierran and low coastal hill regions, respectively.

Extremely fat specimens were not used in this study. In specimens with limited deposition of subcutaneous and intraperitoneal fat, there is also some deposition on the heart, this tending to minimize variability in the ratios. For the present we are assuming that the myocardium does not undergo seasonal variation in size. Because this report is of preliminary nature, the assigning of geographic race names to populations is deemed unnecessary.

ACKNOWLEDGMENTS

Most of the jays (*Cyanocitta* and *Aphelocoma*) were salvaged from a jay shoot in Tuolumne County, California, by Dr. Frank A. Pitelka. Robert S. Hoffman, Victor Lewin, Jr., and Ralph J. Raitt were helpful in providing a number of the fringillids. Determination of ratios was facilitated by use of a calculator in the Museum of Vertebrate Zoology.

RESULTS AND DISCUSSION

The graphs shown in Figure 1 are rather striking in that heart ratios of high-montane samples or individuals are higher in all species than are ratios from lower altitudes. The trend lines for *Cyanocitta stelleri* approach the vertical more closely than those of other species; this might be due not only

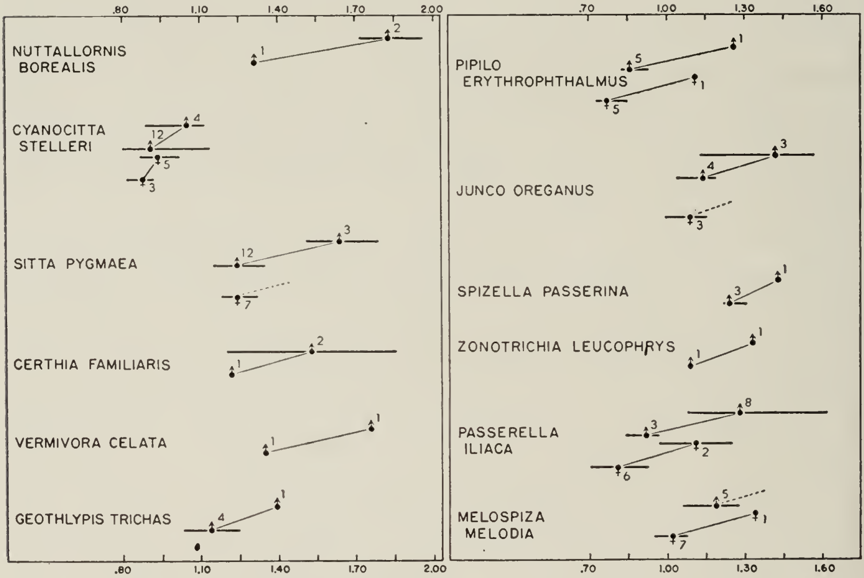

FIG. 1. Variation in heart ratio (heart weight divided by total body weight) of twelve passerine species in relation to altitudinal increase. Sex symbols designate both the sex and mean (or sole, individual) ratio; for each species, symbols to the right refer to the higher altitudes; small numbers near symbols show the number in the sample; heavy horizontal lines indicate the range of ratio values for a given sample; diagonal lines connecting like symbols serve to accentuate the regular trend toward higher heart ratio with increasing altitude.

to the fact that the "lowland" population itself came from 2000 feet, but also because of the large size of jays in comparison with the other passerines. Whatever the altitude, both *Cyanocitta stelleri* and certain fringillid species show higher heart ratios in males than in females. (This is likewise true of *Aphelocoma coerulescens* and other passerines not included in Figure 1.) In the lowland population of Pigmy Nuthatch (*Sitta pygmaea*) the sexes average the same. The two montane specimens of Brown Creeper (*Certhia familiaris*) show marked and probably aberrant difference in heart ratio, due possibly to desiccation or to technical error; both this sample and those of other species, notably the Orange-crowned Warbler (*Vermivora celata*), *Geothlypis trichas, Spizella passerina,* and the White-crowned Sparrow (*Zonotrichia leucophrys*) are admittedly poor and unsatisfactory, but since trends suggested by them agree with those shown by other species, they are included in Figure 1.

Table 1

Precise Values for the Data Plotted in Figure 1

Samples are represented by extreme ratios and means (in parentheses)

Species	Lowland Males	Highland Males	Lowland Females	Highland Females
Olive-sided Flycatcher, *Nuttallornis borealis*	1.31	1.72, 1.96		
Steller Jay, *Cyanocitta stelleri*	0.80–1.14 (0.91)	0.89–1.12 (1.01)	0.82–0.92 (0.88)	0.87–1.02 (0.94)
Pigmy Nuthatch, *Sitta pygmaea*	1.15–1.35 (1.24)	1.52–1.79 (1.64)	1.18–1.32 (1.24)	
Brown Creeper, *Certhia familiaris*	1.22	1.20, 1.86		
Orange-crowned Warbler, *Vermivora celata*	1.35	1.76		
Yellowthroat, *Geothlypis trichas*	1.03–1.26 (1.14)	1.39		
Spotted Towhee, *Pipilo erythrophthalmus*	0.83–0.93 (0.87)	1.26	0.73–0.85 (0.77)	1.11
Oregon Junco, *Junco oreganus*	1.04–1.19 (1.14)	1.13–1.57 (1.42)	1.00–1.16 (1.09)	
Chipping Sparrow, *Spizella passerina*	1.22–1.31 (1.27)	1.43		
White-crowned Sparrow, *Zonotrichia leucophrys*	0.83	1.33		
Fox Sparrow, *Passerella iliaca*	0.84–0.97 (0.92)	1.08–1.62 (1.28)	0.70–0.93 (0.81)	0.97, 1.25
Song Sparrow, *Melospiza melodia*	1.06–1.28 (1.19)		0.95–1.08 (1.02)	1.34

Hartman (1954), in a report on cardiac and pectoral muscles of trochilids, states: "In a series of 300 species and subspecies of birds which I have collected, only 12 possessed hearts 1.5 per cent or more of the body weight. From the activity of hummingbirds, the relatively greater size of the hearts [their ratios ranging from 1.74 to about 2.40] might be expected." Although this thought on hummingbirds is certainly justified by Hartman's quantitative information, the first statement, which applies presumably to a large proportion of passerine species, leads us to suspect that very few, if any, of his specimens were obtained at high altitudes. The data on hummingbirds are well presented (*ibid.*), but the heart-ratio values are not separated according to sex. It would be interesting to know whether male hummingbirds resemble male passerines in having relatively larger hearts than do females. Hartman's trochilid species, excepting the Ruby-throated Hummingbird (*Archilochus colubris*), were obtained in Panama, presumably at relatively low elevations. If, however, certain of his species are represented by both mountain and lowland specimens, it would seem desirable to re-examine the data because of the possibility of altitudinal differences comparable to those indicated for passerines.

Further analysis of variation of heart ratio in birds in relation to altitude, sex, activity, and other matters will be made at a later time. It is sufficient to say at present that in both intra- and interspecific comparisons, both altitudinal and sexual differences provide variables to be reckoned with. Too, in making analyses, one should distinguish nicely between intra- and interspecific variation. To illustrate: in twelve male *Sitta pygmaea,* from 200 to 600 feet in central coastal California, the heart ratios averaged 1.24 (1.15–1.35); in ten male Brown-headed Nuthatches (*Sitta pusilla*), a closely related species taken at approximately 350 feet in Georgia, the ratio averaged 1.56 (1.42—1.68). Similarly, in seven female *pygmaea* the ratio was 1.24 (1.18—1.32); in five female *pusilla* it was 1.47 (1.38—1.56). Whether or not these samples are segregated by sex, there is no overlap between even the extreme heart ratios in these two species of *Sitta.* Curiously, the species *pusilla,* living in a generally warmer climate, has the significantly larger heart (body size in the two compared populations being almost identical). Hence factors influencing such a ratio difference might well relate to intrinsic biological characteristics of the species more than to effects of the physical environment.

Conceivably, measurements of heart ratios of birds will in time be helpful to the taxonomist, not only in the matter of describing and defining closely related species but also in the matter of identification of high-altitude or, perhaps, high-latitude subspecies taken in migration or on wintering areas. It seems probable that such measurements will also be useful to avian physiologists, as has been suggested by Odum (1941:315).

Summary

Evidence from twelve species of passerine birds points to higher heart ratios in high-altitude populations. Such variation in relative heart size, which might be expected on physiological grounds, lends support to earlier findings of Rensch (1931) based on three tropical species. Both altitudinal and sexual differences contribute importantly to variation in heart ratio in

birds as illustrated by passerines, and these variables among others ought to be considered in the analysis of heart-ratio data.

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A NESTING STUDY OF THE LITTLE BLUE HERON IN EASTERN ARKANSAS

BY BROOKE MEANLEY

THE nesting of the Little Blue Heron (*Florida caerulea*) has been observed in its coastal and inland habitats on many occasions, as cited by Bent (1926), Howell (1932), Sprunt and Chamberlain (1949), and others. Most of the heronries discussed in these publications were located on coastal marsh islands or about lakes in the interior. Such heronries, usually isolated from human activity, often are difficult to keep under observation.

The following observations were made during 1952, 1953, and 1954 (mostly in the latter year) at a heronry located within 200 yards of the village of Swan Lake, Jefferson County, Arkansas. The Swan Lake heronry was described briefly in a recent paper by the writer (1954).

It has been reported reliably that this heronry has been in continuous use at least since 1938, the year that the informant moved within sight of it. In spite of its proximity to civilization, the site obviously was chosen because an extensive growth of buttonbushes (*Cephalanthus occidentalis*) at one end of the lake furnished ideal nesting habitat, and because areas of ready access provided an abundance of food.

The location of this heronry was similar to one found by M. G. Vaiden at Benoit, Mississippi. Both heronries were situated on the outskirts of a small village, were surrounded by delta cotton fields, and were about two miles from a river, in sight of the river levee.

METHODS

It was possible to drive to within about 40 yards of the Swan Lake heronry along a well-used farm road and to make observations from the car window; or to sit on the front porch of one of two tenant houses nearby and watch nest building, feeding of young, and other activities.

The use of a blind was unnecessary until after hatching, as it was possible for an observer to approach to within 20 to 30 feet of the nests and to watch the herons with or without binoculars as they went unconcernedly about their ways. When first disturbed the herons would simply fly a few yards away, returning to their nests soon after the intruder stopped moving. The birds became less tame after the eggs hatched.

The role of the sexes in most of the early phases of nesting behavior was revealed by the activities of individuals immediately following copulation.

ACKNOWLEDGMENTS

The writer is indebted to E. R. Kalmbach, and to Robert E. Stewart, Charles C. Sperry and Paul Hickie of the Fish and Wildlife Service for reviewing the manuscript; and to Anna Gilkeson Meanley for assisting in the field work.

NESTING HABITAT

The old riverbed lake in which the heronry was located is known as Old Crow Lake. The lake is fringed on the north and northwest sides by willow (*Salix nigra*) and on the south, southwest and southeast sides by buttonbush, swamp privet (*Forestiera acuminata*), and willow, in order of abundance as named. The buttonbushes actually extend en masse more than 100 feet out into the lake, occupying several acres at the south end.

FIG. 1. Adult Little Blue Herons near nests in buttonbushes at Swan Lake, Arkansas, May 20, 1954.

The Little Blue Heron nesting colony was located mostly along the southeastern side of the lake, while most of the nesting associates, discussed elsewhere by the writer (1954), occupied the south and southwest sides. Although there was some mixing of the species, Little Blue Herons selected the sites closest to land, American Egrets (*Casmerodius albus*) ranged in an intermediate section, and Snowy Egrets (*Egretta thula*) built in the outermost bushes near the open water, and at a lower level than the other species. At least three-fourths of the Little Blue Heron nests were in buttonbushes; the remainder in swamp privet (Fig. 1).

The water beneath most nests averaged two feet in depth during the early part of the nesting season. Since there usually is less precipitation in June and July the water level fell in mid-summer, exposing the lake bottom beneath the nests.

ARRIVAL OF MIGRANTS

The spring arrival of Little Blue Herons at Swan Lake usually is timed with the blooming of the swamp privet. The earliest spring arrival recorded was March 13, 1954, when four birds were observed. In two previous years Little Blues began arriving about the middle of March or shortly thereafter. In 1953 several pairs were feeding small young by April 21, which indicates they must have been at Swan Lake by mid-March; and on March 23, 1952, 400 birds were estimated at the heronry.

By March 27, 1954, due to an unusually prolonged cool period with daily minimum temperatures between 40° F. and 50° F., only a small segment of the nesting population had arrived at the colony, and there were no signs of mating. Wintering or migrant waterfowl using the lake at that time included Mallards (*Anas platyrhynchos*), Blue-winged Teal (*Anas discors*), Lesser Scaup (*Aythya affinis*), and Coots (*Fulica americana*). Approximately 20,000 "blackbirds" (*Agelaius phoeniceus* and *Quiscalus quiscula versicolor*) were roosting in the buttonbushes and swamp privet.

Snowy and American egrets normally arrived during the third or last week in March with "snowies" usually putting in an appearance first. Water-turkeys (*Anhinga anhinga*), the last to arrive, were first seen on April 5, 1952, April 19, 1953, and April 14, 1954.

Several authors have reported all three color phases in a Little Blue Heron breeding colony. At Wilmot, Arkansas, in June, 1910, Arthur H. Howell (1911:26) wrote of finding the three phases about equally represented. Only the adult, blue phase birds were found nesting at Swan Lake. White and intermediate phase birds roosted at the heronry during the early part of the nesting season, but later they roosted near the rice fields in which most of them fed during the day.

COURTSHIP DISPLAY

Data concerning courtship behavior were obtained between April 11 and 14, 1954. At this time some pairs already were mated and had started building nests.

Being unwilling to risk possible loss of later observations by collecting a displaying bird within the heronry itself, the writer did not determine the sex of any of the displaying birds.

Courtship display apparently takes place on the nesting territory and near the nest site eventually used, because in nearly every case observed nest construction was started subsequently near the courtship perch. Usually the same perch was used for repetition of the display, although there was some shifting about to nearby perches in the same bush, and occasionally to nearby bushes.

On the morning of April 11 a displaying bird under observation performed in a buttonbush about eight feet above the water, the average nest height for this section of the colony. Most of the herons nearby were building nests. Perched about two and one-half feet above the displaying bird was the prospective mate. The displaying bird moved twice in a sort of pumping motion from an upright position to a crouch. As it assumed the crouching position the bird opened its bill slightly, but the observer could not be certain whether or not the heron was emitting a sound. During the act the bill was pointed upwards, the back and neck plumes were extended and spread, and the wings were either drooped or spread, or both. Upon resuming a normal standing position the bird twice swayed from side to side.

One Little Blue Heron repeated its performance seven times in 12 minutes, and, at another period during the same day, 17 times in 30 minutes. The prospective mate made threatening gestures at other herons that alighted near it on the same bush, but occasionally stretched its neck in the direction of the displaying bird, looked down, and clapped its mandibles with a rattling sound. The displaying bird then usually followed suit. The prospective mate sometimes attempted to work its way toward the displaying bird, which seemed to discourage it with scolding and a darting bill. However, the former eventually reached a perch near the displaying bird and pecked at its plumes. Both birds then crossed their outstretched necks and kept up a continuous rattling chatter for several minutes, biting at each other's plumes at the posterior part of the body. Once the displaying bird flew from the perch, circled about 30 yards over the lake and returned. The other heron left several times, but always returned within two or three minutes.

At least 20 males were observed in the act of courtship display and all followed a similar pattern; but in most cases there was no indication that a prospective mate was nearby. One individual displayed within three feet of an incubating bird. Courtship continued from sunrise until sunset.

Copulatory Behavior

Copulation commenced during the initial stages of nest building, and, as a rule, took place on the nest platform. During the egg-laying period it frequently followed closely the change-over at the nest (both male and female incubate, feed, and otherwise care for the young).

During copulation, the female assumed a partial or complete crouching position and the male grasped the female with his feet close to her body underneath the wings, just beneath the shoulders. In one case the male was seen to grasp the female on the outside of the bend of the wing or shoulders. The male usually extended his wings to help maintain balance. When copulation was completed, the male stood up on the back of the female and stepped off to the side.

Promiscuity existed throughout the nesting colony, and many females were serviced more by foreign males than by their own mates. A male perched within a few inches of his incubating mate often moved over to a nearby nest, copulated with the incubating female there, and returned to his perch. This frequently was immediately preceded or immediately followed by copulation with his own mate. Females approached by foreign males sometimes stood up in their nests and fought off the males, but usually they submitted under protest; occasionally they made no effort whatsoever to ward off the promiscuous male, merely scolding it a bit after the act. Sometimes the mate of the female about to be attacked was able to prevent the intrusion; however, in at least one case I observed, the male was unable to do so. Intruding males usually approach the incubating females rapidly, whereas a female's own mate is usually much slower and more deliberate.

Promiscuous copulation was noted in 16 cases in a section of the colony during seven hours of continuous observation. Three foreign males were seen to copulate with the same female within a 45-minute period. One male attempted to copulate with five different females and was successful with four of them. In one case a foreign male attempted to copulate with an incubating male, remaining on the incubating bird during the normal period of coitus. This fact was confirmed when the latter bird's mate returned and was in turn mounted by the male, which had been incubating.

NEST BUILDING

Nest building usually began during the last week in March or the first week in April. In 1951, Robert E. Stewart and the writer found eggs in some nests on April 10; in 1952 many pairs were building on April 5; in 1953 adults were feeding young in several nests by April 21, and therefore had constructed their nests during the third week in March; and in 1954 a few nests contained eggs by April 11, but most pairs were just beginning to build.

There seemed to be no inclination on the part of herons to use the previous year's nests, many of which were almost completely intact; nor were these herons seen to remove sticks from the old nests for use in new construction. When the opportunity availed itself they would remove sticks from other newly-built heron nests as well as from the nest of egrets and Anhingas. On the other hand American Egrets and Anhingas sometimes appropriated Little Blue Heron nests, adding material to them and otherwise fashioning them for their own use.

One American Egret made four trips in 30 minutes to a Little Blue Heron's nest to obtain sticks for use in the construction of its own nest. It removed only the larger sticks, tossing the smaller ones aside. Several times while it was tugging at the larger sticks the heron's eggs almost rolled out of the nest. On another occasion, American Egrets, fighting over sticks from a Little Blue Heron's nest, shook the nest bush and all of the Little Blue's eggs fell into the water. One Little Blue Heron's nest, left unguarded, was raided by a Snowy Egret which picked up the eggs and dropped them into the water.

In the nest-building operation the male gathers most of the sticks, carrying them to the nest one by one and presenting them to the female, who works them into place. Julian S. Huxley (Bent, 1926:169), in his study of the Louisiana Heron (*Hydranassa tricolor*) at Avery Island, Louisiana, observed the same behavior. However, when the male is away from the vicinity of the nest the female sometimes gathers sticks. The male when alone at the nest, particularly during the egg-laying and incubation periods, frequently rearranges some of the sticks. One member of the pair nearly always remains at the nest during construction as well as the egg laying period, apparently to prevent removal of sticks by other birds.

Most of the sticks were gathered from the shallow water beneath the nest, but some were picked up from the dry land along the edge of the lake and occasionally they were brought in from a great distance. Frequently a bird which had been feeding brought in nesting material on the return trip. Herons often perched about six inches above the water, reaching out to pick up sticks floating by. Sometimes they waded out into the water to pick up a stick, and occasionally a heron would scoop up a stick from the water's surface while on the wing. Only occasionally were sticks broken from branches of the buttonbushes in which most of the herons were nesting.

Buttonbush twigs were used to make most nests (Fig. 2). A few weed stalks and stems were noted in many nests and one nest was constructed entirely of them. Other herbaceous material used in part for nest construction included stems and pods of a mallow (*Hibiscus* sp.) and those of a milkweed (*Asclepias* sp.). Green leaves were rarely found in nests.

A pair of herons was watched for several hours on April 14 while building a nest which at that time was in the initial stage of construction. Between 10:00 a.m. and 12:12 p.m. only one stick was brought to the nest. However, from 12:13 until 12:34 the male made six trips for sticks, never remaining at the nest for more than two or three minutes at a time. Another bird was observed to make seven trips for sticks in 12 minutes.

One heron continued to bring sticks three to four feet in length to its mate at a nest in the early stages of construction. The female dropped one 4-foot stick three times after spending several futile minutes attempting to place it in the crotch of the bush. The male continued to drop down into the water after the stick, returning it to the female. That nest was never completed and all of the sticks eventually disappeared.

Nest building at the heron colony continued throughout the day, from early morning until dusk. However, at certain nests in various stages of construction, many hours went by when not one stick was added.

Most nests were nearly complete by egg-laying time, usually requiring from three to five days to reach this stage. However, in several nests there were barely enough sticks in the platform to keep the first egg from falling through. At two nests under close observation there was a lapse of six or seven days between the beginning of construction and the laying of the first egg.

Fig. 2. Nest and eggs of the Little Blue Heron, Swan Lake, Arkansas, May 20, 1954.

Following the change-over during egg-laying or incubation periods the male nearly always made several trips to the water beneath the nest to gather sticks. This is apparently a part of the greeting ceremony.

In one section of the colony, 58 nests were on the average eight feet above the water with a maximum of 15 feet and a minimum of three feet. Several nests in swamp privet were 25 feet above the water. As many as nine nests have been counted in a single buttonbush, and most bushes had at least five.

THE EGG LAYING PERIOD

Five to eight days are required for a Little Blue Heron to lay a complete clutch of eggs, depending upon whether the clutch contained three, four, or five eggs. Thus a single egg is deposited on an average of one nearly every other day (see Table 1).

Typical behavior during the egg-laying period is illustrated by the following record of the activities of one pair on April 17. The male was found standing over the single egg in the nest, which posture it alternated with an incubating one for the ensuing 35 minutes. When the female returned the male stood up in the nest. The female sidled in under the male, gently pushing him aside and began moving the egg about in the nest, then rearranging several sticks. Meanwhile the male walked out on a limb about two feet from the nest, where he remained for seven minutes. He returned to the nest and copulation took place. The female left the nest, returning after 25 minutes to move in under the standing male as before. Once again she moved the egg about and tugged at a few sticks before settling down upon the egg. A few minutes later a second egg was deposited and the female stood up in the nest where the male joined her. The two stood together some 15 minutes before the female left and the male settled down upon the eggs.

Each time one bird returned to the nest after being away for a time, elaborate greetings were exchanged. The pair would repeatedly call "*quip-a-quee, quip-a-quee*" to each other, peck at one another's plumes and cross outstretched necks. Although the latter displays gradually diminished and, at later stages, were discontinued, the vocal greetings were regularly exchanged between the members of the pair throughout nearly all phases of the nesting period.

Clutch Size

Bent (1926:179) says that, "The little blue heron usually lays four or five eggs, sometimes only three, and occasionally six." Clutch size in 50 nests at Swan Lake ranged from three to five eggs with an average of 4.04 per nest. Nine nests contained five eggs, 34 contained four eggs each, and seven contained three eggs. Additional eggs may have been laid in any of these nests, but could have been knocked out or removed.

Incubation

At virtually all nests under observation, incubation began after the laying of the second egg. This was evident not only from observations of incubating birds at nests containing only two eggs, but was confirmed in several nests at hatching time. Nests Nos. 7 and 12 (Table 1) contained four eggs on April 24 at 5:00 p.m. On May 10, at 5:00 p.m., there were two newly hatched young and two eggs in each nest. The following day at 12:00 noon there were still two eggs and two young in the nests.

Sprunt and Chamberlain (1949) list the incubation period of the Little Blue Heron as 21 to 23 days. The incubation period for the Swan Lake birds was 22 to 24 days; however 22 or 23 days was the rule (see Table I).

TABLE 1

EGG-LAYING AND HATCHING DATES AT 10 NESTS OF LITTLE BLUE HERONS, SWAN LAKE, JEFFERSON COUNTY, ARKANSAS, IN 1954.

(Number of eggs and/or young in individual nest)*

Date	Nest No. 1	Nest No. 2	Nest No. 3	Nest No. 4	Nest No. 5	Nest No. 6	Nest No. 7	Nest No. 8	Nest No. 9	Nest No. 10
Apr. 17	1 egg	1 egg	0 eggs	1 egg	2 eggs	2 eggs	1 egg	1 egg	2 eggs	2 eggs
Apr. 18	2 eggs	1 egg	1 egg	2 eggs	2 eggs	3 eggs	2 eggs	1 egg	3 eggs	3 eggs
Apr. 19	empty	2 eggs	1 egg	3 eggs	3 eggs	3 eggs	2 eggs	2 eggs	3 eggs	3 eggs
Apr. 20	—	3 eggs	2 eggs	3 eggs	3 eggs	4 eggs	3 eggs	2 eggs	4 eggs	4 eggs
Apr. 21	—	3 eggs	2 eggs	4 eggs	4 eggs	4 eggs	4 eggs	3 eggs	4 eggs	—
Apr. 22	—	4 eggs	3 eggs	4 eggs	—	5 eggs	—	4 eggs	5 eggs	—
Apr. 23	—	—	4 eggs	5 eggs	—	—	—	—	—	—
May 10	—	—	—	—	2 eggs 2 young	3 eggs 2 young	—	—	4 eggs 1 young	2 eggs 2 young
May 11	—	—	—	—	—	2 eggs 3 young	—	—	3 eggs 2 young	—
May 12	—	—	—	2 eggs 2 young	1 egg 3 young	1 egg 4 young	1 egg 3 young	2 eggs 2 young	2 eggs 3 young	4 young
May 13	—	2 eggs 1 young	—	—	—	—	—	1 egg 3 young	1 egg 4 young	—
May 14	—	—	2 eggs 2 young	—	—	—	—	—	—	—
May 15	—	2 young	1 egg 3 young	empty	4 young	4 young	3 young	4 young	empty	4 young

*Nests inspected for contents at 5:00 p. m.

The members of a pair seldom are together for any length of time during the incubation period. One bird was incubating at nest No. 7 when observations began at 10:58 a.m., April 24. At 12:31 p.m., the mate returned and the bird that was relieved left the scene immediately. On this same date at nest No. 6, after the change-over, the bird that had been incubating gathered sticks and presented them to the incubating bird for about 15 minutes, then left the scene. At another nest the mate flew in for the change-over at 11:45 a.m. It stopped about two feet short of the nest. The incubating bird then stood up, moved to the nearest nest (three feet away) and copulated with the bird on that nest, then climbed about three feet above its own nest and preened as its mate moved in and settled on the eggs. In about a minute it left the area.

The typical routine of the incubating bird was recorded during an hour's watch on April 24: At 11:20 a.m. (temperature 85° F.) bird at nest standing over five eggs, shading with drooped wings, bill open and apparently panting; at 11:24 bird settled on eggs with bill open and panting; between 11:28 and 12:20 p.m. it stood up in nest six times, twice to chase off intruding Little Blues, once when a tractor passed by 40 yards away, and three times to preen or rearrange sticks in nest.

In 1954 hatched young were noted in nests during the first week in May, but the peak of the hatching period was toward the latter part of the second week in May. In three previous nesting seasons the first young were found in nests during the third or fourth week in April.

Within a few minutes after hatching, the egg shell is tossed out of the nest by the adult in attendance.

Care and Behavior of Young

Incubation and brooding overlap at hatching time because it takes from three to five days for the entire clutch to hatch. The young therefore are brooded much of the time during their first week of life. At one nest, newly hatched young were covered by an adult approximately 80 per cent of the time from 12:00 noon until 5:30 p.m. Both parents shared in brooding the young with the change-over essentially the same as during incubation.

During the first three or four days the young were fed upon regurgitated food dropped into the nest by the attending parent. The mass of food, if round in shape, was sometimes the size of a golf ball. The young lost no time in attacking the food, even appearing to choke on some oversized morsels.

On May 8, from 12:00 p.m. until 5:30 p.m., observations were made at nest No. 60 which at that time contained three young from two to three days old and two unhatched eggs. One parent bird remained at the nest until 3:14 p.m., occupying its time with brooding the young, shifting position, chasing off intruders, regurgitating food into the nest for the young on five different occasions, and nibbling at some of its regurgitated food. At 3:14 the mate returned and resumed brooding. Two hours later it regurgitated food in the nest for the first time since its return.

By the end of the first week the method of feeding changed and the young were taking food from the parent's bill. This was done by grasping the parent's bill crosswise near the base and tugging at it until the regurgitated food was forthcoming. This procedure is well narrated by Dr. A. H. Cordier (cited in Bent, 1926:180), and similar behavior on the part of an American Egret is described by Bent (*op. cit.*:138).

When a foreign adult alighted near the nest the young poked their heads at the intruder and moved over toward it to be fed, but the adult bird only threatened them with poking bill and backed away or flew off. Sometimes the young attempted to move over to a nearby nest to be fed by the adult in that nest, but they were fast discouraged by the darting bill of that parent.

During the second week the young began to stand in their nests and to walk out short distances on nearby branches. However, most of the time was still spent in the nest where the parents brooded less, usually by merely standing over the young with wings drooped. Sometimes when a parent was perched several feet from the nest the young attempted to climb to it and grasp its bill for food.

Observations at nest No. 60 were continued for a short period of time on the afternoon of May 16. The young at this time were in their second week. Adults exchanged places at the nest at 2:55 p.m. During the next four minutes the parent at the nest fed the young, one four times, another three times, and a third twice, while the smallest or fourth received nothing. The adult standing on the edge of the nest with its back to the sun began brooding by bending its knees slightly, spreading its wings forward and parting its breast feathers. During a 20-minute siesta one of the young remained completely outside the canopy formed by the parent and slept with its bill tucked beneath its wing. The adult, again beset with demands for food, fed only one nestling at that time; then, after preening on a nearby perch for about 15 minutes, it returned to the nest and began to brood once again, pushing the young downward in the nest with its feet. The smallest young tried to get the parent to feed it, but there was no response. Seventeen minutes later the parent again moved out on a branch where it preened and rested approximately 24 minutes before returning. It left the nest when its mate returned at 4:33 p.m. The three older young were fed almost immediately by the returning parent. When they had obtained their fill the fourth and smallest was fed. Sometimes the smallest bird in the clutch picked up a scrap that was accidentally dropped by one of the older nestlings.

By the third week the young were spending more time out on the branches than in the nest, climbing awkwardly about branches, sometimes to the top-most part of the bush to exercise their wings (Fig. 3). Occasionally a young bird lost its balance and fell part way off a branch, but by maintaining its grip it eventually regained its balance on the perch by the use of its neck, bill, feet and wings. The parents were never seen to offer any help in such a situation. During their third week three young birds which were placed in the water were able to maneuver well enough to return to the nest.

Fig. 3. Juvenile Little Blue Herons approximately one month old. Swan Lake, Arkansas, June, 1953.

The young generally remained closer to their own nests than to others, seldom wandering near other nests unless frightened. Straying young were chased away from other nests or nest bushes by the parent bird or the young of that nest. Juveniles out on branches near their nest returned to defend it. I have seen a young Little Blue Heron in its nest inflict painful blows at the neck of an intruding juvenile, sending it away as hurriedly as the itinerant could move; and I have seen this happen to the same stray bird three times in succession.

When a parent returned to its nest, young out on the branches usually hurried back to be fed. Occasionally one or two of the young failed to return and then the parent flew or walked to the branch to feed the young there. However, it was evident that parent birds preferred to feed the young in the nest.

The parents of young in the third week stayed away from nests for increasingly longer periods of time. I observed feeding of young by incoming parents at nests Nos. 90 and 8 at which there were periods of 2 hours, 8 minutes and 2 hours, 46 minutes respectively, during which no parent was in attendance.

By the time the young were a month old they were able to make short flights to nearby bushes or limbs. On August 1, 1953, I observed for some time the feeding of the juvenile birds some distance from the nest. A great many of the younger juveniles, about one month old, remained for the most part within a given area and the adult bird returned to that area to feed them. However, the older juveniles often followed the adult bird about the colony; sometimes two or three juveniles could be seen flying behind the adult bird as it circled far out over the lake. Some such flights lasted at least five minutes. When the adult finally came to a resting place the young were usually but not always fed. Generally when the adult returned with food it did not go directly to the young, but was pursued persistently from bush to bush until overtaken by them.

Since some of the juveniles move about so much it is entirely possible that they are fed by many different adult birds.

Nesting Success

Fifty nests were tagged so that nesting success could be appraised. Later, when young about two weeks of age began to wander widely and even join young from other nests, observations were concentrated on 30 of the 50 nests originally selected. The 124 eggs laid in 30 nests produced a total of 92 young reared to two weeks of age. Of 30 nests, 28 produced one or more 2-week-old young. In ten randomly-selected nests 32 young were hatched, and at two weeks, 26 had survived.

The principal cause of egg losses during the laying and incubation periods appeared to be nest robbing (for sticks) by other herons and egrets. Some eggs were infertile. Eggs laid in partially-completed nests may have rolled out or fallen through the meager platform during periods of high winds. Fish Crows (*Corvus ossifragus*) were seen stealing eggs on several occasions, and a Baltimore Oriole (*Icterus galbula*) was seen to puncture the eggs at one Little Blue Heron nest. Very small young were occasionally pushed out of the nest by the older siblings, or perhaps fell out.

The ponds or lakes over which many of the heronries in the lower Mississippi Valley are located dry up in June or July, thus exposing the young to attack by mammalian predators. At several nests, herons two or three weeks old apparently were killed and partially eaten by raccoons (*Procyon lotor*), since the tracks of this predator led to the nest bush in which the dead young were found. A domestic cat (*Felis domesticus*) was observed jumping from one nest to another. It is possible that the several thousand Black Vultures (*Coragyps atratus*), roosting at the Benoit, Mississippi, heronry may have preyed upon young herons, particularly those young that fell out of their nests onto the dry lake bed.

FOOD OF YOUNG

Food for the young was obtained mostly from "borrow pits" along the Arkansas River levee, bayous, and rice fields. Little Blue Herons, along with American and Snowy egrets, came into rice fields as soon as the fields were flooded, at a time when the rice was six inches to one foot high. This flooding was begun in May and the herons appeared promptly and continued to feed

TABLE 2

FOODS ITEMS OF YOUNG LITTLE BLUE HERONS, LISTED IN ORDER OF THE NUMBER OF PELLETS IN WHICH EACH WAS FOUND.

Dytiscidae larvae (predaceous diving beetles)	20
Libellulidae nymphs (dragonflies)	17
Belostomatidae (giant water-bugs)	14
Rana pipiens (leopard frog)	13
Cambarus sp. (crayfish)	12
Arachnida (spiders)	11
Hydrophilidae larvae (water-scavenger beetles)	9
Gryllidae (crickets)	8
Lissorhoptrus simplex (rice water weevils)	8
Lepomis sp. (sunfish)	7
Tabanidae larvae (horseflies)	7
Noctuidae larvae (cutworms)	7
Notonectidae (back swimmers)	6
Undetermined fish	6
Carabidae (ground beetles)	5
Acrididae (short-horned grasshoppers)	4
Other land Coleoptera	4
Hyla cinerea (green tree frog)	4
Tettigoniidae (long-horned grasshoppers)	3
Solubea pugnax (rice stink-bug)	3
Scarabaeidae (scarab beetles)	2
Stratiomyidae (soldier flies)	2
Hydrophilidae (water-scavenger beetles)	2
Esox sp. (pike)	2
Undetermined insects	2
Elateridae (click beetles)	1
Gyrinidae? (whirligig beetles)	1
Copiphorinae (cone-headed grasshoppers)	1
Oryza sativa hull (rice)	1
Echinochloa sp. (barnyard grass)	1

in the rice fields throughout the summer. A field in which the rice had attained a height of several feet usually was deserted in favor of a field where the rice was shorter. Little Blues were seen feeding all over the rice field but usually preferred the "borrow" along the contour or levee. By feeding on crayfish (*Cambarus* sp.), a favorite food, the herons were perhaps performing a service to the farmer since crayfish are known to make holes in the levees.

Determination of food items fed to the young Little Blue Herons was revealed by examination of 50 regurgitated pellets collected beneath nests containing young from one to four weeks of age. Most of the pellets were obtained on July 11, 1953, after the section of the lake over which the herons were nesting had dried up. The young in question readily regurgitated the material when alarmed by my presence (see Table 2).

LATE SUMMER ACTIVITY

On August 1, 1953, there were still at least 300 adult and juvenile Little Blue Herons at Swan Lake. All of the young observed were out of their nests, although several evidently had not been out more than a few days. The youngest birds observed could not fly. Most of the herons, egret, and Anhingas left the heronry by the last week in August.

Little Blues remained in the general area until about October 1, many of them feeding in the nearby rice fields. American Egrets, with which they had been feeding in the rice fields all summer and early fall, were still plentiful during the last week in October, thus remaining about a month later than the Little Blue Herons.

SUMMARY

A nesting study of the Little Blue Heron was made at Swan Lake, near Pine Bluff, Arkansas, in 1952, 1953, and 1954. This heronry, like many in the lower Mississippi Valley, was located in an old riverbed lake surrounded by cotton fields. Only adult (blue phase) birds nested at Swan Lake. Nesting associates were the American Egret, Snowy Egret and Anhinga. Most of the birds nested in buttonbushes. The earliest recorded spring arrival date was March 13, 1954. In the courtship display the performing bird moved from an upright position to crouch twice in a sort of pumping motion. At the conclusion of the pumping it assumed a normal standing position and swayed from side to side twice. Copulation took place at the nest. All males under observation engaged in promiscuous copulation. Nest building began in late March and early April. The male gathered most of the sticks, presenting them to the female at the nest. There was much stick robbing from nests by other Little Blues, Egrets and Anhingas. Five to eight days were required for completion of a clutch, depending upon the number of eggs laid. Clutch size in 50

nests averaged 4.04 eggs. During the egg-laying period, the male remained at the nest most of the time. Incubation usually began after the laying of the second egg. The incubation period was 22 or 23 days. Both parents shared in incubation and in brooding and feeding the young. At one nest, newly-hatched young were brooded 80 per cent of the time. During the first three or four days nestlings were fed upon regurgitated food dropped into the nest by the parent. By the end of the first week the young were taking food from the parent's bill. During the second week young stood up in the nest. Parents preparing to brood sometimes used their feet to push young downward in the nest. By the third week the young were spending most of their time on branches near the nest, and at about one month were making short flights. In 30 nests, 124 eggs laid produced a total of 92 young herons two weeks of age. One or more young, two weeks of age, were produced in 28 of those 30 nests. Principal cause of egg losses appeared to be nest robbing (for sticks) by other herons, egrets, and anhingas. Tracks leading to certain nests containing dead young indicated that the raccoon probably was an important predator when the lake bottom was dry. Analysis of pellets regurgitated by young Little Blue Herons revealed at least 30 different food items, among which aquatic beetles and their larvae, dragonfly nymphs, giant water-bugs, frogs and crayfish were important.

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ARTIFICIAL INCUBATION OF SOME NON-GALLIFORM EGGS

BY RICHARD R. GRABER

ALTHOUGH there is an extensive literature on artifical incubation of eggs of domestic chicksns and some other galliform birds, relatively little has been published concerning artificial incubation in other birds. Data gained from artificial incubation of wild birds' eggs may have great importance in several phases of ornithology. For example, might not the tolerance of the embryo for humidity or extremes of temperature be an important limiting factor in the breeding distribution of a given species? Also, why is there great variation in length of incubation period among some closely related species? By controlling and varying the conditions of temperature and moisture in the incubation chamber, many such questions could be answered at least partially. Uniformly-incubated eggs are also useful material in cytogenetic studies and studies in comparative embryology.

During the summer of 1954 I tried to determine what problems were involved in a study on artificial incubation, and gathered the few data presented, with a minimum of crude equipment and in the spare time from another project.

Methods

As an incubator I used an asbestos-walled drying oven which measured 10 × 10 × 12 inches. I fitted it with a cartridge-type thermoregulator with a range from minus 100 to 400 degrees F. In the bottom of the oven were metal coils which provided the heat source when connected to standard 110-volt electric circuit. The incubator had two ¼-inch mesh hardware cloth shelves about equidistantly spaced in the chamber. On the bottom shelf (nearest the heating coils) I placed a shallow 9 × 9-inch cake pan which I kept filled with water as a source of moisture for the eggs. The top shelf I used as an egg tray. No fan to stir the air in the incubator was used; this probably would have greatly enhanced temperature constancy.

The question of the temperature to use in incubation was difficult to decide. Baldwin and Kendeigh's work on bird temperature (1932), and Huggins' (1941) work on egg temperatures guided me to a certain extent. Kendeigh (1940:507) stated that "Romanoff (1934) found an increased rate of growth and percentage hatch of pheasant and Bob-white embryos up to 38.3° or 38.9° C. but a distinct retardation at 40.6° C." However, since I planned to work largely with Bell's Vireos (*Vireo belli*), a common species in central Oklahoma whose nests are easily found, I tried to learn about incubation temperatures in this species. This I did by inserting a maximum-registering thermometer through the wall of a vireo nest so that the bulb rested in the midst of the eggs. In this manner I checked a few different nests by leaving the thermometer in place over night and taking a reading on the following morning. Maximum temperatures obtained in this way on different nests were 99°, 100°, and 102° F. Outside temperatures during these tests in early June ranged from 70° to 80° F., both mornings and evenings.

I finally planned to run the incubator at about 38° C. (app. 100° F.), but the best adjustment I could make produced a range from 36.5° C. (98° F.) to 39° C. (102° F.) By keeping a maximum-registering thermometer on the egg tray I knew the maximum temperature to which any egg was exposed. Shortly after I introduced the first eggs into the incubator, its temperature range increased to a usual high of 40° C. (104° F.) from a low of 36.5° C. (98° F.). This was the usual fluctuation throughout the study, though a few times the temperature fell to 35° C. (95° F.) and rose to 41° C. (106° F). On one occasion each, the temperature rose to 42° C. (108° F.), 44.5° C. (112° F.), and 49° C. (120° F.). These 'accidents' helped show the extent of heat tolerance in Brown-headed Cowbird (*Molothrus ater*) and Cardinal (*Richmondena cardinalis*) embryos.

I had no apparatus for recording temperature or humidity, so the figures represent only my recordings. I noted temperature and relative humidity at least four times each 24 hours, and once made 19 recordings in one 17-hour period. Readings of temperature were taken from one Centigrade (–20° to 110°), and one Fahrenheit (–30° to 120°) thermometer. These were inserted in corks in the top of the incubator so that their bulbs were near the egg tray, but the bulk of the columns could be read outside the incubator. These thermometers and the maximum registering thermometers used showed good correlation in reading. I had less control of humidity in this small chamber. Relative humidity readings were taken with an aspirator-type psychrometer, by placing the end of the aspirator against a hole (which was ordinarily covered) in the top of the incubator.

The average of the total (160) recorded incubation temperatures for the entire study period (June 8 to July 11) was 37.5° C. (100° F.) The average of all humidity readings was 59.7 per cent (minimum, 40 per cent; maximum 74). Once I had put eggs into the incubator I made no further adjustment, but merely recorded the conditions that existed. Eggs were exposed to room conditions three times a day for less than one minute, at about 4:00 a.m., 12:00 p.m., and 9:00 p.m., when I turned each egg by hand. All eggs were collected in the vicinity of Cogar, Caddo County, Oklahoma, and were taken directly from nest to incubator. Each egg was numbered and weighed on a centigram balance before it was put into the incubator. The time and date of entry were recorded. I also weighed some partially-incubated eggs, and in a few cases obtained the weights of dry, freshly-hatched birds.

RESULTS

Eggs of the Mourning Dove (*Zenaidura macroura*), Yellow-billed Cuckoo (*Coccyzus americanus*), Bell's Vireo, Brown-headed Cowbird, Cardinal, and Painted Bunting (*Passerina ciris*) were hatched successfully in the incubator, though only the ages of the vireo eggs and two of the dove eggs were known.

Table 1 summarizes part of the data on five species. The period indicated under pipping and hatching is not the true incubation period, of course, but only the period of artificial incubation.

TABLE 1

PARTIAL SUMMARY OF ARTIFICIAL INCUBATION DATA

Species	Egg No.	Days and hours incubation pipped;	hatched	Incubation temperature (1) Average		Minimum		Maximum		Relative Humidity Avg.	Min.	Max.
Zenaidura macroura	1	11- 1	11- 5	37	(98.5)	35	(95)	41	(106)	50	41	60%
	2	12-16	13-20	37		35		41		50	41	60%
	3	13- 0	14-13	37		35		41		50	41	60%
Coccyzus americanus	1	9- 0	9- 4	38.5	(101)	35		42.5	(108)	60	40	74%
	2	7-14	8- 0	37.5	(99.5)	35		41	(106)	54	43	66%
Molothrus ater	1		8- 7	38.5		36.5	(98)	49	(120)	58	40	74%
	2		1- 0	38	(100.5)	36.5		42	(108)	60	52	68%
	3	9-12		38.5		35		44.5	(112)	60	41	74%
	4		9-12	38.5		35		44.5		60	41	74%
Richmondena cardinalis	1		7- 0	38.5		36		48.9	(120)	58	40	70%
	2	7-10	7-18	38.5		36		48.9		60	40	74%
Passerina ciris	(2 eggs)		1-16	39	(102)	36.5		41		63	48	68%

1. Degrees Centigrade, followed by Fahrenheit equivalent (in parentheses).

Some of the species warrant more detailed discussion and tabulation. They will be considered in order of the amount of data.

BELL'S VIREO EGGS

Twelve Bell's Vireo eggs (three clutches) were incubated; of these nine pipped but only five hatched (three of one clutch, one of each of the others). Of the four which pipped but did not hatch, all apparently were normally formed, and only one had not absorbed all of the external yolk. Three eggs were not pipped. I broke one of these in handling, perforated another with a minute hole, and the third, the last egg laid in clutch 1, showed no obvious development after 16 days of incubation. Data on this species are summarized in Tables 2 and 3.

Incubation began with the second egg in clutch 1, but I believe (for reasons given below) that it began with the third egg in clutches 2 and 3.

The variation in weight of eggs from different clutches is interesting and reflected a difference in size which was conspicuous, although I made no measurements. Note difference in weights of eggs *2, 3* and *2a, 3a* at same age (Table 3), and the progressive increase in egg weight from the first to the last egg in the clutch, in all three clutches. Note also that the three eggs of clutch 3 which hatched were also the smallest (lightest). Egg *4,* which showed no development, lost weight at the same rate as developing eggs. Egg *1a,* which was minutely perforated, lost about half its weight in 11 days. In this period weight loss of developing eggs averaged 5.4 per cent of initial weight in clutch 1 (heavier), and about 4 per cent in clutch 2 (lighter).

TABLE 2

INCUBATION DATA FOR THOSE BELL'S VIREO EGGS IN WHICH DEVELOPMENT WAS COMPLETED

(Time counted to perforation of shell in pipping. Eggs checked at least every four hours during the day.)

Clutch No.	Egg No.	Incubation by birds		Incubator Total		Total Incubation	Incubation Temperature (1)			Relative Humidity	
		days	hours	days	hours		Average	Min.	Max.	Avg.	Min.
1	2	2	12	12	12	15 days 0 hrs.	37.8 (100)	35 (95)	42.5 (108)	41	62
	3	0	14	14	21	14 days 21 hrs.	38 (100)	35	44.5 (112)	41	62
2	2a	1	10	13	12	14 days 22 hrs.	37.8	35	42.5	41	62
	3a	1	10	13	12	14 days 22 hrs.	37.8	35	42.5	41	62
	4a	0	10	14	13	14 days 23 hrs.	38.3	35	42.5	41	62
3	1b	6	6	8	18	15 days 0 hrs.	37.2	35	41 (106)		
	2b	6	6	8	20	15 days 2 hrs.	37.2	35	41		
	3b	6	6	9	2	15 days 8 hrs.	37.2	35	41		

The incubation period in each case was within a few hours of 15 days, that is, to the time of pipping through the shell. The data are presented in this way because more birds pipped than hatched, and those which hatched successfully did so within about six hours of breaking the shell. Pitelka and Koestner (1942: 99) give the incubation period for this species as 14 days. The discrepancy between this figure and mine is not surprising, but it is interesting that the artificial incubation period did not change even when natural incubation was performed on four eggs for over a third of the period. The incubation period was especially uniform within the clutch. If the period may vary from clutch to clutch (it seemed to vary slightly even under similar incubation conditions), this is of interest because the shortest possible incubation period that produces sound hatchlings obviously has the best survival value. This suggests a reason why there is much variation in incubation period among closely related species (as in *Vireo*). It is probably an important factor in 'success', i.e., broadness of distributional range or density of population among birds.

Three of the four eggs which were incubated by the parent for the longest

Table 3

Weight Relationship of Bell's Vireo Eggs

Egg	Date laid*	Date entry incubator	Weight (grams)	Second weighing		Date and hour pipped	Weight hatched bird	Remarks
				date	grams			
1	June 12	June 15	1.67					broken June 23
2	June 13	June 15	1.79	June 26	1.70	June 28 5:00 a.m.	1.50	hatched June 28 by 4 p.m.
3	June 14	June 14	1.81	June 26	1.70	June 29 4:00 a.m.		dead in egg June 29
4	June 15	June 15	1.82	June 26	1.73			no development after 16 days incubation
1a	June 12	June 15	1.31	June 26	.72			minutely perforated on June 19
2a	June 13	June 15	1.43	June 26	1.36	June 29 4:00 a.m.		helped from shell at pipping
3a	June 14	June 15	1.52	June 26	1.47	June 29 4:00 a.m.		dead in egg June 29
4a	June 15	June 15	1.63	June 26	1.57	June 30 5:00 a.m.		helped from shell at pipping; died shortly
1b	June 21	June 29	1.29					hatched July 8 by 11:00 a.m.
2b	June 22	June 29	1.24					hatched July 8 12:00 p.m.
3b	June 23	June 29	1.25					hatched July 8 4:00 p.m.
4b	June 24	June 29	1.35					dead in egg July 9

*All eggs laid in early morning

period hatched successfully, as opposed to two of five (that pipped) that were largely artificially incubated. However, egg *4a* might have succeeded without my interference. If temperature were a factor in the apparent reduced vitality of the birds which pipped but did not hatch, then a lower temperature would probably have favored them, in view of Romanoff's findings (see above), and the fact that Huggins (*op. cit.*) found egg temperatures of wild birds to average several degrees lower than the average temperature in my incubator. I would expect the temperature of an egg in my incubator to be at least as high as the average incubation temperature since the 'attentive' period is virtually uninterrupted.

Romanoff (1949) discussed the periods and causes of mortality in avian embryos. He pointed out several causes of death in the late critical period and "that at the end of the developmental period the cumulative effect of all unfavorable conditions may be felt." I noted that I could often hear the embryo tapping on the inside of the shell a full day before any noticeable mark could be seen. Generally the first marks were mere bulges which appeared several hours before the shell actually was perforated. The fact that three birds which died before hatching had actually perforated the shell in a place or two, made me wonder if thinning of the shell by wear in the nest is not a factor in hatching success. Eggs from my incubator were not worn much by my system of turning since I picked the egg up without rubbing it against any surface. I seriously doubt that thickness of the shell is an important factor unless the embryo is weak anyway.

Hanson (1954) has recently shown that the increasing opacity of the egg with development of the embryo has utility as a fairly accurate indicator of age in incubated eggs and in determining with which egg of the clutch incubation began, especially in whitish or non-opaque eggs. On the sixth day of natural incubation I could see by candling the eggs in sunlight that eggs *1b*, *2b*, and *3b* were equally opaque to a degree that the vascular net could just be detected. Egg *4b*, on the other hand, was much less opaque and I could see the vascular net very clearly. The first three eggs also pipped and hatched together, while *4b* pipped considerably later. After the embryo reaches a certain stage, the degree of opaqueness does not change, but until that time the feature has a practical application. (See also the table on Mourning Dove development.)

Mourning Dove Eggs

The two eggs of *Zenaidura* clutch 1 were found on June 23, and were placed in the incubator at 12:00 noon when egg *1* weighed 5.68 grams, and *2* weighed 6.24 grams. Candling in sunlight showed a distinct embryo and vascular net in egg *1* while egg *2* showed no obvious development. The later egg was also heavier in the other clutch (see Table 4). On June 26, egg *1* weighed 5.55 grams and *2* weighed 6.24 grams. Other data on these eggs are summarized in Table 1.

On June 25 I found the first egg of clutch 2. It was being incubated in mid-morning. The second egg was laid on the morning of June 26, and I placed both eggs in the incubator on that date at 11:00 a.m., directly from the nest. Table 4 summarizes apparent development observed by candling, and other data on these eggs.

TABLE 4

DEVELOPMENT OF TWO MOURNING DOVE EGGS AS OBSERVED BY CANDLING

Date	time	Egg 3	Egg 4
June 26	11:00 a.m.	6.53 grams no obvious development	7.16 grams laid by 10:00 a.m. no obvious development
June 27	9:00 p.m.	no obvious development	no obvious development
June 28	5:00 a.m.	definite vascular net over one-fourth egg area (surface)	no obvious development
	9:00 p.m.	vascular net spread over one-half egg area	clouded in central band but no definite structure apparent
June 29	12:00 p.m.		no change apparent
	9:00 p.m.		small but distinct embryo and vascular net that covers about one-third of egg area
July 9	10:00 a.m.	egg shell bulged slightly but not pipped thru	
July 10	9:00 p.m.	hatched between these hours	
July 11	6:00 a.m.	dry at this time	
July 14	p.m.		embryo pecking inside egg shell shell not visibly marked
July 15	p.m.		egg opened; embryo dead, fully developed but some yolk not absorbed.

Three days and at least 11 hours were required for egg *4* to reach the stage of development that egg *3* had reached at 5:00 a.m. on June 28. Assuming a similar rate of development in both, the incubation period of egg *3*, largely under artificial conditions (see Table 1), was between 14 days, 16 hours, and 15 days. Fifteen days is the period in nature, according to Bent (1932:405). The average incubation temperature for the dove eggs was 37° C. (98.6° F.), and Huggins (*op. cit.*:150) found the average temperature to be 36.2° C. (97° F.) in the dove eggs he checked in nature. The correlation of incubation period in nature and in my incubator is very close for this species. Examine the comparable situation with the vireos. Huggins' (*loc. cit.*) figure for average egg temperature for three Red-eyed Vireo (*Vireo olivaceus*) eggs was 32.7° C. (91° F.). If that for Bell's Vireo is comparably low (in nature), then high incubation temperature was a likely factor in the increased incubation period (15 days as opposed to 14 in nature) of vireo eggs under artifical conditions, as well as in the increased mortality of embryos.

BROWN-HEADED COWBIRD EGGS

Data on *Molothrus* eggs are partially summarized in Tables 1 and 5. Three of five cowbird eggs(nos. *1*, *2*, and *4*) hatched in the incubator. Egg no. *3* pipped but did not hatch. When I opened this egg the following day I found that the skin of the head adhered to the shell membrane. Otherwise the embryo appeared normal. The history of these eggs deserves brief description. Egg *1* had been incubated by vireos at least one day, and was subsequently deserted for at least one day. During the 24-hour inattentive period the local weather station recorded temperature extremes of 65° to 90° F., which was probably the minimum range to which the egg was exposed. In addition it was once exposed to a temperature of 49° C. (120° F.) in the incubator, yet it hatched within nine days of these exposures. Eggs *3* and *4* were incubated by vireo hosts for at least three days before being deserted. They were unattended at least 15 hours before I placed them in the incubator. During this period of inattention they were exposed for a full night, during which there was a brief cool shower, and temperatures as given by the local weather station ranged between 61° and 87° F. On the fourth day of incubation these eggs were exposed to a temperature of 45° C. (112° F.) ; even so egg *3* pipped, and egg *4* hatched after 9½ days of incubation.

TABLE 5

SUMMARY OF DATA ON WEIGHT OF COWBIRD EGGS AND YOUNG

Egg no.	Date entry incubator	grams	2nd date weighed	grams	Date pipped or hatched	Wt. of hatched bird (grams)
1	9 June	2.89	14 June	2.86	17 June	2.32
2	14 June	3.01			15 June	2.54
3	15 June	2.68			25 June	
4	15 June	2.88			25 June	2.30
5	19 June	2.85	26 June	2.72	(anomalous embryo died in shell)	

This apparent broad temperature tolerance of cowbird embryos would seem definitely to be advantageous in view of the breeding habits of this species. It led me to experiment by keeping three cowbird eggs on a tray in my work room where the daily temperature (in July) rose to about 102° F. and fell at night to between 70° and 85° F. I turned them as I did the incubator eggs, but otherwise they were subject to the environment of the room. My relative humidity records of the room for this period have been lost, but figures from the weather station indicate a range from about 30 to 68 per cent. My records for June in the incubation room average about 60 per cent, but I am sure that the July average was considerably lower. The three eggs lost an average of 8.3 per cent of their initial weights in nine days, and none showed development at the end of that time.

Cowbird egg *2* came from a Painted Bunting nest, and was introduced into the incubator at the same time as the host eggs. The parasite hatched about 16 hours in advance of the host young, and all hatched within two days of entry into the incubator.

In connection with study of artificially-incubated eggs, a fascinating side project suggests itself. Observation of hatchlings introduced to foster parents offers interesting possibilities. Rather than destroy some of the hatchlings, I offered them to foster parents. I put two Painted Buntings (eggs *1* and *2*) and a Cardinal (egg *1*), which hatched about the same time, in a Painted Bunting nest after taking its contents of eggs. All of these birds fared well and fledged. There was no apparent conflict between young and adults, and the adult buntings did not seem unduly strained in keeping the entire brood fed. A Cardinal (egg *2*) which I turned over to a pair of Bell's Vireos did poorly after the third day. It seemed actually to be starving and left the nest after only six days. I doubt that it survived. This Cardinal was placed in the nest of the parents of vireo clutch 1 within a few hours of the laying of the fourth egg of the clutch. The vireos stayed within a few feet and saw me remove their eggs and leave the hatchling, yet they accepted the condition without hesitation and were bringing green larvae to the Cardinal in less than one minute. I placed egg shells in the nest with each young bird, and invariably these were removed immediately. Vireos from eggs *2* and *2a* were placed in a Bell's Vireo nest on June 29. They fledged successfully on July 10 and 11 respectively. The time required for a complete cycle of these two eggs from laying through artificial incubation and fledging was 27 days. I mention these cases because they seem to present a clear insight into certain facets of bird behavior, and I believe such experiments, if well planned, could have scientific value.

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SUMMER ACTIVITIES OF THE LAPLAND LONGSPUR ON BAFFIN ISLAND

BY GEORGE M. SUTTON AND DAVID F. PARMELEE

FROM June 14 to August 22, 1953, we studied the birds of southern Baffin Island, while living at the Royal Canadian Air Force Base near the head of Frobisher Bay. Among the buildings the Lapland Longspur (*Calcarius lapponicus*) was the most noticeable, if not actually the commonest, bird. With the Snow Bunting (*Plectrophenax nivalis*), Horned Lark (*Eremophila alpestris*), Water-Pipit (*Anthus spinoletta*), and Semipalmated Plover (*Charadrius semipalmatus*), it was in evidence most of the time, both day and night, in the latter half of June and early July.

The longspur inhabited all wet grasslands of the vicinity, notably those of the extensive flats just north of the Base, and of Davidson Point, a mile or so west of the Base, near the mouth of the Sylvia Grinnell River (Fig. 1). Not all longspur-inhabited meadows were low, extensive and level, however. Sloping ones, of varying size and shape, but often only two or three rods wide, bordered tiny snow-fed streams among the foothills. More level ones, of greater elevation, occupied depressions on the hilltops or formed the margins of lakes. The commonest bird of rocky country and therefore of the region as a whole was, of course, the Snow Bunting; but wherever there was a wet, grassy meadow the longspur was apt to be. Wynne-Edwards (1952:385), who considered the longspur the commonest bird of the low ground at the head of Clyde Inlet, Baffin Island, in the summer of 1950, found it reaching a "density of one pair in 5–15 acres (2–6 ha.)" in the most suitable habitats —i.e., the "wet tussocky meadows." Soper (1940:14) mentions the grass tundra's being "particularly rich in nesting Lapland Longspurs . . ."

On our brief visit to a large lake (Lat. 68° 31′ N., Long. 71° 22′ W.) in the Wordie Bay district, along Baffin Island's west coast, on August 8, we saw two longspurs. They were in the only stretch of grassy tundra we found in that barren area. Along the southeast shore of Lake Amadjuak, on the other hand, we saw many longspurs on August 8 and 15. Here (Lat. 64° 38′ N., Long. 70° 28′ W.) low, wet grassland stretched in every direction about us. At Cape Dorchester (Lat. 65° 20′ N., Long. 77° 10′ W.), on August 11, the longspur was decidedly the commonest passerine bird. A vast area of grass tundra, much of it wet, lay about the lake on which our amphibious aircraft alighted.

Precisely why wet grasslands are so all-important to the longspur may be difficult to say. Availability of insect food for the nestlings, of dead grass for building material, of nest-sites not readily accessible to certain predators: these probably have a part in determining the matter. To be attractive the terrain must be more than low and flat; if too well drained, too gravelly, too bare, it will not do. Dry, firm, thinly grassed areas just north of the Base were inhabited by Horned Larks and Semipalmated Plovers, but the longspurs lived elsewhere—a stone's throw away, in the wet, grassy places. Facts of this sort, to be appreciated fully, must be observed and experienced day after day. When a visitor first perceives the noisiness and activity of the tundra's summer birdlife he is apt to feel that the many birds about him live everywhere, but he soon learns that every bird has a special habitat.

Fig. 1. Lapland Longspur nesting habitat. Photographed August 11, 1953, near the head of Frobisher Bay, Baffin Island. Nest 8 was between grassy mounds at lower left.

Our very first observations of longspurs (June 14) were of special interest. Our plane arrived about midnight. The air was cold. We were taken to our quarters in the half-light. Yet atop a wooden pole a male longspur was singing; and below our window, near some drowsy sledge dogs, a female longspur was looking for food. The pole referred to, as well as a considerably higher flag-pole not far away, were, we were soon to learn, almost constantly in use as song-perches. At least two male longspurs of the vicinity apparently had given up flight-singing altogether and were using the poles instead. Males defending territories off to the north, away from the buildings, often sang on the wing. We never saw a bunting, lark, or pipit singing from the pole-tops.

On June 15, a raw windy day, we saw many longspurs. They were commonest in the snow-free lowlands just north of the Base, but we saw them also on the slopes leading up to the high interior. Here the ground was half white with the remains of drifts, some of them several feet thick. Wherever we went that day we heard longspur song, but we witnessed only three flight-songs; perhaps because of the wind, most of the singing was from the ground. Buntings and longspurs seemed to be equally common in some areas, but buntings were decidedly the commoner of the two on the rocky slopes. Most of the buntings obviously were paired. As for the longspurs, we were not so sure: repeatedly we came upon a male or female by itself, feeding quietly in a grassy spot. Nowhere did we see a flock of buntings or longspurs.

Late that morning we found a longspur nest containing five eggs (Nest 1). We found it not through flushing the female, but by happening to see wings fluttering just above the ground several rods ahead of us. Curious as to why any bird, regardless of its species, would flutter in that way, we walked forward, flushed a female longspur at a distance of a few feet, and found the nest, which was deep in the turf and warmly lined with fine grasses and white ptarmigan feathers (Fig. 2). The female flew off rather slowly with tail spread wide and alighted about 15 feet away. Here she puffed out her feathers and shook herself. Though obviously perturbed, she emitted no cry. Presently she flew again, this time in narrow circles about us, alighting occasionally, but giving no callnote. The male did not appear. We marked each of the eggs with a red dot, for we were not sure that the clutch was complete. The nest was about 30 paces from a Semipalmated Plover's nest containing two eggs. The two nests, though near each other in a physical sense, were discrete ecologically; that of the longspur was in wet, spongy grassland, that of the plover in hard-packed, comparatively dry gravel.

That afternoon we returned to take photographs. Again the female longspur flushed closely, flew off without feigning injury, and circled silently. Her mate did not appear. When, now and then, she alighted for a few seconds, her manner was very broody. We concluded that, whether she had finished egg-laying or not, she was incubating in earnest.

June 16 we visited the nest again. This time the female flushed at considerable distance. One egg was resting on the other four—a result, possibly, of the female's sudden departure. The nest was sheltered to the east and northeast by a fold of turf, the ground thereabout apparently having been disturbed by construction work. Nowhere in the immediate vicinity did we see or hear a male bird.

During latter June and the first nine days of July we continued to find longspur nests almost daily (see Table I). Nest 1 was only about 300 yards north of the Base, so we visited it regularly. We usually flushed a bird from the nest, and this bird invariably was the female. Usually she did not fly until we were within three or four feet. Never did she feign injury. We never saw the male go to the nest during the period of incubation. This statement is valid, for we spent much time in a blind placed between the longspur and plover nests.

At 11:45 p.m., June 25, Parmelee visited Nest 1, finding one chick hatched but not yet dry, another hatching and still largely in the egg. When Sutton visited the nest 3 hours and 35 minutes later (3:20 a.m., June 26), he found one young bird, completely dry, and what he thought to be four eggs. The second chick obviously had not emerged. When we both visited the nest at 9:30 a.m., June 26, there were three eggs and one chick. What had happened to the other chick or egg we could only guess. Both parents were near the nest, but only the male gave alarm cries. The down of the chick was pale grayish buff with dark brown tipping.

Fig. 2. Lapland Longspur Nest 1, showing dark eggs and lining of winter ptarmigan feathers. Photographed June 15, 1953.

Day after day we found the one chick and three eggs in the nest. July 2 we saw the male approach the nest several times, but never with food in his mouth. We banded the well-developed nestling July 4. July 5 the nest held only the three eggs. We failed to find the young bird in the vicinity, but the behavior of the female parent clearly indicated that the chick was not far away. It had been in the nest about nine days. The "desertion of the nest by the young on about the 9th day, with the wings still in pin feathers and three to five days more before they can fly," is discussed by Wynne-Edwards (1952:386).

Nest 2. Found June 17. Five eggs. In short grass on a foot-high tussock which was surrounded by water four inches deep; in a 10-acre meadow in the high interior a mile east of the Base; a quarter of a mile from the nest of a Snowy Owl (*Nyctea scandiaca*). The female longspur flushed at about eight feet. She feigned injury only slightly as she flew off. We did not visit the nest regularly. June 24 we watched the female go to it. She wandered about for a time, not much agitated so far as we could see, then flew in and settled promptly. On July 4 and 6 there were five chicks in the nest. July 9 the chicks were so large that the nest seemed badly overcrowded. As the brooding female flushed she gave a low twitter, a callnote new to our experience. As if in response, the male appeared and both parents gave cries of alarm.

Nest 3. June 20. Not quite finished; lined with raven feathers. In the side of a tussock about five feet from the edge of a shallow pond in muddy marshlands on Davidson Point. We found the nest not by flushing the female, but by carefully searching an area guarded by a pair of longspurs.

We did not visit this nest often. June 27 it held four eggs. The glossy black feathers of the lining curled upward and inward, almost hiding the eggs. July 2 there were still four eggs. July 12, on our last visit, there were four young birds, almost ready to leave.

Nest 4. June 20. Three eggs (probably an incomplete clutch). On Davidson Point, in the middle of a 20-foot strip of turf between two large, shallow ponds. Found by watching the female which was, when we first saw her, about fifteen yards from the nest. After standing high and looking about anxiously, she flew straight to the nest. We flushed her, ascertained the number of eggs, and saw her return to them. On the far side of one of the ponds we collected a handsome male (GMS 11717), not realizing that it was her mate. When next we visited the nest, on June 27, we found it torn out and scattered.

Nest 5. June 22. Five eggs. Deep in grass about 350 yards north of the Base, six paces from the edge of a small pond, and 50 paces from a Horned Lark nest in a bare area near a gravel pit. Lined with white ptarmigan feathers and dog fur. Found by flushing the female, which flew off without feigning injury. June 23, 24, 26, 27, and 28 we flushed the female from five eggs. June 29 there were five chicks, all of which had hatched within the preceding 24 hours. Between July 1 and July 5 one of the chicks disappeared. We visited the nest daily from July 5 to 10, invariably seeing the female (usually with food in her beak) at or near the nest. July 8 we paid special attention to the male. He was very tame. If we lay down, he approached us to within five or six feet, apparently curious rather than perturbed. His food loads were smaller than those of his mate, often consisting of one large insect, such as a crane fly (*Tipula arctica*). On July 9 the nest held four well developed young. At 12:55 a.m. and 6:40 a.m., July 10, only two young were in the nest. We failed to find the others in the vicinity. At 4:00 p.m., the nest was empty. The nestling period had been at least ten days, at most, 12 days. The young were not able to fly when they left the nest.

Nest 6. June 22. Five eggs. Near the edge of a gently sloping wet meadow a quarter of a mile southeast of the Base, in moss and grass on a comparatively dry mound. Found by flushing the female, which flew off feigning injury only slightly. We marked the nest with a flimsy cairn of stones. The cairn fell apart and we lost the nest for some time, but we re-discovered it July 7, on which date it held four good-sized young. We did not visit it thereafter.

Nest 7. June 23. Four eggs. In moss and grass in marshy spot on slope just east of Base, about five feet from the edge of a small, shallow pond; slightly sheltered by the leaves of a tiny rhododendron, about six inches from the edge of a huge sunken rock. Found by watching (1) a feeding male; (2) a female, which suddenly appeared, chased a rival female out of sight (a distance of at least 60 yards), returned, and flew directly to the nest. Visited daily June 23 to July 8, except July 6. Three young hatched between our visits of June 27 and June 28. The egg which did not hatch remained in the nest until July 5, and was not seen thereafter. We tried to capture the female with a net, but failed. The three young left the nest between our visits of July 7 and July 8. On July 8 we found all three birds, well scattered, but still unable to fly. Both parents were feeding them. The one farthest from the nest—up the slope about 50 yards—apparently was being fed exclusively by the male. The nestling period had been at least 10 full days.

Nest 8. June 25. Five eggs. Among moss and grass in crevice between two mounds; about 14 inches above wet humus in meadow bordering rocky base of foothill, about 75 paces north of Nest 1. Found by flushing the female, which flew off without feigning injury. Visited June 26, June 27, June 28 (five eggs), and July 1 (four young). What had happened to the fifth egg or young we did not know. From July 1 to 10 we visited the nest regularly. July 5 there were only three young. That day Sutton, partly hidden among rocks 60 yards away, recorded observations from 1:10 p.m. to 2:40 p.m. The female ranged widely for food, coming in with a large mouthful of insects three times, and carrying off a fecal sac after each feeding. Haviland (1916:236) "never saw food in the bill of a bird which was feeding young." The male gathered no food, made no move to accompany his mate, did not fly to greet her when she came in, and did not go to the nest. Instead, he gave alarm notes at a rate of 19 to 22 per minute (checked with a watch) virtually without break, during the whole period. He changed position six times. For about 20 minutes he called from a hummock at nest-level half way between Sutton and the nest. He gave two calls—the familiar *ee-yee* or *chee-yee,* and a softer *yee-ur* or *your.* For a quarter of an hour he was well up the slope to the east, but his calls continued to be distinctly audible. He did not once give chase to another bird; the female did not join him; and he did not sing. The sun was warm. At 2:40 p.m. the nestlings were panting heavily. One of them, when touched with a finger, begged with mouth wide open. The sound of begging was audible to Sutton at about one foot distance, inaudible at two feet.

At 6:00 a.m., July 10, two young were in the nest, but a large moist dropping a few inches away indicated that the third had departed not long since. The two young departed from the nest before 4:20 p.m. that day, leaving before being able to fly. The nestling period had been at least nine days. The empty nest was quite clean. Haviland (*loc. cit.*) reports that nests observed by her in Lapland were "always foul."

Nest 9. June 27. Two eggs, both strikingly gray rather than brown. In clump of moss, among thin grass, in tussock seven inches above wet humus; about 60 paces south of Nest 1. A pair of longspurs was in the vicinity, but the nest probably had been deserted before we found it. We never flushed a bird from it. On July 1 Parmelee examined it carefully, finding a third egg (gray) buried in the lining. On July 2 he found a fourth egg, also gray, punctured and empty, seven paces north of the nest. We put the four eggs into the nest to see what would happen to them. On July 5 they were all there, the empty one crushed. On July 8 another egg was broken and empty. The shell bore what appeared to be double tooth-marks, almost certainly those of a lemming. Both the Collared Lemmings (*Dicrostonyx groenlandicus*) and Brown Lemmings (*Lemmus trimucronatus*) were abundant in the area. On July 21 the nest still held two eggs, both intact.

Nest 10. June 27. Two eggs. Near the Base's dump, six paces from the water's edge in wet meadow bordering a deep pool which flanked a rocky hill. Found by flushing the female, which popped out and flew off swiftly. We marked the eggs. On June 29 we found the lining (grass only; no feathers) strewn about widely. In what remained of the nest-cup were two eggs, one of them marked. About 15 inches away, almost side by side, were two more eggs, one of them marked. Marvelling that any predator could have torn the nest out without destroying its contents, we returned the eggs to the nest-cup. They were still there, intact, July 1, on which date we collected them.

Nest 11. June 27. Six eggs. On Davidson Point, in tussock six inches above water along edge of small pond, 51 paces from Nest 3. Found by flushing the female, which flew off without feigning injury. On July 2 there were four chicks and two eggs; on July 12, one chick and one egg. The nestling was large and alert looking, as if ready to bolt, but when touched it merely crouched, making no attempt to hop or flutter away. It could not fly.

Nest 12. June 27. Five eggs. On bank of small stream, three feet from swift water a foot deep, among moss, grass, and *Cassiope tetragona;* about a hundred yards from the high-tide mark. Found by flushing the female, which ran from the nest with wings spread and flew on reaching the stream's edge. Visited on June 29: five eggs, female flushed. June 30: watched female fly at least a hundred yards to nest. July 1: five eggs, no adult bird there, nest appeared to have been disturbed. July 12: four chicks and one egg. July 16: one egg and mass of feather-sheath particles, but no droppings, in the nest; two young birds, side by side, about three feet from the nest. The female parent was close by, chirping anxiously. The young, though well feathered, could not fly.

Nest 13. July 1. Five eggs. In exposed position among lichens, moss and short grass in comparatively dry meadow several hundred yards northwest of Base; 12 paces from a shallow stream, and about 50 paces from a Semipalmated Plover's nest—the latter on still drier, more gravelly ground. We flushed the female on June 30 but failed to find the nest that day. On July 1 she flushed in the same manner, flying directly from the eggs, alighting with wings spread, and running a few feet with wings partly open. On July 6 the nest held one chick and four eggs; on July 7, four chicks and one egg. The fifth egg hatched, but we do not know when. On July 11 (raining steadily) the five young birds were wet; we saw neither parent, but the nestlings appeared to be in good condition. On July 12 we color-banded the brood, green on right leg. While receiving their bands the nestlings opened their mouths repeatedly, as if for food, but if they made any sound it was exceedingly faint. At 6:30 a.m., July 16, one nestling was still in the nest. It could not fly. We failed to find others of the brood in the vicinity.

Nest 14. July 1. Five small young. North of the Base several hundred yards, in mossy hummock about two feet from a shallow pool. About 60 paces from a Semipalmated Plover's nest which was in a drier, more gravelly area. On July 1 we saw the male go to the nest with food. On July 6 and 7 (*four* young) we saw only the female parent in the vicinity. On July 11 the nest was empty.

Nest 15. July 2. Five eggs. In marsh on Davidson Point, deeply sunk in moss and well sheltered by grass. When female flushed she flew off without feigning injury. Visited by us only once thereafter, July 12, when there were five fairly well developed young.

Nest 16. July 2. At 10:00 a.m., held three eggs and one chick; at 3:10 p.m., three chicks and one egg. In wet meadow just north of Base, about five feet from the edge of a shallow pool. Bottom of nest-cup about an inch above water-level. July 6: four young, the female close by, chirping in alarm. July 8, 9, and 10: four chicks. On July 10 we visited the nest at 1:00 a.m., 6:47 a.m., and 4:25 p.m. The young were large and evidently about ready to leave. One of them, a female, we collected (GMS 11748). Though quite well feathered it was flabby and made no attempt either to run or to fly. July 11 the nest contained two chicks only, and we failed to find the other in the vicinity. Both parent birds chirped incessantly. July 12 the nest was empty except for particles of feather-sheath.

Nest 17. July 5. Three eggs. Located in a comparatively dry spot, but close to several small shallow pools, high on slope east of Base in small rock-rimmed meadow, throughout which the principal plants were moss and lichens rather than grasses. The female, a remarkably confiding bird, we caught and banded on July 7. On July 8 we recorded observations at the nest from 9:20 a.m. to 11:30 a.m., seeing only the female except at 9:45, when a male, without food in his mouth, flew over, giving a *pit-i-tit cheer* cry, and the female instantly left the nest, following him down the slope out of sight. Within a short time she returned alone and went to the nest. At 11:30 a.m., July 8, the nest held three eggs. July 10: three chicks. On July 11 we saw the female take food to the nest, but we did not see the male. On July 16 the nest held two well developed young, both dead.

Nest 18. July 5. Four eggs. In meadow just north of Base, in moss at foot of hummock, eight paces from edge of small, shallow pool; 33 paces from Semipalmated Plover's nest in much drier, more gravelly ground. Female flushed without feigning injury. July 6: four eggs. July 7: two chicks and two eggs. July 8: four young. On July 11 we observed the male, as well as the female, taking food to the nest. On July 15 we color-banded the brood, red on right leg. On July 16 the nest held four large young. It was empty on July 21.

Nest 19. July 5. Four eggs. In damp meadow north of Base, at foot of mossy mound. Neither stream nor standing water close by. Nest held four eggs on July 7, three young and one egg July 8. The three chicks had hatched within about 24 hours. One egg did not hatch. On July 8, we saw both male and female carrying food to young. That day we caught and banded the female. We saw young in the nest as late as July 16, but on July 21 it held only the one egg.

Nest 20. July 8. Five eggs, unusual in that their ground-color was pale olive and their markings few and scattered (Fig. 3). At very edge of mossy islet in wet meadow north of Base, the islet surrounded by water several inches deep. Bottom of nest-cup less than an inch above water-level. Lining without a trace of feathers, fur, or bog cotton. When female flushed she flew off swiftly. We flushed the female on July 9 and 12 (five eggs), but the nest continued to be so wet that we were not surprised to find it deserted on July 15. The eggs were still there on July 17, one of them badly broken (embryo well developed).

Nest 21. July 8. Four well developed young. In wet meadow north of Base, between two tussocks, well sheltered by grass. Found by watching female go to it with large mouthful of food. On July 9 the four young appeared to be about ready to leave. The nest was empty on July 10. We never saw a male bird in the immediate vicinity of the nest.

Nest 22. July 9. Two chicks (one not fully hatched) and one egg. In top of islet of moss and grass in meadow in high interior several miles northeast of Base. We did not flush the female but saw her near the nest. We did not visit this nest again.

From Table I these facts are apparent: (1) Of a total of 97 eggs laid in 22 nests, 22 did not hatch, but only one of the 22 nests was utterly destroyed, contents and all, by a predator. (2) Of 75 chicks known or believed by us to have hatched, 62 apparently left the nest successfully. (3) In each of five nests, a single chick disappeared prematurely. If predation were responsible for this loss it was predation of an unusual sort, for such predators as ravens (*Corvus corax*) and weasels (*Mustela erminea*) usually make off with whole broods. (4) The average clutch-size for 19 nests was 4.5 eggs—a considerably lower figure than that reported by Sutton (1932:240) for Southampton Island, where the great majority of nests in the summer of 1930 held six eggs. In obtaining average clutch-size for the Frobisher Bay area in 1953, we decided against including Nests 4, 9, and 10 in our calculation, for the clutch might not have been complete in these nests. (5) The reproductive cycle ended soon after mid-July, there being no unusually late broods or other evidence of two-broodedness.

FIG. 3. Lapland Longspur Nest 20, showing pale eggs and lining wholly of grass (without feathers or hair). Photographed July 8, 1953.

Nineteen of the 22 nests discussed above were lined with grass and, more or less extensively, with white winter ptarmigan feathers, or dog hair, or both. Neither of the two grass-lined nests was successful, but this may have been a mere coincidence. Nest 3 was lined with raven body feathers and grass. In no nest did we find a single *summer* ptarmigan feather. The only ptarmigan we recorded anywhere on Baffin Island in 1953 was the Rock Ptarmigan (*Lagopus mutus*), and this species was very scarce about the head of Frobisher Bay. Blair (1936:302) discusses an interesting correlation between scarcity of ptarmigan and absence of feathers from longspur nests from 1924 to 1927 in Norway. Many nests found by him during that period contained only three or four feathers, and from two nests "feathers were lacking, the lining being entirely of dry grass."

TABLE 1

DATA FOR LAPLAND LONGSPUR NESTS, BAFFIN ISLAND, 1953

Nest No.	Date found; contents on that date	Clutch size	Eggs known not to have hatched	Observed or estimated date for hatching of first chick	Observed latest date for young in nest	No. young known or believed to have left nest successfully
1.	June 15 (5 eggs)	5	3	June 25	July 4	1
2.	June 17 (5 eggs)	5		June 29 (est.)		5
3.	June 20 (unfinished)	4		July 2 (est.)		4
4.	June 20 (3 eggs)	3?				0
5.	June 22 (5 eggs)	5		June 29	July 9-10	4
6.	June 22 (5 eggs)	5	1	June 28 (est.)		4
7.	June 23 (4 eggs)	4	1	June 28	July 7	3
8.	June 25 (5 eggs)	5	1	July 1 (est.)		3
9.	June 27 (2 eggs)	4?	4			0
10.	June 27 (2 eggs)	4?	4			0
11.	June 27 (6 eggs)	6	1	July 2	July 11-12	5
12.	June 27 (5 eggs)	5	1	July 6 (est.)		4
13.	July 1 (5 eggs)	5		July 6	July 15-16	5
14.	July 1 (5 young)	5		July 1 (est.)		4
15.	July 2 (5 eggs)	5		July 3 (est.)		5
16.	July 2 (3 eggs, 1 young)	4		July 2	July 11	4
17.	July 5 (3 eggs)	3		July 9 (est.)	July 16 (2 dead)	0
18.	July 5 (4 eggs)	4		July 7	July 16	4
19.	July 5 (4 eggs)	4	1	July 8		3
20.	July 8 (5 eggs)	5	5			0
21.	July 8 (4 young)	4		July 1 (est.)		4
22.	July 9 (2 young, 1 egg)	3	?	July 9		?

Nesting Schedule

In the Frobisher Bay area, in 1953, egg-laying must have started about June 10. We know that in Nest 1 the first chick hatched June 25. Wynne-Edwards (1952:385) states that the incubation period in "each of two exactly known cases" at Clyde Inlet was 12 days. That being the case, the fifth egg in Nest 1 probably was laid about June 14, the first egg, June 10. Many female longspurs did not start laying this early, however; or, if they did, their nests came to grief; otherwise Table I would certainly reveal more June dates than it does among the observed or estimated earliest dates for hatching. The table clearly shows that hatching in 13 of the 22 nests started on or after July 1. Note, too, that Nest 1, our earliest nest, was far from 100% successful. Three of the five eggs did not hatch, and another probably did not hatch properly. This failure may well be attributable to severe temperatures. Meteorologists at the Base informed us that the weather was unusually mild for several days in late May and early June. Some of the pipits which started nesting during that period were successful in rearing their young. We saw young pipits, well able to fly, as early as June 30 (see Sutton and Parmelee, 1954*a*). Comparably well developed young longspurs we did not see until July 12.

In the Nettilling Lake area of Baffin Island, in 1925, Soper (1928:114) found the first longspur egg of the season on June 14. That same day he examined several nests which were completed and ready for eggs. In the Bowman Bay area, in 1929, Soper (1946:423) found "the first completed nest, with a single egg" on June 26. On Southampton Island, in 1930, first eggs for the season were laid about June 17 (Sutton, 1932:240). Taverner and Sutton (1934:80) reported June 5 as the date for the earliest egg at Churchill, Manitoba, in 1931. Bailey (1948:299) found eggs as early as June 14 in the "bleak windswept tundra" near Cape Prince of Wales, Alaska. In the "more favorable" Kotzebue Sound area he found a set of five eggs on June 1. Here the first egg could not have been laid *later* than May 28.

We were especially interested in late nests. On June 19, along the east bank of the Sylvia Grinnell River, we happened upon a female with grass in her bill, but her mate continued to give alarm cries and she would not go to her nest. Finally she dropped the grass and flew off, followed by the male. Nest 10, a late nest, came to grief through predation. Had all gone well there, the four chicks would have hatched about July 11 and left the nest about July 20. On July 19, we saw young out of the nest, but unable to fly, near the mouth of the Jordan River, 16 miles west of the Base. Our latest date for a nest with a living egg was July 9; for a nest with one or more young birds, July 16; for young birds out of the nest but unable to fly, July 19. We obtained no evidence whatever of two-broodedness (Witherby, 1948:146; Salomonsen, 1951:531; Nicholson, 1930:293), and no nest that we examined appeared to have been used twice (Wynne-Edwards, 1952:385).

Aware of Wynne-Edwards's statement (*loc. cit.*) that hatching occupied "from two to four days," we paid special attention to this part of the breeding cycle. We observed no simultaneous hatching of the whole brood; but at Nests 5, 7, and 19 the 5, 3, and 3 eggs, respectively, hatched within approximately one day; at Nest 18 the four eggs hatched within approximately two days; and at Nest 13 the 5 eggs hatched within two (possibly more than two) days. At Nest 16, one chick was in the nest when we first saw it at 10:00 a.m., July 2; by 3:10 that afternoon two more chicks had hatched. The fourth egg hatched, but we did not ascertain the time of hatching.

Behavior of Nestlings

Ornithologists who have studied the nesting of such common American birds as the Field Sparrow (*Spizella pusilla*) and Song Sparrow (*Melospiza melodia*) are familiar with the way in which a nestful of well-developed young may, whether able to fly or not, "explode" in all directions when the nest is disturbed or when the parent utters certain cries of alarm. Such behavior apparently is not characteristic of the Lapland Longspur. The tendency for the nestlings to lie low rather than flutter off probably is correlated with their inability to fly at the normal time of departure from the nest. What we have thus far reported clearly shows that young longspurs leave the nest when nine to ten days old, or a little older. Pleske's (1928:145) surmise from "analogy" that "young leave the nest after 14 days (approx.)" apparently is quite wrong. Young birds on leaving the nest are wholly unable to fly. The feather development of a flightless, 10-day old bird is well illustrated by Grinnell (1944, plates 24 and 25). So there is a brief period in midsummer when longspur nests are empty, and the flightless young—neither nestlings nor fledglings, properly speaking—are scattered here and there all over the tundra. Of the nestlings we color-banded not one did we recover. Our earliest date for a strong-flying young bird was July 12. That bird (male, GMS 11750) we shot after three of us had tried for some time to catch it in the hand. Its tail was 39 mm. long. A few tufts of natal down clung to some of the wing coverts and rump feathers. In 1937 Bray found "most young longspurs . . . awing before July 13" in the region of Fury and Hecla Strait (1943:534).

Another interesting fact about the nestling longspur (*i.e.*, the young bird *while it is in the nest*) is that it is comparatively voiceless. (In the discussion of Nest 8, see our comment about the faintness of the begging cry.) Not only do nestlings have a very weak voice; when handled or disturbed, they usually remain silent. Not so the young bird after it had left the nest. Now it gives a loud *tchip* food-cry, through which it can be located by parent or human being. A loud *chee-chee-chee*, which we heard from a young bird out of the nest on July 22, we interpreted as a food cry; but it may have been a cry of fear or distress. We heard it just after one of the parent birds had given alarm notes. A loud *chee-chee-chee* is characteristic of a frightened 12-day old bird held by its toes.

Young birds on first learning to fly have an amusing way of springing from the grass and dashing off with great assurance, only to find themselves suddenly unable to go farther, at which instant they fold their wings and flop to the ground, sometimes tumbling along on the moss as a result of the momentum. Such young birds may appear to be crippled. On July 25 we chased, and probably could have caught, such a poor flier.

Activities of Adult Males

Blair (1936:103) states that in arctic Norway the male longspur, as well as the female, incubates the eggs and broods the young. We never flushed a male from a nest though several times we saw males take food to nests containing young, and we believe that males regularly take charge of the oldest members of the brood as these flightless chicks leave the nest.

At many nests visited regularly by us we noticed that the male was much more given to voicing alarm and protest than the female. We already have discussed one case of this sort (Nest 8). Another case we observed July 3. Here we did not know where the nest was located; but the female was virtually silent while the male continued to give alarm notes of four distinct sorts—the well-known, far-carrying *ee-yee*, which has been transliterated by Haviland (1916:234) as *whee-ee*, and by Salomonsen (1951:532) as *ee-yü;* a short *ear* or *err;* a rough, sharp *chee-ah;* and the familiar *pit-ick* or *fit-ick*, which may not be an alarm note at all. The male gave these cries, and these only, over and over, in about the order used here. He did not repeat himself directly.

While nests are being built and eggs laid, singing by the males is, we presume, primarily a matter of nest-territory defense, though some midsummer singing may be advertisement for a mate. The song-period was at its height in the last week of June. Singing was not exclusively a bright weather activity. On the evening of June 23, while rain was falling steadily and the sky was cloudy and dark, we observed several males singing flight-songs. On June 30 several males sang flight-songs in the heavy fog. High wind stopped the flight-singing, however, and sometimes it stopped singing of any sort. Territory-defense through singing had its amusing aspects. On June 26, on the long slope leading eastward into the high interior, we saw two males singing together in the air, as if in complete accord. They alighted about five feet apart, each on a separate stone. Here, with heads lowered and plumage lifted, they threatened each other with wide open mouths, but remained perfectly silent. A male observed June 23 near Nest 7 did not join his mate in driving a rival female from the nest-territory.

The longspur was the first of the passerine birds to stop singing as summer advanced. Our latest date for a flight-song, indeed for a longspur song of any sort, was July 6. That day we witnessed several scattered performances. We heard several Horned Larks singing as late as July 12, a Water-Pipit singing briefly as late as July 23, and a Snow Bunting in full song (from a rock, not from the air) as late as July 27. July, 1953, was memorable for its foul weather. The recorded mean maximum temperature for the 31-day period was 49.2° F., the mean minimum, 37.6°. Soper (1928:114) reported that in the Nettilling Lake area, in 1925, the male longspurs ceased singing about July 20. July temperatures were "fairly uniform" that year, "mornings registering from 50 to 60 degrees and at mid-day, 10 to 14 degrees higher" (1928:16). In the Bowman Bay area, in 1929, longspur singing stopped between July 12 and 15 (Soper, 1946:423).

It is our carefully considered belief that shortly after the young leave the nest the sexual bond holding males and females together breaks completely. We also are convinced that no such bond as that which holds Horned Lark families together during late summer exists among Lapland Longspurs. We are puzzled by Dalgety's (1936:582) report of seeing in Greenland, as late as August 24, "family parties which had not flocked together." Once the young leave the nests and begin to scatter, they are fed for a while by the males (if they happen to be older and leave the nest first) or by the females (if they happen to be younger and to leave the nest later). All our observations during the latter two weeks of July and first two weeks of August show clearly that adult males, adult females, and young birds were living comparatively solitary lives during that period. Repeatedly we find in our notes such entries as this: "All birds seem now to be 'singles'—single adult males, single adult females, single young birds" (Sutton, July 27); or this: "Never see family groups together and rarely see male and female together—always separate birds—a dull, ratty male, a ratty female, or a trim young one, richly colored and fat-looking" (Sutton, July 31). All adult birds which we saw August 16 appeared to be molting heavily. Pleske (1927:143, 144) reports an adult male in "perfectly fresh" winter plumage taken on New Siberia Island, August 14.

The attachment that three adult males had for each other we cannot explain. We saw these birds near Tarr Inlet, July 7, shortly after singing had stopped for the season. They fed and flew about together, though their behavior was not that of a flock. Their plumage was bright but worn-looking; their postnuptial molt probably had begun.

Activities of Adult Females

Observers agree that the female Lapland Longspur builds the nest (Sutton, 1932:240–1; Witherby, 1948:146). We observed very little nest-building. A female with grass in her bill refused to go to the nest (June 19) probably because we were so near and so conspicuous. Near Nest 3 (not quite finished, June 20) we saw both the male and female, but only the female brought material and went to the nest. We observed little defense of nest-territories by females. On June 19 Sutton witnessed a fight, memorable for its ferocity, between two female Snow Buntings (see Sutton and Parmelee, 1954*b*:162), but we never saw female longspurs fighting in such a manner. Salomonsen (1951:528) says: "I have only a few times seen a female drive another female from its territory." At Nest 7, on June 23, we saw a female chase a rival female 60 yards or more. Birds are, we believe, more apt to be territory-conscious during the periods of egg-laying and incubating than later in the season, when food gathering requires so much effort. It is nevertheless interesting that on July 5 we saw two females approach each other closely as they gathered food in the grass. Though actually side by side, they displayed no animus.

Alarm notes of females seemed to be less varied than those of males. Both males and females frequently called *fit-ick* or *pit-ick.* The far-carrying *ee-yee* seemed to be given principally by males. A female we spent some time with on July 6 gave only one alarm note—*chure* or *ee-ure.* This seemed to be slightly more mellow than any alarm note we had heard from a male.

Activities of Young Birds

Two well-feathered young birds, which we saw together near the mouth of the Jordan River on July 19, were wholly unable to fly, but strong on their feet. They were just out of the nest and must have been siblings. Between July 19 and August 2 we never saw two or more young birds together, nor an adult bird in company with one or more young ones. This was a period of molt. Such birds as we saw were apt to be ragged looking. Sometimes they flew with difficulty.

As late as July 25 young birds that we saw in flight were stub-tailed; but from July 27 on, all young birds appeared to have full-length tails.

Pleske (1928:148) states that young birds "gather into small flocks toward the middle of August, and for some while lead a nomadic life." We observed the first signs of autumnal flocking on August 2. That day, near the dump, in a disturbed soil area throughout which many herbaceous plants grew, we saw a large scattered company of longspurs and buntings feeding together peaceably. Young birds seemed to be somewhat more numerous than adults. The young were not adept at reaching the seeds, many of which they tried to shake from the stalks. When they failed to find enough seeds on the ground they pulled the stems down and trampled them, or fluttered upward, yanking at the stalks with their bills.

Nest Success, Survival of Offspring, and Predation

The fact that 17 of the 22 nests we had under observation were more or less successful, and that only one nest was known by us to have been totally destroyed by a predator, strikes us as being remarkable. The failure of Nest 20 may have been traceable to bad weather, to unfortunate choice of site, or to absence of feathers or other warm material in the lining; that of Nest 4 to our shooting of the male bird; of Nests 9 and 10 to molestation by lemmings; of Nest 17 to disappearance of the male bird, to bad weather, or to both. On July 22 a soldier brought us a stub-tailed young longspur he had found dead. So far as we know, however, no nestful of young longspurs perished during the July 17-21 cold spell so lethal to nestling pipits (see Sutton and Parmelee, 1954*a*). The fact that the numerous husky dogs did not destroy nests continues to amaze us. Foxes and weasels were extremely rare near the Base. The several Snowy Owls which nested in the vicinity preyed exclusively on lemmings. The Ravens of the neighborhood fed regularly at the Base's dump.

We found adult longspur remains in the stomach of a Pomarine Jaeger (*Stercorarius pomarinus*) collected at Lake Amadjuak, August 8, and in the stomach of a Parasitic Jaeger (*S. parasiticus*) collected near Cape Dorchester, August 11. We saw no jaegers of any species at the head of Frobisher Bay.

Descripton of Specimens

We collected four adult Lapland Longspurs, three males and one female, near the head of Frobisher Bay. Measurements in millimeters are:

GMS No.	*Sex*	*Date*	*Wing*	*Tail*	*Culman*	*Tarsus*
11705	Male	June 17	90	62	11	21.5
11717	Male	June 20	95.5	63.5	12	21.5
11724	Male	June 25	90	58	11.5	20.5
11725	Female	June 25	87.5	57	11	20.5

Salomonsen (1951:524) believes that a Greenland race of *Calcarius lapponicus* should be recognized. He measured the bills of 57 Greenland and 36 Scandinavian male specimens, finding the former to average 14.54 mm., the latter, 13.13 mm. in length. In his opinion, Brehm's name, *subcalcaratus*, should be used for the Greenland race. He states further: "The N. American population comes nearest to *C. l. subcalcaratus* and is best referred to that form . . ." Wynne-Edwards (1953:387) refers three males and three females from Clyde Inlet to the nominate race. Unless we took our bill measurements in some manner wholly different to that of Salomonsen, our Frobisher Bay birds are smaller-billed than Greenland birds and probably should be referred also to *C. l. lapponicus*.

The four eggs (possibly an incomplete clutch) from Nest 10 were preserved. These measure: 21.5 mm. × 16.0, 22.0 × 16.0, 22.0 × 15.5, and 22.0 × 15.5 (average: 21.8 × 15.7 mm.). They are dark brown, scrawled, blotched and spotted with darker shades and with black.

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SUMMARY

1. The Lapland Longspur was one of the commonest birds at the head of Frobisher Bay, Baffin Island, in the summer of 1953. It nested almost exclusively in wet, tussocky tundra. A nest built among moss and lichens, rather than among grass, was unsuccessful.
2. Of 22 nests found by us, 20 were lined with grass and with feathers or fur. Two were lined only with grass. None had been used previously.
3. The female built the nest and incubated the eggs. During the egg-laying and incubation periods the male rarely, if ever, went to the nest. We never saw a male take food to an incubating female.
4. After the hatching of the chicks, the male was louder-voiced than the female in sounding protest while we were near the nest. During a mid-day period of observation at one nest the male devoted himself wholly to giving alarm cries, the female to feeding the chicks. At another nest, the male fed the young regularly.
5. The average clutch-size for 19 nests was 4.5 eggs.
6. Egg-laying started about June 10 and continued at least to June 29. Earliest date for a newly hatched chick, June 25; for a chick well able to fly, July 12. Latest date for a chick ready to leave the nest, July 16; for a chick out of the nest, but still unable to fly, July 19.
7. A predator scattered the lining of one nest without breaking any of the four eggs. In each of several nests a single chick disappeared prematurely. Two of four eggs in a deserted nest were chewed at, probably by a lemming.
8. Three eggs in one nest, three in another, and five in another, hatched respectively within a 24-hour period. At one nest, two of the four chicks hatched between 10:00 a.m. and 3:10 p.m. At several nests hatching of the brood extended over a two-day, or even longer, period.
9. Chicks remained in the nest nine or ten days and left while quite unable to fly. Chicks ready to leave the nest never "exploded" in all directions when disturbed.
10. We color-banded nine chicks (two broods) in hope of ascertaining the exact fledging period, but failed to recover a color-banded individual.
11. Singing was at its height during the last week in June and stopped altogether on July 6—long before it did in other passerines.
12. Pairs separated and broods scattered within a few days after the young

had left the nests. Between July 19 and August 2 we observed no longspurs in pairs or in separate family groups. After August 2 we frequently observed mixed flocks of longspurs and buntings.

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BEHAVIORAL MIMICRY IN THE TITMICE (PARIDAE) AND CERTAIN OTHER BIRDS

BY CHARLES G. SIBLEY

NUMEROUS examples of mimicry in color and pattern are known in insects. The Batesian type, wherein a harmless animal mimics a truly dangerous or obnoxious species, is of common occurrence. The harmless mimic derives an advantage from the resemblance because enemies, by instinct or conditioning, will tend to avoid the truly dangerous species and anything which they "identify" as the same thing. Cott (1940) has reviewed the theory of mimicry in detail.

Insect mimicry has evolved primarily under the selection pressure imposed by birds. Because most insectivorous birds utilize the sense of vision in their search for food, and because birds have well-developed color perception, the mimicry of insects has evolved primarily with respect to color and pattern.

The titmice and chickadees (Paridae), which nest in cavities in trees, have apparently evolved a defensive reaction to predators which involves a mimic display of the Batesian type. In these hole-nesting birds the adult, when disturbed on the nest, often performs a display which apparently mimics a hissing, threatening snake.

Pickens (1928) described in some detail the postures and hissing sounds made by the Carolina Chickadee (*Parus carolinensis*) when disturbed while incubating. He was impressed with the resemblance between the hiss of the bird and that of a copperhead snake (*Agkistrodon contortrix*). Pickens stressed, as have many other writers, the startling, even frightening, effect on the observer.

Others who have encountered the display in the Carolina Chickadee include Bent (1946:350) who describes the sound as "an explosive little sound like a sneeze." The bird, which had not yet laid eggs, was inside the nest and responded with the hissing sound each time the tree was tapped on the outside. Dickey (Bent, *loc. cit.*) described the sound as a serpent-like hiss, not unlike a black snake, and noted that adults included the hissing sound in their alarm notes when their young were taken from the nest for examination.

Mr. William C. Dilger has kindly permitted the use of the following quotation from his notes on *P. a. atricapillus*. On June 9, 1954, he found a chickadee excavating a nest cavity in a yellow birch on Slide Mountain, Ulster County, New York. The tail of the bird was visible at the entrance as the bird worked to enlarge the cavity. To test the response of the bird, "I placed my hand over the hole and immediately felt pecking on my palm. When I parted my fingers the bird's activities became apparent. It faced the opening and swayed from side to side with wide open beak. Suddenly it would dart at my fingers and utter a loud hiss at the same time. The effect was very snake-like and quite startling."

Griffee (Bent, *loc. cit.*:343) reports that the Oregon Black-capped Chickadee (*P. a. occidentalis*) responds to an inquiring finger poked into the entrance of the nesting hole with "a hiss and flutter of the wings."

Burleigh (1930:60) records that incubating Oregon Black-capped Chickadees refuse to leave the nest when the nest tree is tapped and will hiss vigorously and thump the sides of the cavity with the wings.

The Mountain Chickadee (*Parus gambeli*), of western North America, has also been found to utilize the "snake display." Grinnell, Dixon and Linsdale (1930:306) describe the response of an incubating bird observed when a slab of rotten wood was removed, revealing the nest. The bird "lunged, at the same time spreading its wings convulsively, and then gave a prolonged hissing sound . . ." The observer watched this performance 19 times. The wall of the cavity was struck by the wings during the convulsive lunge.

The present author elicited the hissing response from a nesting *P. gambeli* at Crescent Meadow, Sequoia National Park, Tulare County, California, on June 29, 1951. Only the hiss could be detected as the nest was in a deep woodpecker hole.

Bent (*loc. cit.*:364) also notes that the Mountain Chickadee is known to respond to disturbance while on the nest with "a loud hissing noise and a rapid fluttering of the wings . . ." Bent (p. 365) quotes Claude T. Barnes as reporting "that five tiny fledglings, in a nest that he examined, 'hissed in the manner of a snake' when he reflected light into the nest."

The Chestnut-backed Chickadee (*Parus rufescens*) was noted by Bowles (1909:56) to respond with a "sudden flutter of wings and fierce cat-like hiss" when he attempted to look into the opening of the nest cavity. Burleigh (*loc. cit.*:61) observed that this species had the same habit as *P. atricapillus* of hissing and fluttering about when the nest tree was rapped.

A Plain Titmouse (*Parus inornatus*) nesting in a bird box "suddenly exploded and hissed" when Mrs. A. S. Allen (1943:155) lifted the lid of the box. Dixon (1949:116) also noted the explosive note which "combines elements of hissing and puffing" given by incubating birds disturbed on the nest.

The present writer had an exceptional opportunity to observe the pattern of behavior accompanying the hissing when a pair of Plain Titmice occupied a nest box provided with a hinged roof. The nest box, located in a low tree near Los Gatos, Santa Clara County, California, was occupied by the birds on April 6, 1952 when nest-building was in progress. On April 14 the hinged lid was raised and a small mirror was held over the opening to permit a view of the interior. The incubating bird raised itself slightly, gaped widely toward the mirror, spread its wings as far as the walls of the box permitted, and swayed slowly from side to side for approximately 10 seconds—then, with explosive suddenness, jumped upward emitting a loud puffing hiss with bill agape while the wings struck the sides of the nest box with an audible thump.

On several successive days the bird was similarly disturbed and always reacted in the same stereotyped manner. On April 16, for example, the activity was elicited ten times in rapid succession during a period of approximately three minutes.

The entire pattern of swaying movement and hissing sound was strongly suggestive of a snake and undeniably startling. In spite of recurrent observations I found myself repeatedly startled by the sudden upward jump and loud hiss. It is not difficult to believe that potential predators would frequently be frightened by this activity.

The "snake display" has also been recorded for a number of the European species of *Parus.* Jourdain (1929:123), noting Pickens' article, pointed out that the Great Tit (*P. major*), Coal Tit (*P. ater*) and Blue Tit (*P. caeruleus*) produced hissing sounds when disturbed on the nest. Jouard (1932) added the European form of *P. atricapillus* and Hinde (1952:148) noted the display in the Great Tit, Blue Tit and Marsh Tit (*P. palustris*).

Certain species of hole-nesting birds, other than members of the Paridae, have also evolved a hissing "snake-display." The Wryneck (*Jynx torquilla*) has a "snake-like hissing when disturbed on nest . . ." (Witherby, *et al,* 1943 (2):293; Coward, 1920). The nestlings of the Flicker (*Colaptes auratus*) are reported (Sherman, 1910:145) to begin to produce a hissing sound soon after hatching. The noise is uttered constantly, day and night, for approximately two weeks. The young cease the sound about the time they begin to exhibit fear reactions.

The Wood Warbler (*Phylloscopus sibilatrix*) of Europe builds on the ground a domed nest, with a side entrance. The nestlings give an explosive hiss when disturbed. Cox (1930) noted that in 18 instances out of 60 the nestlings hissed simultaneously when he disturbed them.

Writing of caged birds, Brooksbank (1949) records that the Cockatiel (*Nymphicus hollandicus*) will hiss like a snake if disturbed in the nest box.

As Hinde (*loc. cit.*) has remarked, the survival value of the "snake display" is obvious. The occurrence of such a display in hole-nesting species is certainly correlated with the fact that there is but one avenue of entrance and exit. The incubating bird cannot escape from a predator capable of entering the nest opening. A high survival value is thus imposed upon any mechanism capable of inducing escape reactions in the intruder. The proof of the effectiveness of an explosive hiss, with or without an accompanying sudden movement, is found in the fact that this same pattern has evolved independently in hole-nesting birds of widely different origins. Even the Wood Warbler qualifies since its nest has but a single entrance.

The suggestion was advanced above that the "snake display" constitutes an example of behavioral Batesian mimicry. It may well be argued that an explosive hiss is of itself a startling sound and that mimicry is not necessarily involved. This viewpoint would hold that the occurrence of hissing in snakes and in hole-nesting birds is simply a matter of convergent evolution. The case for mimicry is based on the fact that many snakes are actually dangerous to possible predators on the birds and thus the harmless mimic derives an advantage by its resemblance to the harmful model.

The effectiveness of the hissing sound in frightening mammalian predators is to be found in their demonstrated sensitivity to sibilants. Rayleigh (cited by Pumphrey, 1950) showed that the sound *sss* has most of its energy in the band between 8 and 12 kilocycles per second, to which the human ear is relatively insensitive. This same band of frequencies includes the peak of sensitivity for the rat (*Rattus*). The hiss of a snake is undoubtedly far louder and more frightening to a rat than it is to a man. It is probably safe to assume that other small mammals, including predaceous species, have a sensitivity to sibilants similar to that of the rat. If so, the frightening effect on them of the hissing produced by a hole-nesting bird should be even greater than that experienced by human observers.

The gaping mouth and slow side to side swaying movement would seem to enhance the mimic effect of a snake but, as Hinde (*loc. cit.*:24) indicates, a common threat posture of the Great Tit sometimes involves just these components. Other parids, for example *P. rufescens* (personal observation), also include a side to side swaying motion in their threat postures. It would thus appear likely that the gaping and swaying movements of the "snake display," as given by a nesting parid, have been derived from movements already present in the normal threat postures of the group. An element of mimicry is present in that the gaping and swaying seem always to be included in the "snake display" but are not consistently a part of the normal threat postures. The sudden lunge and accompanying explosive hiss may well be completely new mimic components.

The resultant pattern of the display, seen in the dim light of the nest cavity, would certainly resemble a snake rather than a bird. The intruder would thus receive a series of sign stimuli, all tending to conceal their origin as a bird and to reveal it as a snake. The testimony of many startled human observers indicates the effectiveness of the display. It seems probable that the "snake display" will be found to occur in all of the cavity-nesting Paridae. The extent of its occurrence in other groups of hole-nesting birds is a matter for experimental investigation. It is to be urged that an attempt be made to observe, and to record in detail, the pattern of movements as well as that of any sounds. It would be of additional interest to determine the point at which the motivation for the display is exhausted, in other words, how many lunges may be elicited from a bird at any one time.

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DEPARTMENT OF CONSERVATION, CORNELL UNIVERSITY, ITHACA, NEW YORK, MARCH 5, 1955

GENERAL NOTES

A possible case of polymorphism in the Lead-colored Bush-tit.—An adult male specimen of *Psaltriparus minimus* (Yale Peabody Mus. no. 7882) was collected by David H. Parsons 12 miles west of Cortez, Montezuma County, Colorado, on July 31, 1953, well within the range of *P. m. plumbeus* but with a typical plumage for that subspecies. Instead of having the usual brown cheeks and nuchal collar, it possessed black cheeks and collar. Otherwise the plumage was typical of an adult *plumbeus*. It probably was not a hybrid nor a stray from the range of the Black-cheeked Bush-tit (*P. melanotis lloydi*), as bush-tits are rather sedentary and the specimen in question was found over 300 miles from the range of *lloydi* or any other subspecies of *P. minimus*. At the time of collection, the specimen was established by Parsons to be an adult male. Subsequent examination of the skull confirmed this age determination, thus eliminating the possibility that the unusual black plumage was a manifestation of immaturity. The specimen's wing, tail and culmen were measured (50.0, 55.0 and 7.0 mm. respectively) and found not to be significantly smaller than the average of 38 other male *plumbeus* skins. Also, no other adult individuals of the Lead-colored Bush-tit with similar aberrant melanism have been reported; therefore it would seem that this specimen does not represent a discrete population.

Swarth (1914. *Auk*, 31:499–526) has advanced the theory that melanism in *Psaltriparus* is an old trait. Black coloration is to be found in the more southern bush-tits which are presumed to be older than the northern, brown-headed subspecies, due to the effects of glaciation upon the regions that the latter bush-tits now inhabit. *P. m. plumbeus* is thought to be the link between the northern and southern species because of the geographical position of its range and the occurrence of black head feathers in its juveniles. Therefore, the specimen under consideration would appear to demonstrate polymorphism in *plumbeus* by exhibiting an ancient color trait that has been suppressed through evolution but that has cropped up again in this adult bird.—Mary Anne Heimerdinger, *Conservation Program, Yale University, New Haven, Connecticut, April 15, 1954.*

Black-billed Cuckoo feeds on Monarch Butterfly.— During the fall migration of 1954 I saw more cuckoos, both Black-billed (*Coccyzus erythropthalmus*) and Yellow-billed (*C. americanus*) than I have ever seen before. These birds were seen on frequent trips to parts of New Jersey and Long Island, New York, areas in which I go birding regularly. In the latter part of September and the first two weeks of October, the cuckoos were quite numerous at Cape May Point, New Jersey. They were seen on the roads, in the hedges and on the porches around the Point and were not at all as secretive as they are at other times of the year. Monarch butterflies also were migrating and were quite plentiful at this time.

On October 9, 1954, while walking with my wife on one of the roads at Cape May Point, we watched as a Black-billed Cuckoo flew overhead and landed in a nearby cedar. As we were looking at it the cuckoo suddenly sallied forth and, with quite an audible snap of its mandibles, captured a passing monarch butterfly (*Danaus plexippus*). It flew back into the cedar with its prey. In the tree, the cuckoo held the monarch by its thorax and shifted it about in its bill, apparently applying pressure to this area. At that time, positive identification of the monarch was made with the aid of 10-power glasses. Then, very deftly, almost faster than the action could be seen, the cuckoo began to swallow the monarch, body first. The cuckoo held its bill straight upward while half of the monarch's wings protruded from its cavernous mouth. The bird was not successful in its first attempt to swallow the butterfly and it regurgitated the swallowed half to repeat this process over again. On the third try, the monarch disappeared very slowly into the seemingly bottomless throat of the cuckoo. For a minute or so after this action, the bird stood very still, looking stupified. This pose was not held for long as the cuckoo soon tried for another passing monarch, making much noise with its bill. This attempt was unsuccessful.

In searching through the literature, I find one other report of monarch butterflies being eaten by birds. Brooks (1952. *Auk,* 69:89.) records Starlings (*Sturnus vulgaris*) catching and eating monarchs. Apparently, the Starlings ate the body portion of the butterflies only, as Brooks says he found the remains of the wings.—Walter Dawn, *Bull's Island, Awendaw, South Carolina, November 1, 1954.*

A May record of the White-winged Crossbill in Michigan.—On May 9, 1954, we observed a flock of about ten White-winged Crossbills (*Loxia leucoptera*) at Hartwick Pines State Park, Crawford County, Michigan. The birds were on the ground in a foot path and apparently were feeding. Dominant vegetation in the area was a mature stand of white pine (*Pinus strobus*).

The pronounced white wing-bars and the crossed bills were readily apparent as the crossbills were observed through binoculars at a distance of about 35 feet. Several Pine Siskins (*Spinus pinus*) were feeding with the crossbills.

Wood (1951. *Misc. Publ. Mus. Zool. Univ. Mich.,* no. 75:475) lists four records of the White-winged Crossbill from Charlevoix County, at the extreme northern tip of the Lower Peninsula of Michigan, during June and July, and two records from the Beaver Islands, at the northern end of Lake Michigan, in July. These areas are at least 50 miles north of the Hartwick Pines. Records from more southerly localities in Michigan extend from late October to early April. No May record for this species is mentioned for any part of Michigan.—T. Wayne Porter and Aelred D. Geis, *Department of Zoology; Department of Fisheries and Wildlife, Michigan State College, East Lansing, Michigan, September 27, 1954.*

Notes on a heron rookery in northeastern Oklahoma.—On July 25, 1954, I discovered a heron rookery one mile east of Owasso, in Tulsa County, Oklahoma. This colony is worthy of notice, as it was inhabited principally by the Little Blue Heron (*Florida caerulea*), a bird that has rarely been recorded nesting in Oklahoma.

The site of the rookery was a grove of catalpa trees averaging 20 feet high and covering an area 250 feet square. They had been completely stripped of leaves by insects. The surrounding terrain is pasture land. A small lake lies in the open pasture west of the grove. A larger lake, situated 300 feet north of the colony, is surrounded by willow and elm trees.

The discovery was made so late in the nesting season that it was not possible to determine the exact number of nesting Little Blue Herons, and what other species may have nested there. However, the Snowy Egret (*Egretta thula*) and the American Egret (*Casmerodius albus*) were identified feeding in ponds near the rookery with large groups of Little Blue Herons. On July 25 all three species were seen returning to the nesting area to roost; I estimated 500 in the flock. One immature Yellow-crowned Night Heron (*Nyctanassa violacea*) also was seen.

On July 27, I watched with Mr. O. W. Letson for a period of two hours before darkness.

We saw many herons return from their foraging trips in the surrounding countryside, singly, and in groups of from two to 23. We agreed that 500 was a conservative estimate of the total number. The farm operator, Mr. F. A. Duty, told us that the herons had been nesting there since his arrival in the spring of 1952, which means that the colony is at least three years old. On August 7 I located 179 nests in the grove of catalpa trees. They were from nine to 18 feet above the ground.

In late July, I found the population divided approximately in the following proportions: 60 per cent were birds with white plumage of the size of the Little Blue Heron, 30 per cent were adult Little Blue Herons, approximately nine per cent had the white plumage mottled with blue, which is characteristic of the Little Blue Heron molting from the immature to the adult plumage, and one per cent were American Egrets. Three Snowy Egrets were identified by Mr. Wallace Hughes, Oklahoma Game and Fish Department, on August 5.

On August 18, half of the occupants had gone, and those remaining were gathering at night in the trees on the north side of the large lake instead of in the nesting area as before. On another visit on September 22, I found them gone. The farm operator told me they were last seen on September 15.

This is the first record of the Little Blue Heron nesting in Tulsa County, and is the second nesting record for the State of Oklahoma, the first having been reported from Oklahoma County by Hughes (1952. *Wilson Bull.*, 64:160.)—John S. Tomer, *4045 E. 27th. St., Tulsa, Oklahoma, November 3, 1954.*

An elevated nest of a Barn Swallow.—On July 12, 1954, in company with H. F. Borchert, T. D. Cotton and J. H. Shutts, I encountered a nest of *Hirundo rustica* on the observation tower of the Mud Lake National Wildlife Refuge, near Holt, Minnesota. The nest with its two eggs and two newly-hatched young had two interesting aspects. Located in the partially glassed-in tower room, it was 107 feet above the ground. Constructed on a ledge with little head room due to the sloping roof, the sides had an outer depth of about one and one-half inches.—Joseph J. Hickey, *University of Minnesota Forestry and Biological Station, Lake Itasca, Minnesota, November 17, 1954.*

The incubation period of the Cape White-eye.—In view of the importance the genus *Zosterops* has assumed as allegedly having the shortest incubation period of any bird, the following observations on the Cape White-eye (*Zosterops pallida capensis*) are perhaps worth publishing at once. M. M. Nice (1953. *Wilson Bull.*, 65:84) cites Neunzig's statement that the incubation period of this White-eye is 10 days, but she rejects this on the grounds that he gives neither details nor authority. There is no other record of the incubation period of this species.

On November 15, 1954, I noticed a Cape White-eye building its nest in a vine on my verandah. The first egg was laid between 7:30 a.m. on November 17 and 7:15 a.m. on November 18; and the second, which completed the clutch, between 5:30 p.m. that same day and 7:15 a.m. on November 19. Incubation had begun by 6:15 p.m. on the latter day. The parents proved very close sitters. No continuous watch was kept, but I never saw the nest unoccupied and I had almost to push the bird off the nest every morning to inspect the contents. The two eggs hatched between 7:30 a.m. on November 29 and 6:45 a.m. on November 30. This gives an absolute minimum incubation time for the second egg of 11½ days from laying to hatching, a period which agrees with the accurate Australian and New Zealand periods for *Zosterops* spp., as quoted by

Nice. A fuller account of this nest, on which observations are continuing, will be published elsewhere in due course.—J. M. Winterbottom, *P.O. Box 1616, Cape Town, South Africa, November 30, 1954.*

An extension of the breeding range of the Killdeer in Florida.— Sprunt (1954. "Florida Bird Life.") reported the southernmost breeding station of the Killdeer (*Charadrius vociferus*) as being at Fort Myers, on the west coast of Florida.

On June 3, 1954, a Killdeer was collected by the author three miles northwest of Corkscrew, Collier County, Florida. Upon examination, this bird proved to be an adult female. The dilated condition of the cloaca and genital tract indicated recent egg laying. This specimen, now in the collection of the Florida State Museum, represents the southernmost breeding record of the Killdeer in Florida.

Since Howell (1932. "Florida Bird Life.") reported the southernmost breeding record of the Killdeer in Florida at Lake Istokpoga, both Stevenson (1939. *Wilson Bull.*, 51:85) and Sprunt (1949. *Auk*, 66:202) have extended its known range. The present specimen, taken some 60 miles south of Lake Istokpoga, is a third extension to the range of the Killdeer in recent years. These records suggest that this bird has not been merely overlooked in this region but that the species actually is increasing its breeding range to the southward. This view is substantiated by the fact that I have observed an increase in the number of breeding killdeers in the Fort Myers area in recent years. The current logging and cutting back of the Big Cypress Swamp may also open up new potential breeding sites for the Killdeer and permit further range extension southward.—Fred D. Bartleson, Jr., *Department of Biology, University of Florida, Gainesville, Florida, December 23, 1954.*

Notes on the myology of the Great Curassow.— Through the kindness of Drs. Leonard W. Wing and Josselyn Van Tyne, I was permitted some time ago to dissect a fresh specimen of the Great Curassow (*Crax rubra*). This bird, from San Luis Potosi, Mexico, was raised as a pet by Dr. Wing from June, 1951, until it died in late September, 1953. Since little is known about the internal anatomy of the Cracidae, and apparently nothing about *Crax rubra*, the following notes seem worthy of record.

Mm. tensores patagii longus et brevis are poorly developed, consisting of a single sheet-like belly with an over-all length of 85 mm. The insertion of the tendon of M. tensor patagii brevis is simple, attaching primarily to the surface of *M. extensor metacarpi radialis*, but it also fuses with the antibrachial fascia.

M. supracoracoideus is composed of two distinct and completely separate bellies and tendons of insertion. The more superficial belly is typical in origin and in the course of its tendon dorsolaterad through the triosseal canal. The tendon inserts on the humerus *15 mm. distal to* the junction of the humeral head and the deltoid crest. The deeper belly arises exclusively from the coracoclavicular membrane. Its tendon also passes through the triosseal canal to insert primarily at the base of the deltoid crest and its junction with the humeral head, but a smaller tendon inserts between this tendon and the tendon of the more superficial belly. Gadow and Selenka (1891. "Vögel." Bronn's Klassen und Ord. des Thier-Reichs, p. 248) say that M. supracoracoideus is bipartite in the "Rasores" and in *Tinamus* and that the tendons of both parts remain separated, but they say nothing about the insertion.

M. entepicondylo-ulnaris (="the gallinaceous muscle") is a triangular-shaped muscle, arising tendinous from the humerus in common with Mm. flexor digitorum sublimus and pronator longus. It inserts by fleshy fibers on the proximal end of the ulna, posterior to the insertion of M. brachialis and anterior to the aponeurotic sheet which, in this species, forms most of M. flexor digitorum sublimus.

M. subcoracoideus arises by two heads. The larger head arises from the sternocoracoidal process of the coracoid and from the coracoclavicular membrane. A much smaller head arises from the medial surface of the acromion process of the scapula.

M. deltoideus major is poorly developed. It arises by a single head from the lateral surface of the scapula. There seems to be no os humeroscapulare.

M. pronator longus is actually a little shorter than *M. pronator brevis* (belly-length, 85 mm.), so that these two muscles extend about the same distance distad on the radius.

M. flexor digitorum sublimus has a typical origin from the humerus, but proximally the belly is rudimentary. From the origin, a flat, aponeurotic sheet extends the entire length of the ulna, attaches to the fascia surrounding the bases of the secondaries, and, distally, narrows to a tendon which inserts on the ulnare. On the ventral edge of this aponeurosis, a fusiform fleshy belly (45 mm. long) arises distally. Its tendon inserts on the base of the proximal phalanx of digit II.

M. extensor metacarpi radialis has a typical origin and belly, but distally its tendon fuses with the tendon of *M. extensor pollicis longus* (a well-developed muscle whose belly is 105 mm. long). The two tendons insert together.

M. abductor pollicis arises both by a strong tendon and by fleshy fibers from the tendon of *M. extensor metacarpi radialis* and also arises by a separate fleshy head from the distal surface of the extensor process of the carpometacarpus. The latter head inserts by fleshy fibers on nearly the entire length of the pollex. The more proximal head inserts through a tendinous sheet of fascia on the distal quarter of the pollex.

The following wing muscles are absent: Flexor metacarpi brevis, Flexor pollicis, Abductor indicis brevis, Proscapulohumeralis brevis.

The muscle formula of the thigh is ABCDXYAmV. As might be expected, many of the tendons are calcified.

M. piriformis pars caudofemoralis is very poorly developed. It consists of a spindle-shaped strap of muscle (belly about 90 mm. long, but only 7 mm. at maximum width), which arises and inserts by thin tendons. It arises from the dense fascia covering the depressor muscles of the tail; there seems to be no attachment to the pygostyle.

M. piriformis pars iliofemoralis is also poorly developed as compared to other birds I have dissected. It is a thin sheet of muscle arising from the ventral surface of the projecting posterior iliac crest. It inserts by fleshy fibers over a distance of 10 mm., beginning 30 mm. inferior to the proximal end of the femur.

M. iliotrochantericus medius is present but is quite small; it inserts distal to the insertion of *M. iliotrochantericus posticus.*

M. gluteus medius et minimus (almost rudimentary) is mostly semitendinous; its insertion is typical.

M. iliotibialis arises from the ilium, anteriorly by an aponeurosis and posteriorly by fleshy fibers. It is aponeurotic in the distal two-thirds of its central portion, as in *Coua caerulea.*

M. iliacus is well-developed. Its origin and insertion are typical.

M. peroneus longus is the most superficial muscle on the anterolateral aspect of the crus. Hence, it covers the bellies of *Mm. tibialis anticus* and *peroneus brevis.*

M. extensor digitorum longus is poorly developed. Its tendon is ossified; it bifurcates a little more than half way down the tarsometatarsus and, near the distal end of that bone, each tendon bifurcates again. The two medial tendons fuse and insert on digit III; one of the lateral tendons inserts on digit II, the other on digit IV.

M. obturator internus is triangular in shape and has a large component which arises from inside the pelvis. I failed to find *M. obturator externus.*—Andrew J. Berger, *Department of Anatomy, East Medical Building, Ann Arbor, Michigan, January 7, 1955.*

Notes on the songs of Lark Buntings.—The songs of Lark Buntings (*Calamospiza melanocorys*) are as distinctive as their plumage, although that fact has not been recognized adequately in the literature available to us. Peterson (1941. "A Field Guide to Western Birds") says the song is "sweet and trilling." Pough (1946. "Audubon Bird Guide; Eastern Land Birds.") adds that it is "warbled in a rich musical voice," and Hoffmann (1927. "Birds of the Pacific States.") speaks, correctly, of "sweet notes and trills, often interspersed with harsh notes."

The following observations are based on our tape recordings of two Lark Buntings in 1954, one on June 13, near Hugo, Lincoln County. Colorado, and the other on June 14, near Cimarron, Gray County, Kansas. The birds were conspicuous as they flitted across wheat fields and pastures where neither bushes, trees, nor rocks, and but few weeds, offered any concealment. Luckily for our recording, the buntings sang fully as well from fence posts as when on the wing. The birds usually were seen in loose groups or colonies containing from two to as many as a dozen singing males. The only other birds we saw near these colonies were occasional Horned Larks, Western Meadowlarks, Savannah Sparrows, and Lark Sparrows.

Broadly, the songs of the two Lark Buntings we recorded on tape, and of others heard but not recorded, consisted of the random use of several distinct phrases, with considerable variation in both the musical quality and pitches of the several phrases. A phrase might consist of a trill, or a buzz, or one or two notes repeated three to ten times.

In all, we recorded 16 songs from the Lark Bunting near Hugo, and 10 from the Cimarron bird. The Hugo bird averaged three to four phrases per song, and the Cimarron bird averaged six to seven phrases per song. For both birds we were able to recognize 11 different phrase types or patterns, although the repetitions of a given phrase-type were not always exactly identical.

The 11 phrase-types of these two Lark Buntings may be placed in four groups. Group A contains three types, Cardinal-like and gliding in pitch: (1) a single-note *sweet*, rising rapidly in pitch for about an octave, this note repeated four to eight times; (2) a slurred double-note *cher-wheat*, rising in pitch, usually repeated about three times; and (3) *weeta*, falling in pitch. Group B contains two types, chat-like and unmusical: (4) *chug* repeated three or four times; and (5) *chut*, repeated more rapidly, usually nine or ten times. Group C contains three types, trills or buzzes: (6) a low-pitched *buzz;* (7) a junco-like trill; and (8) a high-pitched, insect-like trill. Group D contains three types: (9) *toot* repeated four to twelve times, quality clear and piping; (10) *churt* less clear and musical than type 9; and (11) *chew*, rather cardinal-like, but not conspicuously gliding in pitch as in Group A.

The use of these song types by the two males is indicated in the following table:

Song Type Number	*Group*	*Transliteration*	*Number of times used*	
			Hugo	*Cimarron*
1	A	Cardinal-like *sweet*	15	8
2	A	Cardinal-like *cher-wheat*	4	3
3	A	Cardinal-like *weeta*	0	3
4	B	Chat-like *chug*	8	12
5	B	Chat-like *chut*	4	0
6	C	trills; low buzz	0	3
7	C	trills; Junco-like trill	1	4
8	C	trills; high, insect-like	7	9
9	D	single-note *toot*	12	10
10	D	single-note *churt*	1	9
11	D	single-note *chew*	0	1

With three exceptions, both birds began each song with Type 1 phrase. Seven of the 11 types (no. 1, 2, 4, 7, 8, 9, and 10) were used by both birds. Type 5 was used only by the Hugo bird; and Types 3, 6, and 11 were used only by the Cimarron bird. Type 4 was used eight times by the Cimarron bird as the second phrase in his songs; and Type 9 was used eight times by the Hugo bird as the second phrase in his songs.

A typical song of the Hugo Lark Bunting might be written: *sweet, sweet, sweet, sweet, sweet, sweet; toot, toot, toot, toot, toot, toot; chug, chug, chug; tr-r-r-r-r-r-r.*

A typical song of the Cimarron bird would be: *sweet, sweet, sweet, sweet, sweet; chug, chug, chug, chug; tr-r-r-r-r-r-r; toot, toot, toot, toot, toot; buz-z-z-z-z; churt, churt, churt.* —JERRY E. STILLWELL AND NORMA J. STILLWELL, *RFD #2, Fayetteville, Arkansas, December 11, 1954.*

Food-storing in the Sparrow Hawk.— The habit of food-storing in shrikes (*Lanius*) is well known and has obvious survival value. Sparrow Hawks (*Falco sparverius*) might be expected to benefit similarly from such a habit. The observations reported here indicate that food-storing is practiced by at least some Sparrow Hawks.

In February, 1949, I trapped a male Sparrow Hawk near Ann Arbor, Michigan. I kept this bird captive for six weeks, during which it became rather tame. On several occasions this bird stored excess food (usually beef heart) after it had eaten its fill. A typical incident was as follows: After feeding to repletion while on its perch in the living room, the bird flew to the kitchen with the remaining food in its talons. Here the hawk perched on a rod supporting some curtains and then, with actions which can best be described as furtive, placed the meat in the narrow space between the curtain and the wall. The hawk then flew back to its perch in the living room where I tethered it. The place in which the meat had been stored (and later removed by me) was not in sight of the hawk's perch. Twenty-four hours later I again released the falcon, having not fed it in the interim. It flew immediately to the curtain rod in the kitchen where it quite obviously searched for the meat, craning its neck and peering down behind the curtain. Pierce (1937. *Condor,* 39:140) has also reported storage of excess food by a captive Sparrow Hawk.

The behavior of the captive bird convinced me that wild Sparrow Hawks might store food, but proof of this was not obtained until recently. On January 8, 1955, David L. Hardy and I were trying to trap a male Sparrow Hawk near Lawrence, Douglas County, Kansas. This bird was hunting from a high tension line which crossed a 200-acre field devoid of trees. From our car some 300 yards away, we saw the Sparrow Hawk fly to the ground approximately 90 feet north of the high tension line. The hawk remained on the ground for 10 to 15 seconds and then returned to its original perch on the wire with a mouse in its talons. It remained on the wire for half a minute, made no effort to eat the mouse, and then flew to the ground again near the point of capture of the mouse. The hawk hopped around for a few seconds and then flew up and hovered, first at approximately 30 feet and then at 70 feet, over the same spot on the ground. Returning to the high tension wire without the mouse, the hawk perched for 10 minutes. It then flew north again, hovered for 15 to 20 seconds over the spot, and finally flew 600 yards northeast where it perched in a tree.

We went into the field and after some searching found the warm, freshly-killed carcass of a male deer mouse (*Peromyscus maniculatus*) 84 feet north of the high tension line. The mouse was on the ground, belly down, tucked between coarse stems of a large clump of grass (*Panicum capillare*). There was no external evidence of injury although the mouse had the back of its skull crushed. The part of the field in which the mouse was captured and hidden had been planted with soybeans. Harvesting of the soybeans left a large amount of ground litter but little standing vegetation. The mouse was hidden in one of the most conspicuous clumps of grass. One interesting aspect of the hawk's behavior was the hovering over the spot where the mouse was stored. Possibly the hawk was memorizing the exact spot to make it easier to find the mouse when necessary.

On January 26, 1955, near Lawrence, Hardy and I saw a female Sparrow Hawk kill and store a male *Microtus ochrogaster* (weight, 15 grams; estimated age, three weeks). The hawk flew to the ground in two places before finally storing the mouse belly down, eight inches off the ground, in the top of a thick clump of a green grass, *Bromus inermis.* The storage site was almost 100 feet from the point of capture. The elapsed time from capture of the mouse until storage was approximately 45 seconds. The female falcon hovered over the hidden mouse after storing it, as did the male mentioned above.

The fact that the captive Sparrow Hawk mentioned earlier stored its food in an elevated place suggests that trees also might be used as storage places. If storage of surplus food is regularly practiced by Sparrow Hawks, the adverse effect on the birds of prolonged winter storms would be greatly reduced.—HARRISON B. TORDOFF, *Museum of Natural History, University of Kansas, Lawrence, Kansas, January 28, 1955.*

Size of home range in eight bird species in a southern Illinois swamp-thicket.— During the summer of 1950, William Hardy and the writer studied the ecology of a 13-acre tract of swamp and thicket in Jackson County, about one mile north of Murphysboro, Illinois. The study included a plot census of the breeding bird population (Brewer and Hardy, 1950. *Audubon Field Notes,* 4:303). By connecting successive points of observation as plotted on the study maps in such a way as to include the smallest possible area, it was possible to derive the minimum horizontal area utilized by many of the pairs of birds. Since plotted observations included all records of the occurrence of a pair and not merely records of actual or implied defense of a point (such as fights or scolding or singing birds), its seems better to designate the areas delimited in this manner as home ranges rather than as territories (Burt, 1943. *Jour. Mammalogy,* 24:346–352). There was evidence that in some cases the two areas were identical or nearly so.

The study tract consisted of three small ponds, each surrounded by a narrow zone of swamp dock (*Rumex verticillatus*) and mild water-pepper (*Polygonum hydropiperoides*) and a much wider one of cat-tails (*Typha latifolia*) which gave way in some places to alternes of lizard's-tail (*Saururus cernuus*) and of peripheral, interdigitated, and interspersed second-growth thickets of pin oak (*Quercus palustris*), American elm (*Ulmus americana*), red maple (*Acer rubrum*), shellbark and shagbark hickories (*Carya laciniosa* and *C. ovata*), flowering dogwood (*Cornus florida*), and 28 other tree species. The average height of the thicket was 30 feet. The canopy was continuous and the understory consisted of a sparse growth of common ragweed (*Ambrosia artemisiifolia*), a sedge (*Carex squarrosa*), three-seeded mercury (*Acalypha virginica*), white-top (*Erigeron annuus*), spotted touch-me-not (*Impatiens biflora*), adder's-tongue (*Ophioglossum vulgatum*), and wood reedgrass (*Cinna arundinacea*). In some places poison ivy (*Rhus radicans*) and trumpet creeper (*Campsis radicans*) formed low, dense growths. A zone of weeds, shrubs, and shrubby trees occupied varying areas between the swamp and thicket habitats in several places. The characteristic plants of this transition zone were goldenrod (*Solidago altissima*), tickseed-sunflower (*Bidens aristosa*), great ragweed (*Ambrosia trifida*), swamp-milkweed (*Asclepias incarnata*), beard-tongue (*Penstemon tubaeflorus*), brambles (*Rubus allegheniensis*), smooth sumac (*Rhus glabra*), common elder (*Sambucus canadensis*), American elm, and pin oak. A narrow strip of thicket composed almost entirely of black willow (*Salix nigra*) lay along the western edge of the area. The ponds and the swamp stages made up about 41 per cent of the total area, the transition zone about 18 per cent, and the two divisions of thicket about 41 per cent. The land was nearly level. It was bounded on the north and south by similar habitats and on the east and west by cultivated fields.

The study area was visited 22 times from April 23 to August 30. Forty-two territorial males of 16 species of birds were present during that period. Home ranges were calculated for pairs whose movements were confined entirely to the study area and for which more than five observations were obtained. The arithmetic means, the extremes, and the numbers of pairs studied for eight species which satisfied these requirements are presented in the following table.

Species	Number of pairs	Mean size, acres	Range
Carolina Wren, *Thryothorus ludovicianus*	3	0.30	0.12–0.61
Catbird, *Dumetella carolinensis*	2	0.26	0.16–0.36
White-eyed Vireo, *Vireo griseus*	1	0.33	———
Yellow Warbler, *Dendroica petechia*	4	0.42	0.15–0.94
Yellow-throat *Geothlypis trichas*	5	0.56	0.24–1.09
Yellow-breasted Chat, *Icteria virens*	4	0.33	0.14–0.71
Cardinal, *Richmondena cardinalis*	5	0.37	0.31–0.45
Indigo Bunting, *Passerina cyanea*	5	0.26	0.15–0.52

Species resident on the study area but omitted from consideration were Mourning Dove (*Zenaidura macroura*), Yellow-billed Cuckoo (*Coccyzus americanus*), Carolina Chickadee (*Parus carolinensis*), Brown Thrasher (*Toxostoma rufum*), Bluebird (*Sialia sialis*), Blue-gray Gnatcatcher (*Polioptila caerulea*), Red-winged Blackbird (*Agelaius phoeniceus*), and Red-eyed Towhee (*Pipilo erythrophthalmus*).—RICHARD BREWER, *Department of Zoology, Southern Illinois University, Carbondale, Illinois, December 30, 1954.*

Number of feathers and weights of various systems in a Bald Eagle.—As far as I am aware the number of feathers has never been determined for any member of the Order Falconiformes. A yearling female Bald Eagle (*Haliaeetus leucocephalus*) was obtained in Volusia County, Florida, on January 15, 1953. While preparing this bird as a skeleton, I counted the contour feathers. The total count was 7182 feathers, distributed as follows: head 2175, neck 805, body 334, tail 139, left wing 1234 (of which 754 were on the upper surface, and 480 on the under surface), right wing 1369, left leg 551, right leg 535. It is interesting to note that the eagle had only a few more feathers than a Screech Owl (*Otus asio asio*), fewer than a Barred Owl (*Strix varia georgica*), and considerably fewer than several species of swimmers of smaller size (Brodkorb, 1951. *Quart. Jour. Florida Acad. Sci.*, 12:241–245).

The total weight of the eagle was 4082 grams. The weights of various parts of the body are given in the table below:

System	*Weight in Grams*		*Percent Body Weight*	
Integument	1044		25.58	
(Contour feathers)		(586)		(14.36)
(Down)		(91)		(2.23)
(Skin, including rhamphotheca and podotheca)		(367)		(8.99)
Muscles and nervous system	2360		57.81	
(*M. pectoralis superficialis*)		(646)		(15.83)
Skeleton	272		6.66	
Digestive tract	247		6.05	
(Esophagus)		(33)		(0.81)
(Stomach)		(27)		(0.66)
(Intestine)		(130)		(3.18)
(Liver)		(57)		(1.40)
Respiratory System	76		1.87	
(Trachea)		(17)		(0.42)
(Lungs)		(59)		(1.45)
Heart	58		1.42	
Kidneys	25		0.61	
Total	4082		100.00	

In the paper previously cited I estimated that the weight of the plumage might exceed that of the skeleton. This is substantiated by the present data; in fact, the weight of the skeleton of the eagle was less than half that of the feathers.—Pierce Brodkorb, *Department of Biology, University of Florida, Gainesville, Florida, February 18, 1955.*

ANNUAL MEETING

The Proceedings of the Thirty-sixth Annual Meeting, held at Stillwater, Oklahoma, April 7-10, 1955, will be published in the September issue of *The Wilson Bulletin.* The names of the officers elected for the ensuing year appear on the inside front cover. Leonard C. Brecher, retiring Treasurer, was elected a member of the Executive Council. Keith L. Dixon was appointed Editor of *The Wilson Bulletin.*

The proposed amendment to the Constitution changing the name to The Wilson Ornithological Society was passed unanimously and will become effective upon approval by by the State of Illinois. It is hoped that the change can be made operative prior to publication of the September issue of *The Wilson Bulletin.*

LOUIS AGASSIZ FUERTES RESEARCH GRANT

Robert G. Wolk, graduate student at Cornell University, has been awarded the Fuertes Research Grant to aid his "Analysis of Reproductive Behavior in the Black Skimmer," according to Dr. Kenneth C. Parkes, Chairman of the Research Grant Committee.

The American Museum of Natural History has announced the establishment of The Southwestern Research Station. It is located on the east slope of the Chiricahua Mountains, near Portal, Arizona, at an elevation of 5400 feet. The station makes available to scientists and students facilities for research utilizing faunal, floral, and geological features of the area. Further information may be obtained from the Director, Dr. Mont A. Cazier, Department of Insects and Spiders, American Museum of Natural History, New York 24, N.Y.

Volume 1 of "American Bird Songs," which features the voices of 60 species, chiefly of the eastern United States, is now available on two sides of a long-playing record. This well-known set of recordings made by Professors Allen and Kellogg is priced at $7.75. Orders may be placed with the Cornell University Press, 124 Roberts Place, Ithaca, New York.

THE WILSON ORNITHOLOGICAL CLUB LIBRARY

The following gifts have been received recently. From:

Reeve M. Bailey—3 reprints
William H. Behle—6 reprints
Andrew J. Berger—5 reprints
William H. Burt—3 reprints
G. Reeves Butchart—1 book
Robert T. Calef—2 reprints
Detroit Audubon Society—1 bulletin
Karl W. Haller—11 books
Marion L. Hundley—1 reprint
Ernst Mayr—6 bulletins
Margaret M. Nice—18 reprints
Fred M. Packard—11 magazines
Kenneth C. Parkes—2 reprints
Aretas A. Saunders—1 book
Walter E. Scott—1 book, 11 pamphlets
Allen W. Stokes—1 book
H. B. Tordoff—10 reprints
Josselyn Van Tyne—1 book
George J. Wallace—1 book

LETTER TO THE EDITOR

At the start of his interesting review of the value of the Christmas bird count (*Wilson Bull.* 66:184–195), Paul A. Stewart properly asks two questions: "Of what value are the Christmas bird counts? Can we enhance their value and still hold the interest of the many who make them?" Mr. Stewart competently handles this first query and carefully analyzes some 14 categories in which the Count can stand improvement. These analyses lead him to conclude in a final sentence that "the value of the counts can be enhanced without serious infringement of their popular appeal."

Professional ornithologists will, I am sure, agree that the value of the counts can be enhanced; but Mr. Stewart has, I am afraid, unwarrantedly inserted personal opinion into this last conclusion by claiming that his recommendations will not seriously detract from the present recreational appeal of the project. Certainly his recommendations have not been tested in practice nor does his paper report the results of a questionnaire sampling the reactions of Christmas bird counters to his ideas. Thus what purports to be a *conclusion* is in reality an *hypothesis.*

There is no clear-cut test of this hypothesis that I know of, but it is instructive to note that the fine winter bird census launched by *Audubon Field Notes* in 1948 has failed to demonstrate any widespread popular appeal (nor has its counterpart, the *Audubon Field Notes* breeding-bird census). After some 30 years personal contact with Christmas bird counters, I am pretty much convinced that Mr. Stewart's recommendations are laudable, but unrealistic. To avoid looking for birds near feeders, to refrain from making "squeaks" at nonstandardized intervals and with nonstandardized equipment, to make the use of bird dogs illegal on a count, to keep one's party together when crossing a very wide field, —these are absurdities to the lay mind: they minimize the species list and effectively rob the project of much of its fun.

May I submit that Christmas bird counting is based upon a largely emotional component that still has a reputable place in our materialistic society today? Professional ornithologists will all agree with Mr. Stewart's insistence on the need for honest identifications and the need for better census work. However much we may wish for other improvements in the Christmas count, let us recognize that many of these suggestions impose disciplines that most laymen will simply not accept. The Christmas bird count to them is essentially a recreational activity in which distinct elements of competition, surprise, rarities and the big list are bright and personally thrilling.

My quarrel with Mr. Stewart's paper centers, however, not so much on a conclusion which cannot be supported, but more importantly on what I think is the assumption underlying his paper: "list-chasing has no reputable place in our culture." I think it has. It has no place, I am glad to note, in *The Wilson Bulletin;* it has a definite place in *Audubon Field Notes.* It has its place as a sport, and as a sport, it is perhaps limited only by the strain it puts on the faunalists who compile regional lists and state bird books. I would hate to see the professional ornithologists destroy this stronghold of the amateur by a series of pincer movements carried out under the banner of "No More Variables."

To be perfectly fair to Mr. Stewart, I should acknowledge that his list of suggested prohibitions displays considerable restraint. What I really fear is that, even if his list were accepted by a groaning public, some less restrained colleague will offer another list. There are, of course, many other variables in bird counting that one could eliminate. Hindrances to audibility include boys with squeaky shoes and corduroy trousers, college-student automobiles with mudguards that wave in the wind, young girls that talk your head off, the ocean surf, the winds over 25 m.p.h. Variables in visibility include eyeglass wearers who haven't had their eyesight checked this year, eye-glasses that fog up, persons who wash their cars after the count (not the night before), fanatics with telescopes, binoculars in a state of disrepair, boys who always get in front of you at the wrong moment, and trees with the same habit.

Variables in identification technique include newcomers to the club, museum men whose current field work is largely confined to foreign countries, people that do not own a copy of a Peterson field guide, and people possessing field guides with mutilated or missing pages. We could, I suspect, eliminate these variables with firmness and dispatch. Tests could be given each applicant a week before the great event. The elite would then shape up as a hard core of cold professionals intermixed with small numbers of thoroughly subdued amateurs. The Christmas Bird Count would then be on a thoroughly scientific level. But would it be democratic? And would it be fun?

If professional ornithologists need refined winter census data here in North America (as I think they do), let them popularize *Audubon Field Notes*' winter bird-population studies and tinker with this project while it is still young. The Christmas bird count is an old established institution. Its primary function is not ornithological, and it should be left to the amateurs. If our continental duck habitat continues its present rate of shrinkage, the count may ultimately be called upon to do more than serve as a harmless substitute for a nineteenth-century Christmas Day "side hunt."

Joseph J. Hickey

Department of Forestry and Wildlife Management
University of Wisconsin

North American students of bird migration can benefit greatly through an interchange of ideas with their colleagues in Europe. During the past year the undersigned has enjoyed a stimulating correspondence with three leading European authorities on the subject of migration and weather's relation to it. Believing that such intercommunication among fellow workers should be more widespread, I would urge North American students of migration to send their ideas and their reprints to the following: Dr. Holger Holgersen, Stavanger Museum, Stavanger, Norway; Dr. Gunnar Svardson, Omardsvagen 17, Bromma, Sweden; and Mr. Kenneth Williamson. Fair Isle Bird Observatory Trust, 17 India Street, Edinburgh 3, Scotland.

Aaron M. Bagg

72 Fairchild Avenue
Holyoke, Massachusetts

ORNITHOLOGICAL LITERATURE

Florida Bird Life. By Alexander Sprunt, Jr. Based upon and Supplementary to Florida Bird Life by Arthur H. Howell. Coward-McCann, Inc., and the National Audubon Society, New York, 1954: 8 × 10 in., xiii + 527 pp., 56 plates, 40 in color by F. L. Jacques and J. L. Dick, 65 text figs. $12.50.

Alexander Sprunt, Jr., D.Sc., of the National Audubon Society, Fellow of the American Ornithologists Union, has prepared what he states is a "revision-rewrite" of the State bird book which ornithologists have for many years recognized as one of the best. Arthur H. Howell set a standard with his 1932 volume which is hard to equal. It is a shame that the exhaustion of the small original printing of that work has brought about this hastily done book which will probably in time replace it in the minds of oncoming ornithologists as the definitive work on Florida birds.

Of the 42 introductory pages, 36 are taken up with: "Foreword," "Acknowledgments," "List of Illustrations," "Recent History of Florida Ornithology," (since 1932), "The Florida Audubon Society," "The Tropical Audubon Society," "Bird Protection in Florida," (since 1932), and "Note on the Author." The remaining six pages are given over to an emasculated version of Howell's discussion of the Physiographic Regions and Life Zones of Florida. Sprunt divides the State into four regions, Western, Northern, Central and Southern. The boundaries are, as he states, quite arbitrary. This is most obvious in that their positions show no relationship to any known natural factor in the environment. The discussion of "Position and Climate" may serve some useful purpose in attracting tourists to Florida but it certainly does not shed any light on conditions which the avifauna experiences. What information has been added contributes little, and what has been deleted detracts mightily.

The treatment accorded the "Birds of Florida" follows much the same pattern as that found in the earlier volume. This is almost a necessity in that most of the material has been lifted, in quotes, directly from that work. Some of the descriptions have been changed slightly, without noticeable improvement. Measurements, when given, are in inches and seem to have been taken from Howell. In the Foreword the author states that egg measurements have been added. This is not completely true. In a spot check, no measurements were found for the following: White-tailed Kite, Everglades Kite, Eastern Bob-White, Florida Bob-White, Florida Turkey and Limpkin. Range descriptions are usually taken (without quotes) intact from Howell.

Under the heading "History" the author has combined the nicely documented information which Howell presented in his discussion of "Haunts and Habits" and "Food." Sprunt, on occasion, has added his own observations along with information from the recent literature and other sources. For no apparent reason some of the earlier author's comments are deleted. On many occassions they are reworded with the original citations removed, making it impossible for the reader to determine whether Sprunt or someone else is responsible for the data. In other instances the original citations are left in place. This is not of much help to the reader who does not have Howell's book at hand in that all of Howell's references have been removed.

Five of Howell's distribution maps, inexplicably, have been removed. Of the remaining 65, some 25 have additional records indicated. As far as I can determine only eight of these show any extensions of range. On some occasions the validity of these extensions is open to question. Sprunt suggests that the Black Rail has extended its breeding range, on the basis of a song record by a Mockingbird. (D. J. Nicholson reported to him that he had heard a Mockingbird near Boca Grande imitating the notes of a Black Rail.)

The range of the Northern Blue Jay is extended on the basis of sight records by Sprunt and other observers. An October 13, 1946 specimen taken in Levy County is considered to be evidence of an extension of breeding range of *Dendroica dominica stoddardi* Sutton. The October date hardly constitutes a breeding record and more likely indicates migratory behavior. The wisdom of carrying to subspecies the identification of forms new to the State, in the absence of specimens, as is done in the case of *Dendrocygna bicolor helva* Wetmore, is questionable.

Sprunt comments at length on the occurrence of the Black Skimmer on inland lakes, yet the included map shows no such records at all. On the other hand some maps show new locality records (*viz.* the European Starling) without accompanying documentation in the text.

There are many inconsistencies in the taxonomic treatment. The order of presentation follows that of the A.O.U. Check-list, in general, and appropriate A.O.U. numbers are appended. However, the Gadwall is left in the genus *Chavelasmus* [*sic.*] without comment. This unexplained treatment, coupled with the placement of *Mareca* in the middle of the genus *Anas* makes for confusion. The change of *Moris* to *Morus* was overlooked. Several new forms are included which have not been accepted as valid by the check list commmittee (viz. *Dendroica dominica stoddardi* Sutton. *Hirundo erythrogaster insularis* Burleigh, and *Tyrannus dominicensis sequax* Brodkorb) with no comment by Sprunt as to why he considers them valid. Acceptance of *T. d. sequax* requires the substition of *T. d. fugax* for *T. d. dominicensis* yet the latter name is allowed to stand. Contrariwise "*chloristibon*" [*sic.*] is not used as a replacement for *Riccordia* because "official recognition of such is not current."

Strange inclusions are as follows: Green-shank (removed from Check-list of North American Birds in 1931), Ringed Turtle Dove (a domesticated stock), Key West Bob-White (removed from Check-list in 1946), Wurdeman's Heron, as *Ardea wurdemanni* Baird (currently regarded as hybrids). Odd omissions, considering some of the inclusions, are: The King Vulture (the sight record by William Bartram has now been accepted as valid by the A.O.U. Check-list Committee), and the Rock Dove which certainly exists in a feral state in many ruderal areas in Florida.

No measurements are given for forms which are reported as new to the State, although the measurements of others are faithfully transcribed from Howell. The check of literature from 1932 on was apparently not exhaustive. For example, no mention is made of the successful growth of the Eastern Glossy Ibis colony at Biven's Arm and later Lake Alice, near Gainesville, although the reports of the resident Florida Audubon Society Wardens mention it. The Noddy Tern is said never to rest on bare ground although published information (*Auk* 58:259) was available to the contrary.

It is interesting to note that of the 50 forms added to the State list, eight were apparently overlooked by Howell, five are newly described races, and four are based on sight records alone. Most of the others are best regarded as vagrants. In the case of the single sight record for the Red-shafted Flicker, reported in the Hypothetical List, it might be wise to point out that variants resembling its western ally have appeared *in situ* in the eastern stock.

The Hypothetical List includes 36 forms. It would be interesting to know what, if any, reported observations were omitted by the author for lack of adequate documentation.

The book is attractively bound, and the format is pleasing. Mr. John H. Dick has provided several additional plates which are very striking. The original color plates by F. L. Jacques which appeared in the earlier volume appear again, along with most of the original habitat photographs.—J. C. DICKINSON, JR.

SOCIAL FEEDING BEHAVIOR OF BIRDS By Austin L. Rand. Fieldiana: Zoology (Chicago Natural History Museum), Vol. 36, no. 1, 1954: 71 pp. $1.00, plus postage.

In this survey of what has been recorded of the social feeding habits of birds outside the breeding season (when there is the obviously special relationship of parents bringing food to young birds), an attempt is made to distinguish several types of behavior. The author is alert to the danger of assuming phylogenetic inferences in this type of data, and is correspondingly cautious in drawing conclusions. The simplest picture is that which obtains within the species, between individuals of the same kind. Rand discusses the social implications in such matters as the spacing of individuals, locating food and "communicating" such finds within the species, and the combining of effort by several individuals in securing a single item of prey. The attraction of food and the natural gregariousness of many birds provide the basic setting for these further developments.

The next group of situations is that in which birds of one species associate with a non-food animal, not necessarily a bird, for purposes of feeding. Here we have such cases as the cattle egret or the cowbird and large grazing mammals, and such an extreme development as the African greater honey-guide and the primitive tribesmen. In other cases one species may inadvertently provide food for another by leaving small scraps lying about, and finally we come to such instances as one bird stealing food from another, such as the oft mentioned one of the bald eagle forcing the fish hawk to give up its prey.

The most complex situation is that where several species of birds feed together, such as we find in mixed parties of insectivorous birds following a line of army ants, or a mixed flock of sea birds of several kinds. Throughout all the types of social feeding behavior one is aware of the acuity with which birds make use of small elements or small changes in their environment that provide some feeding advantage. Such occasional benefits may, in turn, lead to altered habits, but the apparent ease and rapidity with which these new habits seem to develop suggest that they may not necessarily provide reliable phylogenetic indications, as unrelated groups of birds may end up with similar social feeding patterns.

The paper opens up many problems and provides a convenient summary of a large amount of otherwise disconnected information, thus offering a basic working index to the literature of the subject.—HERBERT FRIEDMANN.

VI BULLETIN OF THE INTERNATIONAL COMMITTEE FOR BIRD PRESERVATION. Published by the International Committee for Bird Preservation, c/o British Museum (Natural History), Cromwell Road, London, SW 7, 1952: 9½ × 6 in., 248 pp., 12 shillings, six pence.

This Sixth Bulletin is the first published since 1939, and this may be a good opportunity to recall the history and object of the International Committee for Bird Preservation. It was founded in 1922 by the late T. Gilbert Pearson, then the President of the National Audubon Society. Immediately after the first World War, Dr. Pearson was very conscious of the importance of coordinating efforts all over the world to preserve the avifauna which was entering a critical phase. In many different regions bird life was decreasing alarmingly owing to human penetration, which meant excessive killing of certain species and destruction of the habitat of others. Something had to be done, and as the United States had some advance on other countries in establishing protective measures, it was natural that they should take the lead. Dr. Pearson came to Europe and met with a few people who were working along similar lines, particularly Mrs. R.

McKenna (Great Britain), P. van Thienhoven (The Netherlands) and the writer of these lines (France). The Committee thus was created. It is made up of National Sections, one in each of the countries where groups interested in the problem of bird protection can be found. Today these number nearly fifty. Each section consists of two representatives of eight institutions and societies. The scheme has worked well in promoting bird conservation ideas throughout the world, in helping and encouraging efforts of small groups and individuals, and in stirring up public interest to a considerable extent. After twenty years many important and tangible achievements have resulted.

The VI Bulletin is printed in four languages: English, French, German and Spanish, each contribution being written in one with summaries in the other three. It starts with the Declaration of Principles, stating the object and aim of the International Committee. Then come the proceedings of the VIII Conference held at Uppsala, Sweden, in 1950, the first plenary meeting since 1938, when many questions were discussed: transport of live birds, status of wildfowl, oil pollution, danger of insecticides, protection of migratory birds, protection of waders, exploitation of birds in the Antarctic islands, species threatened with extinction, and the situation of birds which are a menace to other species, adequate resolutions being adopted on all those important problems.

Following the summaries of the activities of the Panamerican and European sections (which group the national sections of the continents), comes the text of the International Convention for the Protection of Birds in Europe, established at a Conference in Paris in 1948. This constitutes one of the major successes of the Committee. The rest of the volume contains reports by the National Sections concerning the situation in the various countries.

The writer recently returned from the IX Plenary Conference held in Switzerland where he was reelected President of the Committee for a last term of four years. That term will bring his tenure of office to twenty years. Dr. Pearson had previously been President for sixteen years. In a world when transportation and contacts are becoming easier every day, but also when means of penetration and destruction are increasing continually, international organization is highly necessary, and it is to be hoped that those coming after us will develop, make more powerful and efficient the work that we have just started, and help in preserving for many generations to come the incomparable treasure that is the avifauna of the earth.—J. DELACOUR.

CHECK-LIST OF THE BIRDS OF GREAT BRITAIN AND IRELAND. Prepared by the List Sub-Committee. Published by the British Ornithologists' Union, 1952: 5½ × 8½ in., pp. i–xii, 1–106, paper cover. Obtainable from H. F. & G. Witherby Ltd., 5 Harwick Court, London, W.C. 1, England. Seven shillings sixpence, postage sixpence.

This is a revision of the official B.O.U. Check-list, complete to July 31, 1950, the last previous edition having been issued in 1923. The scope is Great Britain and Ireland, including the islands adjacent, except the Channel Islands. Information is presented in highly concise form beginning with the accepted scientific name for the species, with the authority and a common name, the original reference, with the type locality, and a greatly abbreviated statement of range. This is followed by the scientific names for subspecies, if any are recognized, and another line indicating status for each in the area. Where the bird is found in North America the A.O.U. common name for the species is added whenever this differs.

The classification under orders and families agrees fairly well with that of the A.O.U. list, with the same suffixes used to designate the rank of the name. A separate order is added for the flamingos, and there is some variation in the derivation of the group name, e.g. Ardeiformes, instead of Ciconiiformes, and Ralliformes for Gruiformes. The Old World Vultures are placed in a separate family, Aegypiidae, and the family term Falconidae is extended to cover the rest of the hawks and the osprey, as well as the falcons. All of the owls are included in a single family. The genus *Colymbus* applies to the loons, while *Podiceps is* used for the grebes, as is usual in Old World writings. Generic limits are broad, all of the phalaropes being included in *Phalaropus*, our spotted sandpiper and yellowlegs (both stragglers) in *Tringa*, and all of the mergansers listed under *Mergus*, as examples.

The condensed form of presentation allows the inclusion of the 426 species together with whatever subspecies may be represented within the pagination shown above. At the close one page is devoted to an appendix listing a number of races that are not accepted, with reference to the edition of 1915 for other information of this kind. A further statement explains the scope of orders, families, genera, species, and races, with description of the methods of designating types of genera. One index covers the genera, and a second the common names, where American "and other equivalents" are given in italics. Those responsible have done a careful and painstaking job in screening records and names, with commendable conservatism in doubtful cases.

The scope of this work obviously is quite different from that of the official check-list of the American Ornithologists' Union. This B.O.U. list is the authority for the acceptance and standing of the species and subspecies for which there is accepted record within the designated limits. The details of distribution and casual occurrence within the area are left to the multitude of other volumes describing the birds of the British Isles, completely or in part. There is no need therefore for repetition here. Our task in America is broader as it is necessary to provide the detailed range in connection with the accepted list because of the far greater geographic area to be covered, and since state lists and condensed handbooks look to our check-list for this information.—ALEXANDER WETMORE.

BOWER-BIRDS. THEIR DISPLAYS AND BREEDING CYCLES. By A. J. Marshall. Oxford Univ. Press, 1954: 9¼ × 6¼ in., 208 pp., 26 plates, 21 figures. $4.80.

Though some bower-birds are brilliantly colored or ornamented, it is in behavior that this family of some 18 species of the Australia-New Guinea area is specialized. This behavior results in the building of mating stations, known as "bowers," decorated with leaves, flowers, stones, etc. This contrasts with the simpler mating behavior of the bower birds' near relatives, the crows, and the elaborate plumage adornment and physical displays of their other near relatives, the birds of paradise.

Marshall's book falls naturally into three parts: (a) birds' breeding seasons in general, (b) the bower birds, and (c) discussion of bowers.

In the first section, Marshall sketches the physical (neuro-endocrinal) basis for external factors influencing time of breeding, and the refractory period that would produce a rhythm without external controls. He examines a wide selection of breeding seasons that indicate not only that some external factors must be timing them but also that no *one* external factor can be operative in regulating them all. He stresses the very pertinent point that it is not the time of the inception of gonadal growth that is so important to the bird, but rather the time of ripening. (In some north-temperate birds the former may start in the autumn and be interrupted by winter.) This ripening varies from species to species, and from place to place, and is what, through natural selection, has ensured breeding at a time most likely to be successful. The theory of breeding seasons based primarily on internal rhythms and, secondarily, on various external factors, including light, temperature, rainfall, food supply, and the activities of other birds of the same or other species (as with parasitic cuckoos), that may act in combination, is a welcome antidote to the views of those who, disregarding part of the evidence, would have one single simple factor, such as light, in control.

The account of each species opens with a general description of the bird and its range, then its breeding behavior and display, where known. The impression left by this section is how much is yet to be learned about bower-birds. For instance, the locality where one New Guinea species was taken is unknown; of another species we know, besides the description of the skins, only the locality whence the specimens came. The behavior of only one species is fairly well known, the Satin Bower-bird, (*Ptilonorhynchus violaceus*) in which the male makes an elaborate, avenue-like bower, the walls of which are orientated at right angles to the sun's course in the heavens, and which the bird paints, and in front of which it arranges selected objects of certain colors as "decoration." Here the male stations himself and is noisy long before the female is ready to mate. Finally the female visits the bower and is displayed to by the male, which uses the decorations from in front of the bower in his display. Copulation has not been observed at the bower, but probably occurs there, as it does in another species, the Spotted Bower-bird (*Chlamydera maculata*). The male apparently has no associations with the female away from the bower during nesting time; she builds a saucer-shaped nest and rears her young alone. After breeding, flocks of adults and young of both sexes are formed. At the other extreme Catbirds (*Ailuroedus*) apparently are monogamous, have no special display, and the male takes part in some nest duties.

The discussion points out that the bower represents a localizing or focusing of the territory-holding behavior, the favorite song perch, the song and display of passerine birds in general. Its nearest approach is in cleared display areas of certain birds of paradise, and the mound which the lyre bird scrapes together. Now, as specifically distinct as each species' plumage, the bower presumably is an adjunct to display in promoting copulation.

The bower building, Marshall thinks, arose out of a displaced nest-building drive of the male, and bower painting out of displaced courtship feeding. Marshall correlates the selected colors of the decoration objects with colors of the female or rival males, rejecting an earlier theory that the round objects used as decoration were to suggest eggs to the female and stimulate her to egg laying. Both of those views sound as if they came from a psychoanalyst's couch.

Dangerous as it is to theorize on scant data, some further suggestions and comparisons emerge. Marshall seems to think monogamous pairing is the rule in this family, but, as only the "primitive" Catbird (*Ailuroedus*) is known to help at the nest, it is possible that in some species the bower is the mating station to which any female may come, as in some other birds with small display grounds. The possibility that construction, repair, decorating and renovating of the bower may play a part in keeping the male bird occupied and "tied" to his mating station, rather than serving as a bond between the sexes should not be disregarded.

The use of a tool (a wad of material) by the Satin Bower-bird in painting its bower is one of the few instances of its sort among birds, recalling the Galapagos finch that uses a twig-probe to get at insects in crevices, and the anvil of the thrush for breaking snails. The north-south orientation of bowers of some species is the one positive case of its sort in birds, though it occurs in other animals, and it recalls the recent work indicating that homing may be oriented by using the sun in direction finding.

Such concrete expressions of behavior as bowers are excellent objects to arrange in series from simple to complex. From the "primitive" catbird without a bower, through the Toothed Catbird (*Scenopoeetes dentirostris*) with a cleared area decorated with green leaves and the Black Bower-bird (*Archboldia papuensis*) with a cleared area on which dead vegetation is placed, two lines are apparent: one, the saucer-shaped area with a central decorated "maypole" leading to the covered hut and nearby "garden" (*Amblyornis*, the Gardener Bower-bird), and the other, in which two rows of twigs are erected into an "avenue." Marshall, on this basis, makes the catbirds a family (Ailuroedidae) separate from the bower-birds, despite the fact that the evidence he presents on the Toothed Catbird is perhaps the best evidence we have that links the catbirds to the bower-birds. Further, as Stresemann has shown, they agree with the "maypole" builders in laying a plain egg, not heavily marked as with the "avenue" builders.

A tendency to fight anthropomorphism, that prevails the book is understandable when one considers the twaddle that has been written about the intelligence of these birds. But the conclusion that an aesthetic appreciation, a satisfaction given by contemplation of arrangements and colors, does not exist is better ruled out by definition rather than fact.

The illustrations are photographs of the birds, their bowers, and habitats, and microphotographs of gonadal tissues; the figures sketches of bowers, the heads of some species, and maps of ranges.—A. L. Rand

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Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the color-plate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

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CONTENTS

AUDITORY AND VISUAL MECHANISMS IN FOOD-FINDING BEHAVIOR OF THE HERRING GULL

BY HUBERT FRINGS, MABLE FRINGS, BEVERLEY COX AND LORRAINE PEISSNER

THERE are many places along the sea-coast where gulls (*Larus* sp.) regularly gather to feed: refuse dumps, fish-processing factories, docks where fish are loaded and unloaded. Dumps are almost always littered with edible materials, and gulls stay on them all day. They obviously learn to recognize trucks bringing food and flock in whenever one of these appears. Fish-processing factories and fishing wharves are also closely observed by gulls. At sardine packing plants where the offal is carried to bins by a "chum belt," the mere sound of the motor driving this belt immediately attracts those gulls within hearing range. In these cases, the association between food and sensory cues may be either visual or auditory, and it is obviously learned.

In specialized situations, such as these, it is easy to explain the accumulation of flocks of gulls as food becomes available, if one is satisfied to know merely the sensory cues involved. But at most places on the sea-coast one sees only an occasional gull flying over the water's edge or poking the sea-weed looking for tid-bits. Yet one need only throw fish or other food into or near the water, and gulls accumulate rapidly. What brings them from such distances to this food?

Fishermen and other coast-dwellers believe that gulls have a keen sense of smell, or that they have a "sixth sense." None of the scientists who has studied the behavior of gulls, certainly among the most studied of birds, has dealt with this behavior pattern.

Obviously, this attraction to unfamiliar food sources is the first step in habituation to a feeding area; consistent feeding soon results in a large resident, trained population. The original attraction almost certainly involves some means of communication among the gulls. For these reasons, it seemed of interest to study how gulls become aware of food and transmit this information to other gulls where no local predilections or permanent aggregations existed.

General Procedures

The study was made on the coast of Maine, mostly near Salisbury Cove on Mount Desert Island. This island has a highly indented, rocky coastline, with many coves and projecting points of land. Any place on the coast, therefore, can be seen only for a short distance (less than one kilometer) from the same shore. At almost all places, there is a visible opposite shoreline, across a bay. Where this work was done, the opposite shore is about four to five km. distant across open water. Many smaller rocky points and projections produce extremely limited cones of visibility at some places.

The studies were confined almost exclusively to the Herring Gull (*Larus argentatus*) which is the most common gull of this region. The Great Black-backed Gull (*Larus marinus*) is present in small numbers also, and some observations were made on it.

The major work was done from June 30 until August 28, 1954, experiments and observations being made only in non-stormy weather. The observation areas were at some distance from the breeding grounds of the gulls, and there was no evidence of breeding behavior. About July 1, juvenile gulls appeared with the others and increased in numbers until midsummer. There was no feeding of these immatures by the adults, although once or twice young were seen begging fruitlessly for food. In general, the behavior patterns associated with breeding and rearing young, as described so admirably by many earlier workers (Goethe, 1937; Tinbergen, 1953), were not observed. These gulls seemed intent only upon finding food for themselves, and otherwise merely rested on the water or on the rocks.

To separate auditory from visual cues in food-finding, the sounds made by the gulls were recorded with a tape recorder (Pentron, Model 9T-3C) and later broadcast to the birds through the recorder coupled with an amplifier (Stromberg-Carlson, Model AU42, 15 watts output) and one or two trumpet-type loud speakers (University Model PA 30). When specific calls were found to give specific behavioral responses, these were re-recorded from original tapes onto continuous repeating cartridges and broadcast with a small repeating tape recorder ("Message Repeater") through the amplifier and speakers. Power was supplied either by connection with available 110-volt, 60-cycle source or by converters activated by 6-volt storage batteries.

Possible Sensory Mechanism used in Food-finding

Where interpretation is relatively simple, such as at factories, learned visual or auditory cues are used by the gulls in food-finding behavior. These two senses, therefore, suggest themselves as probably involved in the wild conditions. Such an idea would be further supported by the well-known visual and auditory powers of these birds (Tinbergen, 1953). The visual cues which might attract gulls to a site previously not associated with food include: (1.) the presence of a human being; (2.) the act of throwing something by a person; (3.) the fish being thrown or placed; (4.) the splashes made by the fish, if thrown into water; (5.) the behavior of other gulls which have discovered the fish. The auditory cues include: (1.) the sound of the splashes made by fish thrown into the water; (2.) the calls of other gulls.

A common belief among fishermen, however, is that these birds have an acute sense of smell, in spite of the ornithologists' dictum that olfaction is generally poorly developed in birds. The idea that the gulls use an extra sense not possessed by man can only be admitted if the accepted distance senses fail to account for attraction to food-sources.

The Role of Olfaction in Food-finding

Presumably the odor of fish could attract the gulls. Tests of this hypothesis were easily made. Fish with a distinct odor, slightly rotten but still acceptable to gulls, were wrapped in a piece of thin paper and placed on a rock. A similar bundle containing stones was placed nearby on another rock. Some gulls had previously been attracted by slight feeding and these were afloat on the water within easy sight and presumably within easy range of the odor. The observers could smell the fish from their observation post, which was farther from the fish than was the gulls' observation post.

The gulls gave no indication of interest in the bundles. A few flew over, but without any sign of recognition of the food that was easily available. After about 15 minutes of this, a few fish were scattered about the rocks near both bundles. As soon as the observers left the spot, the gulls came to feed. They ate the fish which were visible, even picking up fish lying immediately alongside of the bundle containing the others. At no time did they show any interest in the odorous bundle containing the fish, although they could easily have torn it open and got them all. A repetition of feeding showed that the gulls were still hungry.

These bundles remained on the rocks from 2:30 p.m. until dark, about 8:00 p.m., and were untouched by the gulls. Early the next morning a cat found the wrapped fish and ate them. The cat, with its excellent sense of smell, was not fooled by the paper. The obvious conclusion is that olfaction plays little or no role in food-finding by the Herring Gull, a conclusion which supports earlier reports (Strong, 1914; Tinbergen, 1953).

The Role of Vision in Food-finding

If visual cues are used by the gulls in aggregating at food sources, the first question which arises is: how well do the gulls, as a population, have any given point on the coast under visual surveillance?

There is plenty of evidence that the sense of sight of most birds, including Herring Gulls, is at least as good as that of man (Donner, 1951; Tinbergen, 1953). Conceivably it might be better. Therefore, if a human observer at any given place on the coast can see a gull, it is reasonable to suppose that the gull can see the observer and would have that point under visual surveillance.

Counts were made of the gulls that could be seen afloat, resting on rocks, or flying at many places on the coast. Two methods of counting were used: the observer kept a continuous record of the gulls in sight, or the observer made a count every 30 seconds of the number of gulls in sight. The latter method proved to be simpler and quite useful for graphical presentation.

These counts showed that every point on the coast was under almost constant surveillance from floating, sitting or flying gulls. Only rarely would two or three minutes go by without a gull's passing in flight. Later experiments, in which gulls were attracted by feeding, showed that there were gulls floating on the water which had not been seen. It is difficult to see a floating gull from the land, with the sun glancing from the waves. It is quite easy to see an object on the shore from the water. The seemingly immediate attraction of a few gulls on throwing food could, therefore, result from visual cues.

Three of the suggested visual cues—human beings, the act of throwing, and the splashes—can be disposed of easily. The part of the shoreline where most of these experiments were made was traversed by many people each day, and tourists often stopped to admire the view. There was no apparent attraction of gulls to human beings if they merely stood on the shore. At special picnic areas for tourists, gulls often gathered, and there they were attracted by human beings, but not on the open coast. The act of throwing and the sight of splashes also were not, in themselves, attractive on the open coastline. One could throw stones without arousing much interest on the part of the gulls, unless he had previously been throwing fish. Occasionally, as one would start to throw or skip stones, a gull would fly from its resting place toward the spot, but this was not usual. This is not to suggest that splashing cannot become attractive, through learning, as happens near docks or boats where feeding is regularly done. Under conditions where learning is not involved, however, splashes or throwing as well as mere presence of a human being, are not attractive to gulls.

To test the possibility that the sight of fish being thrown is attractive to the gulls, artificial fish were made from pieces of aluminum foil molded into fish-like shapes. At a distance, these flashed in the sunlight as real fish did, but at close range they were obviously distinguishable from the real thing. They were tested by being treated, in the sight of gulls, as if they were real fish being thrown.

In one experiment, for instance, the gulls were resting on the water at a distance of about 0.5 km. from the place where the decoys were thrown. The gulls thus were able to see the flashing from the artificial fish, but at that distance presumably could not distinguish them from real fish.

The results are shown in Figure 1. Counts were made, at 30-second intervals, of gulls within a 15-meter radius of the place where the decoys were being thrown. At the start, there were three gulls resting on the water near the spot; the others were, as noted, at some distance. As soon as the decoys were thrown, even though the first were thrown on the shore to avoid splashing, the distant gulls rose into the air, flew over the artificial fish and formed a group on the water. Once they could clearly see the artificial fish, they were not interested in them as food, however. One imitation floated out into the interest-group, but only a first-year gull pecked at it a few times in a desultory manner. The others ignored the decoys, and shortly flew away, when nothing more substantial was offered.

Other tests substantiated these results. The flashing of objects through the air is attractive to gulls. A similar response was observed at a sardine cannery, where damaged tin cans thrown from a window attacted the gulls' attention. In the experiment described above, a situation was selected in which many gulls were near enough to see the flashes. Under ordinary circumstances, with few gulls able to see a given part of the coast, the response is quite small. Thus, this alone does not account for aggregation of large numbers under normal circumstances.

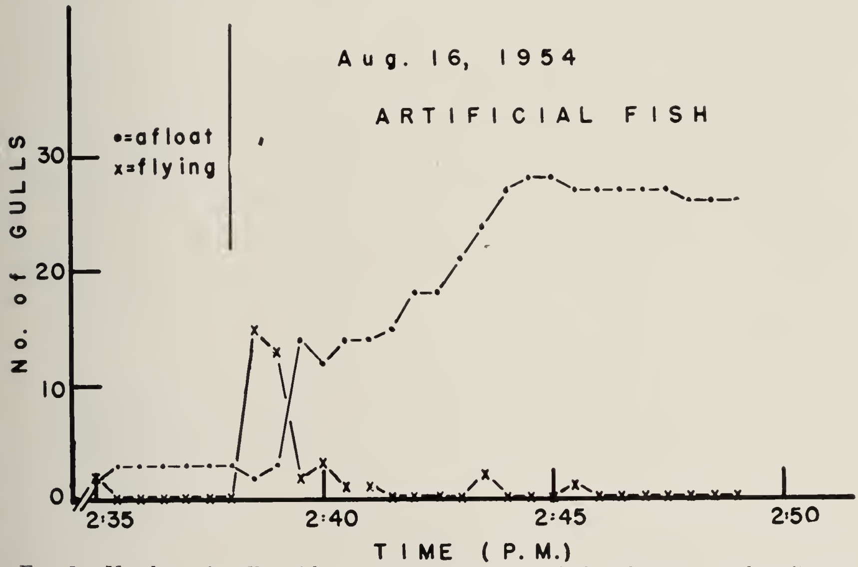

Fig. 1. Number of gulls within a 15-meter radius of the observers, either floating on the water (●) or flying (×), during sham feeding. From 2:35–2:38, there were no untoward activities by the observers. From 2:38–2:40, artificial fish made of aluminum foil were thrown on the shore and in the water and left there for the remainder of the test.

The flash alone is not sufficient to cause gulls to try to feed. If the gulls are close, so that they can clearly see the artificial fish, they do not approach at all. Or, if the artificial fish are scattered about on the rocks, flying gulls give them only passing attention.

The last visual possibility is the behavior of other gulls as witnessed by the birds. There are two patterns of behavior which gulls exhibit when they sight food that could attract others. First is a special flight pattern over the food. If a flying gull sights food, it executes a "figure-8" pattern of flight over the area, losing altitude on the straight arms and gaining altitude as it circles at the ends. This flight pattern, if continued for more than two or three turns, induces other gulls within sight to approach, even though the flying gull remains silent. If food is present and recognizable, they too will execute "figure-8's." If this alone were active, however, only a few gulls would arrive in a short time.

The second behavior pattern is the tendency to accumulate in interest-groups on the water near food. Once an interest-group has formed, other gulls flying near will approach, even though the gulls in the group are silent. If food is present, they will join the group. Actually, the interest-group is not an original attractant and acts late in the attractive sequence, because it requires the prior presence of a number of gulls.

Thus, in the situation here studied, two visual cues can be used by the gulls in food-finding: the flashing of fish-like objects and the flight-pattern of gulls which have discovered food. While every spot is under constant visual surveillance the number of gulls which can see any given spot at any time is usually small. Thus they cannot account for the rapid accumulation of large numbers of gulls.

THE ROLE OF AUDITION IN FOOD-FINDING

At breeding areas, Herring Gulls are quite vocal, (Goethe, 1937; Tinbergen, 1953). Under the conditions of these studies, they were mostly silent, except during the feeding or shortly after dawn when they engaged in some vocalization, mostly restricted to trumpeting and mewing, described below.

There was plenty of evidence that auditory cues were of great importance in food-finding. This is well illustrated by the data shown in Figure 2. In this case, counts of gulls within sight at any distance were made at 30-second intervals, at first with no untoward activity on the observers' part, then when stones were splashed into the water, and finally when fish were thrown. The slight interest aroused by the splashing of stones is plain. As soon as fish were thrown, one of the gulls nearby emitted a special call, which was later taken up by others off and on, as indicated on the graph. Immediately, gulls began to come to the spot. These were not merely gulls that had been nearby; the graph shows all gulls which were visible, regardless of distance. The gulls flew toward the spot from around neighboring high points of land, even over the tops of trees on the points. It is this attraction of gulls from places where they cannot see the food that has led fishermen to postulate a gull "radar."

There were two sounds which might be active, the splashing of the fish and the calls of the gulls. Splashing could almost be ruled out without further tests, on the basis of many experiments such as that described above. Perhaps, however, one might think that fish make splashes which the gull can distinguish from those of stones. Two tests were made of this. First, at a place on the coast where a number of gulls were resting on rocks we mounted a large rocky point of land about 0.5 km. away from the gulls. This point shielded our activities from their view but not from their hearing. There stones were thrown into the water, with no interest on the part of the gulls. Then fish were thrown into the water. Again the mere splashing sounds were unattractive. Climbing on the rock, so that the gulls could see, we threw stones first, then fish. The gulls remained on the rocks when stones were used, but came immediately when fish were used. In this case, there was no interest in mere splashes. The interest in splashes of stones in the tests shown in Figure 2 was probably due to the fact that the experiment was done where the gulls had been fed previously.

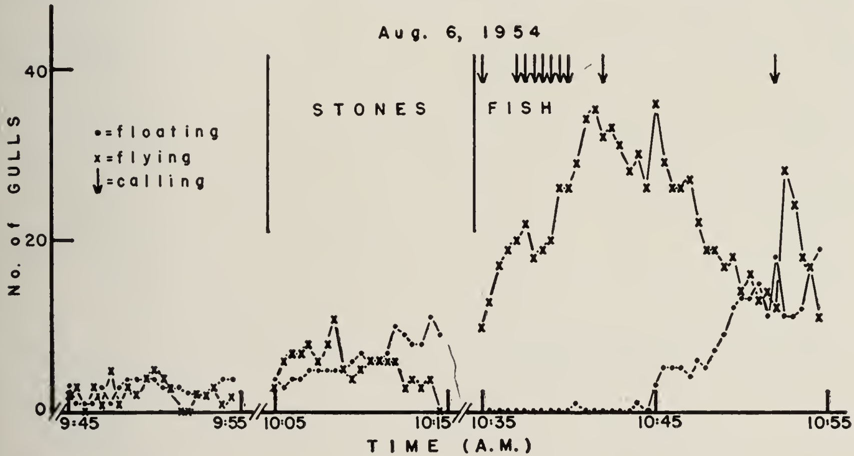

FIG. 2. Number of gulls in sight, either floating on the water (●) or flying (×), before and during feeding with fish. From 9:45–9:55, there were no untoward activities by the observers. From 10:05–10:15, stones were thrown into the water noisily. From 10:35–10:55, fish were thrown into the water. The times at which the special call of gulls at feeding areas was given are indicated by the arrows.

The second test of the attractiveness of splashes was made with recorded splashes. Both stone-splashes and fish-splashes were recorded, again with the possibility in mind that gulls might be able to distinguish between them. These splashes were played to gulls under many different conditions. At no time was there more than transient interest, nor any sign of differentiation by the gulls between the splashes. If a gull were flying quite near to the loud-speaker, it would turn as the splash sounded as if looking for the source. When this was not apparent, it paid little further attention.

Very early in the work, we noted a special call given on the wing by gulls when they found food in quantity. This call we later named the food-finding call, after its importance in this activity was found. It has three main notes, the middle one higher-pitched than the other two and accented. So far as we can determine from syllabic renditions in the literature or descriptions of behavior to calls by earlier workers, the significance of this call has not been recognized previously. After our failure to decipher earlier workers' syllabic designations of calls (unaccompanied by descriptions of the actions of the birds), we conclude that it is useless to invent syllables to represent this or any call. It can be heard by anyone who so desires merely by feeding gulls, or we would be glad to exchange recordings, where feasible.

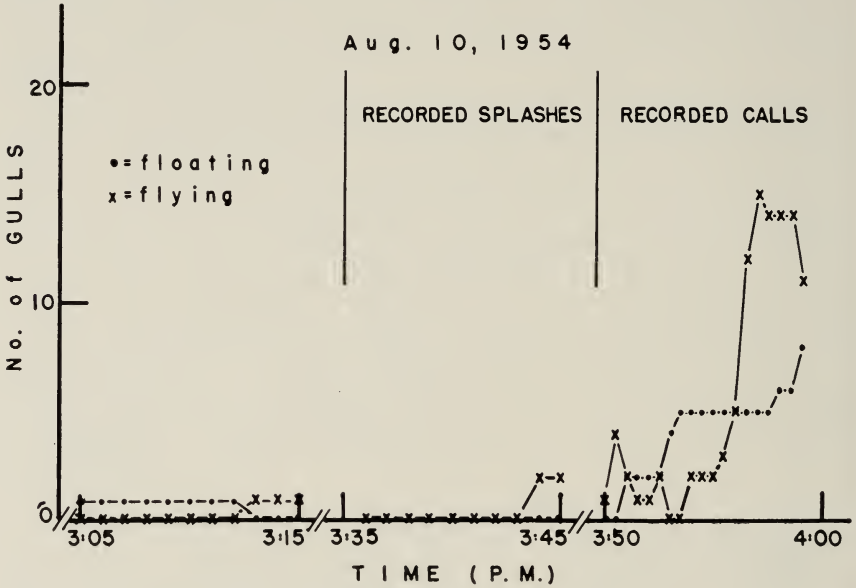

Fig. 3. Number of gulls in sight, either floating on the water (●) or flying (×), during tests of attraction by sounds. From 3:05–3:15, there were no untoward activities by the observers. From 3:35–3:45, recorded splashes made originally by throwing fish in water were broadcast. From 3:50–4:00, the recorded food-finding call was broadcast.

As Figure 2 shows, this call seemed to bring in many gulls. It was recorded, therefore, and played back without presentation of food. The results of one test are shown in Figure 3. The counts represent all gulls visible to the observers, and the observers in this case were on a point of land rising sharply about 10 meters above the bay, so that visibility in all directions over the water was excellent. One gull was in sight, afloat near the point, as the counts began. This individual remained thus for eight minutes, then flew up and circled around. The counts was repeated as before, without activity on the part of the observers, with the same results (not shown on the graph). After that, the recorded sound of splashes made by throwing fish into the water was broadcast. As can be seen, no gulls were attracted. Following that, the recorded food-finding call was broadcast. This was mixed, in the recording, with squeaks of immature gulls which had been with the adults when the original recording was made. The results shown on the graph speak for themselves. The gulls which came toward the speakers flew over treetops and around points of land which certainly cut off their vision, had there been anything to see. They flew around the area, then settled on the water in an interest-group. When the sound was turned off, they stayed for 10 or 15 minutes and then dispersed one by one.

These observations were repeated many times at many places along the coast and even up to three or four km. inland. The gulls on this coast seem to have a much greater degree of auditory surveillance than of visual surveillance. So far as could be determined, auditory surveillance of any spot by many individuals was essentially continuous.

There was no doubt that the food-finding call attracted gulls within hearing range. It remained to be seen whether this call was specific or whether any call by gulls would be attractive. For tests of this, the calls of Herring Gulls were recorded under many different circumstances and later broadcast to the birds. The behavior of the gulls was observed as other gulls emitted the calls and when the recorded calls were played. On the basis of these tests, we were able to identify five or possibly six calls to which distinct reactions are given.

THE HERRING GULL'S VOCABULARY

The food-finding call.—This has already been described. The only syllabic and notational representation in earlier reports which seems similar is given by Goethe (1937) as one of the many under "Lock und Wanderruf," but he does not identify it as having any special significance. Collias and Joos (1953) have identified a food-call in the domestic fowl to which the chicks react by approaching the source.

The food-finding call of the Herring Gull is emitted when gulls see food, particularly if other individuals are already present and there is food in some quantity. It is interesting to note that small quantities of food discovered by one gull will usually be consumed without vocal announcement, while large quantities will elicit the call.

The trumpeting call.—We designated the second clearly-defined call with this term, adopting the one used by Bent (1921), Tinbergen (1953) and others. This has been described in detail by earlier workers, and it has considerable significance during breeding (Portielje, 1928; Goethe, 1937; Tinbergen, 1953). The only reaction to it in feeding (non-breeding) gulls seems to be occasional chorusing. Gulls feed on dumps in large numbers, and, during the feeding, there is an almost incessant chorus of trumpeting, mixed with other calls. The only evidence, however, of a special reaction to the trumpeting is imitation on the part of other gulls. The same results could be obtained with recorded trumpeting.

The mew call.—The third clearly defined call is the "mew call," a term used by Strong (1914) and Tinbergen (1953). This likewise has been described by many other earlier workers: Boss (1943) as "cat-like," Portielje (1928) as "Zärtlichkeitsausdruck," Goethe (1937) as "Nestruf." The last two terms suggest that this is used only during breeding. It is common all summer among non-breeding Herring Gulls. The acoustically descriptive term, "mew" call, seems thus to be preferable. It sounds much like the mewing of a cat, mournful and somewhat ridiculous.

The functions of this call in mating and brooding behavior have been fully described by Goethe (1937) and Tinbergen (1953). In the case of non-breeding gulls, we were unable to discover any definite reaction to it. Often the mewing individual would be alone on a rock and would continue with this sound for long periods of time. Occasionally, the sad solo would be punctuated by the trumpeting call, which would trail off finally into the mew call. At no time was any attraction observed as a result of this call, nor even joining in of other individuals, as with the trumpeting.

Once we observed what looked like the use of the mew call by one gull to direct a group of its fellows. Fish for the gulls had been thrown very close to the microphone of the tape recorder and the observers remained rather close. The gulls were quite wary, and, after initially coming in as if to feed, gathered in an interest-group about 10 meters away on the water, while one gull sat on a rock nearby. Whenever this gull was silent, the group on the water swam slowly toward the fish near the shore. When they came to within about four meters of the fish, however, the gull on the rock would begin the mew call. The others would then slowly swim back to their original stations. This continued for about half an hour, during which time the observers did not move appreciably, and the group of swimming gulls made a number of trips in and out. Finally a juvenile gull flew over and landed at the fish. Immediately all the others swarmed in and the clamor drowned out the voice of the mewing gull. This may have been accidental, or it may have shown a use for this call, aside from those in the breeding season.

The alarm call.—The fourth clearly defined call has also been described previously. It was noted by Dutcher, *et al.* (1903), called the alarm cry or call by Strong (1914), Bent (1921), Boss (1943) and Tinbergen (1953), "Schrecklaut" by Portielje (1928) and "Angstlaut" by Goethe (1937). We have offered a description of it elsewhere (Frings, *et al.*, 1955) and adopted the term, alarm call. Usually it consists of two parts: (1) an attention call of two notes in a descending sequence given very sharply, and (2) the alarm call proper, consisting of two or more, usually three, repeated staccato single notes, with major accent on the first in each series. The attention call is possibly the "Charge Call" of Tinbergen (1953), the "Wutlaut" of Portielje (1928) and the "Schrecklaut" or "Warnruf" of Goethe (1937), although this cannot be decided clearly on the basis of their syllabic descriptions. We prefer to designate it tentatively as an attention call, because it brings gulls up from their resting places and toward the source. It may be used also in conjunction with the food-finding call to bring gulls to feed. It thus seems to be ambivalent in effect, attractive or repellent, depending upon the intensity of expression and the sequel.

Earlier workers have described the circumstances under which the alarm call is emitted by gulls in a breeding colony. The call is most usually heard among foraging gulls when unusual circumstances exist near the feeding area. The presence of a person or a piece of equipment, such as a tape recorder, near the feeding areas induces some to give this call. The call is also given by gulls on sighting one of their fellows in the hands of a captor. This reaction may account for the repellency of captive or dead gulls to free birds. Our recordings were made as captive gulls were held in sight of others, or later during feeding at the place where the captive gulls had been exposed.

The reaction of gulls to the recorded alarm call is striking. With the first notes of the attention call, the gulls rise from their places of rest and fly toward the place from which the call arises. As the alarm call proper is given, they slowly fly away. Only one sequence of the call, consisting of the attention call and two or three repetitions of the alarm call will bring this about. In silence the gulls circle slowly higher and higher and finally out of sight.

The effect when this is done on a dump is rather uncanny. The dump may be crowded with hundreds of gulls, shrieking, trumpeting, flying around. When the alarm call is broadcast once or twice, the gulls rise into the air as one, and in sombre silence glide away, with only a rare attention note from some individual in the flock. Within a few minutes, the dump is deserted and silent. The recorded alarm call was tested as a repellent for gulls on dumps and near fish-processing plants (Frings, *et al.*, 1955). It was possible to repel gulls from these areas and to keep them away for up to two full days merely by playing the recorded alarm call whenever they tried to return.

These four calls of the Herring Gull are found also in the repertory of the Great Black-backed Gull, but pitched about one octave lower. This was checked by recording calls of this species at a tape speed of 3¾ inches per second and playing them at 7½ inches per second, or the reverse with the Herring Gulls' calls.

There seemed to be almost complete cross-reactivity with these species of gulls in the food-finding and alarm calls. The calls of the Herring Gull were effective with Black-backed Gulls and vice versa. This is undoubtedly due to the flocking together of these species and the fact that the alarm calls of all gulls are quite similar (Bent, 1921). The alarm call of the Herring Gull was tested on Laughing Gulls (*Larus atricilla*) in New Jersey, and found to be effective in driving about 5,000 of them from a city dump. Thus there is considerable cross-reactivity in this case too.

Single-noted calls.—The fifth family of calls consists of grunts, clucks and other single-noted calls to which we observed no obvious reactions. These have also been mentioned previously, and Goethe (1937) has attempted an elaborate classification, mostly under "Lock und Warnruf." It is impossible, however, to recognize any particular notes from his elaborate syllabic representations. It is our belief that some of these represent incomplete calls of other types. Certainly listening to the tape recordings suggests this, for these notes often follow or precede complete, clear-cut calls and seem to be fragments of them. At any rate, these clucks or "call notes," to use Tinbergen's (1953) term, seem to be only loosely related to feeding, being heard more often among a large group of feeding gulls. The other calls also, except for the alarm call, were most common during feeding.

A possible "departing call."—One other call seems worthy of mention. This is what might be called a "departing call," matching that reported by Faber (1936) in Orthoptera. If a group of gulls were sitting on the water and one flew up suddenly and silently, the others often rose into the air also. This was noted also by Goethe (1937) at the breeding grounds. Usually, however, if a gull rose off the water without obvious alarm, it would emit a very brief, low, two-noted call, without easily definable tonal qualities, but very characteristic once heard. This seemed to have the effect of keeping the others on the water. Obviously, the testing of this call is very difficult, because its essential result is to maintain the *status quo* among the gulls hearing it. This observation is presented merely as suggestive and should be subjected to critical testing. Suffice it to say that we could recognize this call ourselves and knew, without seeing, when a gull was leaving a group.

The young gulls only gradually develop the ability to produce these and other calls, as all previous workers have noted. Juvenile Herring Gulls emit only high-pitched squeaks, sometimes sounding like falsetto versions of the food-finding call. Older juveniles have these squeaks, plus a rasping rattle which they emit at feeding areas. These squeaks and rattles are quite attractive, when recorded and played back to gulls, both young and adults. Being of high frequency, they do not carry as well as the food-finding call of the adults, but are attractive for those within hearing range.

Summary of Mechanisms used in Food-finding

The food-finding behavior of the Herring Gull, under the conditions observed, involves the following:

1. Almost constant visual surveillance of all parts of the sea-coast by a few, and constant auditory surveillance by many gulls.

2. Visual recognition of food by gulls. This, in the case of fish, apparently is first by the sight of shiny objects being thrown or lying near the water's edge. Only if the fish can be identified as such, on closer examination, however, will the gulls try to feed. Visual cues may easily be reinforced by learning, if feeding occurs regularly at a given spot, causing the gulls to come almost as soon as a person appears or is in the act of throwing.

3. Visual attraction of small groups. The flight pattern of Herring Gulls that have found food is attractive to other gulls which can see the pattern, yet may not be able to see the food. This can result in the appearance on the scene of a small number of gulls.

4. Auditory attraction of large groups. Usually, one of the gulls visually attracted emits a special call, which we have named the food-finding call. This attracts most gulls within hearing, which apparently may be up to 3 to 5 km. distant across open water. As new arrivals come, they too emit the call and more are attracted.

5. Formation of the interest-group and feeding. Usually the gulls first form a group near the food. This arouses the interest of any flying gulls which see it, even if the gulls are silent, and the group grows. From this group individuals fly over the food. If one lands to feed, the others fly in and the welter of calls which then arises may attract still more distant gulls. Shortly the gulls return to the interest-group and await further feeding. Even when food is continuously present, feeding seems to be more or less rhythmic

from interest-groups. If a person throws some more fish, or if a new individual alights to feed, the others again fly to the food, with much noise. Shortly, however, the gulls return to the group area, often leaving some food untouched, to repeat the feeding rush as before within a short time.

General Discussion

Most of the interest in behavior of birds has been in breeding, nesting, and migration. The feeding activities of birds, however, also offer a rich field for study of communication and social behavior. It is tempting to theorize at this point, and to point out that the communication here studied is for the purpose of social assistance and not competition, as is usually studied in experiments on feeding. We prefer, however, to present our data and interpretations without attempts to fit them into any existing theories or to devise new ones.

One item seems worthy of serious note. Earlier workers who studied reactions to or production of sounds by gulls have published detailed reports of their findings. In these, they use syllables or occasionally musical notations to represent the calls of the birds. One soon finds, however, that only their descriptions of the behavior of the gulls allow him to correlate these calls with those he has heard. As Armstrong (1947:75) writes, "Without recording apparatus appreciations of bird song are apt to be so subjective that their scientific value is questionable." Obviously it now is possible to record bird calls easily and to break them down from mere "songs" into informational bits by means of tape recording. With this arises a need for some means of communication among workers, and this obviously is impossible by syllables or bare musical notes which are meaningless without personal explanation.

Field recordings of sounds of animals to which the observer adds, at the same time, oral descriptions of behavior are excellent for later study. They allow the observer to keep a continuous watch on the animals and yet to record immediately his observations. Tinbergen (1953:164) notes that his moving pictures showed a particular posture of the gull in its charge flight which he had never noticed in the field. This sort of thing happens also with sound recordings. In one of our recordings, for instance, the observer remarks that she has not heard the food-finding call, yet the gulls are coming in. Only about five seconds before this remark was made, however, the call is clearly recorded, obviously being given by a gull not in the group on which the observers' attention was fastened. This human tendency to focus attention on some phase of the environment to the exclusion of others may be valuable for much work, but it can lead to mistaken observations in broad field situations. The tape recording, played in a quiet room, without visual distractions, quickly reveals the true situation. As Tinbergen (1953:164) writes, "It teaches one to be very careful in claiming that this or that does not happen because one has never seen it oneself." One might add "heard it oneself," as well.

A word might be said in a practical vein. Many animals which are pests—rodents, birds, insects—produce and receive sounds. Some of these sounds almost certainly are used by these animals for communication. If recorded, they might be used to induce behavior patterns which would aid in control of the pest species. These biologically significant sounds have advantages over mere noise or high intensity sounds: they are specific or nearly so; they need not be emitted at such high intensities that cost is prohibitive; they afford little or no danger to man. The possible future use of sounds in pest control will require many careful studies of behavior of animals in all their life-activities, and especially of their means of communication. It is to be hoped that increased interest in possible practical results will stimulate—and help to secure payment for—much-needed fundamental research in this field.

SUMMARY

Visual and auditory communication in food-finding behavior of Herring Gulls on the sea-coast of Maine were studied using recording techniques to separate the two mechanisms. The gulls can be attracted visually by flashing objects of suitable size and by a typical flight-pattern of individuals that have found food. The major attractant outside the visual field, however, is a special call emitted by gulls that discover food. A study of sounds made by non-breeding gulls at food sources allows the designation of at least four distinct calls: (1) food-finding call, (2) alarm call, (3) trumpeting, and (4) mew call. These were recorded in the field with a tape recorder, and the reactions of gulls to broadcasts of the recorded calls were studied. The food-finding call attracts gulls from distances up to 3 to 5 km. The alarm call repels gulls from food or resting places. Trumpeting elicits only chorusing of nearby gulls. The mew call evokes no consistent reactions under these circumstances. Gulls also have a number of single call-notes, the functions of which are not clear. The alarm call of Herring Gulls induces Great Black-backed Gulls and Laughing Gulls also to fly away from the source of the sound.

ACKNOWLEDGMENTS

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OBSERVATIONS ON THE AUTUMN MIGRATION OF BLUE GEESE

BY GRAHAM COOCH

THERE is much conjecture about the manner in which large flocks of Blue Geese (*Chen caerulescens*) make their autumn migration from James Bay to Louisiana. Although their route lies over an area well supplied with amateur ornithologists and sportsmen, the main James Bay flight frequently escapes detection. Soper (1942. *Proc. Boston Soc. Nat. Hist.*, 42 [2]:203) summed up the situation as it relates to the Baffin Island populations:

> Because of the high, fall flight ordinarily maintained by Blue Geese after leaving James Bay, practically none are taken along the regular migration route south of this point to the lower Mississippi. In fact, so seldom are these geese observed on this long and apparently uninterrupted flight of more than 1,000 miles, that very few records are extant to even indicate the time and nature of their movements.

The Route of the Southampton Island Population

Since 1952, 15,000 Blue Geese and Lesser Snow Geese *(Chen hyperborea)* have been banded at Boas River, Southampton Island, North West Territories, (63° 42′ N., 85° 45′ W.) and Eskimo Point, North West Territories, (60° 50′ N., 94° 25′ W.), and 1,300 of these bands have been recovered. The recoveries indicate that these populations do not migrate through James Bay but stop along the coast of Hudson Bay from York Factory, Manitoba, to Cape Henrietta Maria, Ontario. They migrate up the Nelson, Severn and Winisk rivers, skirt the north shore of Lake Superior, pass through western Minnesota and may stop in the lake country of eastern South Dakota. From there the flight is due south to eastern Texas. The distance covered from Hudson Bay to eastern Texas exceeds 2,100 miles, compared to the 1,700 mile flight required of James Bay populations. Perhaps the longer flight and the earlier date of departure from the Hudson Bay feeding grounds account for the difference in migratory behavior of the Southampton and Baffin island populations. Although in some years the flight of the Southampton Island goose population through the Dakotas is rapid and direct, years in which the birds interrupt their migration are more common. At Sand Lake Refuge, Brown County, South Dakota, major stopovers have occurred in seven of the past twelve autumn migrations.

The Route Through James Bay

The population migrating through James Bay apparently does not exhibit to the same degree this tendency to interrupt its flight, a factor contributing to the paucity of sight records. The lack of band returns from James Bay suggests that the Blue Geese breeding on Southampton Island do not migrate through James Bay. Those geese which do so may breed on Baffin Island. To date no banding has been done on the Baffin Island breeding grounds, and the only records available on the flight of these birds are those from the McIlhenny bandings in Vermilion Parish, Louisiana. These data are not in sufficient volume to permit accurate plotting of the chronology of movement or dispersal patterns. In certain seasons the problem is increased by the apparent rapidity of the southward flight.

While engaged in waterfowl investigations in James Bay in September and October, 1952, the writer noted large flocks of geese flying up the Harricanaw and Kesagami Rivers (51° 08′ N., 79° 46′ W.) on the evening of

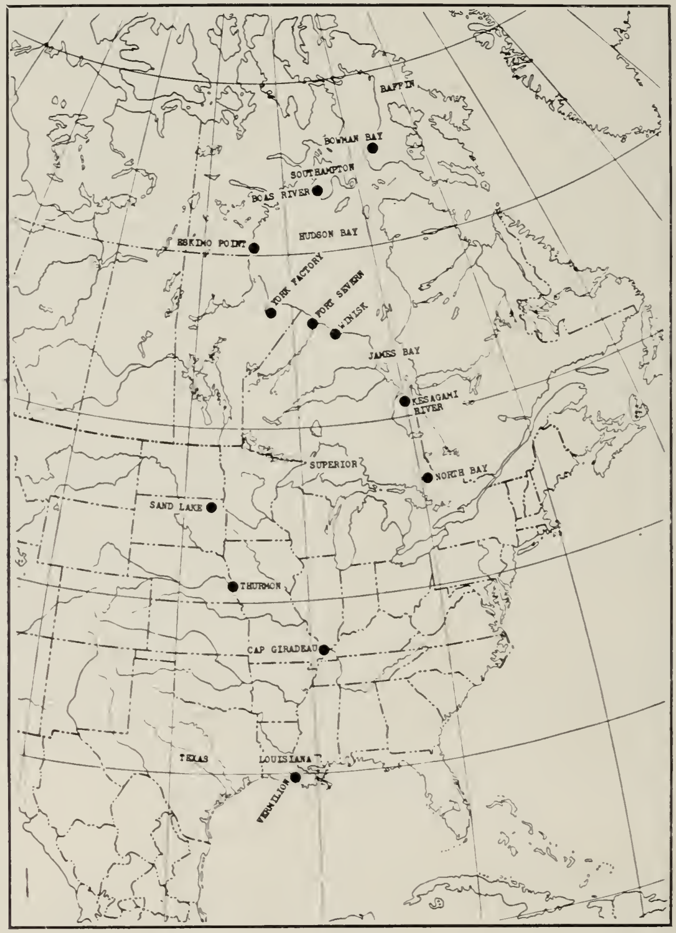

FIG. 1. Map of eastern North America showing the localities mentioned in the text.

October 16. The flocks gained altitude rapidly and headed almost due south. The weather was clear, and wind velocity at ground level was approximately 20 miles per hour, blowing from the northwest. Migrating flocks were heard continuously from 6:00 p.m. to 11:00 p.m.

On October 17, 1952, at North Bay, Ontario, all aircraft operating in the vicinity were warned that flocks of geese flying at 6,000 to 8,000 feet altitude constituted a hazard in the 50 miles lying to the north of North Bay.

Mr. K. R. Esselmont, Station Manager, in a letter to Mr. S. T. Howe, Cargo Representative, Trans-Canada Air Lines, Winnipeg, Manitoba, April 22, 1953, described the situation which existed on October 17. In the second paragraph of his letter he states:

> They were first spotted by the [Department of Transport meteorological] observer who saw them approach from the north east, flying in a southerly direction. There were three separate flocks at intervals of perhaps 5-10 minutes. The weather was clear from our station north and the overcast, consisting of altocumulus, began just over our station and extended south. The first flock, estimated at close to 200, approached the station in formation and immediately over the station they broke formation, flying in all directions and re-assembled in formation just prior to entering the overcast estimated at 8,000 feet.

Mr. S. T. Howe, in a letter to Dr. H. A. Hochbaum, February 12, 1953, quotes Trans-Canada Air Lines pilots who were at North Bay on October 17, 1952, as reporting many additional flocks of migrating geese at 8,000 feet. One aircraft was damaged in a collision with a goose and was forced to return to the airfield. North Bay is approximately 370 air-line miles south of the mouth of the Harricanaw River.

The next report on this movement of geese was obtained from Mr. L. E. Lemke, Thurmon, Fremont County, Iowa. He reported seeing large flocks of Blue Geese flying south along the Missouri River on October 18, 1952, at an estimated height of 3,000 feet. Although these birds were probably part of the Southampton Island flight, similar flights were reported by sportsmen at Cape Girardeau, Missouri, 800 air-line miles south of North Bay, Ontario. These latter flights were undoubtedly part of the Baffin Island population.

The last report of this migration was by Mr. John L. Lynch, U. S. Fish and Wildlife Service, Abbeville, Louisiana, who recorded the first large flights of Blue Geese arriving at Chenier au Tigre, Vermilion Parish, Louisiana, on the morning of October 19, 1952.

Thus it would appear that in 1952 the main flight of Blue Geese required less than 60 hours to complete a passage of more than 1,700 miles from James Bay to Louisiana. Soper *(op. cit.)* comments that, were a given flock of geese to migrate continuously at 45 miles per hour over the shortest possible route from James Bay to Louisiana, the entire journey would require only 40 hours.

During those seasons in which the geese pass rapidly through the northern tier of the United States much concern and discussion results among sportsmen. In 1952, when the geese made a rapid flight directly to the Gulf of Mexico, an article entitled "Where Were The Blues?" appeared in the *Iowa Conservationist*, (December, 1952, Vol. 11 [12]: 91). Perhaps some of the mystery which now surrounds the autumn migration of Blue Geese from James Bay may be attributed to a rapid, direct, high-altitude flight. The reports of pilots and observers at North Bay, Ontario, are concrete evidence that the Baffin Island populations of this species make at least part of their flight at an elevation of several thousand feet, a fact long debated but never previously proved.

ACKNOWLEDGMENTS

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CANADIAN WILDLIFE SERVICE, OTTAWA, ONTARIO, CANADA, APRIL 7, 1955

SOME ASPECTS OF THE KINETICS IN THE JAWS OF BIRDS

BY HARVEY I. FISHER

KINETICS in birds' jaws, as used here, means a dorsoventral motion of the rostral portion of the skull on the cranial part of the skull. Where these two parts come together there is a frontonasal "hinge." The hinge is a horizontal bony plate variously composed of thin extensions of the nasal, premaxillary and frontal bones. Although there is definite articulation here in some species (parrots, for example), in most the movement is partly, if not entirely, made possible by the flexible nature of the thin bones in this region (Figs. 1, 2, 3).

Since the maxillary bones are firmly fused to the nasals in birds, the maxillary must move if the nasal bone moves. When the maxillaries move, the palatines, pterygoids and quadrates also move. As a matter of fact, the chain of sequence is in the opposite direction. Forces applied by muscles to the pterygoids and quadrates cause these bones to move, and their movement impinges on the next bone. The end result is, as we have said, a dorsoventral movement of the upper bill in birds.

Thus, the visible "jaw kinetics" in birds is but a part of the entire mechanism. Kinetics in the classical sense of comparative anatomy encompasses a much wider area including jaw suspension. Type of jaw suspension and kinetics have long been thought to vary with food habits. Differing food habits are also believed to be important selective devices in the evolution of animals. Thus the kinetics of jaws may be a fruitful field for the study of significant adaptations.

Most of the structural parts of the kinetic avian jaw have been known for some time (Nitzsch, 1816; and Huxley, 1867). The basic pattern of bone, muscle, and ligament is well established in the literature (Hofer, 1945, 1950; and Fiedler, 1951). However, it is the change from a basic pattern that is of primary interest to one attempting to correlate food habits with the details of structure and function. In recent years, workers (Kripp, 1933-1935; Engels, 1940; Beecher, 1950-1951) have emphasized the structural differences found upon dissection and have tried to correlate these with food habits. Observing the details of function in a living bird seems beyond the realm of possibility at present.

We must then try to visualize the functional aspect from the structural plan. This is a procedure fraught with the dangers of misinterpretation of the actions and co-actions of the many parts of the kinetic mechanism. Nevertheless, if we are to study this morphogenetic area or apparatus of the bird, we must do the best we can. All qualitative features must be known and we must emphasize the quantitative nature of the mechanism. Subjective evaluations of quantitative materials are notoriously poor. Weight, volume and length of muscles, angle between muscle and bone, relative vectors of muscular force, length of work and force arms on the bony levers, and total movement of the upper bill are but a few of the features that should actually be measured. Knowing these, one can set up physical formulae to calculate the relative effectiveness of the varying jaw apparatuses found in birds.

Kripp (1933-1935) was one of the first to emphasize the functional view, but his complex lever systems fail to include the varying muscular forces that might be indicated, in a relative way, by weights or volumes. Barnikol (1951) studied the problem more recently on a qualitative basis. The only study, of which I am aware, that includes most of the variables known is Donald C. Goodman's (1954) unpublished analysis of the functional features of the kinetic apparatus in waterfowl.

Fisher and Goodman (1955) devised a reliable method of measuring the total movement at the frontonasal hinge.

This present study is designed to demonstrate some of the factors which affect the dorsoventral movement at the hinge between the rostral and cranial parts of the skull. It is by no means an exhaustive work. Rather, it is hoped that the paper will stimulate others to undertake the detailed and extensive studies that will be necessary.

MATERIALS

It is the custom of many hunters of waterfowl at the Horseshoe Lake Refuge in Illinois to have their game cleaned and dressed by professionals. I obtained 75 heads of Canada Geese (*Branta canadensis interior*) and 23 heads of Mallard Ducks (*Anas platyrhynchos*) from these cleaners. Most of the kill was made before noon, and the heads were received shortly after noon. Thus the specimens were as nearly fresh as possible. One group of 20 goose heads was not measured until 24 hours after death.

The 17 American Crows (*Corvus brachyrhynchos*) used in this study were collected at Fairmount Quarries in Vermilion County, Illinois. All measurements on the fresh heads were made within eight hours after collection.

The Double-crested Cormorants (*Phalacrocorax auritus*) were taken from a single breeding colony at Spring Lake, Carroll County, Illinois.

At the Camp Creek Duck Farm at Monticello, Illinois, Pekin Ducks are dressed for market in the morning. We measured the kinetics in these young ducks in the afternoon of the day they were killed. A total of 103 heads of Pekin Ducks was provided by this farm.

Opportunism is evident in the list of materials. It is apparent that the specimens were not selected to show a wide variety of either taxonomic types or of food habits. To secure sufficient numbers of specimens for statistical analysis, it was necessary to choose species easily obtained.

The skulls are preserved in the Natural History Museum of the University of Illinois.

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THE EXPERIMENTS

Preliminary dissections indicated that bony parts, ligaments and the muscles themselves might be factors restricting the amount of movement — either protraction or retraction. Method of preservation of the head, method of preparing the skeleton, and, when dealing with fresh materials, the length of time between death and the measurement were believed to be other factors affecting the apparent movement.

Experiments were designed to evaluate the:

1. Consistency in the results of measurement of skeletal specimens. Consistency might indicate the presence of a bony structure that finally stopped the movement, before actual fracture of the delicate hinge.
2. Limitations imposed by the bulk of the muscle mass, no matter whether these muscles were part of the kinetic mechanism or not.
3. Limitations resulting from the presence of ligaments, joint capsules, and strong fascia (see Fig. 4).
4. Validity of the use of museum skulls as an indication of the degree of kinetics in fresh specimens. It is necessary to soak or steam a skull before the kinetics can be measured. The length of time and the temperature of the water may affect the movement.
5. Validity of the use of preserved materials as an index to the kinetic condition.
6. Effect of the use of preserved specimens as an index to movement.

In all the following experiments, measurements of kinetics were made with the machine described by Fisher and Goodman (1955). Museum skulls were soaked in water of different temperatures. At least 24 hours elapsed between the successive measurements of skulls that had to be soaked more than once. Unless stated otherwise, skulls were uniformly soaked for one hour in water that was at 100 degrees F. when the skulls were placed in it.

Preserved materials were kept in a mixture of one gallon of 10 per cent formalin and one pint of glycerin. Before preservation, all muscles were removed from the head. Before measuring, the heads were soaked in cold water.

In all instances within a species the same heads were used for a complete experiment. Thus in Table 4, the same 52 heads of Canada Geese were measured when they were fresh and complete, fresh with muscles removed, fresh with muscles removed and ligaments cut, and when prepared as museum skulls. A different series of 20 heads was measured when fresh and when preserved. Changes indicated are ones that actually occurred and are not just what might be found by measuring two different series under the conditions stipulated.

Discussion of the Data

If the bony construction of the skull includes a "stop" for kinetic movement, measurements of museum skulls should produce consistent and reliable data. The data on a series of 30 cormorant skulls are presented in Table 1. Variation between the findings of two different observers indicates that no mechanical stop, other than perhaps the rigidity of the hinge, is operating. The significant difference results from different pressures applied by the observers.

Table 1

Degrees of Movement of the Fronto-nasal Hinge in Double-crested Cormorants

	No. specimens	Mean	Standard deviation	Range	Coeff. variation	
Observer 1	30	20.8±0.29	1.59	18–24	7.6	highly significantly different
Observer 2	29	30.7±0.52	2.80	25–35	9.1	

However, in the crow there is a definite bony stop. The orbital process of the quadrate has an enlarged, clapper-like end which presses against a papilla in the posteroventral part of the orbit (Fig. 1) when protraction (dorsal movement of the upper bill) is greatest. This may be observed in fresh heads. Table 2 shows relatively close agreement between the degrees of movement in fresh heads and in museum skulls of crows. It may be observed in Table 3 that in all the species studied there is a significant change in apparent degrees of movement when fresh heads are prepared as museum skulls. Further, the coefficients of variation are greater for skull measurements than for any other measurements. These observations indicate that protraction in living birds may be halted by factors other than bony structures. Even in the crow, the special structure is at most a "final stop" as shown by the fact that fresh heads have a significantly smaller amount of movement.

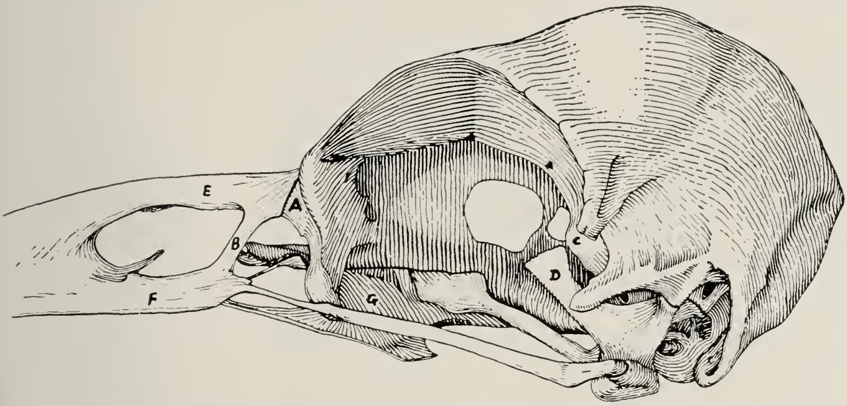

Fig. 1. Lateral view of the skull of an American Crow. A is the lacrimal bone ("retractor stop"); B, the nasal process of the maxillary; C, the "protractor stop" on the posterior wall of the orbit; D, the orbital process of the quadrate; E, the nasal bone; F, the maxillary bone; and G, the palatine bone.

Table 2

Degrees of Movement of the Fronto-nasal Hinge in Seventeen Crows

	Mean	Standard deviation	Range	Coeff. variation	
Fresh heads: complete	16.9±0.38	1.57	14–19	9.3	
Museum skulls:					
soaked 1 hr. at 100° F.	19.0±0.62	2.57	14–24	13.5	increase 12.4%; $P<.01$
soaked 3 hrs. at 100° F.	20.1±0.76	3.12	10–26	15.5	increase over 1 hr. soaking 5.8%; $P>.10$
soaked 30 min. at 180° F.	21.2±0.75	3.09	12-29	14.7	increase over 1 hr. soaking 11.6%; $P=.05$

Bony structures that stop retraction seem to be more plentiful. This might be expected, for the upper bill is usually in the retracted position and maintenance of this position might cause considerable strain on the relatively small retractor muscles. With the several bony stops described below there is no muscular effort necessary, once the bill is retracted.

In the Canada Goose there may be found on the anterior tip of the base of the lacrimal a tooth-like projection which fits into a notch in the posterodorsal part of the nasal process when the bill is retracted (Fig. 3 B). The fit between the "tooth" and the notch is close when the bill is fully retracted. Further, abnormal retraction results in a pull against the length of the bones in the hinge. Without the tooth and notch, abnormal retraction would cause a transverse, breaking force against the bones. The difference is important, because bones may withstand much more force exerted along their long axes than at right angles to these axes. Similar stops are present in the Lesser Scaup (*Aythya affinis*), Mallard (*Anas platyrhynchos*), Whistling Swan (*Cygnus columbianus*), and Hooded Merganser (*Lophodytes cucullatus*). It is not well developed in the latter.

FIG. 2. Lateral view of the area of the frontonasal hinge in *Balearica* to show the ("retractor stop").

In the cranes *Balearica* (Figs. 2, 3C), *Grus*, and *Anthropoides*, and in the Domestic Pigeon (*Columba livia*) a somewhat different retractor stop is found. In these birds the thin nasal process extending dorsoposteriorly to the hinge comes to rest on the dorsointernal edge of the lacrimal when retraction is complete. In *Corvus* (Fig. 1) the nasal process comes to rest partly on the anterodorsal corner of the lacrimal but primarily on the dorsal end of a much inflated bone closely applied to the anterior surface of the lacrimal.

Another source of variation in the measurement of kinetics in museum skulls may be found in the greater flexibility of skulls of young birds. Even casual study of skulls reveals the lesser ossification of the hinge in young birds. The Pekin Ducks may be used as an example. The series for which data are presented in Table 6 was composed of young ducks, because those were the ones primarily available. Five adults were measured; fresh, they averaged 24.6 degrees of movement; as skulls, the movement was 28.0 degrees. If these are compared to data in Table 6, it is seen that the measurements of fresh specimens corresponded fairly closely to those of young ducks, but the measurements on skulls were lower.

A. B. C

FIG. 3. Dorsal views of the area of the frontonasal hinge in *Corvus* (A), *Branta* (B), and *Balearica* (C). See legend for Fig. 1.

Related to this variation is another which concerns the preparation of skulls. In Tables 4, 5, and 6 it is apparent that readings for museum skulls were always lower than for the same skulls when they were fresh but had all the muscles and ligaments removed. At first thought this does not seem logical; the only difference is the drying, "bugging," bleaching and/or degreasing to which the museum skulls have been subjected. However, it is apparent that these processes reduce the possible movement, either by affecting the articulations or the flexibility of the bones themselves. The effect may be brought about by removal of the organic materials.

It is of passing interest that mean movement as measured on skulls in

TABLE 3

INCREASES IN DEGREES OF MOVEMENT OF THE FRONTO-NASAL HINGE WHEN FRESH HEADS ARE PREPARED AS MUSEUM SKULLS

Canada Goose	4.3 degrees (19.4%)	$P < .01$
Mallard Duck	10.5 degrees (44.8%)	$P < .01$
Pekin Duck	7.8 degrees (31.2%)	$P < .01$
American Crow	2.1 degrees (12.4%)	$P < .01$

no instance showed a significant variation from mean movement as indicated by measurement of fresh heads from which the muscles had been removed (Tables 4, 5, and 6).

Since skulls must be soaked prior to measurement, the soaking may introduce other errors. Table 2 contains data from a few experiments on this factor. It seems evident that skulls must be soaked a uniform length of time for measurements to be accurate and comparable.

The experiments with Canada Geese (Table 4), Mallard Ducks (Table 5) and Pekin Ducks (Table 6) demonstrate a significant change when all the muscles are removed. The increase varies from 14 per cent in the Canada Goose to 49 per cent in the Mallard. One might expect some change as the result of removal of the retractor muscles which oppose protraction. But this seems to be something more. In a few fresh specimens all cranial muscles having a possible retractor function were cut across. The amount of movement did not increase significantly over that found in fresh, complete heads. It is thought that simply the bulk of the muscles is a limiting factor.

One might also believe, since the ligaments were still intact, that the limitations imposed by the ligaments prevented a clear-cut demonstration of muscular limitation. However, Tables 4, 5 and 6 contain data which show a significant change when all the ligaments are cut on these same heads. This increase over the movement found when just the muscles were removed ranges from 16 per cent in the Mallard to 28 and 33 per cent in the two series of Pekin Ducks.

There are perhaps eight or ten ligaments which may limit the movement. The diagram (Fig. 4) shows the position of some of these. In addition to these ligaments, the connective tissue in the ligamentous capsules surrounding the joints may be a limiting factor. It was not possible to test for the effectiveness of each individual ligament and joint capsule.

It seemed, from observations made during the measurement of heads in various stages of removal of parts, that the lacrimo-maxillary "ligament" (a broad band of fascia), the pterygo-palato-orbital ligament, and the vomero-orbital ligament were the most important limiting ligaments. Attention was centered on these and on the capsule about the articulation between the pterygoid bone and the basipterygoid process (Fig. 4).

A second series of Pekin Ducks (Table 6) was used to test the effects of successive removals of various ligaments. Data in this table indicate that removal of all ligaments shown on the diagram (Fig. 4) except the lacrimo-maxillary, pterygo-palato-orbital, and the vomero-orbital resulted in an increase of 5.2 degrees of movement (15.8 per cent).

When the lacrimo-maxillary ligament or fascia was cut, no demonstrable

TABLE 4 DEGREES OF MOVEMENT OF THE FRONTO-NASAL HINGE IN CANADA GEESE

	No. specimens	Mean	Standard deviation	Range	Coeff. variation	Percentage change	Probable significance of change
Fresh heads: complete	52	22.2±0.26	1.86	17-26	8.4		
all muscles removed	52	25.3±0.32	2.34	19-32	9.2	increase 14.0	$P < .01$
all ligaments cut	52	30.3±0.36	2.59	20-38	8.5	increase 19.8	$P < .01$
Skulls: museum preparation	51	26.5±0.44	3.16	17-34	11.9	decrease 12.5	$P < .01$
Fresh heads: complete (within 8 hrs. of death)	20	21.6±0.45	2.03	18-29	9.4		
Preserved heads: muscles removed; ligaments intact	20	18.7±0.46	2.07	14-23	11.1	decrease 13.4	$P < .01$
Fresh heads: complete (about 24 hrs. after death)	20	20.8±0.47	2.10	20-32	10.0		

TABLE 5 DEGREES OF MOVEMENT OF THE FRONTO-NASAL HINGE IN MALLARD DUCKS

Fresh heads: complete	23	23.4±0.59	2.84	18-30	12.1		
all muscles removed	23	34.9±0.66	3.15	28-42	9.0	increase 49.1	$P < .01$
all ligaments cut	23	40.3±0.58	2.77	33-48	6.9	increase 15.5	$P < .01$
Skulls: Museum preparation	21	33.9±0.71	3.20	23-40	9.4	decrease 15.9	$P < .01$

change occurred although tightening of this ligament may be seen when the bill is protracted by one's hand.

Removal of the capsule around the pterygoid-basipterygoid articulation increased the movement by 1.8 degrees ($P > .10$).

When the pterygo-palato-orbital and vomero-orbital ligaments were removed from the same specimens, the movement increased significantly by 3.8 degrees or 9.5 per cent.

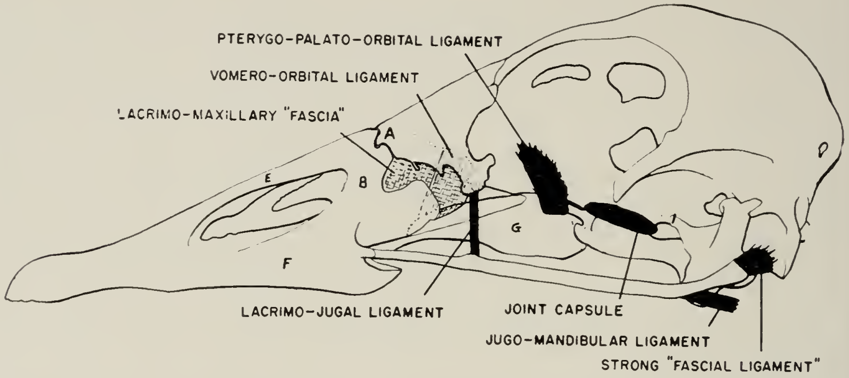

FIG. 4. Lateral view of the skull of a Canada Goose, showing the positions of some soft structures which limit kinetic movement.

The increases noted above, whether they were in absolute or percentage values, can not be construed as the actual extent of limitation caused by the parts removed. The sequence of removal undoubtedly plays a major role in determining these values. Had it been feasible to remove the muscles, ligaments and capsules in different sequences, the values might well have been different. What these increased movements do show is that all these structures are parts of the total mechanism that limits protraction.

THE CRITERIA FOR RELIABLE MEASUREMENT OF AVIAN JAW KINETICS

Knowing that all these soft and bony structures may restrict protraction, or retraction, it is obvious that no valid conclusions concerning the amount of movement can be based solely on measurements of museum skulls. Unless one has previously established for a species an index of relationship between measurements of fresh heads and of skulls, skulls cannot be used. (Note the variations between the species of waterfowl in Table 3 and variation with museum preparation, soaking, and age.)

Preservation of heads in formalin and glycerin and the subsequent soaking that is necessary prior to measurement reduce significantly the amount of movement (Table 4).

TABLE 6 DEGREES OF MOVEMENT OF THE FRONTO-NASAL HINGE IN YOUNG PEKIN DUCKS

	No. specimens	Mean	Standard deviation	Range	Coeff. variation	Percentage change	Probable significance of change
Fresh heads: complete	83	27.0 ± 0.40	3.64	19-38	13.5		
all muscles removed	44	32.4 ± 0.63	4.17	23-42	12.9	increase 20.0	$P < .01$
all ligaments cut	43	41.5 ± 0.78	5.10	26-55	12.3	increase 28.1	$P < .01$
Skulls: museum preparation	20	33.0 ± 1.33	5.97	21-48	18.1	decrease 20.5	$P < .01$
Fresh heads: complete	19	25.0 ± 0.45	1.96	21-30	7.8		
all muscles removed	19	32.9 ± 0.72	3.13	29-40	9.5	increase 31.6	$P < .01$
only lacrymo-maxillary, pterygo-palato-orbital, and vomero-orbital ligs. remain	19	38.1 ± 0.73	3.20	30-45	8.4	increase 15.8	$P < .01$
lacrimo-maxillary ligament cut	17	38.0 ± 1.03	4.26	30-46	11.2	no change	
pterygo-basipterygoid capsule removed	17	39.8 ± 1.18	4.86	29-55	12.2	increase 4.7	$P > .10$
pterygo-palato-orbital and vomero-orbital ligs. cut	19	43.6 ± 0.77	3.34	36-52	7.7	increase 9.5	$P = .01$
Skulls: museum preparation	19	32.8 ± 1.23	5.36	22-42	16.3	decrease 24.7	$P < .01$

Fresh heads are thus the only satisfactory material for measurement of kinetics in birds. It is not always possible to obtain and measure these heads immediately after death. With the exception of a series of 20 Canada Geese, all fresh heads in this study were measured within eight hours of death. Coefficients of variation of these were not unduly high; they were no higher than the coefficient of variation for the series of Pekin Ducks which had just been killed. Amount of movement in the 20 geese that were measured 24 hours after death was not significantly different from that found in another series of 20 measured within eight hours of death. The only special treatment the "24-hour" skulls received was that they were refrigerated and that the stiffness was removed by protracting the bill several times before the measurements were made.

Series must have an adequate number of specimens in them. If one looks over the data presented in the tables, it becomes apparent that there is considerable variation of several kinds. Therefore, we can not study kinetics from measurements or dissections of one or a few specimens. Even with samples of 83 and 19 in Table 6 note that there is an apparently significant difference (27.0±0.40 versus 25.0±0.45) between the two series of fresh heads of Pekin Ducks!

SUMMARY

The kinetics of the avian skull, defined as protraction and retraction of the upper bill, can be a source of valuable information on the evolution of the feeding mechanism and consequently on the evolution of the species. But accurate and consistent quantitative studies of kinetics must be made before conclusions are drawn.

This study has contributed the following information pertinent to the gathering of quantitative information and to the limitations on movement:

1. As just noted, there must be a sufficient number of specimens in a series for the results to have some statistical reliability.
2. Intact, fresh heads must be used; they may be measured as long as 24 hours after death.
3. Skulls prepared for museum collections do not permit reliable or consistent measurement; soaking, "bugging" or cooking, degreasing and bleaching these skulls give rise to great variability in kinetic movement.
4. Skulls may not even be used as an index to kinetics unless there has been established for a species a definite relationship between measurements on the skull and measurements on the complete, fresh head.
5. Heads preserved in formalin and glycerin show a decreased kinetic

movement which makes measurements of them incomparable with measurements of other materials.

6. Although some species, such as the American Crow, possess definite bony structures which stop protraction, most limitation is imposed by soft parts of the head. Retractor stops of bone are present in many species.
7. The entire mass of cranial muscles, including muscles not apparently connected with protraction or retraction, restrains movement.
8. Ligaments, as might be expected, are of major importance in circumscribing kinetic motion. The limitations set up by the vomero-orbital and pterygo-palato-orbital ligaments are noted.
9. Even joint capsules, particularly the one around the articulation between the pterygoid and the basipterygoid process, reduce and limit kinetic activity. The effect of this one capsule was measured.

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WINTER ROOSTS OF MARSH HAWKS AND SHORT-EARED OWLS IN CENTRAL MISSOURI

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THE GROUND ROOSTING HABIT of the Marsh Hawk (*Circus hudsonius*) and the Short-eared Owl (*Asio flammeus*) has been reported by numerous authors. A few have noted large winter concentrations in areas where small mammals were abundant. Stoddard (1931:209–210) stated that Marsh Hawks commonly roosted on the ground in Florida in two's and three's but were sometimes found in groups numbering 30 during periods of abundance of the cotton rat (*Sigmodon hispidus*). Snyder and Hope (1938) and Kirkpatrick and Conaway (1947) reported groups of up to 13 Short-eared Owls in Ontario and Indiana, respectively, in years of high levels in meadow mouse (*Microtus* spp.) populations.

We found a similar response to high mouse populations in central Missouri. In mid-February, 1952, eight Marsh Hawks were observed hunting over a field in the upland prairie region 12 miles east of Columbia. Later observations revealed a large number of Marsh Hawks and Short-eared Owls feeding and roosting there. Signs of great numbers of *Microtus ochrogaster* were evident; above-ground nests, runways, and dead mice were abundant. Reports by local farmers also gave evidence that the *Microtus* population was unusually high during the winter of 1951-1952.

Four adjoining fields were frequented by the birds. All were predominantly wheat stubble fields overgrown with common ragweed (*Ambrosia artemisaefolia*) to a height of two to three feet. Most of the fields were damp, a few having standing water in furrows and ditches. The four fields were within an area of less than one-half square mile. An intensive search of over five square miles revealed no other roosts.

By placing several observers at the edge of each field, an attempt was made to count the Marsh Hawks as they left the roosts in the morning. Counts of as many as 66 hawks were made during mid-March. Since not all took flight and there was some difficulty in counting, it was estimated that 80 to 90 hawks were roosting in these fields. Although both sexes were present, sex ratios could not be obtained because of the similarity of the plumage color of females and juvenile and second-winter males. Short-eared Owls were counted by flushing them from roosts during the day, 13 being the greatest number seen in one day.

ROOSTING BEHAVIOR

Hawks were not abundant in the roosting area during the day. Toward evening, they moved to the roosting fields from all directions, hunting as they came. After hunting over the roosting areas, they finally dropped to the ground and remained there for the night. Hawks went to roost from five to 25 minutes after sunset. Their manner of settling into the roosts made the hawks and the roost inconspicuous; no great number of hawks was in view at one time. Roosting sites were on dry mounds, as shown by fecal droppings and groups of pellets. From the abundance of pellets at some roosting sites, it was inferred that hawks often returned to the same place nightly or that the site was preferred and used by many individuals.

In the morning, Marsh Hawks left the roost more gradually than they settled down in the evening, but when doing so, arose and departed in a straight line of flight. Some hawks were observed taking flight as much as 45 minutes after the departure of the first bird from the roost at about 10 minutes before sunrise. A few were flushed even later in the morning. Hawks were often observed preening on the ground on bright mornings. Rarely did they hunt over the roosting area in the morning, possibly because of the activity pattern of their prey. Calhoun (1945) and Fisher (1944. Unpublished data, Master's Thesis, University of Missouri) agree that while the major activity of *Microtus ochrogaster* comes several hours after sunset, there is a lesser peak of activity at sunset and a decrease in activity at sunrise. As shown by field sign and pellet analysis, *Microtus ochrogaster* was the dominant small mammal in the area and its diel activity rhythm probably affected the behavior of the hawks.

Local farmers reported that the hawks had been in the area since about late October. They remained until late March when they presumably migrated. No mass exodus was noted, but rather, a gradual diminution of their numbers. The Short-eared Owls were not observed after mid-March.

As shown by field sign, mouse populations in 1953 were very low in comparison with those in 1952. Only 13 hawks were seen. These were roosting in a field of a type similar to and four miles from the area used in the previous year. Although no satisfactory measurement of the mouse population was obtained, our observations seem to agree with those of Stoddard, who found that the abundance of Marsh Hawks was an index to the size of the rodent population. Further explanation for the shortage of hawks in 1953 may have been the mild winter which allowed them to winter farther north. None was observed in 1954 or 1955 but the severe drought conditions probably depressed the *Microtus* population.

Food Habits

Thousands of hawk pellets were found in 1952 but only 118 could be located in 1953. Two hundred of the pellets collected in 1952 and all those found in 1953 were analyzed. Leroy J. Korschgen, Food Habits Biologist, of the Missouri Conservation Commission, gave valuable advice and assistance in the analysis of the pellets. The data for the two years are shown in Table 1. Because Marsh Hawk pellets contain little bone, they reflect the prey species taken but not the numbers (Errington, 1930). Therefore, only the frequency of occurrence of each prey species in the total number of pellets for each year is presented. Although *Microtus* was the major food taken during both seasons, there was an obvious decrease in the frequency during 1953. No detailed evaluation of this decrease can be made because of the absence of mouse population data. A comparative study of fluctuations in mouse populations and changes in the frequency of occurrence of mouse remains in hawk or owl pellets might be used to establish a simple technique for measuring mouse populations by analysis of pellets. Although other microtines made up only a small part of the prey, it is interesting, although not statistically significant, that the frequency of occurrence of southern bog lemmings (*Synaptomys*) decreased slightly in 1953. Blair (1948) found that *Microtus* and *Synaptomys* populations fluctuated synchronously in southern Michigan. Of significance is the increased predation on birds and other mammals resulting from the scarcity of mice. Although Marsh Hawks frequented the roosting areas and booming grounds of Prairie Chickens (*Tympanuchus cupido*), there was no evidence that chickens were preyed upon. The only game bird found was one Bobwhite Quail (*Colinus virginianus*). The remains of most songbirds could not be identified.

TABLE 1

FREQUENCY OF OCCURRENCE OF PREY SPECIES IN MARSH HAWK PELLETS

Prey Species	200 Pellets, 1952	118 Pellets, 1953
Microtus ochrogaster	95.0	74.6
Synaptomys cooperi	8.5	7.6
Sylvilagus floridanus	7.0	16.1
Unclassified birds	4.5	27.1
Peromyscus spp.	3.0	4.2
Unidentified snake	0.0	0.8

During 1952, as many as 13 Short-eared Owls utilized roosting areas near those of the Marsh Hawk sites. Owls showed a preference for areas with dense cover of panic-grass (*Panicum dichotomiflorum*) and poverty grass (*Aristida* sp.) less than one foot high. Their roosts were on drier sites than those of Marsh Hawks and commonly in a form in a tuft of grass. Feces, pellets, and feathers were found in these forms. In one such area, owls and hawks roosted together in a stubble field which contained a late summer's growth of panic-grass. Pellets of the two species could be distinguished by associated feathers and by fecal remains: the feces of Short-eared Owls were black and string-like and those of Marsh Hawks were green and pellet-like. In addition, pellets found in forms and with an abundance of bone protruding from the hair were those of owls. Marsh Hawk pellets rarely contained more than a few teeth and jawbones enclosed in hair or feathers.

Data from 184 owl pellets are presented in Table 2 and demonstrate the availability of *Microtus* as food. The frequency of occurrence of *Microtus* in the diet of hawks and owls was similar but owls took fewer *Synaptomys*, deer mice (*Peromyscus*), and birds, and no rabbits.

TABLE 2

FREQUENCY OF OCCURENCE OF PREY SPECIES IN 184 SHORT-EARED OWL PELLETS COLLECTED IN 1952

Microtus ochrogaster	95.7
Synaptomys cooperi	3.3
Unclassified birds	2.7
Peromyscus spp.	1.1
Grasshopper	0.5

During the course of the 1952 observations, five dead Marsh Hawks were found in one roosting area. At the site of one, killed after a light snow, the lack of mammal tracks led to the conclusion that a Horned Owl (*Bubo virginianus*) was responsible for the predation. A Horned Owl roost on a deserted farm site 200 yards from the scene of the kill was examined. Among the 27 owl pellets collected, 25 contained mice, one contained chicken feathers, and one contained the upper mandible and some wing bones of a Marsh Hawk. This unusual and interesting prey of the Horned Owl presents further evidence of the importance of availability in predator food selection.

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Missouri Cooperative Wildlife Research Unit, University of Missouri, Columbia, Missouri, March 24, 1955

NOTES ON THE MOLTS AND PLUMAGES OF THE SPARROW HAWK

BY KENNETH C. PARKES

Examination of the Carnegie Museum's series of 126 specimens of the North American Sparrow Hawk, *Falco sparverius sparverius* Linnaeus, has shown that some recent authors have been confused about certain of the molts and plumages of this little falcon. As is well known, individual variation in color and pattern in this species is so marked that the selection of characters for criteria of age and of geographic variation must be made with great caution. This variability shows its extreme development in the rectrix pattern of males, no two birds being exactly alike in this respect.

Bond (1943), in an otherwise excellent treatment of geographic variation in the Sparrow Hawks of western North America, has made several statements concerning molts and plumages that call for comment, especially as some are in direct contradiction to Bent (1938) and other authorities. On p. 174 Bond states "I can see no evidence that any fall molt of the young takes place. All changes in appearance are attributed to wear and fading. Immature specimens are not always certainly distinguishable even in fresh plumage." Bond then lists several "useful criteria of immaturity," ending with the sentence "Immature females are much more difficult to distinguish than immature males." This is the only one of his statements that I can endorse. Bond also presents a bar graph which purports to illustrate his statement that "First-year birds disappear rapidly after reaching a peak of about two-thirds of the population in August." Bond would have us believe that young Sparrow Hawks suffer a 75 per cent mortality (i.e., from two-thirds down to one-third of the total population) between August and November, a rate which seems excessive for a predator which "has not been reported as a major item in the diet" of any other predator (Clay, 1953:131). Actually, as I shall show, his graph of the "disappearance" of first-year birds is nothing but a representation of the schedule of the post-juvenal molt which Bond claims is non-existent.

Bent (1938:112) states of the young Sparrow Hawk ". . . early in fall changes begin to take place, by fading and by a gradual molt of the body plumage, during September and October; by midwinter great progress has been made toward maturity." This coincides exactly with my own findings; note how the progress of the molt corresponds with Bond's "disappearance" of first-year birds.

Criteria of Immaturity in Males

As to the actual criteria for recognizing juvenile birds, Bent apparently based his rather detailed description on only a single specimen of either sex. Many of the plumage characters he ascribes to young birds are merely those of individual variation. To take these up in order, Bent claims that the young male has "only a hidden trace of the rufous crown patch and . . . larger black spots on the [wing] coverts than in the adult." Neither of these conditions is a character of immaturity. The rufous crown patch varies in our juvenile males from about one-fourth (reference specimen 36146, Malheur Co., Oregon) to about three-fourths (4380, Sheep Creek, Wyoming) of the entire crown area. The Oregon specimen mentioned has heavy black spotting on the wing coverts, while no. 114114, from Marathon, Texas, has these feathers almost immaculate. The series shows all stages of intermediacy in these two characters.

The great variation in the tail pattern of males, referred to earlier, renders meaningless Bent's description of a supposed pattern typical for immature birds. His mention of a single color for the underparts ("pinkish buff") is also without significance, since the color of this portion of the young bird may vary greatly. Specimen no. 36146 (Malheur Co., Oregon) has the breast feathers of a color between the Vinaceous Cinnamon and Orange Cinnamon of Ridgway (1912), while in no. 126043 (Alpine, Arizona) this area is nearly white, though the plumage is fresh and unbleached. There is no correlation between the color of the underparts and geographic distribution among these juvenile specimens of *sparverius.*

By far the best criterion for recognizing juvenile males as such is the heavy marking of the underparts. Only a few adult males exhibit any streaks or spots on the upper breast; this area in fall immature birds is invariably marked with longitudinal black streaks which widen into broad spots along the flanks. Even those few adults which retain some spotting on the chest seldom if ever match the juvenile birds in this respect. Such spotted birds may account for the supposed worn spring immature birds described by Bond (1943:175). Some exceptional individuals may actually retain some of the spotted feathers of the chest, but these normally disappear in the ordinary post-juvenal molt, as described beyond.

Another excellent character for recognition of young male Sparrow Hawks is the more extensive black barring of the dorsum. In adult males the anterior one-third (and sometimes more) of the scapular-interscapular area is immaculate; in juvenile birds the bars extend almost to the posterior edge of the gray of the crown. In most specimens examined, the post-juvenal molt of these dorsal feathers occurred later than that of the ventral plumage, allowing the dorsal pattern to be used as a criterion of immaturity for a longer period.

In juvenile males the light tips of the rectrices are usually washed with a pinkish buff color, although this may be quite pale on the lateral pairs. In adults these tips are either white or gray. There is occasionally a light buffy wash, but the tips of the central pair of rectrices are apparently always gray.

Friedmann (1950:724) and others have indicated that young males usually exhibit dark shafts on the crown feathers. This statement is true, but must be somewhat modified. Some adult males may have well-marked shaft-streaks in the blue-gray areas of the head, especially toward the forehead (reference specimen 12063, Cochise, Arizona). However the brown crown patch of adults is seldom invaded by these shaft-streaks, while in young birds the brown crown feathers have well-marked gray centers.

The material I have examined does not confirm Clay's statement (1953: 130) that the nuchal region which resembles a pair of ocelli or "false eyes" is whiter in young birds than in adults. The pigmentation of this area in *sparverius* appears to be a matter of individual variation, although it is subject to geographic variation in some of the southern subspecies.

The post-juvenal molt of the body feathers in the male Sparrow Hawk takes place primarily in September and October, as amply illustrated by Carnegie Museum specimens. Such molting birds are instantly recognizable in a tray of specimens by the mottled appearance of the chest region. The streaked feathers, usually quite bleached by the time of molt, are replaced by immaculate feathers whose bright color contrasts plainly with the juvenal plumage. A specimen taken at Kenton, Oklahoma, September 22, 1932, (no. 113229) is molting the interscapular feathers, replacing barred with unbarred feathers in the anterior portion of this area. The shaft-streaks of the crown are also a short-lived criterion of immaturity, as illustrated by two specimens which have almost finished the post-juvenal crown molt; no. 4847 taken in Coahuila, Mexico, October 31, 1899, and no. 122283 from Santa Clara, Utah, October 23, 1937. Completion of the molt of these contour feathers leaves the color of the tips of the rectrices as the best indication of age by late fall and winter. This character, of course, is obscured by wear and fading, but this in itself is a clue to the age of a given specimen, since the tails of birds of the year are often quite worn by midwinter while those of adults may be relatively fresh.

Criteria of Immaturity in Females

As mentioned previously, recognition of immaturity in Sparrow Hawks is far more difficult in females than in males. There are ten female Sparrow Hawks in the Carnegie Museum collection which are either obviously young birds (fledglings) or have been marked "juv." or "imm." by the collector. These have been used as a standard to try to determine which characteristics are held in common by young birds and not by adults. Unfortunately none of the three major criteria of immaturity in males — streaking of the chest, extensive dorsal barring and brownish tail-tips — applies to females. The color of the ventral streaks of females of all ages is so variable that I am unable to verify the statements of Bent (1938:112) and Friedmann (1950: 724) to the effect that these streaks are darker in young birds. Bent's statement that the ventral streaks of adults are narrower than those of juveniles is, on the average, true, but variation in this character is so great as to make it undependable as a primary criterion of immaturity.

I have found two characters which appear in most of the young birds, and are possibly diagnostic of immaturity, although not certainly so. The tails of all female Sparrow Hawks are brown, heavily barred with black. Since the tail-tip in unworn birds is brown, the distal black bar across the rectrices may be considered as a subterminal band. In almost all of the young birds examined, this subterminal band is broader than the anterior black bands only, if at all, on the central pair of rectrices. On the remaining rectrices there is no difference in the width of the subterminal and adjacent black bands. In adults, on the other hand, the subterminal band is decidedly wider than the remaining bands on the tail (except, usually, on the outermost pair of rectrices, where all of the bands are much reduced). There is much individual variation in the width of these tail bands, but in adults with wide bands the subterminal one is particularly wide, while in those with reduced tail bands the subterminal one may be quite narrow, but always wider than the adjacent ones.

The crowns of all immature female birds examined bore heavy shaft-streaks, and the gray and brown areas were poorly defined and somewhat blended. In many adult birds the two colors of the crown are bright and clearly defined, with little or no shaft-streaking. However, some adult specimens do approach the young birds in this crown character. One of the specimens examined, from Lake Chapala, Jalisco, was just beginning the post-juvenal crown molt when collected on November 11, 1899. I hesitate to make any generalization from this single specimen to the effect that the post-juvenal molt is later in females than in males.

The Lake Chapala specimen just cited is also beginning to replace the barred feathers of the interscapular region. Comparison of the old and new feather refutes Bent's belief that the black bars are relatively broader in young birds (Bent, 1938:112).

Very young Sparrow Hawks have a rather silky sheen which is quite characteristic of their plumage, but which quickly wears away. It is of little or no use as a criterion of first-year birds, since it disappears while the birds are manifestly young by several other criteria. I am unable to detect any special consistency of the breast feathers as described by Bond (1943:174–175), and Bond admits that this supposed character of immaturity disappears with wear.

Many of the above conclusions concerning the juvenal plumage and post-juvenal molt of Sparrow Hawks conform with the findings published many years ago by Mearns (1892). Although Mearns' paper is listed in Bond's bibliography, Bond apparently consulted only the taxonomic portion, since he cites it only in connection with Mearns' description of the races *deserticolus* and *peninsularis*.

Plumage Changes in Adults

I have little to add to our knowledge of the molts and plumages of the adult Sparrow Hawk. Bent (1938:112) stated "I believe that the full perfection of plumage is not acquired until the bird is two years old, or more. The oldest males have the least spotting on the scapulars, a clear white or cinnamon breast, with only a few round black spots on the flanks, and the most rufous in the tail; probably successive annual molts are required to reach this perfection." I have already indicated my belief that there is no correlation between age and the color pattern of the tail. That this "perfection of the plumage" theory does not hold for other parts of the bird as well is indicated by specimen no. 131283, taken August 10, 1946, at Entrance, Alberta. This bird is an adult male beginning its post-nuptial molt. On the posterior two-thirds of the interscapular area many new heavily-barred feathers are replacing unbarred old ones, indicating that this particular adult is reversing the trend postulated by Bent. As in all adult males, both the old and the new feathers in the anterior one-third of the scapular region of no. 131283 are unbarred.

Summary

1. In spite of assertions to the contrary in the literature, *Falco sparverius sparverius* has a post-juvenal body molt. This occurs mostly in September and October, at least in males.
2. Certain characters which have been proposed as age criteria by various authors do not appear to have any significance in this respect. These include the size of the rufous crown patch, amount of spotting on the wing coverts of males, tail pattern of males, ground color of underparts, ground color of the ocelli of the nuchal region, width of dorsal bars of females, and consistency of breast feathers.
3. Immature males may be recognized by a combination of several characters, including spotting and streaking of the breast, barring of the anterior one-third of the scapular-interscapular region, brownish tips to rectrices, and dark gray shaft-streaks in the brown crown patch.

4. All of these characters except that of the tail-tip normally disappear during the post-juvenal molt. Young males in late winter or early spring may still be recognizable by the relatively greater wear of their rectrices.
5. Recognition of immature females is difficult. Two suggested criteria are the lack of a well-defined subterminal band on the tail and a crown with heavy shaft-streaking and poorly-defined brown and gray areas.
6. Adult males do not necessarily become less barred or spotted with successive annual molts.

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NOTES ON FIELD IDENTIFICATION AND COMPARATIVE BEHAVIOR OF SHRIKES IN WINTER

BY DALE A. ZIMMERMAN

FOR the second year in succession bird observers in Ohio and Michigan have reported numerous Northern or Gray Shrikes *(Lanius excubitor).* In Michigan most winter shrikes are doubtless of that species, but the Loggerhead Shrike (*Lanius ludovicianus*) has been collected in late fall and winter in Monroe, Wayne, and Lapeer counties in the southern one-third of the state. Although unquestionably authentic winter records of Loggerheads have been published (Van Tyne, 1940:35 and Wood, 1951:359), some Michigan observers continue to assume that any shrike seen in that state in winter "has to be" a Gray Shrike.

Dr. Milton B. Trautman informs me that Ohioans in contact with nature clubs have learned that the Loggerhead is supposed to be the only shrike wintering in Ohio, except, possibly, along the Lake Erie shore, and that these observers have automatically considered most wintering shrikes to be of that species prior to the recent Gray Shrike invasions. In the Ohio State Museum and the University of Michigan Museum of Zoology there are 14 late fall and winter shrike specimens from Ohio: seven of these are Loggerheads, seven are Gray Shrikes. Both species have been collected as far south as Perry and Franklin counties in central Ohio.

Obviously, identifications of winter shrikes in this region based on seasonal or geographic probability are valueless.

FIELD IDENTIFICATION

Field identification is often difficult—particularly for persons who are not familiar with both species in life. Misleading, incomplete accounts in the popular bird guides make the problem appear simpler than it is.

Immature Gray Shrikes are washed with shades of brown and are so heavily barred that their identification is easy. The Loggerhead, except for juveniles in summer, is always a gray bird. Unless otherwise stated, the following remarks refer to adults.

Breast vermiculations.—These may be present on both species. Those of the Gray Shrike are narrow and sharply defined, while those of the Loggerhead are wider and less distinct (see Figure 1). Very heavily marked Gray Shrikes can be safely identified on the basis of vermiculations alone if the observer knows the limits of variation in these markings. In the field, however, many adult Gray Shrikes, particularly as their plumage becomes soiled or worn, do not show striking vermiculations. Some even appear clear-breasted. I have found that vermiculations clearly evident through a 20X telescope were frequently invisible through coated 8X and 12X binoculars. The bars on some fall and winter female Loggerheads are remarkably distinct and may be easily seen.

Bill color.—This character is of less diagnostic value than is indicated in most bird guides, for both species may have the base of the bill light-colored in fall and early winter. The pale area is more restricted on the Loggerhead's bill, but is visible at distances of 40 to 50 feet in dull light through 7X binoculars. It is confined to the basal part of the lower mandible. In the Gray Shrike the basal quarter or one-third of one or both mandibles is light-colored—but only in fall and early winter. The bill becomes *entirely* black toward spring—sometimes as early as mid-March.

FIG. 1. Left to right: 2 female Loggerhead Shrikes; adult male Gray, adult female Gray, and immature male Gray Shrikes showing variation in extent and types of vermiculations.

Facial feathering.—The nasal tufts and narrow strip of feathers at the base of the upper mandible are black in most Loggerheads, though in five of 18 female specimens of *L. ludovicianus migrans* examined, the latter region is gray like the rest of the forehead. In the Gray Shrike these feathers are never dark and are nearly always noticeably *white or whitish, contrasting with the darker gray of the forehead and crown.* They are most conspicuous in a full-face view of the bird. ("Squeaking" will often hold the bird's attention long enough for the markings to be seen.) I examined one Loggerhead Shrike that showed whitish feathers at the base of the culmen, but the nasal tufts of that bird were black.

FIG. 2. Six winter shrike specimens showing size differences. Some allowance must be made for differences in make-up of skins, but specimens 1, 4, and 5 (counting from the left) were prepared by the author. Left to right: immature male Gray, adult female Gray, adult male Gray, adult male Gray, male Loggerhead, female Loggerhead.

The mask of the Loggerhead is wide, the anterior portion of its upper margin reaching, in most birds, from the top of the eye to the base of the culmen. Thus the lores and nasal tufts are entirely or largely black. In the Gray Shrike the loral portion of the mask is narrower, its upper margin extending downward from the top of the eye to below the middle of the upper mandible. (Some female Loggerheads have similarly restricted masks but do not show the whitish nasal tufts mentioned above.) Few Michigan Gray Shrike specimens, and those only adult males, show well-defined, complete black masks. Some males (probably second-year birds) have the black of the lores flecked with gray which destroys the continuous pattern of the mask. Still other males (including brown first-year birds) and all females have almost no black in the lores, this color being confined to the postocular portion of the mask (except in the very brown first-year females, in which *all* black is replaced by brown). This "broken" mask effect is a useful field mark. A shrike with much white or gray in the lores and with *conspicuous* light feathers at the base of the upper mandible is certainly a Gray.

At close range another helpful mark, absent in the Loggerhead, is the small white spot below the eye of many Gray Shrikes (better developed in females than in males). Sometimes this spot is joined with the gray of the lores (see Fig. 4).

Discussion of Field Characters and Characteristics

As indicated above an early winter shrike with breast vermiculations and pale-based bill, or a spring bird with apparently clear breast and totally black bill might represent either species. Furthermore, anyone who has studied a shrike perched in the distance or on an overhead wire, knows that it is difficult to be certain of the lower forehead coloration. Fortunately, there are a few additional points, which, while differences in degree only, are useful if used in conjunction with some of the characteristics already discussed. It must be emphasized, however, that a positive identification could not be based on their use alone.

The Gray Shrike is a larger, longer bird than the Loggerhead (Fig. 2), but there is considerable individual variation. Its dorsal plumage is more silvery-gray, contrasting more with the black mask and less with the white scapulars than in the darker-backed Loggerhead. *Some* Grays have very white rumps, whereas *most* Loggerheads in this region have rather dark gray rumps. More important, *the Gray Shrike's bill is longer, heavier, and more strongly hooked than the Loggerhead's, and its head appears longer and larger, in proportion to body size* (Fig. 3). These head and bill differences are very impressive to observers who are familiar with both species. The Loggerhead's stubby bill is a relatively inconspicuous part of the bird. That of the Gray Shrike is noticeable at great distances, even in flying birds.

Voice.—In my experience Gray Shrikes are far more vociferous than Loggerheads. They frequently indulge in chattering, squeaking, mimicry, and even prolonged thrasher-like singing. True singing, while sometimes heard in October and November, seems to become more frequent after mid-January. We need detailed information on the vocal habits of both species.

Behavior.—My field experience with winter shrikes in the northern states has been largely confined to *Lanius excubitor.* Dr. Milton B. Trautman, who has had considerable experience with wintering Loggerheads in Ohio, has generously placed at my disposal important information from his observations on shrikes in that state. In the following account I make frequent reference to his recent letters to me (February 18 and 23, and March 13, 1955).

Several observers have noted that the Gray Shrike's flight often seems more slow and deliberate than that of the Loggerhead. This difference may be more apparent than real, however, for Bent (1950:120) called the Gray Shrike a "fairly swift flier," and mentioned Rathbun's (1934:24) account of clocking with an automobile a bird (of the northwestern race, *L. excubitor invictus*) at 32 to 42 and (briefly) 45 miles per hour on a windless day.

Fig. 3. Adult male Gray (right) and Loggerhead Shrikes (specimens 4 and 5 of Fig. 2), showing differences in width of mask and size of bill. (The bill color is considerably darker than that in living birds.

The Loggerhead seldom perches more than 25 feet above the ground, whereas the Gray Shrike usually chooses a tall tree-top or high wire for a hunting perch—frequently flying directly from one perch to another without dropping near the ground as the Loggerhead ordinarily does. The high, undulating type of flight is common to both species, but when Miller (1931: 222) states that it "is performed higher above the ground, often as high as twenty feet . . . " he undoubtedly refers only to *L. ludovicianus.* The Gray Shrike frequently bounds through the air at tree-top level, and sometimes 75 to 100 feet above ground.

Miller (*op. cit.*:211) also writes that hovering "frequently is observed" in Loggerhead Shrikes. I have noticed it far more often in the Gray, and there is frequent mention of it in the literature pertaining to that species. Trautman writes that this bird "habitually stops and flutters in a stationary position in mid air, as does the Sparrow Hawk *(Falco sparverius)*." He adds that he clocked one for over two minutes, and that he has never noticed hovering "to be of more than momentary duration in the Loggerhead."

The Gray Shrike seems to bob its tail more frequently and energetically than does the Loggerhead, and sometimes it indulges in startling behavior unlike any reported, to my knowledge, for the Loggerhead. Trautman writes about a singing male Gray Shrike observed on South Bass Island, Ohio, February 23, 1955:

> When I first saw the shrike it was perched in the top of a small tree, about 25 feet from the ground, from which perch it sang persistently for over five minutes, after which I left it. Returning later I found the bird near where I had first seen it. Approaching closer I saw the bird doing an amazing thing. It was in the top of a wide branching tree, hopping rapidly from one branch to another, then quickly changing direction and hopping to another branch. It seemed to do a lot of unnecessary bobbing and turning. As it hopped about it sang its lovely phrases, sometimes alternating with cat-calls. I have never seen a similar behavior in any other bird.

I observed nearly identical actions in an immature Gray Shrike near Mt. Clemens, Michigan, on January 31, 1954. The latter bird preceded his antics (performed in the top of a 40-foot elm) with 10 or 12 high-pitched, squealing, sapsucker-like notes.

Near Imlay City, Michigan, December 5, 1954, I watched a subadult Gray Shrike fly from its perch on a roadside wire to a tree near a chicken yard where numerous House Sparrows *(Passer domesticus)* were noisily feeding on the ground. Apparently attempting to startle the sparrows into flight, the shrike began excitedly jumping about—from branch to branch, from the tree to an adjacent wire fence or to low telephone wires and back to the tree again—all the while flopping its tail and repeatedly spreading its tail and wings. As I followed the rapid action (with difficulty) through the telescope I was continually reminded of a Mockingbird's *(Mimus polyglottos)* "wing-flashing." After nearly a full minute of this behavior one sparrow flew upward across the open farmyard, with the shrike following. The sparrow managed to keep above its pursuer and at a point several hundred feet above ground, where both birds appeared as mere specks, the shrike gave up the chase.

In the same region, on March 28, 1954, I watched an adult Gray Shrike perched on a diagonal support cable leading from a tall roadside utility pole to the ground. Fluttering its wings like a young bird about to be fed, the shrike slowly moved sideways down the cable until within a few feet of the ground, uttering high *p'seet* notes which I could barely distinguish from those of several Horned Larks *(Eremophila alpestris)* that were calling from the adjacent field. A few minutes later it flew to the high wires above and began preening. It was heedless of my presence and remained within 15 feet of the road while two or three automobiles roared past.

FIG. 4. Gray Shrike (? female), Arcadia Township, Lapeer County, Michigan, December 17, 1953. Note the interrupted mask and the extent of the light area on the lower mandible. Photograph by L. M. and L. P. Zimmerman.

Miller (*op. cit.*:144) writes: "Apparently *L. excubitor* is less fixed in its winter habitat than *L. ludovicianus*, for it seems to wander about in response to varying local conditions of food and weather." However, both species seem to inhabit definite territories in winter. Several times from December, 1953, through March, 1954, my family and I observed what we believed to be the same Gray Shrikes in certain localities in Lapeer County, Michigan. Although these individuals had favorite hunting perches their territories were large, thus making it difficult to find a particular bird on a given day.

Mrs. Alice D. Miller banded an adult, male-plumaged Gray Shrike at her Leonard, Michigan, station on November 3, 1954, and retrapped the same bird there February 3, 1955. An adult that I banded November 29, 1953, in Lapeer County, was possibly the same banded individual I saw 300 yards south of the banding station on March 21, 1954.

Trautman observed some Ohio Gray Shrikes that seemed to hunt over great circular routes. He "followed one for a distance of 2½ miles during a ½ hour period and it still had not completed its circle." The Loggerhead, according to that observer, is "quite sedentary in winter and the same bird can be seen day after day about its [osage orange] hedge."

Trautman informs me that the Gray Shrike "apparently cannot compete with" the Sparrow Hawk; that when a Gray Shrike enters the winter territory of a Sparrow Hawk it is driven out, and when the falcon enters a Gray Shrike's territory the shrike immediately leaves. His observations indicate that there is no such competition between Sparrow Hawks and Loggerhead Shrikes; he has seen those two species sharing the same hunting territory.

Miller (*op. cit.*:213) stated that "there appear to be more records of *L. excubitor* carrying food in the feet than there are of *L. ludovicianus*." In his extensive field work with western races of the Loggerhead Shrike he never saw a bird carry food in its feet (though he pointed out that the action did occur at least rarely in that species). I have several times seen Gray Shrikes carrying birds or mice for distances of 100 feet to a quarter of a mile; in every case prey was carried in the feet. I have never seen the Loggerhead attempt to carry vertebrate prey. Floyd (1928:46) summarized reports by 23 eastern observers which show that the Gray Shrike may use either its bill or feet in this connection: 13 observers reported the use of bill only, seven observed the use of feet only, and three noted the use of both.

ACKNOWLEDGMENTS

I wish to thank Dr. C. T. Black, Mrs. Alice D. Miller, and Mr. R. A. O'Reilly, Jr., for bringing to my attention various points that I might otherwise have overlooked; my parents, Dr. and Mrs. L. M. Zimmerman, who willingly photographed a very uncooperative and sharp-billed shrike; G. Reeves Butchart, for editorial advice; Dr. Edward S. Thomas, for supplying data from specimens in the Ohio State Museum; Dr. Milton B. Trautman, for giving me the benefit of his valuable field experience with shrikes in Ohio; and Dr. Josselyn Van Tyne, to whom I am indebted for use of specimens in the University of Michigan Museum of Zoology, for reading portions of the manuscript, and for numerous other courtesies.

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MUSEUM OF ZOOLOGY, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN,
MARCH 21, 1955

A NEW RACE OF OLIVACEOUS WOODCREEPER FROM MÉXICO

BY GEORGE MIKSCH SUTTON

Recently I have had occasion to re-identify the 18 specimens of Olivaceous Woodcreeper *(Sittasomus griseicapillus)* in my collection. All of these are from México, three from Veracruz, two from Chiapas, one from San Luis Potosí, and 12 from the Gómez Farías region of southwestern Tamaulipas. The darkest of the series, both above and below, are those from Veracruz (two males and a female from the Río Atoyac, four miles north of Potrero). These we may consider representative of the race *S. g. sylvioides* Lafresnaye, the type locality of that form having been restricted by Bangs and Peters (1928. *Bull. Mus. Comp. Zool.*, 68:392) to the State of Veracruz, México. The female is slightly paler than the males, especially on the under parts.

The two Chiapas specimens, males from the vicinity of Monserrate, are much like the Veracruz specimens just discussed except that they are longer-billed and a trifle paler. Bill-length in the Veracruz males is 13.5, 14.0 mm.; in the Chiapas males, 15.5, 15.5. Wing-length in the Veracruz males is, respectively, 81, 81; in the Chiapas males, 79, 80; tail-length, again respectively, is 76, 76; 78, 81. In the latter Veracruz specimen the tail-spine is obviously worn, so that measurement is of doubtful value.

Tail-length in *Sittasomus griseicapillus* varies a great deal, and I am not sure that averaging and comparing tail measurements serves any useful end. In some specimens before me the terminal tail-spine is wholly absent as a result of wear; in others it is short *or missing altogether* even though the feathers are unworn. A male taken along the Río Sabinas, near Gómez Farías, Tamaulipas, on March 10, 1949, by William B. Heed, is quite fresh-plumaged and unworn, yet the long middle rectrices are virtually without spine at the tip, and the actual tail-tip is not the end of the longest feather's rachis but the most distal part of that feather's inner web. Some southwestern Tamaulipas specimens have extraordinarily long tail-spines. A male taken by J. H. Poppy and E. K. Miller at the Rancho del Cielo, near Gómez Farías, on July 28, 1948, has a tail length of 87 mm., the terminal spine on the left middle rectrix being fully 12 mm. long. Length of the unworn tail-spine, and tail-length itself, may be correlated with age. The longest-spined Mexican birds I have handled are from Tamaulipas. I have not recently examined specimens from south of México.

My Veracruz and Chiapas specimens are dark, as a group, in comparison with the 12 Tamaulipas specimens (11 males, one female) and one San Luis

Potosí specimen (female from Mais) in my series. When I first compared all these birds I noticed that some Tamaulipas males were unusually long-tailed, but I dismissed from my mind the possibility that they might represent the race *S. g. jaliscensis* Nelson, because that race was said to be slightly darker on the under parts than *sylvioides* (see Nelson, 1900. *Auk*, 17:265; and Ridgway, 1911. *Bull. U.S. Nat. Mus.*, 50, pt. 5: 283). Since all of my Tamaulipas and San Luis Potosí specimens were too pale below for *sylvioides*, they would obviously be too pale for *jaliscensis*.

Dr. Herbert Friedmann kindly lent me the type of *jaliscensis* as well as four specimens (one male and three females) of "*sylvioides*" collected by Nelson and Goldman at Metlaltoyuca, Puebla, in February, 1898. With this helpful material at hand, I have gone over my series again. The four Puebla birds are a little paler than my Veracruz and Chiapas specimens. Wetmore used this same Puebla series in identifying as *sylvioides* specimens recently collected by Carriker in Veracruz (Cerro de Tuxtla and Volcán San Martín). He commented (1943. *Proc. U.S. Nat. Mus.*, 93:278) that the Puebla birds were "slightly paler than birds from Veracruz." The Puebla specimens do not appear to have undergone post-mortem fading, though such "foxing" is surely to be borne in mind when we are dealing with dendrocolaptids.

As for the type of *jaliscensis*, a male taken March 17, 1897, at San Sebastian, Jalisco, we must not discount the possibility that, with the passing of the years, the specimen has faded. In any event, its under parts certainly do not impress me as being "darker grayish brown" (Nelson, *loc. cit.*) than those of Veracruz and Chiapas *sylvioides* at hand. It is, however, definitely darker below than all the Tamaulipas and San Luis Potosí specimens before me, and it is also longer-billed and slightly longer-tailed. Confirming Nelson's tail-measurement (89 mm.) of his type of *jaliscensis* is impossible, for part of the tail is now missing. In none of my Tamaulipas males does tail length reach 89 mm., though in two specimens it reaches 87 mm.

Since the Tamaulipas and San Luis Potosí birds are neither *sylvioides* nor *jaliscensis*, and since no name seems to be available for them, I suggest that they be called

Sittasomus griseicapillus harrisoni new subspecies.

Type: From Rancho del Cielo, five miles northwest of Gómez Farías, Tamaulipas, México; 3300 feet. Adult male, no. 12893, Sutton Collection, collected March 30, 1949, by Paul S. Martin (original number 172). Type at the Museum of Zoology, University of Oklahoma, Norman, Oklahoma.

Diagnosis: Similar to *S. g. sylvioides* Lafresnaye as known from Veracruz and Chiapas, but paler, especially on the chin, throat, and chest, where the gray tends to be slightly more ashy and less olivaceous than in *sylvioides*. Similar to *S. g. jaliscensis* Nelson of Jalisco, but paler below. In size, intermediate between these two races, but nearer *jaliscensis*, especially in wing- and tail-length; in color not intermediate, but paler than either.

Range: So far as is known, the foothill country of southwestern Tamaulipas and eastern San Luis Potosí, intergrading with *sylvioides* in Puebla. Areas of intergradation with *jaliscensis* are not known.

Description of Type: Chin, throat, sides of head, sides of neck, and breast Grayish Olive, passing through Citrine Drab on the belly to Tawny on the under tail coverts and to Cinnamon Brown on the under side of the tail. Whole top of head and hind neck Dark Olive Gray, passing through Olive Brown on the upper back, wing coverts, and fore part of the primaries (in the folded wing) to bright Russet on the lower back, rump, tertials, upper tail coverts, and upper side of the tail. Inner webs of primaries dark Mummy Brown at their tips. Capitalized words here used are from Ridgway's "Color Standards and Nomenclature," 1912.

Measurements of Type: wing, 80 mm.; tail, 80; culmen, 13.0; tarsus, 17.0. Unworn spine at tip of middle rectrices, 7 mm.

Remarks: The 11 male Tamaulipas specimens used in this study (including the type of *harrisoni*) range in wing-length from 76 to 83 mm., averaging 79.9 mm. The type of *jaliscensis* has a wing length of 84 mm. Three of my Tamaulipas specimens are so worn that their tail-length is meaningless. The range of tail-length in the eight full-tailed specimens is 77 to 87 mm. (average, 81). Nelson's tail-measurement for the type of *jaliscensis* was 89 mm. In bill-length my 11 male *harrisoni* range from 13.0 to 15.0 mm. (average, 13.8); in *jaliscensis* it is, according to its describer, 16 mm. To obtain this measurement in the type myself I had to part the feathers considerably at the base of the culmen. What one easily sees of the culmen without separating the feathers, measures 15 mm. or a little less. I know of no Jaliscan specimens of *Sittasomus griseicapillus* aside from the type.

I take pleasure in naming this new form in honor of Mr. Frank Harrison, who resides at the type locality, and who has been unfailingly kind to me and to many of my students and friends who have visited him from time to time.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF OKLAHOMA, NORMAN, OKLAHOMA, MAY 14, 1955

GENERAL NOTES

Spring molt of the Harris Sparrow.—Accounts of the prenuptial molt of the Harris Sparrow (*Zonotrichia querula*) by Swenk and Stevens (1929. *Wilson Bull.*, 41:129–177) and Roberts (1932. "The Birds of Minnesota," 2:711) indicate that this molt is limited to the head and neck. My observations, made in Kansas in 1954, show this molt to be more extensive than described.

My problem was two-fold: (1) to ascertain the extent and sequence of the molt and (2) to correlate this molt with changes in weight of body and weight of gonads. Study material consisted of 48 freshly-collected birds and 175 study skins in the University of Kansas Museum of Natural History. The 48 birds that I collected, with assistance from William Thornberry and Norman L. Ford, were prepared as flat skins. Flat skins are especially useful for studies of molt because the papillae of new feathers are evident on the inside of the skin.

In Kansas, the prenuptial molt of the Harris Sparrow begins in the second week in March. Eight specimens taken in January (4), February (1), and early March (3) show no molt. This agrees with the information given by Swenk and Stevens (*op. cit.*: 163). In March, all specimens collected after the 12th were molting. The lateral feathers of the ventral tract, in the region of the lower breast, are the first to be replaced and molt proceeds medially as well as anteriorly and posteriorly. Replacement in the capital tract is complete but only scattered feathers of the rump and belly are molted.

The marginal and lesser coverts ordinarily are molted in spring, but replacement of greater coverts and underwing coverts at this time is incomplete. Other wing feathers appear not to be molted.

In the tail, molt in spring is consistent and is confined to the two central feathers. I found no obvious correlation between the time of molt on the tail and body. Some birds retain worn central feathers in the tail into early April, but other birds lose these feathers early in the molt.

Molt is last evident in the capital tract. The pale-edged black feathers of the crown and the brown feathers of the post-auricular spot are replaced with glossy black feathers. With the completion of the molt in late April or early May, all birds, regardless of sex or age, are in similar breeding plumage.

Total weights, along with estimates of the amount of fat, were taken from the fresh specimens. Of 38 specimens, mostly molting, collected prior to April 28, all were "moderate fat" to "fat" according to the McCabe fat scale (1943. *Auk*, 60:550–558). The weights were as follows: 19 males averaged 38.8 gm. (36.8–41.7 gm.); 19 females averaged 33.7 gm. (31.4–36.3 gm.). A female taken on May 11, in fresh nuptial plumage, was "very fat" and weighed 37.8 gm. These data seem to indicate that the Harris Sparrow does not store large amounts of fat for migratory flights until the prenuptial molt is nearly complete.

The gonads of these birds were weighed to the nearest one-tenth milligram on a torsion balance. As expected, the weight of the gonads increased as the season progressed, but the increase seemed not to be closely correlated with molt in individual birds. The average weight of the largest testis for 11 males collected between March 26 and April 16 was 3.4 mg.; two males taken on April 22 averaged 6.5 mg. Weight of the ovary increased notably in the second week in April. Ovaries of four females taken between March 28 and April 2 weighed from 7.0 to 8.0 mg. Ovaries of ten females taken from April 8 to 23 averaged 15.1 mg. (12.0–19.0 mg.). The ovary of the female taken on May 11 weighed 35.0 mg.

In summary, spring molt of the Harris Sparrow in Kansas begins in the second week in March and is completed by late April or early May. Replacement of feathers on the head and throat is complete. At the level of the shoulders, replacement is heavy but incomplete. At the level of the rump and belly, only scattered feathers are replaced. Some wing coverts seem to be molted regularly while others are molted only sporadically. The two central tail feathers are molted consistently in spring.—Glen E. Woolfenden, *Museum of Natural History, University of Kansas, Lawrence, Kansas, January 30, 1955.*

Notes on behavior of the Wild Turkey.—The note, "Swimming by Wild Turkey poults," by Leo M. Martin and Thomas Z. Atkeson (1954. *Wilson Bull.* 66:271) brings to mind an observation of my own. On June 9, 1951, I encountered a pair of adult Turkeys (*Meleagris gallapavo*) with at least six fledglings perhaps three or four days out of the eggs. The group scattered and one of the young birds walked slowly along a large, flat dead tree extending out into a pond. Upon reaching the small outer end the bird walked off into the water without the slightest hesitation and swam leisurely some 30 yards or more to the far shore. The poult was cold and exhausted when I picked it up without difficulty a few moments later. One parent disappeared. The other remained in plain sight near at hand but showed a minimum amount of agitation. I found one cold, addled egg a few feet distant from the spot where I picked up the fledgling. A. C. Bent (1932. *U.S. Nat. Mus. Bull.* 162:339) quotes Audubon as describing young Wild Turkeys, unable to make the flight across a river, as falling in and swimming to shore. I am informed that a number of different adults, injured, have been seen swimming here.

Not mentioned by Bent is the posture in running, which is somewhat like that of the Ring-necked Pheasant (*Phasianus colchicus*). On June 4, 1949, by pure happenstance I observed an adult running almost noiselessly through the underbrush at a speed faster than that of any human. The bird carried its head and neck outstretched forwards in such a manner as to form a single plane with the back. The region in question, in the eastern United States and further north than the Potomac River, has had rigid control now for going on towards a century. Some interbreeding with domestic turkeys was permitted years ago but I am inclined to believe the dominant strain is that of the Wild Turkey, *M. g. silvestris.*—Wendell Taber, *3 Mercer Circle, Cambridge, Massachusetts, January 27, 1955.*

Cardinal exploits Loggerhead Shrike's artificial food source.—A young Loggerhead Shrike (*Lanius ludovicianus*), barely able to fly, was brought to me on June 24, 1954. I raised this bird and freed it on September 12, 1954, in my yard, which adjoins an orchard on the outskirts of Norman, Oklahoma. With supplementary feeding, the bird established itself and has remained in this vicinity ever since. It comes once or several times a day to the electric wire just outside a kitchen window, squealing and fluttering its wings to be fed. Foodstuff, such as raw meat or cheddar cheese, tossed to the bird, usually is caught in mid-air and carried away to be eaten. The bird hangs part of its food on twigs; and I have seen meat impaled on three or four barbs of the fence.

When the shrike is hungry, a call or a rap on the windowpane will bring it up; at other times its only response may be half-hearted begging from some distant perch. No food trays are maintained and all feedings have come from the hand, except that during six days in December, while we were away from home, the bird fed on cheese and meat placed in a fold of chickenwire fastened to the light wire beside the window.

On November 11, I noted that the shrike's leg had been broken, and for several days thereafter the bird depended largely on our feedings. However, it was not long before it again occasionally showed indifference to being fed. Once since its injury it was seen with a mouse, which it tore and ate on the ground, after futile efforts to manage it in a tree. The shrike continued to be highly intolerant of other birds, fiercely driving away Blue Jays (*Cyanocitta cristata*), Mockingbirds (*Mimus polyglottos*), Starlings (*Sturnus vulgaris*), Meadowlarks (*Sturnella* sp.) and other shrikes.

Presumably, this is a male bird. It first attempted to sing on July 9, and its song (harsh notes mingled with musical phrases of thrasher-like tones) has been noted during each month, except December. Some song periods in October and early November lasted almost 15 minutes.

Late in November a male Cardinal (*Richmondena cardinalis*) began to visit the yard. Soon I noticed that the Cardinal was following the shrike about a good deal of the time, along the back fence, where the shrike "caches" food, and from tree to tree in the orchard.

On November 25, I saw the Cardinal working with something on top of a bird-house in the fence corner, but I did not investigate. The shrike is in the habit of bringing food there to be eaten and sometimes leaving part of it. Later that day, the Cardinal came to a spot on the lawn where the shrike had fed a short time earlier and where food bits remained. I watched the Cardinal nibble at the meat three or four times before it flew.

During the next two days, the Cardinal was observed a number of times, perching along the fence about six feet from the bird-house where the shrike was busily beating meat preparatory to eating. It appeared to be watching the shrike closely. Once I saw it flying away from the nest box with a good-sized piece of cheese showing brightly in its bill, the shrike in hot pursuit. Both birds disappeared on the far side of the orchard.

On November 28, when I called the shrike to the door and fed it, the Cardinal came also. The Cardinal moved about in a nearby tree, while the shrike stood on the lawn eating ground meat. Presently the Cardinal alighted about a yard from the other bird and began to *chip* and hop about alertly, but keeping out of the shrike's reach. When the shrike flew away with part of the meat, the Cardinal at once came and took bite after bite of the remaining portion. In a few moments the shrike returned and flew at the interloper with loud *scree* scolds. The Cardinal fled and the shrike carried away the last of the food. Now the Cardinal came back and began hopping all around the area, looking for food. But when I opened the door to throw it meat, it flew off. This episode took place about 15 feet from the window where I watched.

In several instances, between December 5 and 11, when the shrike came to be fed, it was accompanied by the Cardinal. The latter hunted for and sometimes found bits of food the shrike had dropped; but I did not again see the shrike return to retrieve its food from this apparently protein-hungry fringillid.—Lovie M. Whitaker, *1204 West Brooks Street, Norman, Oklahoma, March 3, 1955.*

White-winged Crossbill eating teasel seeds.—Two White-winged Crossbills (*Loxia leucoptera*) were seen feeding on the seeds of teasel (*Dipsacus sylvestris*) growing among some young Scotch pines at Vineland Station, Ontario, on December 27, 1954. The inflorescence of this plant is an elongate head densely covered with erect, slender-tipped bracts about three-quarters of an inch long, among which the small achenes are set; it bears a rather vague resemblance to a conifer cone. As the birds perching on the heads were watched at the shortest focal limit of 8× binoculars, they quickly removed the achenes with the tips of their bills, split them with rapid movements that could not be followed, and discarded the husks.

The only other bird seen by the writer to remove the seeds from teasel heads is the American Goldfinch (*Spinus tristis*).—Wm. L. Putman, *Vineland Station, Ontario, Canada, March 7, 1955.*

Wasteful feeding by White-winged Crossbills.—On July 8, 1955, Guy Marshall reported that some birds were dropping cones from spruce trees on the campus of the University of Minnesota Forestry and Biological Station. Upon investigation, it was discovered that an adult male and three presumably immature White-winged Crossbills (*Loxia leucoptera*), were feeding on the cones of White Spruce (*Picea glauca*). The method of feeding was peculiarly wasteful in that the cones were clipped off from the cluster, held on a branch by one foot, and then a few scales were torn off and the cone was dropped. Marshall and Robinson timed the procedure for 30 minutes. Fifty-nine cones were clipped off and dropped during the half hour at a rate of 20, 20, and 19 per 10-minute period. After the birds moved on, the cones under the trees where these birds were feeding were collected and given to Hofslund for examination. A total of 619 cones weighing approximately 1230 grams was collected. Few of these had more than four or five scales torn off of them.—P. B. Hofslund, William H. Marshall, and Gerald Robinson, *University of Minnesota Biological Station, Lake Itasca, Minnesota, March 16, 1955.*

PROCEEDINGS OF THE THIRTY-SIXTH ANNUAL MEETING

BY PHILLIPS B. STREET, SECRETARY

The Thirty-sixth Annual Meeting of the Wilson Ornithological Society was held at Stillwater, Oklahoma, from Thursday, April 7, to Sunday, April 10, 1955. It was sponsored by the Oklahoma Agricultural and Mechanical College and the Oklahoma Ornithological Society.

There were four sessions devoted to papers and two business meetings. The motion picture, "Sunrise Serenade," was presented on Thursday evening, and the Executive Council met at the same time. Dr. George M. Sutton presented an illustrated talk on Friday evening, "Comments on the Distribution of Arctic Birds with Special Reference to Baffin Island Observations made during the Summer of 1953," and it was followed by a reception given by the sponsoring groups. The Annual Dinner was held in the Student Union Club on Saturday evening, President Burt L. Monroe delivering the address and the Pawnee Indian Dancers providing entertainment.

Early morning field trips were taken to Lake Carl Blackwell and to the prairie country near Pawhuska, where the Prairie Chickens performed as scheduled. The all-day Sunday field trip to the Salt Plains National Wildlife Refuge featured a buffalo barbecue luncheon.

First Business Session

President Monroe called the meeting to order at 10:00 a.m., Friday, April 8. President Oliver S. Willham, of Oklahoma A. and M. College, welcomed the Society, and President Monroe responded. The minutes of the 35th Annual Meeting were approved as published in *The Wilson Bulletin* for September, 1954.

Secretary's Report

The secretary, Phillips B. Street, summarized the principal actions taken at the previous evening's Executive Council meeting as follows:

1. Council accepted the invitation of the Buffalo Society of Natural Sciences, the Buffalo Audubon Society and the Buffalo Ornithological Society to hold the 37th Annual Meeting at Buffalo, New York, from Thursday, April 26, to Sunday, April 29, 1956.
2. Dr. Keith L. Dixon was elected editor of *The Wilson Bulletin.*

Treasurer's Report

The treasurer, Leonard C. Brecher, submitted the following report on the finances of the Society:

Report of Treasurer for 1954

General Fund

Balance as shown by last report, dated December 31, 1953			$3,120.30

Receipts

Dues:			
Active	$3,794.00		
Sustaining	1,485.00	$5,279.00	
Subscriptions to *The Wilson Bulletin*		506.25	
Sale of back issues & reprints of *Bulletin*		160.55	
Gifts:			
Color Plate Fund	$ 5.00		

Library Book Fund	29.75		
Miscellaneous	61.50	96.25	
Payments for Foreign Postage		6.50	
Refund from Registration Fees, Cape May Meeting		48.62	6,097.17
Total Receipts			$9,217.47

DISBURSEMENTS

The Wilson Bulletin—Printing and engraving	$3,841.96	
The Wilson Bulletin—Mailing and maintenance of mailing list	718.49	
Editor's Expense—Printing, postage, clerical aid, etc.	239.00	
Treasurer's Expense—Printing, postage, clerical aid, etc.	107.37	
Secretary's Expense—Printing, postage for Annual Meeting, etc.	139.18	
Committee and Other Officers' Expense—Printing and postage	54.18	
Purchase of Books from Book Fund for Club Library	48.50	
Purchase of Back Issues of *The Wilson Bulletin* for future sale	5.50	
Miscellaneous: State tax, Corp. Fee, box rental, etc.	10.15	
Louis Agassiz Fuertes Research Grant to William C. Dilger	100.00	
Worthless Checks charged back by bank	8.00	
Transfer of Gift to Endowment Fund	32.00	
Total Disbursements		$5,304.33
Balance on hand in Citizens Fidelity Bank & Trust Company, Louisville, Kentucky, December 31, 1954		$3,913.14

ENDOWMENT FUND

Balance in Savings Account as shown by last report, dated December 31, 1953,		$1,447.71
Receipts:		
Interest on Investments and Dividends	$ 342.95	
Transfer of Gift from General Fund	32.00	
Interest on Savings Account	20.23	
Life Membership payments	850.00	1,245.18
Total Receipts		$2,692.89
Disbursements:		
State Tax on Bank Deposits	$ 2.27	
Purchase 1 share Mass. Invest. Trust Stock	19.28	
Purchase 5 shares Mass. Invest. Trust Stock	132.00	
Purchase 30 shares Firemans Fund Ins. Stock	2,085.00	
Total Disbursements		$2,238.55
Balance in Savings Account, Citizens Fidelity Bank & Trust Company, Louisville, Kentucky, December 31, 1954		$ 454.34
*Securities owned**		
U.S. Postal Savings Coupon Bonds, dated July 1, 1935	$ 780.00	
U.S. Savings Bonds, Series "G," dated September 1, 1943 (maturity value $1,000.00)	986.00	
U.S. Savings Bonds, Series "G," dated December 20, 1944 (maturity value $1,500.00)	1,468.50	
U.S. Savings Bonds, Series "G," dated June 1, 1945 (maturity value $500.00)	488.00	
U.S. Savings Bonds, Series "G," dated July 1, 1945 (maturity value $900.00)	878.40	
U.S. Savings Bonds, Series "G," dated October 1, 1945 (maturity value $1,400.00)	1,362.20	

U.S. Savings Bonds, Series "F," dated February 1, 1947 (maturity value $2,000.00)	1,722.00	
U.S. Savings Bonds, Series "F," dated April 1, 1948 (maturity value $2,000.00)	1,670.00	
U.S. Savings Bonds, Series "F," dated October 1, 1948 (maturity value $1,450.00)	1,191.90	
U.S. Savings Bonds, Series "F," dated April 1, 1950 (maturity value $1,000.00)	786.00	
Total Value of Government Bonds	$11,333.00	
Massachusetts Investors Trust (122 shares at $27.99)	3,414.78	
Firemans Fund Insurance (30 shares at $72.00)	2,160.00	
Total Securities Owned		$16,907.78
Total in Endowment Fund,** December 31, 1954		$17,362.12

*Bonds carried at redeemable value December 31, 1954 (appreciation during the year, $218.06)

Stocks carried at closing prices December 31, 1954 (appreciation during the year, $931.50)

In Reserve:

Louis Agassiz Fuertes Research Fund (special gifts)	$ 425.00
S. Morris Pell Fund (special gift)	75.00

Respectfully submitted,
/s/LEONARD C. BRECHER,
Treasurer.

Membership Committee

Ralph M. Edeburn, chairman, reported that the names of 93 prospective members enrolled since the 1954 meeting were posted for the inspection of members and to be elected by vote at the final business session. On December 31, 1954, the Society had 98 life, 271 sustaining and 1249 active members, a total of 1618. Since January 1, 1955, 61 new members have been added, making a total of 1679 as of April 8, 1955. The addition of 11 new life members since January 1, 1955, is the outstanding membership achievement since the 1954 meeting. There were 154 institutional subscriptions to *The Wilson Bulletin* as of the close of 1954. The membership has been stable during the past several years.

Research Grant Committee

Kenneth C. Parkes, chairman, reported by letter that his committee, consisting of Brina Kessel, John Davis and himself, felt that the early date of the Stillwater meeting would not permit sufficient time for applications to be received and judged in view of the late publication date of the December *Bulletin* with its call for applications. Accordingly, an April 20 deadline was set. Nine applications had been received to date. (The winner subsequently selected was Robert G. Wolk, graduate student at Cornell University, who has been awarded a Louis Agassiz Fuertes Research Grant of $100 as an aid to his study, "Analysis of Reproductive Behavior in the Black Skimmer.")

Library Committee

George J. Wallace, chairman, reported that accessions to the library at Ann Arbor since last year's report totalled 1220 items, comprised of 51 books, 513 reprints, 601 magazines and 55 pamphlets. The excellent showing in reprints and magazines is largely due to an unusually large donation by Fred M. Packard. Donations were made by 63 persons or institutions. Many persons have contributed substantially to this rapidly growing collection of library material, and some appear to have become regular contributors over the years, a habit of which the committee thoroughly approves. The remarkable growth of the library during the past six years can be visualized from the following tabulation of receipts over this period:

	1950	1951	1952	1953	1954	1955	Totals
Books	61	44	44	36	81	51	317
Reprints	1104	278	365	361	465	513	3086
Magazines	78	140	78	273	117	601	1287
Pamphlets	6	27	34	58	82	55	262
Totals	1249	489	521	728	745	1220	4952

The December, 1954, *Wilson Bulletin* carried a second supplementary book list of 49 books received since the previous listing in September, 1953. These two book lists add 92 books to those given in the complete list published in 1952.

Conservation Committee

Robert A. Pierce, chairman, reported by letter. The committee felt it important that the Society should not as an organization be diverted from its primary purpose, namely, the promotion of the study and the advance of the science of ornithology, by becoming too deeply involved in local issues better left to state and federal conservation groups, to which groups many of our members belong. Other members are engaged in professions which enable them to teach conservation or to encourage conservation in their communities. Thus, the Society is in effect a strong force for conservation through the individuals which comprise it. It was suggested that in controversial matters not purely ornithological in nature the Society might well confine itself to commendation of various organizations for conservation activities in which we, as an organization, are especially interested, and, too, that our members might well be encouraged to become active in conservation groups so that by working through these organizations we can guide their programs, as well as influence public thinking, along the lines in which we are interested.

The committee brought two matters to the attention of the Society which they felt merited thought: (1) the present program being carried out, through the Fish and Wildlife Service and various state agencies, regarding the introduction of exotic game birds, and (2) the present status of waterfowl management in the United States. As to the introduction of exotics, it was felt that the program presents certain dangers, especially with respect to the introduction of disease, of hybridization with other species already present, and of ecological maladaptation, including the crowding out of native species. With respect to waterfowl management, several changes have taken place during the last few years about which the membership should be informed, and the increase in hunters together with continued decreases in habitat may necessitate other more basic changes in the future. These are both involved issues which will be solved ultimately by the various conservation organizations concerned. It is felt, however, that the membership should be aware of the problems, the merits of existing policies and future programs, and it is planned to discuss these problems through reports in the *Bulletin.*

At the conclusion of the reading of the report, Margaret M. Nice urged those in attendance to protest the Echo Park Dam in Dinosaur National Monument, and Dr. George M. Sutton expressed similar concern over the threatened encroachment by the U.S. Army in the Wichita Mountains National Wildlife Refuge in Oklahoma.

Temporary Committees

The following temporary committees were appointed:

Auditing Committee

Harvey B. Lovell, Chairman
Mrs. Frederick W. Stamm
S. Charles Thacher

Resolutions Committee

Harvey I. Fisher, Chairman
Albert F. Ganier
Jane S. Mengel

Nominating Committee

Maurice Graham Brooks, Chairman
Aaron M. Bagg
George H. Lowery, Jr.

SECOND BUSINESS SESSION

The final business session was called to order at 10:00 a.m., Saturday, April 9.

The applicants for membership, whose names were posted, were elected to membership.

Report of the Auditing Committee

The committee's report, read by Mrs. Stamm, found the treasurer's books in order. Mr. Brecher, the retiring treasurer, was commended highly for his able and faithful performance of this exacting and time-consuming position.

Report of the Resolutions Committee

BE IT RESOLVED that the Wilson Ornithological Club express its deep appreciation to the Oklahoma Agricultural and Mechanical College and to the Oklahoma Ornithological Society for their warm hospitality and to the Local Committee on Arrangements for its effectiveness in planning this splendid meeting. It is not often that our Club is privileged to meet in such handsome quarters and in such an interesting area.

BE IT FURTHER RESOLVED that the Wilson Ornithological Club extend its sincere thanks and appreciation to our officers for their wholehearted work and enthusiasm in conducting the affairs of the Club during the past year, and especially to our retiring officers—Harrison B. Tordoff, for maintaining the high quality of *The Wilson Bulletin* during his tenure as editor; Leonard C. Brecher, treasurer, for so faithfully and successfully handling the finances of the club during the last four years; and Harold F. Mayfield, first vice-president, who is resigning because of the pressure of other ornithological duties.

BE IT FURTHER RESOLVED that the Wilson Ornithological Club express its thanks to the following retiring committee chairmen for their faithful services in the execution of those committee duties: Ralph M. Edeburn, Membership Committee; George J. Wallace, Library Committee; William H. Marshall, Conservation Committee; and to Joseph C. Howell, the retiring member of the Executive Council.

Amendment to the Constitution

The Amendment to the Constitution revising Article 1, Section 1, to read: "The organization shall be known as the Wilson Ornithological Society" was unanimously passed. The change in name becomes effective upon approval by the State of Illinois, our state of incorporation.

Election of Officers

The Nominating Committee proposed the following officers for the coming year: President, Burt L. Monroe; First Vice-President, John T. Emlen; Second Vice-President, Lawrence H. Walkinshaw; Secretary, Phillips B. Street; Treasurer, Ralph M. Edeburn; Elective members of the Executive Council, A. W. Schorger (term expires 1956), Harvey I. Fisher (term expires 1957), and Leonard C. Brecher (term expires 1958).

The report of the committee being accepted, and there being no nominations from the floor, the secretary was instructed to cast a unanimous ballot for these nominees.

PAPERS SESSIONS

Friday, April 8

H. I. Featherly, Oklahoma A. and M. College, *Natural Scenes in Oklahoma*, slides.

A. Marguerite Baumgartner, Stillwater, Oklahoma, *Nesting Birds of an Army Camp "Gone Native,"* slides.

Frederick M. Baumgartner, Oklahoma A. and M. College, *Bird Life of the Salt Plains National Wildlife Refuge.*

William R. Heard, Oklahoma A. and M. College, *Food Habits of Cave and Cliff Dwelling Owls in Northwestern Oklahoma*, slides.

Arnold J. Petersen. St. Olaf College, *Reproductive Physiology of the Female Bank Swallow*, slides.

Jere Hodshire, Wyandotte High School Science Field Club, *Evening Flights of Wintering Ducks at Wyandotte County Lake, Wyandotte County, Kansas.*

Keith L. Dixon, A. and M. College of Texas, *A Six-year Record of Plain Titmouse Territories*, slides.

Harvey I. Fisher, University of Illinois, *Landing and Take-off Forces in the Pigeon*, slides.

George J. Wallace, Michigan State College, *Problems Involved in Ornithological Textbook Writing.*

Margaret M. Nice, Chicago, Illinois, *Some Comparisons Between Development of Birds and Mammals.*

Lawrence H. Walkinshaw, Battle Creek, Michigan, and Dale A. Zimmerman, University of Michigan, *The Spread of Brewer's Blackbird in Eastern North America*, slides.

Brooke Meanley, U.S. Fish and Wildlife Service, *Blackbirds in the Arkansas Rice Fields.*

Carl D. Riggs, University of Oklahoma, *Water Birds of Lake Texoma, Texas and Oklahoma*, slides.

Saturday, April 9

John C. Johnson, Jr., University of Oklahoma, *Observation on Winter Blackbird Roosts in Central Oklahoma*, slides.

Aretas A. Saunders, Canaan, Connecticut, *A Comparison of the Songs of Three Vireos.*

Donald J. Borror and Carl R. Reese, Ohio State University, *The Accuracy of Mockingbird Imitations* (presented on tape), slides.

Frederick M. Helleiner, Acme, Alberta, *Bird Observations in the Peace River Region of Alberta, 1953-1954.*

Josselyn Van Tyne, University of Michigan, *An Expedition to Northern Baffin*, slides.

Harriet B. Woolfenden, Detroit Audubon Society, *The "How" of the Detroit Audubon's Annual Bird Survey*, slides.

John F. Wanamaker, The Principia College of Liberal Arts, *Unusual Nesting Observations of the Eastern Cardinal*, slides.

Rosalie Edge, Hawk Mountain Sanctuary Association, *Progress of Hawk Protection*, (read by title).

Lovie M. Whitaker, Norman, Oklahoma, *Some Observations on Anting.*

Robert J. Newman, Louisiana State University, *Synthetic Bird Counts—a Means of Studying Observational Variance*, slides.

Johnson A. Neff, U.S. Fish and Wildlife Service, *Albatrosses and Airplanes on Midway*, slides.

John William Hardy, University of Kansas, *Are the Thick-billed Parrot and the Maroon-fronted Parrot Really Separate Species?*

Robert W. Mitchell, Texas Technological College, *The Golden Eagle in West Texas*, motion pictures.

ATTENDANCE

Members and guests in attendance at the meeting included 169 registrants and a total probable attendance approximating 200. Twenty-three states and the Province of Alberta were represented.

From **Arkansas:** 3—*Fort Smith*, Mrs. M. J. Armstrong, Ruth Armstrong; *Stuttgart*, Brooke Meanley.

From **Colorado:** 1—*Denver*, Johnson A. Neff.

From **Connecticut:** 2—*Canaan*, Aretas A. Saunders; *West Hartford*, E. Alexander Bergstrom.

From **Illinois:** 16—*Blue Island*, Karl E. Bartel; *Chicago*, Mrs. Amy G. Baldwin, Mr. and Mrs. L. B. Nice, Millicent Stebbins; *Elsah*, Norwood Hazard, David McBane, Edwin Poole, Mac Stitt, John F. Wanamaker; *Quincy*, Mr. and Mrs. Tom Sorrill, Steven Sorrill; *Urbana*, Harvey I. Fisher, Fred Fisher, William B. Robertson.

From **Indiana:** 7—*Connersville*, Edna Banta; *Hanover*, J. Dan Webster; *Indianapolis*, Mildred F. Campbell, Mrs. S. G. Campbell; *Lafayette*, Mr. and Mrs. Albert G. Guy; *Newcastle*, Mary Rankin.

From **Kansas:** 22—*Baldwin*, Mr. and Mrs. Ivan L. Boyd; *Kansas City*, Wallace Good, Jere Hodshire and 11 members of the Wyandotte High School Science Field Club, Ben King; *Lawrence*, John William Hardy, Mr. and Mrs. Robert Mengel, Harrison B. Tordoff, S. G. Van Hoose; *Manhattan*, Mr. and Mrs. E. K. Beals.

From **Kentucky:** 7—*Anchorage*, Mr. and Mrs. Burt L. Monroe, Burt L. Monroe, Jr.; *Louisville*, Mr. and Mrs. Leonard C. Brecher, Mr. and Mrs. Frederick W. Stamm.

From **Louisiana:** 2—*Baton Rouge*, Robert J. Newman; *Shreveport*, Horace H. Jeter.

From **Maryland:** 2—*Towson*, Mr. and Mrs. Richard D. Cole.

From **Michigan:** 13—*Ann Arbor*, Mrs. R. M. Branch, Mrs. Reuben L. Kahn, Mrs. Bradley M. Patten, Josselyn Van Tyne, Mr. and Mrs. John E. Willoughby, Anne and Alden Willoughby; *Battle Creek*, Mr. and Mrs. Lawrence H. Walkinshaw; *Dearborn*, Mrs. Harriet B. Woolfenden; *East Lansing*, George J. Wallace; *Marquette*, Mrs. Mary Spear Ross.

From **Minnesota:** 4—*Minneapolis*, John G. Erickson, Scott Searles; *Northfield*, Arnold J. Petersen; *Owatonna*, Mrs. Harson A. Northrop.

From **Missouri:** 2—*Webster Groves*, Mr. and Mrs. J. M. Magner.

From **Nebraska:** 4—*North Platte*, Doris Gates, Mrs. Glen Viehmeyer; *Wisner*, Mr. and Mrs. John Lueshen.

From **New Jersey:** 1—*Tenafly*, Mrs. Betty Carnes.

From **New York:** 1—*Buffalo*, Fred T. Hall.

From **Ohio:** 7—*Cleveland*, Vera Carrothers, Adele Gaede, Mildred Stewart, Gene Wachtel, Joel Wachtel; *Utica*, Mr. and Mrs. C. R. Wagner.

From **Oklahoma:** 55—*Arcadia*, Bess Smith; *Locust Grove*, Lea Davis; *Muskogee*, Forrest Bebb, Maurice Bebb, J. L. Norman, Mr. and Mrs. Vaud A. Travis; *Norman*, Charles C. Carpenter, John C. Johnson, Jr., Carl D. Riggs, George M. Sutton, Mrs. Lovie M. Whitaker, Johnny Wiens, Ruth Updegraff; *Oklahoma City*, John Baxter, A. E. Borell, Gladys L. Burnham, Wallace Hughes, Mr. and Mrs. J. E. Martin, Sam Moore, Allan J. Stanley, Eliot J. Stanley; *Ponca City*, Helen Bangs, Mrs. Delia Castor, Mr. and Mrs. Joe C. Creager, C. F. Franklin, William O. Ney, Jr., Mr. and Mrs. J. Frank Pieratt; *Skiatook*, Helen Rogers; *Stillwater*, Mrs. James H. Arrington, Mr. and Mrs. Frederick M. Baumgartner, Milton D. Baumgartner, Mrs. William C. Fawcett, Mr. and Mrs. Colly Hitt, Mr. and Mrs. H. S. Mendenhall, Mr. and Mrs. Ford Mercer, Mr. and Mrs. O. M. Smith, Mrs. Grady Thompson; *Tahlequah*, A. F. Bennett; *Tulsa*, Mrs. Roy L. Ginter, Mable L. Hagan, Mr. and Mrs. Orrin W. Letson, Mr. and Mrs. Bruce Reynolds, John Tomer; *Wakita*, Mrs. Glen Stuart.

From **Pennsylvania:** 2—*Chester Springs*, Phillips B. Street; *Narberth*, Philip A. Livingston.

From **South Dakota:** 5—*Sioux Falls*, Mr. and Mrs. H. F. Chapman; Mr. and Mrs. J. S. Findley, Herbert Krause.

From **Tennessee:** 3—*Nashville*, Albert F. Ganier; *Knoxville*, Mr. and Mrs. Joseph C. Howell.

From **Texas:** 8—*College Station*, Mr. and Mrs. Keith L. Dixon, Terrell Hamilton; *Commerce*, Mrs. Mike O'Neil; *Edinburgh*, Pauline James; *Lubbock*, Mr. and Mrs. Robert W. Mitchell; *Midland*, Nance G. Creager.

From **West Virginia:** 3—*Huntington*, Ralph M. Edeburn; *Morgantown*, George A. Hall, Earl N. McCue.

From **Wisconsin:** 1—*West Bend*, Marvin E. Vore.

From **Alberta, Canada:** 1—*Acme*, Frederick M. Helleiner.

THE WILSON ORNITHOLOGICAL SOCIETY LIBRARY

The following gifts have been recently received. From:

William H. Burt—5 reprints
Donald E. Burton—1 magazine
G. Reeves Butchart—1 book
H. F. Chapman—19 magazines
Sigfrid Durango—1 book
W. W. H. Gunn—1 phonograph record
Karl W. Haller—4 bulletins, 13 books, 2 reprints
F. Haverschmidt—2 reprints
Philip S. Humphrey—1 magazine
Leon Kelso—1 pamphlet
R. Lehrman—9 magazines
Purdue University Forestry Department—1 book, 4 pamphlets
Alexander F. Skutch—1 reprint
Sociedad de Ciencias Naturales La Salle—4 bulletins
Robert W. Storer—10 reprints
Josselyn Van Tyne—10 reprints
Olive P. Wetherbee—2 reprints
Nixon Wilson—2 bulletins
Henry L. Yeagley—2 reprints
Dale A. Zimmerman—1 reprint

CONSTITUTION AND BYLAWS OF THE WILSON ORNITHOLOGICAL SOCIETY*

As adopted December 29, 1930, and amended by the Executive Council on August 11, 1944, and October 13, 1945; the revised Constitution and Bylaws were approved by the membership on November 29, 1946, and amended September, 1951 (mail ballot), and April 9, 1955.

CONSTITUTION

Article I

Name and Object

Section 1. The organization shall be known as the "Wilson Ornithological Society."

Section 2. The object of the Wilson Ornithological Society shall be to advance the science of ornithology, particularly field ornithology as related to the birds of North America, and to secure cooperation in measures tending to this end by uniting in a group such persons as are interested therein, facilitating personal intercourse among them, and providing for the publication of the information that they secure.

Article II

Membership

Section 1. The membership of this society shall consist of five classes: Active Members, Sustaining Members, Life Members, Patrons, and Honorary Members.

Section 2. Any person who is of good moral character and in sympathy with the object of this society may be nominated for membership. Nominations and applications for membership shall be made through the Secretary. Applications for membership shall be endorsed by at least one member. Members shall be elected at the annual meeting by a majority of the members present. Nominations presented in the interim between annual meetings shall be received and confirmed by the Secretary, subject to ratification at the next annual meeting.

Section 3. The annual dues of Active Members shall be three dollars ($3.00); and of Sustaining Members, five dollars ($5.00). Any member may become a Life Member, exempt from further dues, by making a payment into the endowment fund of the Society of one hundred dollars ($100.00). Any member may become a Patron, exempt from further dues, by making a payment into the endowment fund of the Society of five hundred dollars ($500.00) or more. Upon the unanimous recommendation of the Executive Council, honorary membership may be conferred by the Society by a three-fourths vote at any annual meeting.

Section 4. All members shall be entitled to vote and to hold office.

Section 5. All annual dues for the ensuing year shall be due on January 1. Any member in arrears for dues for one year shall be dropped from the roll of members, provided that two notices of delinquency, with an interval of two months between them, shall have been sent to such member.

Article III

Officers

Section 1. The officers of this society shall be a President, two Vice-Presidents, a Secretary, a Treasurer, and an Editor. The duties of these officers shall be those usually pertaining to their respective offices.

Section 2. All officers except the Editor shall be elected at the annual meeting by ballot of the members. The Editor shall be elected annually by the Executive Council.

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* Incorporated under the laws of the State of Illinois on October 16, 1944.

Section 3. Officers shall hold office for one year, or until their successors are elected, and shall be eligible for re-election. Their term of office shall begin at the close of the meeting at which they are elected.

Section 4. The officers of the Society, all past Presidents of the Society, and three additional members who shall be elected by ballot of the Society, shall constitute an Executive Council. The Executive Council shall also constitute the Board of Directors of the Corporation. The business of the Society not otherwise provided for shall be in the hands of the Executive Council, which shall pass upon any urgent matters that cannot be deferred until the next annual meeting. Five members of the Council shall constitute a quorum.

Section 5. Vacancies in the staff of officers, occurring by death, resignation, or otherwise shall be filled by appointment of the Executive Council, but the person so appointed shall hold office only until the close of the next annual meeting of the Society, except in the event of his election to that office by the members of the Society.

Article IV

Meetings

Section 1. The Executive Council shall determine the time and place of meetings of the Society.

Section 2. Twenty-five (25) members shall constitute a quorum for the transaction of business.

Article V

Accounts

Section 1. A committee of two shall be appointed annually by the President to audit the accounts of the Treasurer.

Section 2. The proper care of an Endowment Fund shall be provided for by a Board of Trustees. This Board shall consist of three members appointed by the President, one member for one year, one for two years, and one for three years. At the expiration of each respective term, a member shall be appointed for three years. Any vacancy on the Board, occurring by death, resignation, or otherwise, shall be filled for the unexpired term.

Article VI

Amendments

Section 1. This constitution may be amended at any annual meeting by a two-thirds vote of the members present, provided that the amendment has been proposed at the preceding annual meeting or has been recommended by a two-thirds vote of the Executive Council, and a copy has been sent to every voting member of the Society at least one month prior to the date of action.

Article VII

Bylaws

Section 1. Bylaws may be adopted or repealed at any annual meeting by a majority vote of the members present.

BYLAWS

1. Notice of all meetings of the Society shall be sent to all members at least one month in advance of the date of the meeting.
2. The time and place of the business session shall be published prior to the opening session of the annual meeting.
3. A program committee, of which the Secretary shall be chairman, and a local committee on arrangements for the annual meeting shall be appointed by the President at least ninety days in advance of the meeting.

4. Election of officers, except the Editor, shall be by ballot, but by the unanimous consent of the members, the Secretary may cast one ballot, representing the unanimous vote of the members present. A nominating committee shall be appointed by the President at the beginning or in advance of the annual meeting, which shall offer nominations of officers to serve the Society during the ensuing year. Nominations may also be made by any member in good standing from the floor.
5. A committee on resolutions, consisting of three members, shall be appointed by the President at the beginning or in advance of the annual meeting.
6. The accumulation and care of one or more Wilson Ornithological Society Libraries shall be provided for. A library committee of three or more members shall be appointed annually by the President.
7. The Executive Council shall have power to expel any person found unworthy of membership in the Society.
8. The official organ of the Society shall be *The Wilson Bulletin.* It shall be sent to all members not in arrears for dues.
9. Any member three months in arrears for dues shall be ineligible to vote or to hold elective office in the Society.
10. The fiscal year of this Society shall be the calendar year.
11. The order of business at regular annual meetings shall be as follows:
    1. Calling of meeting to order by the President.
    2. Reading and approval of minutes of the previous meeting.
    3. Reports of officers.
    4. Appointment of temporary committees.
    5. Election of members.
    6. Business.
    7. Reports of committees.
    8. Election of officers.
    9. Adjournment.

    The program may be interpolated in the order of business according to convenience.
12. The rules contained in Roberts' Rules of Order shall govern the Society in all cases to which they are applicable and in which they are consistent with Constitution and Bylaws of the Society.
13. If no annual meeting can be held, election of officers may be conducted by a mail ballot.
14. This constitution may be amended by mail ballot provided that the amendment has been recommended by a two-thirds vote of the Executive Council, and a copy has been sent to every voting member of the Society at least two months prior to the date of action.

ORNITHOLOGICAL LITERATURE

BIRDS OF THE WORLD: THEIR LIFE AND HABITS. By Paul Barruel. Oxford University Press, 1955: 8¾ × 11 in., 204 pp., 16 col. pls. [included in pagination], and many photographs and drawings. $12.50.

This splendidly illustrated volume has been translated from the French edition by the well-known English ornithologist, Phyllis Barclay-Smith. In spite of its title, the book is by no means a "Birds of the World" in the sense of Knowlton or Makatsch, for example. Indeed the prospective reader would have been more correctly informed if the publishers had retained the title of the French edition, "The Life and Habits of Birds."

The text is interestingly written and amazingly accurate, considering its world-wide scope; one regrets that there are only about 75 pages of it. Doubtless the several small misprints will be eliminated from the next edition.

Four of the sixteen color plates are from photographs; the rest are from paintings by the talented author of the book. While bold and almost diagrammatic in treatment, the paintings are very effective and add much to the book's attractiveness; three that appeared in the French edition have been replaced by others which, if rather less artistic, do certainly convey much more ornithological information. Unfortunately the publishers have grouped all of the legends for the color plates in the back of the book, where only the more persistent and industrious reader will find them.

The photographic illustrations, contributed by some of the most distinguished photographers of England, the Continent, and America, are not only superb photographs and well reproduced but each illustrates a point the author has made in his account of the biology of birds. The value of the photographs would be increased if they were accompanied by data and if they were listed for easier reference.

Only about half of the species mentioned in the color-plate legends are identified by scientific name. Even the index contains no scientific equivalents, though such vernacular names as "Gray Jumper" and "Desert Trumpeter Bullfinch" will overtax the resources of most readers.

This very interesting and attractive volume can be recommended wholeheartedly to layman and ornithologist alike.—JOSSELYN VAN TYNE.

FINDING BIRDS IN MEXICO. By Ernest Preston Edwards. Amherst Publishing Co., Amherst, Va., 1955: 6 × 8¾ in., xix + 101 pp., 7 sketch-maps and 7 black-and-white plates (2 by Frederick K. Hilton, 5 by the author). Obtainable from E. P. Edwards and Co., Box 611, Amherst, Va. $1.90.

No bird student contemplating a trip to México should be without this practical, paper-bound guide, which affords both the novice and the initiated a goodly amount of useful information.

The introduction contains numerous suggestions of a general character, notes on climate, vegetation and topography, and a sketch-map showing México divided into six rather distinct regions: highlands, Atlantic lowlands, Pacific lowlands, Chiapas, Yucatán peninsula, and Baja California.

Each region has been given its own chapter which uniformly includes the following: 1.) a map showing the extent of paved highways and the location of selected bird-finding localities along them; 2.) a general definition of the region with a brief indication of its vegetational and topographical characteristics; 3.) the names of from 30 to 72 of the region's most common birds, arranged according to their preferred habitats; 4.) a list of bird-finding localities.

There are 56 of the last-named, and, though well distributed throughout the Republic, they have evidently been chosen primarily for accessibility and for having satisfactory accommodations, many of which are specified. Dr. Edwards has visited all but one of the 56 localities he discusses, and for most of them he lists at least a few species actually encountered. In many cases he provides adequate directions for finding these birds. It may be disappointing to the reader, however, that certain common North American birds are mentioned so frequently, while some of the more sought-after exotic specialties are not included. For example, a somewhat hasty count shows the widespread Boat-tailed Grackle and Black Vulture cited 26 and 19 times, respectively. By contrast, not a single locality is given for any member of the following notable families: Boat-billed Herons (Cochlearidae), Sun-grebes (Heliornithidae), Thick-knees (Burhinidae), Potoos (Nyctibiidae), Jacamars (Galbulidae), Puffbirds (Bucconidae), Antbirds (Formicariidae), and Manakins (Pipridae). Obviously, when dealing with an avifauna as large and imperfectly known as México's, a book of this type cannot be expected to be complete. It is to be hoped, however, that a later edition will fill in some of the more important omissions.

Following the six regional chapters the author presents outlines of eight "sample bird-finding tours" set up for from two to 25 days, next a list of about 20 possible camp sites, and then a brief habitat directory.

Of considerable value is an apparently complete list of up-to-date scientific and common names of all bird species known from México (except extinct species and accidentals not recorded from that country during the last 30 years). Here, as elsewhere throughout the book, common names are printed in lower case letters for birds shared by México and the United States, while capital letters set off species not found north of México. In addition, symbols have been employed roughly indicating in what part(s) of México each species breeds; the absence of symbols indicates transient status. Naturally in a compilation of this kind there are a number of minor inaccuracies. For example, since the hummingbirds *Campylopterus hemileucurus* and *Amazilia beryllina* both breed regularly in the Atlantic lowlands, as defined by Edwards, they should be accorded symbol A (page 79). Many of the letters in the scientific names in this chapter are slightly out of line, but otherwise the printing is satisfactory.

Seven adequate plates depicting about 80 species should prove of real help in the field identification of such difficult groups as the Mexican trogons, swifts, motmots, woodpeckers, woodcreepers (Dendrocolaptidae), and certain hawks.

A directory of paved portions of national highways, a glossary of the native names of about 50 Mexican birds, and an index to localities (unfortunately not to birds also) complete this commendable little book.—FREDERICK W. LOETSCHER, JR.

THE PASSENGER PIGEON: ITS NATURAL HISTORY AND EXTINCTION. By A. W. Schorger. University of Wisconsin Press, Madison. 6 × 9¼ in., xiii+424 pages; 5 tables; 22 figures. 1955. $7.50.

Every worthy subject eventually find biographers. In the fullness of time someone, with wider perspective and more exacting scholarship, writes the "Definitive" history, so recognized by contemporaries and later generations. It seems safe to predict that Dr. Schorger has performed this service for the Passenger Pigeon (*Ectopistes migratorius*).

Because forty years have passed since the last known Passenger Pigeon died, the raw data on which the historian must depend are at hand. Unless isotope chemistry or some other scientific magic unlocks wholly unsuspected doors, the lines of inquiry have been explored, and the returns are in. Those who have even seen a live wild pigeon must call on sixty-year memories. The Passenger Pigeon was, and was not, for God, with a mighty assist from humankind, took it.

No one who reads Dr. Schorger's book will long fail to realize that he is entering an ornithological world which, by any of this generation's standards, is fantastic. In numbers, in food consumed, in power of flight, in habits and extent of nesting, even in the species' biological wastefulness, here is a unique creature with which we can find nothing to compare. In most past human experiences we can trace at least a thread into the present; with the death of the wild pigeon the thread was broken.

Take, for example, the matter of numbers. Alexander Wilson estimated a flock that he saw at 2,230,272,000 pigeons. Audubon cut this number in half as his estimate of a flock which he experienced. Presumably, these were as well-trained observers as we had early in the Nineteenth Century. Discount the figures by any percentage you please, it's still a lot of birds. Or put it another way. Roger Tory Peterson, in one of his books, estimates the breeding bird population of the United States at around six billion individuals. Schorger offers the guess that Passenger Pigeons numbered three billion, and may have reached five billion. He concludes, "It is possible that at one time this pigeon formed 25 to 40 per cent of the total bird population of the United States."

Consider the amounts of food consumed. Audubon's 50 per cent reduction of Wilson's figures still allowed him to conclude that his flock would require 8,712,000 bushels of mast, mostly acorns and beechnuts, per day. Since wild pigeons ate a wide variety of foods, and since domestic grain and garden crops were favorite items, it is no wonder that on more than one occasion the Jesuit fathers in Canada pronounced solemn excommunication upon pigeon-kind.

A business grew up in the extraction of fat from squabs. Barrels of this oil were shipped down the Susquehanna River, to be used for cooking or soap-stock. So cheap and abundant were carcasses of squabs and adult pigeons around the nesting grounds that shippers could take 60 per cent losses and still have a profitable business. Thousands of live pigeons were used as targets in the rapidly-developing pastime of trap-shooting. Ornithologists today will smile wryly when they read that in 1872 Ruthven Deane was one of two persons who purchased 200 birds for a shoot, and that one of the contestants was William Brewster.

This volume contains much information which is not, I believe, known to most bird students. Let me cite an example. When I was a small boy I remember my father's receiving a letter from a mountain hunter in which the writer was positive that he had seen a flock of about twenty "wild pigeons" (this would have been around 1909). The "cracker" or punch-line was properly reserved for the last: he concluded that one reason he thought they might not be wild pigeons was that they all flew down and alighted on Elk River. I have told this story many times, and no hearer has told me that the writer was within the bounds of possibility. On page 24 of Dr. Schorger's book I learn that Passenger Pigeons regularly alighted on bodies of water.

For the data which he presents, Schorger consulted something like 10,000 published titles. This sort of bibliography must place the Passenger Pigeon on a numerical footing with George Washington, Benjamin Franklin, or Theodore Roosevelt — almost in the class of Lincoln, Napoleon Bonaparte, and Hamlet.

After a consideration of all the fanciful explanations advanced to account for the disappearance of the Passenger Pigeon, Dr. Schorger dismisses each one until there remains this simple, stark conclusion. Sometime during the late years of the past century, human beings began killing the birds at such a rate as to make annual losses exceed annual replacements. From that moment the species was doomed. There were, of course, losses from other causes. The biologic "rigidity" of the species, its inability to adapt itself to new situations and surroundings, contributed to the final disaster. But the first cause of this loss was human greed.

Perhaps the long view of history will one day see the death of the Passenger Pigeon as a turning point — a hinge on which swung the conservation of our renewable resources. The disappearance of wild pigeon flocks and buffalo herds in one generation proved that no such things as "inexhaustible" resources exist. There can be little doubt that some species are living today because the pigeons died.

This tale of the wild pigeons is a part of the American epic. Dr. Schorger has gathered and preserved for us a portion of our heritage. As we, in wonder, read his pages, we may perhaps hear again "the rustle of their wings."—MAURICE BROOKS.

BIRDS OF WASHINGTON STATE. By Stanley G. Jewett, Walter P. Taylor, William T. Shaw, and John W. Aldrich. University of Washington Press, published in cooperation with the U.S. Department of the Interior, Fish and Wildlife Service, 1953: 9½ × 7 in., i-xxxii+1–767 pp., 12 color plates, 99 photographs, 51 maps in text, 1 pocket map, cloth cover. $8.00.

Ornithologists of all levels of attainment will welcome the appearance of this treatise on the birds of one of the more fascinating and varied parts of the west. Forty-four years have elapsed since the publication of "Birds of Washington" by Dawson and Bowles. In this interval far-reaching changes have taken place in the state of Washington and in our knowledge of the birds of the Pacific northwest.

It would be difficult to find men better acquainted with the fauna of the northwest than Stanley Jewett, Walter Taylor, and William Shaw. The manuscript in its original form was written by Taylor; much was contributed to this version by William Shaw. Jewett has revised the text and added recent records, while Aldrich is responsible for the nomenclature, the checking of distributional records, and bibliography.

The first section of the book is a systematic classification of the birds of Washington, a listing of the species and subspecies under orders and families. The introduction includes well-illustrated sections on topography of the state and life-zones. The discussions of life-zones include lists of characteristic plants, birds and mammals. A history of ornithology in the state begins with Lewis and Clark and mentions many contemporary workers. Shorter sections deal with birds and reclamation, conservation of birds, national wildlife refuges in Washington, and introduced exotic birds. The species accounts take up the greater part of the book, and are followed by a hypothetical list, a gazetteer, and a bibliography.

The accounts of species are headed by common and scientific names together with a list of "other names" which mentions common names in local use. In small type are sections on status in Washington, description of male, female, young, and downy young (where applicable), nest and eggs, and a summary of the distribution of the species in the state. Following this is an extensive section on natural history. These are on the whole informative and well written and contain comments on nesting, migration, feeding, abundance, and range changes. Much of this material is seemingly based upon the observations of Taylor and Shaw made in the first quarter of the present century. References to observations made by "our party" and "we" presumably are to be attributed to these workers. In other cases statements are backed by literature citations, by reference to individuals who have contributed to the work, or are undocumented.

The reviewer objects to the use of subspecific common names. This practice has been followed throughout the book. The bibliography contains one entry as late as 1952; the great majority are from the 1920's or earlier. The fact that few of the non-taxonomic citations in the text date from later than the 1920's leads one to wonder if the more recent literature were examined as closely as it might have been. The illustrative material is, on the whole, excellent, but the cover jacket drawings are poor and add little to the attractiveness of the book.

Washington is a critical area for the study of the relationships of closely-related Rocky Mountain and coastal species. Knowledge of these relationships is essential to the solution of many problems of Pleistocene range changes and speciation. It is therefore somewhat disappointing to find that more detailed systematic comments on such species as the Blue Grouse (*Dendragapus obscurus*) and the Canada Jay (*Perisoreus canadensis*) were not included.

The above criticisms are of a minor nature. "Birds of Washington State" contains a vast amount of information well organized and presented. It represents a firm groundwork upon which northwestern naturalists may build. The authors are to be commended for producing this major contribution to western ornithological literature.—JAMES S. FINDLEY.

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Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the color-plate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

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THE WILSON BULLETIN

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CONTENTS

General Notes

THE BREEDING CYCLE IN THE BANK SWALLOW

BY ARNOLD J. PETERSEN

THE BEHAVIOR of birds during a considerable part of the year is dominated by activities directly related to reproduction. It is not strange that such striking sequences of behavior recurring annually in the lives of birds have long held the interest of man. Only recently, however, have refined techniques of observation been developed which can be applied to field studies of natural behavior.

A general relationship has long been recognized between morphological changes in the reproductive organs and the orderly progress of the breeding cycle in birds. General summaries of these relationships together with interpretations of their endocrinological mechanisms have been provided by Marshall (1929), Huxley (1932), and Groebbels (1937). More detailed work on gonadal recrudescence in relation to breeding activity has been reported for various species by Blanchard (1941), Höhn (1947), Marshall (1951, 1952*a,b,c*) and others, and many workers have investigated the development of the reproductive structures in relation to environmental factors (Burger, 1949; Farner, 1950). Extensions of these descriptive studies to include various aspects of blood chemistry have been made for domestic pigeons and doves by Riddle and his associates (Riddle, 1937*a*; Schooley, 1937; and Riddle, 1942). Experimental investigations of the relationships between breeding behavior and physiology have been reviewed by Bullough (1945), Beach (1948), and Collias (1950).

The purpose of this study is to examine certain aspects of the behavioral and physiological cycles of a wild species for correlations that might shed light on the physiological regulation of natural breeding behavior. This study was carried out in the vicinity of Madison, Wisconsin, during the years 1950 through 1953 and was submitted as a thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the University of Wisconsin.

ACKNOWLEDGMENTS

This work was carried on under the guidance of Dr. John T. Emlen to whom I am indebted for assistance in planning and practical help and encouragement throughout the study. A research assistantship from the Wisconsin Alumni Research Foundation and a grant from the Louis Agassiz Fuertes Research Fund of the Wilson Ornithological Club are gratefully acknowledged.

I wish to thank the following individuals for many kinds of help: Dr. R. K. Meyer for suggestions regarding the laboratory work, Dr. Nellie M. Bilstad for advice in the histological study, Charles M. Kagawa and Dr. W. H.

McShan for assistance in chemical techniques, Prof. H. H. Hull of Wisconsin Soils Testing Laboratory for assistance with soil analyses, L. A. Joos of the U.S. Weather Bureau for climatological data, and many of my colleagues at the University of Wisconsin who assisted on collecting trips.

The Bank Swallow as a Subject for Study

The Bank Swallow (*Riparia riparia*) was selected as the subject for this study of breeding cycles for several reasons. The species breeds in easily located colonies of up to several hundred pairs and is common in the vicinity of Madison. The nests are built in burrows which are usually readily accessible and from which the birds can easily be collected. Behavioral characteristics of special interest include a sharing of many of the breeding activities of the two sexes, a long period of nestling development, and a fairly close synchrony of activities within a colony.

Difficulties were presented by the closed nature of the nests, screening many of the breeding activities from view. The similarity of the sexes in appearance and behavior and the concentrations of many pairs in a closely-nesting colony made individual recognition difficult. Finally, the small size of the species placed severe restrictions on the chemical studies and necessitated special techniques.

Previous studies of Bank Swallow behavior provided a background of information helpful in the planning and interpretation of my work. The most extensive of these are Stoner's observations of colony composition and Beyer's (1938) observations of activity within the nest chamber from a darkened pit dug behind the burrow. A number of observations reported for the species in England, where it is called the Sand Martin, are noted below. In none of these were techniques for recognition of individual birds used and sex was known only by dissection.

I. Behavior Cycle of the Bank Swallow

Procedures in Behavior Observations

As many colonies of Bank Swallows as possible were located in Dane County, Wisconsin. Specimens for morphological and physiological studies were collected at certain of the colonies; other colonies were left undisturbed for behavior studies. Collection and autopsy procedures will be described beyond.

Observations of the behavior cycle were made principally at a colony on Nine Springs Creek, two miles south of Madison. The creek is a temporary stream which has eroded a bank in a pastured meadow on the Alfred Keller farm. An observation blind protected by an electric fence from trampling by cows was placed 15 feet from the bank, affording a clear view of nearly

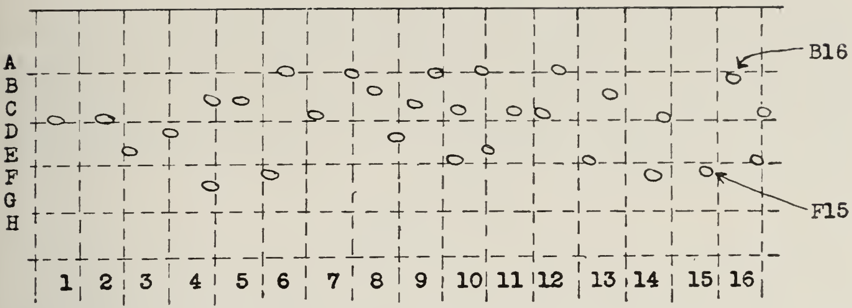

FIG. 1. Map of Bank Swallow burrow entrances illustrating the method of identifying burrows.

all of the burrow entrances. The bank was only six feet high, so the burrows were easily accessible for observation of their interiors and for trapping of the occupants. I attempted to keep the disturbance of my activities at the necessary minimum, and there was no other human interference at this colony.

Individual burrows were identified and designated on a scale map of the burrow entrances with the help of a grid overlay, giving each burrow a letter and a number identification (Fig. 1). Mimeographed copies of this colony map were used for recording observations.

Birds were captured for marking by a method described by Morris (1942). Transparent plastic bags (quart-size frozen food bags) were held by a rubber band over one end of a roll of cardboard and the other end of the cardboard fitted into the burrow entrance. These traps were usually placed just before dawn but were also used with success at various times of day.

The captured birds were individually marked by painting the outer one-inch of the outer or ninth primary feather with airplane dope. The tips of the seventh and eighth primaries were clipped off to completely expose the color marks. Thus, each bird was given a combination of two colors which became its name (for example: left wing-tip orange, right wing-tip red, was abbreviated *OR*).

Sex was determined by presence of a brood patch in females and absence of a brood patch in males.

Eleven broods of nestlings were given colored leg bands (numbered Fish and Wildlife Service bands dipped in airplane dope) designating their brood. This marking proved useful for observations of these birds in the late nesting and early post-nesting stages.

On-the-spot notes were made of activity observed at the colony with the time, and whenever possible specific birds and locations of each action recorded. At times it was found useful to prepare simple tables in which to record activity more quickly. In order to obtain accurate information on nest contents with a minimum of disturbance to the colony a specially designed periscope, dubbed a "Ripariascope," was made. This instrument lighted the nest chamber enabling one to view a nest and it contents quickly and without alteration of the burrow.

Spring Arrival

Bank Swallows usually arrive in the Madison area in the latter part of April. The arrival dates in the years 1947 through 1952 (according to the observations in the University of Wisconsin Zoology Department and Kumlien Club files) range from April 19th to 26th, the average date for the six years being April 22. Each of these observations was made by an experienced ornithologist, so it may be considered a positive record of presence of the species on that date. However, it is entirely possible that in some years the species may have been present for one or several days before the first observations recorded in this file. On the other hand such an observation may indicate the arrival of only a very few erratic individuals. Nevertheless, since these are the best available records of Bank Swallow arrival, it would seem worthwhile to consider their relation to climatological factors.

The April daily mean temperatures and dates of arrival for these years are shown in Figure 2 and summarized in Table 1. These data indicate that Bank Swallows will arrive in Madison earlier than the average date of April 22 when the mean temperatures of the preceding 15 days have averaged above normal. Arrival will be delayed beyond April 22 if the 15

Table 1

Arrival of Bank Swallows at Madison, Wisconsin

Year (In order of arrival dates)	Date of arrival	Mean Temperatures, °F			
		On date of arrival		Preceding 15 days	
		Temp.	Departure from normal	Temp.	Departure from normal
*1949	April 13	50	+ 6	44.1	+3.3
1948	April 19	69	+21	48.0	+4.5
1952	" 20	63	+15	44.1	+0.1
1949	" 22	58	+10	44.3	−0.7
1947	" 22	46	− 2	41.1	−3.8
1950	" 23	49	0	40.4	−4.8
1951	" 26	46	− 4	40.7	−6.0
Averages.....	April 22	55	+ 6.6	43.1	−1.8

*Not included in average.

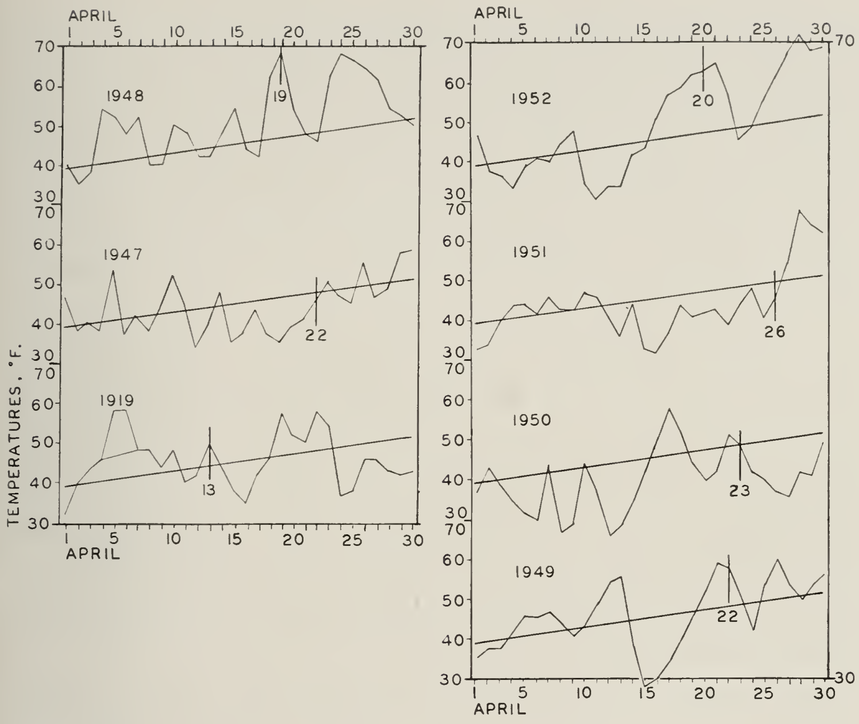

FIG. 2. Spring migration and temperature. Smooth diagonal line represents normal temperature; jagged line connects mean daily temperatures. Vertical bar indicates date of arrival of Bank Swallows at Madison.

days preceding arrival are considerably below normal for the period.

Taylor's observation (Schorger, 1931) of Bank Swallows on April 13, 1919, is the earliest known arrival date for Dane County. Since the temperature on that date was only six degrees above normal and the preceding 15 days averaged only 3.3 degrees above normal, it would seem that this was probably a record of a few birds advancing beyond the usual conditions for migration of the species, about a week ahead of the true migration front. Further evidence to this supposition is the fact that Taylor (unpublished field notes) did not find other late-arriving species of Hirundinidae unusually early in 1919.

Arrival of Bank Swallows at the breeding site may not be coincident with arrival in the area, particularly if the weather is cloudy and cold. In 1950 the species was observed at Madison on April 23. The next nine days were cloudy with mean temperatures below normal and, although there were additional reports of Bank Swallows in the area during this time, the birds were not seen in daily visits to the Nine Springs Creek site until May 3, when warm temperatures and clear skies again prevailed.

In 1951, on the other hand, the earliest arrivals were six birds seen at the Nine Springs Creek bank on the morning of April 26, a day of full sunlight. The following week was a succession of warm bright days, and an increasing number of birds was seen at the colony each day.

Nice (1937) found in her Song Sparrows that the timing of each of several activities, the taking up of territories by resident males, the spring arrival of migrants, and the start of egg-laying, was dependent on its own temperature threshold.

In unfavorable weather the early visits to the sand banks were brief and sporadic. Early arrivals were more likely to be seen foraging over bodies of water, which seem to be the best feeding grounds in April. On the first bright warm day the birds congregated at traditional breeding sites, entering old holes and clinging to any ledges or irregularities that lent support. Flights in large circles within 100 yards of the bank by individuals or small loose groups were frequent, but such flights lacked the close intense pursuit seen later in sexual chases. That interest in holes and ledges on the bank seemed to be by single individuals and that sexual chases were not observed suggest that few if any of these early visitors at the bank were paired.

Positive social forces are strong during these first appearances at the colony site. Usually all of the birds are engaged in the same activity. That is, all are circling overhead, or all are occupied on the bank. Alarm calls frequently put the entire group to flight.

PAIR FORMATION

On successive favorable days the numbers of birds visiting the breeding site and the time they spend there increase. Gradually the increasing number of sexual flights and association of certain *pairs* of birds with particular burrows or areas of the bank suggest that more and more of these birds are paired.

Most Bank Swallows secure mates very quickly during early visits to the colony site. In other instances a week or more may elapse before a pair is formed. Observations of such cases reveal the following sequence of events in pair formation: An unpaired bird (a male in one instance where sex was subsequently determined) selects a burrow site. In the case of some early arrivals this may be a burrow of the previous year. Later the site is more commonly any suitable part of the bank on which the bird can maintain a foothold.

Having selected a site, or territory, a bird defends it against intrusion by use of vocal threats and physical force. Such vocal threat or "territorial song" is a loud coarse twittering, broken into long irregular phrases and directed with apparent vehemence with outstretched neck and bill pointed toward the intruder. These sputterings may be continued for a minute or more, and usually have the result of driving the intruder away. While territorial song seems to me to be aggressive in nature, certain observations suggest that it may serve to attract unmated birds. During this period when territories are being established, it is common to see groups of several or a dozen or more birds move along the bank in hovering flight, and again such birds will hover at a defended niche or even alight and cling to the bank. They are usually quickly driven off by the resident defenders, only to circle and return to the same or another defended ledge.

Against persistent intruders who perch very close, the defending bird intersperses his sputterings with forceful pushes with the bill. Still more forcibly a bird may fly from his ledge or burrow, turn, and, hovering over the intruder, grasp his neck feathers in his bill and thus pull him from the bank. Frequently two such birds become locked in combat and fall together from the bank, sometimes continuing their struggles for many seconds on the ground below.

One among those which continue to return to a defended spot is eventually tolerated and becomes recognized by the bird holding the territory as his mate. Sexual recognition probably depends on a female sexual characteristic of greater persistence in returning to a site in the face of apparent aggressive threat and attack.

One marked male defended his partially-completed burrow with great vigor following disappearance of his first mate. Later, having accepted a new mate, he was noticeably more tolerant of nearby birds whenever the mate was present in the burrow, than when she was away.

Birds entering burrows other than their own usually showed a certain hesitancy of manner contrasting with the deliberate actions of a bird entering its own burrow. Once a pair is formed both members of the pair share in territorial defense, both vocally and physically.

Maintenance of the Pairing Bond

Joint participation of paired birds in breeding activities, such as territorial defense and, as will be described later, burrow digging, nest building, incubation, and care of young, probably contributes to the strength of the attachment. Other activities which appear to serve more specifically toward maintenance of the pairing bond are sexual chase, mating song, and copulation.

Sexual chase is a prominent feature of the behavior of mated birds from the time of pair formation until incubation begins and it is continued (but much less frequently) into the incubation period. In sexual chase the female followed closely by her mate flies from the burrow and after either brief or extensive circling flight usually returns to the burrow. The male maintains close pursuit throughout whatever intricate maneuvers the female makes, and he sings continuously. I have observed sexual chase 10 or 15 times in marked pairs in which the sexes were known and found that in every case the female flew ahead of the male. In a few chases where the birds flew close enough, I noted, as Tooby (1947) frequently observed in the Sand Martin, that it is only the pursuer, that is, the male, that sings.

This song differs from territorial song and from mating song in its being given exclusively by the male. Further, it is neither as loud and harsh as territorial song nor as soft and murmuring as the mating song. During the burrow digging stage it was often noted that sexual chase occurred immediately upon the return of one member of the pair after a brief absence from the burrow. On two occasions a male sitting beside his mate near the burrow entrance was seen to nudge her gently in the side with his bill until she flew, seemingly upon his invitation. In each instance the male followed her in sexual chase.

While sexual chase is clearly an activity of mated birds, a pair will very commonly be joined by one or more additional birds. Unmated birds have been observed to leave their defended niches and join in the sexual chase of pairs from nearby burrows.

The *mating song* is such an inconspicuous form of courtship behavior that it is likely to pass unnoticed amid the more striking hubbub of territorial disputes and sexual chase. Its occurrence is probably more general than my two recorded observations would suggest, although it is mentioned in no previous studies of Bank Swallows.

The mating song is a very soft, pleasing twittering by both members of a pair simultaneously while sitting quietly side by side or facing each other in the burrow opening. It is much more subdued than territorial song or even that of the male in sexual chase, so that it can be heard for only a short distance. (My observations were from a blind 20 feet from the burrows.) It can not be heard at all if nearby birds are engaged in territorial song. Mating song is a continuous succession of notes, not broken into phrases like territorial song. In both cases observed the pairs were in the egg-laying phase and it may be an adjunct of copulatory behavior, commonly occurring as I believe copulation does, within the nest chamber.

COPULATION

I have observed a number of apparently promiscuous copulations. At two different times dead Bank Swallows lying at the foot of the bank have been mounted repeatedly by several birds in quick succession in apparent attempted copulation, in one instance giving rise to an orgy of mountings both of the dead bird and of other copulating birds. A stuffed and mounted Bank Swallow skin placed on the ground likewise elicited many copulatory attempts, but no evidence of semen emission was found on the dummy.

On May 22, 1950, similar quick mountings were observed among a group of birds dusting on a dirt road 50 yards from the colony site at Nine Springs Creek. However, I have never observed copulation in a known or apparently mated pair of Bank Swallows and because of the absence of observations it seems likely that it takes place in the nesting chamber as Emlen (1954) described in the Cliff Swallow (*Petrochelidon pyrrhonota*).

Watson (1946) describes copulation of Sand Martins observed along a road in mid-June. Both the paired birds were crouched low and motionless with bills and heads touching the ground until the male, with his wings waving wildly and his body swaying from side to side, walked toward the female. He mounted her back and the female's wings were raised in a taut curve while coition took place. Then the female shook herself vigorously and both birds flew away. Watson's detailed description of this act implies a deliberateness not apparent in the copulations I have observed.

Burrow Excavation

Once pairing is accomplished the digging of the burrow or rehabilitation of an old burrow usually proceeds rapidly during favorable weather. The work is shared about equally by male and female. Unpaired birds may scratch briefly and intermittently in their defended niches, enlarging their footholds, but no bird without a mate was seen to dig more than a shallow hollow.

Rehabilitation of an old burrow sometimes consists of cleaning the burrow and removing old nesting materials from the nest chamber. In one case eggs left from the previous year were pushed out of the burrow along with newly-loosened dirt before the burrow was re-used. More frequently the burrow is dug deeper and a new chamber excavated. As the freshly-loosened sand is pushed out, the old nest and cavity become covered and partially filled.

Fig. 3. Diagram of a portion of a Bank Swallow colony indicating by solid symbols burrows of which the rate of excavation is known. Burrows 1–6 are in locations above, and burrows 7–12 are in locations below others excavated at about the same time. Refer to Table 2 and Fig. 4.

TABLE 2

PROGRESS OF BURROW EXCAVATION

In burrows located in positions above others at same stage:

Date	Burrow Depth†					
	Nest 1	Nest 2	Nest 3	Nest 4	Nest 5	Nest 6
May 9		* 1				
10	5	8	8		* 1	
11	10	14	13		7½	
12	14	16	17		13	
13	18	17	20	* 3	18	* 3
14						
15	19	19 (7)	20	20	21 (6)	13
16						
17						
18	19	19	20	21 (6)	21	18 (6)
19	19	19	20	21	21	18

In burrows located in positions lower than others at same stage:

Date	Burrow Depth†					
	Nest 7	Nest 8	Nest 9	Nest 10	Nest 11	Nest 12
May 10	* 1	* 1	* 1	* ½	* 2½	* 1
11	1	1	1	1	3	1
12	2	1½	5	1½	9	1
13	2	2	11	2	16	3
14						
15	2	4	22 (6)	5½	21 (6)	15
16						
17						
18	16	11	22	19	21	21 (9)
19	19 (10)	16 (10)		21 (10)	21	21

*Digging started during preceding 24 hours.

†Underlined depth is earliest record of maximum depth in each burrow. Number in parentheses is number of days of digging to attain maximum depth.

If the chosen site is a smooth, newly-exposed surface and affords no projections on which to stand, the bird clings to any slight irregularity of the bank, with the tail and sometimes the wings spread to help support it while scratching with a side to side motion of the bill. The mate often takes a position close beside with an outstretched wing covering and helping to support the one digging. It sometimes appears that this supporting position results when the second bird lands so close to the first that it is unable to close the wing; nevertheless, it undoubtedly aids the bird occupied in digging to hold its position.

As soon as a narrow ledge has been scratched out, the birds support themselves on it in a horizontal position on one foot and frequently with the outer wing widespread against the bank below, while scratching out the beginning of the burrow with the upper foot. Both mates seem eager to take part in the digging, and they exchange positions at short intervals, the arriving bird often forcing his way inside and thus displacing the one at work.

The dirt is kicked back out of the opening with the feet. When the burrow becomes deeper, a shower of sand is sent back out of the burrow at each step of the entering birds, suggestive of a dog digging a deep hole. Contrary to popular opinion (Dawson, 1903; Forbush, 1929) dirt is not carried out in the mouth. I have frequently seen a Bank Swallow on leaving a burrow during the digging stage pick up a grain of sand in its bill and carry it away. This is commoner late in the nesting cycle and would seem to be a nest-cleaning activity.

As noted earlier, territorial defense, like digging, is shared by both members of the pair. The bird which is not engaged in digging is usually busy defending the site and frequently progress of excavation is interrupted when both members of a pair are involved in territorial defense. This is especially evident during the early stages of excavation.

When the burrow is very shallow, defensive threats are given while the swallows are clinging vertically to the bank, but as soon as the burrow is deep enough to accommodate both birds, the defender usually stands in the mouth of the burrow facing out. From this position the vocal threats and pushes are more effectively directed at intruders in positions below or to either side of the burrow, than toward those above the opening. Thus, in effect, higher positions become dominant to those below.

During the days when many pairs are starting their burrows, territorial threats and evictions occupy much of the time of the diggers, especially those occupying the more vulnerable low sites. Birds taking up sites in dominant positions above other territories are relatively free from chal-

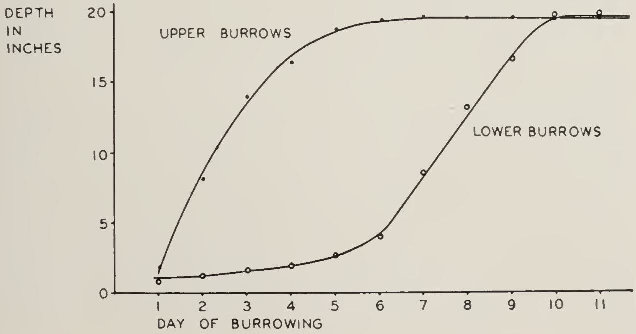

Fig. 4. Progress of burrow excavation. Dots represent mean depths of burrows 7–12 in Fig. 3 and Table 2.

Fig. 5. A Bank Swallow colony in a newly-excavated sand pit at Madison, Wisconsin. Burrows tend to be concentrated near the top of a high bank.

lenging attacks. As a result, burrows located high in relation to surrounding burrows increase rapidly in depth from the first foothold, while the excavation of low burrows is retarded for from two to five days until the hole becomes deep enough for one bird to dig undisturbed (Figs. 3 and 4; Table 2). Once a burrow is about three inches deep, excavation proceeds at a fairly uniform rate of about five inches a day irrespective of its position in the colony.

Thus, high positions would seem to be more favorable than low positions for establishing territories and digging burrows. This may explain why as is commonly observed, on a high bank offering a wide vertical extent of possible sites, the colony tends to be rather high and incidentally is safer from human and animal predators (Fig. 5).

The distance between adjacent burrow openings is determined by the area which a pair can successfully defend. In Table 3 are shown distances between burrow openings (measured center to center) in a densely concentrated colony where the soil was essentially uniform through a vertical extent of eight feet. This colony (Fig. 6) was in a new site and all the burrows were dug in 1952. Minimum spacing of openings was four inches, a majority being from five to seven inches apart. Territory in Bank Swallows is functional in minimizing the chance that adjacent burrows will run together or that the walls between them will break. In every case I have found (14 records) where two or more burrows met, only one has been completed and used for nesting. Stoner (1936) records instances of two nests located side by side in a common nest chamber after the thin

TABLE 3

MINIMUM DISTANCES BETWEEN BANK SWALLOW BURROWS

Distance to nearest burrow in inches	Frequency			
	From HIGH burrows	From MIDDLE burrows	From LOW burrows	Totals
4	2			2
5	10		7	17
6	6	3	2	11
7	13	5	2	20
8	2	3	3	8
9		2	2	4
10		1	2	3
11	1		1	2
12	1		3	4
. .				
17			1	1
Total frequencies...	35	14	23	72
Mean distances....	6.4	7.5	8.1	7.3

partition between had broken down, but it is not stated at what stage the walls broke or whether either of such nests was deserted.

Positive social forces in a colony tend to keep the burrows concentrated. In locations providing extensive vertical banks that appear suitable for nesting, it is frequently found that one particular section is utilized by all or a vast majority of the birds. Adjacent sites having similar physical characteristics may remain untenanted. In several instances small groups of birds established territories at such nearby locations after nesting at the

FIG. 6. Typical burrow spacing at a new site having a wide vertical extent of essentially uniform soil.

main site was well under way. Thus, at Nine Springs Creek in 1951 the traditional site near the road attracted the earliest birds of the colony. Next a small group of about 68 birds took up sites 350 yards upstream where only a couple of pairs nested in 1950. The latest nests were found in four smaller groups between these, where there had been no nesting in previous years. The spatial relationships of these sub-colonies with the number of nests and mean hatching dates in each are shown on the map of the colony (Fig. 7). Stoner (1941) has found by banding studies that the majority of breeding members of a colony reassemble in the same colony season after season.

It has been stated (Stoner, 1936; Bent, 1942) that burrows excavated in loose sandy soil tend to be deeper than those located in gravelly or clay banks. Although the banks used as colony sites in Dane County were fairly uniform in soil texture, a test of this correlation was made at 10 sites in eight colonies in Dane County. Samples were taken and analyzed for soil texture by the hydrometer method (Taylor, 1948). The results of these 10 analyses together with mean burrow depth in each location are shown in Table 4. Soil types varied from *sand* (94 per cent sand) to *sandy loam* (65 per cent sand, 35 per cent silt and clay). The percentages shown for soil textures are only roughly indicative of the degree of compactness, which is partially dependent on other factors. Nevertheless, a positive correlation was found between the mean burrow depths at each site, ranging from 20.4 to 36.2 inches, and per cent of sand in the soil. (The deep burrows at the Sprague-Dawley pit were a marked exception). At each of the colonies where

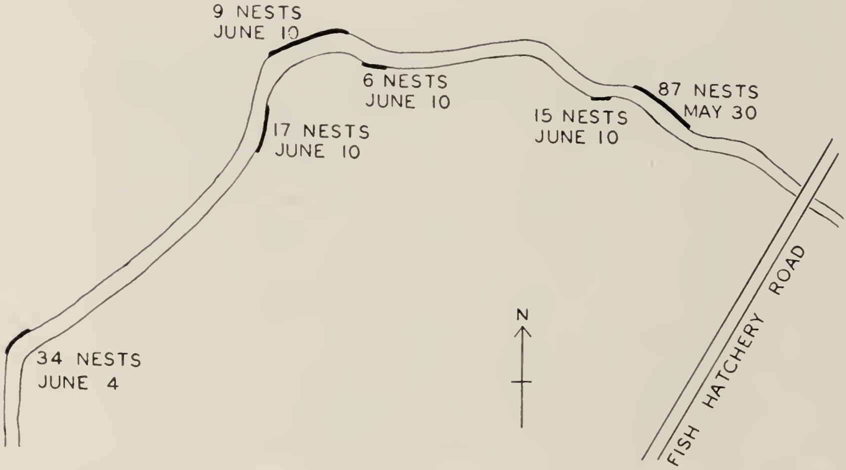

Fig. 7. Nine Springs Creek Colony. The number of nests and mean date of hatching in 1951 are given for each sub-colony.

TABLE 4
SOIL TEXTURE AND BURROW DEPTH

Colony	Mean burrow depth (inches)	Soil Texture		
		per cent sand	per cent fine material	Class
Wisconsin River, Area 1	36.2	92	8	Sand
Wisconsin River, Area 2	33.0	94	6	Sand
Columbia Co. V, Road cut	28.5	93	7	Coarse sand
Black Earth Creek, sandy layer	25.6	94	6	Coarse sand
Black Earth Creek, loamy layer	22.2	85	15	Loamy sand
Dane Co. Hwy. Q, Sand pit	21.6	85	15	Loamy sand
Monona Road cut, lower layer	24.2	83	17	Loamy sand
Monona Road cut, upper layer	20.4	80	20	Loamy sand
Nine Springs Creek	20.7	75	25	Sandy loam
Sprague-Dawley pit	26.5	65	35	Sandy loam

two distinct soil layers were used by the swallows (Black Earth Creek and Monona Road cut), burrows were deeper in the more sandy layer. As observed at these and other colonies where stratification occurs, a preference was shown for the more sandy layers and gravelly layers were avoided (Figs. 8 and 9).

Excavation of the nest chamber requires several days after the burrow has reached its maximum depth. The floor of the chamber is about two inches below the level of the burrow so that the completed nest and eggs are below burrow level. This was convenient for my observation with the Ripariascope, since the eggs or newly hatched young were always well below the instrument where they could be clearly seen and not disturbed or damaged.

FIG. 8. Burrows in horizontal rows are excavated in thin layers of coarse sand in this old sand-pit, Racine County, Wisconsin.

Fig. 9. Bank Swallow excavations in coarse sand layers. Gravelly layers are avoided.

Nest Building

Nest building begins as soon as the nest cavity has been excavated and both members of a pair contribute to its construction. Rather than "nest *building*" it might be more accurate to say "accumulation of nesting materials," for the nest is a somewhat formless mat of whatever materials are most readily obtainable. Fine grass blades and stems are the most common materials in most of the colonies where I have collected. Roots are torn from the eroding bank for use in nests, but the birds seem to prefer to use materials that can be picked up easily. Near farmyards straw is commonly used. The birds are quick to make use of any such materials dropped by others at the foot of the bank. At Nine Springs Creek I have watched Bank Swallows make repeated trips for dried grass from a roadway about 100 yards from the burrows.

The mat is about an inch thick in the middle and thinner toward the edges, conforming to the saucer-form of the chamber floor. When the eggs are laid it is loose and flat-topped. As incubation proceeds the center becomes depressed into a shallow hollow. A lining of feathers is added to the nest during incubation. Feathers, like grass, are brought to the nest by both members of the pair. As the lining is added the eggs are, of course, kept on top of the feathers.

Of thirty nests where the condition of feathering was noted and the stage of egg-laying or incubation known, only one contained a feather before egg-laying was completed and three nests still had no feathers after five and six days of incubation. Usually the first feathers are brought in on the second or third day of incubation and the nest is well lined with feathers

Table 5
Clutch Size in the Bank Swallow

Size of Clutch	Frequency		
	Before June 15	After June 15	Totals
2	–	2	2
3	3	1	4
4	14	13	27
5	64	5	69
6	23	–	23
Totals.	104	21	125
Mean clutch size.	5.0	4.0	4.8

before the eggs hatch. In a few instances I have seen feathers brought to the nest after the nestlings are a week old.

With few exceptions white chicken feathers were used, but colored feathers have also been noted. The number of feathers brought to the nests is much greater in colonies adjacent to chicken yards.

Stealing of feathers from nests left unattended was a common practice at the Nine Springs Creek colony.

EGG-LAYING

Observations with the Ripariascope indicate that eggs are laid at the rate of one per day until the clutch is complete. Data on clutch size obtained in this study are summarized in Table 5 and compared with reports from the literature in Table 6. In 125 completed clutches, I found the usual number of eggs to be five, although clutches of four and six eggs are not uncommon and a small number of clutches of two and three eggs were found being incubated.

I have no records of second nestings in this locality. Clutches started after June 15 were known to be or could be attributed to re-nestings of birds whose first nest was destroyed, usually by slumping of the bank. In one colony under daily observation, marked individuals in a re-nesting attempt took over a burrow recently left vacant by the brood of another pair. In some cases where re-nesting birds utilized old burrows, these were cleaned or dug deeper and a new nest built. In at least one instance a new clutch of eggs was laid in a dirty nest from which a brood recently fledged and to which no new nesting material had been added. The latest date I have found for the starting of a clutch was July 5, 1950. Mean size of clutches laid after June 15, and believed to be re-nesting attempts, was 4.0 eggs as compared with 5.0 eggs in first clutches (Table 5).

Stoner (1936) states that very few birds (his figures suggest about four per cent) rear second broods. His assertion that the second broods are raised is based on one or more observations of a second clutch of eggs in a burrow from which young were fledged earlier in the same season. In the light of my observations this interpretation appears unwarranted. Unfortunately Stoner's statements were misconstrued when Gross (Bent, 1942) says that Stoner "presents concrete evidence that two broods are the usual thing in the colonies studied intensively by him."

Wilson (1812) makes the general statement that the Bank Swallow commonly has two broods. Audubon (1840) says that this species "generally rears two, and sometimes three broods in a season" in Louisiana, produces two broods in Kentucky, and "lays only once" in Newfoundland and Labrador. I was able to find no recent observations to confirm these statements. Oberholser (1938) states that there is "no definite nesting record for Louisiana."

INCUBATION

That incubation usually begins before the clutch is complete is evident from the variation of stages of development found within single clutches of eggs or broods of nestlings. Nearly every clutch, even those just completed showed a difference in apparent age of two to three days between the embryos of greatest and least development. In about two out of 31 instances the four or five embryos in one nest were at the same stage (day) of

TABLE 6

REPORTED CLUTCH SIZE IN *Riparia riparia*

Authority	Locality	Clutch Size
Lack, D. (1947)	England	4–5
" "	Central Europe (Saxony)	5 (6)
" "	Eastern Galicia	5–6
" "	Norway	(4) 5 (6)
Forbush (1929)	New England States	3–7
Jourdain (in Witherby, *et al.*, 1940)	Great Britain	Usually 4–5 Sometimes 3, 6, or 7
Niethammer (1937)	Germany	5 (4–7)
Stoner (1936)	New York State	Early broods: 4 or 5 Late broods: 3 or 4
" "	Iowa	5 or 6 eggs (4 or 5 young)
Cory (1909)	Illinois and Wisconsin	3–6
Petersen (this study)	Dane County, Wis.	Before June 15: 5.0 After June 15: 4.0 Entire season: 4.8

Table 7
Presence of Sexes in Burrows at Night

Stage	Frequency*				Both sexes present	
	Total	Female alone	Male alone	Both sexes present	Female off first	Male off first
Nest-Building	4	1 (25)	1 (25)	2 (50)	2	0
Egg-laying	4	2 (50)	1 (25)	1 (25)	?	?
Incubation	32	21 (65.6)	2 (6.2)	9 (28.1)	3	6
Parental	36	23 (63.9)	6 (16.6)	7 (19.4)	4	3
Totals	76	47 (61.8)	10 (13.2)	19 (25)	9	9

*Actual number followed by percentage of total (in parentheses).

development and so had apparently been incubated an equal length of time. The extent of difference between oldest and youngest embryos in each clutch is not related to clutch size. It is evident therefore that incubation begins with the laying of the third, fourth, or fifth egg. Or it may be as Purchon (1948) found in the Swallow (*Hirundo r. rustica*) that incubation occurs for a short time each day from the laying of the first egg, and is increased each day until the maximum is reached. (In the case cited, incubation determined by day-long observations throughout the incubation period began with 10 per cent daytime incubation on the day the first egg was laid and increased to a maximum of 70 per cent daytime incubation on the eighth day.)

In two instances Stoner (1936) verified by dissection his observation that males were sitting on the eggs during daylight. By observation of marked birds I have found that the members of each pair share time on the eggs about equally during the daylight hours.

In Bank Swallows, as in most other passerines, only females develop an incubation patch. Ryves (1943) and Bailey (1952) believe an incubation patch is necessary for true incubation to occur and so consider that even in species in which males regularly take turns on the nest as in the Bank Swallow, males are incapable of true incubation. Bailey believes that in passerines the female alone will be found sitting on the eggs at night. My collecting records show (Table 7) that in 32 burrows from which I collected Bank Swallows during the incubation stage, the female was alone on the nest in 21 cases (65.6 per cent), both sexes were present in nine burrows (28.1 per cent) and in two instances (6.2 per cent) only the male of the pair was present in the burrow. In the nine instances where both sexes were present, the male left the nest before the female six times, and the female came off the nest first three times. It cannot be assumed however, that the incubating member of a pair will sit more assiduously.

Whether male Bank Swallows or any male passerines actually incubate, that is, raise the temperature of the eggs sufficiently to permit development of the embryos, can be positively determined only by studies of the egg temperatures produced by the males and the temperatures required for development.

In July, 1952, I placed the outdoor bulb of an Airguide indoor-outdoor thermometer among the eggs in a nest where the parent birds were color-marked for individual recognition. Access to the nest chamber was obtained by a hole dug behind the burrow. The thermometer scale was situated above the bank in such a manner that temperature readings could be made with binoculars from a blind while each entrance and exit at the burrow mouth could be observed.

In the first trial both birds deserted the nest. The second attempt was unsuccessful because the thermometer bulb was inadvertently pushed out of the nest. Results obtained in a third nest are shown in Figure 10. The female returned to the nest just once during the observation period and flew out with a feather almost immediately. During the next two and one half hours the male of the pair entered the burrow seven times for periods of two to 19 minutes, each time producing a sudden rapid increase in the nest temperature by as much as 21° F. above that of the unincubated nest. During the longer periods of 19, 17, and 18 minutes on the nest, temperatures of 94, 94, and 96 degrees F., respectively, were attained. Due to the size of the thermometer bulb (9 mm. diameter × 50 mm. in length) it was undoubtedly not covered as efficiently as a clutch of eggs alone would be. In normal incubation there is direct changeover between the members of a pair at the nest, so that eggs would not be subjected to periods of cooling between spells of incubation. It remains for further experiments of this type to provide temperature data of eggs incubated alternately by male and

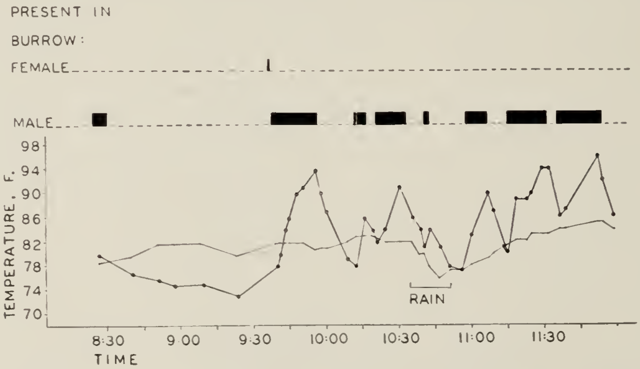

Fig. 10. Temperature of nest incubated by male Bank Swallow, July, 1952. Air (thin line) and nest temperatures were read from an Airguide indoor-outdoor thermometer.

TABLE 8

INCUBATION PERIOD IN THE BANK SWALLOW*

Clutch size	Total frequency	Class frequency		
		13 Days	14 Days	15 Days
3	1	–	–	1
4	2	–	1	1
5	2	–	2	–
6	6	3	1	2
Totals..........	11	3	4	4

*Days from laying of last egg to first egg hatching.

female. Nevertheless, the data presented here are positive evidence of male incubation.

The incubation period.—Incubation, from the laying of the last egg to the hatching of the last egg (when all eggs hatch), was determined in only two nests. It was found to be 15 days in both. In all nests the incubation period, counting from the laying of the last egg to first hatching, was from 13 to 15 days, as shown in Table 8. Evidence presented above indicates that incubation usually begins one or two days before the last egg is laid. Therefore it seems probable that the *actual* incubation period under natural conditions is 15 days, and apparent periods of 13 or 14 days occur when incubation begins two or one days, respectively, earlier than completion of the clutch.

Incubation periods recorded in the literature (Table 9) range from 12 to 16 days.

PARENTAL BEHAVIOR

Since incubation usually began one or two days before the laying of the last egg, hatching of a brood occurred over a period of two or three days and the young in each brood showed a difference of two or three days

TABLE 9

REPORTED INCUBATION PERIODS IN *Riparia riparia*

Authority	Incubation period
Evans (in Bergtold, 1917)	12 or 13 days
Burns, 1921	12 – 13 days
Stoner, 1936	14 – 16 days
Jourdain (in Witherby, *et al.*, 1940)	14 (12 – 16)
Niethammer, 1937	12 – 16
Baerg, 1931	13 – 14
Petersen (this study)	Apparent: 13 – 15 Actual: 15

in development. Egg shells were carried from the nest soon after hatching occurred. Three aspects of parental behavior are considered here: brooding, nest sanitation, and feeding.

Brooding.—The nestlings were brooded almost constantly on the day of hatching, the parents alternating on the nest. On successive days the amount of brooding decreased by a shortening of the length of each period on the nest. Six successive periods of brooding on one nest on the day of hatching were from seven to 28 minutes duration (28, **11**, 7, **10**, 7, **11**, periods by female in boldface). Two days later the same number of periods of brooding was observed per hour, but each period was only from three to five minutes long and longer periods of absence from the nest intervened. My observations do not substantiate Beyer's statement (1938) that the female does almost all of the brooding. His statement is based on his belief that he could distinguish between the sexes by the manner of movement of the birds. My birds were color-marked and the sexes known.

I have no observations on daytime brooding periods after the third day, but Beyer observed that by the seventh day brooding had practically stopped and the parent birds only occasionally sat on the young, usually for less than one minute at a time.

Until they are 10 days of age, the nestlings may be brooded by either or both parents at night. I collected the parent birds at night from 36 burrows containing nestlings (Table 7). The female was found alone on 23 nests, the male alone on six, and both male and female parents were present on seven nests. Observations of more than 100 nests at this stage indicates that the parents rarely spent the night in the nest after the young were 12 days old.

Nest Sanitation.—My observations agree with Beyer's finding that during the first days after hatching, the excrement of the nestling was swallowed. I have seen fecal sacs carried from the burrows when the nestlings were four days old. In the nest watched by Beyer all the excrement was carried away when the nestlings were seven days old and at nine days the young left the nest chamber to void in the burrows. I have observed that by 14 days they run almost to the burrow entrance and turn around to void. Bank Swallow nestlings never eject fecal sacs out of the burrow, so the ground below a colony does not become fouled with excrement as does the area below a Cliff Swallow colony.

Both parents assisted in nest sanitation. If excrement were present it was nearly always removed by the next bird leaving the burrow. Usually only one fecal sac was carried away at a time. If more than one was present, the bird did not return immediately for the second, but it was carried out after the next feeding.

There was a definite tendency for the parent birds to pick up *something* as they left the burrow. If no droppings were present, the birds would pick at or pick up a grain of sand or a tiny pebble as they ran out of the burrow.

Excrement is removed less promptly in the later stages of nestling life. Beyer reported that nest sanitation had stopped when the young were 17 days of age, but his observations continued for only an hour on that day. I have found that while the droppings may be left in the burrow for a time after 17 or 18 days, nest sanitation is usually resumed at irregular intervals until the young leave the burrow. In one instance a marked female returned to her own burrow and removed excrement left by her nestlings when they roosted there at 28 days of age.

Feeding.—My observations of feeding of Bank Swallow nestlings include data on six pairs of marked birds of known sex feeding broods in which the number and hatching date of the nestlings was known.

The mean feeding rate found in 33 nest-hours of observation (morning and mid-afternoon hours on fair, warm days) was 24.7 feedings hourly per nest. Marked differences are found in a comparison of feeding rates reported for this species from other localities during apparently similar weather (Table 10A). These differences are difficult to explain without more extensive study of feeding rates under varied conditions.

TABLE 10

NESTLING FEEDING RATES

A. Mean Hourly Feeding Rates.

Source of data	Locality	Hours of observation	Feeding rate
Petersen, this study	Wisconsin	33	24.7
Beyer, 1938	Ohio	2	24
Moreau and Moreau, 1939	England	24	33.3
Stoner and Stoner, 1941	New York	56	17.1

B. Feeding Rate and Brood Size.

Brood Size		Moreau	This study	Total
3	Hours observed......	14	21	35
	Rate/nest...........	32.4	24.1	27.4
	Rate/nestling........	10.8	8.0	9.1
4	Hours observed......	10	12	22
	Rate/nest...........	34.7	25.7	29.8
	Rate/nestling........	8.7	6.4	7.4

C. Feeding Rate of Sexes.

Number of pairs	Hours of observation	Feeding rate by male	Feeding rate by female	Total mean feeding rate
6	27	14.8	9.7	24.5

TABLE 11
FEEDING RATE AND NESTING AGE

This study			*Previous studies*			
Age	Hours observed	Feeding rate*	Age of nestlings	Hours observed	Feeding rate*	Reference
			3	2	24	Beyer, 1938
			2–4	14	14.1	Stoner, 1941
8	1	25	5–9	35	19.3	" "
9	2	19				
10	0	–				
11	3	20.7	10–12	7	18.3	" "
12	7	25.8				
13	14	30.5	13	2	28	Moreau and Moreau, 1939
14	3	24.7	14	2	44	" " " "
15	2	26				
16	1	24				
17	3	21				
18	7	22.4	"Nearly ready to fly"	20	32.8	" " " "
19	1	19				
20	2	20.5				

*Mean hourly feeding rate per brood.

My observations were spread over a number of days when the nestlings were from 8 to 20 days of age. The rates found for each day of nestling age (Table 11) indicate no trend during this span of nestling life. Data from other studies are presented in a parallel column, but since nestling age is not known exactly in all cases and conditions of time and locality are not uniform, detailed comparisons are not warranted.

The feeding rate at each nest was not proportionately greater in larger broods. Thus, the number of feedings per nestling was greater in smaller broods (Table 10B). In 35 hours of feeding broods of three nestlings (including data from Moreau and Moreau, 1939) the mean rates per hour were 27.4 feeding per nest or 9.1 feedings per nestling. Broods of four nestlings, observed for 22 hours were fed 29.8 times per hour, a mean of 7.4 feedings per nestling. The same relationship between feeding rate and brood size was found in Cliff Swallows (Petersen, MS), in the European Robin, *Erithacus rubecula*, (Lack and Silva, 1949), and Swift, *Apus apus*, (Lack and Lack, 1951).

Twenty-seven hours of observations of the six pairs in which the sex of each individual was known indicate that, as Beyer believed, males feed the nestlings more frequently than do females (Table 10C). The mean hourly feeding rate by males was 14.8, and that for females, 9.7, a total mean feeding rate of 24.5. Individual variation was noted, however, and it cannot be assumed that the bird feeding more frequently in any pair is the male.

Beyer noted during early days of nestling life as I found in older birds, that only one nestling was fed in each visit of the parents. A food call given by the adult bird as it enters the burrow is described by Beyer as a "series of particularly sweet fine notes higher in pitch than the usual Bank Swallow call." The nestlings were first heard to give a similar call at four days of age. I have found that nestlings will give this call whenever the burrow is partially darkened as though by an entering bird.

At nine days the nestlings rush toward the parent in the burrow to be fed. By 12 days of age the nestlings wait about six inches from the burrow entrance to be fed. During the last several days in the nest the fledglings are fed much of the time at the burrow entrance. Two to four or five birds sometimes jostle for front position in the burrow while waiting to be fed. When the parent approaches, each of the fledglings gives a series of loud sharp chirps, repeating it incessantly until he is fed, or until the adult bird leaves. After a young bird has been fed, he usually backs out of sight behind his mates or turns around and enters deeper into the burrow, giving up the front position to one of those who remain.

Eleven broods of nestling Bank Swallows were given color bands designating their home burrows. Eight of the female parents of these broods were individually marked. Observations of these birds indicate that young Bank Swallows fly from the burrows at about 20 days of age, but return to some burrow, frequently their own, during part of the day and for night roosting for several days. Nestlings as old as 28 days have been seen roosting in their own burrows.

The following observation suggests that the first flight of fledgling Bank Swallows may be brought about by a reduced feeding rate and by vocal urging of the parent birds. A marked adult male hovered in front of his own burrow where his three fledglings, 23 days old, were at the entrance calling and gaping. Presently he alighted at a neighboring hole a foot away, alternating his lower-pitched single note with the calls of the young birds. After perching less than a minute he flew back and forth in an area about 10 yards in diameter near the burrow entrance, continuing his low-pitched *buzz*, seemingly in answer to the continued begging of the young. Again he landed at a nearby burrow. This performance was repeated about 12 times in half an hour. Then one of the nestlings flew from the burrow in response to the alarm note of a bird flying overhead. During this period of observation, no food was brought to the nest, but three days later both parents were seen feeding one of the young that remained in or had returned to the burrow. Luring of the young from the nest by irregular or feint feeding or by calling has been reported by Nice (1943) in a number of altricial species, including Barn (*Hirundo rustica*) and Tree (*Iridoprocne bicolor*) swallows.

Stoner (1942) found young Bank Swallows returning to their own or other burrows after their initial flights. My observations of feeding of marked fledglings (from 20 to 28 days old) by marked adults indicate that adult Bank Swallows recognize and will feed their own young which have returned either to their own or to other burrows. None of the marked adult birds was seen feeding a juvenile other than its own, even in the home burrow of the adult. Juveniles landing in a burrow not their own were in several instances attacked or pushed out by the adult resident. Nice (1943) notes that birds with altricial young do not recognize their eggs or nestlings, but that her Song Sparrows learned to recognize their young individually before independence was attained.

Post-nesting Behavior

At the Bank Swallow colonies I have observed, loafing sites such as nearby wires were used very little during the breeding season. At the time when young birds are leaving the nest, however, nearby wires are occupied for longer periods each day, and by increasing numbers of birds, both adult and immature.

During the first two weeks in August, 1950, small bands of recently-fledged young birds were seen on several occasions at the Nine Springs Creek colony engaged in entering holes, scratching at the bank and toying with nesting materials. On August 14 when several broods were still being fed in the burrows about 800 Bank Swallows, including a large proportion of juveniles, visited the colony. About 100 of these birds perched on wires near the bank, while others were engaged in cleaning and enlarging burrows or digging new holes. A constant twittering was heard from the birds. Such behavior suggests abortive nesting behavior.

During August, 1951, a group of post-nesting adults and juveniles was seen near a breeding site a mile west of Mazomanie. The birds sunned and dusted themselves on a long earth bank with a slope of about 30 degrees. Close observation showed that many of the birds were digging shallow holes, none exceeding five inches in depth. It is interesting that a slope unsuited as a breeding site should nevertheless be used for this post-nesting burrowing activity. Stoner (1936) observed post-season burrow-digging by juveniles at some of his colonies in New York State.

In a migrating flock of 2,000 Bank Swallows seen on September 13, 1945, Thom (1947) observed frequent attempted copulation and "threat displays." I saw similar attempted copulations among swallows in a small flock on a road in late July, 1952. I could not detect whether any of the individuals taking part in this activity were juveniles.

The annual appearance of huge flocks of Bank Swallows at traditional roosting sites has been described for a number of localities. Abby F. C. Bates (1895) described the activities at such a roost near Waterville, Maine. O. Widman (1907) states that such flocks begin to accumulate in the Mississippi River bottoms at St. Louis, Missouri, as early as July 1 and that migration continues throughout the month of August, all the birds having left by mid-September. Flocks of Bank, Tree, and Barn Swallows have been described by E. J. Sawyer (1918) in Jefferson County, New York. The largest Bank Swallow flock recorded was one near Toledo, Ohio, in 1931, estimated by Louis Campbell (1932) to include 250,000 birds.

The largest concentration of Bank Swallows I have observed was the flock of 800 that visited the Nine Springs Creek colony site in August, 1950. A group of about 700 birds spent several days in July, 1950, on the Mendota State Hospital farm near the north tip of Lake Mendota. Most of the birds perched along the wires or in large willow trees near the road, but several hundred sunned themselves on the bituminous-surfaced road. This location annually attracts such post-breeding flocks.

In the years 1950 through 1952 all the Bank Swallows had migrated from the Madison region by September 1. Schorger (1931) states that while Bank Swallows usually have migrated from the Madison area by September 1, some individuals may remain into September. The latest date for the species in his records is September 11.

II. Physiological and Morphological Cycles

Procedures for Collection and Autopsy of Specimens

For the study of the physiological and morphological cycles, adult Bank Swallows were collected from their burrows at night throughout the breeding season. A total of 114 adults (79 females and 35 males) was collected during the two years, 1950 and 1951. These were representative of all stages of the behavior cycle from burrowing to late parental stages (Table 12).

Table 12

Numbers of Specimens Collected

Phase of Cycle	Females	Males	Totals
Burrowing	2	0	2
Nest-building	11	8	19
Egg-laying	7	4	11
Incubation	28	10	38
Parental	31	13	44
Totals	79	35	114

After the birds had retired to their burrows for the night and darkness had fallen a number of burrows sufficient to provide the specimens needed were plugged with paper, so that our activities at the bank would not put these birds to flight. Then one burrow at a time was opened and the birds attracted to a flashlight at the entrance where they were captured by hand. Each specimen or pair of specimens was autopsied immediately before another was taken. It was found that specimens could be handled most advantageously by two people working together, one at the bank obtaining the birds and nest contents, and the other doing the autopsy in a laboratory set up in the back of a panel truck. The procedure used for each bird was as follows:

1. The adult bird was taken from the burrow and handed to the laboratory man for autopsy. Meanwhile the bank man measured the burrow, noted the condition of the nest, and collected the eggs and young, which were preserved in 10 per cent formalin for later examination.
2. The specimen was killed as quickly as possible by decapitation and the blood which flowed from the carotid vessels collected into a centrifuge tube.
3. A 0.02 ml. sample of blood was pipetted into 5 ml. of dilute tungstic acid in another centrifuge tube for later glucose determination. The pipette was rinsed with the dilute tungstic acid, then the tubes were corked and the pipette prepared for the next sample by rinsing successively in water, ethyl alcohol, and ether.
4. The bird was weighed on a triple beam balance.
5. The brood patch or ventral apterium was removed by dissection and preserved in Mossman's FAA fixative.
6. The body cavity was opened and the lower back region containing the testes or ovary and oviduct, was removed and preserved in FAA fixative.

The blood samples for glucose determination were refrigerated until the test was run the following morning. The whole-blood sample was frozen for later determination of serum calcium. The preserved organs were held for subsequent measurement and examination.

Determination of Reproductive Stages

The *phase* of reproduction of each specimen was readily noted by examination of the burrow or its contents. Thus, the following phases are represented by specimens: (1) burrowing, (2) nest building, (3) egg laying, (4) incubation, and (5) parental phase. Within each phase criteria were established as described below for determining the more precise reproductive *stage.*

Burrowing.—Only two specimens were secured before the start of nest building and these were from a late stage of burrowing.

TABLE 13
NEST BUILDING STAGES

Stage (Day)	As Determined by Ovary Condition:	As Determined by Nest Condition:
1	No ova over 2 mm. in diameter.	Few bits of nesting material.
2	Largest ovum 2 to 5 mm. in diameter.	Small amount of nesting material.
3	Largest ovum 5 to 8 mm. in diameter.	Moderate amount of nesting material.
4	Largest ovum over 8 mm. in diameter. No ova in oviduct.	Large amount of nesting material.
5	First ovum in oviduct.	Nest apparently complete.

Nest building.—Five stages of nest building were designated (Table 13). In female specimens, the development of the ovary took precedence over condition of the nest in determining the stage since the ovary more accurately indicates time before start of the egg-laying phase. Males collected with their mates were placed in the stage determined by the ovary condition of the female. Reproductive stages of males collected alone during this phase were determined solely by condition of the nest. Nest building does not proceed at a uniform rate in all pairs. Consequently the intervals between stages of nest building are not strictly uniform, although stages 2, 3, 4, and 5 as determined by ovary development do correspond approximately to days.

Egg laying.—Stages of egg-laying correspond to the number of eggs laid, except that where examination of ovary and oviduct indicated that a clutch was complete with less than five eggs (the most frequent number) it was placed in stage 5 of egg laying.

Incubation.—Stages of incubation of collected adult specimens were determined by the stage of development of the embryos measured in days, based on a series of embryos taken after known periods of natural incubation (Petersen, MS). Complications were presented by the fact that embryos in any one nest usually showed a range of development equivalent to two or three days of incubation. Adult specimens were assigned arbitrarily to the stage represented by the youngest or least-developed embryo.

Parental phase.—During the parental phase the specific stage to which each specimen was assigned is equivalent to the determined age of its youngest nestling. In order to establish criteria for aging nestling Bank Swallows observations and measurements were made of nestlings of known age.

The most apparent physical changes in young Bank Swallows during the nestling period are changes in weight and the development of plumage (Fig. 11).

The daily increase in weight for the first 11 days is so great that an average daily weight curve is useful in aging nestlings during this period. After the twelfth day the daily increment decreases until a maximum weight is attained on the fifteenth to seventeenth days, followed by a steady loss of weight to the day of fledging.

The most marked and easily observed feature of feather development is that of the ninth primary, which breaks through the skin on the seventh or eighth day and reaches a length of over 60 mm. at the time of fledging. The daily increment is so great that the length of the ninth primary becomes a useful aging criterion.

The ranges in weights on consecutive days overlap even during the first 12 days of development; likewise, the ranges of lengths of the ninth primary feathers on consecutive days overlap throughout their development. Consequently the age of nestling Bank Swallows as determined by these criteria is approximate and may be in error by one day in either direction.

Body Weight

The body weights of 121 Bank Swallows were obtained at autopsy throughout the breeding cycle. The mean weight of 82 females (Fig. 12) was 14.8 grams (range 11.4-18.5). Marked fluctuations were found during the cycle: (1) A rapid increase during late nest-building stages, paralleling the development of the ovary and oviduct, brought body weight to a maximum of 17.5 grams (mean weight of three individuals) on the day preceding laying of the first egg. This was an increase of 2.7 grams (18.2 per cent) above

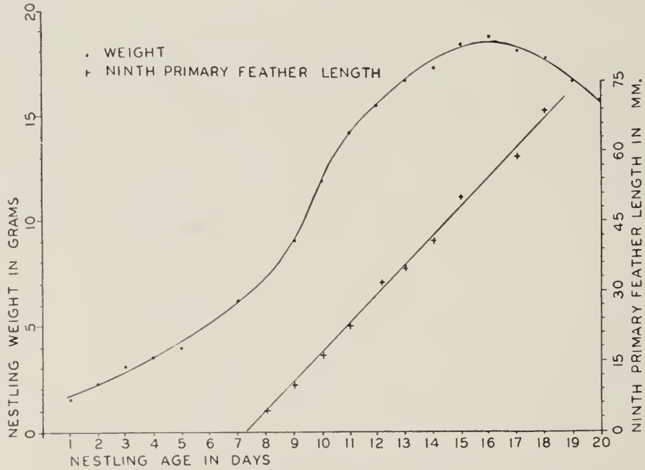

Fig. 11. Body weight and length of ninth primary feather in nestling Bank Swallows. During the first 11 days of nestling life, body weight was used as an aging criterion. Length of ninth primary feathers was used as an aging criterion for older nestlings.

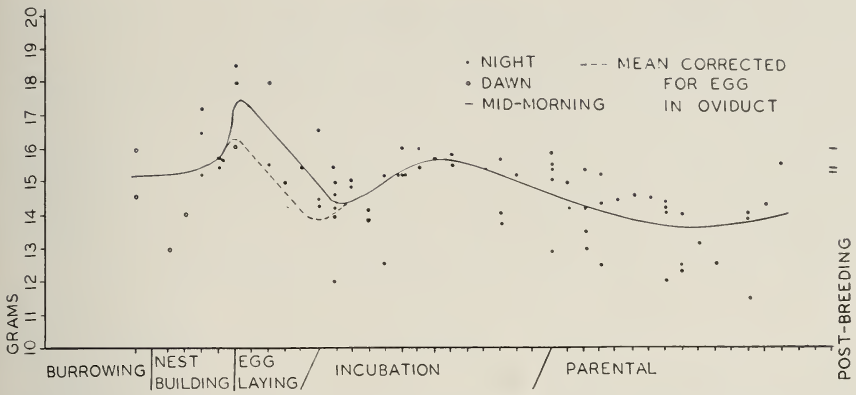

Fig. 12. Body weights of female Bank Swallows. In this and the following figures, the horizontal scale represents the sequence of stages in the breeding cycle.

the total mean weight. (2) During the egg-laying stage and the first day of the incubation phase the female body weight decreased to 14.2 grams. (3) An increase of about 10 per cent during the first half of the incubation period was followed by (4) a gradual decline beginning even before the parental phase. (5) The five specimens collected on the twelfth to fifteenth days of the parental phase suggest the beginning of a return to normal weight. Three individuals collected from post-breeding flocks averaged 15.6 grams (range 15.3–16.0).

The weights of 39 male specimens (Fig. 13) ranged from 11.8 to 16.1 grams with a mean of 13.7 grams, 1.1 grams less than the female body weight. While the difference in body weight between the sexes was greatest at the start of egg laying, females at any stage averaged heavier than males.

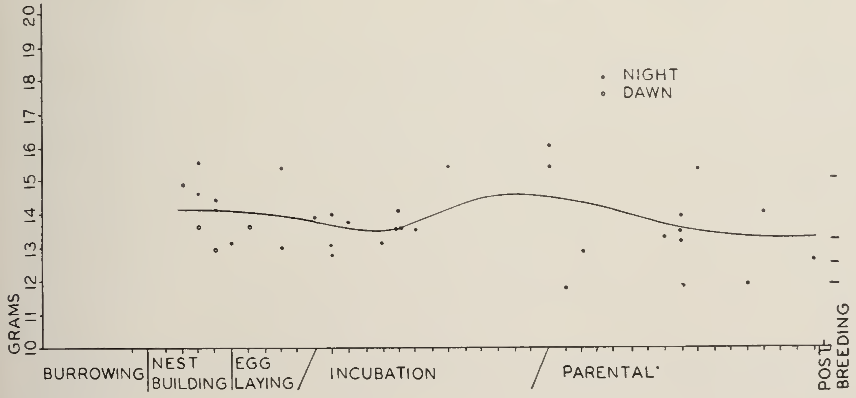

Fig. 13. Body weights of male Bank Swallows.

Fluctuations evident in the weights of males were (1) a slight decrease during nest-building and egg laying, (2) an increase during incubation and (3) a decline during the parental phase. Four post-breeding adult males averaged 13.25 grams (range 11.9-15.2). Nine juveniles collected from a post-breeding flock had a mean weight of 13.2 grams (range 11.6–14.9).

Stoner (1936) analyzed the weights of 249 Bank Swallows, including 22 known females and 13 known males. He reported that females were heavier than males (15.60 and 14.03 grams respectively) and also noted that the average weights declined from May through June and July.

Riddle and Braucher (1931) studied body weight changes during the reproductive cycle in pigeons and doves and found an increase of about eight per cent in weight during incubation. About one-third of this increase occurred in the crop-glands.

Baldwin and Kendeigh (1938) showed that the weights of birds characteristically increase during the day and decrease at night, being lowest at the beginning of each day's feeding activity. In this present study all weights were taken in the evening except a few which were obtained at dawn. These were found to average lower than evening weights during the same stage.

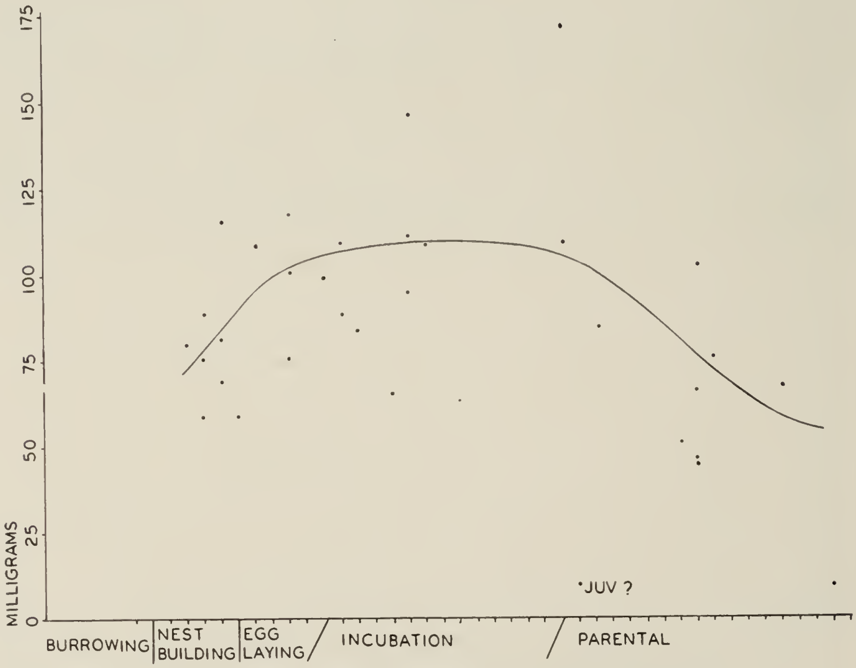

FIG. 14. Bank Swallow testis weights. See text for further explanation.

TABLE 14
BANK SWALLOW TESTIS WEIGHTS

Stage	Frequency	Mean weight	Range (mgm.)
Nest-building	8	78.9 mgm.	59.1–116.1
Egg-laying	4	107.5	80.6–133.5
Incubation	9 (10)	97.3 (87.8)	(2.5) 63.1–147.5
Parental: 1–3	3 (4)	120.0 (92.4)	(9.5) 85.8–163.7
Parental: 8–17	8 (9)	63.4 (57.4)	(9.2) 46.2–103.4

( ) Include three specimens of extremely small size.

TESTES

Weight.—Testes of 35 male Bank Swallows were preserved in fixative and later weighed on a torsion balance. Each of the weights plotted on the graph (Fig. 14) is the average of the two testes of a specimen, except for 10 birds in which one of the testes was used to prepare a smear. At any stage of the breeding cycle a wide range in testes weight was found (Table 14). Three birds had testes much smaller than any other birds so their testes weights (2.4, 9.4, and 9.2 mgm.) are parenthesized in the table.

Histology.—Specimens listed below, representative of each phase of the cycle, were sectioned in paraffin at eight microns and stained in iron hematoxylin and eosin:

Number	*Phase*	*Stage*	*Weight in milligrams*
1.	Nest-building	4	64.2
2.	Egg-laying	3	80.6
3.	Incubation	1	108.4
4.	Incubation	5	134.9
5.	Parental	1	164.5
6.	Parental	3	91.9
7.	Parental	9	44.6
8.	Parental	17	10.7

All of these testes, except no. 8, had bundles of mature sperms around Sertoli cells in the tubules (Stage 7 of Blanchard, 1941). A few free sperms were in the lumens of the seminiferous tubules of specimens from the nest-building and egg-laying stages. In the triangles between tubules large blood vessels and occasional interstitial cells were found. Tubules of incubation and parental stage testes had much greater numbers of free sperm in the lumens. Specimens from the parental stages had increasing amounts of cellular debris. Lumens of the testis from parental stage 9 were quite choked with debris and mature sperms.

Specimen no. 8 appeared to be in an advanced condition of regression. No spermatozoa or spermatids were found in any of the tubules of this testis. Only the basal layer of the tubule epithelium showed any organization and lumens were filled with degenerating cells and cellular debris. The tunica albuginiae and tunicae propriae were several times thicker than any of the other testes sectioned and interstitial cells were relatively more numerous.

OVARY

The ovaries of female Bank Swallows were left *in situ* and preserved in fixative with the whole lower back regions. Later they were dissected, weighed, and examined for the number and size of their ova.

Each of the 79 ovaries collected (from burrowing through parental phases) contained a large number (estimated at from 50 to 60) of white ova of macroscopic size, under 1.5 mm. in diameter. During the four days preceding ovulation from four to six of these ova increased rapidly in size by deposition of yellow yolk. In domestic chickens (*Gallus gallus*) this increase begins 10 days before ovulation (Jull, 1952) and in the Domestic Pigeon (*Columba livia*), about four and one-half days (Riddle, 1916). In the Jackdaw (*Corvus monedula*) the period of rapid increase begins about four days before ovulation (Stieve, in Groebbels, 1937). The enlarged ova showed a distinct gradation in size in each ovary (Table 15). A study of the sequence of sizes together with the presence or absence of an egg in

TABLE 15
WEIGHTS OF OVARIES AND SIZES OF CONTAINED OVA

Specimen number	Stage	Weight of ovary (mgm.)	Size of enlarged ova (dia. in mm.)	Eggs in oviduct	Eggs in Nest
1	B	47.5	–	–	–
2	B	24.0	–	–	–
3	N1	22.0	–	–	–
4	N2	90.8	2, 4	–	–
5	N3	169.5	2, 2, 5	–	–
6	"	186.4	2, 2, 3, 5.5	–	–
7	"	140.0	2, 3, 6	–	–
8	N4	373.0	1.5, 2, 3, 5, 8	–	–
9	"	461.6	6, 8	–	–
10	"	778.3	5, 8, 9	–	–
11	N5	528.8	3, 6, 8	1	–
12	"	462.1	6, 8	1	–
13	"	480.2	3, 6, 8	1	–
14	E2	313.0	8	1	2
15	"	516.8	3, 4, 8	1	2
16	E4	49.6	–	1	3
17	"	40.9	–	1	4
18	E5	37.1	–	–	5
19	"	39.5	–	–	5
20	"	22.4	–	–	4
21–48	Incubation	Mean 31.3 (16.2–52.1)	–	–	3–6
49–79	Parental	Mean 22.4 (6.6–44.1)	–	–	Nestlings

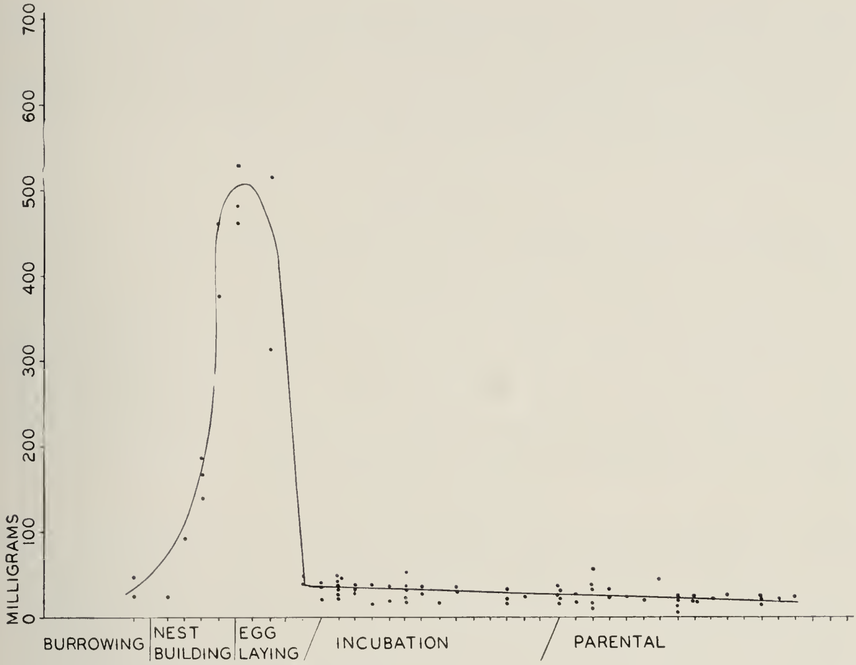

Fig. 15. Bank Swallow ovary weights.

th oviduct indicates that (1) an ovum was two to four mm. diameter on the second day preceding ovulation, (2) four to eight mm. diameter on the day preceding ovulation, and (3) eight or nine mm. diameter at ovulation.

Coincident with the rapid increase in ovum size, the weight of the ovary with ova included increased from about 30 milligrams to over 300 milligrams (Fig. 15). (Seven ovaries containing ova of ovulation size averaged 514.4

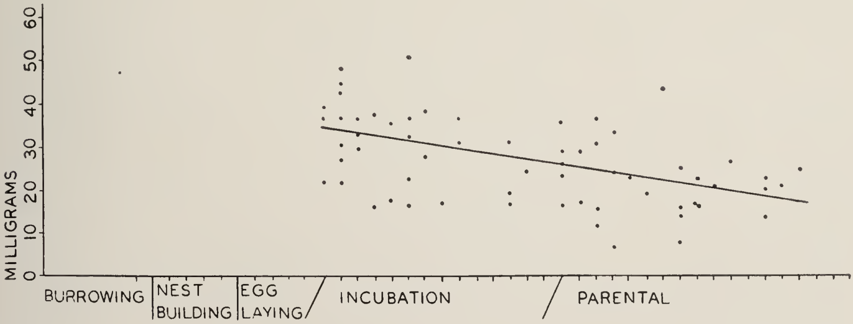

Fig. 16. Bank Swallow ovary weights. Data from specimens taken after egg-laying are repeated here on a greater scale.

mgm.) With the last ovulation the ovary dropped in weight to less than 53 mgm., and looked as it did in the burrowing phase. The appearance of the ovary remained the same throughout the incubation and parental phases, but there was a gradual decline in weight from a mean of 31.3 mgm. in incubation to 22.4 mgm. in the parental phase (Fig. 16).

OVIDUCT

The curve of oviduct weights (Fig. 17) is very similar to the ovary weight curve. The weight increased very rapidly for about three days before the first ovulation. This increase had probably started slowly some days earlier. By the beginning of ovulation the organs weighed 1500 milligrams. The decline in weight of the oviduct with the last oviposition (to a mean of 366.2 mgm.) is slightly less abrupt than the drop in ovary weight a day earlier. A more gradual decline during incubation reduced the weight to about 50 mgm., a level maintained through the parental phase.

INCUBATION PATCH

The incubation patches of 75 females and the ventral apteria of 14 males were dissected from the freshly killed birds and preserved in Mossman's FAA fixative. Specimens representative of various stages in development or regression of the incubation patch were sectioned at eight microns and stained in iron hematoxylin or Mallory's stain for histological examination.

The four stages in the incubation cycle described by Bailey (1952) for

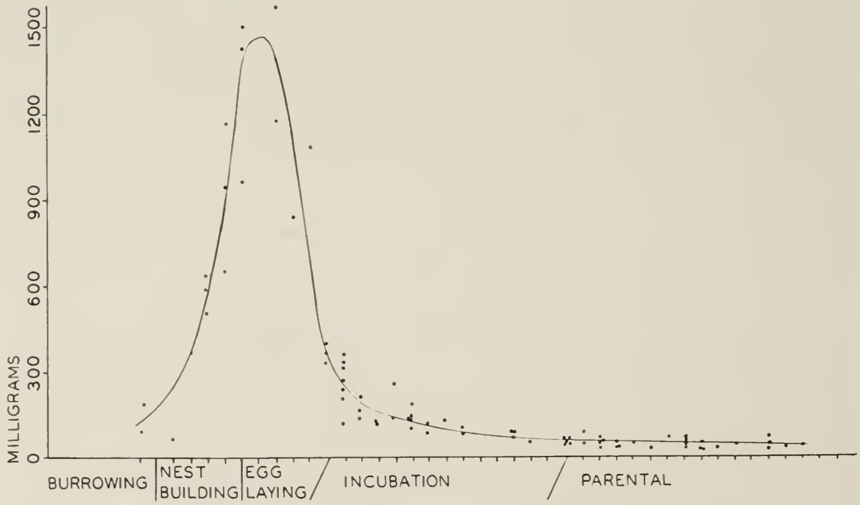

FIG. 17. Bank Swallow oviduct weights. Ova found in the oviducts during the egg-laying phase were removed before weighing.

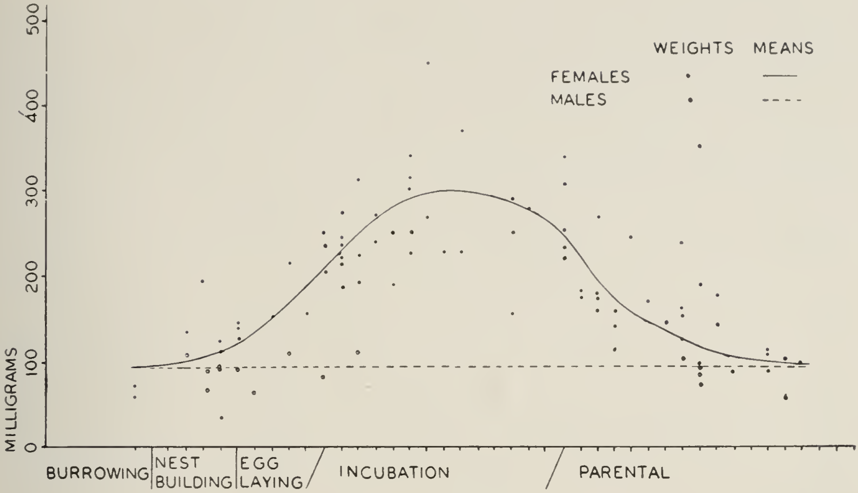

Fig. 18 Bank Swallow incubation patch weights. The open circles represent weights of ventral apteria of males, which do not develop an incubation patch.

the White-crowned Sparrow (*Zonotrichia leucophrys*) are recognized in the Bank Swallow. The following characteristics of each stage should be noted:

Stage I: Defeatherization.—This starts early in the nest-building phase and requires several days, being complete before the first egg is laid. According to Bailey the process is completed in 24 hours in the White-crowned Sparrow and Oregon Junco (*Junco oreganus*).

Stage II: Vascularization.—A remarkable development of the smooth muscle layer of the arteries not noted by Bailey suggests a possible increased development of vasomotor control of these vessels, which deserves further study. Development of such a regulatory mechanism in the incubation patch may have functional significance in conserving body heat while the female is off the egg.

Stage III: Edema.—Distension begins at the time of egg-laying in the lower dermis and as it increases, progresses toward the upper surface until at its maximum the entire dermis is edematous, limited only by a thin upper and basal membrane.

Stage IV: Recovery.—This change begins in the Bank Swallow several days before the eggs hatch, when the edema starts to subside slowly.

Before sectioning, each of the specimens collected was removed from the preserving fluid, rolled carefully on blotting paper to remove any excess of the fluid and weighed on a torsion balance. The weights (Fig. 18) correspond closely to the development and subsidence of edema. The ventral apteria of males underwent none of the changes evident in the females and maintained a uniform weight having a mean of 92.4 mgm. The incubation patches of females developed from apteria of about the same weight, and started to increase in weight during the nest-building phase. They had doubled in weight by the time egg-laying was completed and during the fifth to twelfth

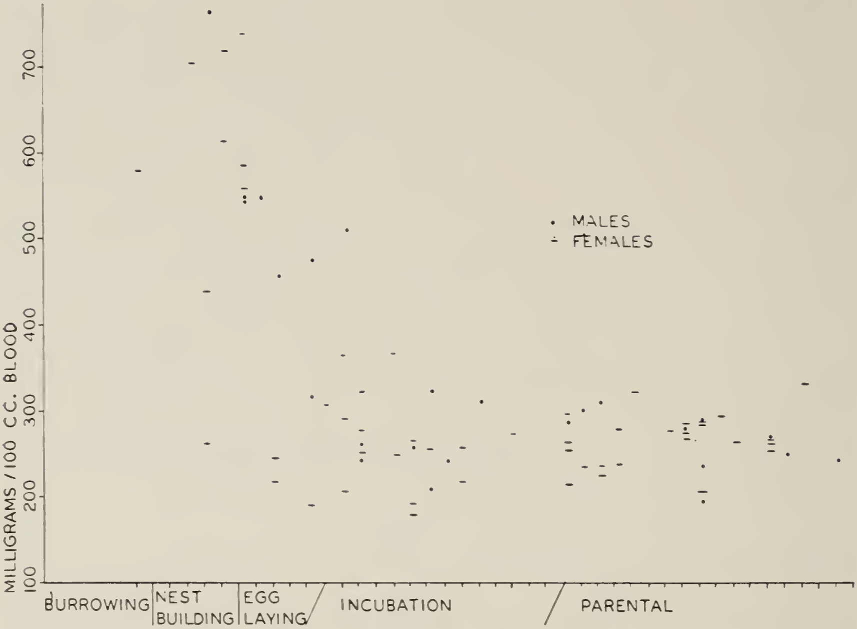

Fig. 19. Blood glucose concentrations in the Bank Swallow. Each symbol indicates the concentration in a single specimen. The mean for each phase of the breeding cycle is graphed in Fig. 20.

days of incubation, maintained a mean maximum weight of 281.0 mgm., about three times the original weight. When hatching began, a decrease in weight had started and by the time the nestlings were two weeks old, the apteria had returned to normal weight.

Blood Glucose

Blood glucose determinations were made by Reinecke's (1942) method on 52 adult females and 25 adult males taken throughout the breeding cycle. The distribution of the individual values obtained are shown in Figure 19.

Table 16

Blood Glucose Concentrations (mgm./100cc.)

Phase in Cycle	Males			Females		
	N	Mean	95 per cent c.l.	N	Mean	95 per cent c.l.
Burrowing	–	–	–	1	582	–
Nest-building	4	601	175	8	579	135
Egg-laying	4	441	136	4	240	80
Incubation	7	263	37	15	264	32
Parental	10	266	25	24	268	12

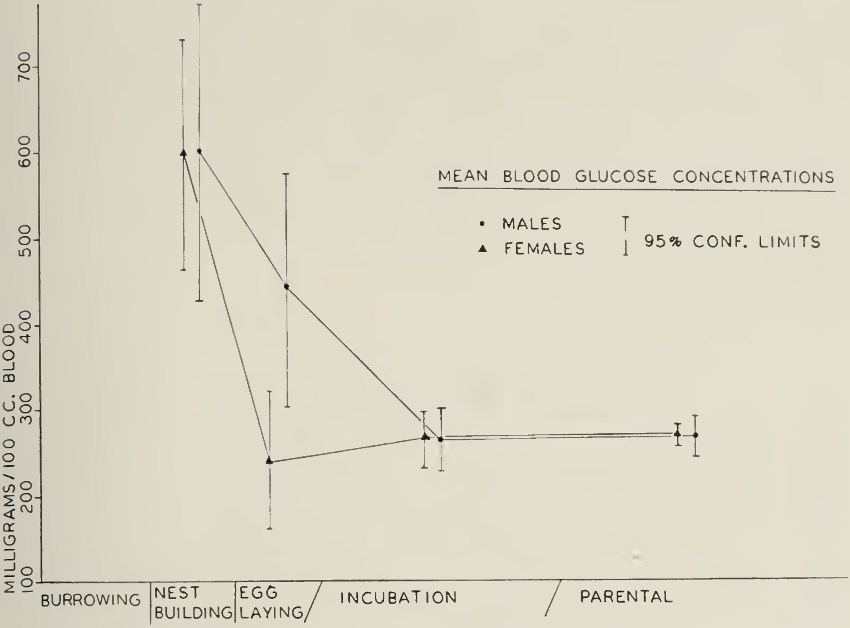

Fig. 20. Mean blood glucose concentrations in the Bank Swallow.

The means for each stage of the cycle are given in Table 16 and are graphed in Figure 20.

During incubation and feeding of young a mean level concentration of 266 mgm./100 cc. was found. Riddle and Honeywell (1924) found that most species of columbiform birds studied had a different and characteristic mean concentration of glucose (from 149 to 258 mgm./100 cc.) and Riddle (1937*b*) found that the concentration for pigeons was maintained at this normal level during incubation and feeding of young. It seems reasonable, therefore, that 266 mgm./100 cc. is the normal concentration for the Bank Swallow.

During the early stages of breeding activity, burrow digging and nest building, there was found in both sexes an elevation of 120 per cent above the level maintained during incubation and feeding of young. From this high the concentration dropped to the normal level quickly in the female and more gradually in the male. It may be conjectured that this striking elevation early in the breeding cycle is related to the high intensity of activity of the birds at that time. It seems probable that the behavior of the birds and the high concentration of blood glucose are both responses to the same hormonal stimuli. Riddle and Honeywell (1923) found a 20 per cent increase in blood sugar of pigeons with each ovulation period, beginning 108

TABLE 17
SERUM CALCIUM CONCENTRATIONS IN THE BANK SWALLOW

Age and Sex	Stage in Cycle	Serum Calcium (m. eq. Ca./l.)
Adult Female	Parental 7	4.9
“ “	Parental 8	3.6
“ “	Parental 9	3.6
“ “	Parental 13	3.4
“ “	Parental 14	3.6
“ “	Parental 15	3.8
Nestling (undetermined sex)	—	3.6
		Mean. . . . 3.8

hours before and maintained at the high level throughout ovulation. The investigations of Riddle (1937) and his associates indicate that the hormonal mechanism of this glycemia is complex. At ovulation in the pigeons a marked hypertrophy of adrenal cortical tissue is found and cortical extracts are shown to moderately increase blood sugar. Prolactin likewise experimentally produces moderate glycemia. Evidence indicates further than an additional substance from the pituitary or adrenal may have a synergistic effect.

The more rapid return to normal apparent in females tested may be due to an increased rate of utilization of glucose associated with other activities including tissue growth in the oviduct and brood patch and deposition of food stores in the eggs by the ovary and oviduct.

SERUM CALCIUM

The method of Sendroy (1942) for photoelectric determination of serum calcium in small quantities of blood was adapted with a modification in the colorimeter filter and light source recommended by W. H. Schaeffer of the Rubicon Company (personal letter). The data obtained are presented in Table 17 but are insufficient for consideration of cyclic changes.

III. CORRELATION OF BEHAVIOR AND PHYSIOLOGICAL CYCLES

A review of the main features of seasonal reproductive cycles in birds seems pertinent before examining the behavior and physiological cycle in the Bank Swallow.

The anterior lobe of the pituitary gland, under the influence of some seasonal environmental factor (such as amount of daylight or temperature) produces gonadotropic hormones which bring the testes and ovaries into breeding condition. In both sexes, two distinct gonadotropic hormones, having separate effects on the gonads, are found. Follicle-stimulating hormone (FSH) brings about growth of ovarian follicles and in the male stimulates development of spermatoza in the seminiferous tubules. An interstitial-cell-stimulating hormone (ICSH or LH) activates the interstitial cells of the testis to secretion of the male sex hormone, testosterone. ICSH is necessary for the production of the female sex hormones by the ovary. The sex hormones have the effects of stimulating development of accessory sex organs and secondary sexual characteristics and of initiating breeding behavior, including taking up of territories, mating, and possibly migration. Physiological effects shown for the female sex hormones, the estrogens, include elevation of calcium, fat, and glucose concentrations in the blood. Large amounts of estrogen have an inhibiting effect on the production of gonadotropins by the pituitary.

Another anterior pituitary hormone directly concerned in avian reproduction is prolactin. The effects of prolactin are initiation of broodiness and maternal behavior. Localized effects demonstrated for this hormone are proliferation of the crop-sac mucosa of pigeons (Riddle, Bates, and Lahr, 1935) and, in synergy with estrogen, the development of the brood patch in fringillids (Bailey, 1952).

The sequence of events in the behavior cycle of the Bank Swallow are brought together in Figure 21 and the factors of the physiological cycle in Figure 22. Physiological factors in the breeding cycle were not measured prior to the nest-building stage, but a brief review of the behavior in this period can be made.

Migration.—Determination of environmental factors effective in inducing migration in the Bank Swallow was not within the scope of this study. Observations were made, however, which indicated that once migration is underway, its rate is correlated with climatic factors. An apparent relationship was seen between time of arrival in the Madison area and temperatures prevailing for the preceding 15 days. Low temperatures may directly inhibit the migratory activity or may impede migration progress indirectly by causing a reduced food supply and necessitating longer periods of feeding. It was noted that activity upon arrival was influenced by weather conditions; fair weather with temperatures near or above normal appear to be necessary for taking up territories and associated behavior leading to pair formation.

Territorial and mating behavior.—On arrival at the breeding grounds the stage of gonadal development of Bank Swallows apparently places them in a disposition to take up territories and to mate.

Territorial behavior centers around a particular burrow. Both members of the pair identify themselves with the chosen site and defend it. The burrow screens much of the activity of the pair from other members of the colony. Thus the actual amount of territorial conflict is reduced, but the attachment to the chosen site is maintained throughout the breeding cycle, and is ex-

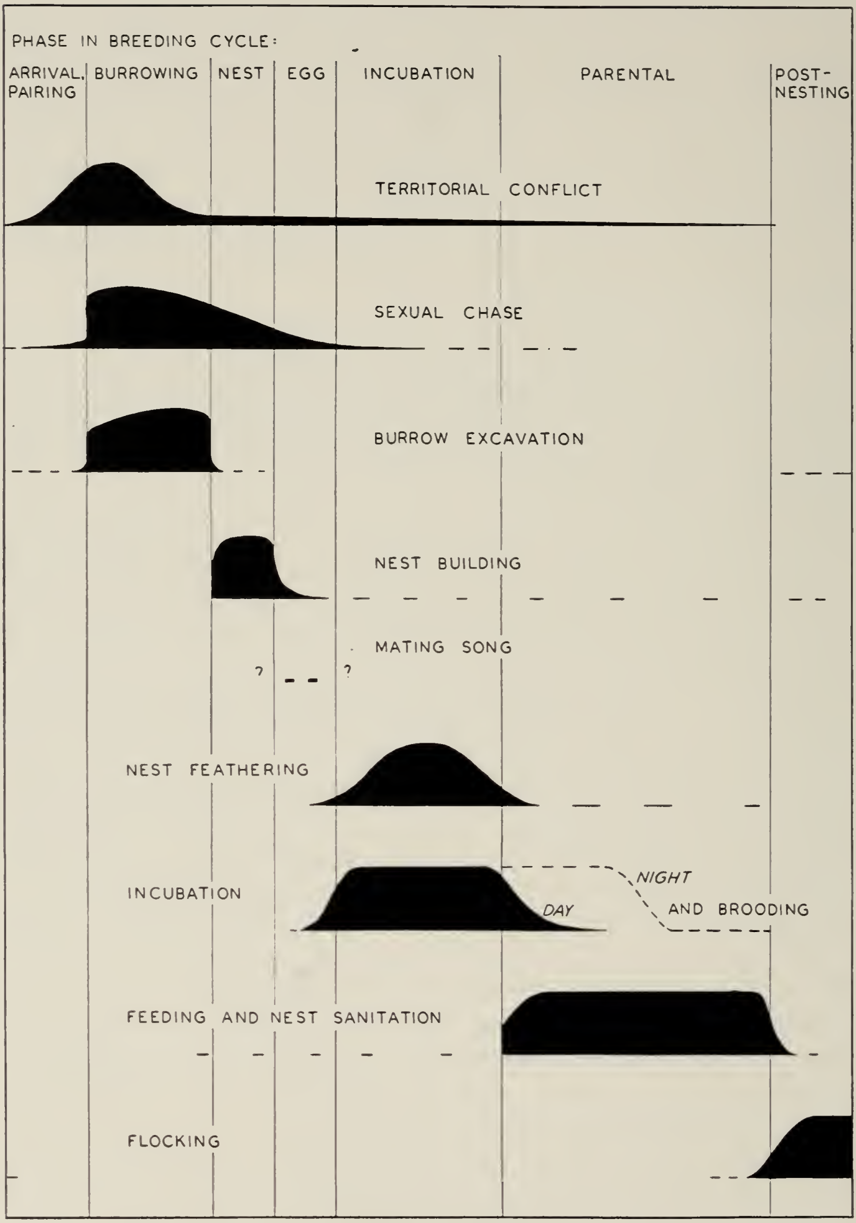

Fig. 21. Summary of behavior elements in the breeding cycle of the Bank Swallow.

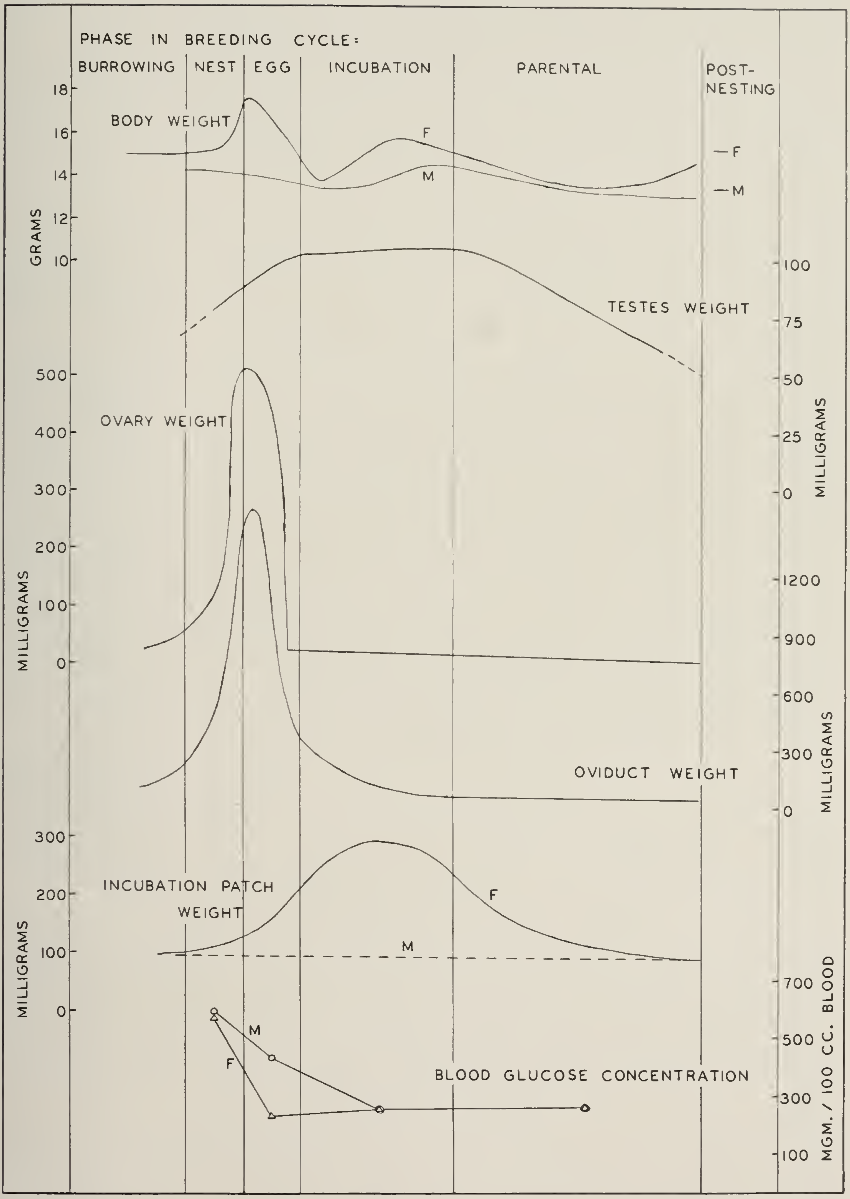

Fig. 22. Summary of physiological factors in the breeding cycle of the Bank Swallow.

pressed by territorial song, threat, or fighting whenever an intrusion occurs. As noted, birds failing to establish territories and obtain mates may leave a colony when breeding gets underway and take up sites in a different place. This also reduces the territorial conflict at the original site.

Mating in various species has been experimentally shown to occur following administration of testosterone in one (Emlen and Lorenz, 1942) or both members of a pair (Noble and Wurm, 1940*b*), or after treatment of one bird with androgen and the other with estrogen (Noble and Wurm, 1940*a*).

Sexual chase in the Bank Swallow is an activity of mated birds. Others join in, but in my observations, do not initiate the chase. This agrees with the findings of R. W. Nero (personal communication) in Red-winged Blackbirds (*Agelaius phoeniceus*). Burrow excavation likewise progresses effectively only after the pair-bond has been formed.

Burrowing and nest-building behavior.—Nest building behavior in the Bank Swallow coincides with the rapid growth of the ovarian follicles. The same correlation has been noted in the pigeon (Riddle, 1916) and Tricolored Red-wing, *Agelaius tricolor*, (Emlen, 1941). In the Bank Swallow nest-building cannot begin until a nest cavity has been excavated, so it seems necessary that some relationship exist between nest-cavity excavation and an internal condition preceding the rapid deposition of yolk. Two possible relationships may be conjectured, either one or both of which may obtain: (1) the activity of burrow and nest-cavity excavation may be motivated by developments which precede *rapid* ovum growth, or (2) excavation and associated behavior activities of the mated pair, such as sexual chase and territory defense, may serve as psychological stimuli for yolk deposition.

Development of the oviduct, as indicated by weight of that organ, follows closely after the ovary increase, but reaches a much higher weight (Note separate weight scales in Fig. 22). Egg production does not reduce oviduct weight as much as ovary weight, but by the end of the incubation period, the oviduct has returned to an inactive condition.

Copulation by mated birds was not observed but probably occurs at least during some part of the nest-building phase. Testes at this time contain large numbers of maturing sperm and relatively small numbers of free sperm in the lumens of the semeniferous tubules, indicating that as spermatozoa mature, they promptly leave the testes. Testes of later stages showed increasing numbers of free sperm in the lumens.

The sharp rise in female body weight in late nest-building can be entirely accounted for by growth of ova and the oviduct. A comparison of the weight of a complete clutch of eggs (7.36 gm. for an average clutch of 5 eggs) with the decrease of ovary weight during five ovulations (about 450 mgm.) and the difference in weight of pre- and post-oviposition oviducts (over 1100 mgm.) indicates that over three-fourths of the material of the eggs is brought into the ovary and oviduct during the period of egg-laying. Relatively little of this comes from other body stores built up in advance, since the post-egg-laying body weight of the female is little lower than her weight before the rapid growth of the ovary.

The slight decline apparent in male body weights through the nest-building and egg-laying phases probably results from the high rate of activity during this period.

The relation of blood glucose concentrations in Bank Swallows to the breeding cycle is obviously not the same as in pigeons in which Riddle and Honeywell (1923) found a 20 per cent increase in blood glucose concentrations of females beginning 108 hours before ovulation and maintained at a high level throughout ovulation, but no change in males. The intense activity apparent in both sexes of the Bank Swallow during the early phases of the cycle indicates an energy utilization distinct from the subdued activity of the domestic pigeon. Some mechanism in the Bank Swallow provides for this need by maintaining blood glucose in both sexes at more than double the usual concentrations. The concentration in egg-laying females returns to an apparently "normal" level. In the incubation and parental phases the blood glucose level is relatively stable in both sexes.

Incubation. In Bank Swallows incubation starts before egg-laying is completed and is the function of both sexes. Incubation and broody behavior have been stimulated in domestic hens by prolactin (Riddle, Bates, and Lahr, 1935). This action of prolactin is accentuated by pre-treatment with sex hormones (Collias, 1946), but is inhibited by a continuing high level of estrogens (Collias, 1940).

Bailey (1952) has shown in fringillids that full development of the incubation patch is due to the combined action of estrogen and prolactin. Estrogen causes vascularization and prolactin causes defeatherization and edema. Stresemann (1934) noted a correlation in many orders of birds between the presence of an incubation patch in either sex and the part played by that sex in incubation. Thus, in most orders, for example Colymbiformes, Procellariiformes, Columbiformes, and Piciformes, both sexes share in incubation and an incubation patch develops in both sexes. In Strigiformes, Falconiformes, and Trochilidae only the females incubate and have incubation patches. In Phalaropes only the males incubate and have patches. Among the passerines the only species in which the male is known to develop an incubation patch is the Clark Nutcracker, *Nucifraga columbiana*, (Mewaldt, 1952). Reasoning that the development of an incubation patch must have functional significance, and that the correlation in most orders between presence of an incubation patch and share of the sexes in incubation must extend also to the Passeriformes, Bailey postulates that male passerines, even where they are known to sit regularly on the eggs, do not incubate. In the Bank Swallow, the male not only sits regularly on the eggs, but in some instances was found to do so at night, and produced a temperature far above the environmental temperature. Development of broody behavior in male Bank Swallows may reflect the presence of prolactin, which in the absence of estrogen fails to produce a brood patch.

Noble and Wurm (1940*b*) found that broody behavior of Black-crowned Night Heron chicks followed treatment with male sex hormone. It is not certain, however, whether this behavior was in response to the testosterone directly or whether the testosterone stimulated the pituitary to secrete prolactin which caused the appearance of the broodiness.

Body-weight in both sexes increases during incubation and begins to decline by the end of that period. The increase may be related to the rather sudden reduction in overall activity in sitting birds. Riddle and Braucher (1931) found that pigeons gain in weight during incubation even though consuming less food per day than at other periods. No data were obtained on the amount of feeding by Bank Swallows during incubation, to determine whether the noted reduction in weight at the end of the incubation period might be related to lowered food consumption.

Feathering of the nest coincides with incubation behavior. Probably the presence of eggs in the nest is an external condition necessary for seeking and carrying feathers to the nest. The variations noted in time and amount of nest feathering may be related to success in finding feathers.

Parental behavior. In Bank Swallows feeding of the young is a response to their own young in the nest or burrow, or later, outside their own burrow. Adults were never seen to feed juveniles other than their own, either in their own or in other burrows. How early in the nestling period they can distinguish their own from other young was not determined.

Emlen (1941) found that male Tricolored Red-wings will feed any young in their own nest at any time after laying has started, but that females will respond only after incubation has started. Emlen (*op. cit.*) and Tinbergen (1939) both noted an incompatibility between sexual and parental activity. This concurs with observations that sexual phases of behavior are under the influence of sex hormones, while parental behavior is induced by prolactin, the effects of which are inhibited by the sex hormones.

SUMMARY

The purpose of this study was to analyse the behavior cycle and certain factors in the physiological cycle of a wild species of bird for correlations that might give insight into conditions that regulate breeding behavior as it occurs under natural conditions.

The Bank Swallow (*Riparia riparia*) was selected as the subject for this study because it breeds in the vicinity of Madison, Wisconsin, in large colonies and the nests are built in burrows from which the birds can be easily obtained.

The arrival dates in the Madison vicinity in the six years 1947–1952 range from April 19 to April 26. Arrival occurred before April 22 in years when the mean temperature of the preceding 15 days was above normal. Arrival was after April 22 when the mean temperature of the preceding 15 days was below normal.

The following sequence of events in pair formation was observed: an unpaired bird (probably the male) selected a burrow site, and defended it by vocal threats and physical force against intrusion. One among those which persistently returned to the defended site eventually was tolerated and became recognized by the bird holding the territory as his mate. Sexual chase and a rarely-heard mating song strengthen the pairing bond. Completed copulations were never observed and are thought to occur within the nest chamber.

Burrows were excavated only by mated birds and both members of the pair shared in the work. Excavation began slowly and erratically in burrow locations where much territorial fighting occurred. Once a burrow is about three inches deep, excavation proceeded at the rate of about five inches a day. A tendency was noted for burrows to be concentrated near the top of the bank. A positive correlation was found between amount of sand in the soil and burrow depth.

The nest chamber was usually supplied with a mat of grass, straw or roots before egg-laying began. A lining of feathers was added after the eggs were laid. Nesting materials were brought by both members of the pair.

Eggs were laid at the rate of one per day. No instances of second nestings were found in this study, but re-nestings following nest destruction were common. Mean size of first clutches was 5.0 eggs. Later clutches, believed to be re-nestings, averaged 4.0 eggs.

Incubation usually began one or two days before the clutch was completed. Contrary to generalizations made for passerine birds, males shared in incubation. An incubating male was found to raise the temperature of the eggs to 96°F., as much as 21°F. above the temperature of the unincubated nest. In two instances the male alone was found at night on nests containing eggs. The incubation period under natural conditions was found to be 15 days. Nestlings were brooded almost constantly on the day of hatching, but the amount of daytime brooding decreased rapidly during succeeding days. Both of the parents or either alone brood young nestlings at night, but the parents were rarely found at night in burrows containing nestlings over 12 days old.

Nest sanitation was maintained throughout the nestling period. The mean hourly feeding rate found in 33 nest-hours of observation in fair weather was 24.7 feedings per nest. The feeding rate was not proportionately greater in larger broods so that the number of feedings per nestling was greater in smaller broods. Males fed the nestlings more frequently than did females. After 12 days of age nestlings are frequently fed at or near the entrance to the burrow. Observation of individually-marked parents feeding nestlings having colored leg bands designating their home burrow indicated that Bank Swallows can distinguish their own nestlings from others, and will feed only their own nestlings, even when they have left their own burrow and returned to the same or another burrow. The nestlings may fly from the burrow as early as 18 days if disturbed, but usually took their first flight at about 23 days of age. In several instances the young birds were lured from the nest by reduced feeding and by calling of the parents.

Abortive burrowing and nest-building was shown by post-breeding flocks of juveniles and adults.

Data on the morphological and physiological cycles were obtained from 79 females and 35 males collected from their burrows at night, together with the nest contents from which the stage of the birds was determined.

The mean body weight of females (14.8 grams) increased with growth of the ovarian follicles and oviduct preceding ovulation, decreased with egg-laying, rose during the first half of incubation, then declined again to the end of the breeding cycle. Mean weight of males (13.7 grams) showed a similar rise and decline in incubation and parental phases.

Testes were heaviest through the incubation period. Regression started early in the parental phase and in a specimen from the seventeenth day of the parental phase, an advanced condition of regression was found.

Ovaries increased tenfold in weight during the four days preceding the first ovulation. Ova were eight or nine millimeters in diameter when ovulation occurred. Oviduct weights increased at the same time as ovary weights and reached a peak of 1500 milligrams at the time of the first ovulation.

A study of the histological and weight changes in development and regression of the incubation patch in females indicated that defeatherization started in early nest-building and required several days; vascularization produced a remarkable development of the smooth muscle layer of the arteries. The weights corresponded closely to the increase and subsidence of edema. No such changes occurred in the ventral apteria of males.

During nest-building blood glucose concentrations of both sexes were more than double the normal level of 266 mgm./100 cc. found during incubation and parental phases.

Correlations between elements of the behavior and physiological cycles were noted and discussed and comparisons made with data on other species of birds.

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SEX AND AGE RATIOS OF SOME JAPANESE BIRDS

BY H. ELLIOTT McCLURE

Over a period of more than two years, from July 1, 1950, to January 1, 1953, nearly 3,000 birds were collected in Japan, mainly by shooting (some were netted). Blood serum from these specimens was tested for neutralizing antibodies to Japanese B encephalitis virus. Since the presence of virus in mosquitoes is a midsummer phenomenon and the birds appeared to be more susceptible to attack by the virus when young, it became desirable to know when the avian population had the largest percentage of juveniles. During the period of active field work the interest lay in the collection of blood, and not particularly in the sex and age ratios of the birds. Every bird that passed before the gun was taken and, when feasible, this was continued with each species until 10 or more specimens were collected.

The object of this paper is to present the accumulated data without drawing generalizations upon the sex and age ratios of Japanese birds, since the number of specimens collected is too small in many cases. It was considered that the desired information concerning the period of greatest incidence of juveniles was obtained by a review of the age ratios of collected birds and by corollary studies of nesting species. The raw data are summarized here in order to make them available to other workers who might be engaged in investigations of age and sex ratios.

Most of the specimens were collected within a 40-mile radius of Tokyo. An additional series of several hundred was taken in Hokkaido, Northern Honshu, and in Kyushu. The habitats selected for collecting included tidal flats, marshlands, rice paddies, upland farms and forest. The upland habitat types were mixed deciduous-evergreen forest with the associated subdivisions. All of the habitats were dominated and greatly altered by man's activities.

Except where there were obvious plumage differences, such as those of the Gray Thrush (*Turdus cardis*), the sex was determined by dissection. Specimens of uncertain sex are not included in Table 1.

First-year passerine birds were separated from adults on the basis of cranial examination. Cranial "ossification" takes place rapidly in the passerine forms as demonstrated by Nero (1951. *Wilson Bull.*, 63:84–88). It progresses in a conspicuous pattern and usually is completed by midwinter. Only those individuals in which the cranium was examined are listed in Table 2.

SEX RATIOS

In the present study 2,311 specimens of 183 species were sexed. The numbers examined each month were as follows: January, 97; February,

TABLE 1

MALE-FEMALE RATIO* OF ABUNDANT BIRDS OF JAPAN, BASED UPON SPECIMENS COLLECTED FROM JULY 1, 1950, TO JANUARY 1, 1953

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Snowy Egret (*Egretta garzetta garzetta*)	—	—	—	—	1:0	1:2	2:0	—	9:12	4:1	1:0	1:1	19:16
Lesser Egret (*Egretta intermedia intermedia*)	—	—	—	—	2:3	5:4	3:1	2:0	8:28	—	—	—	20:36
Black-crowned Night Heron (*Nycticorax nycticorax nycticorax*)	—	—	—	—	1:3	2:4	2:2	0:2	17:18	—	4:4	—	26:33
Kentish Plover (*Charadrius alexandrinus nihonensis*)	1:1	—	0:1	6:2	7:2	0:1	—	—	7:4	2:5	1:1	4:1	28:18
Common Sandpiper (*Actitis hypoleucos*)	—	—	3:2	3:3	—	—	—	1:1	5:6	2:1	—	—	14:13
Eastern Turtle Dove (*Streptopelia orientalis orientalis*)	1:1	0:1	1:0	5:0	0:1	—	—	6:6	0:1	0:3	1:1	1:0	15:14
Skylark (*Alauda arvensis*)	0:2	—	6:1	17:7	1:0	6:1	—	4:0	5:3	8:5	2:0	1:2	50:21
House Swallow (*Hirundo rustica*)	—	—	4:4	—	—	—	2:1	7:2	—	1:0	—	—	14:7
Thick-billed Crow (*Corvus levaillantii japonensis*)	0:1	—	4:2	1:4	—	0:1	—	1:0	—	8:6	2:3	—	16:17
Carrion Crow (*Corvus corone orientalis*)	—	—	3:7	4:5	—	—	1:0	—	1:0	5:9	4:6	—	19:27
Blue Magpie (*Cyanopica cyanus japonica*)	—	1:1	—	1:0	3:2	1:1	8:2	5:3	0:3	—	2:1	—	21:13
Japanese Jay (*Garrulus glandarius*)	—	0:1	1:0	0:1	—	—	—	—	1:0	16:9	6:0	2:0	26:11
Brown-eared Bulbul (*Ixos amaurotis*)	0:1	2:2	4:2	7:4	—	—	—	—	—	7:7	4:4	2:1	26:21
Dusky Thrush (*Turdus naumanni*)	5:3	2:1	2:6	5:6	—	—	—	—	—	—	3:4	1:1	18:21
Pied Wagtail (*Motacilla alba lugens*)	0:1	—	9:4	5:5	—	—	—	—	—	4:3	4:4	1:3	23:20
Bull-headed Shrike (*Lanius bucephalus bucephalus*)	2:0	0:1	5:0	4:1	—	0:1	0:1	0:1	3:4	7:2	1:0	0:3	22:14
Ashy Starling (*Sturnus cineraceus*)	4:3	1:0	7:4	11:11	3:3	5:6	17:11	32:4	22:16	12:4	2:2	4:5	119:69
Tree Sparrow (*Passer montanus*)	0:3	1:0	5:6	5:3	13:19	7:8	13:18	25:6	8:4	38:30	7:10	3:7	124:113
Oriental Greenfinch (*Chloris sinica*)	1:0	1:1	7:7	12:3	0:1	—	1:0	—	—	1:0	6:5	6:1	35:18
Meadow Bunting (*Emberiza cioides ciopsis*)	4:1	1:0	10:2	2:1	1:0	1:1	—	1:1	0:1	1:4	5:12	4:11	30:24
Male-female Ratio*	18:17	7:8	71:48	88:56	32:34	28:30	49:36	84:26	86:100	116:89	55:57	30:36	665:547
Ratio of males to 100 females	105	87	148	150	94	93	136	323	86	130	96	83	123

*Figures are the actual numbers examined.

32; March, 214; April, 264; May, 127; June, 135; July, 141; August, 149; September, 289; October, 417; November, 319; and December, 123. The sex ratio based upon the total specimens and for all species was 120 males to 100 females.

Based upon the total specimens collected each month the sex ratios, expressed as males per 100 females, were as follows: January, 100:100; February, 110:100; March, 130:100; April, 150:100; May, 130:100; June, 150:100; July, 130:100; August, 240:100; September, 83:100; October, 120:100; November, 100:100; and December, 110:100. For November, December, January, and February the ratio was 100:100. In March and April, when the males were setting up territories, were singing conspicuously and were collected easily, the observed ratio rose to 145:100. During May, June, and July, when the females were secretive and occupied with nesting, the ratio remained at 140:100. With the autumn influx of young into the population, the ratio rose to 240:100. Since males may be less secretive than females and juveniles probably are less wary than adults, the appearance of juveniles in the population might weight the collections toward males. This probably accounted for the preponderance of males in August. With dispersal and migration during September and October, the ratio returned nearly to equality. It is to be emphasized that these ratios represent only those existing in the collections made and are not necessarily those of the existing population. The sex ratios of the 20 species collected most commonly are listed in Table 1. The figures presented above include data from all the 183 species collected.

Age Ratios

Since many of the specimens collected were sent to museums and since ripping of the scalp would damage the skin, only 1906 passerines were examined for cranial ossification. The numbers of passerines examined each month were: January, 22; February, 13; March, 95; April, 105; May, 49; June, 41; July, 99; August, 225; September, 126; October, 211; November, 101; and December, 52. The ratios showing incomplete ossification (immature) to complete ossification (adult) among the passerines were as follows: January, 5:100; February, 0:100; March, 1:100; April, 0:100; May, 81:100; June, 70:100; July, 312:100; August, 450:100; September, 300:100; October, 174:100; November, 300:100; and December, 62:100. The percentages of incompletely ossified crania are given in Table 2. Both methods of presenting the data show a normal accession and recession of young birds in the population.

Many factors combine to produce this phenomenon, most conspicuous of which is the maturation of the crania. In some species early migration of juveniles would affect the apparent age ratio, but for resident forms, the area under study in Japan was large enough to include the local movements of juveniles. A differential loss of individuals, greater in juveniles than in adults (Hickey, 1952. *Special Sci. Rept., Wildlife no. 15, U.S. Fish and Wildlife Serv.*), would affect the change in age ratios as well. However, because juveniles probably are less wary than adults, the data probably are weighted toward juveniles. In spite of these variables it is believed that the method used was of value in identifying the period when the habitats were permeated most heavily by birds of the year. Table 2 lists 12 of the passerine species collected in numbers greater than 25 and lists the actual numbers examined for age characters.

TABLE 2

ADULT—IMMATURE RATIOS OF SOME JAPANESE PASSERINES, BASED UPON SPECIMENS COLLECTED FROM JULY 1, 1950, TO JANUARY 1, 1953

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Skylark	2 :0	—	9 :0	24 :0	1 :0	4 :2	—	3 :1	8 :0	10 :4	2 :0	3 :0	66 :7
House Swallow	—	—	8 :0	—	—	0 :1	1 :1	6 :30	—	0 :1	—	—	15 :33
Thick-billed Crow	1 :0	—	6 :0	5 :0	—	0 :1	—	1 :3	—	11 :4	5 :0	—	29 :8
Carrion Crow	—	—	10 :0	10 :0	—	—	0 :1	0 :4	1 :2	10 :6	5 :5	1 :0	37 :18
Blue Magpie	—	2 :0	—	1 :0	5 :0	2 :0	5 :11	4 :11	0 :9	2 :3	1 :6	—	22 :40
Japanese Jay	—	1 :0	1 :0	1 :0	—	—	—	—	0 :1	6 :18	2 :4	2 :0	13 :23
Brown-eared Bulbul	1 :0	4 :0	8 :0	11 :0	—	—	—	—	—	11 :5	1 :9	3 :0	39 :14
Bull-headed Shrike	3 :0	1 :0	5 :0	5 :0	—	0 :1	0 :2	1 :2	5 :2	7 :2	1 :0	3 :0	31 :9
Ashy Starling	7 :0	1 :0	10 :0	21 :0	4 :2	5 :6	10 :23	15 :85	16 :32	10 :14	3 :2	8 :1	110 :165
Tree Sparrow	3 :0	1 :0	12 :1	8 :0	16 :19	11 :6	8 :36	9 :46	1 :43	8 :72	2 :22	4 :10	83 :254
Oriental Greenfinch	1 :0	2 :0	14 :0	16 :0	1 :0	—	0 :1	0 :1	0 :1	0 :1	0 :13	6 :2	40 :19
Meadow Bunting	4 :1	1 :0	11 :0	3 :0	0 :1	2 :0	—	2 :1	1 :4	2 :4	3 :15	2 :7	31 :33
Adult—Immature Ratio*	21 :1	13 :0	94 :1	105 :0	27 :22	24 :17	24 :75	41 :184	32 :94	77 :134	25 :76	32 :20	516 :623
Per cent with Immature Cranial Characteristics	5	0	1	0	46	41	75	81	74	62	75	38	

*Figures are the actual numbers examined.

SUMMARY

From July 1, 1950, to January 1, 1953, nearly 3,000 birds were collected in Japan for serological study, and the majority were sexed and aged by dissection. The overall sex ratio was 120 males to 100 females. The ratio varied from month to month as changes in activities of each species changed their availability to the gun. The fall age ratio in passerines (based on ossification of the crania) was three immature birds per adult. Of 183 species collected, peak numbers of juveniles were taken in September. This peak came in August in the 12 most common passerine species.

DEPARTMENT OF VIRUS AND RICKETTSIAL DISEASES, 406TH MEDICAL GENERAL LABORATORY, APO 500, SAN FRANCISCO, CALIFORNIA, AUGUST 1, 1954

THE SUMMER SCHEDULE OF THE EASTERN WILLET IN GEORGIA

BY IVAN R. TOMKINS

THE Eastern Willet (*Catoptrophorus s. semipalmatus*) comes to the coast of Georgia in spring, breeds, and is gone again by midsummer. Its close relative, the Western Willet (*C. s. inornatus*), appears as a migrant in August and September, and again in February, and a few individuals may be seen at nearly any time of the year.

This paper deals mainly with the Eastern Willets which breed on the coast of Georgia and South Carolina. This population may exist as one distinct from other willet populations of the Atlantic coast. There are many questions concerning these willets which, to my mind, remain unanswered. Where they spend the winter, in what locality the molt takes place, and their appearance in winter plumage are some of these.

I have accumulated notes on this species for more than 30 years, giving enough time for checking various conclusions, and tending to reduce some errors of brief acquaintance. Most of my field work has been done in Chatham County, the most northerly of the coastal counties of Georgia, although it has reached out at times 100 miles northward into South Carolina and an equal distance southward.

Gilbert R. Rossignol has allowed me to use his egg records, covering collections made from 1907 until about 1937. I am indebted to him for this and other considerations.

The summer residence of the willets in our locality appears to be divided into: (*a*) courtship, about three to four weeks; (*b*) egg-laying and incubation, about four weeks; (*c*) care of young, not more than four weeks, or a residence of about three months.

The calendar of our local population may be summarized in this fashion: (*a*) spring arrival, March 7 through March 30; (*b*) establishment of territory, egg-laying and incubation, April 7 through July 7; (*c*) care of young, April 30 until about mid-July. This schedule is general only, based on the normal year. From the data assembled, there seems to be but one nesting each year, and I have made no observations that would indicate re-nesting if a clutch of eggs is destroyed.

ARRIVAL

The first willets arrive about March 7, and there is a full population by the end of March, although it is quite likely a few may arrive still later. I think they arrive at night, for I have heard their ringing courtship notes in darkness prior to the observed arrival of the first individuals. I have seen no evidence of transient flocks bound elsewhere. The birds arrive in well-worn, speckled plumage and courtship is begun (or resumed) at once. For some weeks the willets flock along the shell-banks and reefs of the salt marshes, and on the sand-mud flats, but they are not found on the higher grassy areas where the nests will be abundant later. Flocks of 30 or more are common. In Glynn County, Georgia, on March 24, 1938, I counted 138 birds on a sand-mud flat, some of them feeding, others engaged in courtship activities. On April 6, 1938, in the same place I counted 80 willets.

Though a few nests are found in early April, there seems to be a mass movement onto the nesting grounds about April 20. E. Burnham Chamberlain and I drove through several miles of willet nesting habitat on April 22, 1950, and saw very few birds. The next morning we drove the same route and found willets nearly everywhere, walking across the road and among the short grasses of the road berms. In stating this belief that the courting-grounds are separate from the nesting territory, I have considered those cases where the courting-grounds are close to the nesting territory, as well as the fact that high spring tides will often drive the birds onto the territory for an hour or so. I have covered the marshes at all stages of tide and at all times of day to discount any daily or tidal rhythm in the birds' activities.

Nesting

About six days are required for the laying of the four eggs of the normal clutch, and the incubation period is 23 to 24 days (Tomkins, 1932), although Sprunt and Chamberlain (1949:232) state that the incubation in the Eastern Willet takes from 21 to 23 days. My own determination of 23 to 24 days was based on marked eggs in a number of nests, and a review of the data in my notebooks confirms that conclusion.

When Gilbert Rossignol collected a set of eggs, he listed them in his egg

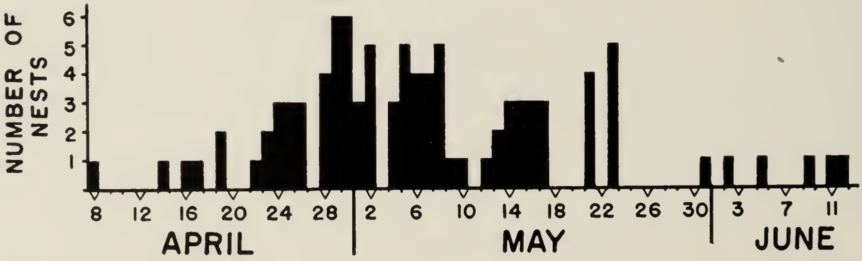

Fig. 1. Seasonal distribution of Eastern Willet clutches, corrected to the beginning of incubation.

record very carefully as "fresh," "slight" or "advanced," referring to the stage of incubation. His egg records from 1907 to 1937 were tabulated as of the date incubation began, and I have added to those the sets covered in my notes which could be corrected to date when incubation started with reasonable accuracy. All other egg records were discarded. The data are presented in Figure 1. The idea was to give a better view of the incubation season than the usual scatter-gun method of listing all dates when eggs were found. It represents nearly 50 years of nesting records (Rossignol's and mine) in the same locality.

The Post-hatching Period

After the eggs are hatched, the nest is deserted very soon, often on the same day, and it appears that the nesting territory has no special value as a home for the family. I have watched nests almost to the hatching point, then a day later found the locality deserted.

Wayne (1910:54) tells of a pair of willets carrying their young away from the nest and across the creek, one by one, until the whole brood was moved. Bent quotes several accounts of other species of shore birds carrying young as follows: European Woodcock, *Scolopax rusticola*, (1927:57); American Woodcock, *Philohela minor*, (1927:68); Spotted Sandpiper, *Actitis macularia*, (1929:90), and there are other accounts of such behavior scattered through the literature. Certainly this behavior might have survival value in marshes subject to tidal overflow, and it may account for the disappearance of the brood from the nesting territory.

The adults are active over the wetter portions of the salt marsh shortly after the eggs are hatched, and show little interest in the nesting territory. It is very difficult to find the young ones then, as the marsh grasses are high enough at that season to provide effective cover. It is also hard to separate the activities of family groups from then on, as one shrieking willet attracts others from far and near, but if one watches from a distance it appears that there is a loose gathering into groups of several families very soon after hatching. Probably as the sexual activity wanes, there is a return of the normal gregariousness characteristic of the greater part of the year, which has to some degree been held in abeyance by the territorial behavior.

On June 29, 1953, Herbert L. Stoddard collected a male willet here that was going through the usual noisy defense of the young presumably hidden in the marsh. This bird had testes about the size one would expect in a winter bird. We thought then that the gonadal regression of the post-breeding season was proceeding rapidly. Both parents share in the incubation duties and both appear to assist in the defense of the young.

FIG. 2. Incubating Eastern Willet, photographed at Oysterbed Island, Georgia, by Frank N. Irving. Note wear of dorsal plumage.

Fall Migration and Molt

Most of the willets simply disappear from the Georgia coast during late June and July. In an earlier account (Tomkins, 1932), I stated that young and old gather on the beaches for a time prior to southward migration. That statement I now believe to be in error. The flocking which some species exhibit prior to their departure is not conspicuous in this willet population.

There is no time in the brief summer stay of *C. s. semipalmatus* for any extensive molt, either prenuptial or postnuptial. This statement appears to be in contradiction to that of Bent (1929:32) who wrote: "Adults have a nearly complete prenuptial molt in March, April, and May, involving everything but the flight feathers of the wings, which are apparently molted later in the fall or early in the winter. I have not actually seen these feathers molting." Bent was writing of the race in its entirety, and I do not know what the molting birds that he mentions were. Our birds arrive in worn plumage, and continue so during their stay here. The Charleston Museum has no specimen showing what *C. s. semipalmatus* looks like in fresh plumage. Perhaps sometime I shall find a delayed migrant here after the postnuptial molt. The plumage of our breeding birds is well illustrated by the photograph (Fig. 2) which was made by Frank N. Irving over thirty years ago, on Oysterbed Island, Georgia. I am grateful to Mr. Irving for permitting its inclusion here.

The Western Willet

It is desirable to discuss briefly the position of *C. s. inornatus* in this locality. There is a fall migration of this race along the sandbars and outer beaches in late August and September, but the spring migration in February is not so marked, and may easily be missed. Some specimens taken on February 22, 1954, from a flock asleep on the beach in the forenoon had empty stomachs, and were most certainly migrants. A few individuals may be seen at any time of year. Some places will have a few summering birds, or some that stay all winter. The Western Willet occupies a more restricted niche than the Eastern, for it does not frequent the muddy creek banks as commonly, preferring beaches and oysterbeds. The stomach of one specimen of *inornatus* contained many small bivalves and some shrimps of the genus *Palaemonetes,* while three specimens of *C. s. semipalmatus* contained only the remnants of small crabs of the genera *Uca* and *Sesarma.* In summer the foraging range of *semipalmatus* reaches into that preferred by *inornatus*, and it is not unusual to find a shrieking pair of Eastern Willets walking among small groups of the Western form.

Field identification of the two forms is possible with a high degree of accuracy. The Western Willet is fully a head taller and is a gray bird lacking the heavy streaking of *semipalmatus*. The grayer bird stands out in flight in a good light. When specimens are in hand, it is clear that the lightly-barred breast feathers of *inornatus* could never wear into the heavily speckled ones of *semipalmatus* as we see it here.

Summary

The Eastern Willet (*Catoptrophorus s. semipalmatus*) spends about three months on the coast of Georgia and South Carolina in spring and early summer. This time is divided about equally among courtship, nesting and care of the young. Courtship takes place on exposed reefs in salt marshes and on tidal mud flats, whereas the nesting territories are located in grassy upland areas. I have found no evidence that molting occurs during the willet's summer stay on this coast.

The Western Willet, (*C. s. inornatus*) passes through in fall and in late winter, and a few remain at other times of the year. This subspecies occupies a more restricted niche than the Eastern Willet, and may be distinguished readily from it in the field.

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1231 East 50th Street, Savannah, Georgia, November 7, 1954

THE AUXILIARY BARREL

BY LOYE MILLER

There has been much shifting of emphasis in the study of Vertebrate Zoology since I embarked upon it (even though crudely) more than sixty years ago. Still, the collecting of specimens in the field is not an obsolete procedure by any means.

Scarcely a week passes that I do not have inquiry from some graduate student regarding equipment for shooting birds, reptiles or small mammals. Their problem is still a real one. Expert machinists are expensive to employ and they lack familiarity with the problem; hence the present day "do it yourself" slogan might well be brought into play. Adult education classes in night schools at many localities offer facilities and training in the use of power tools. I "learned by doing" forty years ago. Why not try it? These suggestions are offered, therefore, to the novice.

My earliest efforts to avoid the "half-load" for standard-bore shot guns were directed toward the shot pistol (Miller, 1893;1915), a device that still has a very definite function (Schmidt, 1951). Quite a number of shot pistols have been put into circulation for my colleagues and students. They are of great importance to the herpetologist and to the man who "travels light." The auxiliary barrel, however, is the most serviceable device for the serious collector who is working in country with a diversified fauna. A fairly large bore double-barreled shotgun with a .38 caliber (or .410 gauge) and a .22 caliber auxiliary barrel make up a good general armament. Even a few shells loaded with a solid slug to represent the opposite "end of the spectrum" may properly be added to the list.

My first "aux", acquired in 1894, was made by taking one of the brass shells of my 16 gauge gun, boring out the anvil at the base, thrusting in a 10 in. length of brass tubing with an inside diameter of .375 in. and then pouring melted lead into the shell around it. The device was pretty crude and tended to "shoot loose" after a while but it survived many thousands of rounds of firing and was used fully four times to the large barrel's once.

My next effort at improvement (with accent on the effort) was to drill lengthwise through 10 inches of Ford axle with a long-shanked 3/8-in. drill, then remove excess metal beyond the chamber. Automobile axles nowadays are made of "sterner stuff" so commercial *cold roll* steel or even "Duralumin" is employed for our purpose though duralumin is a bit "tricky" to bore after the first inch of penetration. The total length also has been reduced to less than 6 inches for .38 auxes in 16 bore guns. Duralumin and brass have been abandoned because they bruise too easily if dropped.

Ejectors were fitted into the first dozen or so of the .38 and .410 auxes which I made but the practice was abandoned after proper methods of chambering were developed. The exploded shell is easily plucked out with the thumb and middle finger nails if the chamber is right and is free from fouling.

This museum has standardized its equipment as 16 bore guns with .38 and .22 caliber auxes. At the present moment we are able to buy and stock "Shelby Seamless Steel Tubing" in proper diameters and bore so that it will ream and polish to .38 and .22 calibers. The proper length tube is then "sweated" into a steel block of proper size for the gun chamber. In the final reaming of .38 or .410 pistol barrels the reamer used has the ultimate 1/4 inch of the point tapered by 10 one-thousandths of an inch. This permits leaving a choke of .005 to .010 inches in the bore, a matter of great importance in the shot pistol.

The initial boring. Boring for a center fire cartridge is a relatively simple procedure. The stock selected must be of diameter sufficient to allow for the maximum diameter of rim at the breech. Cut off the desired length of stock rod, true up the ends, center each end with precision and clamp the work in a lathe dog. Select a twist drill at least 1/32 in. smaller than the desired bore. (Better still, select two drills 1/16 in. and 1/32 in. smaller than the bore and bore twice). The standard twist drill can easily be extended by drilling and tapping the shank and screwing in the desired length of drill rod of proper size.

Place the drill in the lathe chuck, bring the work against the drill point, bring the tail stock center up against the opposite end and tighten slightly. Rest the tail of the lathe-dog against the tool carriage and start the lathe slowly, keeping up gentle pressure by feeding in the tail stock screw. After the drill has gotten properly started the lathe speed may be stepped up, but in a long boring there is a tendency to heat up and the drill binds in the hole. A little patience is a good investment. Use plenty of cutting oil. Withdraw and remove chips frequently especially during the first cut. If your drill is properly ground, with the two lips of equal length and angle, it will follow through straight to the tail stock center. (Don't run too far and cut off the tip of that center). A poorly ground drill results in much grief and a discarded piece of work. Repeat with the second drill and follow with a six-fluted reamer tapered at the tip as suggested above and you will have a fairly smooth bore. A piece of 1/4-in. birch dowel, spiral-wrapped with a strip of crocus cloth, will give the final polish.

Boring for the .22 caliber introduces a new factor. A rim-fire cartridge must be struck by a center-fire firing pin. Theoretically the bore should be off center by 1/2 the diameter of the cartridge—i.e. .125 in. (This offset however could not be used in making a .22 aux for a .410 shotgun.) By trial and error I learned that an offset of .080 in. failed to fire, one .090 inches generally fired but one .100 inches was certain if the firing pin were exactly centered (Fig. 1). Too great an offset brings the pin too

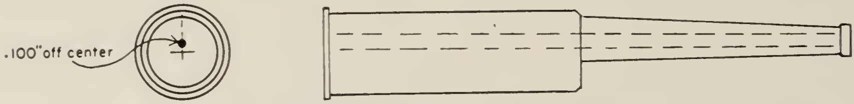

FIG. 1. Ground plan for .22 caliber auxiliary barrel for 16 gauge shotgun. Drawing by Lois C. Stone.

abruptly against the steel block, and one gun with which I had experience tore off the rim of the aux because of its too-powerful hammer springs. The rim gradually yielded with the repeated shocks.

In drilling for a .22 aux the procedure is much the same as for the .38 caliber, except that the offset must be accurately determined and must be on the same radius at each end of the work. This is accomplished readily by using the cross feed screw of the tool carriage which is graduated in thousandths of an inch. Bring a sharp-pointed cutting tool to the exact center, then retract exactly .100 inches and cut a very slight groove. Any point on this circle will have the proper offset. Drag the point lightly across the end and then along the side of the work. Reverse the work in the chuck, continue the fine scratch along the side, then across the face and to the exact center. Retract the cross feed exactly .100 in. and cut a shallow circle: Where the radius scratch intersects this circle determines your point. You then have points on opposite ends of the work that represent the ends of the drilling axis which is parallel to the center axis and .100 in. from it. Place one of these points against the drill and the other against the tail stock center, then proceed with drilling as described above.

In drilling for a .22 aux for .410 gun, a little "fudging" is done in order to leave more supporting metal where the aux tube extends beyond the .410 chamber. The muzzle center is not offset. Theoretically this is all wrong, but practically we find just as good patterns resulting, probably for the following reason: after the charge leaves the aux muzzle the gases confined within the gun bore "shepherd the shot" all the way to the gun muzzle. A little eccentricity at the breech seems to be of minor importance.

Removing excess metal.—Replace the chuck with a face plate and active center. With a lathe-dog the work can then be made to rotate on the axis of its bore between the active center and the tail stock center and against the cutting point. The barrel of the aux, beyond the block, can thus be reduced to the desired thickness and taper. It is wise to leave a slight collar at the muzzle of the aux for the following reasons: (1) it reduces danger of denting the muzzle; (2) it sets up vortex currents in the gas that might otherwise be carried back to the gun chamber. Any deposit of unburned carbon would then tend to form near the muzzle of the aux, thus reducing any tendency to fouling that might cause the aux to stick in the gun chamber.

Chambering the aux. Herein lies the potential source of greatest grief—the stuck shell that has to be rammed out with a stick. The chamber must be extremely smooth and should fit the shell snugly enough so that the brass shell cannot expand beyond the limit of its elasticity and yet will slip out when heated by the discharge.

For the .22 chamber I finally obtained and modified a special chambering reamer for .22 "Long rifle" barrels. This is a six-fluted reamer with a 7/32-in. pilot. The proximal shoulder was cut back sufficiently to allow penetration of the cutting flutes farther into the bore and accommodate the full length of the discharged shot shell. Since modifying the reamer we have had no trouble.

TABLE 1
DRILL AND REAMER SIZES FOR MAKING AUXILIARY BARRELS

Caliber	1st drill	2nd drill	Bore reamer	Chamber reamer
.22	3/16 = .1875 in.	13/64 = .203 in.	7/32 = .2187 in.	Special .227, piloted
.38	21/64 = .328	11/32 = .3475	3/8 = .375	3/8 expansion reamer
.410	3/8 = .375	25/64 = .390	13/32 = .406	13/32 expansion reamer

At this museum we use brass .38 shells retrieved, in part, from the pistol ranges of the police department. Shells are reloaded indefinitely and are "sized" before each reload. A 3/8-in. expanding reamer is used in chambering the auxes. By repeated cut and trial a very nice fit can be accomplished.

In .410 chambers we use stock paper shells. These give less trouble and I have gotten by with a 15/32-in. six-fluted reamer, though a little juggling may be called for on account of the variable brass base of the shells. A 15/32-in. expanding reamer will do this trick—if you have one.

Countersinking the chamber.—The cartridge must be countersunk into the aux a distance equal to the thickness of its rim in order that the breech may be closed.

If you install an ejector, this recessing is best done with a piloted counter bore of proper size (if you have one). The simpler procedure as finally adopted here is as follows: grip the aux in the chuck nearly up to the rim. By using a round-nosed cutting point held at right angles to the aux breech and carefully manipulating the cross and the longitudinal feeds, you can make a shallow open basin in the breech surface that will fully seat the cartridge and also allow room for the finger and thumb nails to pluck out the exploded shell.

If your chambering has been properly done and the aux accurately fitted to your gun you will have a serviceable item of equipment that, if protected from fouling, should give carefree service—until you lose it.

The values given in tables 1 and 2 may be of assistance.

TABLE 2

APPROXIMATE CHAMBER SIZES IN SHOTGUNS

Gauge	Rim diameter	Tapers from —	to
12 ga.	.900 in.	.804 in.	.800 in.
16 ga.	.810	.740	.730
20 ga.	.750	.694	.687
.410 ga.	.530	.474	.468

THE SHOT PISTOL

The shot pistol presents a dual problem. Making a smooth-bore barrel involves no great modification of parts of the above discussion. The main problem is to obtain a lock and stock that is rim fire for .22 or center fire for .38 and which has a cylinder long enough to accommodate the desired cartridge.

If you are in a position to purchase a new gun, follow your own taste. Iver-Johnson Company makes a .22 caliber target revolver with six-inch barrel that is designed for standard "Long-rifle" ammunition. By ordering from the factory they will provide at the same price, the barrel before the rifling grooves are cut. For short range collecting this needs no modification.

If the barrel is unscrewed and replaced with a nine-inch barrel, the range is greatly extended. A 9-inch choke bore for .38 caliber or 12-inch for .410 gauge will make an excellent collecting pistol. If the barrel will not unscrew, cut it off to a stub, drill it out with a drill smaller than the outside diameter of the new barrel, turn down the outside of the new barrel to the proper size and distance so that it slips into the stub and stops against a square shoulder. This reduced part of the shot barrel is then sweated into the stub snug up to the shoulder. If your machining has been done accurately, the junction is scarcely discernible.

A great variety of pistols, old and new, have thus been converted to peaceful function for the ornithologist or the herpetologist.

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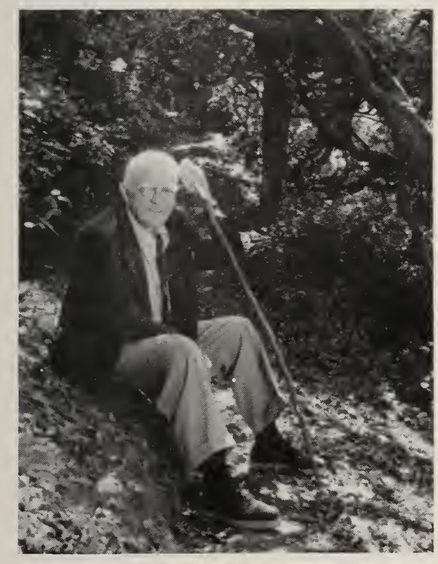
MUSEUM OF VERTEBRATE ZOOLOGY, BERKELEY, CALIFORNIA, MAY 18, 1955

NEW LIFE MEMBER



Loye Miller, Professor of Biology, Emeritus, at the University of California at Los Angeles, is noted for his contributions to three areas of activity, vertebrate natural history, avian paleontology, and the teaching of biology. A legion of his former students refer to him affectionately as "Padre." Professor Miller, a Fellow of the American Ornithologists' Union, took his Ph.D. in paleontology at the University of California in 1912. Since that time he has investigated a variety of topics ranging from natural history of pelagic birds to territoriality in owls. A rich chronicle of his experiences as a naturalist is recorded in his book "Lifelong Boyhood," published in 1951. For the past several years, Professor Miller has lived in the home of his son, Alden H. Miller, in Berkeley and has maintained an office in the Museum of Vertebrate Zoology.

GENERAL NOTES

Distributional and breeding records of some birds from Coahuila—Summer field parties from the Museum of Natural History at the University of Kansas have collected in the past six years several hundred birds from the Mexican state of Coahuila. Several specimens from this collection warrant special consideration and are discussed below.

Recurvirostra americana. American Avocet. A small breeding colony (8 pairs) of this species was discovered by Robert W. Dickerman on May 19, 1954, 8 miles east and 2 miles south of Americanos, on a large grassy playa traversed by rows of creosote (*Larrea tridentata*). A male (KU 31433) and a female (KU 31432) were obtained. The latter was taken from a nest containing four partly-incubated eggs. Four eggs in a second nest contained well-developed, downy young. Breeding Avocets were previously reported in Mexico only from the state of San Luis Potosí (Friedmann, Griscom and Moore, 1950. *Pacific Coast Avif.* 29:101).

Otus scops flammeolus. Flammulated Screech Owl. Two specimens of this comparatively rare owl were collected by R. W. Dickerman: male (KU 31600), weight 50 gms., testes 8 mm. long, on April 4, 1954, 20 miles south of Ocampo, elevation 6000 feet, pine-oak association; male (KU 31581), testes 10 mm. long, on April 9, 1954, 13 miles east of San Antonio de las Alazanos, elevation 9345 feet, pine-spruce-aspen association. Each specimen has a suffusion of cinnamomeous pigmentation, but represents the grayish phase, as described by Ridgway (1914. *U. S. Nat. Mus. Bull.* 50:729). To my knowledge, these specimens constitute the first records of this owl in the state.

Chordeiles minor howelli. Booming Nighthawk. R. W. Dickerman secured a male (KU 31443) on May 16, 1954, 3 miles north and 4 miles east of San Francisco, elevation 4850 feet. This migrant seemingly represents the first record of the subspecies in Coahuila. Nighthawks were heard and seen frequently in this area, and seven birds were observed in flight simultaneously.

Certhia familiaris americana. Brown Creeper. Van Tyne and Sutton (1937. *Misc. Publ. Mus. Zool., Univ. Mich.*, 37:67) recorded a wintering bird of this subspecies as far southwest as Hot Springs, Brewster County, Texas. Data from two specimens collected by R. W. Dickerman are as follows: female (KU 31612), taken on November 27, 1953, at the base of the Don Martin Dam; female (KU 31587), taken on April 5, 1954, 20 miles south of Ocampo. The latter was originally identified by A. R. Phillips. These specimens constitute the southernmost records for the subspecies. I find no previous records in the literature of the Eastern Brown Creeper in Mexico.

Ridgwayia pinicola. Aztec Thrush. A male (KU 31619), the skull of which was incompletely ossified, was taken on December 15, 1953, by R. W. Dickerman, 5 miles west and 22 miles south of Ocampo, elevation 6000 feet, and seemingly represents the northernmost record for this species, which was previously unknown in Coahuila.

Vireo atricapillus. Black-capped Vireo. Four specimens were taken as follows: 2 males (KU 31493–31494), testes enlarged, May 8, 9, 1954, 16 miles east and 18 miles north of Ocampo (R. W. Dickerman); 2 unsexed specimens (KU 32099–32100), July 3, 1952, Sierra del Pino, 6 miles north and 6 miles west of Acebuches, elevation 5250 feet (Sydney Anderson). These specimens seem to extend the known breeding range of the species south to central Coahuila.

Vireo flavifrons. Yellow-throated Vireo. Bent (1950. *U.S. Nat. Mus. Bull.* 197:288) states, "From the records it appears that within the last generation the yellow-throated vireo has extended its range southward or at least has increased in members in the southern part of its breeding range." Harrison B. Tordoff collected a male (KU 32103) on June 20, 1952, 2 miles west of Jiménez. This bird was in full breeding condition, and is the first record of the species in Coahuila.

Vireo solitarius cassinii. Solitary Vireo. A male (KU 31589) was obtained by R. W. Dickerman on July 4, 1954, 20 miles south of Ocampo. The subspecies was previously unrecorded in Coahuila.

Molothrus ater ater. Brown-headed Cowbird. One female (KU 31513), was shot by R. W. Dickerman from a flock of eight birds on May 3, 1954, 21 miles south and 11 miles east of Australia. It measured: wing, 102 mm.; tail, 64 mm.; culmen, 17 mm.; tarsus, 26 mm.; ovary 8×4 mm. I find no previous records of this subspecies in the state.

Passerina cyanea. Indigo Bunting. A male (KU 31544) was collected by R. W. Dickerman on May 5, 1954, in San Marcos. This bird (testes 5×4 mm., moderately fat, in worn plumage) was observed chasing another male, and the pursuer in turn, was followed by a female. The territorial behavior (observed for 2 hours) of this bird suggests the possibility of breeding, but no nest was found. This specimen seems to provide the first record of the species in the state.

Aimophila cassinii. Cassin Sparrow. A male (KU 32158) in breeding condition (testes 7×5 mm.) was obtained by Sydney Anderson, 18 miles south and 14 miles east of Tanque Alvarez, on July 6, 1952. Another male (KU 32157), having testes that measured 5×3 mm., was taken by H. B. Tordoff, 9 miles south and 11 miles east of Sabinas, on June 14, 1952. This species was previously unrecorded in the state. —S. G. VAN HOOSE, *Museum of Natural History, University of Kansas, Lawrence, Kansas, March 12, 1955.*

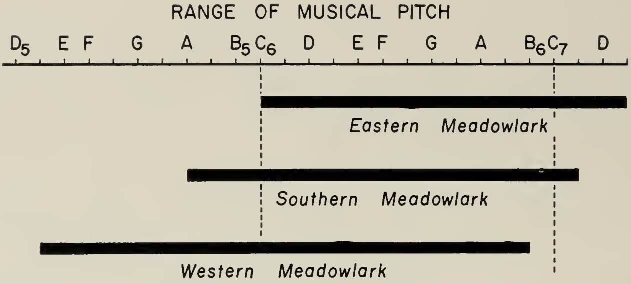
An analysis of the songs of meadowlarks.—In my collection of field records of songs and calls of birds made during the past 40 years, there are 1,050 records of the Eastern Meadowlark (*Sturnella magna magna*). These were obtained largely in Connecticut, but also in several other eastern states. In the years 1950 and 1951 opportunity to travel elsewhere was presented, and I collected 31 records of the songs of the Southern Meadowlark (*S. m. argutula*) in Florida, Georgia, South Carolina, and southern Illinois. I also recorded songs of Western Meadowlarks (*Sturnella neglecta*) on 88 occasions in Oklahoma, Iowa, the Dakotas and Minnesota.

Detailed study of these records leads me to the interesting conclusion that the songs of the southern bird are intermediate between those of the eastern and western birds. This is not particularly apparent in merely listening to the songs, for the qualities of the eastern and southern birds are similar, neither having the gloriously musical voice that the western bird possesses. But details show that the southern bird is closer to the western than is the eastern.

In the matter of time the songs of eastern birds vary from 0.4 to 3.2 seconds in length, averaging 1.55 seconds. The southern bird varies from 0.8 to 1.4 seconds, averaging 1.0 seconds. The western bird varies from 0.6 to 1.8 seconds, averaging 1.2.

The number of notes in songs, counting a slur as two notes, varies from 2 to 9 in the eastern bird, averaging 4.7. The southern bird varies from 3 to 7, averaging 4.6 and the western bird varies from 3 to 11, averaging 6.34.

The pitch of the eastern bird ranges from C_6 to $D\#_7$, a range of 7½ tones. The southern bird is distinctly lower, ranging from A_5 to $C\#_7$, a range of 7 tones. The western bird ranges still lower, from $D\#_5$ to B_6, as shown in the accompanying figure. It is significant that in only 31 records of the southern bird I should find notes 1½ tones lower than the lowest of more than 1,000 records of the eastern bird.



Individual songs of the eastern bird range from 1 to 6 tones in pitch, averaging 2.85 tones. Those of the southern bird range 1½ to 5 tones, averaging 3.17, while those of the western bird range from 2 to 8 tones, averaging 4.3.

In the less exact matter of phonetics, the eastern bird is often entirely clear of phonetic sounds, so far as my ear can determine. Some notes, however, begin with a sound like the letters *ts*, and some link notes together with a sound like the letter *l*. In all of my records only 34 (3.2 per cent) contain the *ts* sound. The *l* sound was found in 112 (10.6 per cent). In the southern bird both *ts* and *l* sounds occur in every song I have recorded. In the western bird *l* sounds occur in every song, and explosive consonants, more like *t* or *k* occur in most of them.

In considering single notes, the eastern bird often sings prolonged notes and slurs, while the southern and western birds sing short, explosive, somewhat staccato notes. However, in the western bird, these are frequently linked together with *l*-like sounds between them.

From these data I would conclude that the Southern Meadowlark is like the Eastern in quality and number of notes, but is intermediate between Eastern and Western in time, pitch and partially in phonetics. It is like the Western Meadowlark in the shortness of notes and the abundant *l*-like consonant sounds. On the basis of certain aspects of the songs, it seems to me that the southern bird is farther removed from the Eastern Meadowlark than its current taxonomic position indicates.

The opportunity to travel and to obtain the data on which this paper is based was afforded by a grant from the American Philosophical Society.—ARETAS A. SAUNDERS, *P.O. Box 141, Canaan, Connecticut, March 23, 1955.*

Cattle Egret in Virgin Islands.—On the morning of February 21, 1955, Mr. Anton Teytaud and I visited a pasture at Sprat Hall, St. Croix, Virgin Islands, from which Cattle Egrets had been reported. Immediately upon our arrival at this pasture we sighted 26 white herons. These birds were feeding among a small herd of cattle. An adult Little Blue Heron flew up as we stopped our vehicle. This led us to suspect that these reputed "African Tick Herons" were nothing but immature Little Blue Herons (*Florida caerulea*).

A quick-stalking, heavy-jowled heron near us began weaving its neck in a peculiar snake-like fashion. It suddenly grabbed an insect flushed by a browsing cow. This was no Little Blue Heron. A careful look through binoculars convinced us that these birds were actually Buff-Backed Herons, *Ardeola* (*Bubulcus*) *ibis.* Here before us was not one lone, wind-tossed straggler cast peradventure on this tiny sea-girt island, but a whole flock of 26 rare birds contentedly feeding as at home as could be. None of these egrets was in breeding plumage and only a few exhibited touches of buff on crown, throat and mantle.

After some difficulty a specimen was secured. As the dead bird lay on the pasture the rest of the flock gathered over it in graceful circles.

The bird collected was an immature male. Its measurements were as follows: wing, 234 mm.; tail, 90; tarsus, 87; bill, 56. The iris was yellow, the feet black, and the undersides of the toes yellowish-green, and the tarsus pale yellow. The stomach contents, identified by Dr. George N. Walcott, Agricultural Experiment Station, Rio Piedras, Puerto Rico, were:

	Number	*Per cent of contents*
Schistocerca americana Drury	1	55
Neoconocephalus triops (Linn.)	1	15
Scyllina (*Plectrotettix*) *gregarius* Saussure	7	14
Acheta simmilis (F.)	2	6
Oecantha niveus DeGeer	1	2
Undetermined spiders	3	6
Carabid beetles	3	2

It is to be presumed that these herons came from Puerto Rico, some 90 miles to the northwest of St. Croix. It is estimated that about 100 are presently on the island.—G. A. SEAMAN, *Box 472, Christiansted, St. Croix, Virgin Islands, March 30, 1955.*

Behavior of migrating birds at sea off San Diego, California.—On April 13, 14, and 15, 1954, the U.S.S. Mount Katmai (AE-16), in which I was serving at the time, was conducting training exercises in a limited area centered 40 miles from San Diego, California, and 15 miles south of San Clemente Island. All three days were overcast, with fog present in varying density at all times. For an hour or so around noon on the 13th four or five Hermit Warblers (*Dendroica occidentalis*) flitted about the ship. Several female Myrtle Warblers (*Dendroica coronata*) were present at the same time. On the next day at about the same hour two Pileolated Warblers (*Wilsonia pusilla*) were seen in company with a small flock of Audubon Warblers (*Dendroica auduboni*) and Myrtle Warblers. Later in the afternoon of the 14th several Mourning Doves (*Zenaidura macroura*), several Audubon Warblers, a Yellow-throat (*Geothlypis trichas*), a Green Heron (*Butorides virescens*), an Ash-throated Flycatcher (*Myiarchus cinerascens*), and an unidentified wren and hummingbird were noted around the ship. On the 15th of April—again around noon—four White-crowned Sparrows (*Zonotrichia leucophrys*), two Sanderlings (*Crocethia alba*), a Black Turnstone (*Arenaria melanocephala*), and an unidentified "peep" sandpiper were seen. At the same time a Rufous Hummingbird (*Selasphorus rufus*) and a Pileolated Warbler were captured by sailors who simply placed their hats over the resting birds.

Opportunities for observation were available at frequent intervals during the three days but neither land nor shore birds were seen at times other than those described. Most of the birds appeared fairly active; the doves, the heron, and most of the warblers would fly out from the ship, sometimes for some distance, and would then circle for a bit before finally returning to alight again on the ship. The turnstone never was seen to land, but for some time coursed low back and forth and roundabout, frequently passing close to the ship's side. The Mount Katmai had one radar set operating at all times, and an additional one in operation most of the time. Other ships in the vicinity presumably always had at least one piece of radar gear in operation also. Whether these electronic emissions causally contributed to the behavior of the birds observed can only be guessed at.—JOHN B. CROWELL, JR., *49 Irving Street, Cambridge 38, Massachusetts, April 30, 1955.*

Hatching of Wood Duck eggs after abandonment.—In the course of studies on the Wood Duck (*Aix sponsa*) at the Patuxent Research Refuge, Laurel, Maryland, I observed an instance of incubation after the eggs apparently had been abandoned by the duck. Several eggs hatched in a nest box during warm summer temperatures, without evident benefit of a setting bird.

On June 15, 1953, a female wood duck was flushed from its nest box containing 15 eggs which were warm and surrounded by a scant amount of down. On June 23 I removed the duck from the nest and fastened over the entrance a protective wooden tunnel of the type designed by the Massachusetts Division of Fisheries and Game to exclude raccoons, *Procyon lotor*, (McLaughlin and Grice, 1952. *Trans. N. Amer. Wildl. Conf.*, 17:242–259).

Five days later, on June 28, the nest box was inspected again but no duck was present. Instead, raccoon hairs were found at the entrance of the tunnel though not on the inside. There appeared to have been no change in the nest since the previous inspection. An "X" was pencilled on the upper surface of each egg so that in a later inspection it would be evident whether the eggs had been turned, as is done periodically by incubating ducks. Before leaving the box, I restored the down to its place over the eggs.

The nest box was inspected again a month later on July 29 at which time nine of the 15 eggs were found still intact and covered with down with the "X" marks still facing upward. The fact that these eggs apparently had not been turned seems to indicate that they had not been incubated by the duck since the time the "X" marks were applied. Ducklings had hatched from three other eggs but were dead in the box, and three more eggs were pipped but the ducklings were dead inside the shells.

The nest box was made of heavy pine boards and erected where it was exposed to the sun during most of the day. Although the insulation provided by the box, together with sawdust and duck down, would tend to "level off" extremes of daily temperatures, the embryos must have been exposed to considerable chilling at night and possibly excessive heating on hot, sunny days. The amount of chilling or overheating that duck embryos will tolerate at various stages of incubation appears to have received little study.

Installation of the entrance tunnel during incubation may have been the primary cause of abandonment, but boxes equipped with these tunnels are used commonly by Wood Ducks. The following year (1954) the same nest box, equipped with the same tunnel, was occupied by a Wood Duck which brought off a brood of ducklings.—Clark G. Webster, *U.S. Fish and Wildlife Service, Laurel, Maryland, May 1, 1955.*

EDITORIAL

In the course of the preparation of the current volume of *The Wilson Bulletin* several persons have given generously of their time in an advisory capacity. It is a pleasure to acknowledge the substantial aid of George A. Bartholomew, David E. Davis, Thomas R. Howell, S. Charles Kendeigh, Harold Mayfield, Robert Mengel, Van Nolan, Jr., Kenneth C. Parkes, George W. Salt, George M. Sutton, Harrison B. Tordoff, and Josselyn Van Tyne.

WILSON ORNITHOLOGICAL SOCIETY ANNOUNCEMENTS

President Monroe has appointed the following committee chairmen to serve during the year, 1955-56: *Research Grant*, Kenneth C. Parkes; *Membership*, John M. Jubon; *Library*, H. Lewis Batts, Jr.; *Conservation*, Robert A. Pierce; *Endowment*, Robert T. Gammell.

1956 ANNUAL MEETING

Dr. Fred T. Hall, Director of the Buffalo Museum of Science, heads the Local Committee on Arrangements for the Thirty-seventh Annual Meeting, to be held at Buffalo, New York, from Thursday, April 26 through Sunday, April 29, 1956. An innovation planned for this year is a Thursday afternoon field trip to Niagara Falls for early arrivals. The Executive Council will meet Thursday evening. Friday and Saturday sessions will be for the presentation of papers. The Annual Dinner will be held Saturday evening, and there will be a field trip on Sunday. An information circular and call for papers will go out to the membership about March 1.

THE S. MORRIS PELL BIRD ART AWARD

An anonymous friend of the Wilson Ornithological Society has donated a small fund in memory of the late S. Morris Pell, a talented bird artist. From this fund grants of $25 each may be awarded to deserving young bird artists, to be applied toward such purposes as the purchase of art materials or the financing of sketching trips. Applicants should send samples of their work together with a brief statement of background and training (both in art and in ornithology), and financial need, to Dr. Kenneth C. Parkes, chairman of the Research Grant Committee, Carnegie Museum, Pittsburgh 13, Pennsylvania. There is no deadline for applications, and more than one award may be made in a given year.

LOUIS AGASSIZ FUERTES RESEARCH GRANT

In the March, 1947, issue of *The Wilson Bulletin* there appeared an announcement to the effect that an anonymous gift had been presented to the Wilson Ornithological Club with the purpose of inaugurating a series of annual research grants honoring the memory of the distinguished artist-naturalist Louis Agassiz Fuertes. From 1948 through 1955 (except 1953, when funds were not available), yearly awards of $100 have been made by the Club through a special Research Grant Committee appointed by the President for this purpose. The current Committee feels that the time has come for a review of the Fuertes Grant, listing the previous winners of the award and summarizing the criteria by which applications are judged.

Previous winners of the Fuertes Grant, with the subjects of their investigations, are as follows:

1948 Leonard R. Mewaldt, Montana State University. Life history of Clark's Nutcracker.
1949 Stephen W. Eaton, Cornell University. A comparative study of the genus *Seiurus.*
1950 (split award) Henry E. Childs, Jr., University of California. Population dynamics and life history of the Brown Towhee. Arnold J. Petersen, University of Wisconsin. Reproductive cycle in the Bank Swallow.
1951 Howard L. Cogswell, University of California. Territory size and its relation to vegetation structure and density among birds of chaparral.
1952 Robert W. Nero, University of Wisconsin. Territorial and social behavior of the Red-winged Blackbird.
1953 No award given.
1954 William C. Dilger, Cornell University. Isolating mechanisms and relationships of the thrush genus *Hylocichla.*
1955 Robert G. Wolk, Cornell University. Analysis of reproductive behavior in the Black Skimmer.

It will be noticed that all of the successful applicants to date have been carrying on their ornithological research as university students. *The Committee wishes to emphasize that such an institutional affiliation is by no means required of an applicant.* We wish, in fact, to encourage more applications from non-student amateur ornithologists who may be in a position to make an important contribution to our science.

The most important factor in the judging of applications is the potential contribution to ornithological knowledge inherent in the project submitted. Demonstrated financial need will also be taken into account. Problems in any aspect of ornithology will be considered, except that applications are discouraged for projects which are primarily concerned with wildlife management rather than with ornithology *per se.* It is felt that ample financial support from other sources is available for management projects.

In general, the most favored applicants are those whose researches are already under way. It is fairer both to the Society and to the applicants to award the $100 to a person who has demonstrated that his project is practicable, and who will have a better idea of how to apply his funds than will one whose work is merely in the planning stage.

The Wilson Ornithological Society requests that at least a portion of the results of Society-sponsored research be submitted to the editor of *The Wilson Bulletin* for possible publication, unless prior commitments interfere.

Application forms for the 1956 Fuertes Grant may be obtained from the Chairman of the Committee. Deadline for applications will be April 1, 1956. The Committee's decision will be announced at the annual meeting at Buffalo on April 26, and published in the June issue of *The Wilson Bulletin.*

RESEARCH GRANT COMMITTEE FOR 1956

Kenneth C. Parkes, *Chairman,* Carnegie Museum, Pittsburgh 13, Pa.
John Davis, Hastings Natural History Reservation, Carmel Valley, Calif.
Eugene Eisenmann, Linnaean Society of New York, New York, N.Y.

ORNITHOLOGICAL NEWS

The American Ornithologists' Union held its Seventy-third stated meeting at the Boston Museum of Science on October 25-30, 1955. The first day was devoted to business meetings, the next three days to papers sessions, and the last two days to field trips. The entire slate of present officers was re-elected for one year:

President: Alden H. Miller, University of California
First Vice President: Ludlow Griscom, Harvard University
Second Vice President: Ernst Mayr, Harvard University
Editor of the Auk: Robert W. Storer, University of Michigan
Secretary: Harold F. Mayfield, Toledo, Ohio
Treasurer: Charles G. Sibley, Cornell University

The Brewster Medal was awarded to William H. Phelps, Sr., Caracas, Venezuela, for his fundamental contributions to the systematics of American birds, particularly those of Venezuela.

THE WILSON ORNITHOLOGICAL SOCIETY LIBRARY

The following gifts have recently been received. From:

Andrew J. Berger—3 magazines
L. B. Chapman—1 reprint
H. Everest Clements—1 book
Powell Cottrille—1 reprint
Karl Haller—17 books
Philip S. Humphrey—1 book
Leon Kelso—1 reprint
Margaret M. Nice—2 magazines, 28 reprints
Göran Nordström—1 reprint
Fred M. Packard—27 magazines, 6 reprints
William H. Partridge—1 reprint
William H. Phelps—2 reprints
Miles D. Pirnie—1 reprint
Robert W. Storer—2 reprints, 2 magazines

LETTER TO THE EDITOR

In the March, 1955, *Wilson Bulletin*, pp. 49 and 54, Henry and Virginia Fitch state that the incubation period of the eggs in a nest of the Summer Tanager (*Piranga rubra*) watched by them was eleven days. They knew the dates of the laying of the four eggs, May 29 to June 1, and of the hatching of two of them on the morning of June 12. They found another nestling hatched the morning of June 13. One egg never hatched.

When eggs are not marked and one of them does not hatch it is impossible to be sure of the length of incubation, i.e., the time between the laying of the last egg to its hatching. The authors assumed that the third nestling "probably hatched later" on June 12 and *on this assumption* state that: "Incubation lasted eleven days." It is clear that this conclusion is unwarranted.

MARGARET M. NICE

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WATERFOWL CONSERVATION IN THE DECADE FOLLOWING WORLD WAR II

(A Contribution from the Wilson Ornithological Society Conservation Committee)

During the decade following World War II, the pressures growing out of an increasing human population have added progressively to the difficulty of and need for waterfowl conservation. Moreover, the events taking place during these 10 years have contributed little to suggest that the waterfowl conservationist's road will be any less difficult in the future.

Waterfowl conservation during this period may be reviewed from three points of view: (1) administration, (2) management, and (3) research. As herein considered, administration embraces the political philosophy and financing of waterfowl management; management includes the manipulation of waterfowl populations and habitat; and research concerns the gathering of facts upon which to base the management program.

Administration: The formation of state conservation agencies into councils for each of the four North American flyways has been a significant development in waterfowl conservation. Each flyway council provides a means of formulating regulations tailored, within limits, to the needs of the individual flyway, and, to a lesser extent, to the needs of each state in the flyway.

As an adjunct to each council, the waterfowl biologists within each flyway may serve as a technical group which is available for consultation by the council. This technical group may also act as an agency through which the research activities of the flyway can be coordinated.

The flyway council system creates one potential danger to waterfowl conservation: It may tend to form a pressure group seeking unwarranted changes in hunting regulations. Members of the councils must endeavor to insure that the welfare of the waterfowl remains of primary concern.

Under new leadership, the U.S. Fish and Wildlife Service appears to be following a liberal attitude toward restrictions on waterfowl hunting. When the continental waterfowl population declined in 1953 and 1954, the Service not only adhered to the 1952 regulations on length of season and bag limit for the Mississippi Flyway, but, in 1953, increased the length of season 5 days for the Atlantic and Pacific flyways and, in 1954, added an additional 5 days on the Pacific Flyway. At the same time, the Service permitted California to conduct an experimental feeding program. The result: Hunters in Ohio and Maryland have clamored for similar privileges.

Whether the present liberal policy toward hunting regulations will affect waterfowl populations adversely remains to be seen. In 1953 and 1954 unusually mild weather prevailed over much of the United States during both hunting seasons, thereby tending to limit the kill of waterfowl. With favorable hunting weather, however, an excessive kill of the breeding stock may take place. Within the memory of living men, such unusually severe slaughters have taken place on at least two occasions. The possibilities appear especially dangerous in the Mississippi Flyway where a large portion of the waterfowl which winter there are relatively accessible to the hunter when concentrated. Thus, it seems apparent that the margin of safety guarding our waterfowl population under present administrative policies is paper-thin and that perhaps we are close to being guilty of gambling with the future of our waterfowl resource.

The philosophy of previous administrations of the U.S. Fish and Wildlife Service toward regulating the kill of waterfowl was voiced by Dr. Ira N. Gabrielson, former Director of the Service, in a talk on May 24, 1955, in Washington, D.C. He stated:

"Since the passage of the Migratory Bird Treaty Act, there is no question but what the administrative policy of the Biological Survey and by the U.S. Fish and Wildlife Service has generally given primary consideration for the welfare of the waterfowl resource. Since the welfare of the ducks and geese is the prime consideration, it is necessary to be somewhat *conservative* in making regulations."

Although the Wood Duck population in the Mississippi Flyway has steadily declined in recent years, the Mississippi Flyway Council recommended that the closed season in force in 1954 be changed to permit one in the bag and in possession in 1955. The U.S. Fish and Wildlife Service accepted the Council's recommendation. In view of the precarious status of this species in the Mississippi Flyway, this decision appeared inconsistent with the need for being conservative in making regulations.

The budget of the U.S. Fish and Wildlife Service in recent years has not been adequate. This has resulted in the use of duck stamp funds for purposes other than those intended when the Duck Stamp Act was passed by Congress. The Act was passed at the behest of sportsmen who had become aware of the need for obtaining and developing lands for waterfowl refuges. The funds have had to be used for activities of the Game Management Branch and the operation and maintenance of existing wildlife refuges to such an extent that only minor acreages have been purchased by the Service during the past 5 years. Larger proportions of these funds should be earmarked for the purchase of refuge lands in the future.

Management: One of the most pressing management problems is that of alleviating crop depredations by waterfowl in southern Saskatchewan and Alberta, and in California. Hazing by aircraft, scaring devices, permit shooting, and feeding have been used with some local success, but the affected areas have been so extensive that "only the surface has been scratched" by the control efforts.

The draining of pot-holes in western Minnesota and in North and South Dakota has abated as a result of a change in policy by the U.S. Soil Conservation Service, but this remains as a continuing threat to the most important waterfowl breeding ground in the United States.

Many of the river basin programs planned by the U.S. Corps of Engineers in the southern United States will drain tens of thousands of acres of overflow bottomland used by wintering Mallards and Wood Ducks. Conservationists should familiarize themselves with the recommendations of the Branch of River Basins of the U.S. Fish and Wildlife Service and then urge Congress to include these recommendations before approving any drainage project.

The state conservation agencies are to be commended for their extensive acquisition and development of waterfowl habitat during the past decade. Prior to World War II, only a few states maintained waterfowl refuges and public shooting grounds. Since the war, however, numerous states have acquired such areas for waterfowl. The acreage in state ownership now approaches that held by the U.S. Fish and Wildlife Service. Because of the large amount of waterfowl acreage being lost as a result of drainage, siltation, and industrial and real estate developments, it is hoped that state conservation agencies will continue an aggressive program of land acquisition for waterfowl.

Research: Two notable programs in waterfowl research were initiated by the U.S. Fish and Wildlife Service during the post-war years: (1) the extensive appraisal of waterfowl populations and of production of young on the breeding grounds and (2) large scale banding of adult and young waterfowl on the breeding grounds. These two programs have added valuable information to the knowledge of waterfowl and aided in their management in North America.

Intensive research on nesting waterfowl by members of the Delta Waterfowl Research Station, by Jerome Stoudt of the U.S. Fish and Wildlife Service at Redvers, Saskatchewan, and by biologists of Ducks Unlimited have supplemented the extensive breeding grounds surveys. In our opinion, however, there is a need for additional intensive research on nesting waterfowl.

An inventory of the wetlands of the United States has recently been completed by the Branch of River Basins of the U.S. Fish and Wildlife Service. This is an important contribution toward better land management for waterfowl because it points up the relative value of existing areas for waterfowl, and the areas most in need of acquisition. It is anticipated that the Branch of River Basins will continue to refine its wetland inventory data. It is hoped that eventually the waterfowl carrying capacity of every important water and marsh area will be evaluated.

Studies on two major diseases of waterfowl, botulism and lead poisoning, have produced some new and encouraging findings. Bell, Sciple, and Hubert (1955. *Jour. Wildl. Mgt.*, 19:352-357) have contributed importantly to our knowledge of avian botulism by developing their microenvironment concept and establishing that *Clostridium botulinum* type C grows and produces toxin in immature forms of insect carcasses in distilled water. Evidence from intensive investigations by personnel of the Section of Game Research, Illinois Natural History Survey, has been interpreted to indicate that lead poisoning is less important as a mortality factor among waterfowl than was formerly feared.

During the fall of 1954 waterfowl biologists in every state in the Mississippi Flyway made bi-weekly estimates of waterfowl populations in their state. Upon compilation, the data provided much needed information on the migration of the waterfowl in and through the flyway. Among many values to be gained from this information may be mentioned one—that of providing for open seasons at the most judicious times.

It is believed that further investigations on the precise nature of crop depredations by waterfowl and techniques for the control of such depredations are also among the foremost research needs.—Frank C. Bellrose and Thomas G. Scott

NEW LIFE MEMBER

Mrs. John William Conboy (Esther Cogswell) received her A.B. Degree from Franklin College and did graduate work at Indiana University and the University of Illinois. She teaches Biological Science in the public schools in South Bend, Indiana, and shares field birding and the making of nature movies as hobbies with her husband. She is also a Life Member of The American Ornithologists' Union.

ORNITHOLOGICAL LITERATURE

An Introduction to Ornithology. By George J. Wallace. New York; The Macmillan Company, 1955: 6¼×9¼ in., xii+443 pp., 180 figs. $6.00.

This book aims to fill the need for an introductory text in ornithology dealing with the whole field in a nontechnical yet academic manner. It is to be recommended for use in courses for college freshmen and sophomores or in courses of cultural aim for the layman.

The book starts with the historical background of man's interest in birds together with comments on opportunities today for professional work in ornithology and the extent of amateur activity. In the next four chapters the bird itself is described as a member of the animal kingdom, and its external and internal features are discussed. A chapter is devoted to sense organs and behavior. Three full chapters are given to annual cycle and one to migration. From then on the topics cover a wide sweep, with separate chapters on the distribution of birds, food habits and economic relations, conservation and management, classification and nomenclature, the fossil record, ornithological methods, and even ornithological organizations and their journals. The book is concluded with a bibliography of 314 titles and a 31-page index.

The broad range of subjects which must be included in a modern textbook of ornithology is impressive. In this book the excursions into anatomy, physiology, behavior, classification, practical management, history, and many other topics reveal how involved the science of ornithology has become. Obviously it is now difficult to prepare a textbook giving fair representation to the many facets of ornithology and yet held sufficiently brief and simple for students with slight background in biology. The author has definitely succeeded in touching on almost every active phase of ornithology. The difficulties which become apparent here and there have resulted in part from attempting to keep the book down to beginners' size.

An outstanding merit is the comprehensive coverage of modern research as reported in the American ornithological journals through 1953. A fair number of foreign research reports are also cited. Documentation is quite thorough. Bibliographic entries are conveniently located at chapter endings and in the terminal bibliography and include titles. This is a truly strong feature and will be useful to students seeking to go beyond the often tantalizingly-brief extractions presented in the text itself. In many places the information cited is alluded to so briefly as to make a reasonable understanding of it impossible short of recourse to the original papers. This makes reading for the students laborious and frustrating. The book has an elementary flavor, belying its nature as a compact summary of recent information, due to the inclusion of trite background material on birds, such as is found in many standard zoological texts.

The three especially-valuable chapters on annual cycles are effectively illustrated with many photographs from nature. Elsewhere, however, some of the illustrations, such as photographs of mounted birds, lack interest. It would increase the meaning of the sketch of the soaring hawk, page 119, if the reader were informed as to whether it was drawn from direct observation or from a photograph. The explanation of territoriality is accompanied by a hypothetical map, page 128, whereas a genuine example would be preferable.

Few important research papers have been overlooked, but a valuable addition to the discussion on distribution of birds in relation to life zones, ecologic formations, and biotic provinces would be a reference to A. H. Miller's, "An Analysis of the Distribution of the Birds of California." Little is given on the physiology of annual cycle mechanisms, though recent ornithological research articles discuss this topic vigorously. The word chromosome does not occur in the index, though the Japanese workers since World War II have reported several pioneer cytological researches significant to avian systematics and evolution.

The chapter on ornithological methods refers to procedures which may be applied by the bird watcher and student of life histories. Yet elsewhere in the book one misses practical information which would instruct the student how to carry out original studies of his own, as, for instance, if he wished to analyze molt in a specimen at hand. Research techniques have not been included to the degree that this book could serve as a handbook or tool. However, the author has pointed out the need for research in many places.

This volume is cast as a beginner's text, and it has been written in such a way as to preserve its usefulness to beginners in the classroom. Undoubtedly it will serve as an effective springboard for participation in ornithological work by students and amateurs. For the more advanced worker it provides a summary of recent work and a convenient guide to modern literature.—Paul H. Baldwin.

The Waterfowl of the World. By Jean Delacour. Vol. I—The Magpie Goose, Whistling Ducks, Swans and Geese, Sheldgeese and Shelducks. Country Life Limited, London, 1954: 8 × 10 in., 284 pp., 33 maps and 27 color plates by Peter Scott. $15.00.

This is the first of three volumes which will provide for the first time a monographic treatment of the waterfowl of the world. It will be hailed as the successor to Phillips' "A Natural History of the Ducks" both because it brings up to date the information and advances in approach of the 30 years since that classic work appeared and because it is much more comprehensive in its scope—it includes the swans, geese and many related and aberrant forms in addition to the true ducks and their relatives. It will be further welcomed because, unlike Phillips, it will be readily available in all libraries and not beyond reach of the individual with a deep interest in this group. Large format, excellent typography and 16 color plates explain the cost.

Both author and illustrator of these volumes have a wide first-hand knowledge of the species through extensive travel and both have lived with most of the species in their aviaries. Thus they have acquired an immense knowledge through day-to-day observations throughout the year. This should provide unusual accuracy in depicting the species in color and in describing their behavior. Any one who pursues this volume will be impressed with the quality of the results.

When an artist must show 12 to 23 birds on a single plate, large enough to depict taxonomic details, he must make illustrations and not paintings. Some may complain that they are too monotonous for illustrations in such a large work and they certainly are reminiscent of the field guide style. However. Peter Scott's skill in arranging so many birds on a plate without making it seem crowded is indeed amazing and shows him to be a master of design. The frontispiece showing Pinkfeet coming in to winter quarters is more in the Scott tradition.

Most of the plates are well executed and the publisher is to be congratulated. However, the color of the bill of the juvenile Black Swan of Plate II is not "brownish black with the nail whitish" as called for in the description.

The present volume is primarily concerned with matters taxonomic, distributional and avicultural. It includes the subfamilies *Anseranatinae* (the Magpie Goose); the *Anserinae*, all true geese, swans and whistling ducks (formerly known as tree ducks); and the first of the tribes of the *Anatinae*, goose-like ducks, shelducks, South American crested ducks and the steamer ducks.

In the introduction Mr. Delacour quotes from his previous paper with Ernst Mayr (1945. *Wilson Bull.*, 57:3-55): "The new classification of the duck family that we propose attempts to do two things: to arrange the species in related groups and in a natural sequence, and to adjust the nomenclature of species and genera to progressive concepts of these categories." The present volume and those to come are to expound further these newer concepts. The influence of this genetic sophistication in making interpretations of species ranges and relationships is evident throughout the volume. It is to be hoped that, with this more formal presentation, this newer approach will gain wide acceptance and may find its way into the A. O. U. Check-list.

The range maps are very clear and will be a most welcome feature of the volumes. Occasionally it is not clear whether the original or present range is depicted (e. g., that shown for the Magpie Goose must not be recent.)

Areas of overlapping breeding range are sometimes referred to as mixed populations (*Anser anser* subsps., p. 100), implying that intermediates are not found and that some isolating mechanism other than a geographic barrier is in operation. But the text shows clearly that intergradation does occur, just as in Bean Geese, *Anser fabalis.* It is not clear what distinction is intended.

From the recent work of Yamashina and others we are told that swans and ducks have the same chromosome number (84 in males) but that the true geese have 90. It is gratifying to learn that chromosome number is not taken as an infallible criterion of species and their phylogeny, a concept so common among the current crop of plant taxonomists. Instead Delacour says: (p. 91) "The significance of chromosome number in establishing relationships is still obscure, and probably of doubtful value."

The literature cited by the author is drawn from a great variety of sources both historical and modern. It is rare to find a man equally aware of sources in both Old and New World. He quotes freely from the best modern works, such as Austin's "Waterfowl of Japan" and Salomonsen's "The Birds of Greenland" and adds a host of unpublished communications and personal observations. His knowledge of avicultural history and practices is most surely unsurpassed in the world today. For those who are not enthusiastic aviculturists the space devoted to this subject (frequently half the total pages allotted the species) may seem out of balance and often a bit tedious.

One searches in vain for much biological and ecological information. Weight data are seldom given and there is no mention of the cloaca and its associated structures so commonly used in America in analyzing age and sex composition of populations handled in banding operations. In fact there seems to have been little use made of band recovery data from North America or Europe. This may stem in part from the fact that most of the goose banding data in America remains in the Washington files, unpublished.

I believe the balance in use of literature is sometimes open to question. For example, trivial unpublished facts are included in the General Habits of the Lesser Snow Goose (including the Blue Goose as a color phase), but no mention is made of Soper's two outstanding works on the species (1930, "The Blue Goose," *N. W. T. Br. Dep. Int. Canada*, and 1942. *Proc. Boston Soc. Nat. Hist.*, 42:121-225).

But we must not judge too harshly now as to omissions, for we are promised in the Introduction that a general account will be given at the end of volume three. "It will include chapters on morphological, anatomical, and biological characters; on history, sport, conservation, acclimatization, care and breeding, and a bibliography." Let us hope that it will be a large volume!

The usual extravagance of publishers' claims is shown on the dust jacket, which says that these volumes will include "all that is known of the waterfowl of the world." I find that the behavior literature dealing with geese is barely mentioned although several striking original observations are included. One is the fact that aggressive behavior in both swans and geese depends on the similarity of plumage pattern of the intruder and not upon the size. Further (p. 93) the pre-flight intention movement of side-to-side shaking of the head is given as a general characteristic of geese.

A few old wives' tales seem to me to be perpetuated. The notion that Cape Barren Geese will abandon their nests if the eggs are touched by human hand (p. 201) taxes my credulity. Also, if "Flocks migrate in V-shaped formations or trailing lines, *led by an old bird*" (p. 99, italics mine), I should like to know the evidence. This thought has long appealed to my imagination but I have never found support for it.

Again one would like to know the evidence for the following statement made concerning Canada Geese (p. 152). "Various populations have repeatedly changed their breeding grounds, flyways and wintering areas as a result of egg collecting, drives and slaughter by northern natives, and of excessive shooting farther south." I have followed the literature on this species closely for many years and have never found evidence for shifting breeding grounds. Shrinkage, yes, but if much of this shifting went on, the reproductive isolation leading to the extreme subspeciation found in this group would not have occurred.

It is welcome to find that 11 geese of the confusing Canada group have been treated as one species, with 12 admittedly tentative subspecies recognized. Since morphometric differences and behavior deviations will undoubtedly be found between each population (and the banding evidence indicates that there are dozens of them), it is hoped that all will not have to be given common names as this type of information accrues.

Common names must be somewhat arbitrary and no one would agree with all that are used. But this is the author's privilege since he must draw from both A. O. U. and B. O. U. lists and add many from other faunas. Some will deplore the continuation of common names for subspecies, especially for those that cannot be distinguished in the field. These common names tend to sanctify the subspecies in the mind of the layman who has difficulty in accepting the idea of tentative names. The American public will never accept brent for brant. Again, there is inconsistency in forming common names for species complexes. All the *canadensis* group have Canada inserted in the name—even to the Cackling Canada Goose; but in the *fabalis* group the Pinkfoot does not become the Pink-footed Bean Goose!

I have long been impressed with the fact that the subspecies of Canada geese do not follow Bergmann's rule but are arranged in the opposite manner. In fact, they show a graded series in size from the large southern forms, *fulva*, *moffitti*, *maxima* and *canadensis*, to smaller more northerly *occidentalis*, *taverneri* and *parvipes*, to the smallest forms, *minima* and *hutchinsi*, breeding on the north sea-coasts and islands. This is clearly shown in Plate VIII but the generalization is not found in the text.

It is disturbing to see the emphasis taxonomists have placed upon measurements of soft parts, because Alpheraky pointed out many years ago (1905) that these structures, especially length of bill, differed in size in the two sexes and increased continuously with age. This basic feature of growth in geese seems to have been ignored until the present work.

The use of similar headings in discussing genera, species and subspecies leads to considerable duplication. For instance, there is great similarity in the discussion of General Habits under *Anser*, *Anser anser*, and *Anser anser anser*, and we are told in three different places that it was the Atlantic Canada Goose that was introduced into New Zealand.

All in all, this volume is a rich compendium of both the old and the new, interestingly presented and well written. It is a volume that every man interested in waterfowl will want to own.—WILLIAM H. ELDER.

THE SPECIES OF MIDDLE AMERICAN BIRDS. By Eugene Eisenmann. Transactions of the Linnaean Society of New York (vol. 7, no 1), New York, 1955: 6×9 in., vi+128 pp. $2.00.

The main purpose of this little book is to provide a suggested list of English or "common" names for the benefit of persons visiting Mexico or any of the Central American countries. However, a number of other useful features are included. It offers a list of technical names and numerous foot-notes pointing out the differences of opinion of taxonomists concerning the matter of those names. The range of each species is given in a general way and there is a short discussion of distribution in the Introduction. An ample, well-selected Bibliography is included.

The names provided are intended to apply to "species," without regard to races. However, it seems that we will never know just what constitutes a species and there is no end of opinions as to just which and how many subspecies should be included in a given species. Thus, the list has to reflect, more or less, the author's views on taxonomy. On this point Eisenmann is very fair in his presentation of the views of other authors and he almost always mentions in the foot-notes the fact that other authors may consider what is listed as a full species as being only a race of some other group or vice versa. All of this points up the futility of an attempt to provide a single vernacular name for a "whole species". Species are "lumped" or "split" so frequently by the taxonomists that the amateur field student should not be expected to change his "common" name for a bird, which he has long known, just because there has been a new technical grouping suggested, and his bird has now perhaps been made a race of some South American species that he never heard of before. From the point of view of a field student, any bird which is easily separated in the field by appearance or song from a species group to which the systematist says it belongs (because of real or supposed evolutionary connections), deserves a separate and distinctive vernacular name.

The English names are not as carefully selected as the technical ones and the list contains far too many new names which either were invented by the author or picked up from one of the other writers who have recently shown a desire to develop new "common" names for birds. While a very few new names, proposed to replace others which had become confused in one way or another, would be welcomed by the field students, a multiplicity of new names is so annoying that all are likely to be ignored. Even the name of a family is changed—the time-honored name of the Dendrocolaptidae, the Woodhewers, is changed to "Woodcreepers". A foot-note suggests that this is done because the word Woodhewer (a translation of the scientific name) is a misnomer. This is indeed a deplorable move, not just because the statement that the name is a misnomer is erroneous (some of these birds do hew wood, and quite vigorously at times) but because the scientific name must remain the same whether it be a misnomer or not, and also because Woodhewer has become so well established in the literature from many decades of use. As a matter of policy it is quite useless for one person to change any name because he thinks it a misnomer. In the first place a name is just a "handle" and it matters not what it is as long as those who use it know what is meant and are satisfied with it. In the second place any new name invented (no matter what it is) to replace the supposed misnomer will in turn be pronounced a misnomer by some other person.

In criticizing the older names such as those from the "Birds of North and Middle America" by Ridgway, it is stated that some of these names have been used to denote more than one species by different authors as though this were something to be abhorred. However, Eisenmann changes the name of the Allied Woodhewer (*Lepidocolaptes affinis*) to Spot-crowned Woodcreeper, although both Hellmayr in "Catalogue of Birds of the Americas" and Chubb in "The Birds of British Guiana" apply the name Spotted-crowned Woodhewer to a bird of a different species. No warning is given even in a foot-note that the name has in the past designated a quite different bird and the reader is not even informed that the name "allied" has been applied to the species in all other literature. When a new name not only attempts to change an old, well-established name about which there never has been any confusion or dispute but actually muddles the name of another species, it is hard to understand what the author is really trying to do. As is illustrated in the example above, another new feature of the vernacular names is that the "doubling of the past participle is avoided for simplicity and euphony." It is doubtful if such a feature really simplifies and some readers might think that "Spot-breasted", for instance, should be applied as a name to a bird with only one spot on its breast rather than to one with many spots.

So called descriptive names are given in place of old patronymics and geographical names as the author says the new, more descriptive names aid in identifying or remembering a species. This might or might not be true. In the case of the Boucard Tinamou, we have a bird which was described as *Tinamus boucardi* in 1859; it has never had the species name changed, although it has been moved into the genus *Crypturellus.* It has been known since the earliest days by the English name taken from the scientific specific name. It has not been called by other common names and there has never been any suggestion of confusion or doubt about what anyone meant when he spoke of Boucard's Tinamou; in addition we had the considerable advantage of having vernacular and technical names that were alike. Still, a new name was given the bird, that of Slaty-breasted Tinamou. Aside from the fact that the new name is longer and a bit awkward, it provides no information that aids in identification of the bird in the field, as this tinamou, when seen in the woods, appears to be the same color all over. Hence the new name merely adds confusion in an area where there had previously been none.

Numerous other examples could be cited where old, established names are replaced by less desirable ones because the old ones were thought to be misnomers, nondescriptive, misleading or were of a subspecific nature. It is surprising to note in regard to the last-mentioned category that in some cases a well-established "subspecific" name that might well serve as a name of the whole species in case the name of the nominate form were almost unknown or otherwise undesirable, was discarded in favor of another subspecific name which was itself almost unknown or less suitable than the one discarded.

Thus it is seen that the list of vernacular names would not serve to acquaint a beginner with the names in use by a majority of field men already working in the area, and that it would prove confusing and an actual hindrance to him if he consulted it to identify some bird he found mentioned by common name in an old book or magazine. Consequently, it is likely that the book will prove useful chiefly in ways other than that of its primary purpose.—L. Irby Davis

THE NATURAL REGULATION OF ANIMAL NUMBERS. By David Lack. Oxford University Press, London, 1954: 6 × 9½ in., viii + 343 pp., 52 text figs. $5.60.

For the serious ornithologist this book is required reading. In a series of chapters a wealth of data about birds is clearly presented. Lack starts out by showing that many populations remain nearly stationary in numbers for periods of years. Then he discusses the significance and variations in clutch size and the breeding season which, of course, determine the reproductive rate of birds. Also, he brings together the data about relation of number of eggs to density of population, which in many cases vary inversely. The next phase in the analysis of regulation is the discussion of mortality. Lack devotes 4 chapters to losses of eggs and young, adult mortality, sex differences, and dependence upon density. The viewpoint now changes from a consideration of forces for increase and decrease to a study of the factors in the environment. Food is described as a limiting factor and then predation and disease are considered. A couple of chapters are squeezed in about the factors limiting mammals and fish and insects just before a series of chapters that, to this reviewer, seem to be a collection of discrete topics that lack a theme. There is a discussion of climate and range, of cycles, of irruptions, of migration, of dispersion and of gregarious and territorial birds. The 4-page conclusion summarizes the main points of the general argument.

No review can cover all the items of importance in a book of this type. Certainly a wealth of data is collected and provocatively analyzed. However, the author may at times seem to stress some ideas more than their general merit permits. For example, Lack at once (p. 21) begins his review of the significance of clutch size. Yet a basic assumption (p. 21, line 16) is that birds are indeterminate layers, which seems to be the exception rather than the rule. It would seem desirable to present the facts as now known and then speculate on their significance. Another question arises concerning the frequent claim that clutch size is related to food supply. Data that illustrate the point are meager because it is difficult to get an experimental situation. Even so, how does this come about—through gonadotropins?

In some places the meanings of terms are not clear. For example, on page 91 in the discussion of avian mortality, Lack does not state whether he is referring to death rate (the number dying divided by the average population) or the probability of dying (the number dying divided by the initial population). Clarification of terms is essential in these confusing problems.

The book is splendidly printed and has only a few typographical errors. The bibliography of 42 pages is an excellent source of references to original data. The index is divided into taxonomic groups and also according to author and subject.

A most valuable aspect of this book is the demonstration that data collected by the amateur in his ordinary pursuits are valuable. The records of clutch-size and nesting dates as well as the results of banding are a real contribution to knowledge.—DAVID E. DAVIS.

INDEX TO VOLUME 67, 1955

This index includes, in addition to names of species and authors, references to the following topics: anatomy, behavior, conservation, embryology, food, fossils, geographic localities, measurements, migration, nesting, physiology, plumages, predation, taxonomy, voice, and weights. Also included are references of biological significance to mammals and reptiles. Names of new forms described in this volume are printed in **boldface** type.

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SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the color-plate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A WORD TO MEMBERS

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

NOTICE OF CHANGE OF ADDRESS

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia. He in turn will notify the publisher and editor.

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