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THE WILSON BULLETIN

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All articles and communications for publication, books and publications for review, and claims for lost or undelivered copies of the magazine, should be addressed to the Editor.

Entered as second class matter July 13, 1916 at Ann Arbor, Michigan under the Act of March 3, 1879. (Application for re-entry at Baltimore, Maryland, pending.)

THE PRESIDENT'S PAGE

The Wilson Ornithological Club is deeply indebted to Dr. Josselyn Van Tyne for his services as Editor of 10 volumes of *The Wilson Bulletin.*

In order to edit this journal, while at the same time carrying on his official routine at the University of Michigan, evenings and holidays were sacrificed and opportunities for original research were curtailed. There was always an endless stream of letters to be answered, manuscripts to be edited, and proofs to be read. In fact, at no time during his 10 years of office was he completely free from the responsibilities which the *Bulletin* entailed.

Edited by him were 40 numbers (No. 1 of Vol. 51 through No. 4 of Vol. 60) with pages totalling 2,847. Altogether they contained 175 papers and 252 general notes representing many aspects of research and observation in ornithology and overlapping fields. Several of the papers proved to be among the most important contributions yet made to biological literature.

In the years of his editorship a number of innovations appeared in the pages of the *Bulletin.* Reviews of all books, monographs, and other publications of similar scope were assigned to persons best qualified to speak critically and constructively. Thus the 168 reviews printed were notable for their usefulness to authors and readers alike. For the convenience of students and research workers, a bibliography (*i.e.,* a list of recent literature of value to ornithologists) was instituted, then later extended and classified according to subject matter. Reprints of this list were made available at cost. Handsome frontispieces became a regular feature; of the 29 published, 8 were in color. A section on conservation, brief biographies and photographs of new life members, and lists of new acquisitions to the Wilson Club Library were additional innovations.

Today the Club has twice as many members as it had 10 years ago. Such a remarkably rapid growth is in no small measure a tribute to the excellence of the *Bulletin.*

Obviously the Club's indebtedness to Dr. Van Tyne cannot be met by words and tokens because his task has been a thankless one. We can only say that we are immensely appreciative of each moment devoted to the pages of the *Bulletin* and that we are extremely proud of the result.

Olin Sewall Pettingill, Jr.

WILSON CLUB NEWS

RECENT DEATHS

Mrs. Vernon Bailey (Florence Merriam) died September 28, 1948.

Dr. T. C. Stephens, editor of the Wilson Bulletin for many years, died November 24, 1948. An obituary will be printed in a future number.

PERSONALS

Oliver H. Hewitt has been appointed Assistant Professor of Wildlife Management at Cornell. He has been with the Dominion Wildlife Service at Ottawa.

William F. Rapp, Jr. has been appointed editor of the Nebraska Bird Review.

The first award from the Pell fund, established by an anonymous friend of the Wilson Ornithological Club in memory of S. Morris Pell, has been made to Mr. Donald Malick in recognition of his ability and promise as a bird artist.

Dr. Daniel L. Leedy has been put in charge of the national Cooperative Wildlife Unit Program to succeed Dr. Logan J. Bennett who has been made chief of the Research Division of the U. S. Fish and Wildlife Service.

EDITORIAL

Your editor fledges his first issue of the Wilson Bulletin with great solicitude. He hopes that members of the Club will remember that the Bulletin is their journal and that the members will freely express their suggestions for improvement. The Bulletin should continuously evolve and adapt itself to the new desires of its readers. Your editor is fully aware of some deficiencies and expects to be advised of others.

In order to economize on secretarial help your editor will reduce his correspondence to the basic essentials. Therefore please accept his apologies for failing to answer letters promptly or for sending a post card.

ANNUAL MEETING

The thirtieth annual meeting of the Wilson Ornithological Club will be held at Madison, Wisconsin, on April 21–23, 1949, with field trips on the following day, Sunday, April 24. The program will offer an outstanding selection of scientific papers and movies. All sessions will be held in the Theatre of the Wisconsin Memorial Union, located at the corner of Park and Langdon Streets. For accommodations or further information about local arrangements, please write George A. Hall, Registration Chairman, Department of Chemistry, University of Wisconsin.

WEIGHT VARIATIONS IN WINTERING WHITE-THROATED SPARROWS IN RELATION TO TEMPERATURE AND MIGRATION

Eugene P. Odum

MANY wild birds in temperate regions undergo seasonal weight variations which presumedly are the result of changes in endocrine balances. Since internal changes may be related to environmental changes or perhaps be the result of an inherent rhythm, knowledge of the seasonal "weight picture" is of both physiological and ecological interest. A regular seasonal rhythm, with an increase in weight in winter and a decrease in weight in summer, has been demonstrated for many species of birds (Nice, 1938; Baldwin and Kendeigh, 1938). It has been suggested that this seasonal cycle is correlated, roughly at least, with temperature, since individual birds usually gain weight during cold weather (provided adequate food is obtained) and lose weight during warm weather (Baldwin and Kendeigh, 1938). It is advantageous to a warm-blooded animal to be heavy at low temperatures (heat loss is decreased) and lighter at high temperatures (heat loss is increased), but of course this does not mean that all birds will necessarily show such an adaptation; changes in feather covering and rate of metabolism, for example, could adapt a bird to seasonal temperature changes without a change in basic weight.

In addition to (or superimposed upon) the winter-summer weight rhythm it would seem logical to suppose that migratory species would show marked weight variations directly related to migration. Despite the fact that collectors have long known that many species become fat (and hence presumedly increase in weight) prior to and during migration, actual weight data demonstrating a migration increase is meager. Since Wolfson (1942, 1945) has recently summarized the literature on the subject, only a brief resume need be given here. Linsdale and Sumner (1934a, 1934b) found that the Golden-crowned Sparrow (*Zonotrichia coronata*) on its California wintering grounds not only gained weight in winter (up to 31 grams in January) but reached an even greater peak just before spring migration (35 gm. in May). Baumgartner (1938) who weighed Tree Sparrows (*Spizella arborea*) both on wintering and breeding grounds found that the highest weights occurred in late February and early March, prior to and during spring migration. Weights were also higher during fall migration than in late summer or early winter. Wolfson (1945) has reported that migratory races of Oregon Junco (several races of *Junco oreganus*) and White-crowned Sparrow (*Zonotrichia leucophrys pugetensis*) are heaviest just prior to spring migration. He also presented preliminary evidence to indicate that fat deposition was largely responsible for the spring peak in the Junco. In the case of the Tree Sparrow, White-crowned Sparrow, and Junco, which migrate early, the premigration peak follows directly after the winter increase resulting in only one major peak in weight. In the Golden-crowned and Fox Sparrows (*Passerella iliaca* data of Linsdale and Sumner, 1934b), which migrate later, the weight decreases in late winter and early spring before the pre-migration increase occurs resulting in two major weight peaks. Wolfson (1945) further presents a table of winter and spring weights of 7 species of permanent residents which shows that these nonmigratory species decrease in weight in the spring without undergoing fat deposition. The data on non-migratory subspecies of the Oregon Junco (*J. o. pinosus*) and White-crowned Sparrow (*Z. l. nuttalli*) are especially significant since the resident forms, in contrast to migratory forms of same species, do not show a spring weight increase.

In analyzing thousands of weights at all seasons taken over a period of several years at the Baldwin Bird Laboratory at Cleveland, Ohio, Baldwin and Kendeigh (1938) failed to note significant weight variations that might be related to migration. However, it should be noted (as has been pointed out by Wolfson, 1945) that most of the weights discussed in this paper were obtained from permanent resident species or individuals of migratory species during or after migration; few weights were obtained *prior* to migration. Also, as will be discussed later, monthly averages may obscure significant variations if they happen to occur in a short period or come partly during one month and partly during another.

There can be no doubt that fat deposition and weight increase before or during migration is advantageous to a migratory bird since extra energy would be provided for the strenuous journey. However, as in case of a winter-induced weight increase, demonstration of advantage does not prove that all migratory species, subspecies or even both sexes of same species necessarily show the adaptation. Species of various seasonal status living in various climatic regions must be studied to determine the actual situation.

Because the White-throated Sparrow (*Zonotrichia albicollis*) is a late migrant and may be easily trapped and collected on its wintering grounds in southeastern United States, it has proved a favorable species for the study of the relative effects of winter and spring on the weight of a migratory bird. A study of the White-throated Sparrow has been undertaken as a part of a joint project with Albert Wolfson, who is continuing his experimental work on the physiology of migration at Northwestern University. The present paper is concerned with the analysis of data on total body weight. A study of weights of body parts and the exact determination of the amount and distribution of body lipids in collected birds is now being made as a joint research with Jesse D. Perkinson, biochemist at the University of Georgia, with the aid of a grant administered jointly by the University and the Carnegie Foundation.

Materials and Methods

For two successive seasons, 1946–47 and 1947–48, weights of White-throated Sparrows were obtained during the seven-months wintering period (mid-October to mid-May) of the species at Athens, Georgia. Of the total of 247 weights (142 males, 105 females) available for analysis, 116 were obtained from collected specimens shot in the late afternoon and weighed within an average of an hour after death. The remaining weights were obtained from 85 individual birds captured and banded on the University campus. Three funnel traps were used which were set near the Biology Building where they could be closely watched and birds removed soon after capture. Weights of repeat and return birds were treated as individual weights provided at least three days had elapsed since the last capture. In order to minimize the daily rhythm factor which is so prominent in small birds (*see* Baldwin and Kendeigh, 1938) and to make weights of banded birds comparable with those of collected birds (which were always taken in afternoon) weights of birds taken in traps before 10:00 A.M. were eliminated from the final data. Our experience has been that at about midday birds recover weight lost during the preceding night. Therefore, weights analyzed in this paper may be considered close to the daily maximum weights. A little over half (133) of the total weights were obtained during the first season (1946–1947). All birds, both collected and trapped, were weighed on the same Ohaus double-beam balance accurate to 0.1 gram. Live birds were placed in a small aluminum box counterbalanced on the scale before each weighing.

The sex of collected specimens was determined positively by internal dissection. For banded birds wing measurements proved to be the most reliable, although by no means infallible, basis for sexing. Wing measurements (the chord measurement without flattening normal curvature) of 116 birds of definitely known sex (collected specimens) were distributed as shown in Table 1. On the basis of these data, banded birds with wings of 74 mm. and over were recorded as males, those with wings of 69 mm. or less, females. Birds of intermediate size were recorded as either males or females according to wing measurement and plumage characters, females having a more brownish cast to nape, head and back. By the second season of work our experience was such that we very rarely were wrong when we predicted the sex of a collected bird before dissection. Undoubtedly, however, errors were made in sexing banded birds, especially intermediate-sized birds, but I do not believe that such errors affect the validity of the trends in weight being analyzed.

We are not sure that we have discovered reliable criteria for age determination and have not attempted to break down the total data into adults and immatures (first-winter birds), although some of the collected birds could be aged with certainty. The possible significance of age is discussed later.

Grateful acknowledgement is made to David W. Johnston, who was largely

responsible for operating banding traps and collecting birds in 1946–47 and to James C. Major who performed the same duties in 1947–48. Robert A. Norris also aided in collection of specimens, especially in the important month of April. Without the diligence of these students in the field it would have been impossible to fit this type of research into a busy academic schedule.

Results

The total data (247 weights) for the two seasons are averaged by months and half-months in Table 2, and plotted by half-months in Figure 1. In effect, the histogram in Figure 1 gives, at a glance, the average "weight picture" of the White-throated Sparrow on its north-Georgia wintering grounds. In

TABLE 1

Wing Measurements of White-throated Sparrows of Known Sex

WING MEASUREMENT IN MM.	NUMBER MALES	NUMBER FEMALES
65	0	2
66	0	1
67	0	9
68	1	12
69	1	18
70	1	8
71	3	4
72	5	4
73	9	4
74	10	1
75	10	1
76	9	0
77	1	0
78	1	0
79	1	0
Total	52	64

Figure 2, data for the first season only (1946–47) are plotted for short intervals together with the average daily air temperatures for the same periods. In Figure 3, 97 weights (for both years) in the critical spring period are plotted individually to give a picture of changes occurring just before northward migration.

Two distinct cycles are evident from the data, a peak in weight being reached in midwinter and another, greater peak in males, being reached in late April just prior to northward migration. Average weights were lowest in October and November shortly after the end of fall migration. The averages for these months (males 26.8; females 25.4) are very close to averages given by Nice (1938) and Baldwin and Kendeigh (1938) for birds trapped during the fall migration in Ohio. From the low point in the autumn, weight gradually increased with a winter peak being reached in early February, males 29.8, females

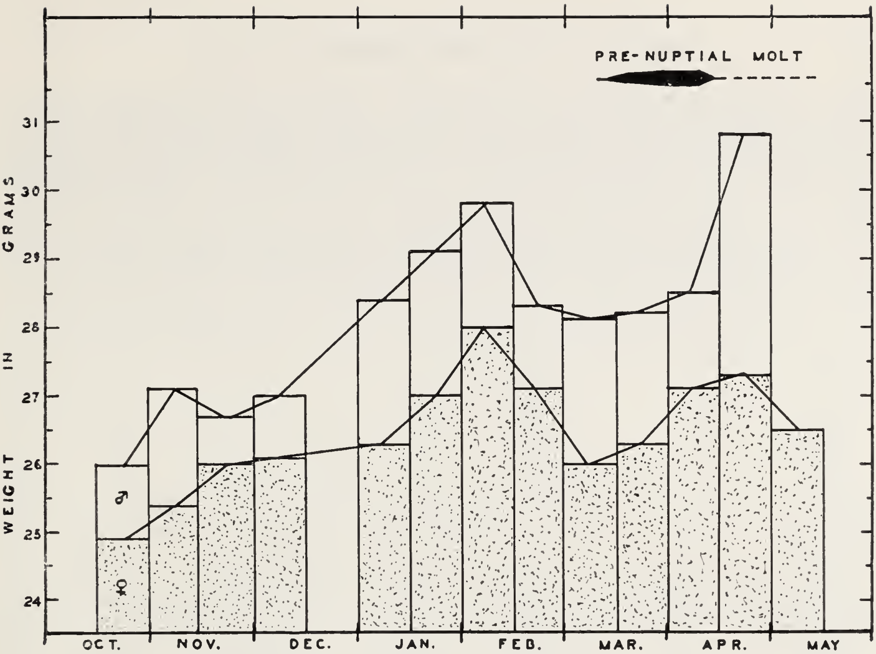

FIG. 1. Histogram of "weight picture" of White-throated Sparrow on its wintering grounds at Athens, Georgia. A summary of two seasons' data (247 weights, see Table 2) with averages plotted for half-month intervals; upper curve male, lower, female.

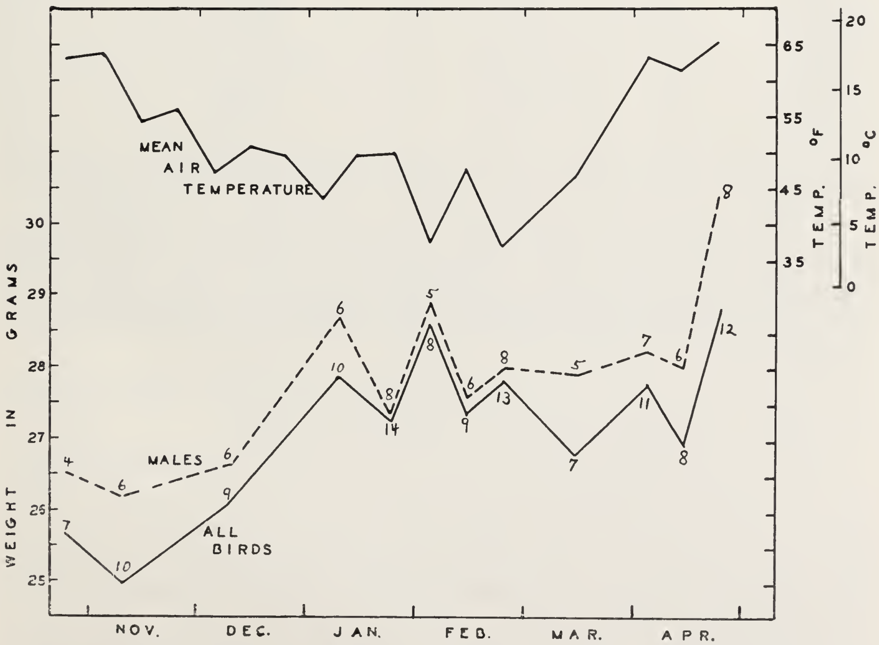

FIG. 2. Average weights of White-throated Sparrows for the 1946-47 season only with means of air temperature recorded for same period by the US Weather Station at Athens, Ga. Figures on the weight curves represent number of individuals on which averages are based.

28.0. As shown in Figure 2, variations in winter weight in 1946–47 are inversely correlated with temperature. Thus, the coldest periods during that year were the first 10 days in January, the first 10 and last 10 days in February; each cold period, especially the first two, coincides with a peak in weight. The same relation to temperature is indicated by 1947–48 data although the weights for this winter are not sufficiently distributed to permit plotting a complete curve. The coldest period in the 1947–48 winter was the last half of

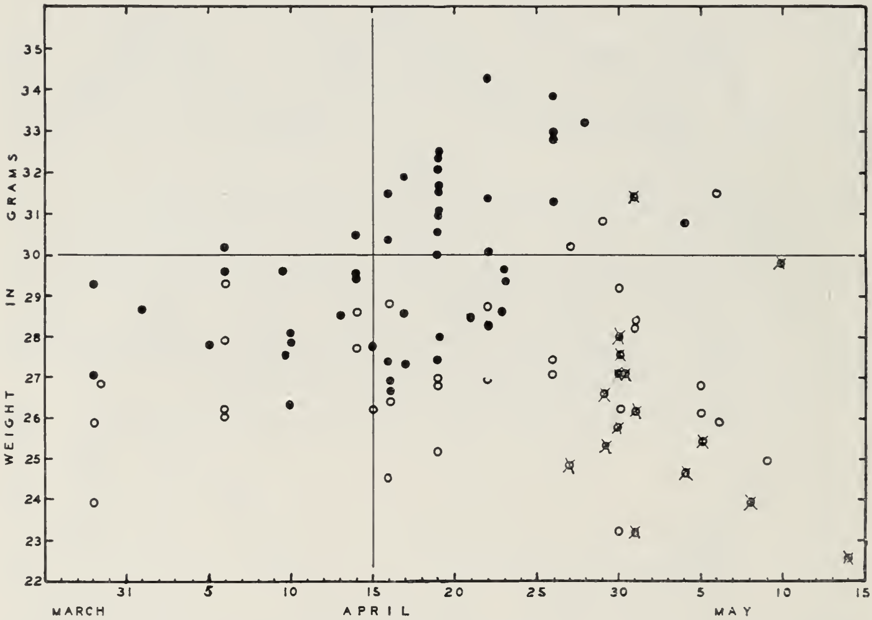

FIG. 3. Distribution of 97 weights from both seasons during the critical late-spring period. Each symbol represents an individual weight record, largely an individual bird since over half the records are from collected birds. Solid circles are males, open circles, femalees. Dull-plumaged, late-molting females, believed to be first-year birds are indicated by ⊠. Note that after April 15 males increase in weight rapidly and leave the region, while response in females is later and much more variable.

January and first part of February and both average peak weights and peak weights for individuals were recorded during this period.

The stimulating effect of low temperatures in winter is further indicated by the fact that males averaged heavier during the cold period January 1 to February 15, 1948, than during the same but warmer period of 1947 as shown in Table 3. The difference, 1.6 grams, is reasonably significant since it is 2.5 times the standard error of difference (0.62) as determined by use of formula for small samples (Fisher, 1936).

Another difference between the two years seems related to temperature. Early November, 1947, was colder than the same period in 1946; likewise November 1947 birds were heavier. This produced the "hump" in the curve of males (see Figure 1) since a large proportion of November weights were obtained in 1947.

TABLE 2

Average Weight of White-throats at Athens, Georgia; two season's data combined

PERIOD OF OBSERVATION		MALE		FEMALE	
		No.	Wt. in grams	No.	Wt. in grams
October	Last half	4	26.0	7	24.9
November	First half	8	27.1	5	25.4
	Last half	10	26.7	6	26.0
	Total	18	27.0	11	25.8
December	First half	10	27.0	5	26.1
January	First half	7	28.4	3	26.3
	Last half	16	29.1	8	27.0
	Total	23	28.9	11	26.8
February	First half	13	29.8	10	28.0
	Last half	11	28.3	8	27.1
	Total	24	28.7	18	27.7
March	First half	4	28.1	6	26.0
	Last half	8	28.2	6	26.3
	Total	13	28.1	12	26.2
April	First half	20	28.5	11	27.1
	Last half	26	30.8	19	27.3
	Total	46	29.8	30	27.2
May	First half	*		15	26.5

* Virtually all males migrated north by May 1. One exception (May 4) is included in late April weights.

TABLE 3

Comparison of Winter Weights of Male White-throated Sparrows for Two Seasons

YEAR	AVERAGE TEMP. JAN. 1–FEB. 15	NUMBER MALES	AVERAGE WEIGHT, GRAMS	PER CENT INDIVIDUALS OVER 30 GRAMS
1947	45.2° F	21	28.6 ± 1.36	19
1948	40.6° F	15	30.2 ± 2.02	53
Difference			1.6 0.62	

During the early spring, weights dropped below the winter peak. The prenuptial molt, a partial molt in this species involving feathers of head and body tracts, began the middle of March and continued into April, every individual examined the first half of April being in molt. By April 15 molting was virtually complete in males, which then began a rapid, almost spectacular increase in weight as shown in all three figures. In Figure 3, for example, it will be noted that during the first half of April only two males out of 17 weighed over 30 grams and none reached 31 grams. Between April 15 and 30, however, 20 out of 31 weights topped 30 grams, and 16 of the 20 exceeded 31 grams. The late April average for males was over 2 grams greater than peak weight for winter of 1946–47 and 1 gram greater than the higher 1947–48 winter peak (see Table 2). By May 1 almost all males had departed from the vicinity of Athens. In 1947, one male was obtained on May 4, while in 1948 no males were collected or trapped after April 25 despite intensive search for them.

Weights of four individual banded males which repeated over long periods are given in grams in Table 4. It will be seen that these individual variations parallel average trends as shown in Figure 1. The first 3 individuals clearly show an increase from fall to winter. Individuals No. 2 and No. 4 demonstrate

TABLE 4
Afternoon Weights (in gms.) of 4 Male White-throated Sparrows (1946–47)

NO. 1		NO. 2		NO. 3		NO. 4	
Date	Wt.	Date	Wt.	Date	Wt.	Date	Wt.
Nov. 6	26.4	Nov. 15	27.9	Nov. 8	25.4	Jan. 18	30.0
Jan. 28	27.4	Jan. 23	27.4	Feb. 12	29.2	Feb. 27	29.4
Feb. 4	30.1	Feb. 4	30.9	Feb. 28	26.3	Apr. 9	29.6
Feb. 11	28.5	Feb. 8	27.6	Apr. 10	27.9	Apr. 28	33.2
Mar. 4	26.3	Feb. 11	28.5	Apr. 17	27.3		
Apr. 1	28.7	Feb. 18	27.0				
		Feb. 27	29.3				
		Apr. 19	31.6				

the premigration peak; the other 2 birds did not repeat late enough in April for this increase to be evident.

The situation in regard to females was not so clear cut. In late April, females increased in weight, but not nearly to the extent of males. Several females exceeded 30 grams but many others remained low in weight (see Figure 3). Females remaining into May were, with two exceptions, low in weight. Seven out of 15 May females were in very dull plumage and still molting; these were evidently immature birds and were very light in weight as shown in Figure 3. The other 8 females were in bright plumage, evidently having completed molting, but most showed little evident fat deposition or weight increase. Thus, even if dull-plumaged immatures were separated from bright-plumaged birds (adults), the weight curve for May would still show a downward trend.

As summarized in Table 5 the sex differential in weight is significantly greater in the spring than in midwinter, the difference, 2.1 gms, being 3 times the standard error (determined by taking the square root of sum of standard deviations squared divided by number of all 4 means). The age factor is probably involved, since there seems to be a tendency for immature females to linger longest on the wintering grounds or perhaps winter further south and move into the area in May. However, even if the May birds believed to be immatures (see figure 3) are not included, raising the spring female average to 27.6, the difference is still of considerable statistical significance. In this connection it might be noted that female White-throats weighed by Nice (1938) during the spring migration in Ohio averaged only 26.4 grams as compared with 29.4 grams for males, a much greater sex difference than found by the same author during the fall migration.

TABLE 5

Comparison of Sex Difference in Weight During Mid-winter and Spring

	JAN. 1–FEB. 15		APRIL 15–MAY 15	
	No.	Average wt.	No.	Average wt.
Male	36	29.2 ± 1.93 gms.	26	30.8 ± 1.77 gms.
Female	21	27.5 ± 1.66 gms.	34	27.0 ± 2.10 gms.
Difference in sexes		1.7 gms.		3.8 gms.
Seasonal difference in sex difference		2.1 ± 0.697 gms.		

Discussion

It is important to note that while the winter increase in weight was a relatively gradual one, the premigration increase in males occurred within an amazingly short time. From the study so far made on collected birds it appears that fat deposition is largely responsible for both weight increases, but especially the spring one. Apparently, more than 2 grams (about 10% of body weight) of fat may be added in about a 7–10 days, the fat being largely deposited subcutaneously and underneath the ventral abdominal wall. In 1947, for example, 10 males taken between April 1 and April 17 showed no evidence of a major increase in weight, all weighing less than 30 grams. On April 19, 2 out of 5 birds exceeded 31 grams while all of a series of 5 males taken April 27–28 exceeded 31 grams, 1 individual reaching 33.9 for highest weight recorded for that year (in 1948 one February bird weighed 35 grams and one April 22 bird, 34.3 grams). In previous years when some weights were obtained at Athens, this premigration peak was largely missed because not enough individuals were obtained during the critical period of late April. Averaging weights by months or other long periods could easily obscure such a weight peak. For example, the average weight for the month of April as a whole might not be greatly different from that of winter months. Yet it is obvious that, when weights are plotted individually as in Figure 3, the weight picture for April 1 is quite different from that of any other month.

Comparison with published data for other migratory species reveals that the White-throat weight curve for winter and spring is very similar to the "two-peaked" curve of Golden-crowned Sparrows on the west coast previously mentioned (Linsdale and Sumner 1934a). Migratory races of Oregon Junco and White-crowned Sparrow have a similar weight picture (Wolfson 1945) but migrate north much earlier in the spring; hence the winter increase and spring increase are not so well separated as in late migrant White-throat.

As has already been indicated, the general winter increase in weight as well as fluctuations during the colder months are definitely related to temperature. Males and females appear to respond equally to stimulating effect of decreasing temperature so that weight curves for both sexes are roughly parallel. In the cold period of midwinter, females come nearest to equalling males in weight. The spring increase is different and appears to be related to length of day, since Wolfson has been able to induce fat deposition experimentally in juncos (Wolfson 1942) and in White-throats (MS) by artificial lighting. In nature, temperature or other climatic factors apparently may influence the light response as is indicated by the fact that males "fattened up" and disappeared from the Athens area about 5 days earlier in the spring of 1948 when compared with 1947. In Figure 3, all records of males after April 25 are from 1947 despite the fact great effort was made in 1948 to obtain males after this time. Spring, especially March, temperatures were higher in 1948.

The unequal response of the sexes in the spring is puzzling, although it is well known that female birds in general respond more irregularly than males to experimental length-of-day increases, at least in regard to gonad recrudescence. One thing our study has definitely shown is that females remain on the wintering ground at least 2 weeks longer than males. We also discovered that these lingering females may sing, as one was shot in the act. While males responded uniformly and departed abruptly, the females showed all degrees of variation, some birds becoming fat, others not (*see* Figure 3 and note large standard deviation of spring females, Table 5). In general, late April females showed a fair degree of weight increase, while May birds did not. To the casual observer, the White-throated Sparrow disappears from the Athens vicinity about May 1, almost no birds being found on the uplands or on the University campus (only 2 birds were caught in banding traps in May). However, in the bottomland thickets small bands of females may still be found for two weeks or longer, May 18 being the latest sight record for this vicinity. These lingering females are quiet, elusive, and difficult to collect. Many of the 15 birds collected in May were dull plumaged, often still molting and were judged to be immatures; they may represent migrants from further south. In any event, most of these birds disappear from this area without "fattening up." The last bird collected (on May 14) was also the smallest on record, weighing only 22.6 grams.

Since it has been known for many years that males of many species migrate ahead of females, it is logical to assume that females would remain on the wintering grounds longer, although this has not often been actually demonstrated. Likewise, it has been suggested that immature birds may migrate north later than adults. Since males push north when the weather may be unfavorable for the species and since males must expend a great deal of energy setting up territory, it is easy to see that a premigration deposition of fat would be of survival value. Perhaps the less extensive weight buildup (or lack of it in late migrants) in females is related to the less rigorous conditions encountered in later migration, or perhaps fat deposition does not occur until the birds are enroute. This is a question that can not be answered as yet.

Summary

During 1946–47 and 1947–48, 247 weights of White-throated Sparrows (131 from banded birds, 116 from collected birds) were obtained over the 7-month wintering period of the species at Athens, Georgia. Two distinct cycles are evident from the data, a peak in weight being reached in mid-winter and another, greater peak in males, being reached just prior to northward migration. On arrival in October, birds were lightest, males averaging 26.0, females 24.9 grams. A gradual increase occurred with winter peak being reached (in both years) in early February, males 29.8, females 28.0 grams. The winter increase seems well correlated with temperature since the coldest periods coincided with peak weights; also, birds averaged heavier in the cold 1947–48 winter as compared with warmer 1946–47 one. During late March and early April, birds underwent prenuptial molt, and weight dropped below the winter level. During the last half of April all males increased greatly in weight, averaging 30.8 grams, with a number of individuals weighing up to 33 and 34 grams. A heavy deposition of fat appears largely responsible for this increase which may occur within 7 to 10 days, or perhaps less. Virtually all males had departed by May 1. Females averaged heavier in April (27.3 gms) but the increase was much less evident than in males and the response was irregular, some females becoming quite fat, others showing little change. Females lingering into May were generally light (average 26.6), many still molting, and some, at least, being first-year birds. Apparently many females leave the Athens region before or without evident fat deposition or weight increase. For the entire spring period, April 15 to May 15, males averaged 3.8 grams heavier than females as compared with a 1.7 gram sex difference during mid-winter period, Jan. 1 to Feb. 15. The difference between these differences is statistically significant, 2.1 ± 0.69 gms.

By way of general conclusion, it appears from observational and experimental data so far available that temperature is a factor, perhaps the chief one, in bringing about the winter increase. Light, that is, length of day, is apparently the chief factor in bringing about the spring increase, temperature

being only a modifying factor. In species of birds which migrate early the significance of this difference is lost since the 2 weight peaks may coincide or be superimposed upon one another. A late migrant species, such as the White-throated Sparrow, is a more favorable subject for study since the 2 peaks are distinct and, therefore, may be studied separately. It is hoped that detailed study of collected specimens now in progress may further clarify the physiology of the temperature-correlated (winter) and light-correlated (spring) weight increases.

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NOTES ON NESTING PIGEON HAWKS AT PIMISI BAY, ONTARIO

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DURING the years 1946, 1947 and 1948 Pigeon Hawks, *Falco columbarius*, resided on a hill at the south end of Pimisi Bay. In 1945 Pigeon Hawks were also sighted in the same neighbourhood during spring and summer and, in all likelihood, nested in the area. While the presence of these falcons during 4 years in the same place indicates that it may have been the same pair returning each year, the male of 1948 was decidedly a darker bird than the one seen in 1947.

In 1946 my observations, covering parts of the townships of Bonfield and Calvin, District of Nipissing, disclosed an unusual number of nesting pairs where previously the species only occasionally had been noted. In 3 different localities I saw groups of juveniles at a time when their presence there could only mean that they had been reared not far from these places.

In 1945 the first Pigeon Hawk was seen on May 14 and the last on September 3, in 1946 the dates were May 17 and August 13, in 1947 April 23 and October 2, and in 1948 April 7 and October 5.

Habitat

At Pimisi Bay, which is halfway between North Bay and Mattawa in central Ontario, the falcons' nesting grounds were located about a quarter of a mile south of the Trans-Canada Highway. To the north and east, with the exception of our home, the land is practically uninhabited. To the south, on the other hand, the Canadian Pacific Railway skirts the nesting hill and not a full mile farther on the country becomes quite densely settled with one small farm beside the other.

In general the region is rough and rocky. Its main lakes and rivers constitute an extension of the Ottawa-Mattawa river waterway and the rolling hills beyond are the northwestern end of the Laurentians. After many fires and extensive lumbering, it is now reforested by mixed second growth. The edges of these woods along clearings, creeks, rivers and lakes provide excellent nesting grounds for wood warblers, thrushes, woodpeckers and other forest-dwelling birds.

The hill that the falcons selected for their nesting was burnt over 14 years ago and a stand of dead pine trees was left, crowning the hilltop. In these the birds found the ideal perching which, according to most observers (Bent, 1938), seems to influence their choice of territory. Another circumstance, which coincides with the observations of John and Frank Craighead (1940: 241), was that the hawk nests, both in 1947 and 1948, were close to water, in neither case more than 75 feet from the shore of Pimisi Bay.

Nesting

In 1947 I found the first nest only after the young had left. The finding of a $\frac{7}{8}$ inch pellet beneath it and the presence of flying young still being fed by their parents in the burnt-out pines just above it, established the identity of the nest beyond much doubt. It was located in a white spruce, *Picea glauca*, about 35 feet from the ground and lodged in a very bushy part of the tree, thus well concealed from all sides and from above. The tree stood at the foot of the hill on the east side and was closely surrounded by two or three of its own kind.

In 1948 the nest was found in a white pine, *Pinus strobus*, which stood on a shelf farther up the hillside, about 40 feet from the old site. The spruce had fallen during the winter and nothing was left of the earlier nest but a few scattered sticks. Both nests were built just above the middle sections of the trees, whereas the Craighead brothers (1940: 241–242), found all of their many nests located near the top, except one which was near the ground.

The new nest was built on the south side of the tree, against the trunk and supported by three stout branches, and also this time the birds had chosen the bushiest part of the tree. It was $39\frac{1}{2}$ feet from the ground and measured 35 inches in diameter with 5 inches inside depth. The nesting tree was the tallest and branchiest tree of the hillside and it stood alone on its rock shelf with scattered red pines, *Pinus resinosa*, at some little distance from it. It commanded a far view over the sheltered south bay of the lake and distant hills. To the north, a distorted tree, the remains of a *Populus grandidentata*, clung to the rocks; it sometimes served the female hawk as a landing perch on her flights to and from the nest and, occasionally, as a plucking anvil.

Behaviour at the Nest

The general pattern of the Pigeon Hawk's nesting behaviour has been rather fully described elsewhere, by Bent, (1938) in his life history of the Eastern Pigeon Hawk and by the Craigheads, (1940) in their paper, "Nesting Pigeon Hawks," and it seems unnecessary to discuss here points other than those which differ or have not been mentioned in detail in the above publications.

The male of this particular pair was not seen feeding the young. During my watches, this was done by the female only. Nor was she observed to go hunting on her own until the male disappeared when the young were about 11 days old. Up to this time, the male was seen to bring all the food, both for the female and the young.

After feedings, an hour's rest for the hunting male was almost a rule, when it would perch in the top of a burnt-out pine, immovable like a sphinx. Occasionally, particularly during incubation when less food was required, the rest periods would extend even longer, two hours or more, when motionless perching might be interrupted by some preening or an odd flight out over the land in territorial defense.

At first the time occupied in the actual feeding of the young was on an average 5 minutes, depending on the size of the prey, up until the hawklets were about a week to 10 days old. During this time the prey brought in was usually small or, if it were larger, the female would sometimes eat part of it before she brought it to the nest. After this, the prey increased in size and then some of the feedings I witnessed took as long as from 25 to 35 minutes. A curious note came from the female while she was feeding and when she fed the young, a sharp "tick . . . tick . . . tick", quite audible from where I sat some 50 feet away. In the beginning I thought this was a kind of clicking noise of the beak, but as it did not seem to coincide with the movements of the bill it must have been a note coming from the bird's throat. When given at the nest it evidently stimulated the eager anticipation of the young.

There would be many reasons to suppose that the home territory of a raptor like the Pigeon Hawk would be a place shunned and deserted by other birdlife. But, to my surprise, I soon found that the small birds nesting near or within the hawks' territory were, and apparently remained, quite safe. In the course of time I recorded the following species nesting in the immediate vicinity: Nashville Warbler, *Vermivora ruficapilla*, Myrtle Warbler, *Dendroica coronata*, Canada Warbler, *Wilsonia canadensis*, American Robin, *Turdus migratorius*, Olive-backed Thrush, *Hylocichla ustulata*, Veery, *Hylocichla fuscescens*, Red-eyed Vireo, *Vireo olivaceus*, White-throated Sparrow, *Zonotrichia albicollis*. Of these, the Nashville Warbler had a favourite singing perch not 50 feet from the hawks' nest; the Myrtle Warbler male had a feeding ground laid out through the red pines immediately south of the nest; the Olive-backed Thrush successfully reared two young in a willow just below the shelf where the hawks' nesting tree stood; the White-throated Sparrow conducted a party of young just out of the nest through the bushes in full view of the female hawk perched on guard; the Robins repeatedly attacked the hawks with such fury that the birds of prey wobbled on their lawful perches, without lifting a wing to counter-attack.

Apart from the resident birds, small birds passing through the territory, such as Chimney Swifts, *Chaetura pelagia*, Cedar Waxwings, *Bombycilla cedrorum*, and Black-capped Chickadees, *Parus atricapillus*, also seemed to be safe. At any rate, I failed to see either the male or the female falcon take after and chase them, although the small birds sometimes passed uncomfortably close to the hawks' nest. A young Hairy Woodpecker, *Dendrocopus villosus*, on the other hand, once shone too brightly in the female falcon's eye. Whether or not, in this case, she intended to kill the woodpecker was hard to determine; her dash after it was business-like enough, but her failure to capture the surprised and inexperienced youngster gave me the impression that her pursuit was more in the nature of a chase.

Birds the falcons obviously regarded as enemies were a Great Blue Heron, *Ardea herodias*, Crows, *Corvus brachyrhynchos*, and Hawks, *Buteo platypterus* for instance. The size of these birds seemed to be a factor in releasing the defense reaction in the small falcons. When espied half a mile away, like irate hornets the falcons dashed off, screaming, to route the intruder. By means of vicious diving attacks this was done in short order; none withstood the surprise and fierceness of the falcons' onslaught.

Squirrels and chipmunks, running freely around on the hilltop, seemed to be largely ignored like the smaller birds; but towards the larger mammals, into which category man might be included, unless overly provoked, the hawks generally adopted a defensive attitude. Once my dog, an English setter, came looking for me in my blind and the female, incubating at the time, immediately left the nest and perched on guard in the top of a nearby tree. Whenever the animal moved she followed screaming and so long as it remained on the hill the hawk did not return to the nest. My own watches were invariably spoiled as soon as the birds detected my presence and, no matter how long I then remained, they would not resume normal activities but perched on guard and screamed each time I moved. One day the female saw me coming when I was still far away and began screaming. I dove into the bush and, thinking I could fool her, hid, waiting for a while, and then made a long and laborious detour through a swamp and a dense thicket until I came to a point where I could overlook the situation. To my discomfiture I found the hawk perched in a dead tree above the thicket I had just crawled through and, a second later, she alighted screaming behind me. My entire manoeuvre was as plain to her as if I had walked through a clearing, and that day's watch was in vain. Certainly, this bird showed herself more suspicious and, in agreement with Craighead brothers (1940: 243), more aggressive than the male, especially when I approached the nest too closely. On such occasions she exhibited great excitement, screamed, dove at me headlong with anything but faked fury, while the male, with a timidity quite inconsistent with his defense behaviour towards birds larger than himself, kept at a distance and only screeched his accompaniment as the female's agitation reached a high pitch, or dashed after her in sympathetic pursuit as her gyrations brought her to the wings of the stage.

Hunting

All the hunting that I had the luck to witness was not closer to the nest than a quarter of a mile and many times I saw the falcons go hunting at far greater distances.

Twice I saw the male hunting at twilight. One time he came streaking along the highway just at the edge of the woods. Suddenly he dashed in amongst the trees and, an instant later, he reappeared with the prey in his talons. He flew into a dead tree where he devoured it, its tousled feathers slowly floating down upon the still air. That even so fleet a hunter as this falcon could have seen, caught and killed another bird in the gathering dusk of the thicket in that split second, seemed almost incredible. Another time, at sunset, my husband and I came upon the male perched in a dead tree. Just as we stopped to watch him, he flew out in pursuit of a fluttering creature which, at first, we mistook for a bat. After some magnificent manoeuvring the hawk caught it on the wing and then returned to his perch to tear it to pieces. One of its wings fell to the ground. It was the wing of a *Polyphemus* moth.

My banding station was occasionally the scene of the falcons' hunting, but to my knowledge never with success. Once one of them came like a bullet towards my window, but within three feet of the pane it made a neat right-about turn and the chickadees scattered safely under cover. Another time I stood watching a White-throated Sparrow feeding five young. The next instant the hawk whizzed past, so close that I felt the wind of its wings on my cheek. It missed every one of the sparrows all colour-banded, which "froze" within inches of the feathered projectile.

On two occasions I happened to be in at the kill. A pair of Eastern Kingbirds, *Tyrannus tyrannus*, were feeding young, 3 days old, in a nest built at the very top of a tall spruce—the most obvious nest tended by the most conspicuous birds of the neighbourhood. The falcon came in from the lake in headlong flight, having from afar espied the female Kingbird on her way to the nest with food. Her mate, just after feeding the young, sat on a twig above the nest. Instantaneous dodging saved the female and, with a force that rocked the sprucetop, the falcon gripped the edge of the nest instead of the bird. The kingbirds, oddly inefficient, screamed and flitted around the hawk which defended itself merely by raising its wings. The hawk looked into the nest, apparently took a young in the beak and flew back with it to the hill. The whole thing happened with such lightning speed that it was only when I later computed the details of my notes and found the abruptly lowered rate of feeding that I realized the full truth of what had taken place. Two days afterwards, all the young disappeared and I can hardly suspect anyone else but the Pigeon Hawk.

The second time, I was watching a pair of Blackburnian Warblers, *Dendroica fusca*. The nest, also this time, was high up in the top of a tree and contained young, 5 days old. The female had been picking mayflies in the neighbouring tree and was flitting back to the nest when the hawk literally nailed the small bird to the nesting branch. The next second the hawk was gone and the following day, in spite of the father's continued feeding, the young warblers died from lack of motherly care and brooding.

In his life history of the Eastern Pigeon Hawk, Bent (1938: 79) quoted Brewster's description of a Pigeon Hawk pursuing a Blue Jay, *Cyanocitta cristata*, which eluded capture by "dropping into a treetop, where the hawk did not attempt to attack it." In the two instances cited above, it may be noted that the hawk did not hesitate to descend into the treetops when capture on the wing proved incorrectly timed and, in the case of the kingbird, the hawk substituted on the spur of the moment the prey first aimed at but missed by another less elusive victim.

Undoubtedly the falcons thus wreaked havoc upon many nestings of the smaller birds. To make an accurate estimate of the predatory pressure they exercised upon the bird population around Pimisi Bay is, obviously, a difficult matter. The longer I watched the food habits of these hawks, the clearer it became what a surprisingly small quantity of food they actually required relative to their size and expended energy, probably due to the highly nutritious value of their diet. However, if it may be assumed on an estimate based on the feedings seen, 1 to 2 in 3 to 5 hours, and the amount of meat eaten by the young after capture, about 50 to 60 gr. a day by 2 hawklets, that each of the adult hawks, on an average, consumed 2 birds a day during 75 days and the young 3 birds a day during 50 days a total of 450 birds killed in $2\frac{1}{2}$ months is reached. Had not the hunting grounds of the hawks extended over so wide an area, to a radius of at least a mile from the nest in all directions, the smaller bird population of a more restricted locality would certainly have been in danger of being wiped out.

On our lot of about 10 acres, a quarter of a mile from the hawks' nest, where I do most of my bird study, some data were obtained, which may partly be connected with the predatory pressure upon the birds breeding there. In 1947, of all nestings found in trees, 33.3% were known to have been interrupted by predatory birds which included Blue Jays, Crows and the Pigeon Hawks. Furthermore, it may be assumed that the nests abandoned for unknown reasons, 14.3%, belonged to birds which were the victims of depredation since, in most of these cases, the mate or mates in question were found to have disappeared unaccountably from their territories after the nestings were interrupted. The next year, 1948, a marked decline followed in the numbers of certain nesting birds, particularly noticeable in bright-coloured and tree-nesting passerines. For example, counted by nests found and singing males, in that year American Redstarts, *Setophaga ruticilla*, decreased from 5 to 1 pairs, Magnolia Warblers, *Dendroica magnolia*, from 4 to 1 pairs, Blackburnian Warblers from 3 to 1 pairs. Least Flycatchers, *Empidonax minimus*, which are not bright-coloured birds but apparently especially vulnerable to such hunting methods as those of the Pigeon Hawk because of their exposed flycatching habits and often rather obvious nests, decreased from 10 to 4 pairs in the same year. In 1947, only 1 of 8 Least Flycatcher nestings was successful and 3 interrupted by the disappearance of one or both of the mated birds. All 4 first nesting attempts of 1948 were unsuccessful and, in two cases, I followed new nestings which also were interrupted for undetermined reasons. While I did not follow the nestings closely enough in 1948 to determine the exact causes of so much bad luck amongst the Least Flycatchers, I feel justified, at least in part, to put the blame on the Pigeon Hawks.

With birds nesting in holes in trees, such as woodpeckers and nuthatches, which are notoriously fair meat to the Pigeon Hawk, the picture presents itself somewhat differently. The area is a mecca for birds requiring nest sites in trees and stumps with soft cores and for comparative lack of treeclimbing predators these nestings are for the most part successful. Three pairs of Yellow-shafted Flicker, *Colaptes auratus*, nested here in 1946, but only one pair in 1947 and 1948 respectively, with a consequent decrease of flying young in these years during July and August. A notable decline in the numbers of Yellow-bellied Sapsucker, *Sphyrapicus varius*, took place as early as 1946 when pairs excavating nestholes were reduced from 3 to 1 and in 1947 there were none. On the other hand, 1948 witnessed a slight comeback of the species with 2 nesting pairs. Flying young after both these nestings were conspicuously absent, which may have been due to the death of some of the adult birds. The decline in Hairy Woodpeckers occurred in 1947, when nesting pairs were totally absent from the study area where two or three pairs had been breeding in previous years. Even an old colour-banded female, that had nested in the neighbourhood during 4 consecutive years, avoided the territory this season and no flying young were seen at any time. But in 1948 3 pairs, including the old female, produced an unusual number of young, of which 8 were banded. The same year saw a notable increase of from 1 to 3 pairs of Downy Woodpecker, *Dendrocopus pubescens*, and from 0 to 4 pairs of Red-breasted Nuthatches, *Sitta canadensis*, with a fifth pair nesting a little outside the area. In due time, most of these pairs appeared with flocks of flying young.

Although these variations in the numbers of breeding birds doubtless reflected other causes as well, a point in evidence is that, in one way or another, a compensating balance was obtained within the bird population itself, which, in the end, counteracted whatever predatory pressure may have existed upon it as a whole.

Of the prey seen in the talons of the hawks I was able to identify a mature male Purple Finch, *Carpodacus purpureus*, and the freshly severed head of a male Scarlet Tanager, *Piranga erythromelas*, was found shortly after the female hawk had been seen devouring the prey on the perch above—both species bright-coloured and tree-nesting birds. In the nest, half buried in a heap of dried excrement, the following remains were found: the leg of Cowbird, *Molothrus ater*, the right leg of Blue Jay, the left leg of Yellow-bellied Sapsucker, 2 left legs and the left wing of Yellow-shafted Flicker.

Behaviour and Development of the Young

The young hatched between June 23 and 29. Judging by their size and ability to move about when I first saw them on June 29, I calculated that they hatched on or about June 24.

I can add little to the Craighead brothers' excellent description of the young at feeding time, (1940: 244). In the nest at Pimisi Bay the 3 hawklets usually ranged themselves in a row before the female, the two largest to the left and the smallest to the right. The largest ones seemed to get the lion's share of the food, probably because they reacted more readily to the female's short quick thrusts with which she offered them the pieces of meat torn off the prey. Between feedings the young were generally quiet, but when the parent bird approached and a meal was in the offing they gave voice to their impatience with a sharp "keeyep-keeyep-keeyep-keeyep" which was quite as peevish as the adults' piercing cry, "ke*ee*yick-kyick-kyick-kyick-kyick." As the young grew older they moved about a great deal, taking little runs across the nest, flapping their wings and pushing each other, preening their thick coats of down, or fighting off swarms of small yellow wasps and bumblebees, which were attracted to the nest by the fleshy remains of the hawks' meals.

On July 5, the male hawk disappeared and the female alone was hunting and feeding the young. I suspect he had been shot either near the nest or while visiting some nearby farm. The next day a Crow alighted on the rim of the nest. The young whined and crouched down into the bottom of the nest. I must confess to a not altogether involuntary movement which scared the crow away. I expected, however, that the Crow, knowing where a good meal was to be had, would repeat the visit at a more opportune moment, but for some reason this never happened or the female may have been there to prevent calamity.

On July 12 the female apparently shared the fate of her mate. I waited in vain for her return and, finally, decided to save the young.

The rescue was achieved without incident. The young hawks threw themselves on their backs at our approach, ready to fling out their talons in self-defense, but at the age of approximately 18 days they had not yet acquired enough strength to inflict injury.

Covered with faintly bluish pearl-grey, thick, woolly natal down and with their eyes surrounded by bare skin which joined the cere at the base of the beak, like goggles, they looked like masked dolls whose droll air of defiant solemnity in a helpless situation only enhanced their goblin affinity. At this time, the two largest ones were fast losing their down and their feathers were beginning to sprout, creamy buff with dark brown, almost black, stripes on the breast, black-brown on the back, particularly on the shoulders, dark slaty brown edged with cream-buff on the tail, dark brown margined with light buff on the wings which, when spread, showed rounded cream-buff markings. The cere was lemon-yellow with a faint tinge of greenish towards the forehead, the featherless eye-ring greenish-yellow, the iris of the eyes brown, and their legs bright yellow.

Weights and measurement were as follows:

No. 1 hawklet			*No. 2 hawklet*			*No. 3 hawklet*		
Weight	161.7	gr.	Weight	165.2	gr.	Weight	105.9	gr.
Length	217	mm.	Length	203	mm.	Length	168	mm.
Wing	119	mm.	Wing	122	mm.	Wing	92	mm.
Tail	66	mm.	Tail	52	mm.	Tail	42	mm.
Tarsus	42	mm.	Tarsus	46	mm.	Tarsus	42	mm.
Ex. Culmen	10	mm.	Ex. Culmen	11	mm.	Ex. Culmen	10	mm.

We fed the young raw meat and liver which they seemed to take quite readily. C. B. Schaughency and his wife of East Orange, New Jersey, who helped me feed them, discovered that the best way to release the gaping reaction was by offering the food with fast jerky movements, similar to the female's way of feeding them. When the food was given slowly and gently the hawklets did not seem to see it but threw themselves backwards in a defensive attitude.

Unfortunately I had to leave home on July 14 and my husband kindly took over the care of the hawks. Since his work necessitated his being away all day and as he was unable to procure fresh meat, he left a dish of canned dog-food in the cage during his absence. The hawks soon learned to feed themselves and the two largest apparently throve on the unnatural diet, but the smallest one died the day before my return, 8 days later.

At this time the hawklets were already fully feathered. Nothing remained of their natal down except a fringe of fuzz at the tip of the feathers on the shoulders and on the crown where it remained longest, like the soft frill of a bonnet. As I opened the cage to feed them, No. 2 hawklet, which, judging by the length of the tarsus, probably was a female and always proved the most precocious of the two, flew out in a flight of about 100 feet. It landed on the trunk of a pine where it clung for a few moments, then flew about 25 feet up in a tree. There it remained for a couple of hours, preening and observing the surroundings. In the evening it returned to feed at the cage, which henceforth was left open except at night. The hawklet did not remain there for the night but roosted in the tree above. Thus No. 2 left the nestcage at the age of about 4 weeks.

Three days later we banded both hawks. No. 2 was trapped as it came to the cage for food. After No. 1 was banded it remained in the cage for a couple of hours and only in the late afternoon it hopped out of its own volition and down on the ground, apparently still unable or unwilling to make as good a first flight as No. 2. It finally got up in a tree by relays and roosted there without coming down for supper.

The first week after the hawks left the cage they passed most of the day and roosted at night close to our home. During this time they indulged in considerable screeching at feeding time or in play with each other and they often heralded my husband's return home at night by screeching.

I placed deermice and raw beef on top of the cage and both hawks came down to feed 3 to 4 times during the day. No. 2 mostly stood on the cage and fed while No. 1 grasped the piece of meat in the talons and flew off with it, devouring it on a branch.

At the age of about 5 weeks, the hawks began to make training flights out over the lake and it was remarkable how fast they acquired agility and technique in flying. I removed the cage and placed the meat on a table. The hawks came to feed a little more rarely than during the first week. With a thud they alighted on the table, bobbed their heads, made a little run to grasp the meat and generally flew off with it in their talons. The meat still had to be cut up in small pieces; if the pieces were too big the hawks dropped them and would not pick them up again until replaced on the table.

At the age of 6 weeks, the hawks began to move away farther afield. Their screeching ceased almost entirely and their movements around the feeding place became silent and furtive. They made extensive training flights, mostly together, when they would wind in and out of each others' paths or chase each other at a fast clip. Feedings at the table now only occurred in the mornings or late in the evenings and it became clear that they must be supplementing these feedings with some hunting of their own. I was reasonably sure that they were not yet able to catch small mammals or birds since they were still dropping pieces of meat when too heavy and could not yet carry away a whole deermouse. My speculation on this matter was solved on August 9 when, for the first time, I watched their performance of flycatching, quite an amazing stunt by young hawks which had no parents to learn from and therefore relied entirely upon innate instinct. In a fluttering flight they rose above the tree-tops where insects swarmed these hot high-summer days, caught their prey by dint of twists and swoops, dropped back on to a branch in some dead tree, smote the prey to pulp and devoured it. By this time, the hawks had found their way back to their true home-grounds on the burnt hill and it was here at night that I now saw them most often.

Throughout the last weeks in August I saw them at different places, once as far as a mile from our home. They still returned for meat at the table. Now they no longer alighted but dove on the table, seizing the meat in passing with their talons. Once No. 2 dropped a piece on the upswing and deftly recaught it in mid-air. Gradually, their visits became rarer, sometimes with several days in between until, on August 29, both perched above the feeding table, looking down for a last meal.

On September 2, I encountered one of them hunting in a place where a pair of American Goldfinches, *Spinus tristis*, were feeding young just out of the nest. The goldfinches behaved with obvious distress and soon afterwards were seen departing with at least one of their young missing. Thus I drew the conclusion that the young falcon had, at last, fully graduated in the hunting techniques of its species.

Summary

A resume is presented of notes on Pigeon Hawks which nested in the same place at Pimisi Bay, Ontario, during at least three years in succession. The habitat was a burnt-over hill near the lake and the nests found were placed a little above the middle-sections of coniferous trees.

The male falcon did most of the hunting and brought food to the female which, in turn, fed herself and the young. The hunting hawk usually took at least an hour's rest before going out on another hunting trip. Small birds and mammals on the hawks' nesting territory were apparently ignored, but larger birds and mammals were not tolerated. It is indicated that the hunting pressure of the hawks upon the smaller bird population was counteracted by two main factors, the extension of their hunting grounds and what seemed to be compensating fluctuations within the bird population itself.

The young hawks, raised by hand for a week after their parents' disappearance, left the nest cage at about 4 weeks of age and reached full independence about 5 weeks later.

In the writing of this paper I am greatly indebted to Mr. W. Earl Godfrey, National Museum of Canada, for his kindness in helping me with the identification of the debris found in the nest. I further owe thanks to Dr. Josselyn Van Tyne for kindly arranging for me the loan of the literature cited below from the Wilson Ornithological Club Library and grateful appreciation to Dr. J. M. Speirs and Mrs. Doris Huestis Speirs for their encouragement, suggestions and criticism with regard to this manuscript.

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Rutherglen, Ontario, Canada

ECOLOGY OF A NESTING RED-SHOULDERED HAWK POPULATION

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An ECOLOGICAL study of the Northern Red-shouldered Hawk (*Buteo lineatus lineatus*) was made on the Coastal Plain of Maryland in Prince Georges and Anne Arundel Counties during the spring of 1947. The objective was to gain information on habitat requirements, population densities, reproductive rate, food habits, and other factors relating to the nesting, survival, and environmental relationships of this species.

Field data accumulated during this investigation form the basis for most of the information in the present paper. However, supplemental data from observations on the Patuxent Refuge during the preceding 4 years are also included. In the field work during 1947 the author was assisted by R. Bruce Overington and Alvis K. Melton. James B. Cope helped with the studies on the Refuge during the preceding years. Grateful acknowledgment is also made to William H. Stickel who identified fragments of mammals, reptiles, and amphibians found in several pellets taken from the Red-shouldered Hawk nests.

The 1947 study area (Fig. 1) comprising about 185 square miles, included almost the entire watershed of the Patuxent River from the fall line (natural boundary between Piedmont and Coastal Plain) down the river valley to a point near the upper limits of tidewater.

In this region the conspicuous courtship maneuvers of the Red-shouldered Hawk generally first become noticeable during the last week in February and continue through March and the first half of April. Nests are completed during the earlier part of this period and the eggs are usually laid between March 20 and April 10. In most cases, the hatching period occurs during the last 10 days in April and first 10 days in May. The young birds leave the nest sometime during the first 3 weeks of June.

Habitat Requirements

On the Coastal Plain of Maryland a combination of fairly extensive flood-plain forests with adjacent clearings appears to meet the major ecological requirements of the Red-shouldered Hawk during the nesting season. Within the study area this habitat combination was found to occur only along the Patuxent River and a few of its larger tributaries. These hawks were almost entirely absent in upland forested areas or in clearings that were situated more than .25 mile from flood-plain forests.

The flood-plain forests differ considerably from most of the upland forests in this region (Hotchkiss and Stewart, 1947). The overstory of the flood-plain

FIG. 1—Map of 1947 Study Area Showing Distribution of Pairs of Nesting Red-shouldered Hawks. The solid circles show the nest locations, while the open circles represent the approximate centers of territories of pairs whose nests were not found. The dashed lines represent the approximate boundaries of the areas that were inhabited by Red-shouldered Hawks, and the outer heavy line represents the boundary of the study area.

forests consists of a considerable variety of deciduous trees, the more important of which are: Sweetgum (*Liquidambar styraciflua*), River Birch (*Betula nigra*), Pin Oak (*Quercus palustris*), Red Maple (*Acer rubrum*), Tulip-tree (*Liriodendron tulipifera*), Beech (*Fagus grandifolia*) and Hornbeam (*Carpinus caroliniana*). Most of the upland deciduous forests are dominated by various species of oak (*Quercus* spp.), although locally, hickories (*Carya* spp.) and Tulip-tree are common. Virginia Pine (*Pinus virginiana*) and Pitch Pine (*Pinus rigida*) are often prevalent on upland areas that have been retired from agriculture.

In general, the Red-shouldered Hawk, throughout its range, occurs in moist, well-drained woodlands or in wooded river swamps during the nesting season. In the New York City region it prefers "richer lowlands where damp woods border on fields and marshes" (Cruickshank, 1942). It is usually far more common in lowland areas than in mountainous regions and prefers the borders of streams, lakes or swampy woods. In Massachusetts this species occurs regularly in the hardwood region of the southeastern part of the State as well as in the White Pine region to the north; and in Florida, the Florida Red-shouldered Hawk (*Buteo lineatus alleni*) "seems to be equally at home in extensive flat pine woods and in the dense live-oak hammocks" (Bent, 1937). In California, the California Red-shouldered Hawk (*Buteo lineatus elegans*) "is essentially a bird of the lower wooded river bottoms between sea level and 1200 feet" (Dixon, 1928) although Sharp (1906) found that it also showed a fondness for Eucalyptus groves.

Population Density

A census of nesting Red-shouldered Hawks in the 1947 study area (185 square miles) was conducted by attempting to locate the nest of each pair in the area, or failing that, to determine the boundaries of its nesting territory. The search for nests was carried out in late March and April before most of the leaves on the deciduous trees had appeared. A large proportion of the study area is open farm land which was covered quickly and satisfactorily by using an automobile. All wooded areas of any size were covered carefully on foot and many were revisited several times—especially when the terrain and vegetation appeared suitable for Red-shouldered Hawk habitation. Nest records and other observations pertaining to population densities and ecology of this species were plotted on War Department Quadrangle Maps ($7\frac{1}{2}$-minute series) that covered the area being studied.

A total of 51 pairs were located within the area and for 43 pairs, occupied nests were found. These 51 pairs ranged over approximately 42 square miles of territory or about 23% of the entire study area (185 square miles). The thoroughness of the coverage of the study area together with the fact that this species is quite conspicuous during the early part of its nesting season, makes it seem unlikely that any pairs were missed.

The population density for the part of the area (42 square miles) occupied by this species was about one pair per .8 of a square mile, while the density for the entire 185 square miles included in the study area would be 1 pair per 3.6 square miles. On an average the territory of each pair included about 160 acres of flood-plain forest which represented one-third of the total area included in the territory.

By referring to the map of the study area (Fig. 1), it may be seen that the nests or territorial centers were distributed fairly regularly over most of the flood-plain forests. This regularity in spacing is especially well marked in areas where the width of the flood-plain is relatively constant. In one such area the average intervening distance between 8 adjacent nests was .56 mile, while the maximum distance was .65 mile and the minimum .45 mile. The minimum distance in this case also represents the shortest distance between any 2 occupied nests in the entire study area.

TABLE 1

Distance Between Nests as Related to Width of Flood Plain

FLOOD PLAIN	MEAN WIDTH (IN MILES) OF FLOOD PLAIN (BASED ON MEASUREMENTS TAKEN AT ½ MILE INTERVALS)	DISTANCE BETWEEN NESTS (OR TERRITORIAL CENTERS) IN ADJOINING TERRITORIES		NUMBER OF NESTS (OR TERRITORIAL CENTERS)
		Mean distance (in miles)	Standard deviation	
Patuxent River (Upper two-thirds)	.48	.67	.22	22
Patuxent River (Lower one-third)	.28	.88	.19	8
Little Patuxent River	.20	.98	.24	10
Western Branch	.12	1.34	.24	6

In general, the distances between nests of adjacent pairs were found to vary inversely with the average width of the flood-plain (table 1). The 8 adjacent nests mentioned above, which averaged .56 mile apart, were located along one section of the Patuxent River where the average width of the flood plain was .53 mile. Along one fairly uniform stretch of the Little Patuxent River the average width of the flood plain was approximately .16 mile and here the intervening distances between 8 adjacent nests averaged about .96 mile.

A noticeable break in the distribution of nests or territories occurred along the lower course of the Little Patuxent River. Here the habitat conditions appeared to be entirely suitable and several old nests were found, although not a single Red-shouldered Hawk was seen or heard. Since this locality is popular for its hunting and fishing it is quite possible that the resident hawks had been shot out.

Bent (1937) found this species to be much more common in Florida than elsewhere. Along the Kissimmee River, 65 nests were found in an area 10 miles long by 5 miles wide, in a single season. On the basis of the nests found, the population density for this area (about one pair per .8 of a square mile) is practically identical to the density found in the 42 square miles inhabited by this species in the Maryland study area. It appears that this figure would approximate the minimum breeding density of the Red-shouldered Hawk where it occurs under optimum environmental conditions.

Apparently the breeding population density of this species is generally somewhat greater in the southern States than it is in other parts of its range. Along the Nueces River in Texas, Hahn (1927) reported that nests were usually from .25 to .50 mile apart. In one clump of trees about .50 mile square he found 5 nests. In southern Florida, Nicholson (1930) found that 2 pairs rarely used the same hammock, although on 2 occasions he found nests a few hundred yards apart. In the Buckeye Lake Region, Ohio, during the period 1922–24, Trautman (1940) found that the Red-shouldered Hawk population averaged slightly more than 22 pairs per year on an area that covered a little less than 44 square miles (1 pair per 2 square miles). In California, Dixon (1928) had a record of 23 nesting locations within a radius of 30 miles of Escondido, which he believed was all that the food supply of the area would warrant. Since the population density of this species is closely correlated with habitat conditions, its probable greater abundance in the southern States may be due to the extensive swamp forests that occur so commonly there. Elsewhere the required habitats of this species are more local and restricted in size.

Nest Sites

All of the nests found during this investigation were located in forested stream valleys. Fifty-one nests were on the flood plain while six nests were found on fairly steep river bluffs. Most of the nests were built in rather large trees. The D.B.H. measurements of the nest trees ranged from 1–4 feet and averaged about 2 feet. The height of the nests above the ground varied considerably, the lowest being 28 feet, the highest 77 feet, and the average about 50 feet. Roughly 90 percent of the nests were built in crotches of the main trunks, the remainder being situated in crotches of branches off the main trunks. One nest was suspended between limbs about one foot above an upright crotch, while another had been constructed on top of an old squirrel nest. Almost half of the nest trees had a fairly dense growth of Poison Ivy (*Toxicodendron radicans*) clinging to them. The nests were situated in a considerable variety of deciduous trees. These are listed as follows:

River Birch (*Betula nigra*)—13 nests
Pin Oak (*Quercus palustris*)—9 nests
Beech (*Fagus grandifolia*)—8 nests
Sycamore (*Platanus occidentalis*)—5 nests
Tulip-tree (*Liriodendron tulipifera*)—4 nests
Red Ash (*Fraxinus pennsylvanica*)—3 nests
Sweetgum (*Liquidambar styraciflua*)—3 nests

Red Maple (*Acer rubrum*)—3 nests
White Oak (*Quercus alba*)—3 nests
White Ash (*Fraxinus americana*)—2 nests
Willow Oak (*Quercus phellos*)—1 nest
Southern Red Oak (*Quercus falcata*)—1 nest
Black Oak (*Quercus velutina*)—1 nest
Swamp Chestnut Oak (*Quercus prinus*)—1 nest

Some preference may be indicated for certain species in this list. Although the first three, River Birch, Pin Oak, and Beech are among the more common species in the flood-plain forest, Sweetgum and Red Maple are equally as common and yet lag well behind in the number of nests that were situated in them. The reasons for such preferences, if they do exist, were not apparent.

Nests of the Red-shouldered Hawk have been found in a considerable variety of deciduous trees throughout its range (Bendire, 1892; Bent, 1937; Dixon, 1928; Trautman, 1940). In the northeastern states they also occur commonly in pine and occasionally in Hemlock, while in the southeastern and gulf states they have been found in pine, cypress, Cabbage Palmettos, Black Mangrove, and various species of broad-leaved evergreen trees (Bent, 1937; Kennard, 1894; Todd, 1940). In California the nests are frequently built in Eucalyptus trees as well as in the bottomland hardwoods, while in Lower California they have even been found in giant cactus and candlewood (Bendire, 1892; Dixon, 1928; Sharp, 1906). In general, the height of the nests above the ground in different parts of its range appear to be similar to those found in the Maryland area, except that nests in the extreme southern part of the range (southern Florida and Lower California) appear to average somewhat lower than those to the north. This may be a reflection of an average lower height of suitable trees in these southern areas. The lowest measurements were 2 nests 10 feet above the ground, 1 in a buttonwood in southern Florida (Bent, 1937) and 1 in a sumac bush in Lower California (Bendire, 1892), while the highest was 1 nest 85 feet above the ground, situated in a Sycamore in California (Dixon, 1928).

Association and Competition with other Raptores

The absence of Red-shouldered Hawks along Collington Branch (Fig. 1) might have been due to the presence there of 2 nesting pairs of the Eastern Red-tailed Hawk (*Buteo jamaicensis borealis*). A few scattered pairs of Red-tailed Hawks were found throughout the study area, although most of them occurred on the upland away from the stream bottoms, so that ordinarily there was probably very little competition between the two species. The habitat requirements of the Northern Barred Owl (*Strix varia varia*) and the Red-shouldered Hawk must be very similar since they were commonly found associated together in the same areas. However, no evidence of any antagonism between them was noted. On the Patuxent Research Refuge in 1943, a Red-shouldered Hawk nest was found only 160 feet from an occupied Barred Owl nest. Other nesting raptores which occurred in the study area, including the Great Horned Owl (*Bubo virginianus virginianus*), Cooper's Hawk (*Accipiter cooperi*), Broad-winged Hawk (*Buteo platypterus platypterus*), and Eastern Sparrow Hawk (*Falco sparverius sparverius*), were all largely restricted to habitats on the upland, and therefore had little opportunity to compete with the Red-shouldered Hawk.

In Massachusetts, Bent (1937) found the Red-shouldered Hawk and Barred Owl to be "tolerant, complementary species, frequenting similar haunts and living on similar food, one hunting the territory by day and the other by night." On the other hand, he noticed that the Red-tailed Hawk and Red-shouldered Hawk seemed to represent competitive and antagonistic species which apparently never nest near each other.

TABLE 2

Contents of Red-shouldered Hawk Nests

YOUNG	NESTS
4	10
3	17
2	16 (two of which also contained single sterile eggs)
1	4 (one also containing 2 sterile eggs and another one sterile egg)
?	2 (contained young but not examined closely)
deserted	3
127+	52

Reproductive Rate

Most of the nests were found during the nest-building, egg-laying, or incubation periods and were not examined closely until after the young had hatched. At the time of climbing to the nests, nearly all of the young had completed half or more of their growth. Out of 52 nests (table 2) which were revisited at this stage, only 3 (6 percent) were found to be deserted. The number of young in the nests which were still occupied ranged from 1–4 and averaged 2.7. Four of the nests with young also contained sterile eggs, 3 nests being found with single eggs and 1 nest with 2 eggs.

Very little could be found in the literature on the number of young Red-shouldered Hawks in nests following hatching, although there is considerable information on the number of eggs that are laid. In the northeastern and north-central states (Bent, 1937; Todd, 1940; Trautman, 1940) 3–4 eggs are usually laid, with 3 being more common than 4. Two eggs are occasionally laid and very rarely sets of 1 or 5 eggs may be found. Bendire (1892) even records 2 sets of 6. In Texas and California (Bent, 1937; Dixon, 1928; Hahn, 1927; Sharp, 1906) 3 eggs are generally laid although sets of 2 are fairly common and occasionally sets of 4 are found. In Florida (Bent, 1937; Nicholson, 1930), the usual number of eggs is 2, although 3 are occasionally found and very rarely 4. These data bear out the conclusions of Lack (1947), that many species tend to lay more eggs in the northern than in the southern part of their range. In this respect, the Red-shouldered Hawks in Maryland are similar to those in California and Texas, being intermediate between the birds of Florida on the one hand and the birds of the north-central and northeastern states on the other.

Food Habits of Nestlings

During the course of this study, a total of 43 food items of about 23 different kinds were taken from 17 nests. These were in the form of freshly killed prey, as older fragments in the nest debris, or as parts of regurgitated pellets. On the basis of occurrence of these food items, reptiles comprise 37 percent (16 items) of the food, mammals 33 percent (14 items), birds 19 percent (8 items), amphibians 9 percent (4 items), and insects 2 percent (1 item). A more detailed breakdown of these foods follows:

Food of Nestling Red-shouldered Hawks

(Percentages Based on Occurrence of Food Items)

Mice, Moles, and Shrews	23%
4 Field Mice (*Microtus pennsylvanicus*)	
2 unidentified mice (Microtinae)	
2 Star-nosed Moles (*Condylura cristata*)	
1 Common Mole (*Scalopus aquaticus*)	
1 Short-tailed Shrew (*Blarina brevicauda*)	
Snakes	19%
6 unidentified snakes (3 Colubridae, 3 Natricinae)	
1 Water Snake (*Natrix* sp.)	
1 Ground Snake (*Haldea valeriae*)	
Small Birds	14%
3 unidentified birds	
2 Indigo Buntings (*Passerina cyanea*)	
1 warbler nest stained with blood	
Lizards	14%
3 Race Runners (*Cnemidophorus sexlineatus*)	
1 Blue-tailed Skink (*Eumeces fasciatus*)	
1 unidentified Skink (*Eumeces* sp.)	
1 unidentified lizard (Scincidae)	
Rabbit	9%
4 Cottontail Rabbits (*Sylvilagus floridanus*)	
Frogs and Toads	9%
2 American Toads (*Bufo americanus*)	
1 Wood Frog (*Rana sylvatica*)	
1 unidentified frog	
Game Birds	5%
1 Mourning Dove (*Zenaidura macroura*)	
1 Bob-white (*Colinus virginianus*)	
Small Snapping Turtles	5%
2 Snapping Turtles (*Chelydra serpentina*)	
Beetles	2%
1 unidentified beetle (Coleoptera)	

Detailed observations of food habits of Red-shouldered Hawk nestlings at 16 nests in New York State (Ernst, 1945) were analyzed as follows: mice and rats (principally *Microtus*)—58%; amphibians (principally Leopard Frogs and salamanders)—18%; insects (mostly grasshoppers, beetles, and caterpillars)—10%; small birds—8%; reptiles—3%; and miscellaneous items—3%. One young domestic duckling brought to a nest was the only authentic case of poultry being taken in 4 years. In western Pennsylvania (Todd, 1940) "the young are fed on mice and other small mammals, frogs, crayfish, insects, snakes, and occasionally small birds." In South Carolina, Wayne (1910) writes that "during the breeding season this hawk frequently catches chickens and even grown fowls, but its principal food is mice, frogs, and snakes."

Besides the records just mentioned, scattered observations of the food habits of nestling Red-shouldered Hawks have been recorded in Massachusetts (Bent, 1937; Hersey, 1923; Kennard, 1894), California (Dixon, 1928; Sharp, 1906), Texas (Hahn, 1927), Wisconsin (Errington, 1933), and New York (Chapin, 1908). On the basis of the occurrence of 52 items thus recorded, mice, rats, shrews, and moles comprise 27% of the food, small birds 17%, frogs 15%, snakes 14%, gallinaceous birds (including poultry) 8%, rabbits and squirrels 6%, and miscellaneous items 13%.

All of these observations, including the records obtained in the present study, help to illustrate the diversified diet of these young carnivorous birds.

Summary

An ecological study of a nesting Red-shouldered Hawk population was made over a 185 square mile area on the Coastal Plain of Maryland in 1947. The courting and nesting season extended from late February until late June.

During the nesting season a combination of fairly extensive flood-plain forest with adjacent clearings appears to meet the major ecological requirements of the Red-shouldered Hawk in this region. A total of 51 pairs was found in the study area, occupying about 42 square miles or 23% of the total area studied. The population density on the land that was suitable for this species was about 1 pair per .8 of a square mile, while the density for the entire study area would be only about 1 pair per 3.6 square miles.

Nests were spaced fairly evenly over most of the flood-plain forests, especially in areas where the width of the flood plain was relatively constant. There was an inverse correlation between the width of the flood plain and the distances between nests in adjacent territories. The nests were all situated in fairly large trees and were from 28 feet to 77 feet above the ground, averaging 50. They were found in 14 different species of trees, all deciduous.

The Barred Owl and Red-shouldered Hawk were commonly associated together in the same lowland habitats. Other raptores were all largely restricted to upland habitats.

The average number of young in 47 occupied nests following the hatching period was 2.7 with extremes of 1 and 4. Only 3 out of 52 nests (6%) were found deserted at this time.

The food habits of nestling Red-shouldered Hawks are very diversified. They feed on many types of warm-blooded and cold-blooded vertebrates as well as invertebrates.

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A COMPARATIVE STUDY OF NESTING BIRDS IN A FIVE-ACRE PARK

Howard Young

THIS paper presents quantitative data on the size and nesting success of a breeding population of birds in a five-acre park land area; it traces the changes in this population and its reproductive fortunes through a complete breeding season, and compares the breeding cycles, the nest density, and the success of the various species composing it.

The material is based on observations made during the spring and summer of 1947 at Ho-Nee-Um Pond, a small portion of the University of Wisconsin Arboretum, in the vicinity of Madison, Wisconsin. By means of frequent searches (almost daily in spring, later about twice a week) a high percentage of the nests on the area was found, and it was possible to trace the history of most of these through the nesting cycle. Approximately 250 man-hours were spent in the field. Mean temperatures for the study period averaged 2.2 degrees below normal during March through July. August was the hottest ever recorded for the Madison region, 8.8 degrees above normal, and September was slightly above normal. Precipitation for the study period was 2.89 inches above normal.

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Description of the Area

The Ho-Nee-Um Pond area (Fig. 1) is a low-lying park on the northwest shore of Lake Wingra. It is roughly trapezoidal in shape and has an area of 5.2 acres. The 2 main plant communities are a mowed lawn of blue grass (*Poa spp.*) covering about 40% of the total area, and numerous plantings of closely spaced arbor vitae (*Thuja occidentalis*), covering about 26% of the total area. These plantings are arranged in irregular patterns, making for extensive environmental edges with the grass area.

The arbor vitae varies in height from 5 to 30 feet, with the average tree about 15 feet high. Mixed with it are scattered patches of red osier dogwood (*Cornus stolonifera*) and staghorn sumac (*Rhus typhina*), and lesser amounts of white birch (*Betula alba*), elderberry (*Sambucus canadensis*), ninebark (*Physocarpus opulifolius*), box elder (*Acer negundo*), honeysuckle (*Lonicera tatarica*), hawthorn (*Crataegus sp.*), and highbush cranberry (*Viburnum opulus*). The ground cover under the plantings is mainly blue grass, nettle (*Urtica sp.*), thistle (*Cirsium sp.*), and burdock (*Arctium sp.*). The vegetation beneath the arbor vitae was cut once, in May, with scythes. Late in the season there were solid beds of swamp milkweed (*Asclepias incarnata*) along some of the edges.

The northeastern corner of the area contains a small group of black locust (*Robinia pseudo-acacia*). The lake shore is lined by occasional cottonwoods

FIG. 1. Ho-Nee-Um Pond Area and Vicinity

(*Populus deltoides*), and there is a thick clump of black willow saplings (*Salix nigra*) in the southwest corner. Near these is a small swampy pond of approximately .3 acres, thickly grown to sedge (*Carex sp.*), with a few patches of cattail (*Typha latifolia*) and reed grass (*Phragmites communis*). The grass contains liberal amounts of dandelion (*Taraxacum officinale*) and plantain (*Plantago major*).

Nest Density and Nesting Chronology

The nesting population of the area is summarized in Table 1. Unless otherwise designated all the data refer to "active" nests (those in which at least one egg was laid). In addition to the species listed, the Cowbird (*Molothrus ater*) bred as a parasite of the Alder Flycatcher, Cedar Waxwing, Yellow Warbler, Rose-breasted Grosbeak, and Song Sparrow. Figure 2 presents the same material in graphic form; in this case, however, only nests actually found were considered.

The high density, ranging up to 9.6 nests per acre (May 19–May 20) is considered of special interest. This is probably due to the great interspersion of plant types, and the large amount of "edge" as shown in Figure 1. There are approximately 5000 feet of arbor vitae-grass edge in the area.

Computed according to the usual manner, i.e., the total number of nests on the area during the season, the density was 164 nests, or 32.8 per acre. This is referred to as "Total Nest Density" in Table 1. These nests represent approximately 94 breeding pairs, a density of 18.5 per acre. Steinbacher (1942) found 111 pairs of birds nesting in the 19 acre Frankfort Zoo park. This density of 5.8 pairs per acre, while only one-third that of Ho-Nee-Um, was considered to be especially high. There do not appear to be other comparable studies in areas of similar size for comparison.

The density data were further analyzed by comparing them from month to month. This showed extensive fluctuations as some species ended their nesting and others started (Figure 2). Following are the average daily densities in nests per acre for the months covered by this study: April—3.5, May—8.6, June—6.0, July—4.8, Aug.—2.1, Sept.—.6. The overall average was 4.3 nests per acre.

It would seem that "Highest Nest Density" (Table 1–D) has a particular significance. Other workers have usually computed what is shown in Table 1 as "Total Pair Density" (Col. F) and "Total Nest Density" (Col. C). These are valuable as indices to the population, but computing the highest nest density has the advantage of showing the greatest nesting population at any one time, and as such is better suited for investigations of the various problems related to social competition such as density tolerance, density-induced behavior, reproductive success, etc.

Inter-specific strife was very low even during the periods of highest density. Of the two most abundant species, Bronzed Grackles and Robins, the Grackles exhibited no recognizable territorial behavior; Robin territories were poorly defined and defended with indifferent vigor (Young: 1947). The other species were not observed sufficiently to draw conclusions regarding territorial behavior.

In Figures 2 and 3, the numbers and stages of the nests shown were determined partly by daily examination, and partly by interpolation and extrapolation. Nests in various stages of the cycle were followed, and averages based on all records were determined for the length of time in each phase. When a new nest

TABLE 1
Species Nesting at Ho-Nee-Um Park, 1947

SPECIES	A Nests found	B Estimated total of nests	C Total nest density	D Highest nest density	E Total no. of pairs (estimated)	F Total pair density
Bronzed Grackle *Quiscalus quiscula*	26	28	5.6	4.2	21	4.2
Robin *Turdus migratorius*	36	37	7.4	3.8	19	3.8
Catbird *Dumetella carolinensis*	22	22	4.4	2.2	11	2.2
Cedar Waxwing *Bombycilla cedrorum*	14	16	3.2	1.6	8	1.6
Yellow Warbler *Dendroica petechia*	12	12	2.4	1.4	7	1.4
Goldfinch *Spinus tristis*	9	9	1.8	1.2	6	1.2
Song Sparrow *Melospiza melodia*	2	15	3.0	.5	5	1.0
Mourning Dove *Zenaidura macroura*	11	11	2.2	1.0	5	1.0
Alder Flycatcher *Empidonax traillii*	5	5	1.0	.6	3	.6
Mallard *Anas platyrhynchos*	1	2	.4	.2	2	.4
R. N. Pheasant *Phasianus colchicus*	2	2	.4	.2	2	.4
Killdeer *Charadrius vociferus*	1	1	.2	.2	1	.2
Rose-Br. Grosbeak *Pheuticus ludovicianus*	1	1	.2	.2	1	.2
Chipping Sparrow *Spizella passerina*	1	1	.2	.2	1	.2
Warbling Vireo *Vireo gilvus*	0	1	.2	.2	1	.2
Yellowthroat *Geothlypis trichas*	0	1	.2	.2	1	.2
Total........................	143	164	32.8	9.6	94	18.5

C & F computed from B & E.
D—highest density at any one time; computed from A.
C, D, & F computed on a per-acre basis.

was found it was thus possible to determine fairly accurately the date on which it was started. For example, observations showed that Robins took about 7 days on an average to build their nest; it then remained empty for an average of 4 days, after which the eggs were laid at the rate of 1 a day. A Robin nest found to contain 2 eggs on April 20 was therefore tallied as having been started on April 7, since 13 days were necessary to bring it to the 2-egg phase of the cycle. In most cases it was only necessary to extrapolate 3 or 4 days. About 35% of the material presented in the figures was thus computed.

The efficiency of nest searches was tested by comparing the extrapolated totals of any given day with the number of nests actually known on that day. On this basis it was found that the number known on any given day varied from 32%

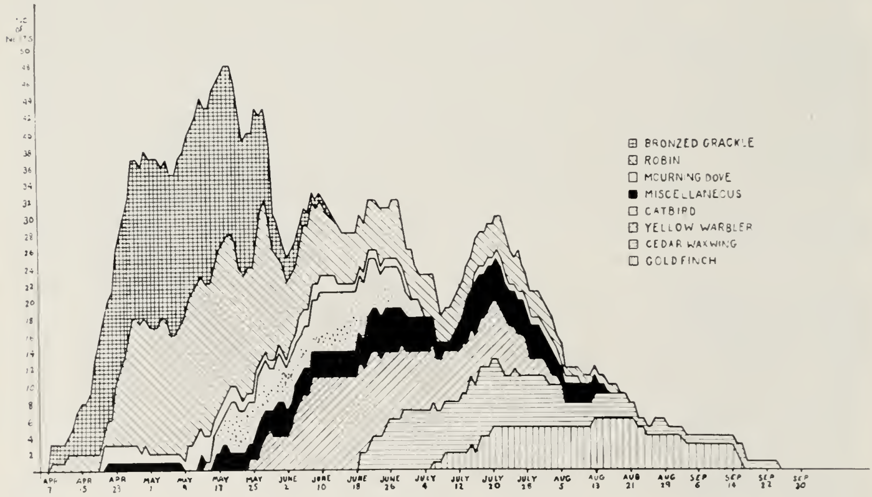

Fig. 2. Ho-Nee-Um Nests, 1947

to 100% of the number actually present. This does not take into consideration nests of Song Sparrows, since time did not permit extensive searches for them, and only 2 were found. On the peak days, May 19–20, 88% of the nests had been located. Comparison of the number of nests found with the estimated total of nests in Table 1 shows that about 87% of all nests were eventually found. In view of these facts the writer believes that Figure 2 represents a fairly accurate graph of the nesting. Errors in extrapolation would push individual peaks and depressions 1 or 2 days in either direction, but these would tend to compensate for each other, and the general picture would remain the same.

Three major peaks in nesting density are discernible in Figure 2; late May (mainly Robins and Grackles), most of June (Robin, Catbird, Yellow Warbler and Cedar Waxwing), and mid-July (Catbird, Waxwing, Goldfinch). The meagerness of the data prevents extensive discussion, but a few interesting things may be pointed out. The overlapping nesting periods of Robins and Grackles, both using the same nesting sites (arbor vitae), makes them competitors. Cedar Waxwings also nested almost exclusively in arbor vitae, but did not start until the Grackles were gone and Robin nesting was much diminished. The Gold-

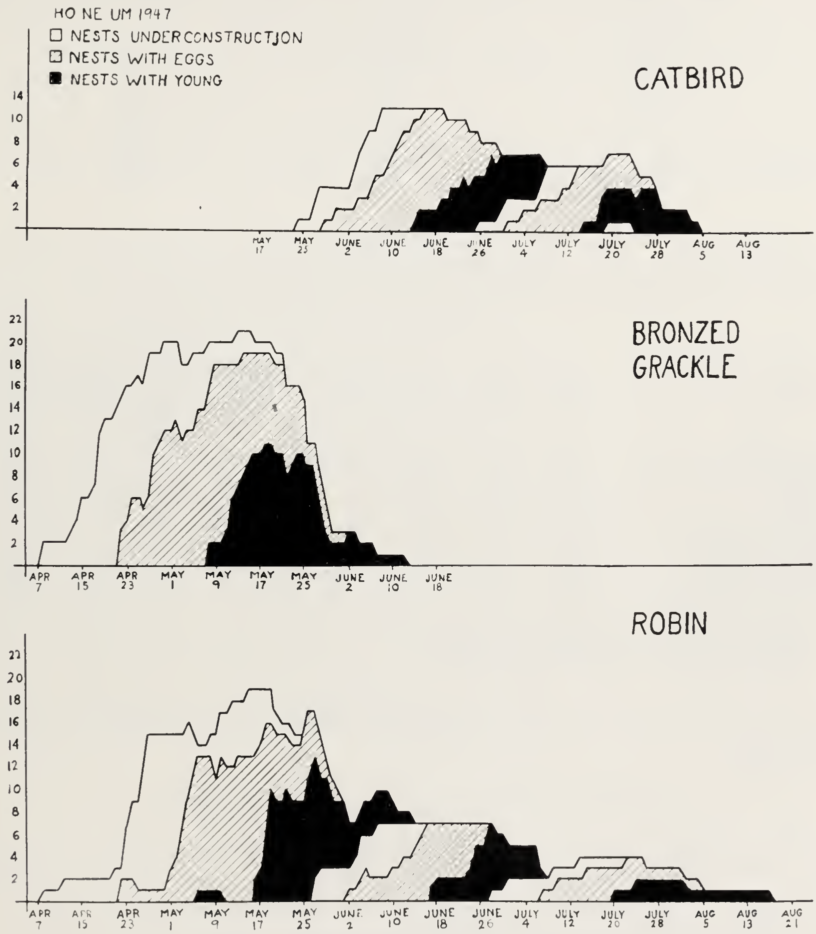

FIG. 3. Comparative Nesting Cycles, 1947

finches and Yellow Warblers nested mainly in ninebark; there was about a two week overlap in their nesting periods. It is impossible to say how much competition for nesting sites affected the density of the various species; as previously mentioned, little interspecific strife was observed.

Figure 3 compares the nesting cycles of the 3 most abundant species at Ho-

Nee-Um. It demonstrates the "Highest Nest Density" discussed before and makes possible comparisons, as between the Robins and Grackles. More Robins nested on the area than Grackles (Table 1), but their nesting was spread over a much longer period, and at no time did they attain a density as high as that of the Grackle's peak. The graph of the Grackles, which are single-brooded, lacks the long "tail" characteristic of the other species. More than half of the Grackle nests were broken up, and it would seem that the lack of a "tail" on their graph indicates that either no renesting attempt was made, or that the birds moved entirely off the area for the next attempt. Part of the sharp fall in the number of Robin nests after May can possibly be explained by the scarcity of hardwood trees on the area. Howell (1942: 549) found that 57% of the Robin nests he studied were built in conifers during the first nesting period, but later, when the

TABLE 2
Ho-Nee-Um Nesting Data, 1947

SPECIES	A Active nests	B Successful	C % Successful	D Eggs per nest	E % Hatched	F Fledglings per nest	G % Eggs producing fledglings	H % of young fledging	I Av. success of productive nests
Bronzed Grackle	26	12	45	4.5	72	4.3	44	61	84
Robin	36	18	50	3.3	61	2.4	37	61	73
Catbird	22	12	55	3.1	65	2.9	51	79	92
Cedar Waxwing	14	8	57	3.9	54	2.6	39	72	77
Yellow Warbler	12	5	42	3.5	48	2.8	33	70	74
Mourning Dove	11	2	18	1.8	30	2.0	20	66	100
Totals and averages	121	57	47	—	61	—	40	66	81

D computed from A; F computed from B.
B—Nests producing at least 1 young.

hardwood trees had leafed out, the number of Robins found nesting in conifers fell to 38%.

Nesting Success and Causes of Failure

Table 2 compares the nesting data of the various species for which at least ten nests were found. Again the small number of nests precludes intensive analysis of the figures, but some basis for comparison of nesting success is available.

Comparison of the percent of eggs hatching (E) with the percent of young fledging (H) shows a differential effect of environment on the various species under consideration. The Robins suffered losses approximately equal during the egg stage and the nestling stage. Catbirds and Grackles were affected in directly opposite fashion, the former having a heavier loss during the egg stage, the latter during the nestling stage. In the case of the Grackles, a bad storm when there were many small young in the nest accounted for much of the mortality.

The same comparison also indicates that the species having the poorest success in hatching eggs generally had a proportionately greater success in fledging their young. It is interesting to note that in comparing success from year to year, Nice's (1937: 141) figures for the Song Sparrow show the same general pattern within a single species. In her Table XVI, by dividing the number of fledglings by the number of hatched eggs, the following figures are obtained:

Year	*% of Eggs Hatching*	*% of Young Fledging*
1930	68%	63%
1931	72%	63%
1932	61%	61%
1933	51%	37%
1934	35%	78%
1935	41%	71%

The non-conformity of 1933 is apparently due to plowing of the nesting area at a time when most of the nests contained small young. Very close correlation should not be expected, since there are many other factors besides hatching success which could influence the fledgling success.

A similar situation is suggested in a study of the Eastern Red-winged Blackbird (*Agelaius phoeniceus*) by Smith (1943: 190). Of two nesting Red-wing populations, "A" hatched 74% of 563 eggs and fledged 80% of the young, "B" hatched 70% of 577 eggs and fledged 84% of the young. Much more data is needed for statistical testing, but it appears that there is possibly a compensatory interaction here following the general pattern that low egg survival results in high nestling survival, or conversely, that high nestling survival is associated with low egg survival. Errington (1946: 170) used Smith's data to illustrate the effects of predation, showing that a high loss of eggs apparently resulted in reduced vulnerability of the nestlings to predation. Another factor possibly involved is competition between nestlings, which Emlen (1942: 151) considered a major factor in nestling survival in the Western Crow.

Comparison between species of reproductive success, based on the number of young fledged per pair or per nest, will always be affected by the varying clutch size among the different species, and the varying number of broods raised. These factors can be eliminated by comparing the percent of eggs producing fledglings (Table 2–G). Considering each egg as a reproductive attempt, this shows what percent of the reproductive potential is attained. On this basis Catbirds were the most successful breeders at Ho-Nee-Um, (51% of their eggs producing fledglings) while Mourning Doves were the least successful, (only 20% of their eggs producing fledglings). The average success of productive nests (Table 2–I) was computed by dividing the number of fledglings by the number of eggs. The Mourning Dove nests were either complete failures or total successes, reflecting the birds' quickness to desert when molested. On the other hand, the Robins were able to bring off broods successfully after disturbances, though in only a few cases were their nests 100% successful.

Reproductive success possibly has the same inverse correlation with density as shown for reproductive activity by Kendeigh (1934: 308). Smith (1943: 204) found no evidence of this in the Red-wing, but Errington (1945: 14) found an inverse ratio between spring density and summer population gain of the Northern Bob-white (*Colinus virginianus*). Now that nesting studies have become more common it should be possible to compile similar data on various species from several areas. The value of these would be enhanced if it were also possible to compare the densities of the different areas, but this information is seldom available. More intensive studies might show optimum densities for

TABLE 3
Nest Success in Various Studies

SPECIES	NESTS	SUCCESSFUL %	REFERENCE	LOCATION	YEAR
Robin	501	78	Kendeigh, 1942	Ohio	?
	136	61	Howell, 1942	N. Y.	1937–38
	64	77	Koehler, 1945	Wisc.	1945
	36	50	This study	Wisc.	1947
	16	13	Thomsen, 1944	Wisc.	1944
Catbird	142	70	Kendeigh, 1942	Ohio	?
	22	55	This study	Wisc.	1947
Cedar Waxwing	29	58	Kendeigh, 1942	Ohio	?
	14	57	This study	Wisc.	1947
	12	50	Lea, 1942	Mich.	1940–41
Yellow Warbler	25	80	Kendeigh, 1942	Ohio	?
	16	75	Kendeigh, 1941	Iowa	1940
	12	42	This study	Wisc.	1947
Mourning Dove	2877	48	McClure, 1946	Iowa	1938–40
	325	47	McClure, 1946	Nebr.	1941–43
	57	54	Kendeigh, 1942	Ohio	?
	11	15	This study	Wisc.	1947
	10	70	McClure, 1946	Calif.	1944

the different species, such as has been shown for various invertebrates by Allee (1931: 161–180).

Nice (1937: 143) postulates 40% to 46% as typical success for open nests of passerines in the North Temperate Zone. At Ho-Nee-Um the passerine species averaged 49.8% successful in nesting attempts, a figure which agrees quite well with her estimate.

Table 3 compares the nesting success at Ho-Nee-Um with that of the same species in other areas. No references were found for the Bronzed Grackles, and again the species are limited to those for which at least 10 nests were found at Ho-Nee-Um. The data of Kendeigh (1942) were adjusted to make them conform to "active" nests as defined in this study. Unfortunately, information on density was not given in the other studies, but the consistently low success at

Ho-Nee-Um (excepting Cedar Waxwings) is possibly a reflection of its high nesting density. However, such a comparison suffers from the fact that the other studies sometimes covered several years, and were from many different area types. Omitting the Ho-Nee-Um data, the nest success of the passerine species listed in Table 3 averages 74%, nearly double Nice's estimate for open nesting of passerine birds.

TABLE 4
Nest Failures Ho-Nee-Um, 1947

	SPECIES							
	Bronzed Grackle	Robin	Cat-bird	Cedar Wax-wing	Yellow Warbler	Mourn-ing Dove	Total	Per cent
Nest failures								
A Predation	4	7	7	3	2	6	29	45
B Desertion	8	6	3	2	4	2	25	39
C Weather	2	5	0	1	1	1	10	16
D Total	14	18	10	6	7	9	64	100
Eggs not hatching								
A Predation	19	14	20	8	11	12	84	52
B Desertion	2	15	2	8	5	2	34	21
C Weather	0	6	0	0	0	0	6	4
D Unaccounted	9	4	0	2	1	0	16	9
E Infertile/addled	3	7	2	7	5	0	24	15
F Total	33	46	24	25	22	14	164	100
Young not fledging								
A Predation	0	10	7	1	0	0	18	21
B Desertion	9	3	0	1	0	0	13	15
C Weather	17	8	0	2	0	2	29	34
D Unaccounted	5	7	2	2	0	0	16	18
E Fell from nest	1	1	0	1	3	0	6	7
F Died in nest	1	0	0	1	0	0	2	2
G Cowbird parasitism	0	0	0	0	3	0	3	3
H Total	33	29	9	8	6	2	87	100

All nest failures could be attributed to one of 3 causes: predation, desertion, or storm damage. The effect of these on the species studied, referring only to "active" nests, is shown in Table 4.

Two Robin nest desertions were directly due to activities of the observer. Three Robin eggs, 1 Grackle egg, and 1 Yellow Warbler egg were accidentally broken; they were listed as lost due to predation. As far as could be determined the activities of the study had no other effect upon the species under consideration.

The predation was nearly 100% by an unknown avian form which punctured the eggs in the nest. Bronzed Grackles were suspected, but were never seen at the nests of other species, or carrying their eggs or young. The Grackles were common on the area from late March to late June, but egg losses continued at about the same rate after their departure. If a predator took 1 egg out of a clutch and the owner deserted, the remainder of the eggs were listed as lost due to desertion. Predation on adult birds was not observed, and its extent is not known. However, it probably does introduce an error in the records on deserted nests, since some of the resident birds may have disappeared because of predation rather than because they deserted.

Predation was the chief cause of nest failure, operating most strongly during the egg stage. Weather of course would act differently on the various species from year to year, depending upon the time that bad storms happened to occur.

Summary

Nesting birds were studied in a five-acre park area with arbor vitae and bluegrass lawn as the main cover types.

A total of at least 15 species (94 pairs) bred on the area during the period of study.

May and June were the months of highest nest density. On May 19–20 there were 9.6 active nests per acre. The average number of nests per acre for the season was 4.3. The total density for the season was 32.8 nests per acre.

The high density did not produce any noticeable interspecific strife.

Catbirds were the most successful breeders, producing fledglings from 51% of their eggs; Mourning Doves were the least successful, producing fledglings from 20% of their eggs.

Those species suffering the greatest loss of eggs in the nest generally appeared to be the most successful in raising nestlings.

Predation by an unknown avian form was the main cause of nest failures.

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THE WILSON BULLETIN PUBLICATION DATES

The actual dates of publication of the four numbers in 1948 were: March 22, June 22, October 13, December 28.

GENERAL NOTES

BREWSTER'S WARBLER BREEDING IN YATES COUNTY, NEW YORK

Potter Swamp, in west-central New York, occupies a long narrow, roughly north-south valley between Canandaigua and Cayuga Lakes. In effect, it represents an extinct member of the Finger Lakes group. Much of the best habitat for the more truly marsh-loving birds is being destroyed at the present time by extensive drainage operations. However, the area continues to support a rich population of nesting birds, the proportion of species encountered changing gradually, as in other drained areas, with the change in environment.

On June 22 and 23, 1948, Stephen W. Eaton and I were collecting in the higher portion of the Potter Swamp area. On the afternoon of June 22, I collected a female Brewster's Warbler (*Vermivora "leucobronchialis"*) and her mate, a typical male Golden-winged Warbler (*V. chrysoptera*). The call-notes of the two birds were identical; the male was not singing. The female bird conforms well with Ridgway's description (U.S.N.M. Bull. 50, part II, 1902; p. 454). Since a well-developed brood-patch was present, Eaton returned the next morning to the spot at which the adult birds had been collected, and succeeded in finding their five young. These birds had apparently just left the nest, and Dr. Arthur A. Allen estimated their age at about ten days.

Assuming that the Brewster's Warbler parent was an F_1 hybrid between *V. chrysoptera* and *V. pinus*, and that the male parent was a homozygous Golden-winged Warbler, the expected Mendelian ratio in the offspring would be 50% Brewster's and 50% Golden-winged Warblers. While it is, of course, impossible to state into which plumage each of our five juvenal birds would have molted, there is a definite color difference. Three of these young birds (two females and one male) have much grayer underparts than do the other two (one female and one male). The three grayish birds are quite uniform as are the two yellowish ones.

Through the courtesy of the American Museum of Natural History, I have been able to compare our specimens with five juvenal *V. pinus* and one *V. chrysoptera* of the same age as our specimens. None of our specimens is like any of these. The one *V. chrysoptera* examined is much darker, both above and below, than any of our specimens. Our two yellowish birds approach the lightest examples of *V. pinus*, but are substantially less intensely colored. Our three grayish birds are much paler and grayer than any of the *V. pinus* or *V. chrysoptera*. It might be of interest to record the colors of these five specimens. There is little, if any, difference in the color of the upper parts among the five. All have the back approximately Citrine Drab (color names from Ridgway, Color Standards and Color Nomenclature, 1912), brightening to Yellowish Citrine on the crown. The wing-bars of all five are Citron Yellow. The three grayer birds have Grayish Olive breasts, shading to Deep Olive Buff on the belly. The two yellower specimens, on the other hand, have the breasts Light Yellowish Olive, shading to Amber Yellow on the belly.

Both the Blue-winged and Golden-winged Warblers have been increasing in New York during the past two decades. The Golden-wing, the commoner of the two over most of the state, is appearing for the first time as a breeding species in southwestern New York, and is spreading out on the periphery of its formerly rather discontinuous range in the central portion of the state. The Blue-winged Warbler must be considered rare throughout most of New York except for the lower Hudson Valley region, Long Island, and the Buffalo region. It has been recorded sporadically over much of central and western New York. Until 1946 there was but one sight record of this species in the Cayuga Lake basin; there have been three since. It would seem logical for an occasional Brewster's Warbler to appear in central New

York, since a stray Blue-wing which lingered on into the breeding season would not be likely to find a mate of its own species, but plenty of available Golden-wings.

In spite of this probability, the Brewster's Warbler has apparently never before been collected in New York away from the southeastern corner. A search through the files of *The Prothonotary* reveals a number of sight records for the Buffalo area, including two nesting records near Versailles. This is not unexpected, as both of the parent species breed in this vicinity. Other than in this western New York area, and in the Hudson valley—Long Island region, there are but a few sight records for Brewster's Warbler; at Rochester, Canandaigua and Corning. None is a breeding record, and no specimen was taken. Our Potter Swamp specimens, therefore, represent the first breeding record of Brewster's Warbler, authenticated by specimens, in New York outside of the southeasternmost counties.

The skins of the two parents and their five offspring have been deposited in the Louis Agassiz Fuertes Memorial Collection at Cornell University. I am indebted to Edgar M. Reilly, Jr., who checked for me the distribution files of the U. S. Fish and Wildlife Service.—Kenneth C. Parkes, Laboratory of Ornithology, Cornell University, Ithaca, N. Y.

RUFFED GROUSE EATS SNAKE

In the Porcupine Mountains, Ontonagon County, Michigan on September 16, 1947, I flushed two Ruffed Grouse (*Bonasa umbellus*) from the ground into tall hemlocks. One shortly fell fluttering to the ground. The second bird then flew down and joined it. On my closer approach, both birds again flushed. A medium-sized snake, probably 1.5–2 feet long, dangled limply from the mouth of one bird. It appeared that the snake had been partly swallowed, but about a foot of its length was left protruding from the bird's beak. The grouse seemed abnormally weak but its peculiar flight and fall may have been due to awkwardness caused by its unusual prey.

The birds could not be located again and the snake was unidentified. Scott (Auk 64: 140, 1947) has recorded finding a small Red-bellied Snake (*Storeria occipitomaculata*) in the crop of a Ruffed Grouse in Wisconsin, but this must be a very unusual food item nevertheless.—George A. Petrides, Ohio Cooperative Wildlife Research Unit, Ohio State University, Columbus 10, Ohio.

CONSERVATION

Waterfowl inventory. The field investigations conducted by the various agencies working with waterfowl have been greatly expanded during the past year, giving promise for a healthier program for ducks. When it was realized, early in 1946, that waterfowl populations had severely declined, naturalists were disturbed by the confusion which prevailed. The setback followed the greatest wildlife management program in history, and evidences of the decline came while managers were most optimistic regarding the security of waterfowl. For more than a year the matter was thrown back and forth between groups which held, on the one hand, that the situation was a matter of small concern, and others which saw further and more serious troubles ahead if drastic measures were not taken to check the kill. This controversy received nationwide attention in the press, with neither side of the question supported by conclusive facts.

Fortunately, one first step taken to meet the situation was an expansion of the field investigations for the appraisal of waterfowl numbers. In 1946 the U. S. Fish and Wildlife Service sent 5 men and 2 aircraft to the Prairie Provinces of Canada, where their appraisals previously had been accomplished by 1 to 3 men in cars. Last year this Service crew numbered 7 men and 3 planes, while the leader of this party, Robert H. Smith, traveled on to the Arctic Coast where he spent a month running air transects over breeding areas between Point Barrow, Alaska and Bathurst Inlet, Northwest Territories. This appriasal work began when the breeding ducks settled on the prairies in late April and continued through August.

These Service biologists have developed for recording the resident breeding populations an objective method which is proving far more accurate than the previous examinations of the summering aggregations. In this spring work they are dealing with a relatively stable population, and one which, area by area, is small enough to be counted. Transects run by car, canoe or from aircraft give a highly accurate figure which can be compared year by year. Two Stinson L-5 aircraft—flying jeeps used during the war—cover the prairie marshes, while the Grumman Widgeon, an amphibian, is used in the Arctic. The spring survey, completed by July 1, provides part of the information upon which the autumn shooting regulations are set. During the remainder of the season the field crews study population shifts, rearing success and water conditions. An intensive breeding-ground banding program was carried out during July and August.

This Fish and Wildlife Service work is but one part of a highly cooperative venture. In Canada, the Dominion Wildlife Service and the Provincial governments have stepped up their own waterfowl programs, and the Service biologists work with these agencies. Moreover, the breeding grounds of the northern States, generally underrated as duck producers, have been carefully covered by a joint project between the State agencies and the Service. The Delta Waterfowl Research Station has been headquarters for the eastern prairie teams which have worked out many of their techniques there. Thus, there is developing a comprehensive picture of waterfowl production, and policy is now being guided by facts to an extent never before possible. The force of this new information has dispelled the controversy and is doing much to win the sympathy and interest of sportsmen, a matter of no small importance in drawing up a workable plan for waterfowl. The 1948 breeding ground inventory gave evidence of improved conditions and permitted anticipation of increased flights in most sections of the United States this fall.

For 10 years the Fish and Wildlife Service has released an annual figure representing their estimate of total waterfowl numbers. This, in recent years, was matched by other population estimates advertised by sportsman's groups, these sometimes being in wide contrast to the Service figures. The various agencies have agreed that total population figures lead to confusion in the minds of many sportsmen, and, therefore, that only estimates of increase or decrease should be released. The annual figure, however, is of great importance in guiding policy, particularly in respect to species with numbers so small as to be endangered by any misunderstandings regarding the size of the population to be harvested. Consequently, the January inventory, like the summer appraisals, is receiving more attention, and has been improved by new techniques and more air observations which now reach deep into Mexico and Central America to cover the wintering aggregations there.

The possibilities of international cooperation for investigation of waterfowl were emphasized by Peter Scott, British naturalist and bird artist, who returned to England after a month in the United States and Canada where he visited many waterfowl refuges and marshes. He is now Director of The Severn Wildfowl Trust, established at Slimbridge, Gloucestershire in 1946, where studies of British waterfowl are being undertaken. Despite the vast differences between British and American wildfowling methods, Scott believes that conservation on both sides of the ocean would be advanced by closer associations between British and American biologists working with waterfowl. The 1948 report of the Severn station is now available, at the price of $1.00. Its 72 pages give details of the Station's program, a description of some decoys and a discussion of a trapping technique in which rockets are used to throw a net over feeding geese. There is also an excellent color plate of one of Scott's recent paintings.

ALBERT HOCHBAUM, Conservation Committee

LITERATURE

Comments on Recent Literature

Subspeciation in Song Sparrows. Similar species having more or less dissimilar ecological requirements frequently occur together, suggesting that they evolved side by side through a process of ecological divergence. Yet with rare exceptions, incipient species (subspecies) of a given species are not found together during the breeding season. Indeed, no very plausible genetic theory as to how a freely interbreeding, localized population could break up into races, and eventually species, has been advanced. In a review of this problem Mayr (1947) concluded that although all subspecies probably differ to some extent ecologically, geographical isolation is necessary for their evolution. Once reproductive isolation is achieved, similar species may acquire overlapping ranges. Competition between them then becomes a potent factor in promoting further ecological divergence.

Many birds once believed to be examples of ecological speciation, such as various Galapagos finches, are now thought to have passed through the usual initial stage of spatial isolation. Another group that suggests the control of speciation by ecological factors, possibly without geographic isolation, is the series of races of the Song Sparrow, *Passerella* (*Melospiza*) *melodia*, found near San Francisco Bay, some in salt or brackish marches, others in the uplands. Thus Huxley (1942: 272) referred to them as "a case of ecotopic subspeciation in birds where the two forms are kept separate by their ecological preferences." A much needed, thorough study of these birds has now been accomplished by Marshall (1948). He personally collected more than 800 specimens during the course of his intensive field studies. These and many others were compared and measured and the stomach contents, along with other ecologically significant data, recorded.

Four races of Song Sparrows are involved. Three, *samuelis*, *pusillula*, and *maxillaris*, are found, respectively in large salt or brackish marshes north, south, and east of the Bay. The fourth, *gouldii*, is found in adjacent suitable habitats around the Bay and merges with other mainland races to the north and south. " . . . The dense bay marsh populations are separated from each other by open water or by ranges of hills jutting into the bay and are separated from upland populations by the width of the arid bayside plain" (Marshall, p. 208). Narrow connecting avenues of Song Sparrow habitat do exist between the ranges of these subspecies where, with one exception mentioned below, complete interbreeding and intergradation occur in the bird populations.

These groups of Song Sparrows thus do not differ from ordinary geographic subspecies as respects isolation but their ranges are unusually small for continental subspecies. The sedentary habits of this abundant, resident species apparently provide sufficient isolation for this subspeciation. Even in Ohio, where many of the Song Sparrows migrate, the banding records of Mrs. Nice as interpreted by Miller (1947) indicate that most Song Sparrows settle within 300 yards of their birthplace.

The second unusual feature of these races of the Song Sparrow is the ecological diversity of the areas they inhabit. Miller (1942) had already suggested that the large number of subspecies found in the Song Sparrow as compared with, for example, the congeneric Lincoln's Sparrow, *P. lincolni*, is a result of the greater ecological tolerance of the former. The Song Sparrow is able to colonize diverse habitats; its sedentary habits then permit the evolution of races adapted to them. The habitats occupied by the Song Sparrow all possess certain characteristics vital to this species such as available water, plenty of light, plenty of vegetation within certain limits as to density, and area suitable for ground foraging. Wherever these conditions are met the Song Sparrow is at home. Thus where small areas of salt marsh are surrounded by upland habitat, the population is continuous and no racial variation is found. Along the marsh edges individual birds may feed daily on the seeds of both marsh and upland plants.

Although the individual Song Sparrow, if transplanted, would as a rule be "at home" in any of these habitats, nevertheless the racial characters of the salt marsh subspecies are presumably adaptive responses to local conditions. Where two races meet and intergrade neither is swamped out in its own habitat. Intergradation is most pronounced in the zone where the habitats themselves are intergrading. Natural selection apparently preserves the racial characters.

These rather isolated subspecies may be expected to have non-adaptive as well as adaptive genetic differences. Miller (1947) has pointed out that even in continuous populations of such a sedentary species local fixation of neutral genetic characters might occur by chance in accordance with the so-called "Sewall Wright effect." This would happen even more readily in small, isolated populations. Marshall, however, with one exception, finds the characters of the smaller or intermediate populations to vary in a gradual, predictable manner that suggests adaptive clines. His final conclusion is: "To my mind, the pronounced geographic variation shown in local Song Sparrows is but another example of this nicety of adjustment of the species to its local environments; nowhere do we find a suggestion of the gross differences in habitat preference or the qualitative differences in foraging, song and mating behavior, nor the overlap in distributions which differentiate Song Sparrows from Lincoln Sparrows and Fox Sparrows, the congeners of *Passerella melodia*" (p. 254).

It is, of course, unlikely that these Bay races of Song Sparrow will persist long enough and in sufficient isolation to become distinct species. Yet I believe that Marshall's attempt sharply to contrast their racial characters with species characters is contrary to what must normally occur in speciation and may be occurring here. The latter suggestion is prompted by Marshall's analysis of the birds of a habitat, since destroyed, on San Francisquito Creek where the upland-willow and salt marsh habitats (and subspecies) met sharply without the usual slow transition. A series of Song Sparrows collected there about the turn of the century by Grinnell shows little hybridization, much less than would be expected if the 2 subspecies had interbred as freely as their proximity permitted. Grinnell (1901), who, incidentally, first realized the importance of these Song Sparrows as material for the study of evolution, concluded, I believe correctly, that at this point the 2 subspecies were behaving like incipient species. In races possessing adaptive modifications to rather different habitats and incipient (at least) preference for these habitats, sufficient time and isolation might well lead to speciation and the eventual acquisition of characters and behavior patterns as "qualitatively" distinct as those of such species as the Swamp Sparrow or the Seaside Sparrow.

Grinnell, Joseph

1901 The Santa Cruz song sparrow, with notes on the salt marsh song sparrow. *Condor*, **3:** 92–93.

Huxley, Julian

1942 Evolution, the modern synthesis. Harper: London and New York.

Marshall, Joe T., Jr.

1948 Ecologic races of song sparrows in the San Francisco Bay region. *Condor*, **50:** 193–215; 233–256.

Mayr, Ernst

1947 Ecological factors in speciation. *Evolution*, **1:** 263–288.

Miller, Alden H.

1942 Habitat selection among higher vertebrates and its relation to intraspecific variation. *Amer. Nat.*, **76:** 25–35.

1947 Panmixia and population size with reference to birds. *Evolution*, **1:** 186–190.

Dean Amadon

These comments are intended to review recent and somewhat unavailable papers covering several aspects of ornithology during the year. Your editor will appreciate remarks from Club members concerning this method of literature review.

Editor

Book Reviews

Birds Over America. By Roger Tory Peterson. Dodd, Mead and Company, New York, 1948: 7 x 10 in., XVI + 342 pp., 80 plates and one end-paper photograph. $6.00.

Better than any other book I know, this one conveys the spirit of the enthusiast in the sport of bird study. Its pages are filled with the "shop talk" of the field ornithologist—query, speculation, anecdote of the kind we hear wherever members of the clan gather: Where is the Bachman's Warbler? How many birds are there in America? Which bird is the most common? What are the prospects for survival of the Ivory-billed Woodpecker? Why is the Peregrine the favorite bird of so many people? What happens to birds in a hurricane? Where are the best places to see birds? What are the attractions (ornithological) of Maine, Cape May, Santee delta, Everglades, Dry Tortugas, Louisiana swamp, Texas coastal plain, Arizona desert, California waters, Utah marshes?

These and scores of other questions receive thoughtful comment in the twenty-five chapters of this book. Through them we gain a new appreciation of the years of vigorous field work, the keen eye, and the precise mind which made possible the famous "Field Guides."

Outsiders may view somewhat quizzically such single-minded preoccupation with avian affairs. Some readers may be disappointed that they do not see more of Peterson's own personality in this book, or that they do not become better acquainted with the other men who appear briefly in it. Probably few will read it as literature, although it has many eloquent passages. And we may all wish that a more colorful and distinctive title had been chosen. But, in total, this work will need no defense before those thousands of people who share Peterson's own enthusiasm for the living bird.

It will be a surprise to most of Peterson's readers to find that this fine artist is such a skilled photographer. The proof is provided in 107 splendid pictures selected from among thousands in his collection. Everyone will have his own favorite, but the three views of the young bald eagle I consider as dramatic as any bird pictures I have seen. Thoughtfully, Peterson has appended a two-page "Photographic Postscript," offering information about his methods and equipment.

An index has been provided, and it is particularly helpful in a book of this kind which touches upon such a diversity of subjects in such an informal manner.

Harold Mayfield

British Birds. By Wilfred Willett. Illustrated by 16 color plates and 44 drawings by Roland Green. A. and C. Black, London, 1948: 9 x 6 in., vii + 196 pp. $2.50 (Macmillan).

This book is written to introduce the adult beginner to 200 of the commonest birds of the British Isles. The introduction gives elementary hints about bird study, such as where and when to look for birds, and what characters are important in field identification; no scientific names appear in the book. Each of the 27 chapters discusses a group of closely related or associated species, giving pointers for identification and prominent aspects of life history of each. Chapter headings list the names, total lengths, and usual habitats of both land and water birds. The style is simple and straightforward, and considerable information is presented. The color plates are fair, and certainly useful; the black and white drawings less so. Six scattered pages of the review copy were inadvertently left blank. While this volume will be useful to Britishers who wish to learn something about their common birds, most Americans who are sufficiently interested to undertake a study of British birds will want a more advanced book.

Hustace H. Poor

Flight Into Sunshine, Bird Experiences in Florida. By Helen G. Cruickshank. Photographs by Allan D. Cruickshank. The Macmillan Company, New York: 1948. 132 text pages, 121 photographs in black and white.

The vogue for naturalists' wives to write of their husbands' activities continues to gain momentum. While the composition of such biographies may be an excellent means for keeping the wives occupied and contented, one wonders what the reason can be for this sudden wealth of second hand books. The answer is probably to be found in the curious fact that the public will buy almost any nature book, and the publishers will therefore accept almost any nature manuscript. After some pioneer discovered that here was a convenient way to make a few dollars, the deluge was on.

The reviewer's complaint is not so much about these books themselves as about other books that appear to be suppressed by them. The husbands, feeling themselves relieved of the responsibilities of authorship, joyfully pursue their calling with scarcely a thought of pencil or pen. Gone are the compelling accounts of nature experiences that sprang from the perceptions and reflections of the naturalists themselves. Yet who can more vividly describe a wildlife phenomenon than the chief observer? Who would dare to compare these current books with the field accounts left to us by Audubon, Townsend, Hudson, Coues, Chapman, Stone or any other of our lately extinct giants?

The foregoing comments are not aimed in particular at "Flight into Sunshine" by Mrs. Cruickshank. In fact the author is to be commended, within the category of books being considered, for her attempts at lucidity and brevity—if not at self-effacement. However the book shares with its fellows a general shallowness that is born of its very essence as the virtual image of another's work. It is reasonably well written, and the subject matter automatically makes it interesting. Due emphasis is placed repeatedly on the subject of conservation; the rôle played by the National Audubon Society in protecting wildlife is high-lighted in satisfying degree.

Twelve chapters conduct the reader from one Florida rookery to another, most of them in the Okeechobee-Everglades region. Pelicans; various herons and egrets; vultures; Florida cranes; wood, glossy and white ibises; and anhingas all obligingly allow themselves to be photographed.

The illustrations at the back of the book are a superb collection of bird photographs. Possibly the most remarkable, Figure 20, shows a brown pelican in flight with its pouch distended. One wishes that a more expensive paper had been used for the reproductions, so that a hard glossy finish could have been obtained. Much fine detail is lost in the present form of the illustrations.

"Flight into Sunshine" will undoubtedly enjoy popularity in the segment of our population that reads nature books. Without question its success will spur the creation of more books of the same sort.

C. Brooke Worth

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The Wilson Ornithological Club

Founded December 3, 1888

Named after Alexander Wilson, the first American ornithologist.

President—Olin Sewall Pettingill, Jr., Carleton College, Northfield, Minn.

First Vice-President—Maurice Brooks, West Virginia University, Morgantown.

Second Vice-President—W. J. Breckenridge, University of Minnesota, Minneapolis.

Treasurer—Burt L. Monroe, Ridge Road, Anchorage, Ky.

Secretary—Harold F. Mayfield, 2557 Portsmouth Ave., Toledo 12, Ohio.

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Manuscripts should be typed on 1 side of white paper of good quality. Everything should be double-spaced and each table should be typed on a separate sheet. Figures, not words, should be used for all numbers (except at the beginning of a sentence). Sex ratios should be calculated as % males. The technical names of the A. O. U. Check List (4th edition), as corrected in the supplements, should be used. Unless specimens have actually been identified to subspecies, only the specific name should be used. Whenever possible a reference for technical names of plants should be listed. Literature should be listed at the end of the article in accordance with the style in previous issues. All articles should have a summary. Authors should avoid footnotes and vernacular phrases. Illustrations should have good contrast. Printing on charts and maps must be large enough to permit reduction. Cuts of figures will be destroyed unless author requests their return on the reprint order form.

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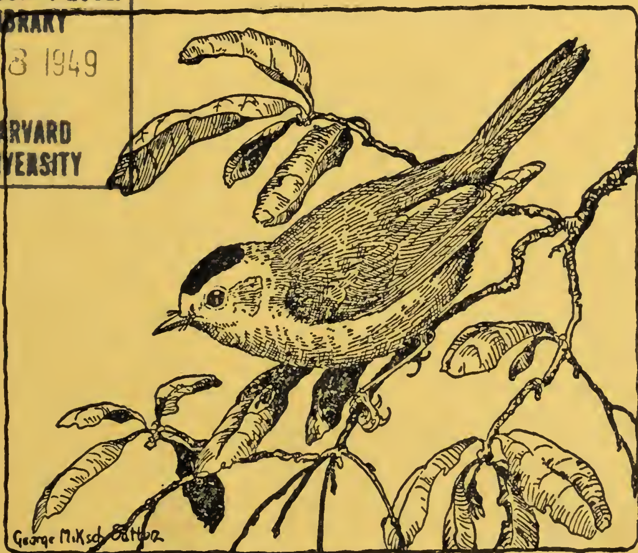

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The official organ of the Wilson Ornithological club, published quarterly, in March, June, September, and December, at Baltimore, Maryland. In the United States the subscription price is $2.00 a year. Single copies, 50 cents. Outside of the United States the rate is $2.25. Single copies, 60 cents. Subscriptions should be sent to the Treasurer. Most back issues of the *Bulletin* are available at 50 cents each and may be ordered from: David E. Davis, Editor, School of Hygiene and Public Health, 615 North Wolfe Street, Baltimore 5, Maryland.

All articles and communications for publication, books and publications for review, and claims for lost or undelivered copies of the magazine, should be addressed to the Editor. Exchanges should be addressed to the Wilson Ornithological Club Library, Museum of Zoology, Ann Arbor, Michigan.

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WILSON CLUB NEWS

1949 Award of the Louis Agassiz Fuertes Grant

The Louis Agassiz Fuertes Grant of $100 for 1949 has been awarded to Mr. Stephen W. Eaton of Cornell University in recognition of his progress and as encouragement for further work on the taxonomy and comparative life history of the water-thrushes.

The Louis Agassiz Fuertes Research Fund was established by an anonymous friend of the Wilson Ornithological Club in 1947. Its purpose is to assist and encourage field research in Ornithology through the awarding of annual grants of $100 to an applicant selected by the undersigned committee. Selection is made on the basis of: (1) merits of the project, (2) prospects of successful completion of the project, (3) displayed or reported ability of the applicant, and (4) financial need. The award is open to any member of the Wilson Ornithological Club and all who are interested are urged to apply.

John T. Emlen, Jr., Chmn.
George H. Lowrey, Jr.
Ernst Mayr
Mrs. Margaret M. Nice
Frank A. Pitelka
Josselyn Van Tyne

Mr. Donald Malick has been awarded $25 from the S. Morris Pell fund in recognition of his ability and promise as a bird artist. This fund, totalling $100, was given to the Wilson Ornithological Club by a friend in memory of the late S. Morris Pell. It is to be used to help promising young bird artists as announced in the September 1948 issue of the *Bulletin*, p. 192. Awards are made by the Research Committee.

The Sixty-Seventh Stated Meeting of the American Ornithologists' Union will be held October 10–14, 1949, at Buffalo, New York. Hosts for the meeting will be the Buffalo Ornithological Society and the Buffalo Society of Natural Sciences. Public sessions will be held October 11–13, 1949 at the Buffalo Museum of Science. The headquarters hotel will be the Hotel Statler where the banquet will be held on Wednesday evening, October 12.

EDITORIAL

Because a number of members have inquired about the reasons for a change in size, it is desirable to explain that the new printer, who was chosen for efficiency, does not have machines set to trim to the former size. However, the type bed is larger and actually about a page of additional print is thereby possible on the same number of pages.

CORRECTION: Vol. 61, p. 48, line 2; for "Cayuga" read "Keuka".

THE PRESIDENT'S PAGE

Since its beginning in 1930, the Wilson Ornithological Club Library has gradually increased in size through (1) gifts of books, pamphlets, and periodicals, (2) occasional purchases of much needed books, using cash obtained by contributions to the New Book Fund or from the sale of duplicate items, and (3) exchanges for *The Wilson Bulletin.* At the present time the Library contains approximately 400 volumes (books and bound volumes of serial publications) and 4500 pamphlets.

The Library is located at Ann Arbor in the University of Michigan's Museum of Zoology, sharing a room with the Library of the Division of Birds. It is separately shelved and catalogued, and in each volume there is a handsome bookplate showing a Long-eared Owl, from a drawing by George Miksch Sutton.

The primary purpose of the Library is to serve those Club members who do not have access locally to adequate reference material. Members may use it in two ways: (1) They may use it in the library room, in which case they may also have the privilege of using the Library of the Division of Birds. (2) They may write in and borrow items. (See the instructions for borrowing on the inside front cover of this number.) By arrangement with the University of Michigan, our collection is not only allowed permanent housing, but also such valuable services as cataloguing and shelving all items received, binding and repairs, transportation costs one way on loans to any address in the United States or Canada.

There is every evidence that the purpose of the Library is being well fulfilled. Each month many items are borrowed by mail. Quite frequently borrowers live in places hundreds of miles from the nearest reference sources. Of the various items borrowed, new books head the list.

In view of the important service which our Library is performing, we should make a great effort to keep it up to date, to augment as rapidly as possible the collection of rare and out of print books and pamphlets, and to complete the files of serials. There are at least three ways in which these objectives can be met: (1) By monetary contributions. Already a Book Fund has been generously established by two members and is being used for the purchase of newly published books. Additions to this fund would permit us to obtain worthwhile books as they appear on the market. (2) By gifts of publications. In case such gifts should duplicate certain items already in the Library, they can be readily sold and the money received can be turned over to the Book Fund or they will be returned to the donors. (3) By gifts of new books and reprints of papers. All authors are particularly requested to remember the Library when giving away copies of their latest publications.

Of the various functions of the Wilson Club, the maintenance of our Library is one of the most important. Like our *Bulletin* and the annual meeting, it is a means of advancing the science of ornithology, the object to which we are dedicated. Any contribution, however modest, is most welcome.

OLIN SEWALL PETTINGILL, JR.

COLIMA WARBLER AT ITS NEST

THE NEST OF THE COLIMA WARBLER IN TEXAS

Emmet R. Blake

SINCE its discovery in the Sierra Nevada de Colima, Mexico, in 1889 the Colima Warbler (*Vermivora crissalis*) has remained one of the rarest and least known members of its family. As recently as 1928 the species was represented in collections by only 11 Mexican specimens collected in widely separated localities, and virtually nothing had been learned of its habits.

An adult male taken by Dr. Frederick M. Gaige in the Chisos Mountains, Brewster County, Texas on July 20, 1928 extended the Colima Warbler's range northward from the Sierra Guadaloupe, Coahuila, and brought the species within the scope of the A.O.U. check-list for the first time. Four years later a concerted effort was made by competent ornithologists to study the breeding population found in Boot Canyon, locale of Gaige's first American record. The very satisfactory results of these studies, including photographs and a description of the first Colima Warbler nest and eggs known to science, have been published by Van Tyne (Misc. Publ., Mus. of Zool., Univ. Mich., No. 33, 1936, pp. 5–11).

In May and June, 1941, Melvin A. Traylor, Jr. and I spent approximately 4 weeks in the Chisos Mountains while conducting special studies of the nesting birds of the area for the Chicago Natural History Museum. We had numerous opportunities to observe the local, and evidently isolated, breeding population of Colima Warblers while occupying a camp maintained at Boot Spring (alt. 7500 ft.) from May 22 until June 7. Unfortunately the demands of other duties prevented our undertaking a detailed study of these birds, but certain observations made while photographing the nesting birds add somewhat to our knowledge of this exceedingly rare species.

Our initial camp in the Chisos Mountains was established May 15 in the "Bowl", present site of the Park Administration Headquarters. The semi-arid and generally precipitous slopes of the vicinity support a profuse upper Sonoran flora characterized by juniper, yucca, sotol and staghorn cholla. Ecological conditions in the Bowl itself do not at all meet the requirements of the Colima Warbler, nor was it found with representative Transition elements that occurred in an oak forest on the south-eastern perimeter.

Colima Warblers were first heard singing near the head of Boot Valley on May 22. The relatively well watered and untouched forest of this isolated valley consists principally of maple, oak, Arizona cypress and yellow pine, the latter being most prominent on exposed ridges above 7500 feet altitude. Colima Warblers were extraordinarily abundant throughout deciduous forest and it was not unusual to hear 3 or even 4 birds singing at once in as many directions, particularly during the mornings. Although no methodical census in Boot Valley was undertaken, I am certain that not fewer than 15, and very probably more, individuals were identified in various parts of the area by song alone. An estimate of the total numbers of breeding pairs occupying the valley during the summer of 1941 should considerably exceed this figure if it is assumed that the species also occurred in those parts of the area, no less suited to its needs, that we failed to visit.

Discovery of the first Colima Warbler nest known to science was made by Van Tyne (loc. cit.) in Boot Canyon on May 7, 1932. A second nest was found in the same locality by Sutton on May 20, 1933. These and 4 additional nests subsequently found in the vicinity of Boot Spring by the Chicago Museum expedition evidently represent the only definite nesting records of a species that is believed to occupy a breeding range extending from Texas (Chisos Mts. only) southward at least to Miquihuana, Tamaulipas.

A nest containing 4 highly incubated eggs was found May 25 embedded in the earth at the base of a clump of "goats-beard" grass (*Piptochaetium fimbriatum*) from which an adult was flushed. The nest was perfectly concealed from all sides by the dense overhanging growth. It consisted solely of a symmetrical cup woven entirely from fine rootlets and grass stems to a thickness of 0.5 inches. Inside dimensions of the cup were approximately 2.25 by 2.25 inches. The eggs, which were permitted to hatch, were creamy white, unevenly speckled and rather boldly blotched—particularly at the larger end—with shades of brown and cinnamon.

On May 28 Traylor found a second nest containing 4 eggs under a root at one side of a dry stream-bed. In this instance also, the bird had to be flushed from the nest several times before its exact location among the oak leaves could be determined. The outer portion of this nest, which we collected, consists of moss, although the cup itself is woven from fine rootlets and grass stems. It has an inside diameter of 2.25 inches and measures 1.75 inches in depth. The eggs were entirely concealed from above by the root, and by dead leaves that formed a partial dome over the nest.

A third nest was discovered May 29 on a hillside about 200 yards above Boot Spring. Although not actually domed, this nest was well concealed by ground cover that prevented its detection at a distance of 6 or 8 feet. Four young birds approximately 2 days old occupied the nest. A fourth and last Colima Warbler nest containing 4 well-feathered juveniles was found June 6 embedded in the earth among clumps of grass (*Piptochaetium*) on a fairly open hillside near Boot Spring when an adult was flushed directly from the nest.

Absence of a brood patch in breeding male Colima Warblers has been remarked by others. Nevertheless, my observations indicate that the male attends the nestlings assiduously, as does the female. Between visits the male sang periodically, but briefly, in small trees in the vicinity. The young were fed at frequent intervals by both adults. Food brought to the nestlings consisted solely of animal matter. Small, green caterpillars, otherwise unidentified, were most frequently provided, but the young occasionally received small grasshoppers, or similar insects as well. Cooperative care of the young also extended to the removal of fecal matter. This was accepted and carried away by the adults indiscriminately, but I was unable to determine its ultimate disposition.

The present status of the breeding colony of Colima warblers in the Chisos Mountains is uncertain. I have been informed (April 18, 1948) by Mr. Peter Kock, well-known wildlife lecturer of Marathon, Texas that he failed to find the species in Boot Valley during several summer visits in 1947, although he had noted it there in previous years.

Summary

North of Mexico, Colima Warblers are known only from the Chisos Mountains, in Brewster County, Texas, where the species was first reported July 20, 1928.

Numerous breeding birds were observed in the Boot Canyon section of the Chisos from May 22 until June 7, 1941. The local population, estimated from singing males, exceeded 15 pairs.

Four nests discovered May 25, 28, 29 and June 6 were uniform in construction, the symmetrical bowl of each being woven from fine rootlets or grass stems, and embedded to ground level. Concealment was excellent. Four eggs constitute a normal clutch. Egg-laying occurs principally during the second half of May.

The Chisos population has been reported absent since 1946.

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AGE GROUPS AND LONGEVITY IN THE AMERICAN ROBIN: COMMENTS, FURTHER DISCUSSION, AND CERTAIN REVISIONS

DONALD S. FARNER

SINCE the publication of an analysis of the recoveries and returns of American Robins (*Turdus migratorius*), banded as young, in terms of age groups, mortality rates, survival rates, and longevity (Farner, 1945), publications of other investigators and the results of the author's own further studies make it desirable to present certain comments, additions, and observations.

The author, although accepting full responsibility for the contents of this paper, wishes to acknowledge the truly helpful assistance, suggestions, and criticisms kindly contributed by Margaret M. Nice, Harold Michener, Alden H. Miller, Morris S. Knebelman, Morris Rockstein, David Lack, Charles F. Yocum, and Elizabeth Brown Chase. Appreciation is again expressed for the kind cooperation of F. C. Lincoln, John W. Aldrich, Seth Low, and Chandler Robbins of the Fish and Wildlife Service in making records from the bird-banding files available to the author.

THE INITIAL DATE FOR THE ESTIMATION OF LONGEVITY, LIFE EXPECTANCY, AND AGE GROUPS

In the estimation of longevity, life expectancy, and age groups from the records of recovered birds which were banded as young it is necessary to fix an arbitrary initial date. To avoid bias in the sample of recovered birds this date must be placed sufficiently beyond the time of departure from the nest to allow the banded young to disperse. There is not sufficient information for the evaluation of the high rate of mortality before this dispersal and there is also the possibility that a dead banded bird of the year may have a better chance of being recovered through the activity of the bander before the dispersal than after. The initial calculations for the American Robin were based on the first of August as had been done by Lack (1943a, b, c, d) in his studies on several European species. On this basis, a higher mortality rate was obtained for the American Robin for the first year than when a later date, such as the first of November, was used. Because it could not be demonstrated satisfactorily whether this rate was actually higher or only apparently so because of bias of the sample, the earliest date by which it appeared that the migratory habits of the species would insure the necessary dispersal of the banded young was selected. The date thus chosen was November 1. Kraak, Rinkel, and Hoogerheide (1940) in their analysis of the records of recovered Lapwings used January 1 as the initial date; Marshall (1947) has used September 1 in his study of

Herring Gulls; whereas Plattner and Sutter (1947) used November 1 in their studies on Tits and Nuthatches. The question was raised (Farner, 1945: 58) whether the higher first-year mortality rates found by Lack, using August 1 as the initial date, were real or the result of bias of the sample in the manner described above. In consequence of this suggestion Lack (1946a, b) has reanalyzed the data on the European Blackbird, the Song Thrush, the Starling, and the Lapwing. The results indicate that the higher rates calculated from August 1 are genuine and not the result of biassed samples, and that this higher mortality rate persists approximately through December. Lack, however, (1946a: 263) suggests that in the future, annual mortality rates based on records of banded birds be calculated as of January 1. This procedure should eliminate the possibility of biassed samples as well as the period of increased and unstable juvenile mortality rate following the departure from the nest. Of minor consideration is the increased ease of calculation with January 1 as the initial date. The author agrees with Lack's recommendation that such future studies involving records of banded birds be based on the first January 1 as the initial date, at least for passerine species. It seems desirable, therefore, to present a recalculation of the more pertinent data of the earlier analysis of recovered Robins despite the fact that the results show no significant differences if one considers the size of the samples. (See Table 1, lines 1, 2, and 3; and Table 2, lines 1 through 4.)

Studies of the type presented in this paper are based on two fundamental assumptions. First, the sample used is sufficiently random and unbiassed to allow the calculation of a mortality rate and the construction of an average pattern of death about which the annual mortality rates and the patterns of death in the total population each year should fall in approximately normal frequency curves. Secondly, the population of the species involved is relatively stable, *i. e.*, its number is approximately the same on the same date each year, for example, on the successive January firsts of this study. The second assumption is particularly involved in calculations of longevity from annual mortality rate.

The annual mortality rate (M), as of a selected initial date, which in this study is the first January 1 in the life of the bird, may be obtained by dividing the number of birds which were alive on the initial date and which died during the ensuing year by the total alive on the initial date. In this study the mean M is obtained by dividing the number of birds recovered between the first and second January firsts (291) by the total number of dead birds recovered ($M = 291/597 = 49\%$). Likewise, since the annual survival rate (S) may be obtained by dividing the number of those which were alive at the initial date and which survived the ensuing year by the total number in the sample, in this study ($S = 306/597 = 51\%$). In these calculations the mortality rate is actually based on the year following the first January 1 and it is assumed that the mortality rate is approximately the same in all age groups, which is substantially true. However, to avoid inaccuracies which may occur because of different mortality rates in different age groups, the method used by Lack (1948: 266) and in my earlier paper (Farner, 1945: 62) is used in line 3 of Table 2. In this method the mortality rate is calculated by dividing the total deaths (597) by the total of birds alive on all January firsts (1148). This process may be expressed as:

$$M = \frac{D_1 + D_2 + D_3 \cdots}{D_1 + 2D_2 + 3D_3 \cdots}$$

where D_1, D_2, D_3, etc., are the numbers of birds recovered each year, after the first January first. M thus computed is actually a weighted average of M values for each age group; the weighting factor, in each case, is the number of individuals on which each M is based.

Thus, in this study,

$$M = \frac{597}{1148} = 52\%$$

$$S = 100 - 52 = 48\%$$

In comparing my calculations with those of Lack an important difference in method should be mentioned. Lack (1948: 264–266) assumes, in calculating expectancy, that there is a uniform monthly distribution of deaths and that the mean period lived after the beginning of the year in which death occurs is 0.5 years. This period is herein designated as p. According to Lack the purpose of this arbitrary value is to avoid the effect of seasonal bias in the recovery of dead birds. The assumption of a uniform monthly distribtion only crudely approximates the effect of the action of a uniform mortality rate. For example, an annual survival rate of 50%, is the result of a monthly survival rate of 94.8 %. (Monthly survival rate = $\sqrt[12]{\text{annual survival rate}}$; see Tinbergen, 1946: 30.) Thus the mean period (p) after the first of the year lived by the birds which die during the year would be about 0.45 years which is scarcely significantly different from Lack's assumption of 0.5 years.

In the calculation of p by the use of the monthly survival rate ($\sqrt[12]{S}$), it is assumed that the mean period lived by birds in the month in which their deaths occur is 0.5 months. This involves, in principle, an error analogous to Lack's assumption in the use of annual mortality rates, that is, the mean period (p) lived during the year of death is 0.5 years. However, the error is scarcely significant in consideration of the accuracy of the data to which these calculations are compared. In the calculation of p from S, accuracy depends on the interval selected; for example, the application of a weekly survival rate ($\sqrt[52]{S}$) gives greater refinement than the use of the monthly rate. The general equation for the calculation of the population size (N_t) at a given time t is

$$N_t = N_o \left(\sqrt[i]{S}\right)^t \qquad (1)$$

where N_o is the size of the population (number of live birds) at the beginning of the year (January 1); N_t is the number of birds alive at time t; t is time from the first of the year expressed in terms of selected time intervals; i is the number of time intervals in the year; and S is the annual survival rate. If i is 12 equal time intervals, *i.e.* months, where $t = 6$; or, if i is 365 equal time intervals, *i.e.* days, and $t = 211$, reference is made to a period extending from 1 January to the end of the sixth month, June.

From equation (1) an equation for the calculation of p, the mean period lived during the year of death, can be erected:

$$p = \frac{(N_o - N_1)\frac{1}{2i} + (N_1 - N_2)\frac{3}{2i} + (N_2 - N_3)\frac{5}{2i} + \cdots + (N_{i-1} - N_i)\left(\frac{2i-1}{2i}\right)}{N_o - N_o S} \quad (2)$$

Substituting $N_o (\sqrt[i]{S})^t$ for $N_1, N_2, N_3, \cdots N_{i-1}$, where $t = 1, 2, 3, \cdots i - 1$,

$$p = \frac{(N_o - N_o S^{1/i}) + 3(N_o S^{1/i} - N_o S^{2/i}) + 5(N_o S^{2/i} - N_o S^{3/i}) + \cdots + (2i-1)(N_o S^{(i-1)/i} - N_o S)}{2i(N_o - N_o S)} \quad (3a)$$

$$= \frac{(1 - S^{1/i}) + 3(S^{1/i} - S^{2/i}) + 5(S^{2/i} - S^{3/i}) + \cdots + (2i-1)(S^{(i-1)/i} - S)}{2i(1 - S)} \quad (3b)$$

$$= \frac{(1 - S^{1/i})\,[1 + 3S^{1/i} + 5S^{2/i} + \cdots + (2i-1)S^{(i-1)/i}]}{2i(1 - S)} \quad (3c)$$

From (3c) can be developed the general equation for the calc.ılation of p.

$$p = \frac{1 + S^{1/i}}{2i(1 - S^{1/i})} - \frac{S}{1 - S} \quad (4)$$

As previously indicated, the calculation of p becomes increasingly refined as i increases. Moreover, p computed as the limiting value as i approaches infinity, can be expressed in the equation

$$p = \frac{-0.4343}{\log_{10} S} - \frac{S}{M} \quad (5)$$

(N.B. $1 - S = M$)

This constitutes a continuous solution for p taking into account the constant effect of M on the population.

As the annual mortality rate decreases, p approaches 0.5 years; however, as the annual mortality rate increases p decreases significantly to less than 0.4 years at an annual mortality rate of 80%. On analysis of the distribution of the recoveries of Robins in the sample used in this study (see Table 4) birds recovered dead may fail to display a uniform monthly distribution. However, until indicative studies are forthcoming, it seems necessary to remain uncertain as to whether such a sample is the result of biassed seasonal recovery as suggested by Lack, or the result of a true seasonal variation in mortality rate, which is highly probable, and which is constant from year to year, or both.

The Relation Between Mean Longevity and Annual Mortality Rate

The reciprocal relation between annual mortality rate (M) and mean longevity (Y) *beyond the selected initial date* in a stable population has been used for calculating each of these from the other. The formula of Burkitt (1926: 97), which is impractical in its original form, and the simplified forms employed by Nice (1937: 191), Farner (1945: 65), Marshall (1947: 194), and Hann (1948: 10), when used to calculate longevity, in reality assume that all birds which die during a given year actually live to the end of that year, or that there is a period which may approximate 0.5 years between the date of hatching and the initial date in which case a *mean total longevity* is calculated for *those alive on the initial date.* The former is readily apparent if an annual mortality rate of 100% were assumed. Then in accordance with the unmodified reciprocal relation,

$$Y = \frac{1}{1.00} = 1 \text{ yr.}$$

Thus, all of the birds would attain the age of 1 year. Therefore, all must die on the last day of the year! The same reasoning, although less obvious, is involved in using this relationship with other mortality rates. Because of the particular dates involved, the calculations presented in the previous paper (Farner, 1945: 66, Table 7) give approximations for the total mean longevity, from the date of hatching, for birds surviving the first November 1, since at that date the birds are approaching 0.4–0.5 years in age. The artificial nature of this application and the restricted conditions thereof make its further usage inappropriate.

Mean longevity (Y), as of the selected initial date (first January 1 in this study), can be calculated from the formula,

$$Y = \frac{1}{M} - (1 - p), \tag{6}$$

where p is the mean period of survival after the first of the year for birds which die during the year. If Lack's assumption of a uniform monthly distribution of deaths is accepted, p is 0.5 years. If a uniform mortality rate is operative throughout the year and if the annual mortality rate is not greater than 50%, p is probably not significantly less than 0.5 years. If p is calculated, maximum accuracy is actually obtained by use of the continuous solution for p equation (5) which substituted in equation (6) gives a simple calculation for Y,

$$Y = -\frac{0.4343}{\log_{10} S} \tag{7}$$

However, if the mortality pattern is known definitely to deviate from that of a uniform rate, p should be calculated directly. For example, if the monthly pattern of deaths shown by Table 4 is actually unbiassed, p would be 0.34 years. However, until differentiation can be made between true and biassed monthly mortality patterns within the year, it seems advisable to follow Lack's assumption of a uniform monthly distribution of deaths or the assumption of the action of a uniform mortality rate throughout the year providing that the annual mortality rate is not in excess of 50%. Then, in either case the equation becomes

$$V = \frac{1}{M} - 0.5. \qquad (6a)$$

The applicability of this equation is illustrated by using the mortality rate, 52%, from lines 3 and 4 in Table 2, indicating a mean longevity (V) of 1.4 years compared with the actual mean longevity of 1.3 years and the calculated value of 1.4 years obtained by following Lack's assumption of a uniform monthly distribution of deaths. Assuming the operation of a uniform mortality rate ($p = 0.44$) the calculated V would be 1.3 years.

The mean longevity, as of the initial date, for Robins is compared with that of some other passerine species in Table 3. Although the calculations in Table 3 are based on a variety of initial dates they are actually quite comparable since all initial dates (except Bourlière, 1947) are well beyond the period of unstable mortality rates between departure from the nest and the first winter, and further since it now appears to be generally true in passerine species that the annual mortality rate and life expectancy beyond this unstable period do not vary appreciably with time. Erickson's calculation (1938: 309) of longevity in a small population of Wren-tits using the original Burkitt formula indicate a total mean longevity of 4.4 years for birds which survive to the first breeding season. By deducting the age at the first breeding season and correcting the Burkitt formula one would obtain a mean longevity of about 3 years as of the first March. On the other hand, the statement (p. 310) that 36% of the adults die each year would indicate a mean longevity of 2.3 years as of the first March. Both calculations ascribe an unusual longevity for such small birds. Further investigations on the population dynamics of this species would be of considerable interest.

The formula, $V = \frac{1}{M} - (1 - p)$, is particularly useful in instances where mortality statistics are available but in which the ages of the birds at death are unknown.

Monthly Distribution of Deaths

The monthly distribution of deaths, as indicated by recovered birds, is recorded in Table 4. There is a preponderance during the first part of the year over the expected distribution based on the operation of a uniform mortality rate or the expected distribution based on Lack's assumption of a uniform monthly occurrence. Whether this reflects a true distortion in the mortality curve or, as Lack suggests, a bias in favor of finding dead birds during these months, is not apparent. A comparison of the distribution of deaths among birds between their first and second January firsts to deaths among older birds (lines 1 and 2, Table 4) does not yield a tangible clue. The bearing of this on the value of p, as shown by Table 4, is obvious. This problem of the monthly distribution of deaths through the course of the year deserves careful investigation.

The Use of Birds Recovered by Trapping in the Calculation of Annual Mortality Rate

Plattner and Sutter (1947: 20) have questioned the reliability of samples which combine records of birds recovered dead and birds recovered by trapping. Combining these 2 types of records assumes that death and trapping function at approximately equal rates for all age groups. Their data (p. 21) indicate that the mortality rate calculated from a trapped sample (number of birds in first year after initial date divided by total number in sample) is higher than that calculated from the samples of birds recovered dead. The basic assumption in the calculation of M from a trapped sample is that, were the trapped sample a truly random sample, then in a stable population the birds in their first year after the initial date must be numerically equivalent to the number of deaths, during the preceding year, of birds which had passed the initial date. Hence, dividing the number trapped in their first year after the initial date by all trapped after the initial date should give an annual mortality rate. The results, however, indicate that in trapping there is bias in favor of young birds. An examination of the data on the Robin confirms this suggestion. (Compare rates in Table 2.) Similar data for the Cardinal (*Richmondena cardinalis*) to be published subsequently indicate a similar bias in trapping in this species. Further investigation is needed to determine to what extent bias in trapping may affect the calculation of mortality rate from birds of unknown age, trapped and banded, and subsequently recovered dead.

Loss of Bands

Analyses of the type presented here, as well as those by, among others, Lack (1943*a*, *b*, *c*, *d*), Lack and Schifferli (1948), Marshall (1947), Hann (1948), Bourlière (1947), and Nice (1937), assume that the sample of birds banded as young and recovered dead is typical of the population. This obviously assumes that there is no appreciable loss of bands or if there is, it operates randomly and independently of age. Thus, the chance of loss by an individual is the same regardless of age attained at death. Kortlandt (1942: 178, 201, 205), in a detailed investigation of a colony of European Cormorants in Holland, observed the loss of bands and calculated indirectly that the loss of bands, although conjectural, together with loss account-able to "accidents" incidental to banding and the wearing of bands, could be as high as 10%. Lockley (1942) has reported the loss of bands, because of wearing, among Manx Shearwaters and Stuart (1948: 198) is of the opinion that this must occur among British Cormorants. Among passerine species, Lovell (1948) has reported the removal of bands by Cardinals and summarizes other published records of such removal. Linsdale's (1949) investigations at the Hastings Reservation indicate that there may be some loss of bands, as a result of wearing, among Brown Towhees and Spotted Towhees. The replacement of worn bands is not an uncommon procedure in the operation of a banding station. Bands which become sufficiently worn to warrant replacement have been carried 3 years or more. Obviously any loss of bands at a uniform annual rate, or at a rate that increases with age, would result in the calculation of an exaggerated mortality rate and too low a life expectancy. Because of limited sizes of samples, the calculations on passerine birds possible at this time usually have little significance beyond the second or third year. It seems unlikely that errors which may be introduced by the loss of bands should be of a magnitude greater than that of other errors inherent in the method. This assumption, however, should be tested by studies directed towards ascertaining the extent to which bands are lost. At least 2 approaches to the problem are apparent. First, some important information could come from large banding operations in the form of data on the length of time between banding and the time when replacement of the worn band is necessary. Second, an index of some significance could be established by banding with 2 bands (1 on each leg or 2 on 1 leg); the index would be the ratio of the number of double-banded birds recovered with a single remaining band to the total double-banded birds recovered with either 1 or 2 bands. This is based on the probability that the 2 bands would be unlikely to wear at the same rate. Data thus obtained should be correlated with the size, and manufacturer's lot, of band. The data would be of increasing importance as studies, of the kind presented here, become more refined with the accumulation of greater numbers of records. Calculations beyond the third year, when errors due to the loss of worn bands might become important, will then be based on significant numbers of records. The necessity, then, of reasonably precise information on band loss is obvious.

Summary

1. At least in studies involving passerine species, it is suggested that calculations involving longevity, mortality rates, etc., using data from banded birds, be based on the first January 1 in the life of the bird as the initial date in accordance with the suggestion of Lack. The data on the American Robin, presented in an earlier paper have accordingly been recalculated and tabulated.

2. In the calculation of mean longevity (Y) from mean annual mortality rate (M) by the use of the reciprocal relation of M and Y in a stable population, Y must be based on the same initial date as used in the original calculation of M. Y is therefore to be defined as the mean longevity *as of the prescribed initial date.* If it is desirable to calculate a *total mean longevity* from birth, for those alive on the initial date, the mean period from hatching to the prescribed initial date must be added to Y. A *true total longevity* from birth *for all birds hatched* is difficult to estimate because of the high and unstable mortality during the first few months after hatching.

3. In the calculation of Y (as of the prescribed initial date) from M it is neces-

sary to correct the simple reciprocal to allow for the continuous action of M throughout the year. This is accomplished in the equation,

$$V = \frac{1}{M} - (1 - p) \qquad (6)$$

where p is the mean period lived during the year in which death occurs.

4. Providing the M is not in excess of 50%, placing p at 0.5 years, as suggested by Lack, approximates a uniform mortality rate. If M exceeds 50%, and a uniform mortality rate is assumed, p should be calculated by applying a monthly (or weekly, for additional refinement) mortality rate as described on page 70. Maximum refinement may be obtained by a continuous solution for p, in which p is computed as the limiting value as i approaches infinity.

$$p = \frac{-\ 0.4343}{\log_{10} S} - \frac{S}{M} \qquad (5)$$

If p is thus calculated, rather than obtained by direct observation, a substitution may be made into the equation (6) for the calculation of V, giving the simple expression,

$$V = \frac{-\ 0.4343}{\log_{10} S} \qquad (7)$$

Actually because of the probability of non-uniform mortality rates within the year, p should, if possible, be obtained from the observed annual mortality pattern and V, if to be calculated, should be obtained by use of equation (6).

5. Whereas it is true that the simple reciprocal of the mortality rate gives an approximately total mean longevity from birth for those birds alive on the initial date *providing* that the period between hatching and the initial date is a fraction of a year, this is a coincidence operating within restricted conditions in which 1-p approximates the mean period from birth to initial date. Since it does not have general application it is suggested that its use be discontinued.

6. As suggested by Plattner and Sutter for Tits and Nuthatches, there is apparently bias in retrapping Robins; this bias exaggerates the number of young birds with the result that M, when calculated on the basis of the ratio of birds in the first year after the initial date to older birds, is too high.

TABLE 1

Life Expectancy (e) in the American Robin on Successive January Firsts[1]

DESCRIPTION OF SAMPLE		*e* IN YEARS[2]				
Cause of death	Number dead	1st Jan. 1	2nd Jan. 1	3rd Jan. 1	4th Jan. 1	5th Jan. 1
All causes	597	1.3	1.2	1.0	1.0	1.3
Killed by cat	48	1.3	1.1	—	—	—
Shot	51	1.4	1.2	—	—	—
All causes[3]	597	1.4	1.3	1.1	1.1	1.4

[1] Compare with Farner (1945: 69, Table 9). The records used here are the same as in the previous analysis except for birds which were recovered between the first November 1 and the first January 1; also a few records, unusable in the previous analysis, have now been adequately verified and have been included.

[2] In the calculation of *e* in lines 1, 2, and 3, for each Robin recovered dead the time elapsed between the selected January 1 and the date of death (actual date of recovery) was calculated to the nearest month from its card in the files of the United States Fish and Wildlife Service. The expectancy (*e*) for a particular January 1 was then obtained by calculating the mean period from the selected January 1 to the date of death for all birds alive on that January 1. For convenience in comparison with other authors the means were then expressed in years.

[3] Calculated according to the procedure of Lack (1948: 265–266) in which it is assumed that each bird which dies during the year lived for half of the year in which it died; Lack makes this assumption because of the possibility of "seasonal bias in the chances of recovery." Deevey (1947: 284, 295) has also pointed out that *e* may be calculated by use of the formula, $e_x = \frac{T_x}{l_x}$, where T_x is the total individual-years (individuals × years to be lived) as obtained from his "life table" for x years, and l_x is the number of individuals alive at the beginning of the year x. Both Lack and Deevey assume an approximately uniform distribution of deaths through the year; this will be discussed further in this paper.

TABLE 2

Age-Group Composition of American Robins Based on January 1[1]

DESCRIPTION OF SAMPLE	TOTAL ALL AGES	YEAR OF LIFE 1st	2nd	3rd	4th	5th	6th+	RATIO[2] ADULT / YOUNG	S %	M %
All recoveries	824	438	204	109	50	13	10	88:100	47[3]	53[3]
Same, in *per cent*	*100*	*53*	*25*	*13*	*6*	*2*	*1*			
Recovered dead	597	291	154	94	40	9	9	See footnote 4	48[4]	52[4]
Same, in *per cent*	*100*	*49*	*26*	*16*	*7*	*1*	*1*			
Recovered alive[5]	217	143	48	15	7	3	1	52:100	34	66
Same, in *per cent*	*100*	*66*	*22*	*7*	*3*	*1*	*1*			

[1] Compare with Farner (1945: 59, 62; Tables 1a, 1b, 4, 5). The records used here are the same as in the previous analysis except for birds which were recovered between the first November 1 and the first January 1; also a few records, unusable in the previous analysis, have now been adequately verified and have been included.

[2] Used in this study as the ratio of birds which on January 1 have attained at least their second January 1 to those which have attained their first January 1. Here, 386:438 = 88:100.

[3] Per cent *per annum* after first January 1, assuming a stable population. Survival rate = 1 − mortality rate. In a stable population the annual mortality rate equals the ratio of surviving first-year birds to the total population, since the number of young surviving from each year (taken in this study as those alive on their first January 1) is equal to the number of second-year and older birds which have died during the year, provided that the mortality rate is the same for each age group.

[4] From mortality rate (1 − survival rate) computed by dividing the total number of deaths (597) by the combined total of birds alive on all January firsts (1148). This is the more accurate method since it takes into account any differential mortality rates that may exist. It is the same method as employed by Lack (1948: 266) as expressed by the formula,

$$M = \frac{D_1 + D_2 + D_3 \cdots}{D_1 + 2D_2 + 3D_3 \cdots}$$

where D_1, D_2, D_3, etc., are the numbers of deaths during the first, second, third, etc. years of life respectively. The survival rate would be 51% (mortality rate 49%) if calculated on the same basis as the line above. Compare with Farner (1945: Table 5, p. 62.)

[5] Mostly by trapping.

TABLE 3

Mean Natural Longevity (Y) of Some Passerine Species[1]

SPECIES	NUMBER OF RECORDS	Y IN YEARS	HOW OB-TAINED	INITIAL DATE	REFERENCE
American Robin	597	1.3	R	1st Jan. 1	This paper
American Robin	597	1.4	C	1st Jan. 1	This paper
European Blackbird	258	1.9	R	1st Jan. 1	Lack (1946a)
Song Thrush	262	1.55	R	1st Jan. 1	Lack (1946a)
British Robin	130	1.1	C	1st Aug. 1	Lack (1943d)
European Redstart	383	1.1	C[2]	Breeding season	Ruiter (1941)
Song Sparrow	54	2.0	C[3]	April	Nice (1937)
Song Sparrow	54	1.9	R[4]	April	Nice (1937)
Starling (England)	154	1.6	R	1st Jan. 1	Lack (1946a)
Starling (Netherlands)	205	1.5	C[5]		Kluijver (1935)
Starling (Switzerland)	306	1.1	R	1st Jan. 1	Lack and Schifferli (1948)
Oven-bird	38	1.7	C[6]	Breeding season	Hann (1948)
Great Tit	252	1.4	C[7]	1st Nov. 1	Plattner & Sutter (1947)
Great Tit	225	1.1	C[8]	1st Nov. 1	Plattner & Sutter (1947)
Blue Tit	69	1.4	C[9]	1st Nov. 1	Plattner & Sutter (1947)
Marsh Tit	89	1.6	C[9]	1st Nov. 1	Plattner & Sutter (1947)
Rook	121	1.4	R	Departure from nest	Bourlière (1947)

R = mean longevity (Y) obtained by averaging the ages (from initial date) at death of birds banded as young and subsequently recovered dead. C = mean longevity as of initial date calculated from mortality rate (M), $Y = 1/M - 0.5$.

[1] Compare with Farner (1945: 67, Table 8) in which Y is the approximate *total longevity* for individuals alive on the initial date.

[2] From Ruiter's data (1941:204, Table VIII) indicating an annual mortality rate (breeding season to breeding season) of 62%. This agrees with Lack's (1946a:262) interpretation. Ruiter's statement (p. 210), that the mean age attained by young which return to the breeding area is 27 months, excludes birds which die before their first breeding season.

[3] Recalculated from the annual mortality rate (April to April) of 40% "in a well-situated population."

[4] Nice gives her data as of the date of birth for those alive at the beginning of the first breeding season. Here these data have been adjusted, by deduction of 0.8 years (the period between birth and the first breeding season), to give Y (observed) as of the initial date, *i.e.*, the beginning of the first breeding season. Actually Nice's sample contains many birds which were certainly more than a year old at the beginning of the breeding season. Since e does not change appreciably, the value of Y obtained by including these individuals is not

modified appreciably. If the 18 known first-year birds in this sample are used alone, the observed V as of the beginning of the first breeding season is 1.7 years. This lower value coincides with Nice's statement that these birds were subjected to an unfavorable removal of cover.

[5] Recalculated from the annual mortality rate of 50%. Kluijver's calculation of 3.0 years is total longevity for birds which reach breeding age (1–2 years) and excludes birds which die before this time.

[6] Recalculated from the annual mortality rate (breeding season to breeding season) of 46%. The "mean minimum life span" of 2.2 as calculated by Hann (1948: 6) is not comparable since it is a minimum mean span from birthdate for birds which have survived at least to the first breeding season.

[7] Calculated from the annual mortality rate in a sample of birds banded at unknown ages.

[8] Calculated similarily from a sample of birds banded as young.

[9] Calculated similarily from a mixed sample, *i.e.*, birds banded as young and birds banded at unknown ages.

TABLE 4

Monthly Distribution of Deaths as Indicated by Robins Recovered Dead with Comparisons to Theoretical Distributions Based on Uniform Monthly Distribution of Deaths and on Uniform Monthly Mortality Rate

PERIOD	DESCRIPTION	NUMBER	PER CENT PER MONTH												p^1
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	
1st Jan. 1–2nd Jan. 1	Actual recoveries	286	15.0	15.7	9.1	15.0	18.5	11.5	4.2	3.5	2.5	1.7	2.1	1.0	
After 2nd Jan. 1	Actual recoveries	311	10.6	14.5	11.3	16.7	12.2	9.3	8.7	2.6	5.1	2.6	1.3	5.1	
Total after 1st Jan. 1	Actual recoveries	597	12.7	15.1	10.4	15.9	15.2	10.4	6.5	3.0	3.8	2.2	1.6	3.2	0.34
Total after 1st Jan. 1	Theoretical, uniform monthly distribution[2]		8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	0.50
Total after 1st Jan. 1	Theoretical, uniform monthly mortality rate[3]		11.4	10.8	10.0	9.5	8.9	8.5	7.9	7.3	7.0	6.7	6.2	5.8	0.44

[1] p = mean period lived after January 1 of year in which death occurred.

[2] See Lack (1948: 265–266).

[3] Based on annual mortality rate of 52% (or annual survival rate of 48%), calculated using the formula, $p = \frac{-0.4343}{\log_{10} S} - \frac{S}{M}$.

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TWENTY-FIVE EGGS APPARENTLY LAID BY A COWBIRD

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WHILE working with the Eastern Field Sparrow (*Spizella pusilla*) during the past few years I have had opportunity to observe some of the habits of the Eastern Cowbird (*Molothrus ater*). During the summer of 1944, I estimated by censusing the number of birds in the flocks on the area, that 5 pairs of Cowbirds were breeding on a 100-acre census area in Pennfield Township, Calhoun County, Michigan. I spent a total of 242 hours on this area from March through July 27. As the summer advanced I became aware of the similarity among the Cowbird eggs laid in the nests of a certain section of the 100 acres and a small area to the north and east. These eggs were shaped alike, were about the same size, and were almost identical in color, being spotted much less than the usual Cowbird egg. I found 25 of them and, of this number, I knew the exact date of laying of 19 and the date within 1–2 days for 4 others. No 2 were laid on the same day. The first was laid in a nest of the Towhee (*Pipilo erythrophthalmus*) on May 15 and the last in a Field Sparrow's nest, probably on July 20, a period of 66 days. The Cowbirds were not banded but the similarity of the eggs and the fact that they were laid on different days helped confirm my opinion that 1 female laid all 25.

In Table 1, I have listed the dates the eggs were laid and, following this, more detailed notes on the 21 nests parasitized by, apparently, the 1 Cowbird. The territory in which the eggs were laid was a roughly triangular area of about 12.5 acres, 321 feet along the west side, 972 feet from northwest to southeast, and 1,288 feet along the south side. It consisted of open shrubby fields covered sparingly with trees and a small cut-over, burned-over woodlot, with many small shrubs. It included the territories of at least 3 pairs of Towhees, 3 or 4 pairs of Vesper Sparrows (*Pooecetes gramineus*), and 16 pairs of Field Sparrows. One nest of a Towhee was parasitized and 20 nests of 14 pairs of Field Sparrows (9 pairs: 1 nest each; 4 pairs: 2 nests each; 1 pair: 3 nests). The eggs were laid in the early morning, before 5 or 6 a.m. Usually eggs of the host species were removed in the early morning, but one was taken between 7 a.m. and 8 p.m.

The average measurement of 11 of these Cowbird eggs was 21.8 x 16.9 mm and the average weight 3.18 grams. The extremes in length were 21.4 to 22.1 mm and in width, 16.4 to 17.1 mm—a remarkable similarity in size. The extremes in weight were 3.0 and 3.3 grams when fresh. A statistical analysis of these 11 eggs and of 22 other Cowbird eggs showed that for the 11 eggs the mean length was 21.8 $\pm$ .20 mm and the mean weight was 3.18 $\pm$ .10 gms.

For the 22 other eggs the mean length was 22.7 ± .81 mm and the mean weight was 3.16 ± .17 gms. A comparison of the standard deviations by the F ratio method showed that the variability in length differed significantly in the 2 samples but the variation in weight did not differ significantly.

The Towhee and 15 of the Field Sparrows deserted their nests when the Cowbird laid eggs and removed the host eggs. Two parasitized nests were destroyed by unknown agencies. In 3 nests, young were raised; 1 of these was a nest in which the young were 6 days old when the Cowbird egg was laid.

TABLE 1
Data on Cowbird Eggs Apparently Laid by One Female

DATE LAID	HOST	NEST	HEIGHT	EGGS OF HOST	
				Laid	Disappeared
May 15	Towhee		on ground	3	2
May 16	"		" "		
May 20	Field sparrow	1	22 cm.	1	1
Found	" "	2	on ground	?	?
May 25	" "	2	" "		
May 26	" "	3	18 cm.	0	0
May 29	" "	4	on ground	1	1
May 30	" "	5	" "	3	2
June 5	" "	6	" "	4	(4 yg.)
June 7	" "	7	22 cm.	1	1
June 10	" "	8	on ground	3	1
June 11	" "	8	" "		
June 13	" "	9	27 cm.	1	1
June 18	" "	10	12 cm.	1	1
June 19	" "	10			
June 22	" "	11	on ground	3	0
June 23–24	" "	12	13 cm.	4	3
June 30	" "	13	12 cm.	2	1
July 8	" "	14	41 cm.	2	1
July 11	" "	15	27 cm.	3	1
July 10–12	" "	16	40 cm.	?	?
July 14	" "	17	42 cm.	2	1
July 16	" "	18	34 cm.	2	1
July 17	" "	19	25 cm.	2	1
July 20?	" "	20	25 cm.	3	0
May 15–July 20		21		41	23

The following additional notes were made at the nests:

Towhee Nest. Built May 11 to 13. Towhee eggs laid May 14, 15, and 16. Cowbird eggs laid May 15 and 16, before 6 a.m. Two Towhee eggs were missing May 16 One of these was lying about a foot from the nest with a bill hole through the side. Nest deserted.

Field Sparrow Nests. 1. Built May 13 and 14. First Field Sparrow egg laid May 19, before 7 a.m. On May 20 at 7 a.m. this egg was gone and a Cowbird egg was present. Nest deserted. Female Field Sparrow 140–32215.

2. Found May 25 with 2 Cowbird eggs. Nest deserted. The female on this territory unbanded.

3. Female Field Sparrow unbanded (male 140–87740). Nest built May 24 and 25. On May 26 it contained a Cowbird egg and was immediately deserted. The female Field Sparrow started a new nest, which I found May 28, and she laid an egg when it was barely started. She finished building the nest, covering her own egg, then laid another egg May 31, but the egg was destroyed by some unknown agency during the day.

4. Female 140-87741 building nest May 25 and 26. One Field Sparrow egg laid May 27 was gone May 28. Apparently the Cowbird egg was laid May 29. I observed it early during the morning of May 30. Nest deserted.

5. Female 140-32203 building nest May 26. Nest completed May 27. No eggs on May 28. Not visited May 29. On May 30 the nest contained 1 Field Sparrow egg and 1 Cowbird egg, both newly laid. On May 31 the second Field Sparrow egg was laid and on June 1, the third, between 5:15 and 7:00 a.m. Two Field Sparrow eggs disappeared June 4. Nest deserted.

6. Female 140-32208. Nest found May 23 with 4 Field Sparrow eggs. Three hatched on June 2, the fourth on June 3. On June 5 the young were gone. A Cowbird egg had been laid in the nest.

7. Female Field Sparrow, 140-32206, building nest June 5. On June 6 at 7 a.m. it contained 1 Field Sparrow egg. At 7 p.m. this egg was gone, but on June 7 at 6 a.m. it contained a Cowbird egg. Nest deserted.

8. Female Field Sparrow, 140-32202, found building nest June 9. On June 10 the nest contained 1 Field Sparrow and 1 Cowbird egg. On June 11 the first Field Sparrow egg was gone; a second Field Sparrow egg and a second Cowbird egg had been laid. A third Field Sparrow egg was laid June 12. On June 13 these eggs had been destroyed by some unknown agency.

9. Nest built (Female 140-32204) June 8 and 9. First Field Sparrow egg laid June 12. On June 13 at 6 a.m. this egg was gone and a Cowbird egg had been laid. Deserted.

10. Female Field Sparrow, (140-32214) found building nest June 15. On June 16 it was nearly completed. First Field Sparrow egg laid June 17. On June 19 this nest contained 2 Cowbird eggs. The Field Sparrow egg was gone. Nest deserted.

11. Nest found June 5 with female 41-120060 sitting on three eggs. Two hatched June 16, and a third June 17. With 3 young in the nest 5 and 6 days old, the Cowbird laid an egg June 22, in the early morning. The young left the nest the same day.

12. Nest built June 15 and 16 by female 140-87741. First Field Sparrow egg laid June 17; fourth on June 20. All 4 eggs were in the nest on June 22. In the early morning of June 25, the nest was found deserted. It contained 1 Field Sparrow egg and 1 Cowbird egg, both damp with dew. The Cowbird egg had been laid June 23 or 24.

13. Completed nest built by female Field Sparrow 140-32214, found June 28. First Field Sparrow egg laid June 29, 5:30 a.m. On June 30 at 6 a.m. the first egg was gone and a second Field Sparrow egg and a Cowbird egg had been laid. The female was sitting on the nest. She did not desert these eggs, but the nest was destroyed by some predator July 16.

14. Female 140-32205. Nest found with one Field Sparrow egg July 7. This marked egg was gone July 8 but a second Field Sparrow egg and a Cowbird egg had been laid. Nest deserted.

15. Female 140-32213. Found July 8 when empty and not yet completed. On July 10 at 7 a.m. it contained 1 Field Sparrow egg. At 7 a.m. on July 11 the first egg was gone and a second Field Sparrow egg had been laid, as well as a Cowbird egg. At 7 a.m. July 12, the third Field Sparrow egg had been laid. On July 17 the Cowbird egg was found on the ground beneath the nest. Two young Field Sparrows hatched July 24 and left July 31.

16. Female 140-32205. This female was observed regularly July 9 to 12 in this area but I did not find the nest until July 13. It contained 1 Cowbird egg. From observations at other nests, the nest must have been built July 9 to 10 and the Cowbird egg laid July 10 to 12. The Field Sparrow had moved to a new location and built another nest in which she deposited her first egg July 13 (nest 17). The Cowbird egg was deserted.

17. Female 140-32205. Nest found July 13 in the early morning with 1 Field Sparrow egg. On July 14 at 7 a.m. it contained 2 Field Sparrow eggs and 1 Cowbird egg. The first-laid Field Sparrow egg had a bill hole in it. Nest deserted July 15.

18. Female 41-120060. Completed nest found July 13. At 7 a.m. July 15 it contained 1 Field Sparrow egg. On July 16 at 8 p.m. it contained a second Field Sparrow egg and 1 Cowbird egg; the first marked Field Sparrow egg was gone. Nest deserted.

19. Female 140-32228. Fully constructed nest found July 13. On July 15 at 7 a.m. it contained 1 Field Sparrow egg. At 8 p.m. July 16 this egg was gone, but a second Field Sparrow egg had been laid. At 7 a.m. July 17 it still contained the second Field Sparrow egg and a newly-laid Cowbird egg. Nest deserted.

20. Nest found July 18. First Field Sparrow egg laid July 19. When revisited in the early morning July 24, it contained 3 Field Sparrow eggs and 1 Cowbird egg. Apparently no Field Sparrow egg was removed. The female, 41-73350, hatched only 1 young, on August 2. This young Field Sparrow left the nest about August 9. I removed the Cowbird egg July 24 to keep it with a number of similarly-marked eggs taken from the above deserted nests. It was the only Cowbird egg I found on this particular area during the summer that might have been successful. It was the only one with which I interfered.

Summary

From May 15 to July 20, 1944, 25 Cowbird eggs were laid, apparently by one female, on a 12.5 acre area in Pennfield Township, Calhoun County, Michigan. It was concluded that the eggs came from the same female because (1) they were very similar in coloration (2) no 2 were laid on the same day (3) the length of 11 similarly colored eggs had significantly less variability than the length of 22 not-similarly colored eggs.

The eggs were laid in a nest of a Towhee and in 20 nests (belonging to 14 pairs) of Field Sparrows. Three or 4 pairs of Vesper Sparrows also nested on the area but apparently were not parasitized.

Cowbird eggs were laid in relation to the laying of the first egg of the host as follows: 2 before the host had laid any eggs; 2 were laid the same day; 11 on the day after; 4 on the second day after (2 of these being second Cowbird eggs for the same nest). One Cowbird egg was laid 3–4 days after the completion of the host's clutch; one was laid when the host's young were 3 days old, and one when the host's young were 6 days old. In 1, possibly 3, parasitized Field Sparrow nests no Field Sparrow eggs were laid.

At least 17 Field Sparrow eggs and 4 young (in 16 nests) and 2 Towhee eggs (in 1 nest) disappeared from the nests, presumably removed by the Cowbird (2 eggs were found with bill holes in them). From 3 nests no egg was removed.

Eggs disappeared from the hosts' nests in relation to the laying of the first Cowbird egg as follows: 3 the day before; 7 eggs and 4 young on the same day; 3 eggs on the day after. From 1 nest 3 host eggs disappeared 5 days after the Cowbird egg was laid. Excluding from consideration the nest in which a Cowbird egg was laid when the host young were ready to leave, 15 out of 20 parasitized nests were deserted. In 1 nest the Cowbird egg was found on the ground below the nest 6 days after it was laid.

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MORTALITY OF BIRDS AT THE CEILOMETER OF THE NASHVILLE AIRPORT

Walter R. Spofford

THE purpose of the following account is to record the apparently singular circumstances surrounding an accident to a migratory flight of birds at the ceilometer at the Nashville Airport. During the second week of September, 1948, numerous reports appeared in the press of substantial numbers of birds killed at various locations from New York to Texas. In at least several of the instances, the accidents were typical in that the wave of birds collided with an obstacle, as at the Empire State Building in New York. In an account of the Empire State occurrence, Pough ('48) attributes the accident to the fact that the bird flight was riding a southward moving mass of cold air, and that the latter was continuously being pressed to a lower altitude by an overlying northward moving mass of warmer air. At New York City the flight was sufficiently low to strike the shaft of the world's tallest building.

Presumably, similar conditions may have been operative at a number of eastern seaboard locations, such as at the 491 foot Philadelphia Savings Fund Building and the 450 foot WBAL television tower in Baltimore, on the same evening (Sept. 10–11, 1948). At Nashville, however, on the preceding night, Sept. 9–10, the birds fell to the ground while flying across the vertical beam of light sent up from the ceilometer and apparently death was due to impact with the ground or runways. Although it may be reasonable to assume that the birds crossing the beam of light were temporarily blinded and hence fell to their deaths hundreds of feet below, the actual combination of circumstances responsible for the accident is a mystery, because the ceilometer has been in use at Nashville for years with no previous known effect on migrating birds, and furthermore such ceilometers are in use at other airports.

The instrument in question, made by the Crouse-Hinds Company of Syracuse, New York, sends a vertical beam from a mercury-vapor lamp of great intensity high into the sky, recording cloud levels up to 15,000 feet, and is said to be visible from 30,000 ft. At Nashville it is set in a low, brick housing on the airfield close to the runways. The beam of the light may be seen at night as a narrow, blueish column, and on cloudy nights the light spot it makes on the clouds can be seen from several miles away. The caretaker of the light, Mr. Charles Linville, stated that at close range the light is so intense as to blind for several hours anyone so unfortunate as to look directly into it, and that it can cause third degree burns. However, if the intensity falls off as the inverse square, it is doubtful that such effects can be considered important factors in arresting a bird flight hundreds of feet in the air overhead. Presumably in a period of several years birds must have passed over the ceilometer on numerous occasions and apparently without effect. On the morning of Sept. 10, however, between midnight and 4:30 A.M., some 300 birds fell down the column of light, to be picked up dead (for the greater part) or variously incapacitated on the ground.

The accident was reported to the Nashville Children's Museum by Mr. Skinner of the airport staff, and the actual observation was made by Mr. Linville. On the night in question, at 6:30 P.M. of Sept. 9, the weather record shows that the cloud ceiling was at 2400 ft., the ground visibility 6 miles, a 4 mph NW wind, and a temperature of 67°F. At 11:30 P.M. the ceiling had lifted to 4200 ft., and visibility increased to 10 miles, with wind and temperature about the same. At this time birds were first noted going overhead (reported as various calls, including a "honking" sound (Green Heron?)). An hour later when the first birds began to fall, the ceiling was at 5000 ft., gradually lifting to 9700 ft. at 4:30 A.M., when the last birds fell. Most of the birds fell in the first hour. Mr. Linville stated that as he looked up the shaft of light, as far up as he could see, birds were tumbling down to land on the ground and adjacent runway, mostly dead. He watched for over an hour, but when Pied-billed Grebes and an American Bittern appeared overhead he took shelter. In the morning he gathered 248 birds which were taken to the Nashville Children's Museum for study by Mrs. Amelia Laskey and the writer. Mr. Albert Ganier later prepared a few of the specimens for his private collection. Before the main group of birds was taken to the museum, however, some dozens of badly damaged birds were swept off the runways, and not recorded.

It is clear that with the atmospheric conditions reported, there can hardly have been any considerable factor of poor visibility, and in fact it would seem none at all. There had been cloudy and unsettled weather with small amounts of precipitation from Sept. 3 through the 9th, but the morning of the accident brought clearing. Since the beam of light was not directed at any object except the clouds thousands of feet overhead, there can have been no appreciable factor of flying toward the beam. Rather, only those birds actually crossing the beam were intercepted. It is not impossible that, becoming aware of the light below, birds started downward towards it, and becoming incapacitated, fell to their death. It is noteworthy that most fell within 50 to 100 ft. of the instrument, but some were found at somewhat greater distances. The slight N to NW wind tended to carry birds to the south side of the impact area, but a considerable number was on the north side as well. This might suggest that they fell from no great height, but Mr. Linville stated that he thought that he could see them at least a 'thousand' feet up. Since it is doubtful just how far the smaller birds at least could be seen under such conditions, 500 ft. may be a more reasonable estimate, and of course birds may have entered the column of light at various altitudes. This is low, however, in terms of the heights recorded

Record of Birds Killed at Nashville on the Night of Sept. 9–10 and at the Empire State Building on the Following Night

Species		Nashville	New York
Pied-billed Grebe	(Podilymbus podiceps)	6	0
American Bittern	(Botaurus lentiginosus)	1	0
Sora Rail	(Porzana carolina)	2	0
Empidonax Flycatchers		20	0
Yellow-bellied	(Empidonax flaviventris)	19*	
Acadian	(Empidonax virescens)	1*	
Wood Pewee	(Contopus virens)	5	0
Olive-backed Thrush	(Hylocichla ustulata)	2	0
Veery Thrush	(Hylocichla fuscescens)	2	1
Yellow-throated Vireo	(Vireo flavifrons)	1	0
Red-eyed Vireo	(Vireo olivaceus)	95	8
Black and White Warbler	(Mniotilta varia)	9	7
Prothonotary Warbler	(Protonotaria citrea)	2	0
Worm-eating Warbler	(Helmitheros vermivorus)	0	1
Blue-winged Warbler	(Vermivora pinus)	0	1
Tennessee Warbler	(Vermivora peregrina)	7	3
Nashville Warbler	(Vermivora ruficapilla)	1	1
Yellow Warbler	(Dendroica petechia)	4	0
Magnolia Warbler	(Dendroica magnolia)	5	7
Cape May Warbler	(Dendroica tigrina)	0	3
Black-throated Blue Warbler	(Dendroica caerulescens)	0	6
Cerulean Warbler	(Dendroica cerulea)	1	0
Blackburnian Warbler	(Dendroica fusca)	1	0
Chestnut-sided Warbler	(Dendroica pensylvanica)	3	3
Bay-breasted Warbler	(Dendroica castanea)	0	5
Black-poll Warbler	(Dendroica striata)	0	4
Prairie Warbler	(Dendroica discolor)	1	1
Oven-bird	(Seiurus aurocapillus)	6	16
Northern Water-thrush	(Seiurus noveboracensis)	7	5
Louisiana Water-thrush	(Seiurus motacilla)	2	0
Kentucky Warbler	(Oporornis formosus)	9	0
Connecticut Warbler	(Oporornis agilis)	0*	10
Mourning Warbler	(Oporornis philadelphia)	4*	0
Yellow-throat	(Geothlypis trichas)	4	4
Yellow-breasted Chat	(Icteria virens)	20	5
Wilson's Warbler	(Wilsonia pusilla)	1	0
Canada Warbler	(Wilsonia canadensis)	20	1
Redstart Warbler	(Setophaga ruticilla)	4	6
Bobolink	(Dolichonyx oryzivorus)	1	1
Baltimore Oriole	(Icterus galbula)	1	3
Rose-breasted Grosbeak	(Pheucticus ludovicianus)	0	1
Savannah Sparrow	(Passerculus sandwichensis)	1	0
		248	103

* Tentative identification.

by the ingenious method of Carpenter (1906); but the observation of Stone (1906) recorded a flight passing quite low over the lumber yard fire he described.

On the other hand, the observation showed that the birds did not fly either into the light or into the ground, but were arrested high in the air, to fall to the ground with death by impact. It is interesting that both legs of the bittern were broken by the fall, but the heavy-bodied grebes were not badly damaged. Overing (1936) mentions that during one night flight at the Washington Monument, many sparrows appeared at the ground, flying down and apparently resting from the flight, but no such factor was apparent at the Nashville flight. Although it is clear that a major role was played by the ceilometer light, it is equally clear that other and unknown factors were operative, because of the fact mentioned that similar occurrences have not been noted at Nashville before, and that similar instruments are in operation at many or most other airports.

In the accompanying table are recorded the birds of the Nashville group and also the birds from the Empire State Building in New York, supplied through the kindness of Mr. Pough. In each case the list is incomplete, and while the Nashville list probably contains by far the greater percentage of the total killed, there is no such assurance for the New York group, where it may be supposed that a much larger proportion was lost.

The imposing group of warblers is not a complete representation of the flight, as a short field trip later in the day revealed 2 Golden-winged Warblers as well as several Yellow-throated Vireos. It does not seem possible to allocate the Nashville birds to any one origin, as both 'Canadian' and 'Carolinian' forms are represented. Wilson's Warbler, Canada Warbler and Northern Water-thrush are matched by Yellow-breasted Chat, Cerulean, and Kentucky Warblers. It is interesting that the Empire State group contains 5 Yellow-breasted Chats. Overing (1936, 1937, 1938a, b) has provided a well worthwhile record of birds killed at the Washington Monument. Of 874 warblers of 22 species picked up in three seasons, 347 (39%) were Yellow throats, 181 (21%) were Magnolias and 94 (11%) Black-throated Green. Not a single Canada Warbler appeared in that list, while at Nashville 18% were of this species. Since the Nashville group is from a single flight it is not as significant as the substantial sample published by Overing, but the considerable differences in the proportions of various species are worth noting. The presence of rails, grebes, and a bittern at Nashville indicates a wider representation of families, but whether this is due to differences in the collection of the sample, to real differences in fly-way cross-section, or merely to fortuitous factors, is not apparent.

Summary

On the morning of September 10, 1948, approximately 300 birds were killed or incapacitated at the ceilometer of the Nashville Airport, and 248 of these were studied at the Nashville Children's Museum. The occurrence appears

to be unique in that the birds did not collide with some object while in flight, but were intercepted upon crossing the vertical beam of the ceilometer light, down the long narrow column of which they fell, to be picked up dead, presumably from impact with the ground. The light itself is not a sufficient cause of the accident, as it has been in use for years without incident, and other such instruments are in use at other airports. Furthermore, visibility was high and the cloud level was at 5000 ft. or above during the accident. The actual combination of factors responsible remains a mystery.

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THE EFFECT OF AGE ON LAYING DATES, SIZE OF EGGS, AND SIZE OF CLUTCH IN THE YELLOW-EYED PENGUIN

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IN THE twelve-year period from August 1936 to May 1948 I have carried out a banding study of the Yellow-eyed Penguin, *Megadyptes antipodes*, on the Otago Peninsula, New Zealand. In the course of this study it has been possible to note the behaviour of 162 young penguins from the time when they entered the water as fledglings until they disappeared from my field of operations. The age of individuals under review varied from 1 to 11 years with only 2 birds attaining the age of 11 years. It is obvious, therefore, that by the time the study ended several of the penguins had become aged. Nevertheless, for the purpose of this paper all birds whose age is known are considered 'young penguins.' In addition to the 162 young penguins whose date of hatching could be determined there were also under observation 298 other young penguins which were banded in their first year. It was unknown when and where these juvenals were hatched but as all eggs of the Yellow-eyed Penguin are normally laid within a space of approximately 3 weeks in any one season, the age of these young birds is therefore known to within 3 weeks.

From the study of the behaviour of 460 young penguins in relation to their age, much information has evolved relative to the influence of age on breeding biology. In this paper only 3 aspects will be considered: (1) the influence of age on laying dates; (2) the influence of age on size of eggs; and (3) the influence of age on size of clutch.

Two terms need defining. (1) From the time when a young penguin enters the sea as a fledgling until it moults into its first adult plumage such a bird will be known as a *juvenal*. This period varies from approximately 14 to 18 months. The juvenals are easily recognised by the lack of a sulphur-yellow band of feathers across the back of the head as obtains in adults. (2) In the period between the first and the second adult moults, the penguins will be described as *two-year-olds* and so on for succeeding age-groups.

An outline of the annual cycle of the Yellow-eyed Penguin has already been published (Richdale, 1941). Briefly, the cycle is as follows: Towards the end of August the penguins begin to spend much time ashore in the daytime preparatory to egg-laying. From the middle of September to early October all eggs that are to be laid that season will appear. Since incubation lasts approximately 42 days, by the end of the third week in November practically all chicks which are to hatch, have hatched. For approximately 8 weeks the chicks are continuously guarded by each parent in turn but after that the chicks are left unguarded in the daytime. Towards the end of February the chicks gradually enter the water and approximately 2 weeks after that, on the average, the parents begin their annual moult. One month previously, on the average, however, juvenals and adults which have not been feeding chicks pass through their moult. In the winter months this species of penguin does not migrate but tends to spend part of its time on the breeding grounds in the evening and during the night. It is at this period that the majority of the new pairs for the ensuing season are formed.

Age of Bird and Laying Dates

As the years of the research passed by and as more and more females of known age laid for the first time, it became obvious that age had no influence whatsoever on the date of laying of any particular female. To test the matter statistically the relative data have been tabulated in Table 1. Young birds laying for the first time totalled 59 individuals made up of 34 two-year olds, 23 three-year-olds,

TABLE 1

A Comparison of Laying Dates of Females Laying for the First Time and of Older Females of Unknown Ages

TYPE OF BIRD	NUMBER OF EGGS	MEAN DATE, SEPTEMBER	STANDARD DEVIATION IN DAYS	STANDARD ERROR IN DAYS
Young	104	26.06	5.70	.56
Age unknown	100	27.45	5.37	.54

and 2 four-year-olds. The 52 older birds were of unknown age because they were already adults when first banded. The dates of egg-laying used for these older birds are those when the individual bird was either last seen in its place of breeding or else in the twelfth year of study. This means that the birds ranged in age from at least 7 years to at least 14 years when the data concerning them were taken.

Of the 104 eggs laid by the young birds, 45 females produced 2 eggs and 14 females only 1 egg. Of the 100 eggs laid by older birds, 48 females produced 2 eggs and 4 females only 1 egg. Had these single eggs in both groups of birds been excluded the mean laying dates of the 2 sets of birds would have been much closer but even so the difference as it stands is not statistically significant. From more than 700 records of laying dates in twelve years, the earliest laying date for a young bird is 11 September and the latest is 12 October. For an older bird the earliest laying date is 13 September and the latest is 15 October but the latter date is not included in the data in Table 1 because the laying date of a later season has been used for the particular female penguin concerned.

Age of Bird and Size of Eggs

In Table 2 are given details of egg weights at various ages from 2 to 11 years of age. In some instances the number of eggs weighed has not yet reached an adequate sample, especially for the later years, but the investigation is still continuing. All eggs were weighed shortly after being laid. As the figures stand for first and second eggs laid by two-year-olds there is no significant difference, but the sample is small.

It is interesting to note that three-year-old females laying for the first time do not produce eggs lighter than those by three-year-olds which had already laid as two-year-olds. As two-year-olds lay eggs which are significantly ($P < .005$) smaller than those produced by both types of three-year-olds, it is

TABLE 2

A Statistical Comparison of Weight of Eggs at Successive Ages of Females

TYPE OF EGG	NUMBER OF EGGS	MEAN	STANDARD DEVIATION	STANDARD ERROR
		grams	grams	
First egg of two-year-olds	34	115.12	6.06	1.04
Second egg of two-year-olds	19	118.68	7.86	1.85
All eggs of two-year-olds	53	116.39	6.61	0.91
Eggs by three-year-olds laying for first time	47	130.04	5.70	0.83
Eggs by three-year-olds laying for second time	42	131.36	7.74	1.19
All eggs of three-year-olds	89	130.66	6.41	0.68
All eggs of four-year-olds	64	135.31	5.46	0.68
All eggs of five-year-olds	40	137.07	7.29	1.14
All eggs of six-year-olds	29	136.69	7.80	1.44
Eggs by birds 7 to 11 years old	35	139.91	7.91	1.34
Eggs by other birds 8+ to 14+ years old	100	139.19	10.17	1.02

obvious that age is the main factor in the smallness of the eggs laid by two-year-olds and that if two-year-olds do not lay until a year later they are physiologically able to lay eggs as large as those females which have already laid as two-year-olds.

On comparing the three-year-olds and the four-year-olds it may be observed that egg weights increase still further significantly but between successive years no significant increase is registered again. If, however, the four-year-olds are compared with the grouped ages from seven to eleven years another significant difference seems apparent. This means that by the age of four years the egg weights have almost reached their maximum and that over a course of several years a slight significant increase may possibly obtain. More data are required to say exactly when the increase ceases and when, if any, there is a decline in weight due to age.

As a further check, statistics from 100 eggs laid by birds whose ages ranged from at least 8 years to at least 14 years were worked out. When compared with these, the eggs laid by four-year-olds indicated a significant difference but those laid by five-year-olds did not so that egg weights, on the average, probably reach their maximum when the females are in their fourth and fifth years.

In Table 3 statistical data for the length of the egg have been worked out in the same way as for the weight in Table 2. An endeavour has been made also

TABLE 3

A Statistical Comparison of Length of Eggs at Successive Ages of Females

TYPE OF EGG	NUMBER OF EGGS	MEAN	STANDARD DEVIATION	STANDARD ERROR
		mm.	mm.	
First egg of two-year-olds	34	74.7	3.36	.58
Second egg of two-year-olds	19	76.6	2.57	.59
All eggs of two-year-olds	53	75.4	3.28	.45
Eggs by three-year-olds laying for first time	47	76.5	2.02	.29
Eggs by three-year-olds laying for second time	42	76.1	2.34	.37
All eggs of three-year-olds	89	76.3	2.17	.23
All eggs of four-year-olds	64	76.7	2.63	.33
All eggs of five-year-olds	40	76.2	1.93	.31
All eggs of six-year-olds	29	76.5	1.75	.32
Eggs by birds 7 to 11 years old	35	76.7	1.95	.33
Eggs by old birds 8+ to 14+ years old	100	76.0	2.64	.26

to discover if there are any significant differences in the various age-groups for lengths but in no instance is any difference significant. It is noticeable, however, as far as the study has proceeded, that in eggs laid by two-year-olds there is a greater spread of egg lengths which lessens with age. With birds in the group at least eight years old and more the length again becomes irregular, suggesting an interesting problem to investigate when penguins of a known age become older.

An examination of the data relative to the width of eggs (Table 4) reveals a situation comparable to that for weights with the exception that the difference in egg-width between the four-year-old birds and those birds for the group from 7 to 11 years old is not quite significant statistically. The above means therefore that there are 3 significant differences for egg-width involving the same age-groups as for weights. These are (1) birds 2 years old lay narrower eggs than birds 3 years old and older (2) birds 3 years old lay narrower eggs than those 4 years old and older (3) birds 4 years old apparently lay slightly narrower eggs than birds of age ranging from at least 8–14 years.

Two other points are of interest. (1) Between three-year-olds laying for the first time and those three-year-old birds which laid as two-year-olds there is, as with weights, no significant difference in their egg-width. (2) The difference in egg-width between the four-year-olds and the last 2 age-groups mentioned in Table 4 is not quite significant for the group from 7–11 years but the difference is significant for birds at least from 8–14 years old. This information suggests that birds may lay slightly wider eggs after 4 years of age, but, as with the data for weight, more details are required for definite decisions.

TABLE 4

A Statistical Comparison of Width of Eggs at Successive Ages of Females

TYPE OF EGG	NUMBER OF EGGS	MEAN	STANDARD DEVIATION	STANDARD ERROR
		mm.	*mm.*	
First egg of two-year-olds	34	53.31	1.49	.26
Second egg of two-year-olds	19	53.34	1.46	.33
All eggs of two-year-olds	53	53.32	1.48	.20
Eggs by three-year-olds laying for first time	47	55.95	0.94	.14
Eggs by three-year-olds laying for second time	42	56.36	1.17	.18
All eggs of three-year-olds	89	56.15	1.08	.12
All eggs of four-year-olds	64	56.98	1.14	.14
All eggs of five-year-olds	40	57.52	1.37	.22
All eggs of six-year-olds	29	57.25	1.35	.25
Eggs of birds 7 to 11 years old	35	57.75	1.35	.23
Eggs of old birds 8+ to 14+ years old	100	58.05	1.59	.16

TABLE 5

Age in Relation to Size of Clutch

	AGE OF BIRD IN YEARS				
	2	3	4	5–10	7–14
Number of females	40	53	39	63	63
Number of eggs	67	104	78	124	123
Mean eggs	1.68	1.96	2.00	1.97	1.95

Age of Bird and Size of Clutch

The normal clutch size for the Yellow-eyed Penguin is 2 eggs. In collecting data for this investigation I have included only those clutches from breeding areas in which I was working frequently in the period when the eggs were being laid. It is not safe to wait until the eggs have been incubated for a time for, in the interval since the eggs were laid, a number certainly disappear for various reasons.

Table 5 lists 258 females and the number of eggs laid by them according to age. All records were taken soon after the eggs were laid. Of 40 two-year-olds, 13 (32.5%), laid only 1 egg to the clutch; of 218 older penguins, 7 (3.2%) as far as I could ascertain, laid only 1 egg to the clutch. A further point of interest is that of 31 three-year-olds which did not lay as two-year-olds, only

1 bird failed to produce the normal complement of 2 eggs to the clutch. Of an additional 22 three-year-olds which had already laid the previous season as two-year-olds, only 1 did not produce 2 eggs. As this bird suddenly changed its mate (a most unusual happening) some 2 weeks before laying, my impression was that this unusual procedure was the cause of the single egg to the clutch. Further, the egg did not hatch.

Discussion

As for other species of birds not much information is available relative to the effect of age on laying dates, size of eggs, and size of clutch. In connection with the effect of age on laying dates Nice thinks (1937: 106) that in the Song Sparrow, *Melospiza melodia*, the earliest sets of eggs are laid by adult birds and that the young females probably lay later. She also quotes authors who indicate that in the Starling, *Sturnus vulgaris*, and in the Grey Heron, *Ardea cinerea*, old birds tend to lay earlier than young females.

Further evidence on the matter under discussion is as follows: From 9 January to 26 February 1948 I spent 48 days on the sub-Antarctic islands, The Snares, which are situated some 64 miles south-west off the end of the most southerly of the 3 main islands of New Zealand. Among other things it was possible to study the laying period of Buller's Mollymawk, *Diomedea bulleri*. Females of this species began to lay on 16 January and had almost completed laying for the year when we left on 26 February so that the span of laying is approximately 7 weeks. A total of 132 eggs was weighed and measured (only 1 egg forms the clutch). There was no tendency for large eggs to be laid first and for smaller eggs to appear later. All sizes were scattered indiscriminately throughout the entire laying period. Therefore, if my surmise is correct that young birds in Buller's Mollymawk lay small eggs, age is not a factor in determining laying dates of individuals in that species.

In conclusion, it would seem that in penguins and petrels which tend to have restricted laying spans and which tend to breed at a relatively late age, that age does not affect the date of laying. Age at breeding in species of petrels which I have studied has varied from the end of the second year as in the Diving Petrel, *Pelecanoides urinatrix*, to as long as the end of the eighth year as in the Royal Albatross, *Diomedea epomophora sanfordi*. It should be noted, however, that all species of penguins and petrels may not have a restricted laying period. For example, from my own observations the Little Blue Penguin, *Eudyptula minor minor*, has a laying span of several months.

In species of birds like the Song Sparrow which may breed more than once in a season and may re-nest if a nest is destroyed, it is possible that the breeding rhythm in young females has not developed fully by the time the old birds are ready to reproduce early in the season. This would mean that young females would tend to lay subsequently to the older females which had bred previously.

In connection with the effect of age on size of eggs it is well known that the young birds of the domestic fowl produce small eggs. Nice (1937: 113–121) in her study of the Song Sparrow indicates a comparable situation to that which obtains in the Yellow-eyed Penguin. For example, in the Song Sparrow, egg-width and egg-weight increase with age, being 3 % for width and 7% for weight; egg-length is variable. Reduced egg-width and consequently reduced egg-weight would seem to be governed in young birds by the lack of a fully developed oviduct due to youth.

As for the effect of age on size of clutch in birds in general, some information is available in the literature but, although probably many of the statements are valid, little statistical support is offered. Nice (1937: 108–111) and Lack (1947: 313–314) summarise the known data and opinions. Much more research is needed. In the Yellow-eyed Penguin, as already noted, two-year-old birds definitely tend to produce a clutch less than the normal complement of 2 eggs. After that, unless advanced age has an influence, age does not affect size of clutch. In conclusion, it may probably be found that young birds of many species tend to produce small clutches. As regards aged birds, the position is somewhat doubtful and may not be so general. Lack (1947), for instance, quotes species which are apparently not affected.

Summary

In the course of a 12-year study (1936-48) of the Yellow-eyed Penguin, *Megadyptes antipodes*, it was possible to study the effect of age of bird on laying dates, size of eggs, and size of clutch.

From 104 eggs laid by 59 young penguins which laid for the first time the mean date of laying was 26.06 September; from 100 eggs laid by 52 older birds the mean date of laying was 27.45 September. The difference is not significant statistically. In practice eggs laid by young penguins may appear at any time in the short laying period of approximately three weeks—age does not affect date of laying.

Two-year-old Yellow-eyed Penguins produce significantly lighter and narrower eggs than older birds but although the difference in length is not significant, individual measures are dispersed over a wide range. Three-year-olds lay much heavier and wider eggs than two-year-olds but not so heavy nor so wide as do four-year-olds. Subsequently there is possibly a further slight significant increase in width and weight. In old age there appears to be a tendency towards a reduction in weight and towards irregularity in length but width of eggs seems to increase.

Of 40 two-year-old Yellow-eyed Penguins, 32.5% laid only 1 egg to the clutch whereas of 218 older birds only 3.2% did so. Youth, therefore, in this species, does affect size of clutch.

In Buller's Mollymawk, *Diomedea bulleri*, age does not appear to affect date of laying.

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THE SNOWY OWL MIGRATION OF 1946–47

Third Report of the Snowy Owl Committee

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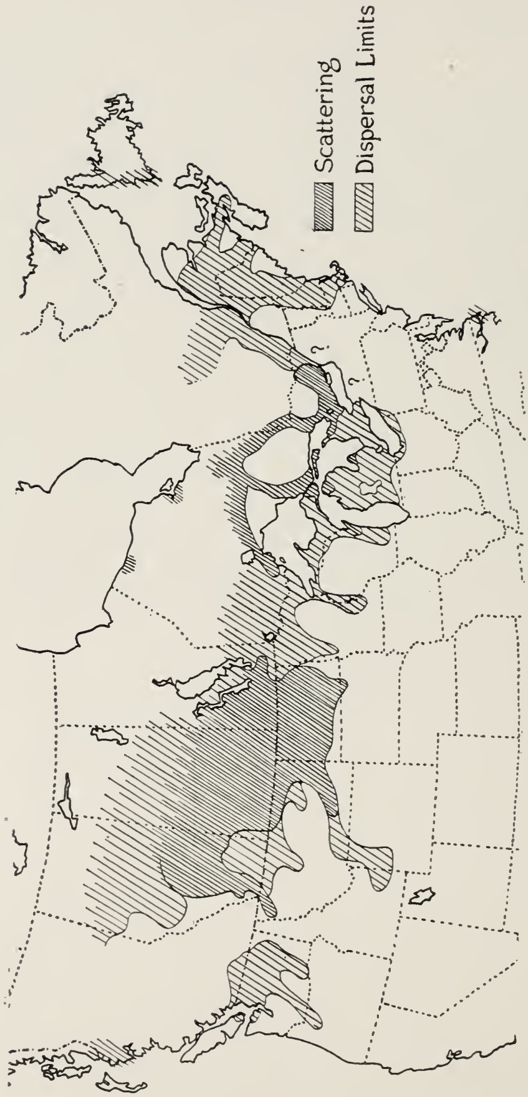
REPORTS on two major migrations of Snowy Owls (*Nyctea scandiaca*) have been made by the Committee. The first (*Wilson Bull.*, **55**: 8–10) concerned a flight in the autumn and winter period of 1941–42. The source of this flight was the eastern Arctic and its spread largely involved southeastern Canada and the northeastern and north-central United States. Occurrences in the Prairie Provinces during the period probably represented a more or less regular winter population, not an excessive influx. Sources which provide information annually on the status of certain birds indicated an inconspicuous repetition-flight of Snowy Owls in the east during the autumn of 1942 but nothing noteworthy in the west. The minor movement in the east was considered too insignificant to warrant a full scale Committee survey and report. Presumably, the basic condition for any Snowy Owl flight in the east, or an excessive influx in the west, is an unbalance in the Arctic between the owl population and its food supply. It would therefore be expected that a repetition or "echo" flight would follow a major flight in the succeeding year if unbalance still existed. A relatively small number of owls involved in an echo flight could be accounted for either by a depletion of the owl population, or by improvement in its food supply in the Arctic, or both.

The second report of the Committee (*Wilson Bull.*, **59**: 74–78) concerned the major flight of 1945–46. Again, the source of the flight was largely the eastern Arctic, from the Boothia Peninsula eastward through Baffin Island and northern Ungava. There was some evidence of a precursory population rise of Snowy Owls on Victoria Island and at the western end of Coronation Gulf but it was not general through the western Arctic as it was in the east. The 1945–46 flight was a major one, apparently the largest on record. Its spread involved both the east and the west with heavy concentrations in suitable areas in the former region and a heavy influx and broad scattering in the latter.

The present report and map concern the flight of the following year, the autumn and winter of 1946–47. In the east this flight was a mere echo of the migration of the previous year. For example, in Ontario occurrences approximated only 13% of the volume for 1945–46, in Michigan about 7.5%, in Ohio about 2%, and in Maine and Massachusetts little more than 1%. However, scattering carried representatives as far south as North Carolina where two were observed in the Pea Island area of Dare County.

Because of the general rarity of occurrence of Snowy Owls in the east during



Extent of Snowy Owl Migration of 1946–47 the autumn–winter period of 1946–47 it has not been possible clearly to trace the course of the flight and time its progress. Therefore, it is uncertain whether the birds which appeared in the east emanated from the eastern Arctic where the population was known to be currently low, or from the western Arctic where the population was at a peak. Very few records were received from the Province of Quebec and there was but one each from New Brunswick and Nova Scotia. Of the few owls reported from Newfoundland it was suspected that some had remained over the summer from the flight of the previous year. The comparatively weak flights in other eastern Provinces and States have already been noted. The earliest observation of a Snowy Owl in Ontario was made in September at Lake Nipissing. The first reported in a more southerly locality in Ontario was observed at Toronto on October 3. In Michigan the earliest report concerned one observed in the east-central part of the state (Lapeer County). Most of the subsequent early October reports came from the western half of the Upper Peninsula. The few records from Ohio indicated a November entry there, apparently via both the east and west ends of Lake Erie. It has not been possible to obtain precise information relative to occurrences in New York State.

The situation was markedly different in the west. It should be recalled that a heavy influx occurred in the west, as in the east, the previous year. It became evident in October 1946 that another heavy flight was under way. Many observers in settled portions of the Prairie Provinces and in North Dakota considered the flight to be as large or larger than the previous year. This opinion is substantiated by census figures for the Prairie Provinces where the total of Snowy Owls reported for 1946–47 was approximately 47% higher than for 1945–46.

Because observers are rather sparsely distributed and there are unavoidable imperfections in practicable means of gathering data in the west, little more than a general impression of such a flight can be given for this vast region. Probably there were no conspicuous lines of flight or marked concentrations, scattering being the rule for ecological reasons. Although the total of owls observed, the number killed, the time of first occurrence, and the period of largest numbers for particular sections cannot be precisely presented for the west, we have the broad picture of a repetition flight the year succeeding a major flight, becoming conspicuous in central portions of the Prairie Provinces from early to mid-October. By the end of that month, forerunners occurred in North Dakota, Montana, Washington, and southern British Columbia and by early November individuals had reached northern South Dakota (Columbia), southwestern Idaho (Bingham County) and northwestern Oregon (Scio). By December the impetus of the flight was spent and the number of Snowy Owls in the northwestern tier of States was at a maximum. Relatively fewer Snowy Owls are killed in the west, than in the east.

The migration was not conspicuously evident in the midwestern and north-central United States. No Snowy Owls were reported to the Committee from Indiana, Illinois, or Iowa. Only a few were observed in Minnesota, the first at Duluth on October 5th. The first record for Wisconsin was for September in the central northern part of the State (Vilas County). Opinion in that State considers that the principal port of entry was in the northeast via the upper peninsula of Michigan from whence migrants spread south along the Lake Michigan shore, and west along the south shore of Lake Superior, thence down the Mississippi.

The general picture of density and distribution in the north-central United States suggests that Snowy Owls entered the region from the northeast, i.e. from east-central Ontario, and from west of the Great Lakes, presumably from Manitoba. It is not altogether clear whether Snowy Owls passing south through east-central Ontario came from the east or west of Hudson Bay. The largest concentration of Snowy Owls reported (approximately 100 in October) from a restricted locality was at Attawapiskat Post halfway up the west coast of James Bay. This report suggests that Snowy Owls may have followed the coast line eastward from the west side of Hudson Bay and thence southward.

Undoubtedly, the flight of 1946–47, which was pre-eminently a western event, had its origin principally in the western Arctic. Arctic stations reporting a high population of Snowy Owls for the period immediately preceding the flight are situated from Holman Island (off western Victoria Island) eastward to Repulse Bay and south through Baker Lake to Eskimo Point on the west coast of Hudson Bay. No information on the status of Snowy Owl populations in Alaska is available. The owl population was low in the eastern Arctic. Extreme southeastern occurrences of Snowy Owls during the 1946–47 flight may be interpreted as peripheral scattering of the flight from the western Arctic, or the result of a weak echo-flight of the decimated eastern Arctic population. It is evident, within the experience of this Committee, that heavy incursions in the east depend on an exodus of a peak population in the eastern Arctic. There seems no reason to suppose that any heavy periodic influx of Snowy Owls in extreme eastern North America has its origin in the western Arctic though a notable influx in the west may result from an exodus of a peak population in the eastern, or western, Arctic. Consequently, it is unlikely that a heavy flight of Snowy Owls in New England reflects conditions in animal populations west of Hudson Bay.

Members of the Committee: Roy N. Bach, Wm. B. Barnes, Irven O. Buss, C. T. Black, W. J. Breckenridge, B. W. Cartwright, J. D. Cleghorn, Alfred O. Gross, Lawrence E. Hicks, C. M. Kirkpatrick, Gordon M. Meade, J. A. Munro, Harold S. Peters, T. M. Shortt, R. W. Tufts, Willet N. Wandell, Leonard Wing, J. Van Tyne, L. L. Snyder, Chairman.

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THE *ORNITHOGRAPHIA AMERICANA* OF FATHER PLUMIER, 1689–1696

François Bourliere

FATHER C. Plumier was a noted pioneer of West Indian botany. Between 1689 and 1696, he undertook 3 successful expeditions in the West Indies, visiting various islands such as Martinique, Saint Domingue (now Haiti),

Green Heron. Pen and ink drawing of Father Plumier. Plate 87 of his unpublished *Ornithographia Americana*. Courtesy Museum National d'Histoire Naturelle, Paris.

Saint Vincent, Bequia, Saint Christophe, Santa Cruz and Saint Thomas. Most of the botanical results of these expeditions were published in a series of famous books: *Description des plantes de l'Amérique avec leurs figures*, 1693; *Nova plantarum americanarum genera*, 1703; *Traité des fougères de l'Amérique*, 1705 and *Plantarum americanarum fasciculus primus* [*-decimus*] . . ., 1755–1760. These beautiful books are especially noteworthy for their plates engraved after the field-sketches of the author. But Father Plumier, like many old-style naturalists, was not solely interested by plants and, during his travels, made numerous sketches of birds, mammals, fishes and various invertebrates. These unpublished drawings are now preserved in the central library of the Museum National d'Histoire Naturelle in Paris. Among them, a beautiful collection of ornithological plates, bound in a folio volume bearing the number Ms 27 and entitled *Ornithographia americana*,. s worthy of interest for ornithologists.

Through the kindness of Madame G. Duprat, librarian of the Museum National, I have been able to examine at length these drawings and, with the help of Mr. J. Berlioz, curator of the ornithological department of the same institution, I succeeded in identifying most of the birds figured. Most of the drawings are water-colors probably made in France after the field-sketches preserved in a second volume (Ms 29) and bearing numerous notations on the color of the plumage and soft parts of the birds. Other drawings are exact pen and ink replicas of the original sketches.

Some of the birds are unusually lively, e.g. the Green Heron of the plate 87 here reproduced, and suggest that they were sketched from life. A few plates are very careful anatomical drawings, e.g. plates 91 to 93, while a lot are mere "stuffed" pictures, probably drawn from dead birds. A few birds cannot be identified, the sketches being unfinished or lacking in precision. Also, some birds pictured are unquestionably composite ones (plates 71 and 94), drawn from memory or after freakish descriptions of some settlers.

A good deal of these drawings are completed by manuscript notes giving vernacular (French and Carib) names and some peculiarities of the birds pictured.

The following 68 species may be easily identified.

Colymbus dominicus (pl. 59)
Podilymbus podiceps (pl. 60)
Puffinus lherminieri (pl. 27), with egg.
Phaëthon aethereus (pl. 34, 35). Plumier notes that this bird was observed by him "apud insulam Martinicanam".
Pelecanus occidentalis (pl. 91 to 93)
Fregata magnificens (pl. 7 and 36). Plumier observed this bird forcing boobies to disgorge fish.
Casmerodius albus (pl. 80 and 85)
Florida caerulea (pl. 77 and 78). Plumier figures the adult and the immature birds.
Butorides virescens (pl. 83 and 87)
Nyctanassa violacea (pl. 81 and 86)
Ixobrychus exilis (pl. 84)
Plegadis falcinellus (pl. 75)
Guara alba (pl. 76).
Ajaia ajaja (pl. 95)
Phoenicopterus ruber (pl. 96)
Buteogallus anthracinus (pl. 4), seen by Plumier in Union Island, Grenadines.
Falco sparverius (pl. 5 and 6)
Aramus guarauna (pl. 82)
Porphyrula martinica (pl. 65 and 66)
Gallinula chloropus cerceris (pl. 69 and 70)
Fulica caribaea (pl. 68)
Jacana spinosa (pl. 73 and 74)
Haematopus ostralegus (pl. 88). In his notes, Plumier describes the peculiar feeding behavior of this bird. He said he never observed it elsewhere than in the Grenadines.
Charadrius vociferus (pl. 63)
Capella gallinago (pl. 61)
Totanus melanoleucus (pl. 90)
Erolia minutilla (pl. 65)
Himantopus himantopus (pl. 89)
Larus atricilla (pl. 30)
Sterna dougallii (pl. 31 and 32)
Sterna fuscata (pl. 28). Plumier figures the egg and describes the nest. He said that an important nesting colony was then located at "Le diamant" (Diamond Rock) near Martinique. [James Bond suggests that this may be *S. anaethetus*. Editor]
Anoüs stolidus (pl. 29)
Columba squamosa (pl. 23)
Columbigallina passerina (pl. 25)
Oreopeleia chrysia (pl. 24)
Coccyzus minor (pl. 14). Said to exist in St. Domingue and Tortuge Island.
Saurothera longirostris (pl. 12 and 13). Said to be common at St. Domingue.

Crotophaga ani (pl. 19). Observed in St. Domingue. "Gregarim vivunt", said Plumier.

Tyto alba (pl. 8 and 9). Observed only at St. Vincent.

Speotyto cunicularia (pl. 10). Named by Plumier Ulula cunicularia or Chevêche lapin. The burrowing habits of this owl are well described in manuscript notes as well as the bird's amusing habit of bobbing up and down when alarmed.

Chaetura sp. (pl. 38)

Eulampis jugularis (pl. 41)

Orthorhyncus cristatus (pl. 40)

Temnotrogon roseigaster (pl. 16 to 18). St. Domingue.

Todus angustirostris (pl. 42). Said to live "apud insulam Sandominicarum". [*T. subulatus?*]

Centurus striatus (pl. 14)

Tyrannus dominicensis (pl. 46)

Progne subis dominicensis (pl. 38)

Corvus leucognaphalus (pl. 58). St. Domingue.

Mimocichla ardosiacea (pl. 51)

Cichlherminia l'herminieri (pl. 52)

Myadestes genibarbis dominicanus (pl. 47)

Dulus dominicus (pl. 63)

Coereba flaveola (pl. 41)

Dendroica erithachorides rufigula (pl. 39)

Dendroica discolor (pl. 42)

Seiurus aurocapillus (pl. 43)

Quiscalus lugubris (pl. 53)

Icterus bonana (pl. 39)

Phaenicophilus palmarum (pl. 43)

Saltator albicollis (pl. 50)

Loxigilla violacea (pl. 50).

Among introduced species, the following were observed by Plumier between 1689 and 1696:

Ortalis ruficauda (pl. 57). Said to be very common in St. Vincent and Grenadines. The species was certainly introduced very early and was already naturalized at the end of the seventeenth century.

Crax alector (pl. 54 and 55), *Icterus jamacai* (pl. 44) and *Rhamphastos erythrorhynchus* (pl. 15) were undoubtly pictured after cage birds. For the last species, Plumier notes that this bird is not indigenous in the West Indies.

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GENERAL NOTES

BIRD NOTES FROM NORTHERN MICHIGAN

In a recent paper (1948) I have detailed in part the results of a wildlife survey of the Huron Mountain district, Marquette County, Michigan, made from October 1939 to July 1942. Included therein are a description of the area and an inventory of its vertebrate fauna, among which are listed 206 species and subspecies of birds, with only the briefest of notes appended. Certain additional data of special interest as well as Huron Mountain records of some forms not to my knowledge previously published are presented. Mentioned in the present notes are 29 species.

Common Loon. *Gavia immer.*—This is a common summer resident, and pairs may be found on most of the inland lakes. On June 25, 1940, I located a nest containing 3 eggs (2 is the usual number) on a small island in Howe Lake. On June 26, 1942, at Mountain Lake I observed 2 chicks riding on the parent's back. From July to October groups of from 2 to 6 loons are frequently seen on Lake Superior, near the shore, usually in early morning or evening.

Blue Goose. *Chen caerulescens.*—Bayard H. Christy has told me that 2 geese, seen on the Cranberry Marsh by Herbert E. Perkins in May 1926, were accurately described as this species.

American Pintail. *Anas acuta.*—This species has been reported once in the Huron Mountains, on September 28 (probably since 1930), by B. H. Christy.

Gadwall. *Anas strepera.*—S. Morris Pell observed 1 of these ducks on Howe Lake on September 2, 1941.

Wood Duck. *Aix sponsa.*—This species continues to breed in limited numbers in the Huron Mountains. In 1941 there appeared to be at least 2 broods on the Salmon Trout River. A downy juvenile, probably not over a week old, was taken in a weir by F. Wallace Taber on June 2, 1941. On 2 other occasions from then until June 25, 1941, Wood Ducks were captured in this weir—once an adult together with 5 young.

Canvas-back. *Aythya valisineria.*—I observed a flock of 30 flying southward in V-formation over Mountain Lake in the late afternoon of October 9, 1941.

Old-squaw. *Clangula hyemalis.*—I observed one of these ducks over Conway Bay on February 1, 1941.

White-winged Scoter. *Melanitta fusca.*—On January 25, 1940, I saw a pair about 200 yards from shore, at the edge of the ice on Lake Superior, near West Flat Rock. Again, on May 16, 1940, I observed 1 male and 3 females resting on the water of Conway Bay.

American Merganser. *Mergus merganser.*—A few winter in the Huron Mountains. On November 20, 1939, and for about a month thereafter, a flock of more than 200 was congregated on the south bay of Rush Lake; over 75 per cent of them were males. After May 31, broods were frequently encountered, numbering from 6 to 14. On June 10, 1942, I observed a female swimming on Mountain Lake, with 7 young on her back.

Bald Eagle. *Haliaeetus leucocephalus.*—Usually at least 1 pair nests in the region each year. Near West Flat Rock, in the summit of a large white pine about 100 yards from the Lake Superior shore, was an aerie which had been used for several years. On July 8, 1940 (as seen with binoculars from a boat) there was 1 young bird in this nest, and another trying its wings on a nearby branch; 1 adult perched in a neighboring tree top, while another flew along the shore. On July 9, 1941 2 birds were seen in this nest, at least 1 of them apparently an adult. Another aerie has been reported, in years past, on Conway Point; immature eagles were seen in flight near here on June 15, 1941 and again on June 7, 1942.

Sharp-tailed Grouse. *Pedioecetes phasianellus.*—This bird is a recent arrival in the Huron

Mountain region. Baumgartner (1939) stated that the first authentic record in the Upper Peninsula of Michigan was in 1922, and that the species appeared to be "spreading eastward on a broad front extending from Lake Superior to Lake Michigan." I noted 1 in a cutover area on Salmon Trout Point on November 10, 1939; B. H. Christy saw 1 near the town of Big Bay on July 3, 1941, and S. M. Pell saw 1 on May 26, 1942.

Upland Plover. *Bartramia longicauda*.—I observed a single bird on September 24, 1941, in a grassy clearing among jack pines between Pine Lake and Lake Superior.

Greater Yellow-legs. *Tringa melanoleuca*.—S. M. Pell saw 1 on Third Pine Lake on October 5, 1941.

Ruddy Turnstone. *Arenaria interpres*.—B. H. Christy observed 1 on the Lake Superior beach near the mouth of Pine River from the last week of August until September 13, 1937. I noted 1 at the same spot on October 5, 1941.

Pectoral Sandpiper. *Erolia melanotos*.—S. M. Pell noted 1 at the Cranberry Marsh on October 5, 1941.

Red-backed Sandpiper. *Erolia alpina*.—B. H. Christy and I observed 1 on the shore near the outlet of Ives Lake on October 13, 1939.

Wilson's Phalarope. *Steganopus tricolor*.—A bird, seen at about noon near the eastern Huron Islands by S. M. Pell and me on July 9, 1941, was believed to be this species.

Yellow-billed Cuckoo. *Coccyzus americanus*.—One bird, which I preserved, was found dead at the Anne Lake landing on the west shore of upper Mountain Lake on October 4, 1940.

Snowy Owl. *Nyctea scandiaca*.—Mrs. Carroll Paul reports that 1 was shot at the Ives Lake Farm in the winter, about 1937. David M. Nason tells of seeing 1 near the Five Forks on January 26 and again on April 5, 1940. Several were reported seen, and 1 killed, at the town of Big Bay in November 1941.

Great Gray Owl. *Strix nebulosa*.—B. H. Christy reported seeing this bird repeatedly, and in successive years, on the upper reaches of Pine River from about 1900 to 1905.

Richardson's Owl. *Aegolius funerea*.—One bird was collected "in the late fall in the woods between Rush Lake and Lake Superior" (Gregory, 1929). This specimen was taken about 1910 by Hans Jensen and given to H. E. Perkins, who had it mounted; it is now in the collection of the University of Michigan Museum of Zoology.

Saw-whet Owl. *Aegolius acadica*.—One specimen was collected by D. M. Nason at his home a few miles southeast of Big Bay on February 23, 1941; it is in the collection of the University of Michigan Museum of Zoology. B. H. Christy reported seeing and hearing 2 of these owls in woods south of Pine Lake on July 12, 1941.

Chimney Swift. *Chaetura pelagica*.—H. Emerson Tuttle, in 1936, located a hollow nesting tree along the Trout Lake trail; debris and egg shells a foot deep outside the tree indicated long occupancy. Leopold (1939) mentioned "one bird found in a hollow basswood near Trout Lake, May 31, 1938." B. H. Christy once found a nest in a boathouse cubicle near the mouth of Pine River.

Rough-winged Swallow. *Stelgidopteryx ruficollis*.—B. H. Christy and I observed several at the Ives Lake Farm in the early evening of July 12, 1940, in company with Barn Swallows and Chimney Swifts. I observed the species again over the Cranberry Marsh on July 12, 1941; B. H. Christy has also seen it at the dam on the Salmon Trout River.

Raven. *Corvus corax*.—Ravens are moderately common permanent residents of the Huron Mountains, but no nest has yet been located, to my knowledge. On September 19, 1940, near Ives Mountain I witnessed the masterful aerial performance of a Raven; with wings partly closed it went into a steep dive, then executed a twist and pulled out of the dive, sometimes upside down, on extended wings. This performance was repeated several times by the Raven, while another hovered in the air nearby.

Eastern Winter Wren. *Troglodytes troglodytes*.—This is a common summer resident, but seldom remains after mid-October. I observed a straggler on January 13, 1940, very active among brush piles and windfalls near a dense cedar swamp on the West Flat Rock trail.

Blue-headed Vireo. *Vireo solitarius.*—This uncommon summer resident is usually seen among jack pines; I noted it on 5 occasions, in jack pines and in mixed hardwood-hemlock stands. On July 9, 1940, in low bushes among maples and hemlocks on the shore of Rush Lake (nearly a mile from the nearest jack pines), I observed an adult feeding 2 young out of the nest. The fledglings were just beginning to fly and were able to perch on low shrubs.

Eastern Cowbird. *Molothrus ater.*—This bird is a rather common summer resident in the Huron Mountains. B. H. Christy noted young Cowbirds out of the nest, and being fed by a Myrtle Warbler, on July 17, 1941; S. M. Pell again observed a Myrtle Warbler feeding young Cowbirds on August 1, 1941.

Greater Redpoll. *Acanthis flammea rostrata.*—One male which I collected at the Oscar Webster homestead on January 30, 1941, was identified by Pierce Brodkorb as this subspecies.

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THE VERNACULAR NAME OF THE BALTIMORE ORIOLE

Erroneous statements concerning the vernacular name of the Baltimore Oriole (*Icterus galbula*) have been printed so often in the last half century that it seems worthwhile to assemble the scattered proofs of their errors. Various of the statements appear in such widely circulated works as Mabel Osgood Wright's "Birdcraft," 1895: 172–173; Neltje Blanchan's "Bird Neighbors," 1897: 212; E. H. Forbush's "Birds of Massachusetts," II, 1927: 444; "Birds of America," edited by T. Gilbert Pearson, 1936, II: 260–261, and Malcolm MacDonald's "Birds of Brewery Creek," 1947: 111.

The statements—sometimes presented as tradition, sometimes as fact—are that George Calvert, the first Lord Baltimore, visited Chesapeake Bay in 1628, saw the bird for the first time, and was so pleased by it that he adopted its colors as his own; that colonists who came to Maryland with Cecil Calvert, the second Lord Baltimore, misnamed the bird "oriole"; and that Linnaeus named the species from skins, and named it Baltimore Oriole because its colors were those of the Calverts.

The errors in those stories are shown by historical and ornithological works as follows: A formal "exemplification," or statement, of the Calvert family coat of arms was issued in England in 1622 (1) and this document, a possession of the Maryland Historical Society in Baltimore, shows that the Calvert colors had already been established as "or and Sables"—that is, gold and black. It was not until 1625 that George Calvert became the first Lord Baltimore (2) and not until 1629 that he visited the Chesapeake (3). Cecil Calvert never visited America (4). Thus it is certain that the Baltimore colors were not adopted from the bird, and that Cecil has no part in any tradition.

It is as certainly true, on the other hand, that the bird was named after the Baltimore colors. Linnaeus, however, was not the first person to so name it. Initially, in the tenth edition of "Systema Naturae," 1758, I: 108, he himself named it *Coracias Galbula*. Only in the twelfth edition, 1766, I: 162, did he rename it *Oriolus Baltimore*. Already 100 years before that, the colonists in America were calling it "the Baltimore bird." Nathaniel Shrigley's "A True Relation of Virginia and Maryland," London, 1669 (5), contains a reference (p. 4) to "the Baltenore bird, being black and yellow"—the name there marred by an "n" for an "m"; the Calverts themselves at that period sometimes spelled their title "Baltemore" (6). John Lawson (7), mentions "the Baltimore-Bird, so called from the Lord Baltimore, Proprietor of all Maryland" (p. 152 of reprint). Likewise, Catesby (8) called it the "Baltimore Bird" and explained: "It is said to have its name from the Lord Baltimore's coat of arms." The "Systema Naturae" indicates, and hence the American Ornithologists' Union (9) considers that it was not from skins but from Catesby's book that Linnaeus included the bird in his classification, and from Catesby that he adopted the species designation *Baltimore*.

As for the "oriole" part of the vernacular name, it was the ornithologists, and not the lay colonists, who made this mistake. To the colonists the bird was simply the "Baltimore bird." Catesby, however, giving the first naturalist's description of it in Latin, termed it an *icterus*, which was the Latin name for the birds that Europeans later came to call orioles. Linnaeus, relying on Catesby's description, in 1758 classified it along with the European birds in *Coracias*, and then in 1766 separated this whole group as *Oriolus*. And down to 1785 *Oriolus Baltimore* stayed strictly a technical name. Only in that year, it seems, was this translated into the English "Baltimore Oriole," by Thomas Pennant (10). And only after that name had become firmly attached were our birds discovered to be only superficially like the "true" orioles of Europe.

To sum up, what can be accurately said about the origin of the name "Baltimore Oriole" is that the designation "Baltimore" became attached, because the bird's colors were those of the Calverts, soon after these proprietors began colonizing Maryland (their first colonists landed in 1634; and Shrigley's "True Relation" shows that in 1669 the name was being used). This designation the ornithologists adopted from the colonists. The ornithologists also for a time regarded the bird as congeneric with the European orioles, and before they changed their view the term "oriole" had become fixed in vernacular usage.

For access to, and help in using, some of the ornithological works cited I am greatly indebted to Dr. John W. Aldrich and Allen J. Duvall.

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BIRDS FEEDING ON EUROPEAN CORN BORER IN NEBRASKA

While surveying and collecting European corn borers in the vicinity of corn borer parasite release points in eastern Nebraska during October and November 1948, the writer noted that considerable numbers of infested corn stalks bore typical woodpecker punctures. The first of these was noted October 13 at Fontanelle, Nebraska where two stalks were found that showed bird work. On October 22, 25, and 27 more than 30 stalks were examined just south and west of Fremont, Nebraska. Likewise on October 28 and November 4 a number of bird beak punctures were noted in corn stalks on the University of Nebraska Experiment Farm east of Lincoln. On October 23, while surveying counties where the corn borer had not previously been recorded in Nebraska, two similarly punctured corn stalks were found four miles east of Hebron in Thayer county.

No borers were found in any of the above stalks (more than 50 examined) that had been worked by the birds, indicating that they were successful in taking the borers. The punctures in the stalks were all of the same type. No woodpeckers were noted working on corn stalks, but on two different occasions Hairy Woodpeckers (*Dendrocopos villosus*) were seen along the edge of borer-infested corn fields. This bird predation was noted in eastern Nebraska the second year after the establishment of the European corn borer in the state. The borer apparently was also preyed on the first year it was recorded as common in Thayer county in south-central Nebraska.—Clarence A. Sooter, Department of Entomology, University of Nebraska, Lincoln, Nebraska.

THE STUDY OF HAWKS IN FLIGHT FROM A BLIMP

The Tide Water Associated Oil Co. granted the Urner Ornithological Club the use of their advertising blimp on Sept. 21, 1948 to assist in studying the migration of the Broad-winged Hawk (*Buteo platypterus*) over New Jersey. The day chosen was clear with a 10 mph northwest wind and a temperature of 65°F. A total of 2,150 Broadwings were observed from the ground during the day chiefly from a vantage point in Upper Montclair. It was more difficult to locate the birds from the air than from the ground. Although 1800 hawks were spotted from the ground while the blimp was in the immediate vicinity, only 290 were spotted from the blimp. Radio communication from the airship to ground observers is recommended.

Observations made on only 1 day may not represent average behavior, even though the ground observers in this case described the day as a normal, good day for a Broadwing flight. The height at which the blimp found kettles, that is, a flock of hawks spiraling upward, was, in 4 cases, 1500, 2000, 2700, and 2400–2900 feet above sea level. These hawks were above a valley of 190 feet elevation and rising to fly over a ridge of 590 feet elevation. It is not known that these were the highest kettles of the day, nor measured at their highest point except for the 2000 foot kettle. Although earlier ground estimates had placed the kettles at greater heights, the maximum height reached may well be only 3000 feet, and many times the birds abandon their upward spiraling and "peel off", or enter their straight, downward glide, at only 2000 feet.

The birds peeling off from the 2000 foot thermal, a rising column of air heated from a warmer ground area, were successfully followed until they roosted in trees 4 miles away at a ground elevation of about 450 feet. Thus the ratio of glide to fall was about 12 to 1. The air speed of the Broadwings in the glide was 32 mph in one measurement and 26 mph in another. Judged by the criterion that the hawks were not frightened if they continued their glide in an undeviating line, the birds did not seem to mind the airship provided it was more than 300 feet distant.

Earlier ground observations, in addition to overestimating the height reached in the thermals, were unable to judge accurately airspeeds and distances of glide. Complete details of the undertaking may be found in "The Urner Field Observer", **3** (5–6): 2–9 1948. Further observations from a blimp appear to be a profitable method of obtaining new information on behavior of hawks in flight.—E. I. Stearns, 92 Farragut Road, Plainfield, New Jersey.

SOME WHISTLING SWAN OBSERVATIONS IN WESTERN ALASKA

Herbert W. Brandt (Alaska Bird Trails, 1943: 325) stated that Whistling Swans (*Cygnus columbianus*) were rare in the Hooper Bay region during the summer of 1924. Through the efforts of the Alaska Game Commission much greater protection has been given the species in recent years. Due to this protection and the decreased shooting by Eskimos, the species has increased a great deal during the past decade. Henry Kyllingstad, teacher at Mountain Village on the lower Yukon from 1942 through 1948, stated that he had seen a remarkable increase while he was there.

On an hour trip at Bethel June 4, 1946, I observed 2 swans just north of the village. On an all-day hike June 5, 1946, at Johnson River I flushed 15 swans, all feeding on lakes southwest of our cabin. They were in pairs except for 1 individual. They were on the move at 3:24 a.m., 5:05 a.m., 5:22 a.m., and 5:35 a.m. Their calls resembled "O-o-o-o-o-oa" or "Goo-oo-oo-a". When they rose from the water the pounding of their wings on the surface was plainly audible from .50 to .75 mile away. Many of the lakes and streams west of Johnson River (30 miles west of Bethel) were frozen, which could account for the concentration of swans at that time. During 165 hours in the field at Johnson River between June 4 and 20, I observed 30 swans (observations on 6 of 17 days), an average of 0.18 per hour. No swans were seen during the plane trip from Bethel to Johnson River and return.

During a 125 mile flight from Bethel to Chevak (just east of Hooper Bay) on June 20, 1946, 2 pairs and 3 single birds were seen. One was sitting on a nest near the shore of a small lake, while its mate was feeding along the shore.

On June 21, 1946 I flew from Chevak to Mountain Village, a distance of 85 miles, observing the greatest concentration of swans—8 single individuals and 8 couples—, totaling 24, and probably representing 8 to 16 pairs. As a rule they were feeding on small lakes. Two were sitting on nests, 1 of which was on an island about 9 feet long near the shore. It was well lined with down, and when we flew over, the adult slid off into the water. We passed over her so swiftly, though, that she returned immediately to the plainly discernible eggs. The other swan had built her own island in the marshy lake border. It was a large mass of vegetation several feet across and also contained eggs. The incubating swan slid off the eggs as we came into sight but returned immediately after we had passed. Her mate was feeding only about 300 feet away. At the second nest the swan's mate was not observed. We did not observe any swans on this trip after crossing the Yukon.

On June 22, we flew from Mountain Village to Marshall, a distance of 60 miles, observing only 1 swan, and that on the south side of the Yukon. From Marshall to Bethel, another 57 miles, an area with a few scattered stunted spruces, but still tundra in nature, we observed 3 groups of 2 swans.—LAWRENCE H. WALKINSHAW, 1703 Central Tower, Battle Creek, Michigan.

TWO BIRDS NEW FOR THE RIO GRANDE VALLEY

On May 13, 1939, a storm of great violence struck Green Island in Laguna Madre, Texas. The following morning a great concentration of passerine birds covered the island. Among the multitudes of warblers, orioles, flycatchers, and other land birds was a small flock of male Bobolinks (*Dolichonyx oryzivorus*). The local authorities stated that to their knowledge this was the first record of the Bobolink for the county, and probably for the entire Rio Grande valley.

On May 6, 1948, while driving from Port Isabel to San Benito we came upon an adult Sooty Tern (*Sterna fuscata*) resting on the road. This individual could not have been in good physical condition for I barely missed catching it in my hands. Aided by a strong wind, the bird just managed to rise and sailed off with an unsteady flight over extensive chaparral country, and from all appearances settled far out in that area. I have been unable to find another record of the occurrence of the Sooty Tern in the Rio Grande valley.—ALLAN D. CRUICKSHANK, Rye, New York.

SUMMER TANAGER IN MICHIGAN

On November 6, 1948, George M. Sutton and I collected a Summer Tanager (*Piranga r. rubra*) about a mile south of Pinckney, Livingston County, Michigan.

The specimen, an immature female, weighed 28.2 gms. The wing measured 91.5 mm, the tail, 69. The ovary was small and the skull was incompletely ossified. The stomach was full of fruit remains (grape?), with traces of insects. The specimen, number 116078, is now in the Museum of Zoology, University of Michigan.

This bird is the first record of the Summer Tanager for Michigan. However, its occurrence in Michigan is scarcely as remarkable as the date of its occurrence. Even the Scarlet Tanager (*Piranga olivacea*) leaves Michigan long before November, usually by the middle or end of September, although Magee banded a female and noted a male nearby at Sault Ste. Marie on October 21, 1923 (Magee, 1926, *Wilson Bull.* **38** (3): 163). In central Ohio, *Piranga rubra* breeds north to Licking County; in eastern Ohio it ranges farther north; in western Ohio, it breeds only to the general region of Dayton (Hicks, 1935, *Ohio State Univ. Studies* **40** (5): 175).

Although it may be useless to speculate on the reason for the bird's visit, it seems worthwhile to record the fact that the weather during the early part of the month was stormy, and on November 5 and 6 a rather strong south wind prevailed.—HARRISON B. TORDOFF, Museum of Zoology, Ann Arbor, Michigan.

TEXAS HABITAT OF BOTTERI'S SPARROW AND GULF COAST RECORDS OF WINTERING SPARROWS

It is perhaps worth recording that the habitat of Botteri's Sparrow (*Aimophila botterii*) in the Brownsville, Texas, area has changed materially since the publication of Harper's article on that species (1930, Auk, 47, 177–185.). Harper gives a careful description of the terrain between Brownsville and Port Isabel on the coast. Overgrazing, which he specifies as not existing in the area at the time of his visit, is now all too apparent. Once the citrus groves and the richer tableland growth ends and the salt prairie to the east begins, there is no vegetation but a stubbly grass with patches, along the road, of cedars, agarita and mesquite. The typical salt grass association, which appears to be the strict habitat preference of this species and which is well illustrated in his photographs, now occurs only on the very borders of the sea itself or the neighboring lagoons, both near Port Isabel and farther south at Boca Chica. It was here only that I found Cassin's Sparrow (*Aimophila cassinii*) singing from March 11, 1946 on, and later on March 22 farther north above Corpus Christi at Rockport in similar environment. From the above evidence it seems that the summer range of Botteri's Sparrow has been seriously reduced in the Brownsville area of Texas.

The following species were collected and positively identified during this period:

Savannah Sparrow (*Passerculus sandwichensis oblitus*), a common wintering species along the sea edge from Rockport to Boca Chica, taken between March 4 and March 23.

Nevada Savannah Sparrow (*Passerculus sandwichensis nevadensis*), found at Port Isabel in tufts of grass along the beach, March 11.

Western Grasshopper Sparrow (*Ammodramus savannarum perpallidus*), taken at Brownsville and at Austwell, Mar. 3–11. The upper mandible seems to become darker with the approach of the nesting season, starting with the ridge of the culmen and working downwards on each side.

Cassin's Sparrow (*Aimophila cassinii*), was in breeding condition and also in very worn plumage, from March 11 on. Two specimens show pronounced head moult. Their faint distinctive song carries for well over a hundred yards. A spelling made in the field was: "Tse, Tse, Tseee (prolonged), (interval), uh-tsee, uh-tsee."

Black-throated Sparrow (*Amphispiza bilineata bilineata*), was singing and in breeding condition at Port Isabel as early as March 11.—S. Dillon Ripley, Peabody Museum of Natural History, Yale University, New Haven, Conn.

CLOSE PROXIMITY OF TWO NESTS OF AMERICAN BITTERNS

On May 12, 1948, in a marshy pasture 1.5 miles east of Warren, Macomb County, Michigan, I flushed an American Bittern (*Botaurus lentiginosus*) from a nest containing 5 eggs. An examination of the area nearby revealed another Bittern nest 58 feet away which also contained 5 eggs. Both nests were matted platforms of marsh grass built up to a height of about 8 inches above the water, which was ankle deep in the surrounding area. The locality where these nests were found is not a typical marsh habitat but rather a wet meadow with scattered clumps of cat-tails. Bent (1926. *U. S. Nat. Mus. Bull.* **135:** 75) found 5 nests of this species in Saskatchewan in an area 0.25 mile square, but does not indicate the distance between them.—Douglas S. Middleton, 7443 Buhr Avenue, Detroit 12, Michigan.

TWO OBSERVATIONS OF WING-FLASHING BY MOCKINGBIRDS

Twice during the summer of 1947, in Jefferson County, Nebraska, I watched the wing-flashing of Mockingbirds (*Mimus polyglottos*). On July 1, a Mockingbird on the top of a schoolhouse was making 4-foot vertical flights. As the bird paused on the roof between flights it frequently raised and extended the wings in the manner illustrated by Sutton (1946 *Wils. Bull.* **58:** 206–209) and Allen (1947 *Wils. Bull.* **59:** 69–128) This observation is contrary to Sutton's conclusion that wing-flashing is done only when the bird is on the ground. Fear, suspicion, illumination of dark areas, or procurement of food do not appear to have been factors in this instance.

In Perkins County on August 7 a Mockingbird was apparently picking up insects in a fallowed wheat field. This bird flashed the wings outward in a horizontal position, not upward as described by Sutton and Allen. The wings when extended appeared to form an angle of 180 degrees. After appearing to catch and eat several insects, the bird flew to the shoulder of a gravel road, alighting in sparse weedy cover where there were 3 other birds which apparently made up a brood. They seemed to search for food for themselves, and at least 2 birds accompanied their movements with wing-flashes, which amounted to the partial opening of the wings horizontally. Wing-flashing and "begging" calls were noticeable when the adult bird appeared on the ground nearby. Twice the adult alighted near the young birds and flashed its wings as though to attract their attention. Then it moved over to a bird and fed it. Once the adult, after a series of quick dashes and wing-flashes caught what appeared to be a grasshopper.

The adult may have instinctively flashed the wings while searching for food, as Sutton suggests. Since the movements after food were made in an easterly direction, perhaps the wings did serve to take advantage of the early morning light in illuminating crevices in the rather level terrain, as Allen suggests. Wing-flashes on the part of adult and young birds as they approached each other appeared to be signals, although perhaps unintentional and unnecessary.—John H. Wampole, Grant, Nebraska.

CATBIRD ATTACKS SNAKE

On July 3, 1948 about 2 p.m., at Kelly Bridge, 3 miles south of the village of Slippery Rock, Butler County, Pennsylvania, in company with the late Mr. Edmund W. Arthur, and

Mr. John M. McCormick, I encountered a pair of Catbirds (*Dumetella carolinensis*) scolding furiously. We found they were attacking a snake which was about 2 feet above the ground in a crotch of a large apple tree. The snake was about 2 feet long and had its head drawn back in position to strike. An adult Catbird had advanced to within a foot of the snake, apparently trying to catch it by its thin tail.

When we came close the bird backed off a few feet and the snake resumed its climbing of the tree, going straight up the vertical side of the trunk. As soon as the snake got above our heads, the bird closed in again. At a small branch, the snake resumed its defensive position, but the bird retreated only a matter of inches. When once more the snake started to climb, the bird darted in, and, on the wing, grasped the tip of the tail, yanking the snake loose from the bark so that it fell 10 feet to the ground. There we captured it, and tentatively identified it as an immature black racer (*Coluber constrictor*); the snake escaped before we got home, so identification is not positive. The alternative is an immature pilot black snake (*Elaphe obsoleta*). At no time did it actually strike at us or at the birds.

The Catbirds had young, out of the nest, but we could see none in this particular tree. We found one fledgling about 20 yards away. Apparently the bird knew exactly how to handle the snake, and did the job like an expert, in the twinkling of an eye.—F. W. Preston, Box 149, Butler, Pennsylvania.

NORTHERN SHRIKE AT PLAY

Suspended from the top of a 60-foot radio antenna pole near the government school in Mountain Village, Alaska, was a 12-foot length of light rope, having on the end a large knot of frayed rope. On August 25, 1946, this rope was whipping about in a wind of 31 mph. For several minutes a Northern Shrike (*Lanius excubitor*) played an aerial game; the bird would fly down, seize the knot, and then struggle to maintain equilibrium. Apparently he did not try to fly off with his "prey", but only to hold on and remain upright without bumping against the pole. My wife had witnessed a similar performance the previous day. The knot later came off, but I was tempted to tie on another "lure" to see if the bird would play the game for a movie camera.—Henry C. Kyllingstad, Fort Yates, North Dakota.

CONSERVATION

Members of The Wilson Ornithological Club, in touch with its Conservation Committee only through these pages, might easily wonder what kind of work we can do for conservation. The committee, on the other hand, is anxious to be more than a nominal group; which means that we must work closely with our fellow members. Our first concern is the manner in which the club can serve best the cause of conservation; how can we, a widely-scattered ornithological group, fit in with the national picture. The answer, we feel, is to be found in Section 2, Article 1 of our Constitution which states: "The object of The Wilson Ornithological Club shall be to advance the science of ornithology, particularly field ornithology as related to the birds of North America, . . ." Our main job, then, is to conduct original research in ornithology. This is fundamental to bird conservation, hence our position in this field is clear-cut and long established.

Today, conservation is big business. It spends many millions of dollars each year. It sends 15C0 delegates to its annual convention. It publishes reports by the ton. Yet with all its money, with all its manpower, the great conservation program in this land of ours promotes but a meagre schedule of fundamental wildlife research. Gustav Swanson most recently pointed this out in his summary of the last North American Wildlife Conference. Anybody who cares to thumb through the transactions, journals and reports produced by our conservation program will note for himself the shortage of original research. Since this is a natural characteristic of the rapid development of the program, we are underlining rather than criticizing this point. It is simply a fact we must face. Administrators, politicians, and taxpayers who put up the money want to see things done right now: tomorrow, next month, or by year's end at the latest. Since research usually labors 2 to 5 years before producing tangible results, it is little wonder that it is not popular with budget committees at this stage of the game.

We must not fret then for want of a job; our obligations to the conservation field stare us in the face. Our main concern is the manner in which we can fit more closely with the national conservation program, and to this end we might organize our thoughts as follows:

1: More work with the larger species. This classification no doubt is awkward, yet stated simply, those birds which are game or predators or which conflict with our civilization are mainly the larger ones. These are the birds which need conservation most, and which have been studied least. The smaller kinds, particularly the passerines, may be studied close to home over long periods with small budgets, hence the greater attention they have received. Yet we must advance to our larger species the same kind of fundamental research which Mrs. Nice applied to the Song Sparrow. It particularly behooves those of our members who are professionally engaged in some phase of the conservation program to help direct research of this kind, and to plant the seed of an idea where a project can grow and thrive.

2: Broadened associations. In the rapid development of professional conservation biology during the last 15 years, the *game manager* or the *wildlife technician* has built up a science of his own which sometimes breaks too far away from the fundamentals of biology upon which it was founded. It has come to the point where the ornithologist and the technician often are worlds apart, having different associates, following different literature, going to different meetings, seldom associating with each other in common understanding. The ornithologist often considers the technician too "practical" in his interests, while one often hears the professional biologists referring aloofly to what they like to call the "*dickey-birders*". Both groups and the birds as well are the losers in this misunderstanding, and we must by all means bring them closer together. That means, of course, aiming first at closer associations within our own club, for our membership includes both groups. We must remember that the professional biologist is constantly under pressure to produce practical results; otherwise his funds may be cut short. And the professional must realize that in the meticulous studies which have been made of the Song Sparrow or of the Snow Bunting, there are clues that surely will lead him to a far better understanding of the larger species that concern him.

Moreover, we should extend ourselves to the point of following the work of European biologists more closely. Our general disinterest in overseas biology is appalling, despite the fact that not a few foreign workers such as Lebret, Siivonen, and Tinbergen publish in our own tongue. In waterfowl biology, for instance, there is so very much we could learn about our own problems if we would only give attention to some of the foreign work that has been done with these birds.

3: Cooperation. As a relatively small group, our work is greatly strengthened when we join forces with our associates in other parts of the country. Along this line, Richard H. Pough, Curator of Conservation at The American Museum of Natural History, has drawn up a plan whereby the Conservation Committees of The Wilson Ornithological Club, The American Ornithologists' Union, and the Cooper Ornithological Club will work closely together as a cooperative group. The development of special study projects to be carried out on a long-term basis will be encouraged under this new plan. There will be more about this in the next issue of the Bulletin, but we give notice here that the first of these study projects has been set up in our club under the direction of Walter E. Scott. This will investigate the Old-squaw mortality in the Great Lakes fishing industry. Members living in the Great Lakes region who would like to cooperate on this important project should get in touch with Walter Scott.

There are, thus, 3 specific activities in which members may advance the cause of conservation.

Albert Hochbaum, *Chairman*

LIFE MEMBER

Dr. A. W. Schorger, a member of the Wilson Ornithological Club since 1927, is president of the Burgess Cellulose Company. He has received degrees from Wooster College, Ohio State University, and the University of Wisconsin. He is a past-president of the Wisconsin Academy of Sciences, Arts, and Letters. Field work has taken him in this country from coast to coast, and to Mexico, England, and Morocco. While most of his published papers are on the present distribution and early history of the birds and mammals of Wisconsin, he has been especially interested in collecting material for a monograph on the passenger pigeon.

LITERATURE

Comments on Recent Literature

Clutch Size in Birds. Great differences exist among the families of birds in the number of eggs laid per clutch. Since the populations of most species remain more or less constant, it is usually assumed that such variations in clutch size represent adjustments to different mortality rates. Yet it is difficult to understand how mortality factors affecting the whole life span of a bird can influence the number of eggs laid. In a recent important series of papers by David Lack on clutch size in birds and litter size in mammals, he points out that natural selection will favor those individuals producing the greatest number of offspring, regardless of potential dangers involved in overpopulation.

Natural selection, operating in the direct manner just suggested, presumably explains the egg laying feats of a codfish or a queen termite. Here physiological capacity (including seasonal cycles of the ovary) sets the only limit upon the number of eggs laid. The same may be true of most reptiles, but among birds it seems to hold only for the Megapodiidae and possibly for some parasitic species—in other words, for birds that do not incubate their eggs or care for their young.

Incubation imposes great restrictions upon clutch size. Sandpipers, for example, lay 4 large eggs; apparently this is the maximum number that can be covered by the parent. In some of the larger gulls a clutch of 3 is very constant and may also be as many as the bird can successfully incubate. These gulls have 3 distinct brood patches, 1 for each egg, suggesting that this clutch size is of long standing. Further evidence of this is the fact that sandpipers and gulls are "determinate" layers (Davis, 1942); if eggs are destroyed or removed during the laying period the birds will not lay additional ones in an "attempt" to complete the clutch as so many birds do.

Although clutch size in gulls, sandpipers, and probably a few other groups is apparently determined by the number of eggs the parent is capable of incubating, Lack believes this to be exceptional. Most species can incubate more eggs than they normally lay. Even the partridge, *Perdix perdix*, which lays as many as 15 eggs, can incubate 20 or more without decrease in hatchability (Lack, 1947). Lack believes that in such species—and this is his most important conclusion—clutch size is equivalent to the maximum number of young that can be reared by a given species at a particular season and locality.

In support of this plausible hypothesis Lack has assembled a certain amount of direct evidence. In the Starling, *Sturnus vulgaris*, banding records show that birds laying clutches of above average size actually leave fewer descendants than do those laying average clutches. Though some of the former group succeed in fledging unusually large broods, the young apparently leave the nest in a weakened or retarded condition, since their mortality during the first few months thereafter is greater than among birds from broods of normal size (Lack, 1948b). In the Alpine Swift, *Apus melba*, analysis of banding records also suggests that normal clutch size represents the maximum number of young that can be reared (Lack and Arn, 1947). This paper has been criticized at some length by Bender (1948), who emphasizes some of the difficulties involved in such studies, and suggests a number of additional factors which may influence clutch size.

Lack has assembled circumstantial evidence in favor of his hypothesis that is impressive because of its very quantity. Latitudinal increases in clutch size he attributes to the longer days of the northern summer, permitting birds to care for larger broods. In the night feeding goatsuckers this trend is absent. Differences in the number of eggs in first and second broods also seem to agree well with seasonal variations in the quantity of food available. The larger broods usual in cavity nesting birds he considers a result of lessened predation. This permits, without excessive mortality, a longer nestling period than is possible in many species that build open, exposed nests.

If natural selection produces a normal clutch size corresponding to the maximum number of young a pair of birds of a particular species can rear, rapid increases in population might be expected. Such increases are potentially possible but as the numbers of a species mount, its mortality factors operate more stringently and eventually equal the rate of reproduction (Nicholson, 1933). Predation, to mention one population control, increases greatly, as Errington has shown, when a species becomes so numerous as to overcrowd is normal habitats. In the Gray Heron, *Ardea cinerea*, a severe winter sometimes decimates the British population. Recovery is then very rapid, but as competition for food or other essentials becomes sharper, the population again becomes stabilized (Lack, 1946). Clutch size usually remains the same throughout such fluctuations, though in a few raptores it responds to variations in food supply.

This review barely suggests the great amount of data on clutch size and related subjects that Lack has assembled and tabulated. His analysis leads to important conclusions but at the same time reveals the need for much additional investigation. Many of the problems remaining unanswered can be studied to advantage by anyone able to spend some time in the field during the nesting season.

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DEAN AMADON

BOOK REVIEWS

Birds of Cincinnati and Southwestern Ohio. By EMERSON KEMSIES. Ohio Audubon Society, Cincinnati, Ohio, 1948: $8\frac{1}{4}$ x 11 in., mimeographed, pp. ii + 60.

The region covered by this bulletin includes Hamilton, Clermont, and Butler counties in Ohio. Within the area are Ohio River bottomlands and upland pastures. The author properly calls attention to an interesting local transition between northern and southern birds. Data are given on 292 species and races, most of them represented by specimens, but a few of questionable status. There are brief notes on the ecology of some species.

The American Woodcock is interestingly considered "a regular and frequent summer resident throughout the area". Red-shouldered Hawks are listed as "fairly common summer residents", while Red-tailed Hawks are not recorded as breeding, and are "seen much less frequently than the following species" (i.e., Red-shouldered Hawk). In the nearby Appalachian region, with which this reviewer is much more familiar, the Red-tailed Hawk is generally a breeding species of the broad river valleys, while the Red-shouldered Hawk is much more common in the mountains.

Accidental confusion between the ranges of the Trumpeter Swan and the Whooping Crane seems apparent. On page 15 the Whooping Crane is described as ". . .now almost extinct except for a few pairs in Yellowstone and British Columbia. . .".

Bird students in the Cincinnati region will find Mr. Kemsies' bulletin a very useful publication. Other observers in the Ohio Valley will be interested in comparing local conditions in southwestern Ohio with those prevailing in their own regions.

MAURICE BROOKS

How to Know the Birds: A Simple Aid to Bird Recognition. By ROGER TORY PETERSON. A Mentor Book, Published by the New American Library of World Literature, Inc., New York, N. Y. Pp. 144, profuse illus. in black and white. Paper covers. Index. 1949. Price 35¢. Also published by Houghton Miflin Co., Boston with cloth covers and 5 colored plates. Price $2.00.

The ornithologist has had access to expensive reference books that told him the lengths of bills, tarsi, and folded wings in millimeters, numbers of eggs per clutch, egg measurements, etc. But this inexpensive book tells how to identify birds through perception of their silhouettes, markings, actions, or habitats.

The Peterson Field Guides, superseding all former such publications in their design, may still exclude a number of impecunious bird lovers from owning them, but there is now no excuse for the veriest beggar not to argue with his companion in poverty as to whether that lately-seen bird was a Chipping or a Field Sparrow.

Cheap literature, in the reviewer's opinion, is a blight on the reading public, but in this instance all he can find breath to say is, "Bravo!" We would have a better land and culture if more of our experts would take time to bring their experience within the compass of casual readers.

So much having been read in general praise of the booklet, the reader might want a few concrete facts. The bird examples are said to be restricted to a small number of types, but actually a wealth of species is included, and only the more-than-average amateur will find lacunae in the coverage. The black-and-white illustrations sustain Mr. Peterson's reputation as a delineator of birds in conventional, functional states. The text sounds no note of condescension, although it is masterfully levelled a pitch or two lower than the language in his Field Guides. There are no technical names. A notable aspect of the book is the series of brief characterizations of each family of birds and further the excellent short sketches of the habitats of birds.

C. Brooke Worth

The Parasitic Cuckoos of Africa. By Herbert Friedmann. Washington Academy of Sciences Monograph number one. xii + 204 pages. 20 figs. 1 map, $4.50.

The present information concerning the habits of the parasitic cuckoos is merged in this book with original observations made by the author in 1924–25. Five genera (15 species) are discussed to the extent that the meager data permits. The distribution, courtship behavior, egg, young, and foster species are mentioned, when known, for each species. The introduction to each genus indicates its place in the evolution of social parasitism.

The 3 species of the genus Clamator are interesting because they show a courtship-feeding pattern and display no instinct to evict the young of the host. Information about the genus Cuculus (4 species) shows that at least some members are less perfectly parasitic than the European Cuckoo. There are traces of courtship feeding and a lack of the evicting behavior in *C. solitarius.* The monotypic genus Pachycoccyx is poorly known as are the 3 species of the purely African genus Cercococcyx. Some of the 4 species of the genus Chrysococcyx, unique among parasitic birds, feed their fledglings after these young birds have left the nest of their foster parents. There is courtship-feeding behavior.

The last 2 pages of the book, titled "A few concluding remarks", comment on some aspects of parasitism all too briefly but then, the data are not available and more extensive comments would be largely speculation. It is hoped that this summary of present knowledge will stimulate additional research.

David E. Davis

Tropical Birds (from plates by John Gould). By Sacheverall Sitwell. B. T. Batsford Ltd., New York. 12 pp., 16 colored and 2 uncolored plates, $2.00.

Ornithologists interested in good reproductions of John Gould's famous pictures will enjoy this little book. The plates (7 by 5 inches) compare favorably with the original large pictures done nearly 100 years ago. They show 4 birds of paradise, 7 parrots, 2 kingfishers and a toucan, a finch and a fruit pigeon. The notes on the pictures however, are an amazing jumble of miscellany. Some are apparently original observations and are ornithologically worthless, while the style of writing consists of long, involved sentences guaranteed to confuse the reader.

David E. Davis

The Flight of Birds Analyzed through Slow-motion Photography. By John H. Storer. Cranbrook Inst. Sci. Bull. 28, 94 pp. Illus., 1948. $2.50.

Ever since man can remember, he has envied birds their ability to fly. Attempts have been made to imitate the birds, but from the earliest recorded case of Daedalus and Icarus, the efforts have been unsuccessful until recently. Modern science and modern machines have finally overcome man's handicap and lifted him from the ground in a manner that he did not learn directly from the birds.

Part of the reason why it took man so long to learn how to fly was that he had great difficulties in studying and analyzing the flight of birds, because the motions are so fast that usually the eye cannot follow them. It would be interesting to speculate on what the history of human flying would have been if it had been possible to make an exhaustive study of the flight of birds beforehand.

John H. Storer gives in the present volume the results of careful studies on the flight of birds carried out over many years. By making photographs with a high speed motion picture camera and then slowing down the films, many features in the flight of birds become apparent which otherwise are hidden. Thus it becomes possible to find out just how birds are able to propel themselves through the air.

Mr. Storer applies the well established principles of aerodynamics to the flight of birds. He shows that birds and aeroplanes work largely on the same principles. The wing acts as an airfoil; by changing the angle of attack (tilt) of the wing the bird can control the lift. It appears that the birds could not have had a better wing design if they had first taken elaborate courses in aerodynamics.

Different birds have their wing structure specialized for different purposes. Thus, the albatross has a long and narrow wing, giving it a large "aspect ratio" as it would be expressed in aeronautical terminology. This equips it admirably for gliding and soaring. Birds needing great maneuverability have short stubby wings like a fighter plane, enabling them to make quick turns. A hummingbird that can hover almost motionless over a flower uses its wings more like the horizontal propeller of an autogiro. Mr. Storer finds that the flaps of an aeroplane wing, the slots, and other features have their analogs in special feathers which serve the same purposes as their counterparts on aeroplanes. The outer part of the wing constitutes the propeller. It can change its pitch readily, which is even more important than for an aeroplane propeller as it can only make a semicircular motion and then return to its initial position. When the bird soars, the propeller changes its function and merely becomes a part of the lifting wing.

These analogs are explained in simple, non-technical language and illustrated by many photographs and diagrams so that it is easy for the average bird lover to follow. The book is intended for the nature lover, the biologist and the aviator. In the words of the author: "The biologist will see the reason for the structure of bone and feather as each part of the wing takes, for a split second, some unexpected shape and position. The aviator will find interest in the similarities of design and function in bird and plane. The nature lover will discover new beauty and logic in his favorite subject."

G. H. Dieke

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See also *Physiology:* Moreau *et al.*

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BLAKE, EMMET R. First Mexican Records of Tropical American Birds. *Nat. Hist. Misc. No.* **42,** March 16, 1949: 1–3. (*Caprimulgus maculicaudus, Rhytipterna h. holerythra, Sayornis nigricans aquatica, Ptilogonys cinereus molybdophanes*)

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MENGEL, ROBERT M. Evidence of the History and Former Distribution of the Raven in Kentucky. *Kentucky Warbler* **25** (1), Feb. 1949: 1–6, 1 photo.

RAND, A. L. Note on the red crossbills in the Ottawa District. *Can. Field-Nat.* **62** (5), Sept.–Oct. 1948: 162–163.

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STEWART, CHARLES A. Observations on the American Egret in Iowa. *Iowa Bird Life* **19** (1), March 1949: 2–5.

WALKINSHAW, LAWRENCE H., AND JOHN J. STOPHLET. Bird Observations at Johnson River, Alaska. *Condor* **51** (1), Jan.–Feb. 1949: 29–34, figs. 1–5.

Evolution and Speciation

GRANT, VERNE. Pollination Systems as Isolating Mechanisms in Angiosperms. *Evolution* **3** (1), March 1949: 82–97, figs. 1–2. (Including pollination by birds)

HALDANE, J. B. S. Suggestions as to Quantitative Measurement of Rates of Evolution. *Evolution* **3** (1), March 1949: 51–56.

HEBARD, FREDERICK V. Sexual selection in woodpeckers. *Auk* **66** (1), Jan. 1949: 91–92.

PARKES, KENNETH C. Brewster's Warbler breeding in Yates County, New York. *Wils. Bull.* **61** (1), March 1949: 48–49.

See also *Anatomy:* Cole *et al.*

Migration and Flight

HEWITT, O. H. A local migration of the brown-headed chickadee in James Bay. *Can. Field-Nat.* **62** (4), July–Aug. 1948: 123–124.

PRESTON, F. W. The Pacific flyway of the golden plover. *Auk* **66** (1), Jan. 1949: 87–88.

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See also *Physiology:* Odum

Ecology

COTT, HUGH B. The Palatability of the Eggs of Birds. *Ool. Rec.* **23** (1), March 1949: 1–9.

STEWART, ROBERT E. Ecology of a Nesting Red-shouldered Hawk Population. *Wils. Bull.* **61** (1), March 1949: 26–35, fig. 1.

WING, LEONARD. Breeding Birds of Virgin Palouse Prairie. *Auk* **66** (1), Jan. 1949: 38–41. (Washington)

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AUSTIN, OLIVER L. Site Tenacity, a Behaviour Trait of the Common Tern (*Sterna hirundo* Linn.). *Bird-Banding* **20** (1), Jan. 1949: 1–39.

BROWNLOW, H. G. The Under-water Movements of the Dipper. *Brit. Birds* **42** (3), March 1949: 69–73. (*Cinclus cinclus*)

CRAIGHEAD, FRANK C. JR., AND JOHN J. CRAIGHEAD. Nesting Canada Geese on the Upper Snake River. *Jour. Wildl. Manag.* **13** (1), Jan. 1949: 51–64, fig. 1. (Wyoming)

DERLETH, AUGUST. January song in black-capped chickadee. *Auk* **66** (1), Jan. 1949: 93.

EDWARDS, GEORGE, ERIC HOSKING, AND STUART SMITH. Reactions of some Passerine Birds to a stuffed Cuckoo. *Brit. Birds* **42** (1), Jan. 1949: 13–19, pls. 1–9.

FITTER, R. S. R. Birds robbing other birds of food. *Brit. Birds* **42** (1), Jan 1949: 32.

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Gross, Alfred O. The Antillean Grebe at Central Soledad, Cuba. *Auk* **66** (1), Jan. 1949: 42–52, pls. 4–5. (*Colymbus dominicus*)

Hesterberg, Gene A. Michigan's Second Canada Jay Nest. *Jack-Pine Warbler* **27** (1), March 1949: 3–6, 2 photos.

Hodges, James. A robin rears a cowbird. *Auk* **66** (1), Jan. 1949: 94.

Lawrence, Louise de Kiriline. Notes on Nesting Pigeon Hawks at Pimisi Bay, Ontario. *Wils. Bull.* **61** (1), March 1949: 15–25.

Nichols, John T. Shorebirds and Decoys. *Wood Thrush* **4** (3), Jan.–Feb. 1949: 82–91, illus.

Penot, J. Notes biologiques sur le Cingle plongeur *Cinclus cinclus* (L.). *L'Oiseau et Rev. Franc. d'Ornith.* n.s. **18,** 1948: 141–151, illus.

Skutch, Alexander F. Life History of the Ruddy Quail-Dove. *Condor* **51** (1), Jan.–Feb. 1949: 3–19. (*Oreopeleia montana*)

Skutch, Alexander F. Life History of the Yellow-thighed Manakin. *Auk* **66** (1), Jan. 1949: 1–24, pl. 1. (*Pipra mentalis*)

Van Ijzendoorn, A. L. J. A preening phalarope (*Lobipes lobatus*). *Auk* **66** (1), Jan. 1949: 89–90.

Young, Howard. Atypical copulatory behavior of a robin. *Auk* **66** (1), Jan. 1949: 94.

See also *Food and Feeding Habits:* Ramsay and Cushing.

Food and Feeding Habits

Dennis, John V. Records of Butterflies being used as Food by Birds. *Bird-Banding* **20** (1), Jan. 1949: 51.

Dexter, Ralph W. Aquatic snails eaten by woodcock. *Auk* **66** (1), Jan. 1949: 88.

Mendall, Howard L. Food Habits in Relation to Black Duck Management in Maine. *Jour. Wildl. Manag.* **13** (1), Jan. 1949: 64–101, fig. 1.

Petrides, George A. Ruffed Grouse eats snake. *Wils. Bull.* **61** (1), March 1949: 49.

Ramsay, A. O., and John E. Cushing, Jr. Acquired feeding behavior in mallards. *Auk* **66** (1), Jan. 1949: 80.

See also *Life History and Behavior:* Fitter.

Population (including age, and mortality rates)

Dexter, Ralph W. Banding Studies on the English Sparrow. *Bird-Banding* **20** (1), Jan. 1949: 40–50.

Hodges, James. Another Cause of Mortality in Land Birds. *Bird-Banding* **20** (1), Jan. 1949: 51.

Howell, Joseph C. Comparison of 1935, 1940, and 1946 populations of nesting bald eagle in east-central Florida. *Auk* **66** (1), Jan. 1949: 84.

Lack, David. The Apparent Survival-rate of ringed Herons. *Brit. Birds* **42** (3), March 1949: 74–79. (Banded *Ardea cinerea*)

Lack, David. Family Size in Certain Thrushes (Turdidae). *Evolution* **3** (1), March 1949: 57–66.

Young, Howard. A Comparative Study of Nesting Birds in a Five-Acre Park. *Wils. Bull.* **61** (1), March 1949: 36–47, 3 figs.

See also *Ecology:* Stewart, Wing. *Techniques:* Kimball.

Techniques (including banding)

KABAT, CYRIL, IRVEN O. BUSS, AND ROLAND K. MEYER. The Use of Ovulated Follicles in Determining Eggs Laid by the Ring-Necked Pheasant. *Jour. Wildl. Manag.* **12** (4), Oct. 1948: 399–416, figs. 1–3.

KIMBALL, JAMES W. The Crowing Count Pheasant Census. *Jour. Wildl. Manag.* **13** (1), Jan. 1949: 101–120, 4 figs.

THOMPSON, DAVID H., AND JOHN JEDLICKA. A Method for Correcting Kill Estimates from Waterfowl Banded During the Hunting Season. *Jour. Wildl. Manag.* **12** (4), Oct. 1948: 433–436, fig. 1.

WADKINS, L. A. Dyeing Birds for Identification. *Jour. Wildl. Manag.* **12** (4), Oct. 1948: 388–391.

See also *Life History and Behavior:* Nichols. *Population:* Dexter.

History, Biography, Bibliography, and Institutions

HAVERSCHMIDT, FR. Biographical Notes on the Penard Brothers. *Auk* **66** (1), Jan. 1949: 56–60.

Paleontology

HOWARD, HILDEGARDE. Avian Fossils from the Marine Pleistocene of Southern California. *Condor* **51** (1), Jan.–Feb. 1949: 20–28.

OBITUARY

Dr. Thomas Calderwood Stephens died at Sioux City, Iowa, on November 24, 1948, aged 72 years. A half of his span of life was spent in distinguished service to ornithology. Though taking a degree in medicine, he could not resign himself to reducing this training to practice. A fondness for the biological sciences and an inherited bias for teaching led him to accept the chair of biology at Morningside College. He resigned from the professorship in 1946 after 40 years of continuous duty. He taught also for 16 summers at the Iowa Lakeside Laboratory where classroom instruction was supplemented by field trips to permit his students to learn the habits of birds in their natural surroundings.

The editing of a scientific journal requires not only a broad knowledge of the particular science but unlimited time and patience. In 1925 Dr. Stephens succeeded Prof. Lynds Jones as editor of the Wilson Bulletin and served in this capacity until 1938, a period of 14 years. Dr. R. M. Strong paid a well deserved tribute to these men when he wrote: "Finally, some consideration should be given to the devoted and effective work of the editors of the publications of the Club and especially to Professors Jones and Stephens. . . . Dr. Stephens, taking on the duties of editor, . . .has been conscientous and highly successful." Prior to assuming the editorship he served as President of the Wilson Ornithological Club from 1914 to 1916.

The broad range of his interest in birds is shown by his membership in other societies such as the American Ornithologists' Union, Cooper Ornithological Club, Iowa Ornithologists' Union, Nebraska Ornithologists' Union, Sioux City Bird Club, Iowa Academy of Science, and the Sioux City Academy of Science.

The number of his publications on birds is approximately 75. Living in extreme western Iowa, contiguous to Nebraska and South Dakota, his ornithological activities knew no boundaries. In 1945 he published privately, "An Annotated Bibliography of South Dakota Ornithology." He was engaged at the time of his death on manuscripts covering the ornithological bibliographies of Iowa and North Dakota, the birds of Woodbury County, Iowa, and those of Union County, South Dakota.—A. W. Schorger.

Benjamin Franklin Bolt, as associate member of the Wilson Ornithological Club for 35 years, died in Kansas City, Missouri on January 1, 1949 at the age of 78. He was born on March 26, 1870 in Elmwood, Illinois where at the age of 12, he became interested in ornithology. In the Kansas City region he accumulated a representative collection of birds' eggs and an extensive library on the subject of birds, and was considered the best read man in this section of the country in the literature on ornithology. Mr. Bolt was a quiet, mild-mannered gentleman and a fine companion in the field.—Dix Teachenor.

THE WILSON ORNITHOLOGICAL CLUB LIBRARY

The following gifts have been recently received. From:

R. M. Anderson—1 book
A. J. Berger—1 reprint
L. V. Compton—14 books, 60 periodicals, 638 reprints
David E. Davis—1 book
Adrian C. Fox—1 book
Leon Kelso—1 pamphlet
Emerson Kemsies—1 book
Henry C. Kyllingstad—1 reprint
Robert M. Mengel—1 reprint
Allan R. Phillips—8 reprints
Frank A. Pitelka—1 book, 1 collection of pictures
Katie M. Roads—1 book, 10 reprints
Haven H. Spencer—1 book
Milton B. Trautman—8 reprints
J. Van Tyne—5 reprints
Lawrence H. Walkinshaw—11 reprints

REPORT OF THE TREASURER FOR 1948

Balance as shown by last report, dated Dec. 31, 1947	$180.21	
Receipts, Jan. 1 to Dec. 31, 1948		
Dues:		
Associate	1,562.65	
Active	1,872.90	
Sustaining	695.00	
Subscriptions to *The Wilson Bulletin*	158.75	
Sale of back issues of *The Wilson Bulletin* and of reprints	259.67	
Interest from Endowment Fund	150.97	
Contributions for printing colored plates	50.00	
Contributions to Library Book Fund	43.55	
Gifts; miscellaneous receipts	6.58	
Total receipts		$4,980.28
Disbursements		
The Wilson Bulletin: printing, engraving, mailing	$3,442.26	
Purchase of back issues of *The Wilson Bulletin*	176.69	
President's expense: printing, postage	33.05	
Editor's expense: reprints, postage, secretarial aid	462.51	
Secretary's expense: stationery, postage, clerical aid	205.01	
Treasurer's expense: stationery, postage, clerical aid	219.93	
Membership Committee's expense: postage, printing	292.42	
Contribution to European Ornithologists Relief Fund	50.00	
Purchase of books for Library	12.25	
Dues to Ecologists Union	4.00	
Bank charges: taxes and foreign exchange	4.36	
Total disbursements		$4,902.48
Balance on hand in Citizens Fidelity Bank and Trust Co., Louisville, Kentucky	77.80	
LOUIS AGASSIZ FUERTES RESEARCH GRANT FUND (special gift)	400.00	
S. MORRIS PELL FUND (special gift)	100.00	

ENDOWMENT FUND

Cash balance in savings account, Dec. 31, 1947	$1,231.44	
Received during year:		
Interest on U. S. bonds and on savings account	150.97	
Life Membership payments	500.00	
Gift from Jennie N. Putnam Estate	500.00	
Sale of U. S. Savings Bonds, Series C, dated Aug. 1, 1938	1,075.00	
Total		$3,457.41

Transferred to checking account (interest)	150.97		
Purchase of U. S. Savings Bonds, Series G, dated June 1, 1945	500.00		
Purchase of U. S. Savings Bonds, Series F, dated Apr. 1, 1948	1,480.00		
Purchase of U. S. Savings Bonds, Series F, dated Oct. 1, 1948	1,073.00		
Bank charge (State tax)	.15		
Total		$3,204.12	
Balance			$253.29
Bonds:			
U. S. Postal Savings Coupon Bonds, dated July 1, 1935			780.00
U. S. Savings Bonds, Series G, dated Sept. 1, 1943 (maturity value, $1000.00)			949.00
U. S. Savings Bonds, Series G, dated Dec. 20, 1944 (maturity value, $1500.00)			1,420.00
U. S. Savings Bonds, Series G, dated June 1, 1945 (maturity value, $500.00)			474.00
U. S. Savings Bonds, Series G, dated July 1, 1945 (maturity value, $900.00)			855.90
U. S. Savings Bonds, Series G, dated Oct. 1, 1945 (maturity value, $1400.00)			1,331.40
U. S. Savings Bonds, Series F, dated Feb. 1, 1947 (maturity value, $2000.00)			1,490.00
U. S. Savings Bonds, Series F, dated Apr. 1, 1948 (maturity value, $2000.00)			1,480.00
U. S. Savings Bonds, Series F, dated Oct. 1, 1948 (maturity value, $1450.00)			1,073.00
Total Endowment Fund			$10,106.59

Note: Bonds are listed at their present redeemable value.

Respectfully submitted,

BURT L. MONROE, *Treasurer*

December 31, 1948

Approved by Auditing Committee

R. ALLYN MOSER

MILTON B. TRAUTMAN

Recommendations for Preparation of Manuscripts

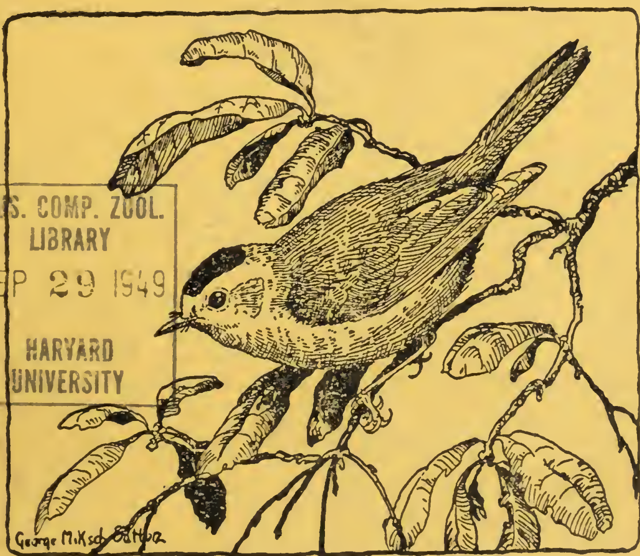
Manuscripts should be typed on one side of white paper of good quality with title and author's name written on a separate sheet. Everything should be double-spaced and each table should be typed on a separate sheet. Figures, not words, should be used for all numbers (except at the beginning of a sentence). Sex ratios should be calculated as % males. Express data in quantitative and tabular form, wherever possible, and when giving averages, also give the standard deviation. The technical names of the A.O.U. Check List (4th edition), as corrected in the supplements, should be used. Unless specimens have actually been identified to subspecies, only the specific name should be used. Whenever possible a reference for technical names of plants should be listed. Literature should be listed at the end of the article in accordance with the style in previous issues. All articles should have a summary. Authors should avoid footnotes and vernacular phrases. Illustrations should have good contrast. Printing on charts and maps must be large enough to permit reduction. Cuts of figures will be destroyed unless author requests their return on the reprint order form.

Aj-W

September 1949

VOL. 61, NO. 3 PAGES 129–208

The Wilson Bulletin



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The Wilson Ornithological Club

Founded December 3, 1888

Named after Alexander Wilson, the first American ornithologist.

Membership dues per calendar year are: Sustaining, $5.00; Active; $3.00; Associate, $2.00. The Wilson Bulletin is sent to all members not in arrears for dues.

Wilson Ornithological Club Library

The Wilson Ornithological Club Library, housed in the University of Michigan Museum of Zoology, was established in concurrence with the University of Michigan in 1930. Until 1947 the Library was maintained entirely by gifts and bequests of books, pamphlets, reprints, and ornithological magazines from members and friends of the Wilson Ornithological Club. Now 2 members have generously established a fund for the purchase of new books; members and friends are invited to maintain the fund by regular contributions, thus making available to all Club members the more important new books on ornithology and related subjects. The fund will be administered by the Library Committee, which will be glad of suggestions from members on the choice of new books to be added to the Library. Harold F. Mayfield (2557 Portsmouth Avenue, Toledo, Ohio) is Chairman of the Committee. The Library currently receives 65 periodicals, as gifts, and in exchange for *The Wilson Bulletin.* With the usual exception of rare books in the collection, any item in the Library may be borrowed by members of the Club and will be sent prepaid (by the University of Michigan) to any address in the United States, its possessions, or Canada. Return postage is paid by the borrower. Inquiries and requests by borrowers, as well as gifts of books, pamphlets, reprints, and magazines, should be addressed to "The Wilson Ornithological Club Library, University of Michigan Museum of Zoology, Ann Arbor, Michigan." Contributions to the New Book Fund should be sent to the Treasurer, Burt L. Monroe, Ridge Road, Anchorage, Kentucky (small sums in stamps are acceptable). A preliminary index of the Library's holdings was printed in the September 1943 issue of *The Wilson Bulletin,* and each September number lists the book titles in the accessions of the current year. A brief report on the recent gifts to the Library is published in every issue of the *Bulletin.*

The Wilson Bulletin

The official organ of the Wilson Ornithological club, published quarterly, in March, June, September, and December, at Baltimore, Maryland. In the United States the subscription price is $2.00 a year. Single copies, 50 cents. Outside of the United States the rate is $2.25. Single copies, 60 cents. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available at 50 cents each and may be ordered from the Treasurer.

All articles and communications for publication, books and publications for review should be addressed to the Editor. Exchanges should be addressed to the Wilson Ornithological Club Library, Museum of Zoology, Ann Arbor, Michigan.

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WILSON ORNITHOLOGICAL CLUB NEWS

The Tenth International Ornithological Congress will be held in Uppsala, Sweden, June 10–17, 1950. A program of papers and excursions is being planned by the Ornithological Society of Sweden. Details may be obtained by writing to: Tenth Ornithological Congress, Uppsala, Sweden.

A federation of 17 local bird clubs in New York State was formed at an organization meeting in Amsterdam, N. Y. in October, 1947. The first annual meeting was held November 13–14, 1948 at Rochester with an attendance of 125. Dr. Gordon M. Meade was elected president.

An International exhibition of Nature Photography will be held at London, England from March 17 to April 3, 1950. Information and entry forms may be obtained from: Miss Phyllis Barclay-Smith. ℅ Country Life, 2–10 Tavistock Street, Covent Garden, London, WC2, England.

LIFE MEMBER

Robert T. Moore has a wide range of interests including fox-breeding, poetry, exploration, conservation, and particularly ornithology. Although his residence is near Onawa, Maine, he spends much time in research at California Institute of Technology at Pasadena. His studies concern principally the taxonomy of Mexican birds. He graduated from University of Pennsylvania, obtained a Master's at Harvard, and an Honorary D. Sc. from Occidental. He is an active member of numerous ornithological and conservation organizations.

Erratum: Vol. 61, No. 2; p. 71, line 5: for 211 read 180.

THE PRESIDENT'S PAGE

Wilson Club members who consider themselves amateur ornithologists are strongly urged to make contributions to our knowledge of bird life. Though they may not realize it, they are quite capable of adding substantially to existing information. Too often the erroneous notion prevails that any contribution, to be important, must be based on weeks of concentrated study, must deal with a rare species, and must involve an expensive expedition. Actually, a worthwhile contribution can be obtained in a few hours of observation on a common species near home.

Among the dozens of gaps in our knowledge of common birds, the following are mentioned specifically in order to demonstrate the variety as well as the ease with which they may be filled.

Length of incubation period. The exact length of the incubation period is definitely known in relatively few species. By noting when incubation starts and when eggs hatch, the period can be measured by counting the intervening hours.

Length of nestling life. In only a small number of altricial species do we know the exact number of days spent by young birds in the nest from the day of hatching (usually called 0 day). The time involved can be determined simply by marking each nestling at hatching and visiting the nest at frequent intervals as the estimated day of nest-leaving approaches.

Daily activity rhythms. We have only scattered data concerning the minute to minute activities of wild diurnal birds from break of day to dusk. When opportunity permits, the movements of individual birds can be followed and recorded in detail with special attention paid to periods of feeding and sleeping.

Size of clutch. Much information is desired on the number of eggs in clutches of different species and the external factors which cause variation within species. For example, it is believed that smaller clutches are laid at the end of the season and that cold weather reduces the size of the clutch. Upon finding nests with eggs, a record can be kept of the number finally laid, the time of the year, and the average weather conditions that occurred during the egg-laying period.

Where diurnal birds spend the night. Our knowledge of where day birds roost at night is very meager. By watching the movements of individual birds as darkness approaches, it is often possible to discover their roosting sites.

Water requirements. Apparently some species of birds drink and bathe, while others drink but do not bathe, and *vice versa.* Amateur ornithologists who maintain bird baths have an excellent chance to find out how different birds use water. At present we are not certain of the water requirements of the majority of species.

Members desiring further instructions either in following the above suggestions, or in pursuing problems of a similar nature, may obtain them by communicating with Dr. Charles G. Sibley, Chairman of the Research Grant Committee, Museum of Natural History, University of Kansas, Lawrence, Kansas.

Olin Sewall Pettingill, Jr.

A FAMILY-SIZED FLOCK OF CANADA GEESE

ROLE OF THE FAMILY IN THE FORMATION OF GOOSE FLOCKS

William H. Elder and Nina L. Elder

THE organization of birds into flocks must have intrigued man since time immemorial. One who sees a wedge of geese emerge from the gray murk of an early morning is impressed by the strength of the bond which holds the birds together. But the nature and meaning of that bond has not yet been thoroughly explored.

Our purpose in this paper is not only to draw together the scattered bits of evidence concerning the nature of the bond holding the members of a goose flock together but also to add our own observations indicating that the flock is a family. We wish to point out how this information may possibly be used as an index of annual fluctuations in productivity. Finally, we wish to explore the possibility of using counts of small flocks of geese, made after the open season, as a measure of the hunting pressure sustained by the population. This study was suggested by Arthur S. Hawkins. To Aldo Leopold we are indebted for generosity with his data and for the stimulation of his advice. Part of the data we gathered while the senior author was an employee of the Illinois State Natural History Survey.

The significance of the organization of birds into flocks has been questioned and discussed by many writers, among them Huxley (1916), Allee (1923, 1931: 342), Sherman (1924), Leopold (1933: 119), and Darling (1938a: 81). Trowbridge (1914) has postulated survival significance for the echelon flight pattern shown by migrating flocks.

The question, "Is the flock a family?" has brought comment from many observers, especially those interested in waterfowl. Alpheraky (1905: 2) states categorically, "Geese pair for life, i.e., they are genuine monogamists, and both parents show equal solicitude for their progeny . . . from individual pairs or families of geese (broods) are usually formed considerable flocks, the members of which carry out their wanderings and migrations together." One wishes that the nature of the evidence had been explained. But Alpheraky's statements have been confirmed in part for the genera *Anser* and *Casarca* by Heinroth (1911) and Lorenz (1935). When Pike (1902) killed 5 from a flock of 6 Bean Geese he found them to be an adult pair with 3 young. Darling (1938b: 28), speaking of a large flock of Barnacle Geese, makes the following statement: "The birds rose in a cloud into the gold of the dying sun, and we could see through our binoculars that the string formation of what I believe are separate families, was kept within that great concourse." Witherby (1939: 181) reported that Grey Lag Geese also appeared to be still in family groups in spring. In passerine birds, flocks of some species may retain families as entities (Whittle, 1926), while in other species, followed by means of colored bands (Butts, 1931, Odum, 1942), flocks were found not to be composed of families.

On the North American continent we have a splendid opportunity to watch flock organization, for in several of our species of waterfowl the young may be clearly distinguished by their plumage. McAtee (1924) mentioned that he had seen hundreds of families of swans, their composition being easily distinguished —2 white-necked birds accompanied by 2 to 5 gray-necked ones. Bailey (1928), in observing Lesser Snow Geese (*Chen h. hyperborea*) on the wintering ground in Louisiana, found that each huge flock seemed to be made up of family groups, ". . . instead of a great band of individuals, it was composed of hundreds of groups of 3, 4, 5, . . ." Again, Bailey and Wright (1931) noted that in dense flocks observed in the same region ". . . the dark colored young were numerous (in fact, the big flocks appeared to be formed of family groupings). . ." Rowan (*in litt.*) has noticed the same phenomenon in this species in Alberta. The same groupings have been observed in the Greater Snow Goose (*C. h. atlantica*) by Howard (1940), while McIlhenny (1932) has given us a careful description of the behavior of family groups in Blue Geese, strongly indicating that parental care and defense of young are maintained on the wintering ground.

In the genus *Branta*, young of the year cannot be distinguished by their plumage unless the bird is in the hand (Elder 1946a); consequently, evidence concerning the persistence of the family group is more difficult to obtain in this genus. Most of our general works on birds state that Canada Geese (*B. canadensis*) mate for life, that the young migrate with their parents, and that the flock is invariably led by an old gander; but none, as far as I have discovered, presents any supporting evidence except what could be adduced from captive birds.

Occasional statements by early ornithologists give evidence of family groups in wild Canada Geese as shown by their behavior. Mackay (1896) says that when a flock alights on a pond it breaks up into families at once, "each gander and goose with their young keeping together, the gander leading." Bishop (1901), Phillips (1910, 1922), Miner (1923: 114–115, 121), McAtee (1924), and Trautman (1940: 96) have witnessed similar behavior. One who spends much time watching geese sees convincing examples of family bonds persisting in winter. Once we watched 4 Canada Geese feeding together and moving slowly through a large, loose flock of the same species resting in a winter wheat field. Two of the 4 birds carried our colored bands, showing that one was an adult gander, the other a juvenile goose. As the group passed very near to other geese they received the usual postural and vocal challenges. The red-banded juvenile and what was assumed to be her sibling invariably gave way to any challenger, while the other 2 birds, one of which was the banded adult gander, advanced to meet the challenger in every instance.

On 2 occasions while we were stationed at Horseshoe Lake Refuge in southern Illinois, small groups of geese wandered into deer traps operated on the island. In each case cloacal examination (Elder, 1946a) proved that the group trapped together consisted of an old pair and 2 or 3 young. More than once Phillips (1916) observed the killing of an entire small flock of Canada Geese at a shooting stand in Massachusetts. Here again, the flock was found to consist of an adult pair with several young. Jack Miner (1923: 121) cites an instance of a small flock of geese caught and banded by him in one group, and later shot in one group, the bands all being returned to him.

Another convincing line of evidence supporting the belief that goose families remain intact during migration is supplied by the many instances of badly shot up flocks circling and returning to the spot where their companions had fallen to the guns. Bishop (1901), speaking of Canada Geese in North Carolina, states ". . . if both old birds are shot the young will return to decoys, but if 1 old bird escapes it will guide the young to safety." Phillips (1916) records the same behavior of Canada Geese in Massachusetts and believes that the return of the remaining birds in the flock is due to sudden loss of leadership with the death of the parents in the first volley. This behavior often enables the gunners to bag an entire small flock of geese. Bent (1925: 219) records the same behavior in Canada Geese, Black Brant and Emperor Geese.

The evolutionary significance of the flock as a family unit is brilliantly discussed by Mayr (1942: 242). Basing his conclusions upon the work of Heinroth (1911) with *Anser* and the unpublished notes of James Moffitt, Mayr states: "Geese are among the very few birds in which the family does not break up at the end of the breeding season, but parents and the young stay together for nearly a year. They migrate together to the winter quarters, they spend the entire winter together, and they do not separate until after the return to their nesting area." He goes on to point out that as a result of this social segregation and geographic isolation there is extreme inbreeding of small populations, concluding that "No other arctic or subarctic bird breaks up into so many pronounced races as the geese."

Since Canada Geese tend to move in much smaller flocks than do Blue and Snow Geese, it is easy to make accurate counts of the birds seen. One of us counted while the other recorded every small flock that passed; we thus tabulated flocks both in migration and in local feeding flights. One group of counts of flocks engaged in local flights at Horseshoe Lake Refuge in Illinois was made before the opening of the hunting season, another after its close. Counts for each period were tabulated separately so that the percentage of flocks of each size could be plotted graphically (Figs. 1 and 2).

Upon a more thorough perusal of the literature we found that Phillips

(1916) had gathered similar data for the same purpose some 30 years earlier. Because his paper was not cited by any of the authors mentioned in our review of the literature above, it seems apparent that the title of his paper, "Two Problems in the Migration of Waterfowl," so obscured its content that it had been overlooked. We therefore take this opportunity to present his data again (Fig. 1). In all graphs, flocks numbering more than 20 birds have been excluded because of the difficulty in getting accurate counts of larger flocks.

Of nearly 300 flocks of Canada Geese counted by Phillips (Fig. 1) as they

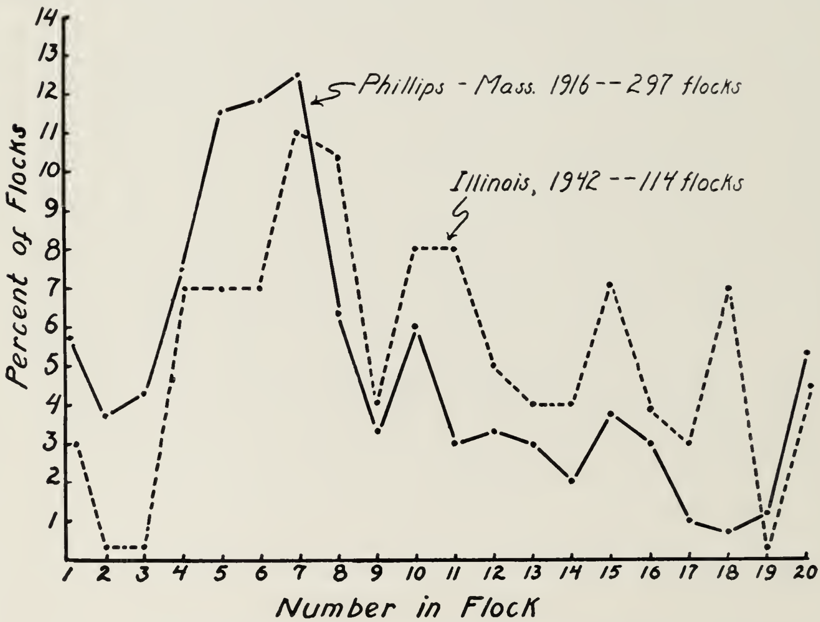

FIG. 1. Size of Flocks of Canada Geese in fall migration.

passed over his shooting stand in Wenham, Massachusetts, by far the greatest number were small groups of 5, 6, or 7 birds or approximate multiples of these numbers. Hundreds of brood counts made by Williams and Marshall (1938) establish that the mean size of a clutch in this species is between 4 and 5. This fact supports Phillips' conclusion that "It is hardly necessary to state that the apex of this curve at 6 or 7 represents the average size of a family of Canada geese. . ."

When we plotted the counts of the 114 small flocks which we saw in migration in Illinois (Fig. 1), we found a surprising similarity between Phillips' curve and our own, not only in the peaks representing the one-family size flock but also, apparently in the rest of the curve. Whether or not the other peaks have real significance we cannot say; but it seems highly probable that they represent aggregates of 2 or more families. If this is true, the smaller the flock (say, 5) the more likely it is to join or accept union with another flock—hence accounting for the peaks at 10 and 15.

To discover whether the extreme hunting pressure and unusually heavy kill of geese at Horseshoe Lake, previously reported (Elder 1946b), were reflected in family or flock size, we made a large number of counts before and after the

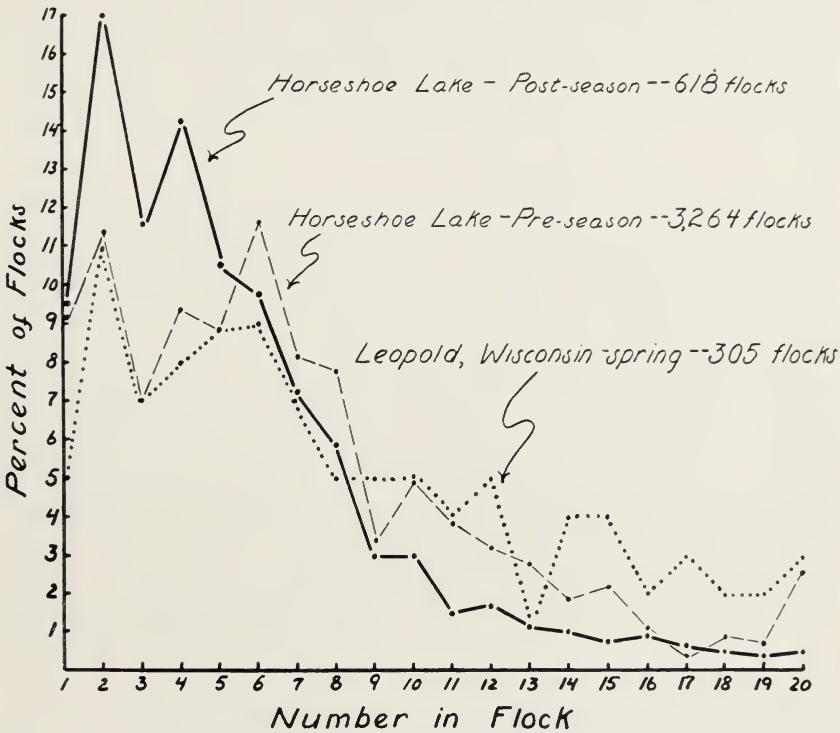

FIG. 2. Size of Flocks of Canada Geese in local movements. Pre- and post-season refers to counts made before and after the hunting season, October 15 to December 13, 1942.

shooting season. The broken line in Fig. 2 shows the distribution of more than 3,200 flocks counted before the season opened. Again, a sharp peak is found at the family-size flock of 6.

In the 618 flocks counted after the close of the shooting season (Fig. 2) we see that the family-size peak has shifted from 6 to 4. That this change indicated a great loss of young geese due to shooting was confirmed by a bag-sample of 761 birds containing 5 juveniles per adult pair. In contrast, among the 1,028 geese we trapped and banded, mostly after the hunting season had closed, there were only 3 juvenile birds per adult pair. (These adults undoubtedly included some 2-year old geese as yet unmated and with no young—*cf.* Elder 1946a).

Another distinct difference in the curves presenting pre- and post-hunting season flock counts is the sharp increase in the number of pairs seen. We do not believe that this is due to pair formation prior to the spring migration, but rather to an increase in number of pairs that had lost all of their young during the fall season of heavy kill.

After 1925, when Jack Miner (1932) first began banding Canada Geese in fall as well as in spring, his returns showed that the geese nesting on the west coast of James Bay, passing through his sanctuary in fall to winter in southern Illinois and Missouri, returned to the north in spring not through his sanctuary but more to the west, in Michigan and Wisconsin. This was confirmed by returns from our own banding. The difference in the spring and fall routes is easily seen in Wisconsin where goose flocks are scarce in fall but numerous in the spring flight. It is very probable that the counts made by Aldo Leopold (unpublished) at his hunting shack on the Wisconsin River were actually of the same population that we studied at Horseshoe Lake Refuge. In any case, the flock-size distribution plotted from his data (Fig. 2) shows the same curve as do the pre-hunting season data from Illinois.

In comparing the graph of flocks seen in migration (Fig. 1) with that of flocks engaged in short flights between loafing areas and feeding grounds (Fig. 2) one clear difference appears: there is a much greater percentage of ones, twos, and threes in local movements than in migratory flights. Seemingly geese may go to feed or gravel either alone or in twos or threes, but before starting migratory flights they join other flocks. The abundance of these small groups is undoubtedly due to the extreme shooting pressure on all sides of the Horseshoe Lake Refuge; the percentage of shot-up, fragmentary flocks may be even higher than the graph shows, for some undoubtedly may join family groups on their way to feed. This would explain why the peaks at multiples of family size (10 and 15) are so much more prominent in Fig. 1 than in Fig. 2—the former representing flocks not yet subjected to much shooting. Phillips (1916) believes that the existence of any migrating flock of 1, 2, 3, and probably 4, is the result of shooting.

Another factor possibly contributing to the abundance of pairs seen in local movements may be the habit which Jack Miner (1923: 122) describes—adult geese occasionally leaving their young "but seldom for more than an hour."

Due to the kindness of Dr. Harrison F. Lewis (*in litt.*) we present in Figure 3 data from another species, the Brant, *Branta bernicla*. This curve was drawn from counts of 83 small flocks seen by Dr. Lewis and Mr. C. Doire, May 24–June 14, 1935 at Seven Islands Bay, Saguenay County, Quebec. We again see in this curve 3 general peaks which may represent family size and multiples thereof.

Before concluding, we wish to suggest one more factor which may affect the curve of flock-size frequency distribution: the possibility that after the young are fledged the parents may readmit to the family circle the sub-adult, non-breeding young of the previous year's brood. This has been observed by Jenkins (1944) in crowded captive geese and by ourselves in captive Whooper Swans (*Cygnus cygnus*); but Sherman (1924) was of the opinion that in both geese and swans "... the bonds between parents and young are of very short duration, and that those between mated birds are of the most tenuous sort." However, all of these observations are from captive birds and it would be dubious at best to extrapolate to the wild for it has been our experience that the degree of crowding of captives markedly affects their social organization.

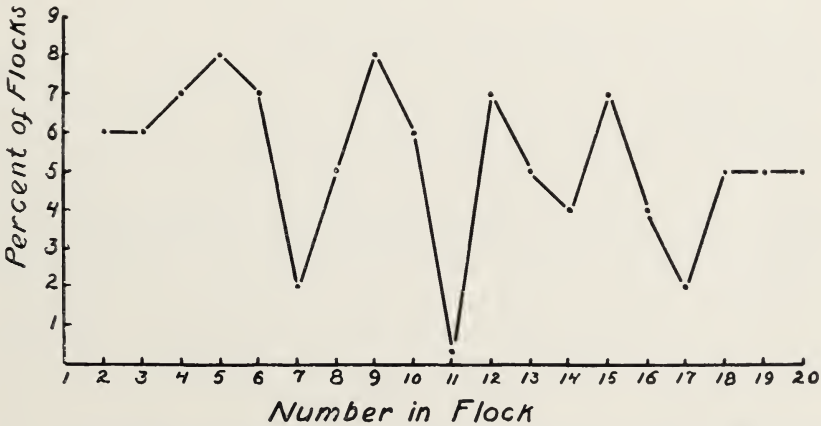

FIG. 3. Size of Flocks of Brant counted by Harrison F. Lewis and C. Doire, May 24 to June 14, 1935, Saguenay County, Quebec.

SUMMARY

We believe we may be certain that the small goose flock is usually a family and that larger flocks are frequently multiples of families rather than mere aggregations of individuals, as are flocks of ducks.

It seems likely that a count of several hundred small flocks arriving at a refuge in the fall might be a good index of the success of that year's hatch. Since the peaks in 4 of the curves presented correspond so closely, we think it likely that productivity in Canada Geese is very nearly constant from year to year. This is in sharp contrast to the productivity in Blue Geese, which in some years produce few or no young (McIlhenny 1932, Smith *in litt.*).

Finally, a comparison of the flock-size most frequently occurring before and after the shooting season may give a measure of the shooting pressure sustained by that population. It would indeed be interesting to see a frequency distribution curve for migrating *spring* flocks.

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THE LIFE HISTORY OF THE CEDAR WAXWING

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Introduction

THIS observational study of the Cedar Waxwing (*Bombycilla cedrorum*) began in 1939 and continued throughout 5 additional summers. The objective has been to determine the relationships between members of the pair, between the pair and other members of the population, and between the population and the environment, correlating these phases into the whole of the breeding behavior of the waxwing.

The Peach Point area, in which the major part of the study was carried on, is a small peninsula extending from the north central part of South Bass Island, which lies in Lake Erie, north of Sandusky, Ohio. The area is not on the main migration path, and waxwings are not common in this locality until the nesting population arrives. Peach Point is a park type area consisting mainly of closely spaced summer homes. At the base of the peninsula is an old orchard which slopes toward Terwilliger's pond to the south. West of the orchard is a dense second growth woods which was largely bypassed by the birds in their activities. The most abundant tree is cedar (*Juniperus virginiana*), although hackberry (*Celtis occidentalis*) and maple (*Acer* sp.), as well as domestic fruit trees and mulberries (*Morus alba*, *Morus rubra*), are common.

The collection of data for this paper has been largely a matter of field observation during 6 seasons from 1939 through 1946. No data were taken during 1943 or 1944. Several thousand hours have been utilized in an attempt to make the data quantitative with as many as 170 hours being devoted to 1 nest. In spite of this, weakness in certain data is apparent. Unless otherwise stated general descriptions of behavior have been supported by 25 or more observations. All hours are given in solar time.

The plan of work has been to survey the study area early in the season, determine the nesting population, and follow it and the individual pairs through the breeding season. Since the solution of many of the problems depended upon the identification of individual birds, much time and effort were spent in attempts to trap and band them. Feltes (1936) was able to trap numbers of waxwings from winter flocks in California, but lacking the favorable baiting conditions of his situation, other means had to be developed in the present study. Two methods have been used: the first using a nest trap and the second a drop trap.

The nest trap was cylindrical in shape, had a diameter of about 9 inches, and a height of about 10 inches. A trap door in 1 side was hinged at the top and closed downward. The trap was placed over the nest with the door facing the normal path of the birds to the nest, and the bottom was closed with cloth netting. The most favorable trapping period was from 5 to 8 days after hatching, before the lag in attention by the female. It is desirable to place the trap on the nest at least a day before trapping. The birds were best trapped in the morning; both sexes should not be trapped on the same day. If the birds can be identified, trapping the female first is believed desirable. Before this method was refined, a successful trapping of the pair was accomplished in about 13% of attempts. Later, success was obtained in 67% of attempts.

The drop trap involved baiting with nesting materials. This method proved workable in 50% of attempts and is more simple to put into effect. Its difficulty lies in the fact that the pair must be located and trapped on the days, usually the second and third, during which the birds are most active in building. At best both methods leave much to be desired.

Since the work extended over several years, numbers which facilitated identification of nests were designed. The first figure indicates the year, the second the number of the nest, and the letter indicates the first or second nest of a pair known to raise 2 broods during the season, e. g., 46-09B; 1946, nest 9, second nest. To supplement field notes 9 young waxwings were taken from their nests during the summer of 1941 and confined until the fall of 1942. A comparative study of the caged young and of wild waxwings was made.

The production of this paper has been encouraged by Dr. T. H. Langlois. Dr. Charles F. Walker has contributed immeasurably by his stimulating guidance and thoughtful criticism. Plants were identified by Dr. R. B. Gordon. Statistical assistance was given by Dr. D. R. Whitney and Mr. R. S. Gardner of The Ohio State University Statistics Laboratory. The figures were drawn by Mr. Robert H. Albertin. Mrs. Mildred M. Putnam assisted in the field on many days, as well as in the preparation of the manuscript. This is a contribution from Franz Theodore Stone Laboratory, Ohio State University, Put-in-Bay, Ohio. Botanical names follow Core (1948).

Migration and Movements

The Cedar Waxwing is an erratic winter resident in northern Ohio. Jones (1910) noted occasional flocks in the lake area and described their winter occurrence in the larger Lake Erie Islands. Waxwings have been noted at Put-in-Bay many times throughout the non-breeding season. During the winter of 1941–42 small flocks, usually not exceeding 6 individuals, frequently perched near or on the cage of the captive young; however, the wintering population in this region is small and according to Charles F. Walker could account for only a fraction of the local nesting population. Banding efforts so far have failed to yield information regarding the wintering range of Put-in-Bay waxwings. Study of the recovery records (Lincoln, 1929, 1936, 1939; Cooke, 1937; Bryens, 1943) in addition to migration reports indicate that the movement of waxwings is considerable both in area and numbers. Typical of such reports are those of Scott (1889) who observed large flocks in April and May along the Gulf Coast of Florida and Brown (1906) who saw on February 3, 1905, at Camden, South Carolina, migrations of robins and waxwings at an estimated rate of 14,000 per hour.

The nesting population usually arrives at Put-in-Bay during the latter half of May. In 1942 numbers of birds were noticeable on May 24, and 3 nesting attempts were observed by May 28. In 1946 the main migration was about May 30. The first fairly well built nest was found on June 6, and 2 were started on June 7. The season was retarded in 1947, and the waxwings did not arrive in numbers until June 6. The first nest building was seen on June 13. Only 2 of 54 banded adults returned, while none of 174 young ever has been reported again. The 2 adults were both males which returned in 1946 from a group of 10 adults banded in 1945. Eighteen adults were banded in 1946 and none of these was seen during the 1947 breeding season. The breeding population of this area varied somewhat during the time of study. The largest number of pairs nesting simultaneously was 15 in 1941 and the smallest was 8 in 1942

The birds are dependent upon the seasonal fruits and berries which abound, and their activities throughout the summer shift over the area in relation to the development of these food plants. The earliest birds, in late May and early June, feed principally in the laboratory region upon the cedar berries and such hackberries as may still be available from the preceding year. Soon thereafter feeding shifts to the sour cherries (*Prunus Cerasus*) in the Chandler yard, and when these cherries are exhausted, the concentration of feeding changes to the mulberry (*Morus alba*) at the laboratory. After this, flights are started to the red mulberry (*Morus rubra*) at Lescheid's, some distance away. Throughout the season waxwings also feed on Gibraltar Island, earlier on cedar berries and hackberries and then on shadbush berries (*Amelanchier sanguinea*) and choke cherries (*Prunus virginiana*). By the time these fail, the elderberries (*Sambucus canadensis*) along the lake shore and the black cherries (*Prunus serotina*) at Chandler's are ripening, and the birds feed on them. In late August flocks of 20 to 50 waxwings are often seen flycatching among the trees.

Formation of Pairs

The rapid formation of pairs after the first appearance of the birds and the early onset of nest building would indicate that pair formation may take place in the flock, or, at least, must originate in the flock and be completed soon after arrival, as appears to occur in some other species (Blanchard, 1941: 42; Odum, 1941; Davis, 1941; Thomas, 1946: 147).

Pairing behavior in waxwing flocks has been noted by several observers.

Warren (1890) mentioned "billing and pluming" between members of a spring flock, although Grinnell (1901) noted no attempts at pairing. Feltes (1936) reports courtship hopping and copulation in April in a migratng flock in California. Allen (1930) indicates that waxwings "get acquainted" with their mates in flocks. Shaw and Culbertson (1944) found both males and females in about equal numbers in a wintering flock in California, a condition which would facilitate pairing. On April 17, 1947, Mr. Douglas Stancombe reported seeing 2 pairs of waxwings from a flock of 30 at Columbus, Ohio, hopping back and forth and passing food. Two additional personal observations of this occurred in the same flock before May 1. Hopping and food passing were noted in the captive young in April 1942.

Although information regarding pairing behavior is not complete, observations of 7 pairs of waxwings which nested in the area (Fig. 1), supplemented by more than 30 other field notes, indicate that recognition involved in pairing is based on sexual differences in behavior. For example, on June 9, 1946 in a group of 6 waxwings 1 bird was observed to approach a second by the characteristic sidewise hopping, which is mentioned below under "Courtship". The second bird gave no response. The first waxwing then hopped toward a third bird which responded by hopping and a few minutes later they flew together. On another similar occasion 5 waxwings perched on the wires in the road area (Fig. 1) and performed as follows. Bird A approached B. B responded with a threat display, which involves forward tipping and lowering of the body, partial fluffing of feathers, and raising of the crest while the head is held close and the beak, which may be snapped quite vigorously, is opened. A then retreated and approached C. C retreated and flew about 2 feet away. Bird A finally approached D and was greeted by a strong threat followed by an attack, and A was driven off and left the area. D circled, returned, flew up to E and hopped. E responded by hopping. D and E then flew up to Nest 46-03 and B and C flew off together. In this same area (at a later date, July 2) the Nest 46-10 male was at his guarding perch and a second bird was below on the wires. This situation continued for about 5 minutes until the second bird gave several side hops. The guarding male at Nest 46-10 immediately attacked and drove the hopping waxwing from the neighborhood.

In the captive birds many observations of pairing tactics were made. On April 13, 1942, notes show that during the day Spike obtained food and hopped at various times to Chirp, Doc, and Butch. All 3 accepted the food and entered into the courtship dance. When Spike approached Dude on 2 occasions he encountered the threat display. Dude, however, was noted hopping with Butch in which case Dude was the instigator. Spike later proved to be a male and Butch a female, and although the sex of Dude never was known definitely, it probably was male. In these and other cases the bird instigating the court-

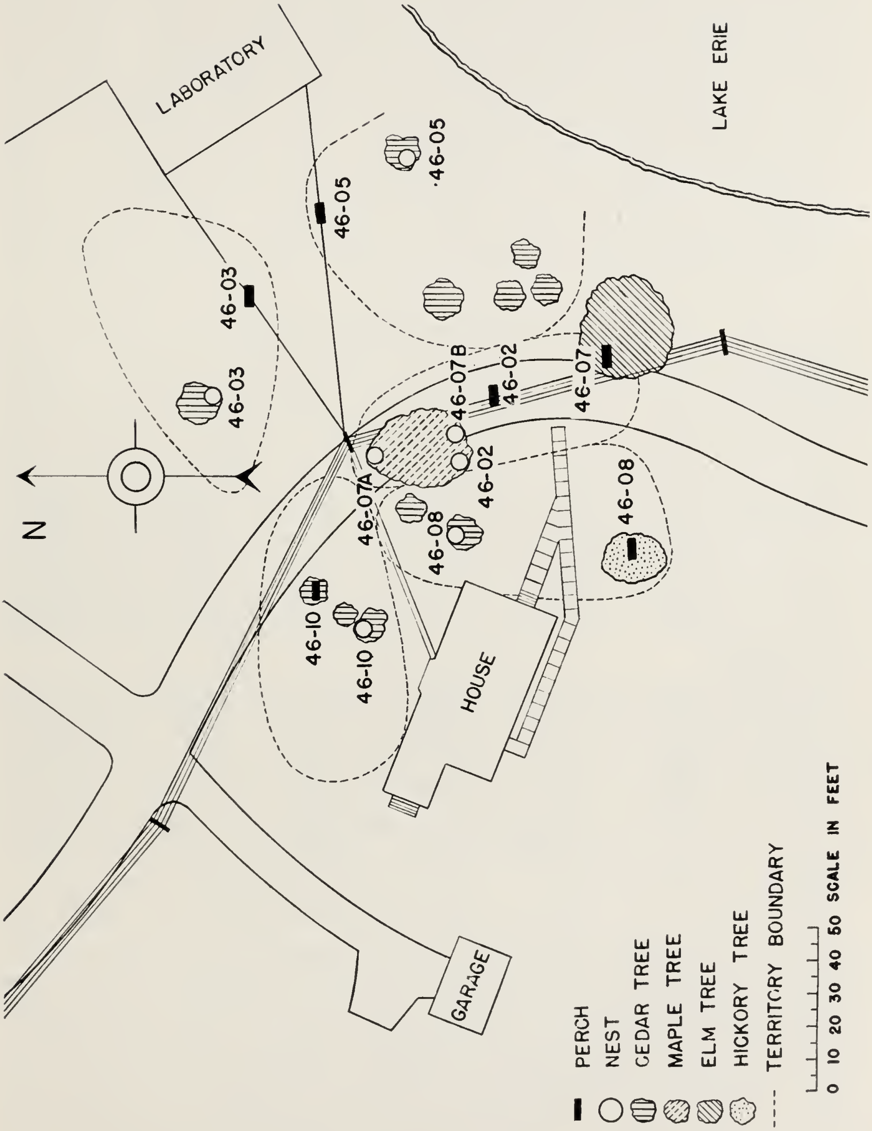

Fig. 1. Sites of nests near Laboratory, 1946

ship or pairing behavior was assumed to be a male. Females may respond by no movement, may retreat, or may return the hopping. In some cases, possibly when mated and on territory, females may give a threat display, since at least 3 notations describe females attacking strange males in a nest area and 1 describes an incubating female giving the threat display from the nest to a strange male. Breeding males probably respond by threat display or attack, and in either case the approaching male retreats. Additional evidence that the sexes behave as described might be drawn from the fact that in 7 cases of renesting (discussed later) where the pairs were banded, instigation of the courtship dance was seen only in males and completion of the dance occurred only when females responded by hopping. The precise point at which pairing may be said to be completed remains somewhat conjectural. Presumably pairing is complete when the female continues to reciprocate the hopping of the male and the birds remain in almost constant association. The soft vibrating "courtship note" is heard constantly and occasionally the sharper "location call" is given if the birds are separated. If the "location call" is not answered, it is repeated with greater intensity until the mate responds, whereupon the separated bird flies speedily to the mate. Such short separations, not over 2 or 3 minutes, frequently culminate in a burst of energy exhibited in fast circular flights about the nest area and often precede the courtship dance. Which of the sexes leads in the flight remains unknown. These flights may represent a critical point in the process of pair formation. In some early-season observations of hopping, the ceremony appeared to exhaust itself without resulting in such flights.

The retardation of breeding activities in 1947 gave opportunity for verification of pairing behavior. Flock behavior was noted in the mornings and evenings from June 9 to 12 when the birds gathered and fed on the staminate flowers of a mulberry tree. During the day, however, they broke into small groups of 2 to 6, and in these groups pairing behavior was noted frequently. By June 12 pairs were perched about in situations suggestive of nesting. Building was noted on June 13.

Pairs probably stay together through the breeding season. The pairs listed in Table 1 are known to have done so. In several cases in which pairs have been broken up during the nesting cycle, the females have completed caring for the young through fledging and for several days after. None of the separated members of these pairs was found renesting during the same season. That a rather strong bond exists between the pair is additionally indicated by the behavior of the birds when separated or during trapping. In at least 15 instances 1 bird has flown close and given the anger note when the mate was handled. The free bird perched near, gave the disturbance note, and flew rapidly to the banded bird when it was released. At Nests 45-10 and 46-11 when the males disappeared the females gave the disturbance note for the next 2 days.

The types of mating based on sex recognition described by Lorenz (1937) are reviewed by Tinbergen (1939: 52–55). Of these, the intermediate or cichlid fish type seems to best characterize the mating behavior of the Cedar Waxwing. Here dominance by 1 member is not essential and both members of the pair engage in pairing display which may or may not be identical in the sexes.

The formation of a pair is primarily a problem of discrimination of sex and of the individual. Nice (1943: 192) stresses this fact, pointing out that in birds the recognition process is probably visual or auditory. In a bird such as the waxwing in which sexual dimorphism is not present and in which functional song is absent, recognition must be based on behavior. For behavior to operate, the sexes must come into proximity. In many species (Nice, 1937; Lack, 1946) this is accomplished when the female enters the territory of the male. In the waxwing, proximity is maintained in the flock and the male originates pairing by "testing" the readiness of individuals to participate in the courtship dance or flight. The approach of the male probably is the same to either sex. From the data at hand, this approach in itself is a "signal" (Nice, 1943: 10) of maleness.

TABLE 1
TIME INTERVALS OF NESTING CYCLE

NEST	BUILDING	1ST EGG	COMPLETE SET	HATCHED	FLEDGED	TIME FOR FLEDGING TWO BROODS
			First nests			
45-08A	6/16	6/25	5–6/29	7/10	7/26	
46-07A	6/20	6/25	5–6/29	7/10	7/26	
46-15A	6/15	6/19	4–6/22	7/3	7/18	
46-16A	6/22	6/26	5–6/30	7/11	7/26	
41-10A	7/2	7/5	5–7/9	7/20	8/4	
42-12A	6/22	6/26	4–6/29	7/10	7/24	
46-18A					7/18	
			Second nests			
45-08B	7/25	7/29	5–8/2	8/13	8/28	69 days
46-07B	7/17	7/25	4–7/28	8/8	8/23	65 "
46-15B		7/21	4–7/24	8/4	8/19	68 "
46-16B	7/23	7/27	4–7/30	8/10	8/25	64 "
41-10B		8/3	3–8/5	8/17	9/1	62 "
42-12B	7/21	7/24	3–7/26	8/6	8/21	60 "
46-18B		7/18	4–7/21	Deserted		

Average time for fledging first brood—34.8 days.
Average time for fledging two broods—64.7 days.

While some uncertainty regarding the response of another male or a non-receptive female certainly exists, it seems fairly certain that the response from a sexually receptive female is active participation in the courtship dance. During this testing procedure the birds usually separate slightly from the group, and if sexual synchronization is obtained, the separation continues into courtship. The entire behavior of a pair is one of mutual cooperation in the display, and no convincing evidence of sexual dominance by either member has been noted. While this description of pairing tends to oversimplify what is probably a complex behavior, the uniqueness of the courtship dance among behavior patterns of birds would certainly go a long way toward the prevention of false matings. This function of behavior is recognized by Nice (1943: 192) in the discussion of "isolating mechanisms", as well as by Tinbergen (1939: 57).

Territory

The social habits of the waxwing have been discussed more fully in the literature than have the territorial phases of its behavior. Crouch (1936) and Lea (1942) briefly mentioned territory but did not clarify its status. The territory is similar to *Type B* described by Nice (1941b) which includes mating and nesting but not feeding. Some mating behavior has been noted outside the territory, and it has been shown that the pairs are formed previous to the establishment of territories. As in the Kingbird (Davis, 1941), the territory is considerably influenced by the location of the nest site. Some question remains as to whether the territory or the nest site is selected primarily. In observations of Nests 46-02, 46-03, and 46-05, the pairs were found when scouting for nests, and building and territorial defenses were observed simultaneously. Pair 46-04, however, was found defending an area back of Stranahan Laboratory on June 7. On June 9 the birds made several trips to a fork in the limb of a cedar tree but did not carry nesting materials until the next day. Indication that territory may be the dominant factor is found in the fact that 5 out of the 7 pairs which raised 2 broods (Table 1) built their second nests in the same territories as the first ones. The other 2 second nests may have been in the territories since their boundaries were not as well determined.

The requirements of the territory are simple, consisting of a nest site, a guarding perch, and a small amount of space. The size of 3 territories was 270, 225, and 1100 square yards. The shortest distance between any of these nests was 38 feet. Several nests have been found closer; in 3 cases not over 25 feet separated 2 nests. However, in 1 case, a territory nearly an acre in size was defended. The guarding perch of this nest was on a tall elm tree (*Ulmus americana*) about 100 yards from the nest. Territorial defense of this area was observed from June 28 to 30 when the male and several times both of the pair attacked a new pair and drove it away. Both these new birds lacked the red secondary tips, and since, on July 3, a similar pair was found building in the west end of the orchard, it was thought to be the same. This nest was at least 300 yards away. Although there were numerous favorable nest sites, no other pairs nested in this area.

The male waxwing guards from a perch overlooking the territory, and his frequent calls serve in communication to the female and may serve as warning for intruders as noted by Cameron (1908). There is little in the way of display. If an intruder comes within a distance of a yard or so the threat display may be given, and it is usually followed by direct attack. As the guarding bird is on the perch it is generally higher and thus dives on the adversary. Strange birds have always been noted to retreat and depart. Only once was actual contact observed: in a contest between 2 waxwings over a perch on the electric wires between the 2 territories. In this case one dived into the other while they were flying and both birds temporarily lost their equilibrium. The affair was settled by the establishment of opposing perches on adjacent wires.

Attacks on intruders may be made from any place in the territory. This is especially true during nest-building when both of the pair join in the pursuit. Of 55 records in which the sex and identity of the pairs have been quite definitely known, 71.0% of the attacks were made by the male while the female stayed at or near the nest, 12.7% by both members of the pair together, 9.0% by the female alone when the male was absent from the territory, and 7.3% by the male alone when the female was absent. These records indicate that the territory is recognized and defended by both members of the pair, and since attacks have been noted by either sex during the absence of the mate, the defense cannot be considered merely as defense of the sex partner. While the threat reaction is occasionally seen between birds coming close together in a feeding area, fighting or chasing does not occur as would be expected if strong sex-partner defense were present. A banded male was observed several times from June 11 to June 17 feeding with his mate in a cherry tree. During this time many waxwings fed in this tree and no fighting or attacking was observed. In 1 instance, on June 13, the pair alighted on an electric wire with 3 other birds, all within a span of 3 feet, and perched for several minutes in the sun. No aggressive behavior occurred.

A good example of the change in behavior from the feeding place to the territory was observed on June 9 by the corner of Stranahan Laboratory where a pair of waxwings was feeding on wild strawberries (*Fragaria virginiana*). Soon 8 birds were attracted to this locality and fed on the berries. When disturbed by the slamming of a door, the birds flew, perched together on a wire overhead, and after a short pause were back feeding. When the berries were consumed the birds scattered somewhat but 6 of them landed farther west on the same wire. Two of these, pair A, then began attack on the others, the B pair soon flew south to Nest 46-05, the third pair, C, subsequently chased by the A pair, circled into 46-05 territory and was immediately chased by the male of pair B which only a moment previously had fled from pair A. Pair number C continued hastily across the road into Nest 46-02 territory pursued by the pair B male. When the latter crossed into 46-02 territory, he suddenly checked his flight, circled rapidly, and returned to Nest 46-05 tree. Pair A, the original attackers, in the meantime had circled, perched on the western part of the wire, and soon flown to Nest 46-03. These birds were evidently the pairs from Nests 46-02, 46-03, and 46-05 as indicated on Fig. 1. This instance not only exemplifies the change from gregarious feeding to territorial defense by waxwings but the sudden retreat of the 46-05 male presages recognition of the territory of a neighbor. Lack (1946: 36) described a similar behavior in the English Robin. Further evidence for the recognition of territorial boundaries was seen when pair 46-02 deserted on June 13 after the nest had been disturbed by trimming of the branches in which it was located. Although no attack could have been possible on June 14 and 15, it was noted that pairs 46-03 and 46-05 continued to detour this area in travelling to and from their own territories.

Aside from incubation and care of the young, scarcely any activity can be said to be strictly confined to the territory. A major share of nesting materials comes from the territory though trips outside have been noted. At one time the birds from Nests 46-07, 46-08, and 46-12 all were collecting wool yarn from an area at the edge of 46-12 territory. Pieces of this yarn were found later in all 3 nests. Much of the courtship takes place within the territory, chiefly near the nest site or the guarding perch of the male. Two pairs in 1945 were noted carrying on some courtship feeding in a feeding area adjacent to their nests, and the 46-03 pair was observed courting in a large tree not in its territory. Field observations of waxwings gave the impression that reduction in territorial disputes occurs as the nesting cycle proceeds. Of 46 ejections in which the nesting stage was known, the average per day was 4.2 during nest building (5 days), 1.8 egg laying (5 days), 1.0 incubation (12 days), and 0.25 nestling period (16 days). Two suggestions can be made in explanation of this behavior. First, the routine patterns of nest life are developed in such a way that trespassing is greatly reduced, and second, the aggressive tendency of the birds themselves is reduced. In the first instance pairs 46-07, 46-08, and 46-10 were building nests at the same time (June 10–24) and started incubation about June 27. During this period ejections occurred and were recorded at least some time on every day. Later during incubation and feeding of the young less friction was noted. The 46-07 pair always came and left the nest tree from the east while 46-08 pair travelled from the south and 46-10 from the west. A glance at Fig. 1 will reveal that under these conditions little chance for conflict would occur. On the other hand while observing Nest 46-15A during the middle of the nestling period, about July 10–12, no ejections or aggressive actions were seen but from July 18–21, the period during which Nest 46-15B, the second nest, was being built, there were several. Here it appears that changes in the behavior of the pair in relation to neighbors were responsible. Probably both of these factors have some influence though more data are needed to clarify their relation.

Both sexes ignore most other species of birds in the territory. The Yellow Warbler (*Dendroica petechia*), the Indigo Bunting (*Passerina cyanea*), and the Red-eyed Vireo (*Vireo olivaceus*) have all been observed within close range of nests with no apparent alarm on the part of the female waxwing. The smaller birds especially have been within a few inches of the nest without disturbance. The male at Nest 45-08B was noted attacking a Redstart (*Setophaga ruticilla*) and several times a House Wren (*Troglodytes aëdon*). The bird most consistently attacked was the Bronzed Grackle (*Quiscalus quiscula*) which was observed more than a dozen times being aggressively repelled by 1 or both members of a pair.

Courtship

The courtship of the Cedar Waxwing progresses through 2 phases: first, a display which strengthens the bond and culminates in copulation, and second, a display which maintains the bond throughout much of the nesting cycle. Behavior of the first phase is usually observed simultaneously with the arrival of the birds and is chiefly characterized by the courtship dance, or hop, which has been mentioned as a probable feature in the formation of the pair. This display is performed regularly from the earliest time that the pair can be recognized up to the onset of incubation. The dance itself may or may not be combined with actual feeding, but in a majority of the cases, food plays a part in the dance. The dance is seen more frequently in the morning and evening, usually 2–4 hours after sunrise and 1–3 hours before sunset, but may occur quite commonly at any hour of the day. A horizontal perch, ordinarily a small dead limb or electric wire, may be the scene of activity. The male flies away a short distance, procures an insect or berry (in many cases the food fragments are small and can be seen only with binoculars), and returns to the female. He approaches by hopping sidewise, usually facing the same direction as the female, thus bringing the bodies of the birds into parallel positions. The food is presented by a turn of the head. If the female is receptive she takes the food by a similar motion and hops away from the male then back to him and returns the food. He in turn hops away and back as the process repeats. Between hops the male frequently executes a bowing movement. The entire courtship dance is highly stereotyped and gives the impression of spring-wound mechanical toys in operation. Observations of banded birds or ones individually known showed that the female usually terminated the display by eating the food. Thus a dance of a dozen hops would be interrupted while the male made other short food forays. Courtship dancing may last for a period of 1–5 minutes then alternate with a fast circular flight in the nest area. The activity varies in duration from 3–15 minutes and usually is followed by a feeding trip or a session at nest building. Crouch (1936) gives a good description of this courtship display; however, he stated that, "At the end the male takes the berry and either drops it or eats it". Other accounts of courtship hopping and feeding were given by Silloway (1904) and McCoy (1927).

Copulation takes place during a comparatively few days, and the behavior of the birds during copulation is quite subdued. Copulation records have been comparatively infrequent. During the 6 years' study only 25 observations of copulation have been made. In all cases except 1 these have taken place during courtship dances. After a few hops by both birds the female assumes a crouching position and the male mounts almost instantaneously. The female may vibrate the wings slightly but makes no audible sound. The male appears in an almost upright position with the crest somewhat elevated and has not been observed to use the beak in grasping the feathers of the female. The position is held only a few seconds after which the male hops down. Courtship may continue, the longest observed being 5 minutes interspersed by 3 copulations. The 1 exception in which no dancing accompanied copulation occurred after the pair had been feeding in a cherry tree. The female flew into a maple and the male followed and at once copulated with the female. Copulation was repeated 3 times in quick succession after which the birds flew away. Copulations were seen more frequently from 5:30 A.M. (Solar time) to 9:30 A.M. and after 2:30 P.M. in the latter part of the day. Only 1 was seen during the middle of the day. In 10 cases in which the identity of the pairs was reasonably certain the observed copulations took place between the third day before the first egg was laid and the day the third egg was laid. The distribution was: 2 on the third day before laying, 4 on the second day before, 2 on the day before, 1 on the day of the first egg, and 1 on the day of the second egg. Four of these copulations were near the nests and 6 close to though not in the feeding areas. None of the identifiable pairs was seen in copulation on more than 1 day, although it must certainly have been more frequent. The captive birds copulated on the 3 days preceding laying of the first egg, and the male attempted copulation on the day after the second egg was laid. (Only 2 eggs were laid.) The absence in the literature of comment concerning copulation indicates that it has not been seen frequently. Copulation probably takes place only during a restricted time when the pair is sexually synchronized and if successfully completed results in little subsidiary behavior. Copulation marks the climax of the first phase of courtship. Hereafter the courtship dance and the circular flights become less frequent and disappear as egg laying proceeds, while the character of the call notes and feeding behavior changes.

The second stage of courtship wherein the male feeds the female is characterized by 2 phases: an earlier one in which the male feeds the begging female, and a later one in which the male feeds the female previous to the feeding of the young. About the day of the first egg the male starts feeding the female at the nest and the female displays begging behavior. Herrick (1935: 61) mentioned and described this display as follows: "The perched bird, presumably the female, was shaking her wings and giving the sibilant call, when another waxwing appeared, passed something to her bill, and flew away". Nice (1941a) located a pair of nesting waxwings by means of the begging call of the female. The begging and feeding display takes place at either the nest or the "perch", although since the female actively pursues the male the pair may move about considerably. The attitudes, voice, and behavior of both birds are indistinguishable from those involved in the feeding of a young bird. Lack (1946: 61–62) in describing the begging by the English Robin might well be giving the behavior observed in the waxwing. The begging behavior of the female was at first believed to have some relation to sexual readiness. Later observations of banded birds showed that this display developed in association with egg laying and continued throughout incubation. So far as is known, begging is not involved in copulation behavior but only in the maintenance of the bond. This idea is ascribed by Lack (1946: 62) to the same display in the European Robin.

The second phase abruptly succeeds the begging reaction when the young hatch. The male comes to the nest, invariably feeds the female first, and then both adults feed the nestlings. Crouch (1936), Lea (1942), and others have described the feeding of the young, and their statement that the male presents food to the female first and then both parents feed the young together has been verified consistently during this study. Food presentation to the female continues throughout the brooding period, ceasing only when the young are well grown. Its relationship to the second production brood will be apparent later.

The importance of food as a factor in courtship should not be overlooked. It seems probable that much of the first stage (courtship dancing) is accompanied by the passing of food and that some reports of "symbolic" feeding may have been due to the small size of food particles; yet, there is little doubt that symbolic feeding does occur. Bagg and Eliot (1937: 470) quote Merriam's description of a courtship dance. "They had nothing in their bills and their bills were shut." Crouch (1936) described the birds "touching bills", and in several instances at Put-in-Bay the beaks of dancing birds were not opened when touching. Lack (1940: 173) notes symbolic feeding in the Cedar Waxwing. In either case the basic element of the behavior is food and the function of the act is the strengthening or intensifying of the bond between the pair. In the second stage of courtship food is presented to the female both during incubation and feeding of the young. The food presentation to the female during the nestling period is especially significant since it maintains the male with the female at a time when in many species association between members of the pair is weakened by the constant stimuli of the nestlings. This entire series of behavior patterns, which follows pairing and continues through the nesting cycle, promotes close contact between the members of the pair and in so doing maintains the bond. In this sense the series represents "true courtship" (Lack, 1946: 59).

Voice

The call notes of the Cedar Waxwing in the main are derived from a fundamental tone of high pitch, lacking, for the most part, in overtones and as a result having little of the resonance which gives quality to the song of many birds. This may result from the relatively poorly developed vocal organs, mentioned by Maynard (1928); however, the sound is transmitted for some distance, and under favorable conditions it may be heard at least a quarter of a mile. No exact tests were possible at Put-in-Bay, but it was thought that the pitch was somewhere near D_8 or slightly above 9,000 v.p.s. Brand (1938) found the pitch on 1 vocalization to vary from 7,675 v.p.s. to 8,950 v.p.s., with a mean of 8,400.

According to the definitions of Nice (1943: 144) and Tinbergen (1939: 74) song is not present in the Cedar Waxwing since of the call notes given by this species none is restricted to the male, none is definitely used as a warning, and none is particularly characteristic of the beginning of reproduction. The absence of song does not prevent a somewhat more extensive vocabulary than generally has been recognized. This vocabulary consists of 7 call notes which are divided into 2 groups.

Call types with constant vibration frequency: 1. Flock Call: A clear repeated note of unchanging vibration frequency used by members of a flock in flight and given as a signal in take offs or landings. Crouch (1936) and Nice (1941a) mention this note in connection with flight.

2. Distress Call: Similar to a location call but having a distinct drop in pitch as the note ends. The call is given by a bird separated for any length of time from its mate or is given as a signal when the nest area is entered, in which case either adults or young will go into "freezing" behavior (Allison, 1906; Nice, 1941a: 62). In 3 cases in which females were abandoned by their mates the females gave this note for a considerable part of the next 2 days. Cameron (1908: 406) described this note as given by the parent when a man attempted to capture a young bird.

Call types with variable vibration frequency: 1. Anger Call: The most intense call given by waxwings. It has a rapidly changing vibration frequency which gives the note a marked vibrato. This call may be given by the adults and accompanied by attack if the young are disturbed by banding operations, especially if the young themselves give the note when handled. Adults also frequently emit this note while being held in the hand. It is sometimes used in attack on intraspecific intruders but is commonly heard during interspecific attack on larger birds such as the Bronzed Grackle. Whittle (1928: 82) calls this "danger note", and Nice (1941a: 62) labels it "alarm seep".

2. Begging Note: The tone character is similar to anger call but has a medium intensity and is used exclusively by females or young in feeding behavior. This call occurs during begging behavior, as described by Herrick

(1935: 61), Nice (1941a), and Crouch (1936). It appears shortly before egg laying and continues throughout incubation.

3. Location Call: A modified flock call of less intensity than the begging note but more musical. It may be heard in flocks feeding or perching and is commonly used by a pair in the nest area or at a feeding station. During incubation a perching male quite frequently exchanges this note with a nesting female.

4. Courtship Note: A soft buzzing warble used by the pair during courtship and particularly during nest building. The begging note of young birds up to 5 or 6 days is very similar. Used as a field identification mark, this call has been useful in locating newly started nests.

5. Warbling Note: The most musical call given by the Cedar Waxwing and one not heard frequently because of its extremely low intensity. The captive young in 1941 and 1942 gave this note frequently while perching in the sun, and it is given in the wild under similar conditions. In 2 cases, where the nests were quite low, the females were heard warbling on the nests during incubation. Both Whittle (1928) and Crouch (1936) describe warbling given by their captive birds.

The various waxwing calls prove useful in the field as a gauge of the stage of the nest cycle. The courtship note usually indicates building, a begging female, a nest and, commonly, eggs. The location call given by a perching male ordinarily is an indication of later incubation or early feeding. During later feeding stages the young increase in begging while the adults become more silent, and at fledging the outburst of begging by the young is unmistakable. Call notes thus undergo certain cyclic tendencies during the breeding season.

Calling fluctuates also during the day. From 4:30 A.M. (Solar time) to about 9:30 A.M. in any area occupied by nesting waxwings, calling is heard frequently. A quiet period develops during the middle of the day and then another interval of calling occurs from 3:30 P.M. to about 7:00 P.M. The periods of vocalization are correlated directly with the periods of activity. There is evidence that physical activity of waxwings is reduced with high temperatures (90°F. or above), and since voice is almost synonymous with other physical activities it is much reduced on hot days.

Voice functions in species recognition and communication and probably in individual recognition. Evidence supporting this statement is largely circumstantial yet it merits some consideration. Numerous observations have been made in which 1 of a pair or both have answered and joined a small flock of waxwings en route to the feeding area. Several notations have been made of nestlings begging in response to the flight note of waxwings as they flew past. On July 23, 1946, 4 immatures and 2 adults "froze" when the Nest 46-15 male gave a disturbance call. At Nest 42-12 when the male was trapped the female flew down and gave the anger call. Two other Cedar Waxwings not previously seen responded and flew to her. All 3 perched and gave the disturbance call for at least 5 minutes when the male was released.

Individual recognition of the calls of pair members at least must exist. In Webster's orchard, Nests 46-15, 46-16, and an unmarked nest were all within a 50 yard radius yet the females responded only to their respective males. In many of these instances there is reasonable certainty that the responses were not the result of visual stimuli. At Nest 41-10 call responses were noted although the "perch" was at least 75 yards away from the nest and

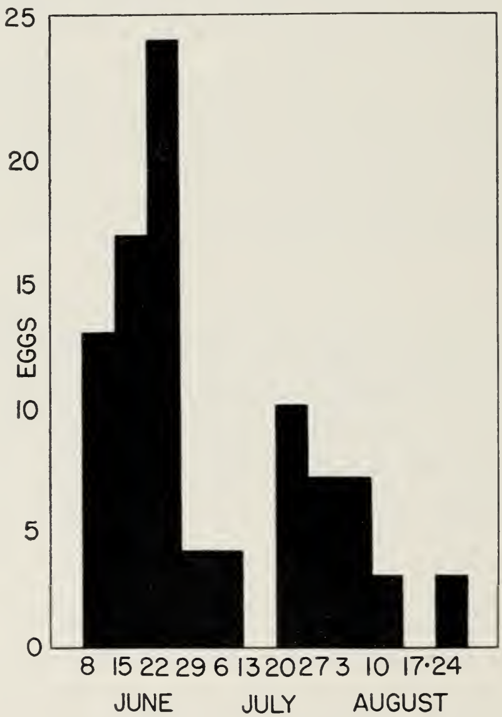

FIG. 2. Number of first eggs found per week

obscured from the nest by another tree. The male in this case was banded and could be identified through the telescope. The constant calling between pairs of waxwings is some evidence of recognition and communication.

NESTS AND EGGS

As mentioned previously nest building occurs soon after the main spring migration of waxwings. Usually some activity is noted the first week in June, but the height of nesting customarily falls in the latter half of the month (Fig. 2).

The early nesting attempts appear to lack much of the vigor which accompanies the later ones. Of 45 nests built before June 20 only 22% were successful. In contrast, of 51 nests built after June 20, 55% were successful. When interference was the probable cause of desertion, the nests were disregarded for these calculations. This failure of early nests and the late migration results in a delayed nesting season for the waxwing, a fact commented on by Herrick (1935: 60), Crouch (1936), Saunders (1911), and others. The loss of early nests seems in part due to inactivity on the part of the birds; however, storms are common at this season and hard rains and wind account for 10 out of 29 desertions in which causes could be ascertained.

The nest site is determined by the pair, although the female appears to be more active. At least 9 observations of the selection of nest sites have been made. A good example of this behavior is illustrated by pair 46-04. These birds were found on June 7 just north of the laboratory workshop. During the afternoon they were active in courtship feeding and hopping and in making circular flights. The birds flew from tree to tree in this area and the female frequently perched in favorable limb forks and went through body motions of nest shaping. It was noticed that after several trials the pair kept returning to a particular fork in a cedar tree and 2 days later the beginnings of the nest could be seen in this fork. This pair seemed slow in starting the nest as most of the pairs seen have started building on the day of nest location. Second nests built by the same pair usually are close to the first ones. In 5 cases both nests have been in the same tree.

In a record of 99 trees used as nest sites, the percentages were as follows: maple—28%, cedar—27%, apple (*Malus pumila*)—14%, pear (*Pyrus communis*)—10%, hackberry—6%, plum (*Prunus domestica*)—5%, sycamore (*Platanus occidentalis*)—4%, elm (*Ulmus americana*)—2%, and coffee nut (*Gymnocladus dioica*), yellow oak (*Quercus Muhlenbergii*), and cottonwood (*Populus deltoides*)—1% each. The nest height was generally 4 to 50 feet from the ground, though more usually from 5 to 20 feet, agreeing with Crouch (1936). The nests are built away from the trunks where the limbs become horizontal and usually where lateral forking occurs. Lea (1942) gave the average height of 11 nests as 3.63 meters and distance from trunk 2.06 meters.

Materials used in the waxwing nest vary considerably. Grass, small twigs, plant stems, rootlets, string, and many other fibrous materials have been found in nests. Nests are lined lightly with cobweb, fine grasses, or moss. One nest, 46-07A, was almost completely woven from wool yarn which had been scattered on the grass in the nest area. The writings of the major workers on waxwings are supplemented by many excellent notes on nests, i.e., Benson (1920) on the use of twine and rags, Burleigh (1923) on location and materials, Merrill (1898) on use of moss, and Smith (1915) on building. Cedar Waxwing nests are loosely woven and bulky. Good measurements of a typical nest were given by Crouch (1936).

The average time of nest construction as determined from 11 nests was 5.55 days (S. D. 1.6), with extremes of 3 days and 9 days. The time was counted from the start of nest building up to the day of the first egg. Lea (1942) found 2 nests built in 6 days and 1 nest in 5 days. The length of time for construction decreases as the season progresses. The 5 nests built between May 30 and June 10 averaged 6.8 days, while the 6 nests built between June 12 and 21 averaged 4.5 days. The nest building activity is not uniform but rises to a peak during the third or fourth day and then subsides. Some building, at least addition of lining, may continue through the second day of egg laying. During the height of nest building the birds may work a great part of the daylight hours, but activity during the morning is more intense. Building is not continuous and is alternated with periods of feeding, courting, and preening. A period of increased building also occurs in the late afternoon. Both sexes are active in construction and gathering materials. In some cases the female appears to be slightly more aggressive in building, but the general impression in most instances is that the work is quite equally divided. In dismantling an average-sized nest, 2,327 individual pieces could be recognized besides numerous fragments or lining such as cobweb or plant fiber which could not be counted. Taking the weight of a typical nest as 23.1 grams (average of 3 nests) and the weight of material carried on an average trip as 90 mg. (average of 20 straws from nests), a pair of waxwings would make 2,566 trips in building a nest, or 1,283 trips per bird. To accomplish this in 5 days working 10 hours per day, each bird would be required to make 1 trip every 2.35 minutes. While these are only estimates, they represent someting of the considerable effort expended by the birds. During the height of nest building 1 or 2 trips per minute for short periods of 10–15 minutes are not uncommon.

Egg laying commonly occurs as soon as the nest is completed. The eggs are laid in the morning usually between 5:00 A.M. and 8:00 A.M. (see Table 2), on consecutive days. Of 65 complete sets 41.6% had 5 eggs, 40% had 4 eggs, 10.7% had 3 eggs, and 7.7% had 2 eggs. A nest found by Sanborn and Goelitz (1915) contained 6 eggs. There is a definite tendency for birds to lay fewer eggs late in the season. In 36 cases of early nests in which incubation was in progress before July 5 the average number of eggs was 4.5 per nest. In 24 cases of late nests after July 15 the average of eggs per nest was 4.0. A statistical analysis of these data was conducted on the hypothesis that there is no relationship between the season and the number of eggs laid. This hypothesis was rejected since the value of χ^2 indicated a "significant difference" which would occur by chance less than 5 times in 100. Another indication that the greater reproductive activity falls early in the summer is that of 300 eggs laid during 5 years, 51.7% were laid between June 15 and June 30. These data are subject to some variation since field observations could not always be comparative.

Incubation

I. The Role of the Sexes

Throughout this study the only field method for the discrimination of sex has been the difference in behavior characteristics of the male and female. The confirmation of these characters has resulted from observations of 7 pairs of banded or marked birds. There were at least 10 other pairs in which the sexes were determined positively by less obvious identification marks. The sex was determined at all nests by identifying the egg producing member of the pair. Such characters have been referred to by several writers. Littlefield and Lemkau (1928) wrote of the nesting female and her mate. Nice (1941a), Crouch (1936), Gross (1929), Herrick (1935:61), and Saunders (1911) differentiated male and female behavior while Post (1916) noted behavior differences but did not associate them with sex. The only structural character which proved valuable was the presence of a definite brood patch on the female during

TABLE 2
Time (Solar) of Egg Laying at Six Nests

NEST NUMBER	DATE	TIME OF LAST OBSERVATION BEFORE LAYING (A.M.)	TIME OF FIRST OBSERVATION AFTER LAYING (A.M.)	MIDPOINT A.M.
41-10A	7/5	5:29	7:19	6:24 ±55
	7/6	5:53	7:24	6:38 ±45
	7/7	5:52	7:54	6:53 ±61
	7/8	5:43	7:33	6:38 ±55
	7/9	5:58	7:36	6:47 ±49
41-14	7/23	5:53	7:53	6:53 ±60
	7/24	6:12	7:52	7:03 ±50
	7/25	5:55	7:38	6:46 ±52
	7/26	5:08	7:23	6:15 ±68
40-12	8/2	5:39	6:35	6:08 ±27
	8/3	4:58	6:21	5:40 ±41
	8/4	4:54	6:05	5:30 ±35
	8/5	4:53	6:03	5:28 ±35
41-10B	8/5	6:16	7:08	6:42 ±26
41-18	8/7	6:08	7:38	6:53 ±45
	8/8	5:53	7:53	6:53 ±60
40-13	8/7	4:43	6:53	5:48 ±65
	8/8	7:06	7:45	6:26 ±19
	8/9	6:28	7:53	7:10 ±43
	8/10	6:05	6:48	6:26 ±22
	8/11	6:39	6:02	6:51 ±12
Mean.				6:29

the nesting season. With careful examination the male invariably shows down feathers scattered on the abdomen. In addition to behavior differences Crouch (1936: 4) described the female as having less black on the throat. While true in individual cases its reliability as a differentiating character has not been established. At Put-in-Bay during the observation of over 100 pairs of nesting waxwings all gradations of color have been seen in both males and females. Females either may be duller or brighter in color than their mates and may have more or less black on the throat. One of the most colorful of the captive birds, "Butch", reared in 1942 was the female which later nested in the cage. Mearns (1878), after examining a large series of specimens, commented on the variability of red wax-like appendages on the secondaries by saying, "In this series I can scarcely detect any sexual difference in that respect except that the particularly well developed specimens were all males."

Incubation probably is performed only by the female. During the summer of 1939 at the first nest observed during this study the adults were thought to have shared incubation, although at 10 nests in which 1 or both birds were color banded, the female alone incubated, and in more than 60 other instances there has been no clue of male incubation. Crouch (1936: 4) states that incubation is performed entirely by the female. Gross (1929: 181) observed 1 nest where both birds incubated and another where only the female was active. Saunders (1911) noted that only the female incubates. Lea (1942) stated, "The female waxwing did all the incubating and brooding".

Characteristic behavior of the female while on the nest includes frequent egg turning, changing directions, raising the crest to attention, "freezing" as described by Cameron (1908) and others, stretching, and feather preening. Notes for July 18, 1941, indicate that egg turning took place 12 times between 7:28 A.M. and 8:33 A.M. This frequency is not at all uncommon. In an hour's observation waxwings have been seen to face in all compass points, and on August 23, 1942, at 3:11 P.M. the female on Nest 40-15 was facing directly west into the sun. Crouch (1936) states that while on the nest the female faces away from the sun and changes as the day progresses.

Waxwings are more quiet during the period of incubation than at other times during the life cycle, although frequently females when coming to or leaving the nest give soft flock notes. The fact that females give the warbling note while incubating was discovered when the vibration of the throat of the female while sitting on the nest was noted. This movement was observed with the spotting telescope and when checked, the sound was found audible only to a distance of 15–20 feet from the nest. Nice (1941a) in describing notes of a captive bird under observation had not heard this note, but she mentions that Whittle (1928) described notes of similar character. Crouch (1936) mentions a "peeping call", probably the same and used under similar conditions as observed here. This note was heard repeatedly among the group of 9 young captive waxwings.

While the male takes no part in incubation, he ordinarily is very active in feeding and nest attention. The male feeding behavior has been described well by Crouch (1936). The female may be fed by the male either at the nest or at a habitually frequented perch in a nearby tree. Herrick (1935: 61) never noticed this habit. This behavior, however, is recorded both by Crouch (1936) and Gross (1929) and has been seen frequently and consistently throughout observations at Put-in-Bay.

On the subject of feeding, there are 2 particulars worthy of mention: (1) the food carrying capacity of the male and (2) the visits by the male to the empty nest. Many nest feedings have been observed and the particles of food which were given to the female or young counted. The male may carry 5 large mulberries but usually only 3. The usual number of chokecherries was 7 and of elderberries 9–10, although once a male brought up 13, 1 after another. Several times males have been noted coming to the nests during incubation when the females were absent. On some of these visits the male takes his regular perch and regurgitates food. Then after peering into the nest, he finally swallows the food himself and may leave at once or may remain for several minutes exactly as though he had carried out the complete reaction.

As a criterion that incubation was in progress, a single perched waxwing seen frequently at a salient point such as an electric light wire, high, dead limb, or the top of a cedar tree has proved almost infallible. Numerous instances in the notes of observations on banded birds have shown this perching bird to be the male.

The correlation of changes in behavior of both sexes with variability in weather conditions has been mentioned by several writers. Herrick (1935) and Crouch (1936) mention the panting and crest raising displayed by the incubating female on warm days. This characteristic response has been recorded in the notes on almost every day in which the maximum temperature was 90°F. or above. A particularly marked response was observed on July 21 when the temperature was 90°F. The female spent from 2:10 P.M. until 4:30 P.M. alternating at about 3 minute intervals between covering the eggs and perching near the nest in the shade. This behavior occurred again on July 23 when the temperature was 91°F. Since the afternoon sun fell directly on the nest the actual temperature at the nest must have been considerable. Males are less active with increasing temperatures. Rain apparently retards activity in both sexes. Females stay close to their nests and males are less attentive. Feltes (1936) noticed that on rainy days the birds were more subdued and fed more frequently at his traps. The above statements are based on 15 to 20 observations, and further study of weather is contemplated before any comprehensive discussion is attempted.

II. Attentiveness

Rhythmic attention during incubation has been reported in a number of species. The existence of rhythm in the attention of the Cedar Waxwing cannot be established at present, although there is a tendency for the females to incubate more periods of a given length than other intervals.

The frequency of attention intervals (Table 3) of the female was prepared from the data on 11 nests involving 402 hours of observation. The mean time interval was 44.8 minutes (S.D. 31.1 min.). In the examination of these data on the hypothesis that uniform distribution of frequencies existed, a χ^2 test was carried out and a "highly significant" value of χ^2 was obtained. Thus the hypothesis can be rejected in favor of a definite grouping of the frequencies. This grouping of the frequencies is somewhat below the mean due to the influence of the few exceedingly long periods. On this point data are imperfect since the actual length of the longest periods is not always known. Many of the longer periods on the nest started before the observer arrived or ended after he left. The longest of these incompletely observed attentive periods exceeded 240 minutes. In interpreting the above, it appears that there is a significant tendency for the birds to incubate more periods of 20 to 40 minutes than other intervals. While this in itself is not proof of rhythmic attention it shows that if rhythm exists, the periods of the rhythms tend to have similar values. If hunger is the basis for incubation rhythms, as suggested by Nice (1937), the irregularity and the obscuring of possible rhythm in this species by extremely long attentive periods is understandable since the female is fed frequently and in considerable amounts by the male. Nice (1937) found that the Song Sparrow spent from 20 to 30 minutes on the nest and stayed off from 6 to 8 minutes. Fautin (1941), studying the Yellow-headed Blackbird, noted a fairly definite rhythm. Pitelka (1940) observing the Black-throated Green

TABLE 3

Frequency of Attention Intervals at Eleven Nests

TIME INTERVAL (MINUTES)	FREQUENCY	TIME INTERVAL (MINUTES)	FREQUENCY
1– 7	12	85– 91	6
8–14	21	92– 98	6
15–21	23	99–105	1
22–28	26	106–112	5
29–35	26	113–119	3
36–42	30	120–126	1
43–49	14	127–133	0
50–56	18	134–140	2
57–63	14	141–147	1
64–70	8	148–154	0
71–77	11	155–161	1
78–84	6	162–168	1

Warbler described a rhythmic attention in which the periods lengthened during the middle of the day.

The lengths of the attentive periods during the morning and during the afternoon as well as at the beginning and toward the end of incubation are compared in Table 4. No significant differences in length were found between mornings and afternoons. The morning period for 3–7 days of incubation was significantly less than the (8–12) or (13–17) day morning period, and the (3–7) day afternoon period was significantly less than the (13–17) day period. Differences in inattentive periods were not significant. In the waxwing the instinct to incubate manifests itself before the eggs are laid, increases in intensity with their deposition, and continues to increase slightly until the young are hatched. At 2 nests observed during an average of 11 hours per day for 17 days during egg laying, incubation, and hatching, the percentages

TABLE 4

Attentiveness of Female at Eleven Nests

DAYS OF INCUBATION	MORNING			AFTERNOON		
	Periods	Mean Length	Standard Deviation	Periods	Mean Length	Standard Deviation
			Attentive			
3– 7	79	37.0	26.4	35	42.6	32.1
8–12	35	48.1	31.8	16	51.4	23.6
13–17	41	52.8	37.6	31	58.1	38.7
			Inattentive			
3– 7	91	7.2	—	52	9.1	—
8–12	40	3.2	—	21	2.8	—
13–17	44	5.8	—	35	5.3	—

of attention during observed periods were: 28% and 42% on the day of the first egg, 40% and 61% on the second, 65% and 70% the third, 77% and 78% the fourth, and 87% and 88% on the fifth when the clutches were complete. For the next 3 days the attentiveness increased gradually to 95%, and for the following 9 days varied only from 93% to 97%. The highest percentage of attention noted was 97.3, shortly before hatching. These figures are much above those of any of the 8 passerine species for which comparable data are summarized by Fautin (1941), but do not equal those given by Weston (1947) for the Black-headed Grosbeak in which both sexes incubate.

While male waxwings usually are quite active in bringing food to the nest during incubation, no definite feeding rhythm has been noted. In observations at 1 nest covering a 14 day period, attention intervals were highly variable, ranging from 0.38 feedings per hour to 1.4 per hour. A review of data from 7 nests based on average feedings by the male per hour is as follows: nests visits decreased from 2.5 per hour on the day the first egg was laid to 0.75 per hour on the day the 5th egg was laid; the visits increased gradually to 1.9 per hour on the day before hatching; the visits were accelerated to 3.1 per hour on the day of hatching. At 1 nest, Gross (1929) reported male visits once every half hour during incubation and Saunders (1911) once every hour. From the standpoint of averages it can be seen readily that the statements of the writers mentioned could be true during some part of the incubation or feeding period, since there appears to be considerable variation in male attention. It is evident that there is a decline in male attention during laying and that after reaching a low ebb on the day after the last egg is deposited in the nest, there is a gradual increase in male nest attention until hatching, so that in a normal 5 egg nest, there is a decrease for the first 5 or 6 days and a gradual increase for about 11 days.

III. Incubation Period

Moreau and Moreau (1940) defined the incubation period as the time from laying to hatching of the last egg. At 2 closely watched nests this period was 12 days and 5 hours. At 6 other nests with less complete records the last egg is known to have hatched between 12 and 13 days. The incubation period has been given by various writers as follows: Crouch (1936) 12–14 days, Gross (1929) 14 days, Bergtold (1917) probably 14 days, Post (1916) 12 days, and Saunders (1911) 12 days. Lea (1942) gave the average incubation period for 18 marked waxwing eggs as 11.7 days, with a maximum of 13 days and a minimum of 11 days. Any of these might be accepted, depending upon the definition of the incubation period and the accuracy of observations.

During 1942, 1945, and 1946 the 12 day 5 hour incubation period in conjunction with the information below on the development of individual eggs in a nest has been used as a basis for the accurate prediction of more than 25 hatching dates of nests where dates of laying were known. Since in the waxwing some incubation occurs during laying, thus exhibiting Bergtold's (1917) "apparent period", an understanding of the incubation period would not be complete without a study of the complete set of eggs in a nest. To determine accurately the developmental period of the eggs, it was necessary to know (1) when each of the set was laid, (2) the time at which each of the eggs hatched, and (3) the amount of time spent by the incubating bird. To determine the time of egg laying, nests were examined early each morning before the eggs were laid and again as soon as feasible afterwards. Usually the observations were continuous and nests were inspected whenever the female left. The order of laying was recorded by marking each egg as laid with India ink.

Crouch (1936) reported that waxwing eggs were laid before 11:00 o'clock in the morning. While this has proved to be true, usually such statements are based on observations which extend from the previous day, and as pointed out above may involve almost a 24 hour error in laying time. Error can be reduced greatly with more frequent observation. The hour of egg laying was taken as the midpoint (Table 2) between the time of last observation before laying and first observation after laying. The mean egg laying hour (6:29) is an average of the calculated egg laying times and might be considered as the most probable time for an egg to be laid.

The time of hatching was determined much in the same manner as egg laying. The pipping of eggs was often of assistance in determining the approximate time, and the female's habit of eating the shells was of great value in timing the completion. At 2 nests during manipulation of the eggs the India ink numbers which had been marked on them were plainly visible through the telescope, and the identity of the hatched young could be determined. The order of hatching in all cases in which it had been possible to mark the eggs was the same as the order of laying. Hatching is spread over a period of more than 2 days and is not a simultaneous hatching. Six other records were obtained in which hatching spread into the second day. Crouch (1936) and Gross (1929) state that the young hatch at the same time.

The incubation time of the female was determined by multiplying the percentage of observed time the female was incubating on the day by the number of daylight hours at that day of the year. As this would cover only the daylight period, an attempt was made to learn something of night incubation. It was possible to obtain 3 records of nests inspected nightly, following the laying of the first egg. In each case the bird was first found on the nest the night following the deposition of the third egg, and she continued to be present on the nest each night thereafter. With the above 3 factors of the data known it was possible to approximate rather closely the total incubation received by each egg before it was hatched. Table 5 summarizes the incubation of the individual eggs in Nest 41-10A

It will be noted that the lapse in time between the hatching of the first and last eggs is much less than that between laying of the eggs. Nice (1937:122) mentioned this in the relation to the Song Sparrow and related it to the irregularity in the starting of incubation by the female. If there were no incubation until all the eggs were laid, we would expect the eggs to hatch at the same time; however, since incubation increases progressively with laying of the eggs and hatching is spread over more than 1 day, there should be some relation between the two. That a relation does exist is apparent from the fact that the eggs have always been found to hatch in the same order as laid. A comparison of the figures (Table 5) of estimated incubation and intervals at hatching shows that there is a trend toward compensation which however remains incomplete. The earlier incubation, which consists of shorter periods more widely spaced, seems not to be as effective as the later, which is consistently at a higher level, since none of the first 4 eggs hatched quite as far in advance of the fifth as would be expected from the amount of incubation received in the first few days. In relation to poultry, Jull (1938) states, "The longer that hatching eggs are stored at room temperature before being incubated the longer the time usually required for incubation". This might apply to the partial incubation of first eggs lying in the nest.

The facts as revealed by this study of incubation in the Cedar Waxwing show that it is impracticable to determine any one definite point at which incubation begins. For purposes of comparison with other species the incubation period as defined by Moreau and Moreau (1940) may be satisfactory. This leaves untouched a major problem of development, namely, the factors which control the rate of development of the embryo, upon which further field and laboratory study is needed before satisfactory conclusions can be reached.

TABLE 5
Incubation Data from Nest 41-10A

	EGG 1	EGG 2	EGG 3	EGG 4	EGG 5
Time laid	7/5 6:24 A.M.	7/6 6:38 A.M.	7/7 6:53 A.M.	7/8 6:38 A.M.	7/9 6:47 A.M.
Time hatched	7/19 11:24 A.M.	7/20 7:13 A.M.	7/20 6:56 P.M.	7/21 5:56 A.M.	7/21 11:57 A.M.
Hours in interval between laying and hatching	353.0	336.5	324.0	311.3	293.2
Per cent of incubation on day laid	43.2	63.8	71.6	79.2	90.6
Estimated hours of incubation during first day	6.5	9.6	10.7	11.8	13.6
Estimated hours of incubation at night	0	0	9	9	9
Total estimated hours of incubation before 5th egg	55.1	50.1	40.6	20.9	—
Hours hatched before 5th egg	36.5	28.7	17.2	6.2	—
Hours unaccounted for by difference in incubation	18.6	21.4	23.4	14.7	—

Care of Young

A striking change in male behavior at hatching apparently was set off by visual stimulation when the male saw the young in the nest. The female communicated the presence of the young by rising from the nest. Both spent a few minutes looking down into the nest, after which the male flew away, and the female settled back on the nest. Two developments followed: first, the male, previously having fed the female mulberries or wild cherries, produced on his next visit a white soft material which seemed to consist of a mass of small caterpillars; second, the average of nest visits was accelerated from 1 visit every 30 to 45 minutes to 1 every 15 or 20 minutes. It definitely was known that the male at Nest 41-10A did not see the young before 6:25 A.M., and the first appearance of the new type of food occurred at 7:12 A.M. Also at Nest 41-10B the male first saw the young at 12:30 P.M., and at his next visit at 12:58 P.M. he brought insect food for the first time. The characteristic pattern of feeding has been described well by Lea (1942: 232).

Attempts to feed the young usually began within 2 hours after the first young hatched and often earlier. At Nest 41-10A, on August 17, only 20 minutes after the young was out of the shell, feeding was attempted. Gross (1929) saw feeding on the first day. Feeding progresses with considerable regularity after the first day. Post (1916) gave a good report of second-day feeding. From the third day on the food brought to the young is largely fruit. Lea (1942: 233–234) gives data on this somewhat unusual condition.

In regard to brooding all observations during this study indicate that the male did not brood. The female broods almost continuously for at least 3 days as 2 records for the third days after hatching showed the female to be on the nest for 89.6% of the observed time and 93.7% of the observed time (8–10 hours), respectively. From the third or fourth day after hatching a considerable decrease in the nest attention of the female was noted. The female does not desert the nest area as brooding wanes but perches in the nest area and guards the young. This guarding behavior is noticeable particularly after the eighth day. At Nest 45-08B on August 20, the eighth day, the female spent more time standing near the nest rim or perched in the tree than actually on the nest and on 1 occasion drove a grackle from the nest area. The fact that the young are becoming more active might play a part in reduction of brooding. Unusual stimuli may result in a recurrence of brooding as at Nest 46-07A when the female stayed on the nest continuously during the morning of the tenth nestling day in response to a heavy rain.

As brooding diminishes the female starts to make feeding trips. Feeding trips by females during the first 5 days usually are infrequent. At 2 nests feeding trips were not noted the first 2 days during 8 hour observation periods. One female captured a mayfly while brooding and attempted to feed it to the young on the third day but made no other feeding trips in a 3 hour observation. During a 4 hour observation no feeding trips by another female were observed on the third day.

Both sexes are active in nest sanitation. After feedings the adults probe the anal areas of the young and invariably eat the fecal sacs. During the first 10 days this behavior occurs as frequently as feeding (see Fig. 3) but then decreases when the young begin to defecate in or over the nest rim. The Figure 3 published by Lea (1942) is typical of the process as seen at Put-in-Bay. An excellent description of the nest sanitation behavior was given by Littlefield and Lemkau (1928).

The relationships between the brooding of the female and the feeding cycles of both males and females are shown in Figs. 3 and 4. The graphs of feeding are based on averages of several observations taken at 8 nests involving 90.5

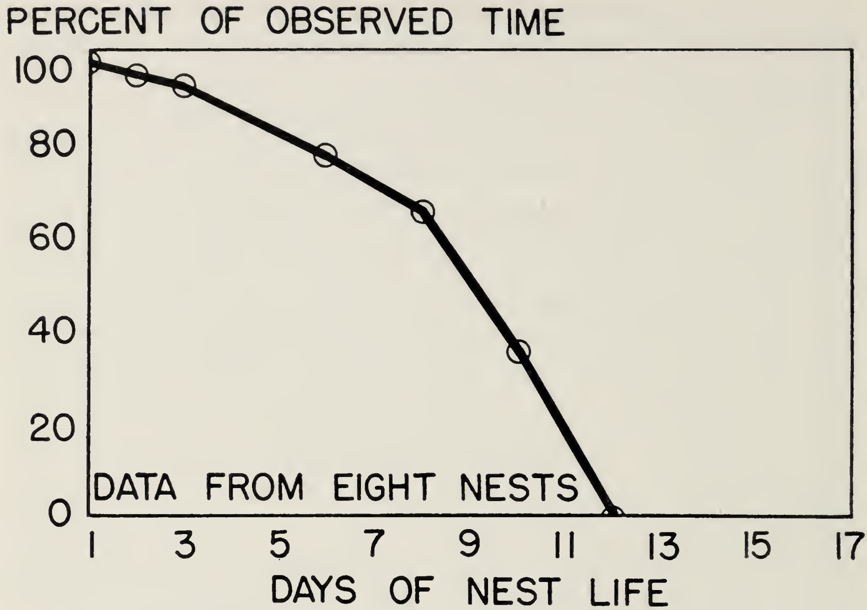

FIG. 3. Relation between time on the nest (during daylight) and day of nest life

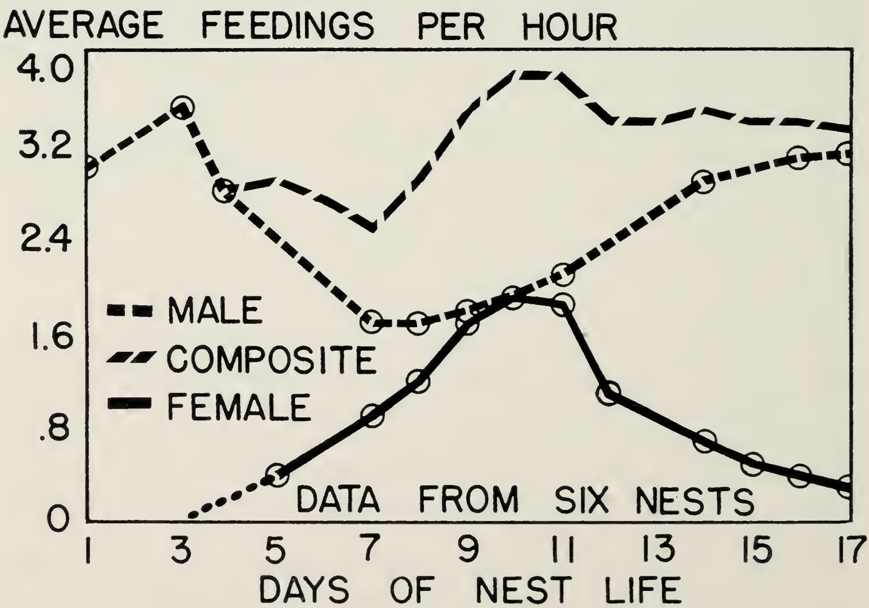

FIG. 4. Relation of average feedings per hour and day of nest life

hours of observations and are illustrative of the trends which have been noted in the field. During the first 5 days, when the female spends 75% or more of the daylight period in brooding, little time is available for feeding activity. As brooding decreases, feeding by the female increases until the latter part of the period, when the feeding activity is reduced or in some cases absent. This clarifies the behavior of the sexes as described by Littlefield and Lemkau (1928) who noted that both birds brought food to young on the ninth day but as late as the twelfth day found 1 bird perched in a tree while the other did most of the feeding. Post (1916) also did not specifically mention the presence of both birds at the nest after the tenth day.

The frequency of feeding by the male generally is inverse to that by the female. There is a sharp increase at hatching, followed by a decline in the early part of the nestling period, and then later by a gradual increase at the time of fledging. The composite graph line (Fig. 4) is the sum of feeding visits by the male and female. It should be pointed out that with the interaction of male and female feeding, the food delivered to the young is very probably proportional in amount to the requirements of the various growth levels of the young. Following the composite graph line it can be seen that during the period of rapid growth of young (days 4–10, Fig. 4), the total of food trips per hour increases. When the growth rate of the young diminishes, the rate of feeding also levels off but is maintained at a high level. The reduction of male feeding trips during the first 5 or 6 days may not involve a reduction in quantity of food since at the third day, as stated, there is a change from insect food, which probably is not regurgitated and thus carried only in small amounts, to fruit. Considerably more of the berry or fruit food can be carried per trip.

The young are fed by the parents for 6 to 10 days after fledging. In the 7 pairs, Table 1, which renested only the males fed the fledged young. Three cases were observed at Put-in-Bay in which females successfully reared young when males disappeared. At 2 nests where females were lost both males deserted the young.

Development of Young

The young of 1 nest were studied twice daily, at 5 A.M. and 5 P.M., from hatching until fledging. These data supplemented by other observations at 9 nests form the basis for a brief outline of development.

The newly hatched young were completely naked when examined under a binocular and the skin was soft and pink. The skin began to darken especially on the femoral, sacral, and primary regions when the young were half a day old. By the evening of the second day the rectrices had penetrated the skin slightly, and feather sheaths had ruptured the skin in all the principal feather tracts on the fifth day. The most noticeable change in plumage occurred on the ninth and tenth days when the feather sheaths rapidly disintegrated and the young suddenly appeared in almost full feather (Herrick, Fig. 137). The plumage was quite complete by the fourteenth day although the rectrices were not full length.

During the first days of nest life the main activities were gaping and defecating. On the third day the young were able to maintain a sitting position (Herrick, Fig. 136) and also to produce a faint buzzing call note. On the sixth and seventh days wing movements were observed and the eyes were partially opened. By the ninth day the birds gaped at the hand and gave very audible begging calls. The legs were sufficiently developed that banding was feasible. During the eleventh day of nest life the young answered calls of their parents and "froze" in response to warning notes. They stood up, gaped, and begged when other waxwings gave calls in the vicinity. On the twelfth day and after

TABLE 6
Individual Weights of Young—Nest 46-22

DATE	"YELLOW" WEIGHT		"GREEN" WEIGHT		"BLACK" WEIGHT		"TAN" WEIGHT	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
Aug. 10		2.7g.		3.2g.		3.2g.		
11	3.5g.	5.4	3.6g.	5.2	4.0g.	6.2		3.2g.
12	5.5	7.9	5.3	8.1	6.7	8.7	3.7g.	5.4
13	7.4	11.1	8.2	11.9	8.1	12.9	5.4	8.3
14	10.9	14.9	10.7	15.6	11.8	16.3	8.5	12.6
15	14.1	17.8	14.2	19.1	15.1	20.4	11.1	17.0
16	16.3	22.5	18.8	22.2	18.3	23.5	14.5	20.2
17	20.9	26.9	21.3	25.5	22.4	27.3	18.4	24.3
18	23.6	28.3	24.5	29.6	25.0	30.6	22.6	28.5
19	26.4	30.8	28.5	30.7	28.7	31.6	27.1	31.7
20	29.1	30.1	30.1	31.6	29.9	31.7	29.1	31.4
21	29.8	32.0	31.0	33.5	31.0	33.2	30.3	34.5
22	32.4	35.0	31.6	33.0	31.0	35.2	33.4	36.2
23	33.5	32.2	32.6	34.0	33.3	33.9	33.7	35.6
24	31.2	32.8	30.4	34.3	32.6	33.8	34.4	35.8
25	Fledged		Fledged		Fledged		Fledged	

there was much activity demonstrated by stretching, wing movements, and preening. At this time the young may be flushed easily although until the fifteenth day are not able to maintain level flight. The general behavior and growth agreed favorably with descriptions by Post (1916) and Saunders (1911).

Table 6 summarizes the weight changes of young during nest life. Review of this table shows the rapid weight gain of the 46-16B nestlings during the first 10 days. Using the morning weights, which were subject to less fluctuation and thus give a more exact representation of the weight, it can be calculated that the average daily gain in weight for these days is 3.1 g. per day. This is a gain in weight per day approximately equal to the average hatching weight of 3.1 g. After the tenth day there was a leveling off of weight gain followed by a drop just before the young left the nest. The 4 fledglings gained weight with equal rapidity and individual weight curves drawn from the data in Table 6 show similar sigmoid curves. Schrantz (1943) studying the Eastern Yellow Warbler shows graphs indicating a similar rapid growth period followed by decelerated growth as the young left the nest. He stated also that, "The last hatched of any nest may gain weight as rapidly as the first hatched". The overnight weight loss of the 46-16B nestlings was not excessive when compared with other species. Nice (1929) found that captive Mourning Doves lost between 8 and 9% of their early morning weight. Taber (1928) found an average of 7.7 per cent overnight weight loss for 15 species, and Kendeigh (1934) noted a 10 per cent loss in English Sparrows and a 14 per cent loss by House Wrens. The maximum relative weight loss of these young occurred during the sixth and seventh nights when the weight loss percentages were 9.08 and 10.23, respectively. For the first 3 days, overnight weight loss was minimal. Starting with the third night the weight loss increased rapidly, averaging 8 per cent for the third, fourth, and fifth nights. Weight loss continued about this level through the ninth night and then underwent a reduction to about 5 per cent during the following 4 nights. On the fourteenth night a sharp increase to 8.2 per cent weight loss was noted. Further study of these weight losses should reveal corresponding changes in the metabolism of the young.

Following the progress of the young after fledging was made possible by banding. For the first 3 days after leaving the nest the young are very dependent upon the parents, stay close to the nest during the day, and roost nearby at night. In 2 instances the young were not seen farther than 75 feet from the nests during the first 2 days, and in 6 cases the birds were 100 yards or less from the nests on the first 3–4 days. These young roosted in the area at night for the first 3 days, often perching close together. The movement away from the nest after this early period is probably related to the ability of young to feed. On the first day out of the nest the birds often pick at matter on leaves nearby. On the second day there is some improvement and one of the young (18 days old) was noted walking up and down a limb hunting and eating insects. This young was alert and fast in picking up food and on 1 occasion wiped its bill in adult fashion after eating. On the third day after leaving the nest the fledglings fed more by themselves. This feeding was particularly noted at 46-15A where 19 day old young were seen alternately eating currants and being fed by the male in Webster's orchard. The young are fed in part by the parents for 7–8 days after leaving the nest. During the first days out of nest the fledglings had some difficulty in landing, but by the fifth or sixth day they controlled themselves almost as well as the adults. Young at 46-15A fledged July 18 and were observed July 23 flying and handling themselves well. At this time their tail feathers were considerably developed, a structural factor probably important in this behavior change because landing precision of 3 adult birds noted with mutilated rectrices was also reduced. Nice (1941a) noted landing difficulty in her captive waxwing until it was almost 4 weeks old.

Independence probably is attained by the age of 25 days; almost certainly by

30 days. At least after this age the fledglings have not been observed being fed by the parents and have left the nest area. After independence is attained the young form small flocks which fly about feeding and catching flies. These flocks are seen in the latter part of July and early part of August. Instances of these juvenile flocks are cited under "Social Behavior". Toward the end of August these flocks may be composed of both adults and young. Crouch (1936) noted mixed flocks in late summer.

Renesting

At Put-in-Bay there is reason to believe that under favorable conditions most waxwings would rear 2 broods of young in a shorter span of time than might be expected since some of the activities at both nests may proceed concurrently. Of 8 pairs of waxwings which were together at the fledging of the first brood and in which 1 or both birds were banded and their identity definitely known, 7 were found rearing a second brood. These 7 pairs (Table 1) demonstrated a considerable overlap of activity at the 2 nests. During observation of first nests it appeared that the reduction of brooding during later nest life coincided with the resumption of courtship. Courtship behavior may appear after the seventh nestling day. Among 6 of the pairs listed courtship was seen once on the eighth day, twice on the ninth day, thrice on the the tenth day, and consistently in all by the thirteenth day. Building started within a day of courtship in the 4 cases where starting of the second nests was observed. Pair 46-07A was noted picking up building materials on the eighth nestling day, the same on which they resumed courtship. During this phase of the nest cycle the male is at the peak of activity. In addition to feeding the first young and courting the female he builds with early season vigor on the second nest. It was during this period that the male of 46-07A was trapped while obtaining nesting materials for the second nest. This bird was caught and banded at 12:52 P.M. July 21 and was seen at 7:22 A.M. July 22, feeding the young of the first nest. Observations during the day showed him to be building, courting the female and feeding the young about once every 20 minutes. During the afternoon from about 3:52 to 4:52 the male made either a feeding or building trip once every 7 minutes, which exceeded the female in building and feeding trips about 5 to 1. As mentioned under "Care of Young" the attention of the female to the first nest decreases at this time; however, as egg laying at the second nest approached the female became more active in building at the second nest. The resumption of begging behavior by the female occurred also.

The laying of the first egg in the second nest varies from the day before fledging at the first nest to 3 days after. The number of eggs in second nests tends to decrease slightly, there being an average of 4.57 eggs per nest in the first nests and 3.86 eggs per nest in the later ones . This corresponds with the data given previously on early season and late season nests.

With the exception of the male activity in feeding the first young the nesting behavior at the second nest is similar to that of the first. After 4–5 days when the young have moved away from the nest it is identical. In the later part of the second nesting the activity of the female in feeding the young is reduced as at the first nest but no further courtship behavior between the pair has been seen. How long the family remains together and what relationships exist are unanswered questions, requiring additional data. Theoretically, if the nesting cycle of a waxwing were to be repeated, 2 broods would be reared in about 75 days from beginning of construction of the first nest. The data from Table 1 show that Cedar Waxwings can nest and fledge 2 broods in from 60 to 69 days, or an average of 64.67 days. This rapidity of reproduction results from a definite overlapping of the 2 nesting cycles, in which building of the second nest may appear as much as 7 days before fledging of the first young. Frequently egg laying may take place in the second nest before the young of the first are fledged. At the nests shown in Table 1, attempts to trap and band the birds were made when second courtship should have recurred, a time probably critical to the beginning of the second nest, and the removal of this interference might further condense the production time of 2 broods. The data indicate that in a nesting population of waxwings, nesting overlap is certainly common, and with no interference it would occur regularly as part of the breeding cycle. Figure 2 supports this conclusion since the date of laying of first eggs in 104 nests reveals a peak from June 20 to 26 and a corresponding peak from July 20 to 28. The average time lapse between the known first and second nests was 29.84 days.

The overlapping of first and second nests is made possible by the tremendous activity and close cooperation of the pair. Two conditions notable in the behavior of waxwings which seem to be particularly involved in bringing about this relation are: the maintenance of the bond between the pair, and the assumption of the feeding of the young by the male during the latter part of the nestling period. Certainly the first factor is obvious since continued contact between the pair would facilitate courtship. In many species, i.e., Song Sparrow (Nice, 1937), English Robin (Lack, 1946), and House Wren (Kendeigh, 1941), territorial behavior tends to hold the pair together. In the waxwing where territory is not a completely isolating mechanism, the extended courtship behavior probably is the binding factor.

In regard to the second factor, Kendeigh (1941: 118) pointed out that male attention at the first nest aided remating for a second brood since the physiological condition and behavior patterns could be maintained in adjustment. This seems to apply in waxwings especially because of the relation between feeding and courtship. Fig. 4 is a graphic summary of the attention of the pair. Here the reduction of brooding by the female can be compared with her increased feeding activity during the early part of nest life. After the tenth day the high feeding activity of the male concurs with a reduction of activity of the female thus permitting physiological readjustments involved in egg production. The fact that such adjustments are in progress is evident in the changes in behavior at this time. The material fact that eggs are found in the second nest before or at the time of fledging is proof that the changes are complete and the second nest is well under way.

Social Behavior

Social behavior perhaps is not as well developed in birds as in some groups of animals, but it is definitely apparent in the activities of birds when groups, under given conditions, act as a behavior unit rather than as several individuals. Cedar Waxwings demonstrate social characters throughout the year, except as stated above, not in the breeding territories.

Large flocks of waxwings are often seen during the fall, winter, and early spring. The compactness of the flock while in flight, perching, bathing, or feeding, and the unending communication by means of the "flock call" are evidences of gregarious behavior. Typical of many similar observations in the literature are those of Staebler and Case (1940) and Feltes (1936). An excellent example of flock unity was observed by Dr. Charles F. Walker at Put-in-Bay when 1 of a group of waxwings was struck and killed by a Sharp-shinned Hawk (*Accipiter striatus*). The birds "froze" as a group and shortly flewaw ay with extreme speed in a compact body.

During the breeding season large flocks are unusual but small social units composed of birds nesting in the same area are common. Due to the shape of the island, 2 definite groups could be identified at Put-in-Bay, one from Peach Point and the other from Webster's orchard. These groups often fed together in a large mulberry tree but behaved as separate units, arriving and departing at different times. The groups were identifiable by certain members which were color banded. In the vicinity of the nests known individuals and pairs have been seen joining or separating from the group as they passed by on the way to or from the feeding ground. Evidence of social behavior is found also in the change of feeding areas noted during the season. Under the discussion of territorial behavior an example of 6 waxwings feeding on wild strawberries was cited. These birds appeared in this spot, not more than 2 square yards in area, in not over 3 minutes time while the observer was standing only about 75 feet distant. Obviously something in the behavior and calls of the first birds present brought forth an aggregatory response on the part of the others. On a larger scale, observations during 5 summers have shown that the feeding areas of Peach Point birds shift in a regular predictable pattern throughout the season. It is understandable that birds should respond more strongly to certain foods, but it is not probable that acting in complete independence the majority of the Peach Point nesting birds would locate these food areas so rapidly as some of them were over 0.75 mile apart. The mere gathering of food seems inadequate to account for the presence of the color banded female 46-11 feeding with the flock almost a mile distant from the place where she normally gathered food for her young. Saunders (1911) and Nice (1941a) commented on the group behavior of waxwings during the nesting season.

Social behavior is apparent rather early in the life of a waxwing. There seems to be a definite tendency of fledglings to remain together after leaving the nest and to join with the young of other nests in the area into local groups. In 2 instances the banded young from neighboring nests formed a small flock on the 3–4 day after fledging. Small groups of young are commonly seen flying about or feeding after the middle of July. The largest group of juveniles observed in a definite flock was noted on the east point of South Bass Island August 9, 1945, about 6:30 P.M. There were about 30 well-developed young flycatching from a tree and from light wires along the road. Flocks of young are common until the end of August when mixed groups may be seen. Crouch (1936) noted mixed age groups in late summer. The social nature of waxwings was demonstrated by the captive young which at regular intervals fed, bathed, sunned, and flew consistently in the cage as a group.

The Cedar Waxwing is an example of a social species during the non-breeding season but which in summer exhibits both social and territorial activity. The integration of these phases of behavior is an important feature in the life history of this bird since it is intimately related to reproduction and food habits and should be considered further.

The following elements in territorial behavior have been pointed out. First, the pairs are formed when the selection of the territory is made, and both birds are active in its selection. Second, much of the courtship takes place within the territory. Third, the male is more vigorous in defense of the territory but the female is also active against either male or female intruders. Fourth, while the territories are small they are strongly defended and do exist since away from them no intra-specific fighting is observed. These conditions of behavior apparently function in limiting interference with reproduction, as suggested by Nice (1941b). That crowding or interference does limit nesting behavior was demonstrated in 1942 with the captive waxwings. These birds, though kept in a cage 8 ft. by 4 ft. by 4 ft., seemed to be normal in their activity and gave indications of reproductive behavior fairly early in the season. Two nests were started in the cage but so much fighting and confusion resulted that little progress resulted. Attempts at courtship were frustrated continually by direct interference of other birds. When 5 of the birds were removed the remaining 2 finished a nest, the female laid 2 fertile eggs, and 1 young was raised. The activity of the pair and the young in all respects noted was identical with non-captive birds.

The function of social behavior in the waxwing seems to be related to the highly seasonal food. The social responses of fear, sunning, tolerance in the group, and apparent recognition of group members culminate in units which enhance the opportunities of the individuals in obtaining food. Some attempt has been made to determine the factors which control the interaction of these 2 types of behavior. The territorial behavior of birds has been related generally to 2 major factors: seasonal physiological changes and the psychological effect of familiarity with a given area. Blanchard (1941: 12) associated the change from a social level of winter behavior to the more territorial activity which accompanied seasonal physiological changes. Nice (1943: 83) mentions a similar condition, the flocking of birds in cold weather. Physiological change is certainly in part responsible for territorial behavior in waxwings and may account for seasonal variation in a waxwing's aggressiveness, but it could scarcely account for the variation between behavior of a waxwing in the territory and at the feeding place. The factor of nearness to some central part of the territory, usually the nest (Davis, 1941), as increasing the defensive response seems more adequately to explain this change. The behavior of the female is illustrative in this regard since cases were mentioned in which sometimes a mere infringement of territory was disregarded, but intruders approaching the nest were driven off Since the territory is small the basic gregarious behavior could function away from the territory and the stimulus of area familiarity could bring into play the territorial level. An additional factor making possible the interaction of territorial and social behavior is the apparent absence of fighting in defense of mates. Such a condition permits close contact in flight and at feeding areas. On the other hand this might have led to reproductive confusion had not a particularly binding relationship developed between the pairs. When we consider the rather low mortality and the high nesting success of the waxwing it would seem that this integration of the territorial advantage of little nest interference with the normal advantages of social existence make for a rather high degree of efficiency. This efficiency in reproduction as well as in time has been stressed in various parts of this article. Late starting of nesting, cooperation of pair members in nesting activities, contraction of time in brood production, and the integration of territorial and social behavior are conditions remarkably adapted to the food habits of the species. The ceremonies of pairing, courtship, and bond maintaining are associated with food. It cannot be overlooked that the behavior of the waxwing centers in the problem of food. Fruit, which is the major item of diet, is highly seasonal in its availability and in addition is extremely variable in quantity from year to year. The entire sequence of waxwing behavior during the reproductive cycle seems to be admirably adapted to the efficient utilization of this food supply.

Nest Success

Over 200 nesting attempts have been observed throughout the 5 years; however, only 60 are considered here. Fifty-six nests were lost at various stages as the result of observational interference and the remainder never contained eggs. Of this remainder, losses during nest building were: 54.8% caused by storms, 33.3% by desertion of unknown origin, and 12.0% by incompleteness of data. Sturm (1945) found weather to be a major cause of early nest loss over this same area.

Of the 245 eggs laid, 22.9% did not hatch, but only 4.6% had no observable development. Of the 60 nests in which eggs were laid, 76.7% fledged at least 1 young. The greatest cause of nest loss after the eggs were laid was predation. Eggs either were punctured or stolen from 4 nests, and young were taken from 3. Storms accounted for 4 nests. Mites probably caused desertion of 2 nests,

TABLE 7

Frequency of Eggs, Young Hatched, and Young Fledged

EGGS PER NEST	NESTS	YOUNG HATCHED	NESTS	YOUNG FLEDGED	NESTS
1	1	0	12	0	15
2	4	1	0	1	0
3	9	2	4	2	6
4	21	3	10	3	9
5	25	4	19	4	20
6	0	5	15	5	10
Totals.............	60		60		60
Mean...4.08		3.15		2.82	

TABLE 8

Annual Nesting Success

	YEAR					TOTAL
	1940	1941	1942	1945	1946	
Number eggs laid...........................	53	50	43	36	63	245
Per cent young hatched from eggs............	62.3	62.0	83.7	100	84.1	77.1
Per cent young fledged from eggs.............	56.3	48.0	81.4	88.9	82.5	69.8

which were the only ones ever found with mites. At both of these nests the birds had been observed obtaining nesting materials from old nests of grackles which were thought to be the source of the infestation. The cause of loss in the 1 remaining nest was unknown. Cowbird (*Molothrus ater*) eggs were not found in any of the Put-in-Bay waxwing nests. The considerable decrease of loss due to storms during this period can be attributed to the presence of the female in the nest. In the 60 nests, there was an average of 4.08 eggs laid per nest, 3.15 young hatched per nest, and 2.82 young fledged per nest (Table 7). Table 8 summarizes the data by years and as a whole.

The success of these nests is somewhat higher than that reported by Nice

(1937) for 11 studies of open nesting passerine species, and it is well above that of Lea (1942) in his study of waxwings at Douglas Lake, Michigan. His figure, 47.7% success, was based on nests producing fledglings rather than on a comparison of eggs laid to numbers of young fledged. From his Table 1, 25 young were fledged from 44 eggs laid, or 56.82%, a figure more comparable to the data presented here.

In reviewing the nesting cycle of these birds it should be recalled that once egg laying starts the nest is very infrequently left unattended by the birds. With the close incubation by the female and the attention of the male throughout incubation and feeding of young, there is good reason to believe that a high percentage of success should result. Since practically all nests known in this area were observed or checked in some manner there is a possibility that certain nests discarded because of interference would have been lost through normal desertion. This would tend to result in an increase in the percentage of nest successes. On the other hand failure to appreciate interference with nests could have been responsible for figures of lower percentages. To be valid, nesting success measures probably should be based on even larger samples with the factor of interference reduced to a minimum.

Summary

A study of the Cedar Waxwing was conducted at Put-in-Bay, Ohio, during 1939 and 5 additional summers. The Put-in-Bay area consists mainly of summer residences, old orchards, gardens, and vineyards. The objective was to determine the relationships between individuals or groups and their environment. Birds were trapped and color banded for identification.

An erratic winter population is present in this region in most years but never in sufficient numbers to account for the nesting population which arrives during the latter part of May. Nesting attempts are noted immediately but many of these early nests are not successful, and the height of the reproductive season is delayed until the middle of June. The movements of the birds throughout the summer are related to the seasonal fruits which compose a major part of the diet of both adults and young.

Pairing probably occurs in the flock or soon after arrival of the birds. Sex recognition involved in pairing is based on behavior probably instigated by the male. When the female responds a highly stereotyped "courtship dance" occurs which often is followed by fast circular flights. Following pair formation the members of a pair associate almost constantly and may stay together throughout the breeding season. The cichlid fish type of pairing behavior (Lorenz, 1937) seems to best characterize the waxwing, and no sexual dominance is apparent.

Small territories are established in which mating and nesting occur. Both sexes defend the territory although the male is more aggressive. Defense of the territory diminishes during feeding of the young. The same territories may be

maintained throughout the breeding season, although occasionally shifting does take place when second nests are built.

Courtship follows pairing and progresses through 2 phases: (1) a bond-strengthening display which culminates in copulation, and (2) a bond-maintaining display which continues throughout much of the nesting cycle. The focal point of both phases of the courtship display is the presentation of food, either actual or symbolic.

A distinct advertising song is not present in the Cedar Waxwing although several call notes are given by both sexes. Voice functions in individual and species recognition and is important in pair relationships, as well as in group activities.

The nest site is determined by the pair; the female, however, seems to be more active in its selection. Nests are constructed of various plant fibers and small twigs. They are somewhat bulky in appearance but usually are supported securely in a horizontal limb fork. Both sexes build and nests are completed in an average of 5.55 days. Egg laying takes place between 5:00 A.M. and 8:00 A.M. Early season nests have more eggs, averaging 4.5 per nest, while later clutches average 4.0.

Incubation is performed entirely by the female. During incubation attentiveness for the day is heightened as the incubation period progresses. The tendency to incubate manifests itself before egg laying and gradually increases as the eggs are laid. After the last egg is laid, attention rarely falls below 90% of observed daylight time. Periods of attention by the female are of unusual length, often extending more than 2 hours. While incubating, the female is fed frequently by the male either at the nest or on a perch near by. Females make some food forays alone. The eggs hatch over a period of 2 days, in the same order as laid, and the incubation period is 12 days, 5 hours (293 hours), using the last egg as a standard. The first eggs laid seem to receive more incubation before hatching than do the later ones.

At hatching there is a change in the type of food presented by the male at the nest. The fruit which the male has brought previously to the female is replaced by insect food, which both parents feed to the young. This feeding of insect food continues for approximately 3 days, after which fruit is again brought to the nest. Both sexes remove the fecal sacs ejected by the nestlings. Females brood closely for the first 3 or 4 days, after which brooding diminishes, ceasing entirely by the twelfth day.

As brooding diminishes the female gradually increases feeding of the young until the tenth day, when a rapid decline is noticeable. An increase in male attention at hatching is continued for the first 3 days, and then is followed by a decline until the seventh day. During the latter part of the nestling period the male assumes the major role in caring for the young.

Newly hatched young are devoid of natal down. Their skin color at first is pink, but areas in which feather development takes place become darker on the first day. By the tenth day the plumage of the nestlings is fairly well developed, although it probably is not complete until a week after the young have left the nest. The nestlings gain weight rapidly for the first 10 days, less rapidly for the next 3 days, and decrease in weight shortly before fledging. The length of the nestling period averages 15.9 days, and young which remain in the nest for the full term are able to fly well upon leaving the nest. The young tend to stay together and are fed by the parents for at least a week after fledging. The fledglings from several nests form small flocks which often feed in the nesting area.

About the ninth day of nest life the first phase of courtship may recur and a second nest be built, in which eggs are laid before or soon after the first young fledge. The average fledgling time for 2 broods is 64.67 days from the beginning of building of the first nest. First broods fledge on the average in 34.83 days; the second follow in 29.84 days. Overlapping of broods results from the tremendous activity and close cooperation of the pair.

Cedar Waxwings are gregarious and even during the breeding season display social characteristics when away from their territories. Groups of the birds, seemingly local units, fly from the nesting regions to the feeding areas where they associate without discord. Social behavior is apparent early in the life of the waxwing when young birds tend to form small flocks. The integration of social behavior with territorialism is an important factor in the ecology of waxwings since nest life is free from interference, yet group activity enhances the procurement of food. Many of the distinctive features in the reproductive behavior of these birds seem to be related to the seasonal character of the food upon which they exist and upon its very local distribution.

As compared with other passerine species which nest in open situations, waxwings are fairly successful in the production of young. Of 60 nests which contained eggs, 76.7% fledged 1 or more young. Of 245 eggs laid, 77.1% hatched and 69.8% young fledged. The eggs are 95.4% fertile. The relatively high rate of success is due in part to the large amount of time which the adults spend near the nest after the eggs are laid. No parasitism by the Cowbird (*Molothrus ater*) has been noted.

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BIRDS AND HUMAN DISEASE

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CONSIDERING the abundance of birds, both domestic and wild, one is astonished to realize that they play so small a rôle in human medicine. The mammals with which man is closely associated frequently share their diseases with him—in fact it is sometimes a matter of sharing in both directions: were either man or his mammalian companions to cease existing, some parasites would automatically become extinct. This is true, for example, of the beef tapeworm, for which man is the only known final host and for which cattle are the only intermediate hosts.

But with birds the situation is entirely different. There are but a few instances in which an avian host is essential to the maintenance of organisms that are capable of infecting man. In some other cases birds divide the capacity of acting as disease carriers with mammals in the same environment, thus merely enlarging the scope of the total reservoir. Generally, however, birds appear to be immune to the creatures that cause human ills, and man likewise is barren ground for would-be invaders from birds. No one can guess how many mosquitoes, laden with infective sporozoites of avian malaria, have bitten human beings—yet there is not a case on record of bird malaria infection in man. Nor has human malaria been encountered in birds.

From the physiological standpoint it is not so amazing after all to contemplate this apparent chasm preventing cross-infection between birds and man. Phylogenetically birds are closely related to reptiles, while a vastly nearer bond unites man with other mammals. But it would be hard to define just what the physiological differences are, since it is difficult to imagine why the warm circulating bloods of a bird and a bat should be individually so unique as to be welcomed by a parasite in one case and repudiated by it in the other. If, however, host specificities exist even among the mammals themselves (and they do, often with sharp distinction), it must be natural for a much wider gap to obtain between mammals and birds. It is this biological discrepancy, seemingly, that results in the small list of diseases common to birds and the human race.

To begin the discussion, it would perhaps be best to mention the general "medical" effects of birds in man's environment. The avian army's war on insects has been mentioned so often in connection with agricultural topics that its controlling activities against arthropod carriers of disease may have been neglected. The numbers of yellow fever mosquitoes or dysentery-carrying house flies consumed by birds can never be estimated, although they are undoubtedly significant. No one is to blame for the oversight, since it is usually impossible to appraise such situations.

"Usually." There is an interesting example, however, that makes necessary the use of the qualifying adverb. In Egyptian hieroglyphic writings the sacred ibis plays a prominent part in the religious ceremonies of the people. Apparently the bird achieved its position of veneration through the astute observation of the Nile inhabitants that tributaries on which ibises could be found were healthful places for human beings: No ibises, poor health.

Such things smack of folk-lore and superstition, but a modern scientific explanation has justified the 5000-year-old myth. Ibises are famous snail-eaters, and it is obvious that where these birds are common, the snail population will be reduced. It so happens that in the Nile Valley two forms of the disease called schistosomiasis exist in endemic form. Schistosomiasis is an infection of the small veins of certain abdominal viscera by blood flukes, the schistosomes. Eggs of these flatworms are discharged in urine or feces of infected individuals, and the eggs, upon reaching fresh water, hatch into primary larvae that bore into the bodies of certain snails. After a period of larval development in these intermediate hosts, asexual multiplication results in the liberation of clouds of secondary larvae. If a human being now bathes in the water, or merely wades in to fill a vessel, he is attacked by the secondary larvae which penetrate his skin, invade the blood stream, and finally mature as adult flukes in his abdominal venules. The Egyptians would have been fully aware of schistosomiasis areas, but the wonder of it is that they made the connection between ibises and freedom from disease.

Ordinarily no such nice demonstration of birds' asset to the environment is possible. Modern human populations being so mobile, so destructive to the natural environment, and so disquieting to bird economy, those balances that exist are constantly being disturbed, and practically the only way one can observe a balance of nature is from the standpoint of the degree of its departure from equilibrium. The vultures along highways in the southern United States seem almost conditioned to the abundance of hog and cattle carcasses in "open range" districts; here they continue to be of use in consuming carrion. But could one draw a conclusion comparable to the one involving sacred ibises? There is nothing implicit in the vulture-automobile situation except that cars have been bumping into cows for the past few decades.

Vultures, and birds of prey that kill live quarry, may serve as disseminators of fleas and other ectoparasites capable of infecting man with such diseases as plague, tularemia, and Rocky Mountain spotted fever. It is possible that they also spread anthrax spores from diseased carcasses.

The question of migration as a means of introducing exotic diseases has been voiced occasionally, but as yet there is no knowledge of trans-continental or trans-hemispheric spread of human infections by migrating birds.

In a few specific cases, however, one can pin birds down as real biological reservoirs of diseases of mankind. Several forms of encephalitis may be the most common and important examples, although some less significant diseases have received wider publicity. The encephalitides, including St. Louis encephalitis, Japanese B encephalitis, and eastern and western equine encephalomyelitis, are virus diseases affecting man, other mammals, and birds. They are transmitted chiefly by mosquitoes. Their status at present is hard to define, since new virus modifications are being discovered with great rapidity; moreover the list of bird hosts is increasing with almost equal speed.

The part birds take in this scheme is apparently related to a typical epidemiological series of events. At the beginning of the breeding season there are many immune adult birds and few susceptible ones, due to exposure and infection of the majority during the previous year. There are therefore few virus carriers. In addition the mosquito population is at a low ebb, there being few individuals available to serve as transmitters. As the season progresses, mosquito-breeding advances rapidly, so that before long there are: (1) an entire new population of susceptible birds and (2) a swarm of new mosquitoes ready for the business of virus transmission. Hence within a few months encephalitis virus is widespread in the environment, reaching its peak about August. The human disease appears at this time, as a "spill-over" from the bird-mammal epizöotic, and continues until frost does away with most of the mosquitoes.

Ornithosis—a form of atypical pneumonia or virus pneumonia—is one of the publicized recent medical discoveries. It has been found that semi-wild pigeons in large cities are sometimes naturally infected with the causative virus, and it seems on epidemiologic grounds that they may be the source of occasional human infections. One large eastern city became so concerned with the problem that it passed an ordinance forbidding the feeding of pigeons in public parks. It took the pluck of an elderly lady to test the strength of the prohibition: she was caught, blatantly gorging pigeons on peanuts, and her trial made the front pages of the newspapers. Meanwhile young sympathizers equally blatantly strolled through the parks with bags of cracked corn—bags with large holes in them, although the strollers of course had no idea of such defects. The pigeons have fared well through their public supporters.

The host range of ornithosis virus among birds is only partially known. A signal point of its prevalence is in birds of the parrot-parakeet-macaw group, where the disease is called psittacosis. A respiratory malady transmitted as an airborne infection directly from sick birds to human beings, it is responsible for present quarantine regulations against the importation of psittacine birds from South America. Foci of psittacosis in aviaries of parrots or love birds already in this country are stamped out as soon as detected.

The obscure disease, toxoplasmosis, probably of protozoan etiology, is being recorded from a growing list of mammals and birds. Nothing is known of its transmission, although human infants born of infected mothers have died of its effects on the central nervous system. As widespread as toxoplasmosis is, it will probably not be too long before some research group gives leading information on the subject, and then it will be possible to state whether avian *Toxoplasma* organisms and the ones infecting mammals are one and the same.

Swimmer's itch, finally, is an ill attributable directly to birds in some instances. As in the case of the Egyptian blood flukes, a combination of warm-blooded hosts, snails, and schistosomes is involved. But in this example the final host is a teal or muskrat. The human bathers in a Wisconsin lake or neighboring resort waters who encounter secondary worm larvae, find themselves covered with itching welts that may become encrusted and infected. Not only do the victims regret the situation; the worm larvae, attracted only by the stimulus of a warm-blooded skin, die as a consequence of their entry into a wrong host. For here again is the formula of host specificity: a schistosome of teals cannot mature in man. After causing the people sufficient pruritic agony and bewilderment, the larvae die. Eventually the superficial dermatitis terminates with the sloughing of a final crusted scale.

A consideration of the relation between birds and human disease should not be concluded without mention of the place of birds in medical research. For a number of years canaries and ducks have been used extensively in malaria research. At present the barnyard chicken is emerging as the darling of medical science—not by its proud male struttings, but by the triumphal cackling of the hen that lays a fertile egg. One can hardly conceive of the use to which fertile eggs may be put ultimately, when one scans what is being done at present. Incubated eggs, inoculated with various viral and rickettsial (typhus-like) agents, have recently provided vaccines in sufficient abundance to protect entire populations of human beings against diseases that were formerly not to be combated. The lowly egg, previously valued chiefly at breakfast, has become the greatest tissue-culture vehicle ever imagined.

Suspensions or extracts of various tissues of embryonated hens' eggs yield materials useful either as vaccines in immunizing human beings and domestic animals against disease, or as antigens in performing laboratory tests for the diagnosis of the same diseases. Heretofore these products were available in extremely low abundance, sometimes even obtained by the painstaking dissection of the digestive tracts of infected lice and ticks.

Eggs are being used currently also as media for the growth of all sorts of foreign tissues. They may therefore afford a new avenue for cancer investigators.

Thus it can be seen that some birds are doing their best to atone for the disease-spreading activities of their less considerate relatives. Since the score against birds is a very small one anyhow, one may suggest that the wrong has already been over-compensated.

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GENERAL NOTES

HAWKS TRAPPED NEAR STILLWATER

During the fall, winter, and spring of 1947 and 1948, Mr. Driskel trapped hawks and other predatory birds on his farm in the tallgrass prairie type 8 miles east of Stillwater, Oklahoma. The area consists of rolling pasture lands, cut through at intervals by streamways lined with elms, willows, and other bottomland trees, and with the blackjack-postoak forest type not far distant in any direction. The following species were examined by us on April 5, 1948:

Marsh Hawk	91
Crow	85
Red-tailed Hawk	82
Horned Owl	8
American Rough-legged Hawk	4
Short-eared Owl	3
Barred Owl	1
Sparrow Hawk	1
Swainson's Hawk	1
Sharp-shinned Hawk	1
Screech Owl	1
Prairie Falcon	1
Total	279

Mr. Driskel explained that most of these birds were taken in small steel traps set on the ground, although a few were set on poles. Most of the traps were baited with jack rabbit, but others with tethered birds or live bait. It may also be of interest that practically none of these birds, with the possible exception of the Sharp-shinned Hawk, can be considered harmful from the standpoint of the economics involved.

The catch cannot be considered representative of the population since only those species were taken which were amenable to capture by steel traps mostly set on the ground; nevertheless, the record gives some indication of the composition of the migratory and resident predators found in this part of the country during the cooler parts of the year.—Fred M. Baumgartner, Department of Zoology, Oklahoma Agricultural and Mechanical College, and Walter P. Taylor, Oklahoma Cooperative Wildlife Research Unit, Stillwater, Oklahoma.

BUTCHER BIRD FEEDS ON GROUND SQUIRREL

On June 7, 1948, on rolling prairie land north of Elmira, Solano County, California, Gunnar Larson and I found a nest of the California Shrike (*Lanius ludovicianus*) 6 feet from the ground with the dried skin of a Douglas Ground Squirrel (*Citellus douglasii*) hanging from a twig 10 inches from the nest. The flesh had been stripped from the squirrel's body, leaving the head, the skin, and leg bones attached to the skin. I concluded from the available evidence that some mammal, or possibly a Turkey Vulture, had stripped the squirrel prior to its discovery by the shrike. The squirrel, after removal of the viscera and a large part of the flesh, would probably not have been too heavy for the adult shrike to carry. The skin was attached to the twig in such a way as only a shrike could have accomplished.—Emerson A. Stoner, Benicia, California.

NESTING OF THE NARROW-BILLED TODY

On June 12, 1930, on the summit of Morne Tranchant approximately 5900 feet above sea level in southeastern Haiti, I flushed a Narrow-billed Tody (*Todus angustirostris*) from an open, level spot where a horse had been tethered. The lush grass had been cropped short and presented a lawn-like appearance. Although I did not suspect a nest, later in the day when I again flushed the tody from the same place my suspicions were aroused. I found the nest in a tiny burrow in the side of a horse's hoof-print. The burrow was almost straight and was about a foot in length, culminating in a small chamber where 2 eggs had been deposited, approximately 1 inch below the surface of the ground. As a result of the daily torrential rains of the season, the "nest" was saturated and the eggs almost half embedded in the soft mud. I collected the eggs, which were fresh and perhaps did not constitute a complete clutch. They measure 15.2 x 13 mm. and 16 x 13 mm. The only other nest of this tody that has been described was found by Abbott on May 9, 1919, below Hondo Abajo, Dominican Republic (see Wetmore and Swales, 1931, *U. S. Nat. Mus. Bull.* **155:** 288–289). This likewise held 2 eggs, one of which contained "a fair sized embryo." They measured 15.5 x 13.5 mm. and 15.7 x 13.5 mm.

It will be noted that eggs of *T. angustirostris* are definitely smaller than those of the better known *T. subulatus*. Eggs (23) of the latter species taken by Abbott in the Dominican Republic measure from 16.4 to 18.8 mm. in length (average 17.5 mm.), 13.8 to 15.1 mm. in width (average 14.4 mm.); eggs (14) collected by me on Gonave Island, Haiti, measure 15.9 to 18 mm. in length (average 16.8 mm.), 13.3 to 14.6 mm. in width (average 14 mm.). In view of the fact that specimens of *T. subulatus* from Gonave Island examined by Wetmore and Swales (*l.c.*, p. 286) were "very slightly larger" than those from Hispaniola, it is rather surprising to find that eggs of this tody from Gonave Island average smaller than those from the mainland.—James Bond, Academy of Natural Sciences, Philadelphia, Pennsylvania.

NESTING BEHAVIOR OF NUTTALL'S POOR-WILL

On Mt. Timpanogos, Utah County, Utah, June 2, 1945, I observed an unusual nesting performance of Nuttall's Poor-will (*Phalaenoptilus nuttallii*). A poor-will was flushed at a distance of about 6 feet, revealing a single egg on the bare ground. Closer examination showed, to my surprise, a second bird sitting close to the exposed egg. This bird made no effort to escape, but allowed me to handle it with little resistance. When this second bird was picked up the second egg of the nest was exposed. Even after being replaced on the nest the bird showed no inclination to escape, but opened its mouth wide, raised its wings, and trembled violently. I finally decided to save the bird as a specimen. It proved to be a male with well developed gonads and the crop filled with insects. Both eggs were completely fresh.

The nest site was on a south-facing hillside where small bare areas alternated with a dense chaparral, chiefly Gambel's oak. The "nest" was situated on a moderate slope, entirely exposed except for a small oak sapling 4 to 6 inches high that gave it a little shade. It consisted of a slight hollow about 4 inches wide in bare earth and without lining of any kind.—C. Lynn Hayward, Brigham Young University, Provo, Utah.

A LARGE NEST OF THE ROUGH-WINGED SWALLOW

On June 2, 1944, 2 Rough-winged Swallows (*Stelgidopteryx ruficollis*), presumably a pair, were observed to be carrying nesting material into the garage at the Cranbrook Institute of Science, Bloomfield Hills, Oakland County, Michigan. This behavior continued sporadically for about 2 weeks until the door was closed for a period of several days. Attempts to find the nest were unsuccessful until June 22, when a large mass of material was found in the open on the top of a tool cabinet 7 feet above the floor and about the same distance below the garage ceiling. The dimensions of this mass were 22 by 17 inches by 4 inches thick at the center. The dry weight was 435 grams.

Structural materials of the whole mass included the following:

Material	Minimum distance carried	Approximate percentage
Dry leaves of quaking aspen	100 feet	50
Dead twigs of quaking aspen	100 "	20
Bark strips of quaking aspen	100 "	10
Dry leaves of Red Oak	150 yards	1
Coarse weed stalks	100 "	5
Twigs of Tamarack	200 "	1
Dry Willow leaves	200 "	1
Dry leaves of Baytree	150 feet	1
Fine grasses	150 "	10
Seeds of Red Maple	200 "	
Strips of paper		
Bits of cellophane	50–100 feet	1
Wooden match stems		
Cigarette stubs		
		100

The actual nest, at one edge of the main mass, was outlined by fine grass stems and weed stalks, loosely constructed and without lining. It measured seven inches outer diameter, $2\frac{1}{2}$ inches inner diameter and one inch inside depth. The one egg was abandoned due to the closing of the garage door which excluded the birds for several days. I find no reference in the literature to such a bulky nest of this species.—Walter P. Nickell, Cranbrook Institute of Science, Bloomfield Hills, Michigan.

LATE BLUE JAY NESTING

On December 2, 1948 I observed 3 obviously young Blue Jays (*Cyanocitta cristata*), later joined by 2 others, being fed by an adult jay at our home on Park Hill in North Little Rock, Arkansas. This continued until December 17th, at which time they began using the feeders themselves. All 5 young were trapped and banded, but not the 2 adults. These young jays were retrapped continually through February 1949; one was retrapped 11 times in 2 weeks. I had never seen them before December 2nd, and know nothing about the nest location, or when they left it, but they were obviously quite young birds having the short tail, general awkwardness, smaller size, and the infantile look about the head, eyes, and beak.—Terrell Marshall, Pyramid Building, Little Rock, Arkansas.

LITERATURE

Comments on Recent Literature

Development of Plumage Color Patterns. For the experimental biologist investigating the factors that control the processes of development, a major problem has been the selection of well defined criteria of embryonic differentiation, which, in response to experimental treatment, undergo definite, unequivocal changes. The striking and intricate plumage color patterns of birds, long recognized as important tools by students of speciation and evolution, afford an unexcelled system for the experimental analysis of problems in embryonic differentiation. Willier (1942, 1948) has emphasized the advantages of the feather papilla in this respect: (1) it appears regularly after plucking the feather and is thus readily accessible for experimental study, and (2) it has many characteristics of a developing embryonic organ, for example, axial organization, inductor action, and physiological gradients in response to various stimuli. Willier also has reviewed the recent advances in our knowledge of the genetic and environmental (particularly hormonal) control of development contributed by studies on the differentiation of plumage pigment patterns in the fowl. Most widely studied have been a group of pigments, called melanins, that are probably derivatives of the amino acid, tyrosine, and that range from yellowish brown to black, and that are deposited in the feather in the form of granules by branched pigment cells, the melanophores. These highly specialized cells have their origin in the embryonic neural crest and migrate while in an immature, unpigmented form (melanoblasts) to the feather papillae of the skin. (For extensive review of this phase of the problem, see Rawles, 1948.)

Of the components essential to melanin pigmentation of the feather, only the melanophores have an extrinsic origin. This condition makes it possible to produce feathers which are characteristic, in every respect, of the pigmented breed from which they were derived, except for a complete absence of color. This production is accomplished by transplanting the embryonic limb bud of a pigmented breed, prior to the entrance of the melanoblasts, to the coelom of a White Leghorn embryo, an environment essentially free of pigment cells, where normally shaped, but unpigmented, feathers are formed.

The melanoblasts, under certain physiological conditions as yet poorly understood, invade the feather papille, and are there subject to the action of environmental factors imposed by the growing papillae. The specific response of the pigment cells is, however, governed primarily by their genetic makeup. For example when neural crest cells of one breed are grafted into an embryo of another breed, the resultant color pattern in the host feather invariably resembles that of the donor breed. The analysis of Willier and Rawles (1944) who tested the response of melanophores derived from embryos that have sex-linked differences in plumage coloration showed that in every instance the kind of response corresponded precisely with the genetic constitution. The response may be uniform in all parts of the body, as in the Black Minorca, or may vary from tract to tract, or even from feather to feather within a tract, depending on the locus of the feather papilla in which the pigment cells occur. However, there is no correlation between the origin of melanoblasts and their differential tract responses. Young pigment cells at all axial levels are identical, as can be seen when they are studied after transfer to ectopic positions. In such experiments the feather color pattern is invariably that of the new position, never of the site of origin. Thus, if melanoblasts of the saddle region are transferred to the wing, the pattern produced is a typical wing pattern. The melanoblast itself, therefore, is not "tract-specific", but is only capable of responding to specific influences of the other components of the feather papilla, and tract differentials must be attributed to regional differences in the physiological characteristics of the papillae. That such differences exist has been shown by injections of female sex hormones into Brown Leghorn capons. In this "estrogen-sensitive" breed, injection of estrogen into the male or capon produces a characteristic abrupt change in pigmentation pattern in the saddle, neck-hackle, and breast regions. The feathers in each region, however, have a distinct threshold of reaction, in that concentrations affecting those in one region may have no influence on those in another. Furthermore, feather papillae within a tract may exhibit an orderly spatial arrangement of response to sex hormones, and in general, the response of the melanoblasts to estrogen is a function of the position of the feather papilla within the tract.

In addition to the melanoblasts, the feather papilla contains 2 components essential to normal differentiation: (1) the dermal papilla is the permanent body of the follicle, without which regeneration is impossible; (2) the epidermal component that, as a result of "induction" by the dermal papilla, produces a new feather. The epidermal component forms anew with each regeneration. In a series of well controlled experiments, Lillie and Wang (1944) and Wang (1943) have demonstrated that the dermal papillae are not tract specific in their organizing action, but that the specificity of response in feather regeneration is due to the specificity of the epidermal component. A dermal papilla of the breast placed in a saddle follicle leads to the formation of a saddle feather, and conversely a dermal papilla of the saddle region placed in a breast follicle induces a breast feather. It would appear, therefore, that the response of melanoblasts to estrogen is conditioned by the properties of the epidermal component of the feather germ. This conclusion has been confirmed by Trinkaus (1948) who further demonstrated that the inability of melanoblasts in young chicks to respond to estrogen is due to an "immaturity" of the epidermis. To show this, it was necessary to combine melanoblasts from an adult (in which they normally respond to estrogen) with epidermis of an immature papilla, and following their establishment, to test the effects of estrogen. The results are summarized as follows: (1) when melanoblasts of regenerating breast feathers of an adult Brown Leghorn capon are transplanted to the wing bud of a 72-hour White Leghorn embryo, the coloration of the down and pigmentation pattern of the juvenile feathers of the host are typically like those of the donor chicks. (2) Upon administration of estrogen, these melanoblasts show no response, which is in contrast to the marked response of similar melanoblasts to estrogen when in the epidermis of breast feather germs of the adult.

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James D. Ebert

Book Reviews

Know Your Ducks and Geese. A. H. Shortt and B. W. Cartwright. Sports Afield Publishing Co., Minneapolis, Minn. 1948. $5.00.

This book, a superb example of a combination of art and science, presents excellent portraits of 36 ducks and geese with concise, modern descriptions. For each species there is a 10 x 12 inch colored plate of 1 or more individuals in flight and, printed on glassine paper, there is a small black and white sketch of male and female on the water, a map of the wintering and breeding distribution and a discussion of distribution, migration, food, weights, courtship, and nesting as well as references and a description of various plumages. The book measures 12 x 14 inches and is bound in padded leatherette. The low price is truely amazing in these days. The plates, made from oils or water-colors by A. H. Shortt, are lively, colorful, have splendid backgrounds, and are true to life. The picture of a pair of Cinnamon Teal exploding from the water, and that of the Baldpates settling quietly into the marsh are especially satisfying. The text, written by B. W. Cartwright, is a model of brevity and clarity. The emphasis on courtship and nesting data exemplifies modern studies of ducks. The Wilson Ornithological Club can indeed be proud that two of its members have produced this outstanding contribution.

David E. Davis

The American Wild Turkey. Henry E. Davis. Small-Arms Technical Publishing Co., Georgetown, South Carolina. 1949. 319 pages, illus. $5.00.

For hunters of our finest game bird, this book provides an interesting merger of personal adventures and opinions with the scientific data culled from the excellent research of Mosby and Handley. Much of the book deals with methods of hunting. Concerning conservation of the turkeys the author emphasizes stocking and control of predators with a bare mention of environmental improvement for turkeys. This book is reviewed here because ornithologists need to be better acquainted with the opinions and problems of the sportsmen.

David E. Davis

The Avian Egg. Alexis L. Romanoff and Anastasia J. Romanoff. John Wiley and Sons, Inc. 1949. xiii + 918 pages, 424 figs. $14.00.

Every serious student of ornithology should examine this book in order to appreciate the vast store of knowledge about the egg of the most abundant bird in the world, the domestic fowl. The ornithologist will be disappointed, however, to find so little about the eggs of wild birds. Indeed, only a few introductory or comparative remarks are included. This discussion of the chickens' egg is divided into 3 parts: morphogenetic expression, biophysicochemical constitution, and bioeconomic importance. From these titles it is obvious that the book emphasizes the physiologic aspects. It is hoped that the appearance of this splendid compendium of information will stimulate an ornithologist to write a book about the eggs of all birds.

David E. Davis

Birds in Britain. Frances Pitt. Macmillan and Co., London. 1949. 576 pages, photographs and 16 colored plates. $7.25.

Those who wish a simple description of the behavior of British birds will find this book satisfactory. Although the colored plates by Roland Green are rather crowded with an assortment of small birds, the photographs, which are present on almost every page, give a good representation of most species. The first 90 pages of the book describe the structure, distribution, migration, and behavior while the rest of the book discusses the species in familial order starting with the Crows. The material is rather anecdotal and unorganized but does provide a general idea of the species. Detailed indices make information easy to find.

David E. Davis

Wildlife Management. Upland Game and General Principles. Reuben Edwin Trippensee. McGraw-Hill Book Co. 1948. x + 479 pp. $5.00.

The field of ecology suffers from a genuine scarcity of attempts to establish general principles. This book is a serious attempt to present the facts and to develop principles for game management, one of the adolescent offspring of ecology. But unfortunately this presentation merely accentuates rather than satisfies the need for generalizations. The book is divided into sections on farm, forest, and wilderness wildlife which discuss the game species of these habitats. The ornithologist will welcome the summaries of the life histories of pheasants, quail, grouse, and turkeys, especially because quantitative data are brought together in tabular form. The last 2 sections of the book, called Wildlife Relationships and Administration, are a condensation of material which was to be added to a discussion of aquatic wildlife in a second volume. Hence, the treatment is sketchy and oversimplified. For example, the discussion of predation, covered in only 9 pages, completely omits the extensive work on theory of the predator-prey system. While this book will be useful for its accumulation of factual matter, it is hoped that the author will be able to publish the second volume.

David E. Davis

High Jungle. William Beebe. Duell, Sloan, and Pearce. New York. 1949. 379 pages, 49 illus. $4.50.

Beebe, who in the past contributed to the science of ornithology, here describes in simple anecdotal style his everyday adventures with the animals in the Venezuelan Andes. Most of the book is about insects but one chapter describes the courtship of some hummingbirds and another tells about the migration of the Blackpoll Warbler. One is impressed by the advantages of the use of telescopes from the laboratory windows; indeed, it was seldom necessary to enter the jungle itself. It is a relief to read a book of tropical natural history which avoids the spectacular and usually fictitious episodes with poisonous snakes and man-killing mammals. A list of published scientific papers from the Venezuelan trips, the technical names of the species, and a fair index complete the book.

David E. Davis

Bird Hiking. Leon Augustus Hausman. Illustrations by Harold Minton. Rutgers University Press, New Brunswick, New Jersey. 1948. 5½ x 8¼ in., 107 pp. $2.00.

Dr. Hausman, recently the author of several bird books including 2 guides (*Field Book of Eastern Birds* and *Beginner's Bird Guide*) has now written this attractive little volume to encourage bird hiking. According to him, bird hiking "is measured, not by the number of miles covered, but by the number of birds seen, or by the number of interesting experiences with birds—or other forms of life or natural objects—that have been enjoyed."

In 5 successive chapters Dr. Hausman tells in earnest detail, sparked with quiet humor, where to go on bird walks, what to wear and what to take by way of essential equipment, how to get close to birds and watch them, when to search for birds, and how to identify birds and become familiar with their habits. In another chapter he explains the desirability and methods of collecting bird nests deserted in the fall and winter. The final chapter is concerned with recommendations of books that will provide the bird hiker with up to date information on birds and other natural history subjects to be encountered.

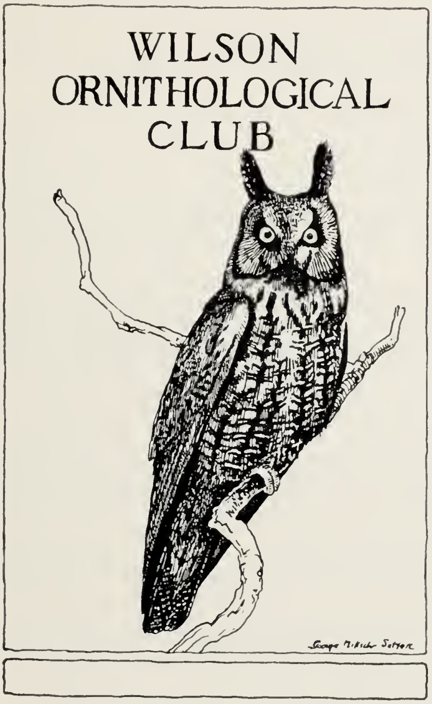
The book is directed to beginning, or potential, bird hikers, not to experienced field ornithologists. Hence it is necessarily elementary,—an approach which is a virtue rather than a detraction. We have here an excellent supplement to many bird manuals and guides which too often ignore some of the simple pleasures and fundamental techniques of bird finding and study on the assumption that they are too obvious, when to beginners they are not obvious at all.

Olin Sewall Pettingill, Jr.

THE WILSON ORNITHOLOGICAL CLUB LIBRARY

The following gifts have been recently received. From:

Ralph Beebe—16 magazines
Milam B. Cater—1 reprint
Ernest P. Edwards—5 reprints
Fr. Haverschmidt—1 reprint
K. A. Hindwood—12 reprints
John C. Jones—11 reprints
Leon Kelso—2 pamphlets
Robert M. Mengel—1 reprint
Margaret M. Nice—2 books, 1 reprint, 1 periodical
Max M. Peet—7 reprints
William H. Phelps—2 reprints
Alexander F. Skutch—8 reprints
Katie M Roads—2 books
J. Van Tyne—18 reprints
L. H. Walkinshaw—1 bulletin, 1 reprint



BOOKS: List 7

Books added to the Wilson Ornithological Club Library since the publication of List 6. Lists 1 to 6 were published in the September issues of *The Wilson Bulletin*, 1943 to 1948.

Anderson, R. M., Methods of Collecting and Preserving Vertebrate Animals. (rev. ed.) 1949.

Brewster, William, Birds of the Cape Region of Lower California. 1902.

Bryant, Harold Child. A determination of the economic status of the Western Meadowlark in California. 1914.

Cory, Charles B , and Charles E. Hellmayr, Catalogue of birds of the Americas. Part 4. 1925.

Edwards, Milne, Zoologie. (12th ed.). 1877.

Fuertes, L. A., and others, Compiled book of plates. 1938.

Gadow, Hans, A classification of vertebrata. 1898.

Goethe, Friedrich, Vogelwelt und Vogelleben im Teutoburgerwald-Gebiet. 1948.

Harrison, H. H., American birds in color. 1948.

Kemsies, Emerson, Birds of Cincinnati and southwestern Ohio. 1948.

Lehtonen, Leo, Lintuparatiisi Pääkaupungin Liepeillä. 1945.

Macpherson, H. B., The home-life of a Golden Eagle. 1911.

Peterson, R. T., How to know the birds. 1949.

Philips, A. W., The value of soil conservation. 1949.

Sass, H. R., On the wings of a bird. 1929.

Sharpe, R. B., A hand-book to the birds of Great Britain. Vol. 1. 1894.

Stejneger, Leonhard, Results of ornithological explorations in the Commander Islands and in Kamtschatka. 1885

Storer, John H., The flight of birds. 1948.

Swarth, Harry S., A systematic study of the Cooper Ornithological Club. 1929.

Swarth, Harry S., The avifauna of the Galapagos Islands. 1931.

Tenney, Sanborn, and Abby A. Tenny, Natural history of animals. (7th ed.) 1884.

Thomson, A. L., Bird migration. [1942].

Wheelock, I. G., Birds of California. 1912.

Wilder, G. D., N. G. Gee, and L. I. Moffett, A tentative list of Chinese birds. 1926–1927.

PROCEEDINGS OF THE THIRTIETH ANNUAL MEETING

By Harold Mayfield, Secretary

The Thirtieth Annual Meeting of the Wilson Ornithological Club began Thursday, April 21 and continued through Saturday, April 23, 1949, on the campus of the University of Wisconsin at Madison. It was a joint meeting with the Wisconsin Society for Ornithology, and was sponsored by the Kumlien Club and the University of Wisconsin. All sessions were held in the Wisconsin Memorial Union.

There were seven sessions devoted to papers and motion pictures, two general business meetings, and a meeting of the Executive Council. The Annual Dinner was held on Saturday evening.

In addition to the official sessions of the Wilson Ornithological Club, the three-day program included the following events: an informal reception in the Union Library by the Kumlien Club on Thursday evening; a business meeting for the Wisconsin Society for Ornithology, Thursday afternoon; a meeting of people interested in Audubon Field Notes on Saturday morning; a meeting of the Inland Birdbanding Association, the Michigan Birdbanders, and the William I. Lyons Banding Council, on Saturday afternoon; and a series of field trips on Sunday, April 24.

Exhibits at the meeting included a group of bird paintings prepared by Owen J. Gromme for his forthcoming monograph on the birds of Wisconsin; an exhibit of bird photographs, both color and black-and-white; a display of books for sale; a collection of ornithological bookplates; and a set of bird traps.

Meeting of the Executive Council

Upon invitation of the Brooks Bird Club, the Council decided to hold the Thirty-first Annual Meeting on Friday and Saturday, April 28 and 29, at Jackson's Mill, near Clarksburg, West Virginia.

David E. Davis was unanimously re-elected Editor for 1949.

The Council decided to make no change in the membership dues in spite of the increasing costs which have faced the club.

Reports were heard from the following committees: Endowment, Research Grant, Membership, Affiliated Societies, Library, Wildlife Conservation, Illustrations, and Emergency Committee for Relief of European Ornithologists.

After thorough consideration and after solicitation of the views of the other societies concerned, the Council concluded that the benefits of affiliation and the friendliest of relations with regional associations could continue to exist without the formal machinery of affiliation. Therefore, the status of "Affiliated Society" was discontinued. Special appreciation was expressed to Charles L. Conrad for his fine work as chairman of the Affiliated Societies Committee.

First Business Session

President Olin Sewall Pettingill, Jr., called to order the first business session on Friday morning. The minutes of the Twenty-ninth Annual Meeting as published in the *Wilson Bulletin* for March, 1948, were approved. The report of the Secretary was read and approved, and a list of applicants for membership, supplementary to that appearing in the *Bulletin* for December, 1948, was posted on the bulletin board for later action by the club.

The Treasurer's report was read but action on it was deferred until after the report of the Auditing Committee at the final session.

Temporary Committees. The President appointed three temporary committees as follows:

Resolutions Committee:
Maurice Brooks, Chairman
Dwain W. Warner
George J. Wallace

Nominating Committee:
G. M. Sutton, Chairman
S. Charles Kendeigh
Mrs. Margaret M. Nice

Auditing Committee:
Milton B. Trautman, Chairman
R. Allyn Moser

Second Business Session

The second and final business session was called to order at 9:00 A.M. Saturday, April 23, by President Pettingill.

Report of Resolutions Committee. The Resolutions Committee presented the following resolutions which were formally adopted:

1. Resolved: That the Wilson Ornithological Club express its deep appreciation to the University of Wisconsin for its generous hospitality and for the use of its splendid facilities during the Thirtieth Annual Meeting of the club.

2. Resolved: That the Wilson Ornithological Club extend its deep thanks and appreciation to the Kumlien Club, which, as host, has made this joint meeting so outstandingly successful.

3. Resolved: That the Wilson Ornithological Club hereby go on record in favor of the early completion of the Quetico Superior International Peace Memorial Forest on the Minnesota Ontario boundary; that the club favor the provision of adequate Federal funds to purchase the remaining privately owned tracts in the roadless area of the Superior National Forest; and that the club endorse the proposed creation by the President of the United States of a Federal air space reservation over the roadless area for the purpose of excluding much of the airplane travel there, which is at present impairing the wilderness character of the region.

4. Resolved: That the Wilson Ornithological Club recommend to the United States Forest Service the setting aside of an area in and around Cranberry Glades, Pocahontas County, West Virginia, and within the present Monongahela National Forest, as a "natural area".

Report of the Auditing Committee. The Auditing Committee reported that the books of the Treasurer were in excellent condition and the report was accepted.

The Treasurer's report delivered at the first business session was accepted.

Report of Research Grant Committee. John T. Emlen, Jr., Chairman of the Research Grant Committee, reported that the Executive Council had approved a grant of $100 from the Louis Agassiz Fuertes Fund in 1949 to Stephen W. Eaton, graduate student at Cornell, as encouragement for his work on the taxonomy and comparative life history of the members of the genus *Seiurus*.

An award of $25 was given to Donald Malick from the fund established in memory of the late S. Morris Pell. This fund is to be used for non-competitive awards to promising young bird artists. Club members may submit suggestions to the committee at any time for this award.

Report of European Relief Committee. Miss Theodora G. Melone, reporting for the Emergency Committee for the Relief of European Ornithologists, stated that more than 3000 packages are known to have been dispatched to needy scientists in Europe as a result of the activity of this committee. Although conditions in many countries are improving, there are still about 75 families on the list who are in urgent need of assistance. Therefore, all members who would like to contribute food or clothing (through this committee or communicating directly with a selected family) are urged to get in touch with Lawrence I. Grinnell, Carl Welty, Grenville Hatch, or Miss Melone.

Report of Library Committee. Harold Mayfield, chairman of the Library Committee, reported that donations, as shown in the five issues of the *Wilson Bulletin*, March, 1948, through March, 1949, include 1004 bulletins, reprints and periodicals, and 19 books. In addition, four books were purchased through the special fund established for this purpose. The committee urged that members, particularly those in areas with limited library facilities, make use of the library, and that members everywhere consider the library as a possible repository for surplus items from their own and their friends' libraries.

Report of Illustrations Committee. T. M. Shortt, chairman of the Illustrations Committee, reported by letter that the activity of this committee had been confined mainly to supplying illustrations required by the editor of the *Bulletin*—three maps and a number of photographs, some of which may be used later—and advising the editor about certain drawings submitted for publication.

Report of Membership Committee. Mrs. Dorothy M. Hobson reported by letter for the Membership Committee. All candidates for membership, whose names had been posted since the first business meeting, were elected to the Wilson Ornithological Club. At the beginning of 1949 the club had 1661 members and 75 subscribers to the *Bulletin*.

Election of Officers. S. Charles Kendeigh, reporting for the Nominating Committee, proposed the following officers for 1949: President, Olin Sewall Pettingill, Jr.; First Vice-President, Maurice Graham Brooks; Second Vice-President, Walter J. Breckenridge; Secretary, Harold Mayfield; Treasurer, Burt L. Monroe; Elective Members of the Executive Council, John T. Emlen, Jr., (term expires in 1950), Richard H. Pough (term expires in 1951), and W. C. Vaughan (term expires in 1952).

The report of the Nominating Committee was accepted and the nominees were elected.

The session was adjourned at 10:00 A.M.

Papers and Motion Pictures Sessions

Thursday Morning, April 21

1. Harvey I. Fisher, University of Illinois. Populations of Birds on Midway Island and the Man-made Factors Affecting Them. During the past 50 years the birds of Midway have been seriously affected by the various factors introduced by man. First, the plume hunters and then the coming of the armed forces to these islands during the last war, together with the arrival of the commensal rat, have decimated the number of many species and caused the extinction of at least 2 species. On the other hand, man has established soil and vegetation and has increased the total surface of the islands, which has been favorable to certain forms particularly since the end of the war.

2. M. Dale Arvey, University of Kansas. A revision of the Passerine Family Bombycillidae. In a recent study of the waxwings (Bombycillidae) and their relatives, it has been found that two other families of passerine birds, the Ptilogonatidae (silky flycatchers) and Dulidae (palm chats), are so closely related to the waxwings in both structure and behavior that they should all be combined in one family, the Bombycillidae. Nevertheless, the species previously assigned to the Ptilogonatidae and Dulidae are sufficiently distinct from one another and from the present species in the Bombycillidae to warrant retention of subfamily categories, which become Bombycillinae, genus *Bombycilla:* Ptilogonatinae, genera *Ptilogonys, Phainopepla* and *Phainoptila;* and Dulinae, genus *Dulus*.

3. Ben J. Fawver, University of Illinois. Some Breeding Bird Populations of the Great Smoky Mountains. The breeding bird populations of various vegetation types in the Great Smoky Mountains National Park were studied in the summers of 1947 and 1948. The relationships of population density and species composition to vegetation and altitude were noted.

4. Harry W. Hann, University of Michigan. Conflicting and Doubtful Statements in the Literature Regarding the Water Ouzel. There are a number of statements in the literature about the Dipper that conflict with one another or that have been repeated for many years with a doubtful basis of fact. These questions, along with the observations and opinions of the author, were considered: (1) Does the Dipper always build its nest where the moss is kept green by spray? (2) Does the Dipper sprinkle its nest? (3) Do the birds hop, walk, or run, when on land? (4) Do they walk on the bottom when feeding under water? (5) Is it the upper eyelid or the nictitating membrane which is responsible for the winking? (6) How long is the incubation period of the Dipper? (7) How long do the young remain in the nest? (8) How many broods do they rear in a season?

5. Robert A. McCabe and Harold F. Deutsch, University of Wisconsin. Electrophoretic Studies of Bird Albumen. The behavior and composition of the various proteins in the albumen of fresh eggs were observed when in the presence of charged electrodes. Charts of such observations reveal a distinctive pattern for each species of bird. The relationships between these patterns may throw new light on the relationships between different species.

6. David E. Davis, Johns Hopkins University. Preparation of Papers for The *Wilson Bulletin.* An explanation of the aims of the *Wilson Bulletin,* with suggestions to authors on the preparation of articles and notes for publication.

Thursday Afternoon, April 21

7. Margaret M. Nice, Chicago, Illinois. The Question of Sexual Dominance. A revision of the prevailing opinion that in pair formation the male overawes the female; this former interpretation seems to have come from a confusion of sexual and social dominance, as well as from the apparent exemplification of the theory with the pigeon. Now, however, the Heinroths have shown that with this bird there is no dominance between the pair, so the theory has lost its chief support.

8. William J. Beecher, Chicago Natural History Museum. A Possible Sensory Basis For Bird Navigation. A consideration of the possibility that birds, even while in flight, are able to detect minute forces through the sensitive structures of the ear. The semicircular canals report to the brain movements of rotational nature, and the otolith organs of the inner ear report an eccentric head position of long duration. In correlation with these facts, each bird has a characteristic attitude of the head in rest which orients the horizontal canal and the utriculus level with the ground. This is also the usual position of the head in flight. The almost gyroscopic ability to hold the head level while the body may twist and bank suggests that birds can probably maintain level flight even when out of visual contact with the ground. These circumstances combined with the discovery of membranous sacs in the outer ear of passerines, which are capable of being inflated with venous blood and protecting the ear drum from various wind pressures due to rapid flight suggests that it might be possible for the canals to detect the Coriolis effect even while birds are in flight.

9. Charles G. Sibley, University of Kansas. The Significance of Interspecific Hydrids in Speciation. Interspecific hydrids provide tests of the degree to which species formation has

proceeded at the time the secondary contact was formed which permitted the two parental forms to hydridize. Examples such as are found in the genus *Pipilo* in Mexico, the genus *Anas*, and certain Tetraonids, indicate that morphological differences may become great while physiologically the 2 forms may be very similar. The degree to which morphologically "good" species form hydrids in nature may be applied as a criterion in systematics, especially at the generic and specific levels. If this is a valid criterion several of our currently accepted generic splits should be critically reexamined.

10. Robert Cushman Murphy, American Museum of Natural History. A Naturalist in Changing New Zealand. A photographic story of an expedition to New Zealand to study some of the little-known birds of that region and to excavate for the skeletons of extinct birds, including the Moa. This trip included a visit to the Snares, a group of islands where almost no ornithological study has been carried out previously.

Friday Morning, April 22

11. J. Dan Webster, Jamestown College, Jamestown, North Dakota. Altitudinal Zonation of Birds in Southeastern Alaska. Most of Southeastern Alaska (from sea level to 1500 feet) consists of dense coniferous forest. Climax communities of Sitka Spruce and Western Hemlock have these common breeding birds: Steller Jay, Chestnut-backed Chickadee, Winter Wren, Varied Thrush, Golden-crowned Kinglet, Pine Siskin, and Red Crossbill. Sub-climax communities in rocky and in wet, swampy soil, and a special cottonwood sub-climax confined to the large mainland river channels are described. An intermediate altitudinal zone (from 1500 to 2500 feet) is characterized chiefly by the Alpine Hemlock and Yellow Cedar, with such birds as the Pileolated Warbler and Pine Grosbeak. The Arctic-Alpine zone (above 2500 feet) has no trees; among the breeding birds are the American Pipit, the Hepburn Rosy Finch, and three species of Ptarmigan.

12. Josselyn Van Tyne and Harold Mayfield, University of Michigan and Toledo, Ohio. Bird Problems on New Providence Island, Bahamas. Very little is known about the habits of some species of birds to be found in the Bahama Islands. Also, there are doubtful statements in the literature about the relationships of some of these birds to other species in Central and North America. Because of the number of problems awaiting solution and the ease with which a person may reach these islands from the United States, it was suggested that the Bahamas offer an excellent field for American students.

Symposium: Modern Approaches to the Study of Bird Populations.

13. John T. Emlen, Jr., University of Wisconsin. The Problems and Significance of Population Studies. Populations are not mere assemblages of individuals but are distinct entities representing a level of organization above that of the individual. Like the individual organism, they may be studied for their anatomy (structure and composition), their physiology (dynamics), or their ecology (responsiveness to environmental influences). Birds provide good subjects for the study of natural populations.

14. S. Charles Kendeigh, University of Illinois. The Distribution of Bird Populations. The distribution and abundance of a bird depend on the distribution of the particular ecological niche to which it is specifically adapted. Habitats have changed and are changing. Tertiary and Pleistocene climates and vegetation are reflected in present distributions.

15. David E. Davis, Johns Hopkins University. Problems of Recruitment in Bird Populations. Recruitment is determined by the potential reproductive rate of the species, modified

by variable factors associated with length of season, pair formation, ovulation, size of clutch, hatching success, fledging success, and juvenile mortality. Variations in recruitment affect population levels.

16. Allen W. Stokes, University of Wisconsin. Studies of Population Turnover in Pheasants. Data on sex and age composition of trapped and hunted populations provide the basis for an analysis of productivity and annual turnover in this species.

17. Joseph J. Hickey, University of Wisconsin. Productivity Versus Mortality in Bird Populations. Tendencies to renest and to raise more than one brood are fundamentally associated with high adult mortality rates; large clutch size is only indirectly associated. All these phenomena operate without reference to population density. Postponement of sexual maturity is similarly independent of density and correlated with adult mortality; non-breeding may or may not be density dependent. Density-dependent regulating mechanisms in bird populations must, by inference, be mortality factors.

18. Paul L. Errington, Iowa State College. Population Mechanics and Regulating Factors. Population levels are regulated by and fluctuate in response to environmental conditions, density and competition factors. These responses may themselves show periodic changes.

Friday Afternoon, April 22

19. Frederick V. Hebard, Philadelphia, Pennsylvania. A Survey of Injury-feigning Birds in the A.O.U. Checklist. Injury-feigning already has been reported in over 210 species and 240 forms on the A.O.U. Checklist. This list is still growing and the author would like to receive communications from observers who can add to the information now available on this subject.

20. Milton B. Trautman, Ohio State University. Observations on the Spring Courtship Behavior of the Black Duck. A discussion of observations made since 1946 on spring courtship: (1) the male's territory; (2) the male behavior while standing guard outside his territory and while the female hunts for a nesting site; (3) methods employed by the female to "escape" from the male's territory, and methods by which she enters the territory; and (4) behavior of a pair of mated Black Ducks which have entered the territory of another male. Slides show the male's territory, location of a nest and the guarding station of the male.

21. Seth H. Low, U. S. Fish and Wildlife Service. Migration of the Pintail in North America. An analysis of some 30,000 birdbanding records of Pintail Ducks which have been accumulated in the Fish and Wildlife Service in the last 30 years. The evidence indicates a rather complex interlacing of flyways with the birds often taking a different route in the spring as compared with the fall. The records include a bird banded in Iceland and recovered 2 years later in Quebec, and another banded in August in Labrador and shot in southern England in September.

22. Henry L. Yeagley, Pennsylvania State College. Further Studies on "A Physical Basis of Bird Navigation". The author, a physicist, has been exploring the hypothesis that birds navigate by orientation to 2 physical effects: magnetic force and the Coriolis effect (caused by rotation of the earth). The Coriolis lines (latitude) intersect with the lines of equal magnetic force in two points within the United States. Recognizing that one such point in Pennsylvania has a conjugate point in Nebraska, the author has used homing pigeons trained at one point and released nearer the other. He has accumulated some evidence indicating that the birds travel in the general direction of the conjugate point rather than at random or toward

the home loft. In his analysis he has used the method of vectors based upon the composite returns from a group of birds released at one time.

Friday Evening, April 22

23. Clayton G. Rudd, Minneapolis, Minnesota. The Towering Tetons. A color movie showing the natural beauties of the magnificent mountain area about Jackson's Hole in Wyoming. A feature of this showing were some splendid close-ups of Sparrow Hawks.

24. Edward Morris Brigham, Jr., Kingman Museum of Natural History, Battle Creek, Michigan. Some Experiences with Michigan Birds. A selection from the author's extensive set of movies of Michigan birds featuring some remarkable views of immature Great-horned Owls.

25. Murl Deusing, Milwaukee Public Museum. Safari in Africa. A color movie, telling the story of a motor caravan traveling across the big game area of Central Africa. His picture included close-up views of spectacular animals and birds, and a glimpse of the cloud forest in the mountains of equatorial Africa.

Saturday Morning, April 23

26. Samuel D. Robbins, Mazomanie, Wisconsin. Ornithological Rarities in Wisconsin During the Last Decade. Information about 8 rare birds identified in Wisconsin in the last decade, of which the first 3 were new to the State: Ivory Gull, Burrowing Owl, Varied Thrush, Brown Pelican, Purple Sandpiper, Pomarine Jaeger, Parasitic Jaeger, and Dovekie.

27. Lee Steven, Milwaukee, Wisconsin. Hawk Migration in Wisconsin. A banding station operated by the Milwaukee Public Museum in Sheboygan county, Wisconsin, has captured more than 1000 hawks within recent years and has had returns on about 10 percent of these birds. Two of the returns were from Duck Hawks recovered in Central America. It has been found that hawks move in considerable numbers down the western shore of Lake Michigan in fall.

28. A. W. Schorger, Madison, Wisconsin. Changes in the Avifauna of Wisconsin. During the last century the White Pelican, Sandhill Crane, Long-billed Curlew, Trumpeter Swan, Whooping Crane, Swallow-tailed Kite, Passenger Pigeon, and Wild Turkey have become extremely rare or have vanished entirely, although they were once common in Wisconsin. However, among those birds which have increased in numbers or extended their range since the coming of man to the State are the Black Duck, American Egret, Crow, Carolina Wren, Bewick's Wren, Western Meadowlark, Cardinal, and Brewer's Blackbird. The English Sparrow was introduced in 1869, and the European Starling reached Milwaukee in 1923.

29. Winnifred Wahls Smith, Two Rivers, Wisconsin.

30. Aaron Moore Bagg, Holyoke, Massachusetts.

31. W. W. H. Gunn, University of Toronto.

Relationship of Weather to Migration. These 3 papers were presented and discussed as a unit since they referred to different aspects of a joint study. The investigators reported a close relationship between migration and weather conditions. Major movements in spring may be expected with rising temperature and a falling barometer. Analysis of the detailed records of the late William Dreuth of Chicago from 1938 through 1942 supported this conclusion. (Smith). The period of April 19–22, 1948 was examined in detail to illustrate the relation between the moving warm and cold fronts of a pressure system and a concurrent bird wave reported progressively eastward from Wisconsin to New England. (Bagg). The seasonal shift of the northeast trades in spring favors migration from northern South America and southern Central America to the Gulf region where, as illustrated by Bagg, the movement of warm air is then northeastward rather than northwestward. It was suggested that this warm-air track may have been a fundamental factor in the development of migration routes and gross distribution of many North American migrants. (Gunn).

32. Howard Young, University of Wisconsin. Territorial Behavior in the Eastern Robin. A consideration of existing definitions of territory and an examination of these definitions by the behavior of the Robin, which does not always conform to the traditional standards. The study included quantitative analysis of the territorial fights between Robins, and their outcome. The Robins tended generally to be most successful in fighting within their own territories, and males generally tended to be victorious over females.

Saturday Afternoon, April 23

33. Doris Huestis Speirs, Pickering, Ontario. Ontario Nestings of the Evening Grosbeak. An analysis of the nesting of the Evening Grosbeak, based on data from 5 nests discovered in the period from 1944 to 1946 in Ontario. This study included 4 days' observation of a fledgling in the field after it had left the nest.

34. George J. Wallace, Michigan State College. Four Years of Michigan Bird Records. Under the auspices of the Michigan Audubon Society, a cooperative program has been in operation for 4 years to systematize the accumulation of records from all localities within the State. The results of this study to date include several prospective additions to the Michigan list, additional records for unusual species, and new wintering and new nesting records.

35. Oscar Hawksley, Central Missouri State College. Breeding Behavior of the Arctic Tern. A moving picture showing the breeding behavior of the Arctic Tern from fish-flight stage through the rearing and fledging of young. Included were sections on associates, social flights, posturing, copulation, egg recognition, egg rolling, bathing, preening, care of the young, and the breeding of white-faced individuals.

36. W. J. Breckenridge, Minnesota Museum of Natural History. Wood Duck Nesting Study. A study of nesting behavior of the Wood Duck, based in part on the use of an ingenious mechanical device for recording automatically attendance at the nest. The periods of attendance were discussed, particularly as they correlated with minimum daily temperatures. The movie included the emergence of two broods of Wood Ducks from nesting cavities.

37. Fran Hall, Carleton College. In Nature's Realm. This moving picture provided some excellent views of various phases of nature, with particularly outstanding closeups of insects.

38. Edgar Monsanto Queeny, St. Louis, Missouri. Prairie Wings. Views of wildfowl during the fall in Arkansas. Outstanding features of this sound film were the actual voices of ducks and geese recorded in the field, and an exceptional series of slow-motion closeups of ducks in flight.

Annual Dinner

At the Annual Dinner on Saturday evening, April 23, in the Great Hall of the Wisconsin Union, Olin Sewall Pettingill, Jr., President of the Wilson Ornithological Club, served as toastmaster and principal speaker. In the course of his address he named 10 American ornithologists (living men excepted) whom he considered most influential in advancing the science of bird study, in alphabetical order: John James Audubon, Spencer Fullerton Baird, William Brewster, Frank Michler Chapman, Elliott Coues, Louis Agassiz Fuertes, Joseph Grinnell, Francis Hobart Herrick, Clinton Hart Merriam, and Robert Ridgway.

Field Trips

On Sunday morning, April 24, members and guests visited the following interesting areas: Horicon Marsh, Wisconsin River valley, and the University of Wisconsin Arboretum and University Bay.

Attendance

Three hundred sixty-one members and guests registered at the meeting, representing 22 states of the United States, 3 provinces of Canada, China, and England. Next to Wisconsin, Illinois was the state with the largest attendance. The list of members and visitors follows:

From **China:** 1—K. C. Huang, *Mokiang.*

From **Colorado:** 1—Richard E. Pillmore, *Boulder.*

From **England:** 1—Winifred MacVicar, *London.*

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Wilson Ornithological Club Appointments for 1949

President Olin Sewall Pettingill, Jr., has made the following appointments for 1949:

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Board of Trustees. James Henry Bruns (1947, 1948, 1949), A. W. Schorger (1948, 1949, 1950), and Frederick V. Hebard (1949, 1950, 1951).

Other appointments will be announced later.

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Manuscripts should be typed on one side of white paper of good quality with title and author's name written on a separate sheet. Everything should be double-spaced and each table should be typed on a separate sheet. Figures, not words, should be used for all numbers (except at the beginning of a sentence). Sex ratios should be calculated as % males. Express data in quantitative and tabular form, wherever possible, and when giving averages, also give the standard deviation. The technical names of the A.O.U. Check List (4th edition), as corrected in the supplements, should be used. Unless specimens have actually been identified to subspecies, only the specific name should be used. Whenever possible a reference for technical names of plants should be listed. Literature should be listed at the end of the article in accordance with the style in previous issues. All articles should have a summary that gives the data in brief form. Authors should avoid footnotes, vernacular phrases, and the use of nouns as adjectives. Illustrations should have good contrast. Printing on charts and maps must be large enough to permit reduction. Cuts of figures will be destroyed unless author requests their return on the reprint order form.

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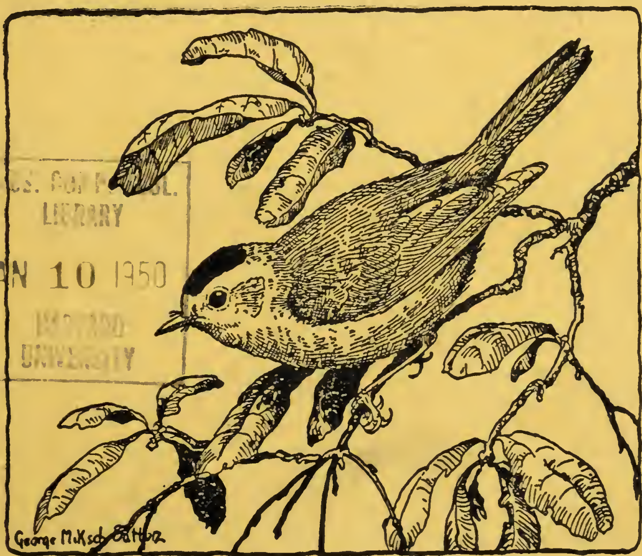

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Membership dues per calendar year are: Sustaining, $5.00; Active; $3.00; Associate, $2.00. The Wilson Bulletin is sent to all members not in arrears for dues.

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The Wilson Bulletin

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All articles and communications for publication, books and publications for review should be addressed to the Editor. Exchanges should be addressed to the Wilson Ornithological Club Library, Museum of Zoology, Ann Arbor, Michigan.

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CONTENTS

STARLING IN RECENTLY ACQUIRED FALL PLUMAGE (upper)
AND IN THE WORN SPRING PLUMAGE (lower)

Allan Cruickshank f
National Audubon Sc

A REVIEW OF EXPERIMENTAL INVESTIGATIONS ON SEASONAL REPRODUCTION IN BIRDS

J. Wendell Burger

Trinity College, Hartford, Conn.

Mankind has known for centuries that domestic hens could be made to lay more eggs in winter by putting lights in the coops at night. Known also have been certain photoperiodic manipulations (Miyazaki, 1934), (Hoos, 1937) through which caged birds could be induced to sing unseasonably. Despite the considerable work which has been done with poultry, the accumulated knowledge concerning photoperiodism in plants, experiments dealing with the effect of light upon plumage (Beebe, 1908), and various theorizings concerning the effect of light upon the annual cycle in animals (Schaefer, 1907, and others), the experimental study of seasonal reproduction has not been attempted until very recently. The work was initiated in 1925, by Rowan, who was interested primarily in migration, and expanded by Bissonnette in 1930.

Rowan's chief finding was that precocious spermatogenesis could be brought about in sexually inactive male Juncos by adding several hours of artificial illumination to natural winter day lengths. Bissonnette, working with the Starling, confirmed Rowan's findings. (For summaries of the avian studies carried on by these two workers, see Rowan, 1938 and Bissonnette, 1937.) The basis for this work was the frequently observed correlation between increase in gonad-size and lengthening of days in spring. This shift in the proportion of daylight-hours to darkness-hours has been known as long as mankind has been aware of the equator, the poles, and the season. The difference between the total of daylight hours on the longest and shortest days of the year is least at the equator and greatest at the poles. Baker (1938b) graphs the day lengths at various seasons and latitudes.

From Rowan's and Bissonnette's observations has arisen the generalization that increase in day lengths induces spring gametogenesis in birds. Much of the work of the past 20 years has tested the validity of this generalization. Rowan himself, on the basis of earlier experiments with the exercising of birds, came to the conclusion that lengthening of days had no direct photic influence upon the gonads, but that it did permit the birds to exercise more. Wolfson (1941) perceived a correlation between degree or incidence of wakefulness and increase in day length and in gonad size. No experiment thus far devised has proven that any external stimulus, *operating in darkness*, induces precocious gametogenesis.

Gonadotropins secreted by the pituitary are believed to stimulate the gonads, release sex hormones, and cause gametogenesis. The release of sex hormones is closely correlated with the development of the reproductive organs, of secondary sexual characters, of some sexually dimorphic characters, and of behavioral patterns. Reproductive rhythmicity may be, basically, hypophyseal rhythmicity; the activity of the adult gonad merely a reflection of hypophyseal activity. What is it, then, that controls the avian pituitary? The bald answer is that no one knows. What we do know indicates that external environment determines the activity of the pituitary at least to some extent.

We must never lose sight of the fact that the environment of the many species of birds varies widely. What is true of one species may not be at all true of another. We are justified in talking about 'the bird' only when we have learned, through patient observation, that the several species, races, and individuals which we are discussing behave uniformly. Unfortunately, the field naturalist and the laboratory worker often do not understand each other. The one complains that factors operating on the bird in the laboratory are very different from those operating on the bird in a wild state; that results obtained through laboratory observations do not *prove* anything about the wild bird. The laboratory worker, on the other hand, is justified in maintaining that tests, observations, and experiments carried on in the laboratory can and do lead to important and significant discoveries. Environmental factors which may seem of great importance to the field worker may, when tested carefully, prove to be of little significance.

It is unfortunate and regrettable that so little work is being done today in the tropics and the southern hemisphere; and that there is no such thing as a correlated study of trans-equatorial migrants such as might be carried on were the ornithologists of South America, Africa, and Australia organized for collaborating with ornithologists of the northern hemisphere. What little we know —and it is fragmentary knowledge at best—has to do principally with birds of the North Atlantic area and of western North America.

The following review of the literature is not by any means the equivalent of a complete bibliography. I have made a point of discussing at some length the most important papers which have appeared, but unimportant papers I have not even mentioned. With a few exceptions, I have consulted all references while preparing the manuscript. I wish to thank T. H. Bissonnette for the use of his personal library and for his counsel during our association at Trinity College. I wish also to thank E. E. Bailey for his help. My work has been supported largely by grants from the Penrose Fund of the American Philosophical Society.

Seasonal Reproduction

The studies of Baker (*vide* Baker, 1938b) form an important survey of the seasonal factors that are present throughout the world. Baker's generalizations are sufficiently important to quote verbatim (p. 578):

1. As one goes north from the temperate latitudes one finds a general tendency for the egg-laying seasons of birds of all kinds to start later and later at the rate of some 20 or 30 days per 10° of latitude.

2. As one goes south from the temperate latitudes into the northern tropical and equatorial zones one finds a general tendency for the Accipitres, Coraciiformes, and, to a less extent, the Passeres, to start their egg-laying earlier and earlier.

3. The Charadriiformes, Grallae, Herodiones, and Anseres behave differently. In the northern hemisphere they tend to breed later in the tropical and equatorial zones than in the subtropical and temperate.

4. There is a general tendency for birds in the tropics to reach the height of their main breeding seasons somewhat before the sun passes overhead. Two breeding seasons in the year are therefore quite common, but birds which breed only once select either the northward (Accipitres, etc.) or southward (Grallae, etc.) swing of the sun.

5. The main proximate causes of the breeding seasons of birds in nature are thought to be temperature and length of day in the boreal and temperate zones, and rain and/or intensity of insolation near the equator. The time of arrival from migration is often an important factor.

6. Much egg-laying occurs when days are getting shorter, and indeed it often proceeds rapidly while they are decreasing in length and only between 11 and 12 hours long.

7. There is, however, little egg-laying when the day is shorter than 11 hours, and almost none when it is less than 10.

8. Under natural conditions birds exhibit no tendency to start breeding everywhere when the days reach a certain length nor when they are becoming longer particularly quickly.

Baker (1937) states that not many equatorial birds are known to breed all the year round, despite almost uniform length of day. These generalizations of Baker indicate the need for world-wide testing under controlled conditions. Moreau, Wilk, and Rowan (1947) have studied the males of 3 species of birds at 5° south of the equator. In all 3 species, the testes were largest between September and March; smallest in the following cooler and rainy season; and became larger when day lengths were increasing by only 20 seconds per day.

Reproduction must first have a genetic basis. While the domestic fowl is in many ways not like wild birds, poultry breeding does demonstrate that reproduction can be modified by genetic factors. Through genetic selection, strains that lay eggs for long periods, that continue to lay despite molt, that have lost broodiness, etc. have been developed. Riddle, Smith, and Benedict (1932) crossed a South American dove, *Zenaidura auriculata vinaceo-rufa*, which breeds the year round in captivity at New York (when protected from cold), with the Mourning Dove, *Zenaidura macroura*, which in captivity breeds only between April and August. The hybrids were intermediate between the parents, i.e. the testes were not reduced in the fall as much as in the *auriculata* parent. Bullough's (1942) studies of the Starling indicate that in Great Britain there are 2 races, a Continental and a British. The Continental race has a longer period of gonadal inactivity; and so-called out of season breeding occurs only in the British race. Among other intra-specific differences might be mentioned the fat deposition (light affected) of resident and migratory forms. This fat deposition does not occur in a non-migrant such as the English Sparrow (Wolfson, 1947). These differences point to the need for considering genetic differences when one compares individuals of a species from different localities.

Attention may be focused too narrowly on the environmental alone. When a group of birds is introduced into a new locality, one should consider the possibility that selection may alter the reproductive pattern.

Baker and Ranson (1938), who have collected a great deal of information on the reproductive rhythms of southern hemisphere birds moved into the northern hemisphere, find that most birds change to the equivalent season. The Australian Black Swan, however, changes from a restricted breeding season to breeding at any time of the year in the northern hemisphere. A few birds (Northern Rosella Parrot, Gouldian Finch, Budgerygah) tend to retain their original southern hemisphere periodicity in the northern hemisphere.

Baker (1938a) has tabulated the egg laying periods for Old World birds. The breeding season of the Starling introduced south of the equator into New Zealand extends from August to December instead of from April to June (as in Britain or Germany). The English Sparrow breeds principally from May to August in Britain, but from August to December in New Zealand. Baker's tables show that the English Sparrow breeds the year round in Ceylon and Great Britain, but not in Germany or subtropical northern India.

A fascinating case is discussed by Davis (1945). Several Silver Gulls (*Larus novae-hollandiae*) were moved from Australia to a zoo in the United States. For 2 years the birds nested in November, following their original custom, then changed to nesting in spring and early summer. After 20 years of captivity, their descendants reverted to a fall and winter breeding. Murphy (see Bissonnette, 1937) found that European Storks confined to Lima, Peru, bred below the equator at the time when they would have bred north of the equator.

A much quoted example is the observation of Witschi (1936) that the Orange Bishop, *Euplectes franciscana*, an African weaver finch, maintained its original timing of the plumage cycle when confined in Iowa. Brown and Rollo (1940) and Rollo and Domm (1943) have shown that this species' plumage cycles and testicular states are modifiable by photoperiodic manipulations. Thirteen to 14 hours with 126 foot-candles of illumination were found to be optimum for the production of nuptial plumage. Thus, an apparently inflexible rhythm proves to be flexible when analyzed experimentally. Friedmann (1937, p. 423) says that two races of *Euplectes franciscana*, found respectively in Ethiopia and the Sudan, have different breeding periods.

Even birds that breed the whole year round, such as the Brown Booby in the Cape Verde Islands (Baker and Ranson, 1938), tend to have 1 or 2 breeding periods in a year. So far as is known, no wild bird has equal reproductive vigor at all seasons; and in no wild species does reproduction occur independently of external influences. The common pigeon breeds almost continuously on farms, but it has smaller gonads in the fall and is depressed reproductively by cold (Riddle 1925, 1938).

The domestic fowl also breeds more or less continuously but it, too, is influenced by the environment. The large literature on the fowl is somewhat obscured by the preoccupation with problems of poultry management. It would be most instructive if the less 'domesticated' breeds were investigated thoroughly. Semen production in the fowl is highest from about November to May and lowest for the rest of the year (Parker and McSpadden, 1942, Wheeler and Andrews, 1943). Jones and Lamoreux (1942) have reported that strains bred for high fecundity mature more rapidly and produce more sperm than do less fecund strains. David (1938) found that injection of androgen induced a seasonal comb growth. (In capons combs may be twice as sensitive to androgen in the winter as in the summer.)

In only a few species of birds is the inherent reproduction rhythm relatively inflexible; and, as has been shown to be the case in *Euplectes*, this inflexibility may not be real. Effect of environment on the labile internal reproductive machinery appears to determine the breeding period for each species. Both the internal cycle and the environment are variables. For example, the Starling on the Atlantic coast breeds about a month later in the Gaspé region (Ball, 1945) than in Hartford, Connecticut or Ohio (Hicks, 1933). This is less than 10° of latitude and fits the generalization of Baker (see above). However, the breeding time in Connecticut and in Great Britain (Bullough, 1942) is roughly the same despite a difference of about 10° of latitude. The climate of Great Britain resembles that of Connecticut more than it does that of the Gaspé peninsula. The sexual cycle of English Sparrows breeding in the United States (Ringoen and Kirschbaum, 1937) roughly coincides with that of English Sparrows breeding in Russia, presumably near Leningrad (Polikarpova, 1940), with a difference in latitude of about 20°. Linsdale (1933) found that the peak of the breeding season for birds in Kansas came in June, while at a similar latitude in California it came in April and May. He believed this discrepancy to be correlated with rainy periods and availability of food.

Riddle, Smith, and Benedict (1932) found that the conditions of captivity gave the Mourning Dove a slightly longer than natural breeding period. Rowan (1929) found that the canary, a subtropical bird with protracted breeding season, exhibited pronounced sexual behavior in captivity in winter in Canada. Male canaries which were not lighted at night had larger testes and were more active sexually than captive native Juncoes.

Experimental Stimulation of Gonads

While the goal of reproduction is the production of viable young, a study of fertile matings may not reveal the factors involved in securing this result. Most of the experimental work has dealt with the male. The female as such, and the reciprocal relationships of the sexes have received little attention. Most studies, furthermore, have been concerned with the factors inducing gametogenesis. The factors involved in inducing and maintaining the non-breeding condition are less well known.

Tests indicate that all birds that breed seasonally are responsive to photoperiodic manipulations. Scott and Payne (1937) got no response from the guinea fowl. More recently, however, Davis and Penquite (1942) got a slight testicular response (no sperm) through exposing male guineas to continuous light (begun January 31).

The basic test consists in giving sexually quiescent, non-refractory birds a daily period of artificial light added to natural day lengths, or by making an artificial day solely by artificial light. Sperm is produced usually in this way in about 1 month.

Activity and Wakefulness. As a result of his early experiments with the Junco, Rowan (1929, 1938) believed that exercise (and later the general activity resulting from the longer days) acted as the primary stimulus for gonadal activation. Wolfson (1941) modified Rowan's theory to read, "As the days increase in length, birds are awake for longer periods of time because the state of wakefulness, at least in some birds, is a conditioned response to light; the concomitant activity of the hypothalamus causes an increased production or release, or both, of the gonadotropic hormones from the anterior lobe of the pituitary; these, in turn, stimulate gonadial recrudescence." Wolfson reported no original avian work to confirm his speculations.

Bissonnette (1931a, 1937) using Rowan's technique, was unable to confirm Rowan. Riley (1940), and Kendeigh (1941) rotated English Sparrows in drum-like cages in darkness. The daily period of rotation corresponded in length to the usual added period of illumination. No gonadal stimulation resulted from this enforced activity and wakefulness in darkness. Thornton and Cummings (1945) gave (in darkness) an added period of noise as a supplement to short days, and found no gonadal stimulation with the English Sparrow. Benoit (Benoit and Ott, 1944) immobilized ducks, and secured a response to light. Burger, Bissonnette, and Doolittle (1942) kept Starlings awake with flashing light. They could produce stimulation or no stimulation by varying the length of the flashes and the intervals of darkness between the flashes. Strangely enough, the demonstrated fact that, for some species, the blue end of the visible spectrum fails to activate males, has not been mentioned in various arguments. Wolfson (1941) in his long critical paper fails to mention this type of evidence. Starlings subjected to long "days" of blue light act as though they are awake; they feed, bathe, etc. (Burger, 1943). Miyazaki (1934) first noted that captive birds subjected to artificially long days were very quiet and drowsy, though activated sexually.

Whatever the ultimate solution of this problem, the exercise-activity-wakefulness theories, as currently phrased, are clearly inadequate. Thus far, no external environmental stimulus except light has been *shown* to induce complete spermatogenesis in seasonally reproducing birds.

Food. Perry's report (1938) that irradiated food activated English Sparrows sexually was not confirmed by Kirschbaum, Pfeiffer, Van Heuverswyn, and Gardner (1939), or by Perry himself. Bissonnette (1931b) found that Starlings with low protein diet did not respond sexually even when the days were long. Kendeigh (1941) noticed no difference in testicular stimulation in English Sparrows if food was given in restricted periods or over the whole light-period. Birds ate as much food in the first instance as in the latter, but in less time. The relation of food to natural reproduction is not easy to determine. Kendeigh (1941) wrote, "The energy demands for full development of the testes and partial development of the ovaries appear not to be large. . . . The final and complete formation and laying of eggs, however, requires considerable energy output". This is well recognized in poultry.

Temperature. External temperature has no *prohibitive* effect in most birds tested. Rowan's original work was done at subzero temperatures. Bissonnette and Csech (1937) induced pheasants to lay eggs in a snow bank. Kendeigh (1941) compared temperatures of 72° F. with 36° F. for effect on the English Sparrow, and noticed no difference in response. Outdoor weather in Kansas did not depress the breeding of turkeys (Scott and Payne, 1937). Schildmacher (1938) secured testicular activation with *Phoenicurus* at temperatures around 0° F. Suomalainen (1937) found no difference in response to light between one lot of *Parus major* kept at an average temperature of 1.9° C. and another kept at an average of 20° C.

Reproduction in pigeons is depressed by cold (Riddle, 1925). Kendeigh (1941) found that clutch size and egg size of the House Wren were correlated with temperature. A temperature of 67°F. was correlated with more and larger eggs than one of 77°F. Lee, Robinson, Yeates, and Scott (1945) reported that high temperature reduced egg laying among domestic hens in Australia to about once a week. Many eggs were soft and deformed. Some increase occurred even though the heat was maintained. There was found also a difference among breeds in susceptibility to heat. Laying was not abolished entirely. One must distinguish, however, between effects on seasonal reproduction as a whole, and effects on individual ovulations and clutch formation. In the latter 2 examples, clutch formation, rather than the ability to breed at all are influenced. In nature, the ornithologist mostly sees clutch formation or its lack, but does not know more about the ovary.

Burger (1948) found that Starlings kept under conditions of long days and relatively constant temperatures of 90° to 100° F. had testes far larger than those developed in the same time by birds kept under cooler fluctuating temperatures. These warm temperatures, however, did not induce progressive spermatogenesis under short days. The significance of these results is not clear. These temperatures are higher than those experienced by the Starling for any great time during the normal breeding season. The results do demonstrate that external temperatures approaching the Starling's body temperature do not suppress spermatogenesis nor cause testicular involution.

At Hartford, Connecticut, the winter of 1947-8 was much more severe than that of 1948-9. In early spring of 1948, testicular enlargement occurred in wild Starlings despite the presence of snow on the ground for the preceding 3 weeks and a mean daily temperature of about 30° F. In the milder 1949, testes secured on the same date as those of 1948 were only slightly larger. It is highly desirable that a study be made over a period of several years at different latitudes or for different conditions for a given species, in which both testes and ovaries are studied at different periods in the cycle. Records of nesting times alone do not tell whether the whole breeding complex is delayed, say by cold weather, or whether only a phase is delayed.

Photoreception. The conventional view is that light is received by the eye which sets off an unknown sequence of events terminating in stimulation of the pituitary. It now appears that stimulation of the pituitary is not effected by nerve fibers going to the anterior lobe via the stalk. Drager (1945) found in the chick no fibers from the stalk going to the anterior lobe. Bissonnette and collaborators (unpublished) have cut the pituitary-stalk of ferrets (a mammal) without loss of sexual activation induced by long days. Many data of this type show that the hypothalamus is involved in mammals.

Considerable evidence indicates that the eye is the primary receptor. For example, hooding the head prevented light from effecting stimulation in 6 of 9 English Sparrows (Ringoen and Kirschbaum, 1939). The 3 that showed response were assumed not to have had tight hoods. Hooded immature ducks did not respond to light until an opening was made in the hoods (Benoit and Ott, 1944). Ivanova (1935) got in the English Sparrow no suppression of spermatogenesis by hoods; she considers the plucked skin (Ivanova, 1935) as a possible receptor for light. Benoit got no response by illuminating the plucked skin, while Ringoen and Kirschbaum (1939) do not confirm Ivanova's hooding experiment.

Benoit (see Benoit and Ott, 1944 for a summary and bibliography) achieved spectacular results in a long series of experiments on immature ducks. He found that light induced spermatogenesis when: 1) the optic nerve was cut but the eyeball remained in the socket; 2) the eyeball was removed and the orbit illuminated; 3) the hypophysis was illuminated directly by a narrow beam of light; and 4) parts of the rhinencephalon and hypothalamus were illuminated by a narrow beam of light. Gonadal response was slight when blue light was used and the eye kept intact, but when the eye was removed and the hypophysis was illuminated directly with blue light, marked gonadal response occurred. Benoit considered the hypophysis to be stimulated by a dual system: 1) an oculo-hypophyseal system, and 2) an encephalo-hypophyseal system. He believed that both systems are able to function at the same time, i.e. light could stimulate the eye proper and, by penetration of the head, stimulate deeper areas. By illuminating with strong light, half a duck's head, placed on photographic paper, Benoit found that light could penetrate to the pituitary. The penetration was best with red rays, the rays that in the normal duck are the best activators of spermatogenesis. The different effects on the intact bird of various wave lengths of light (see below) would be explained as due to a differential absorption by the tissues of the various wave lengths. Photostimulation is not considered entirely dependent on color vision.

Wave length. Bissonnette (1932a) and Burger (1943) using Starlings, Scott and Payne (1937) using turkeys, Benoit and Ott (1938, 1944) using ducks, find that the blue end of the spectrum stimulates the gonads little if at all. Benoit and Ott (1944), and Burger (1943) agree that the far-red and near infrared are not stimulatory. The most effective wave lengths lie in the yellow-red. Burger (1943) places the wave lengths that will induce sperm in the Starling, approximately between 0.58 and 0.68 microns. There is no evidence that ultra-violet is stimulating or necessary. All investigators, except Rowan (1938) find different effects by different wave lengths within the visible (human) spectrum. Details of Rowan's experiments do not seem to be published.

Light Intensity. The influence of light intensity has been investigated. Burger (1939b) found that when Starlings were subjected to a constant 10.5 hour artificial day, a gradual increase in intensity from Mazda lamps from 25 watts to 500 watts produced no spermatogenesis. Intensity of illumination did not substitute for adequately long lengths of day. Bissonnette (1931b *et. seq.*) first tested intensity in a coherent manner. With long days, Mazda lamps were effective on Starlings in the following order of wattage: $10 < 15 < 25 <= 40 = 50 = 60$. When a sunlamp was equated with a 200 watt Mazda lamp for luminous intensity, and a 1000 watt lamp equated with the 200 watt lamp for heat intensity, the 200 watt lamp was the more effective. Bissonnette (1932a) found that 1.7 foot-candles of filtered red light was sufficient to induce complete spermatogenesis. The minimum intensity has not been established, but an unmeasured faint light did not stimulate spermatogenesis. On figures given for the domestic fowl (Dobie, Carver, Roberts, 1946) no difference in egg production was found with intensities between 1 and 31 foot-candles.

One rather obvious fact about comparative measurements of intensity seems to be not clearly recognized. Since one may secure a differential effect because of wave length, and since spectral distributions vary with different lamps and intensities, comparative data can only be accurate if monochromatic bands are used. Furthermore, no one has tested the possible significance of a source of light from a single bright source such as a Mazda lamp in comparison with a light that is diffuse.

Bartholomew (1949) working with English Sparrows found that in the fall, 10 foot-candles are less effective than 200 foot-candles from "Daylight Fluorescent Lamp". In the winter however, 10 foot-candles were as effective as higher intensities. Ten foot-candles were more effective than lower intensities. A low intensity of 0.7 f.c. induced sperm in 46 days, while a still lower intensity, 0.04 f.c. was only one-tenth as effective as 0.7 f.c. Relatively low and moderate intensities seemed sufficient to induce complete spermatogenesis, but the rate of response, increased with an increase in intensity. Very faint light, did not, however, induce spermatogenesis, and high intensities were not increasingly effective. One might expect an increase in effectiveness with high intensities due to an increased cranial penetration, if Benoit's theory holds.

Length of Day. Since both intensity of light and wave length vary, and since natural days vary not only in length but also in intensity of light and wave length, experimental work of a quantitative nature should be done under standard conditions. These conditions have not been defined. Each worker has made his own conditions, so most quantitative data in the literature are really qualitative.

Burger (1940) concluded that the minimum day length required by the Starling for the *rapid* production of sperm was slightly less than 12.5 hours. Days of 10.5 hours induced spermatogonial multiplication only. Rollo and Domm (1943) found 13–14 hours optimal for inducing nuptial plumage in the weaver finch, *Euplectes fanciscana*. With poultry, the usual long day administered is 13–14 hours. Bartholomew (1949) secured some interesting data on the English Sparrow. Judging by rate of activation, he found that winter days of 12 and 14 hours were as effective as days of 16 and 24 hours. With days only 10 hours long he was able to secure sperm in 46 days in his 2 experimental sparrows. These 2 birds had previously served as controls for another experiment where they were on days of 8 hours. In another of his experiments (p. 444) one of 2 controls kept on an 8-hour day had a marked testicular development. It might be profitable to repeat these studies on a larger scale. There seems to be a difference between the English Sparrow and the Starling, since in the Starling 10.5 hours of light caused no progressive activity between Jan. 27 and April 20.

It must be noted again, as has been said by many authors, that as one goes toward the equator, day lengths become less and less variable between the solstices. As Bartholomew (1949) pointed out, day lengths even in the United States may remain longer than necessary to activate the English Sparrow. One phase of this problem may have been clarified by work on the Starling (Burger 1939a, 1939b, 1940). Here spermatogenesis did not occur when day lengths were gradually increased from 6 to 9 hours. Spermatogenesis, however, did occur at no reduced rate when day lengths were gradually reduced from 20.5 hours to 16 hours. It was concluded that spermatogenesis in the Starling is not induced by an increase or a decrease in day length as such, but because the length of day is reached which is sufficiently long to be stimulating.

Testicular Inactivity and Refractoriness

Most experimental work has dealt with stimulation of the testes. In order to secure stimulation the testes must at first be in an inactive state. Such inactive gonads are found in immature birds and in adult birds in what Polikarpova (1940) quaintly calls the "dead sexual season", i.e. the period of testicular quiescence following a breeding period. The quiescent period of the immature and that of the adult are not entirely homogeneous either when compared to each other and when compared to themselves over a period of months. With the immature bird, one must consider the special problem of maturation. Riley (1936) found that additional light given to adult English Sparrows on September 30, induced no subsequent spermatogenesis. Juveniles, however, did respond. Adults lighted on November 18 did produce sperm. Obviously, between September 30 and November 18, the adults passed from a refractory state to a state where light stimulation was effective. Schildmacher (1938) reported that juvenile *Phoenicurus* became completely stimulated by added light only after October 10, but before October 25. Bissonnette and Csech (1938) present an interesting example of the relation of juvenile maturation and day lengths. Ring-neck Pheasants hatched on Christmas day from eggs precociously secured by photoperiodic manipulations, laid 2 infertile eggs on July 25–26 under natural light conditions. These eggs were laid later than the normal season for adults, in the juveniles' first 7 months of life. Here obviously, maturation had progressed sufficiently for the long days of July to be an effective stimulus. Riddle (1931) found that pigeons and ring-doves mature more slowly when the time of maturity as set by the date of hatching, occurs in the autumn. Maturity is hastened in the period February to July. Chicks of the domestic fowl hatched in summer grow more slowly than chicks hatched in winter, presumably because of a reduced feed consumption during hot weather. Night lighting of chicks improved the rate of growth in the summer (Heywang, 1944) in Arizona.

While adult birds can be activated precociously by long days, this stimulus is unable to keep the testes in a continuous state of spermatogenesis. The gonads involute after an active period, just as they do in nature. The post-breeding involution and sexual quiescence is due not to the absence of an initially effective stimulus. In nature, day lengths are still increasing when the gonads of Starlings involute. An internal refractory state develops, i.e. the bird no longer will remain in or initiate gametogenesis when given long days. This refractoriness must 'wear off' before external stimuli can induce a new gonadal activation. The duration of the refractory period in conjunction with the annual light cycle seems to control the *general* form of the annual reproductive cycle of many birds tested. The refractory state may wear off before day engths are too short to be completely non-stimulatory. Hiatt and Fisher (1947) found that the Ring-necked Pheasant has a partial sexual activation in the fall (Montana). Witschi (1935) writes, "prolonged Indian summers with sunny days extending until late November bring about precocious development of the testes in free living English Sparrows of Iowa". In general, the refractory period lasts so long that autumn days are too short to induce a complete gametogenesis.

This problem of refractoriness is perhaps the greatest relatively unsolved problem in reproduction. A seeming contradiction to the statements about the importance of the refractory state arises from the fact that many investigators have been able to produce 2 or 3 cycles of spermatogenesis in a year. Rowan (1929) first produced for the Slate Colored Junco, 2 spermatogeneses, one in January and the other in May. Miyazaki (1934) secured 2 cycles with Mejiro (*Zosterops palpebrosa*). Damste (1947) induced 3 cycles in the Greenfinch. Burger (1947) got 2 cycles with the Starling.

Results with the Starling (Burger 1947, Bissonnette, unpublished) seem to resolve this contradiction. In all the above cases, the first additional spermatogenesis was produced by first reducing the day length while an active spermatogenesis was occurring and then later increasing the day length. In the Starling, if day length was reduced just as sperm was being first formed due to long day stimulation, the testes promptly involuted. A second addition of long days induced a new spermatogenesis in all birds. If, however, the first spermatogenesis was allowed to continue until a natural involution set in, then a period of short days followed by another period of long days resulted in a less successful reactivation. If a complete involution, produced naturally, was allowed to develop, then a rest of a month on short days followed again by long days resulted in still less testicular activation. In all cases, however, a period of short days was followed by at least some testicular reactivation when long days were reapplied. Birds kept on long days without a rest on short days went through one testicular cycle and then remained quiescent. When continuous light was given, an initial spermatogenesis occurred, followed by involution. The testes after one spermatogenesis remained quiescent for 15 months after the start of this experiment. If, however, the continuous light was reduced to shorter days and then readministered, a new testicular stimulation took place.

These results indicate that 2 kinds of testicular quiescence occur in the adult. A reduction in day length produces an involution which is not characterized by a refractoriness to long day stimulation. If spermatogenesis is allowed to run its *full course* under long days then a refractoriness to long-day stimulation sets in. This latter refractoriness can be dissipated (at least for the Starling) only by a 'rest' on short days. For the Starling, there seems to be no inherent gonadal rhythm which can act independently of external light changes.

This latter type of testicular quiescence, i.e. that produced under long days, is here designated as true refractoriness.

In the research of Rowan (1929), Miyazaki (1934), and Damste (1947), the extra cycles perhaps occurred only because true refractoriness was not allowed to develop. Short days caused the gonads to involute before true refractoriness was established. It should be emphasized again that the research on the Starling indicates that the refractory phase of the gonadal cycle is influenced by light just as much as is the phase of progressive spermatogenesis.

For the Starling the natural end of refractoriness has not been determined, although it does end before mid-November at Hartford, Conn. Rowan (1929) first noted that the refractory period ends gradually. Riley (1936), confirmed by Kendeigh (1941), found that for adult English Sparrows, the refractory period ended before November 18. Miller (1948) with adult and immature Golden-crowned Sparrows determined the end between November 5 and 20. Wolfson (1945) with Oregon Junco (3 adult and 8 immature) got no response to light begun on October 18. A few White-crowned Sparrows did respond at this time. Rowan (1929) for Slate-colored Juncos got complete spermatogenesis with lighting begun November 1, and a slight response from October 2 lighting. For immature English Sparrows Riley (1936) got stimulation starting at September 30. Miller got no response with the Golden-crowned Sparrow from October 10 lighting. Schildmacher (1938) got sperm in immature *Phoenicurus* only when lighted about October 25, not earlier. Of course, date of hatch must be considered, since early hatched juveniles would be expected to mature before late hatch birds. The above figures indicate for the species mentioned a good deal of similarity for the time of ending the refractory period in the adults.

Miller (1948) continued his lighting until April. He observed that birds that did not respond to long days when tested early in the fall never did show testicular development. Interpreted in the light of our results in the Starling, it would seem that the long days prolonged the refractory period, which had not yet 'worn off'.

It is worthwhile to elaborate further on the results secured by Damste (1947) on the Greenfinch. His birds were activated by natural spring day lengths in the laboratory. In mid-May, before a natural testicular involution occurred, the birds were placed on very short days until August 14, when they were exposed to natural day lengths for that season in Holland. A new spermatogenesis resulted, followed by an involution which began about November 4, and which was completed by early December. In early December, artificial long days were given and a third spermatogenesis induced. These results are explicable in this wise: The 2 involutions were produced by short days, one artificially, the other naturally. These short days prevented true refractoriness from developing. After each involution, the birds were able to respond to longer days. It is interesting to note that late summer and early fall day lengths are sufficiently long to be stimulating for the Greenfinch, provided the bird is not in a refractory state. To put it another way, some birds do not breed in the late summer because they have bred in the spring. Bissonnette (1937) seems to have been the first to discuss refractoriness as the limiting factor of reproductive periodicity.

Brown and Rollo (1940) kept Weaver Finches in nuptial plumage for more than a year by continuous long days. Rollo and Domm (1943) found that both short days and long days retarded the appearance of nuptial plumage. These findings show that inherent periodicity requires the cooperation of external day lengths. One must remember that plumage cycles and sex cycles are not the same thing. Testicular activation and the appearance of nuptial plumage are more or less congruent in this example.

For the Starling, it seems that day lengths affect the whole seasonal cycle, and do not merely fire an internal mechanism which, once set off, is self-controlling.

The question arises as to how the pituitary is inactivated internally. Miller (1949) demonstrated that the inactive testes of adult and immature Golden-crowned Sparrows could be activated by the injection of pregnant mare serum. This suggests that failure of testicular response is not due to a refractoriness of the testis. Riley and Witschi (1938) found that male English Sparrows responded equally well at all seasons to injected gonadotropin. Females, however, showed a seasonal response to the same treatment.

Witschi and Miller (1938) showed that both sexes of the Starling formed male and female sex hormones. Either or both of these hormones might depress the pituitary. For the domestic fowl, Riley and Fraps (1942) have tentatively suggested that the "gonadotropic content of the pituitary would . . . be inversely proportional to the sex hormone concentration . . . it is probable that the gonadotropic content of the hen's pituitary is influenced by more than one factor." Pfeiffer and Kirschbaum (1941) have suggested that androgen may cause a release of gonadotropic hormone in the female English Sparrow.

Burger (1944, 1945) found that testosterone neither blocked photoperiodic stimulation nor depressed an already activated testis in the male Starling. Estradiol had a disruptive, unnatural effect on the testis, but, when given with testosterone, this effect was abolished. Burger (1947) suggested that the testis does not give off a substance which inhibits the pituitary.

Witschi and Fugo (1940) found that testosterone did not have a depressing effect on the ovary of Starlings. Ringoen (1940) found that theelin had no depressing effect on the ovary of the sexually inactive female English Sparrow but that depression did occur in the activated ovary. Unpublished data (Burger) for estradiol in the female Starling confirm Ringoen.

The evidence thus far does not indicate that testicular involution and inactivity in the adult male is due to a hypophyseal inhibition induced by male or female sex hormones. The situation in the female is more ambiguous. In the Starling, the bills of both sexes darken after the breeding season, indicating a low level of male hormone. Since a reduction in day length is enough to produce testicular involution in several species, there seems no need to suppose that some inhibitor is given off by the testis. The female exhibits 2 cyclic reproductive phases: (1) seasonal gametogenesis on which is superimposed (2) shorter cycles of ovulation. The fact that egg laying can be prolonged by merely removing an egg from the nest could be taken to indicate a limited role of the sex hormones in framing seasonal rhythmicity. Avian endocrinology has developed such an extensive literature that a review of other endocrine factors can not be condensed into this summary.

Experimental Studies of Breeding

When captive wild birds are subjected to photoperiodic manipulations, the females with few exceptions fail to lay eggs, but the males form sperm. Male Starlings which have been activated by light do not attempt to copulate with females, and there is a marked failure of the sperm to leave the testis. Cole (1933) seems to have been the first to induce a captive wild bird (the Mourning Dove) to breed by the manipulation of light. Benoit (1935) secured eggs from light treated immature ducks. The Black-crowned Night Heron has been stimulated to breed in the laboratory under light treatment (G. K. Noble, personal communication). Several other species have been induced to breed by light manipulations, and numerous species have bred or ovulated spontaneously in captivity.

It has been frequently suggested that psychic factors probably are involved for those species which do not breed under experimental conditions. A striking example of a psychic factor is given by Emlen and Lorenz (1942). Sexually inactive California Valley Quail were stimulated to mating behavior, apparently through contagion, i.e. the behavior of birds treated with sex-steroids affected non-treated birds. In ornithological literature, there exists a mass of descriptive, observational, and experimental data on the supposed and actual external factors and behavioral patterns existing at the breeding season. Little information exists, however, for the whole female sexual cycle of any one species, except for the common pigeon and the domestic fowl.

Polikarpova (1940) succeeded in inducing caged English Sparrows to lay eggs. The following factors were found: "Lengthening of the daily period of light stimulates the gland of the female up to a certain stage. The presence of the active male advances the development of the sexual gland of the female by one stage. For complete maturation and for egg laying the presence of nests is necessary." (p. 95). Polikarpova's results are compressed into a short paper; the size of the cages and the nature of the nests are not given. Except in one case, it is not clear whether the Sparrows were allowed to build their own nests, or whether they were presented with prefabricated nests.

For the female Starling, I have accumulated a good deal of experimental data. When only females are caged together, long days induce a substantial development of oocytes. As with the male, the gonads regress if the long days are continued, and regress more rapidly if short days are given. If a number of males are caged with a number of females, ovarian development under long days is no better than with females alone. Much larger oocytes (two-thirds of ovulating size) were secured under the following complex: the daily light ration was increased gradually; birds were caged in pairs; nest boxes and nest material were provided. Isolation in different experiments of the following factors indicated that each *alone* is no more effective than light alone: the presence of the male; song from males not visible to the females; nest building; daily agitation of the cloaca for 12 days; insertion in cloaca of a macerated sperm-filled testis, with or without supplementary injections of estradiol. The aerial chase preceding the natural copulation of the Starling probably makes the laboratory breeding of this bird difficult or impossible, except perhaps in a large aviary.

Glass and Potter (1944) found that reduced lighting in the spring inhibited egg laying in the Quail. Hale (1946) temporarily suppressed egg laying in the summer in the domestic hen by the use of one hour of daily light filtered through a blue glass. The depression produced by the blue filter was more marked than that produced by restricted feeding.

It should be emphasized again that egg laying or its failure gives only partial information on the condition of the ovary. Failure to ovulate may mean that only the terminal stages of ovarian activity are lacking. For example, I have caged egg laying Starlings, which on autopsy possessed full-sized ovarian oocytes. Rarely, however, did one of these females lay an egg. On the other hand, it is well known that in some species, the removal of an egg from the nest will induce the laying of an extra egg. In poultry, the disruptive effect of the cock on egg laying is well known.

Kendeigh (1941) found that House Wrens under cooler conditions produced larger clutches and larger eggs than at the peak of the breeding season. Schooley and Riddle (1944) by light were able to modify the spacing of the two eggs of a clutch of Ring-doves. Fraps, Neher, and Rothchild (1947) placed domestic hens under continuous light, and then by restricted feeding were able to control the time of ovulation. These activities, however, are terminal events which occur in a previously activated ovary. The results of Fraps, et. al. do not demonstrate that reproduction in the hen is solely conditioned by feeding time.

By the use of appropriate gonadotropins, a successful ovulation has been obtained in the hen (cf. Fraps and Riley, 1942 for details and bibliography). This is apparently the first complete ovulation secured by hormonal treatment.

A sexual difference in response to a level of gonadotropin is seen in the work of Kirschbaum, Pfeiffer, Van Heuverswyn, and Gardner (1939) on the English Sparrow. The ovary during long days remained relatively inactive, but immature testes transplanted into these females formed sperm. This may mean that the gonadotropin output under the light stimulus is the same for the 2 sexes in the Sparrow. The female may get the additional output of gonadotropins necessary for the ovarian cycle by other, non-photic stimuli (cf. Polikarpova's results). It may be that non-light stimuli can raise the gonadotropin output in the male. I have tested several times the testicular response of Starling males caged with males, and males caged with females. There seems a slight added effect produced by the presence of the female. It will be noted that in the female Starling, light alone brings the ovary up to the point of readiness for the later growth changes, i.e. perhaps to the point where additional gonadotropins that are not stimulated by light must be added. This may clarify formulations about the influence of light in the female.

Conclusions

The experimental data are yet too fragmentary to explain seasonal reproductive rhythmicity the world over, if indeed a single unified theory is possible. Genetic selection in poultry has been able to modify reproductive rhythmicity, giving evidence that natural selection has utilized the genetic variability from which species differences can be built. There is no evidence for any species of bird that its reproductive rhythmicity occurs independently of controls in the external environment. In certain species, at least, there is a difference in the factors effective in the two sexes.

All truly wild species of birds tested have been influenced to some degree by photoperiodic manipulations. How light effects pituitary stimulation is largely unknown. The theory as currently phrased, that light acts indirectly by promoting increased hypothalamic activity through longer bodily activity or wakefulness, stands "not proven". The alternative view that light acts in a less indirect fashion has more experimental substantiation, but it too is "not proven". The influence of other environmental factors beside light are most obscure. Likewise, little is known as to the relation of psychic factors to gonadal state. Most of the birds tested are native to the northern hemisphere, and either are not migrants or do not migrate deep toward the equator or trans-equatorially. Several annual spermatogenetic cycles have been produced in the laboratory for both resident and migratory birds by photoperiodic manipulations. Modification of the plumage and the testicular cycle of one tropical bird has been reported. This reviewer is not a partisan of the photoperiodic theory, he merely states that photoperiodic changes are the only widely spread factor capable of modifying reproductive rhythmicity which is moderately well-known through experimental testing.

Attention is called to the idea that in seasonally reproducing birds, sexual activation can occur only when a refractory period has been experienced and dissipated. This refractory period can be modified, in some species at least, by photoperiodic manipulations, just as the progressive phases of the cycle can be modified by light. Long days effect a persistence of the refractory phase, and short days favor its dissipation. It can be suggested that when the relation of the refractory phase to environmental conditions is understood more precisely, reproductive rhythmicity will be better understood. Attention has been focused too narrowly on the progressive phase of the reproductive cycle.

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THE LAYING RHYTHM OF COWBIRDS

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THE remarkable observations of Walkinshaw (1949) on a female Cowbird that laid 25 eggs in one season have thrown new light on the vexed question of the laying rhythm of *Molothrus ater*. Does she lay in clutches? If so, does she lay every day? What are the intervals between sets? How many eggs are laid in one season?

The 3 females observed by Friedmann laid as follows: A, 5 eggs May 23–27, 1922; B, 5 eggs, May 27–31; C, 4 eggs, May 22–25. Bird B was collected 3 days after it had laid its fifth egg and 5 discharged egg follicles were found in its ovaries. Birds A and C remained for 3 weeks longer, but no more eggs were found. From May 31 for a month and a half "it rained more or less violently every day. As fast as nests were found, they were destroyed or washed away by the heavy rains, and, of course, it became impossible to keep any check on the actions of the Cowbirds. Over a hundred nests were lost during this period, directly or indirectly due to the stormy weather," (1929:182.)

With 3 South American species of Cowbirds, Davis, (1942) reports, "A histological study of serial sections of the entire ovary of 11 specimens of *Molothrus bonariensis* and one each of *M. rufo-axillaris* and *Agelaioides badius* shows that these species lay in clutches and that the maximum number of eggs per clutch is five."

As to my own experience with Cowbirds in Columbus, Ohio, while studying Song Sparrows, I came to the conclusion that these birds laid "three (and possibly four in some cases) 'sets' of eggs with intervals of 6 to perhaps 12 days between 'sets' . . . it may well be that an egg is sometimes held over, so that 5 eggs may be laid in 6 or 7 days," (1937:155). With 3 types of eggs I found evidence of 3 sets, with 5 types of at least 2. Of type E 5 eggs were laid in 5 days; with type G 4 (at least) were laid in 5 days; with type A 4 (at least) in 7 days.

Davis (1942:10) was adverse to the idea of a Cowbird missing a day when laying. He writes, "if we assume that each female lays only five eggs in each set and lays at daily intervals, Nice's table must be rearranged, leading to the conclusion that the interval between the clutches is as short as three days." I know of no bird having an interval between clutches of less than 5 days. With passerines 5 days is the usual interval between the destruction of one set and the start of another. Riddle (1922) found that the ovum grows very slowly most of the time, but that it "jumps in a *day* from its accustomed rate of increase to a rate that is probably from eight to twenty times higher. . . . The time interval between the beginning of rapid growth of the 6 mm. egg [in the fowl] and the breaking of the egg from the ovarian follicle (ovulation) is normally between five and eight days."

Near his home at Battle Creek, Michigan, Walkinshaw (1949) has been making an intensive study of Field Sparrows, color-banding the breeding birds and locating every nest. Between May 5 and July 24, 1944 he found 25 eggs that he believed were laid by one Cowbird, basing this opinion on their similarity in size, shape, and color, and on the facts that all were laid in an area of 12.5 acres and that no 2 were laid on the same day. He "knew the exact date of

TABLE I

Laying Rhythm of Cowbird at Battle Creek, Michigan, 1944

NUMBER OF DAYS		DATES LAID	NUMBER LAID
Non-laying	Laying		
	6	May 15, 16, 17*, 19*, 20	5
5			
	5	May 26, 29, 30	3†
5			
	9	June 5, 7, 10, 11, 13	5
4			
	6	June 18, 19, 22, 23	4
6			
	1	June 30	1
7			
	10	July 8, 10, 11, 14, 16, 17	6
5			
	1	July 23*	1
Total 32	38		25

* See text.

† It is possible that the Cowbird laid even more than 25 eggs, as Dr. Walkinshaw writes me that he did not find all of the Towhee nests on the area, although he believes he found all the Field Sparrow nests.

laying of 19 [of the eggs] and the date within 1–2 days for 4 others." "One nest of a Towhee was parasitized and 20 nests of 14 pairs of Field Sparrows."

From Walkinshaw's table of dates of finding of the eggs I have constructed table 1 arranged to show the laying and non-laying periods in the 70 day span.

Assuming that the 2 eggs found May 25 were laid May 17 and 19 and belonged to the first clutch, and assuming that the egg found July 24 was laid July 23, rather than on the 20th as Walkinshaw suggests, then we find that the 25 eggs fall into 7 "clutches", the first 4 ranging from 3 to 5 eggs, the sixth consisting of 6 eggs, the fifth and seventh of single eggs. The non-laying periods lasted 5, 5, 4, 6, 7, 5 days. (This arrangement gives a slightly misleading impression; for instance, there were 4 non-laying days between June 13 and 18 on which the bird did not lay, but the interval between egg-laying, which occurred very early each morning, is 5 days, corresponding to the minimum reported for other passerines.)

It is surprising to note the length of the laying periods, for in all but those with single eggs, there were gaps of 1 or 2 days. It sometimes happens with other passerines that a day will be skipped, especially in unfavorable weather.

Evidence from these 4 observers shows that Cowbirds lay in clutches, 1, 2, 3, and, exceptionally, 7 in a season. (The 1 report to the contrary comes from a letter of F. L. Rand of St. Louis, Mo. to the U. S. Biological Survey in 1921, quoted by Friedmann (1929:184), telling of a hand-raised bird that laid 13 eggs in 14 days. I can find no information as to Mr. Rand's standing as an ornithologist and it is impossible to judge of the reliability of his statement.) The interval is 5 to 8 days, perhaps sometimes longer. They may lay at daily intervals, or may skip 1 or 2 days in depositing a clutch, depending somewhat perhaps on the availability of nests. Clutches probably usually consist of 4 or 5 eggs, but Walkinshaw's bird near the end of a long season had clutches of 1 and 6 eggs. As to the total number of eggs laid, this ranges from 4 and 5 with 2 of Friedmann's birds to the 25 of Walkinshaw's. It may well be that ordinarily they lay between 12 and 15 eggs.

Does a parasitic bird adjust the number of eggs laid to the opportunities presented? Chance (1940) found this to be true with the European Cuckoo (*Cuculus canorus*) by regulating the supply of Meadow Pipit (*Anthus pratensis*) nests available to the bird he watched for 5 seasons. The year when the supply was cut short she laid 15 eggs starting May 12 and ending June 13, while in the 2 years (the Cuckoo's third and fifth seasons) when Chance continually broke up Pipit nests, she laid 21 eggs from May 13 to June 27 and 25 eggs from May 11 to June 29. Cuckoos do not lay in clutches, but in a series, laying every other day, and when a regular supply of hosts is offered they lay practically continuously.

With the Cowbird, phenomenally bad weather cut off the nest supply for Friedmann's birds. As to Walkinshaw's female, it is a little hard to understand her unabated zeal for Field Sparrow nests. Usually in this area the Field Sparrow deserts when parasitized by a Cowbird. It might be thought that this response had worked as had Chance's deliberate collecting of Pipit's eggs and that the Cowbird was unduly stimulated by a continuous supply of building Sparrows. A study of the record, however, shows that this happened only with one pair, where the Cowbird laid in one nest July 8, in the substitute (and empty) nest about July 10 and in the third nest July 14.

Summary

Four observers have found that 4 species of Cowbirds lay in clutches and that the intervals between clutches last from 5 to 8 days and possibly longer. Eggs may be laid at daily intervals or 1 or 2 days may be skipped.

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GENERAL NOTES

AN EARLY RECORD AND DESCRIPTION OF THE IVORY-BILLED WOODPECKER IN KENTUCKY

The State Historical Society of Wisconsin has the Journal (Draper, Vol. 2, ZZ) of Col. William Fleming. He gives a description (pp. 12–13) of the Ivory-billed Woodpecker (*Campephilus principalis*) which is much more detailed than that of Mark Catesby (Natural history of Carolina, Vol. 1. London, 1731:16). The Journal was printed by Newton D. Mereness (Travels in the American Colonies. Macmillan, N. Y., 1916:632). While purporting to be a faithful copy, comparison with the original shows that several words, in one case a sentence, were omitted.

Fleming, born in Scotland on February 18, 1729, was educated as a surgeon at Edinburgh. In 1779 he was a member of the Virginia Commission sent to Kentucky to settle land claims. St. Asaph's, or Logan's Fort, was situated one mile west of modern Stanford, Lincoln County. There are very few definite records of this woodpecker for the state. The Journal contains the following entry:

March 7, 1780. "Rode up to St. Asaphs from Col. Bowmans, I observed a species of the woodpecker which I had not met with before, the Cock and the hen, they are larger than the large brown [juvenile pileated woodpecker?], the cock had a bright red head with remarkably long tuft of feathers on the Crown so that it may be cald the Peacock Woodpecker the body & wings white & black, the hen darker colored the bills of both a great length & white.

"One of these birds was shot by my servant, which I took to be the hen, the feathers on the throat and belly and part of the wing and tail a shining black, it had nine stiff & strong feathers or pinions in the tail forked at the end, the midle one being six inches long from where the feathers begin the whole length being $7\frac{1}{2}$ inches the others on each side shortened in length, its wings ten inches long from the shoulder to the tip 18 long feathers in the wing, the two first and longest black the 3rd tip'd with white and each succeeding one more till those next to the back are all white, both above & below, the front & fore part of the Crown black, from the junction of the upper & lower bills white feathers on each side, leaving a triangle of black feathers from the Eyes and back part of the Crown which is a deep red, the white feathers run backwards as far as the white on the wings intermixed with black so that the bird from the head so far appears speckled, the red part of the crown appears triangular, its legs was an inch & half long, with four toes set forwards & back two each way, armed with strong crooked claws, the two outer ones the longest & 4 inches in length [spread?]- the bill white and bony, verry strong & firm at the point shaped like a wedge each $\frac{1}{8}$ of an inch broad and from that a ridge runs both in the upper and lower so that each forms a triangle an inch & quarter broad at the Junction of the upper and lower bills, which is three inches in length, the tounge is six inches in length. The Iris when dead of a bright Yellow so far it differs from any of the species I have seen, the mechanism of its parts being as usual in birds of this kind, it weighed upwards of 1 lb."

The error in sex is obvious.—A. W. SCHORGER, 168 N. Prospect Ave., Madison, Wis.

WOODCOCK AT SEA

On July 6, 1949, at 7:30 A.M., an American Woodcock (*Philohela minor*) alighted on the flight deck of the airplane carrier U. S. S. Midway at 39° 55′ N, 70° 05′ W. This point is 82 miles due south of Nantucket Island, the nearest land, and 108 miles southeast from Montauk Point, Long Island. Only one bird was observed. It flew alongside the ship, attempting to alight for approximately 15 minutes before it succeeded. The flight of the woodcock suggested fatigue but it kept up with the ship with little difficulty. The weather had been overcast for the preceding 12 hours; at this time additional fog and haze were on the surface, and an 8 knot wind was blowing. The ship was on course 223 and steaming at 17 knots. The bird was on deck for only 45 seconds when it was frightened away. It flew alongside for several minutes again attempting to land, but was unsuccessful. Another large carrier was approximately 2,000 yards abeam, and when last seen the bird was headed in that direction.—Walter Rosene, Jr., Fish and Wildlife Service, Gadsden, Alabama.

LITTLE GULL AT COLUMBUS, OHIO

On March 22, 1949, at O'Shaughnessy's reservoir, north of Columbus, we had the good fortune of observing a Little Gull (*Larus minutus*). The bird, an immature, was standing in the shallow water at the margin of a small bay, in company with an immature Bonaparte's Gull (*L. philadelphia*) and eight Ring-billed Gulls (*L. delawarensis*).

We were able to observe the bird through 8× and 10× binoculars and a 20× telescope at a distance of 200 feet over a period of 15 minutes. It was much smaller than the neighboring Bonaparte's and its beak was shorter and smaller. It showed the characteristic dusky nape, as contrasted with the spot behind the eye of the Bonaparte's. Several times when it stretched its wings we were able to see the dark streak down the wing and the black primaries. Its tail had a black subterminal band.

This appears to be the first reported occurrence of this species for Ohio away from Lake Erie.—Marian W. Thomas and Elder P. Hengst, Columbus, Ohio.

MOCKINGBIRD IN THUNDER BAY DISTRICT, ONTARIO

On July 20, 1948, while in the grounds of the Mental Hospital, about 5 miles west of Fort William, Ontario, our attention was attracted by an unusual song, shortly followed by the clearly enunciated call of the Whip-poor-will. Our suspicions were immediately aroused, and although the bird was extremely restless, constantly flying from tree to tree, we were eventually able to get a good view and to identify it as a Mockingbird *Mimus polyglottos*. This is unusually far north for this species, and constitutes, we believe, the first record for this district.—A. E. Allin and L. S. Dear, P. O. Box 127, Port Arthur, Ontario.

A WINTERING CHAT IN SOUTHEASTERN MICHIGAN

On Jan. 26, 1949 a Yellow-Breasted Chat (*Icteria virens virens*) was found fluttering around in a garage. An item in the local press brought a phone call from a feeding station operator, by the name of H. Crain of 220 McKinley, Grosse Pointe, who reported he had been seeing the chat at his feeder since the first of the year. The specimen was sent to the University of Michigan Museum of Zoology. H. B. Tordoff determined that the specimen was referable to the race *virens*, and offered the following comments: "It is, as far as I can tell without an exhaustive check of the records, the first occurrence of the species in Michigan in winter. The specimen was a male, in fine plumage. There was some fat, so obviously it had been getting enough to eat. It weighed 26.6 grams, an entirely normal weight. I would say that the bird was in good general physical condition. However, there was an irregular tail moult in progress, and this may have been the result of a former injury. Perhaps the specimen was injured by a car, or in some other way and did not make the fall migration."—Clarence J. Messner, 308 McKinley, Grosse Pointe 30, Michigan.

LITERATURE

Comments on Recent Literature

"Swallows certainly sleep all the winter. A number of them conglobulate together, by flying round and round, and then all in a heap throw themselves under water, and lie in the bed of a river."
Dr. Samuel Johnson.

Accounts of hibernating birds, though circulated since the time of Pliny, have found little favor in scientific circles. Hence the recent discovery that the Poor-will, *Phalaenoptilus nuttallii*, sometimes does hibernate came as a great surprise. Culbertson (1946) found a torpid Poor-will half buried beneath a pine limb on the ground near Fresno, California. This was on February 6, following a month in which the temperature had dropped below freezing almost every night. Stressing the improbability that the bird had been able to feed during this period, Culbertson suggested that hibernation might be involved. A year or two later, Jaeger (1948, 1949) during a visit to the Chuckawalla Mountains in the Colorado Desert found a dormant Poor-will nestled within a niche in a canyon wall. This bird was banded, photographed, and periodically examined during 3 successive winters, which it spent in the same retreat. Its body temperature ranged from 18.0–19.8° C. (about 66° F.). This was about the same as the surrounding air temperature but far below the usual body temperature of birds. Since the basic feature of hibernation is the transformation of a normally warm-blooded animal into a cold-blooded one (Suomalainen, 1940), the winter dormancy of the Poor-will may be considered true hibernation.

Jaeger found the wintering Poor-will to be in a generally low state of metabolism. Usually it gave no response when handled or even when a flashlight was shined directly into its half-open eyes. No chest movements or heart beat could be detected with a stethoscope. Even a driving sleet storm did not cause the bird to move, although its plumage was considerably battered. During the only winter of complete observation (1947–1948) Jaeger is certain that this Poor-will was in "profound hibernation torpidity" from on or before November 26 until shortly after February 14. It survived and was back in its "hibernaculum" on November 24, 1948.

There is little good evidence of migration into Mexico by Poor-wills. Some winter records for the United States, however, are of normally active birds. Whether the birds of the Great Basin usually migrate or whether they hibernate is unknown, but there is some reason to believe that hibernation may occur there as it does in California (Jaeger, 1949).

McAtee (1947) recently published an annotated bibliography on torpidity in birds. No convincing evidence of hibernation is presented for any other species. There is, to be sure, a detailed account of hibernation by Chimney Swifts, *Chaetura pelagica*, quoted from a "recognized ornithologist," but unfortunately one recognized chiefly for his unreliability. Hanna (1917), however, found that inclement weather may induce White-throated Swifts, *Aëronautes saxatalis*, to remain in their rocky retreats for several days. After a cold snap some of these swifts were brought to him in a torpid condition. European Swifts *Micropus apus*, bunch together in large masses to conserve body heat when a prolonged spell of cold rainy weather prevents them from feeding (Kuhk, 1948), but under such conditions heavy mortality begins almost immediately. Temporary lethargy, usually as a result of chilling, has been reported in a number of other species, notably hummingbirds, but there is no reason to believe it does not lead to death in a few days at most if the birds are not revived. Nevertheless, such physiological tolerance of chilling probably made possible the development of longer periods of inactivity in the Poor-will.

Brief torpidity, though known from comparatively few species of birds, is perhaps possible in many others under certain conditions. The following incident, related to me by Dr. James P. Chapin, tends to confirm this: "In 1910 Herbert Lang and I were encamped in a remote part of the northeast Congo forest gathering material for an Okapi group. From time to time natives would bring us a supply of live chickens to be dispatched as needed for the table. On one such occasion the boys were caught in a torrential downpour accompanied by a sharp drop in temperature. When the party finally arrived in camp, the chickens were found piled up in the bottom of the carrying-basket, drenched and to all appearances dead. The natives, who obviously knew their chickens better than we did, placed them on their sides around the camp fire. After a few minutes they turned them over to warm the other side. Before long some signs of life appeared, and soon all but one of the chickens were running about normally."

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Dean Amadon

Book Reviews

Nature and Its Applications. By Jessie Croft Ellis. (F. W. Faxon Company: 1949) 7 x 10½ in., xii + 861 pages, $17.00.

This large volume will serve as a valuable tool for ornithologists who must search through literature for references to particular species of birds. In brief, it is an index to illustrations (*i.e.*, reproductions of photographs, drawings, paintings, etc.) of various nature subjects ranging from Aardvarks to *Zygadenus elegans.* An attempt is made to include "not only subjects of nature in their natural setting and form but also nature as used in art, sculpture, advertising, paintings, toys, and every form of decorative design work." Persons using this index will find that it is possible to obtain much written information about the subjects included since illustrations are accompanied occasionally by explanatory legends and frequently by articles relating to them.

Over 125 books and periodicals have been indexed. These include *Audubon Magazine* (also its predecessor, *Bird-Lore*) and *Nature Magazine* which have regularly published extensive information on birds, as well as the following which have on numerous occasions carried information useful to persons interested in birds: *American Forests*, *Field and Stream*, *National Geographic Magazine*, and *Natural History.*

The present work is a new edition of "Nature Index" by the same author and is limited to 1,000 copies. Both the author and publishers are to be commended for having performed this great service to workers in the field of natural history.

Olin Sewall Pettingill, Jr..

The Birds of Concord. By Ludlow Griscom. (Harvard University Press: 1949) 340 pages 16 illus., 1 map. $5.00.

In this book, the most expert field ornithologist of our generation compares his notes with those of William Brewster, the most expert of the preceding generation. The result is a treasure of data concerning changes in the avifauna of the region around Concord, Mass. The introduction describes the Concord area, summarizes the ornithological work and explains the study methods. Brewster in 1868 began recording observations of birds at Concord in voluminous diaries and notebooks. Griscom has abstracted these and added his own recent notes. Part I of the book, titled Population Trends, describes the basic ecological factors of the region and of the birds. Then follows a summary of fluctuations in animals and a description of the increases and decreases in populations. Part II describes the present bird life and gives in a systematic list the abstracted notes of Brewster and others.

For the general ornithologist by far the most important sections deal with the changes in abundance of a number of species (p. 97–132). For example, the Indigo Bunting was common from 1830–1879, declined from 1880–1930, and subsequently increased. The Nighthawk not only fluctuated in abundance but also changed from nesting on the ground to nesting on the roofs. The spectacular results of protection of Wood Ducks and Egrets are clearly shown by the records for 100 years. Perhaps the most significant parts are the discussion of Brewster's principle of population overflow and the estimates of populations at Hurd's Pond, Wayland.

While these histories of populations are fascinating, the critical ornithologist will be concerned at the superficiality of the discussion of results. Terms such as Gaussian curve, periodicity, capacity, etc. are loosely used. Furthermore, the author, who is also an expert botanist, could have given a more specific description of the vegetation, citing the numbers and kinds of plants. The discussion of cycles (p. 123) shows an amazing lack of understanding of cyclic phenomena. The words density (birds per unit) and population (total birds) are frequently confused. Lastly, the illustrations are excellent photographs (none by the author) but do not illustrate the book; a picture of hundreds of Snow Geese is inappropriate as an illustration for an area reporting only 84 geese in a century! A Bald Eagle on its nest is similarly inappropriate. While the Concord ornithologists will find this book of immense value, its numerous deficiencies will tantalize the serious ornithologist.

David E. Davis

Birds of Prey of Northeastern North America. By Leon Augustus Hausman. (Rutgers University Press: New Brunswick, N. J.: 1948.) xxv + 164 pages, 31 ill., 1 col. plate. $3.75.

In an attractive format and at a price which is, for these days, quite reasonable, the rather suddenly prolific Dr. Hausman gives us a book which is a pleasant introduction to the birds of prey. For each of 35 forms a short description is given of adults and young with measurements of body length and wingspread. This is followed by a discussion ranging in length from a few paragraphs to a few pages. For the falconiforms a list of common names other than the accepted ones is provided. Besides the specific or subspecific accounts there are general discussions of the vultures, the hawks, the eagles, the falcons and the owls. Illustration plays a prominent part in the book and consists of a colored frontispiece by Sutton and 31 full-page drawings by Abbott. There is a systematic appendix, a bibliography, and an index of names.

The book presents a pleasing appearance. There is good spacing, wide margins, and clean printing; the page-size is large (7 x 10 in.); the binding is tasteful. From the initial paragraph of the book, the author maintains a sympathetic attitude toward the birds of prey. He points out that many birds, including the most of our admired song birds, prey upon other forms of animal life. The appeal of hawks, eagles, and owls to the aesthetic sense is constantly brought brought before the reader, and the role of the predator in maintaining healthy populations of useful prey species is not neglected. The writing is lucid and adequate to the purpose.

In this book exhortation and reasoning take the place of documentation and numerical data; tables of figures are never allowed to mar the pages, though poetry finds a place. The only major typographical error is the misuse of the subspecific name of the Northern Bald Eagle. More serious is a curious confusion between species and subspecies (p. 86). The appendix giving the classification seems unnecessary padding in view of the systematic arrangement of the body of the book; it merely copies the names of the 1931 Checklist without regard to the supplements, and commits several errors in the copying. The illustrations are adequate, though the use of brown ink in reproducing them reduces the sharp contrast which is one of the chief glories of pen and ink work. In some instances the choice of prey shown in the illustrations seems unfortunate from the viewpoint of the author's emphasis. While the text stresses other prey, the Red-tailed Hawk is shown with a rabbit, the Swainson's Hawk with a squirrel, and the Rough-legged Hawk with a muskrat, all favorably regarded animals.

Subject to the limitations of its aim and scope, this book can be recommended to the general reader and seems particularly suitable for school libraries.

Haven Kolb

Audubon's American Birds. By Sacheverell Sitwell. (B. T. Botsford: 1949) 12 pages, 16 plates. $2.00.

This volume is in the same series as *Tropical Birds* and reproduces excellently plates (9.5 x 7.5 inches) of the Wild Turkey, Baltimore Oriole, Carolina Paroquet, Florida Jay, Collie's Magpie-Jay, Pileated Woodpecker Meadowlark, White-Crowned Pigeon, Wood Duck, Wood Ibis, Mallard, American Eider, Roseate Spoonbill, Scarlet Ibis, Woodpeckers, Flamingo. One wonders why these particular plates were chosen. The 12 pages of comments are a horrible miscellany of irrelevant matter written in endless sentences which leave the reader thoroughly bewildered. For example, why include nearly 2 pages of names of races of fighting cocks. It is a pity that the publishers did not ask one of the many capable English ornithologists to write the notes.

David E. Davis

Blackie and his Family. By M. E. Cook. (Harcourt, Brace and Co.: 1949) 69 pages, illus. $2.00.

This review of a book for children is included in the Wilson Bulletin because it is believed that ornithologists are probably teaching their children about birds. Your editor will appreciate comments from the members concerning the desirability of reviewing children's books.

Blackie (apparently a Brewer's Blackbird) and his wife Dusty lived in a garden and built a nest in a pomegranate. They successfully repelled Mr. Darting Hawk, Chucky Ground Squirrel, and Old Man Gopher Snake. After raising 4 young, the birds join a flock and eventually migrate. Ornithologically the book is satisfactory. There are no serious errors in life history data and the anthropomorphism is not excessive although (p. 4) the function of song has the erroneous poetic interpretation. Conservationists will regret the emphasis upon the hawk episode. From the viewpoint of a psychologist the book is satisfactory but not impressive. Children from 5–8 will enjoy a couple of readings. Unfortunately, the hawk and snake episodes are likely to make the greatest impression. Ornithologists have discovered a gold mine in adult books. Why shouldn't they invade the field of children's books and teach our children correct ornithology?

David E. Davis

W. E. Saunders, Naturalist. Edited by R. J. Rutter. (The Federation of Ontario Naturalists, Toronto: 1949) $6\frac{1}{4}$ x 9 in., 66 pages, 5 photos, cloth.

This is a tribute to Saunders the man, by those who knew and loved him in his native Southern Ontario. His enthusiasm for and his interest in all about him, extended to music, horticulture, town planning, conservation, insects, mammals, birds and his fellow men. He taught practical chemistry at one time; carried on his vocation, pharmaceutical manufactory; for years wrote a weekly newspaper column; and delighted to talk and lecture about his interests. Included in this volume are samples of Saunders' writings, appreciations by P. A. Taverner, J. R. Dymond and J. L. Baillie, and Baillie has provided a 13 page bibliography of Saunders' writing.

A. L. Rand

THE WILSON ORNITHOLOGICAL CLUB LIBRARY

The following gifts have been recently received. From:

Hilda F. Amidon—2 reprints
Ralph Beebe—8 magazines, 3 books
Hervey Brackbill—7 reprints, 2 books
G. Reeves Butchart—1 reprint
Robert D. Edwards—1 reprint
Herbert Friedmann—6 reprints
Fr. Haverschmidt—2 reprints
Harold M. Holland—4 books
Leon Kelso—1 pamphlet
S. Charles Kendeigh—4 reprints
Haven Kolb—20 magazines
Margaret M. Nice—17 reprints, 2 magazines, 1 book
Eugene P. Odum—2 reprints
Kenneth C. Parkes—4 reprints
William H. Phelps—2 reprints
N. S. Potter, III—1 reprint
Richard W. Russell—1 book
Gordon C. Sauer—1 magazine
Johann Schwartzkopff—2 reprints
Robert W. Storer—1 reprint
J. Van Tyne—12 reprints
University of Wisconsin Department of Wildlife Management—4 reprints

To the Members of the Wilson Ornithological Club:

THE OFFICERS OF YOUR CLUB are very desirous of increasing the Endowment Fund of the organization in order to secure an ample permanent income.

Due to higher costs of printing, postage, secretarial service, etc., the revenue received from membership dues is not adequate to carry on the expanding activities of the Club. As you well know, the *Bulletin* is the most valuable asset of the Club, and it could be increased in size, with more photographs and an occasional color plate, if funds were available. There are many other services and research projects that could be amplified if the means were at hand.

The interest received from the monies invested has been increasing slowly each year as the Endowment Fund has grown. It is our hope to build this fund as rapidly as possible. This may be accomplished by three methods:

1. From receipts of Life Memberships, which have been allocated to this fund. A payment of $100.00 at one time, or 4 annual installments of $25.00 each, entitles one to Life Membership, with exemption from further payment of dues. This method should appeal to every younger member who can possibly afford it. Won't you seriously consider taking this step?

2. From outright gifts, either from yourself over and above the payment of your regular membership dues, or from friends whom you might interest in our cause.

3. From bequests. Many of you have devoted years to ornithology, as a hobby or as a vocation. Isn't it logical then to perpetuate your interest by leaving some sum to the Club on your death? We hope that you will take steps promptly toward such a bequest.

We urge you to contribute to the extent of your ability so that *your* Club may grow in its value to you and to society in general.

THE ENDOWMENT FUND COMMITTEE
Clinton S. Banks
Robert L. Edwards
Robert T. Gammell
Robert A. McCabe
Leonard C. Brecher, *Chairman*

THE PRESIDENT'S PAGE

Many of our Wilson Club members keep records of their field trips for birds and take notes on their observations of behavior, habits, ecological relationships, and other aspects of birdlife. In respect to these tasks, the following question occurs to me: Are the records and notes being carefully organized and conveniently filed for immediate reference? Or, to put the question another way: Are the notes and records being accumulated in such a manner as to make them useful not only to persons performing the tasks, but also to persons who may eventually have access to them?

No two ornithologists hold identical interests; it can, therefore, be expected that their records and notes are slanted in different directions. Basically, however, their information must be accumulated and kept in a systematic fashion, if it is to be of lasting value. Let me point out the methods of two ornithologists well known to this organization.

Mr. Ludlow Griscom is engaged in the study of bird distribution, migration, and populations. While on field trips he is constantly looking for evidences and explanations of range extensions, migration irregularities, population increases and declines, and seasonal variations. He has a daily record book in which he enters the temperature, wind velocity, and sky conditions of each day, whether it is a field trip day or not. Thus he can quickly reconstruct the weather history of a particular season. In this same book he also enters a brief account of each field trip, the list of birds seen, and careful counts, or estimates, of the number of individuals of each species. In addition, Mr. Griscom has a series of loose-leaf ledgers in which all North American birds are arranged in phylogenetic order. In it, his observations are recorded under each species by year and states. From these ledgers it is a simple matter to obtain the data for any particular species or area that interests him at the moment.

Dr. George Miksch Sutton, being a bird artist, is constantly studying the attitudes and behavior of birds; furthermore, he is always observing the habits and ecological relationships of birds in specific localities. When working in the field he keeps a journal in which, at each day's conclusion, he notes significant weather conditions, gives descriptions of the area covered, and puts down his impressions of habitat relationships. He also has at hand a loose-leaf notebook, one page to a species, arranged in chronological order (*i.e.*, the order in which each species is first seen). After each day's trip, he goes through the notebook, writing down the number of individuals of each species counted and giving terse accounts of nests, their contents and location, of flight peculiarities, of songs and call notes, of feeding habits, of defensive reactions, of instances of predation. When Dr. Sutton is through working in the field and returns to his office, the journal is filed away by year, but the loose-leaf notebook is treated differently. Species pages are rearranged in phylogenetic order, numbered, and indexed. The species pages are then disassembled and filed in folders, one to a species; the index is placed in a folder with indices from earlier notebooks. This system keeps together in one folder all species data gathered by him through the years, while at the same time permitting, by means of the indices, the reassembling of species pages resulting from a particular trip.

I sincerely hope that Wilson Club members handle their records and notes in an equally efficient manner so that the information will be useful to them in their lifetimes and to future bird students. William Brewster, one of America's greatest ornithologists, painstakingly obtained and methodically preserved a mass of information on the New England birds of his day. Now long after his death, we have an accurate, readily available picture of an avifauna that has since become modified.

Olin Sewall Pettingill, Jr.

ANNOUNCEMENT OF ANNUAL MEETING

NOTE: This is the official announcement of the annual meeting. In previous years the announcement has been issued in the form of a letter from the Secretary, mailed individually to members.

Place and Time. The Thirty-first Annual Meeting of the Wilson Ornithological Club will be held at Jackson's Mill, West Virginia, Friday and Saturday, April 28-29, 1950. On Thursday, April 27, there will be a meeting of the Executive Council, and on Sunday, April 30, there will be organized field trips.

Jackson's Mill and How to Reach It. Jackson's Mill is the site of the West Virginia 4-H Camp, a nationally known youth center and meeting place. The Camp has some thirty permanent buildings, on a tract of five hundred acres. It is four miles north of Weston, and twenty miles south of Clarksburg. It is reached by surfaced highway, which leaves U. S. Route 19 near the city limits of Weston. At Jackson's Mill "Stonewall" Jackson lived as a boy, and the old grist mill built by his grandfather is still standing.

Attractions. It would be difficult to imagine a more pleasant place for a meeting than the southern Appalachians in late April. Jackson's Mill is in hilly wooded country just west of the Allegheny ridges. Redbud and early dogwood should be in bloom along the roadsides, and there will be much of outdoor interest. Depending somewhat on the season, there should be heavy migration of birds at this time. At the Camp, field trips begin at your cottage door. The group in attendance will live and dine together, with no outside distractions. Plans for the meeting include a series of papers on birds of the Appalachian region on Friday afternoon, an informal gathering after the Annual Dinner on Friday evening, and a motion picture session on Saturday afternoon. On Saturday night Mr. H. P. Sturm will show his outstanding color film, "Wild Flowers of the Alleghenies".

Sessions. Sessions will begin at 9:00 a.m. and continue until about 5:00 p.m. Daytime meetings will be in the Century of Progress Building. Night meetings will be in the Assembly Hall.

Special Events. After the Annual Dinner on Friday evening the host organizations will welcome members and guests at an informal reception and entertainment at the Assembly Hall. There will also be an informal gathering on Saturday evening. A small exhibit of Southern Highlands handicraft articles, weaving, wood carving, hand-made jewelry, etc., will be available at the Camp. On Saturday after supper a tour of the Camp grounds, with a chance to visit the old Jackson mill, will be conducted.

Meeting of the Council. The Executive Council of the Wilson Ornithological Club (all officers, all past-presidents, and three elected members) will meet on Thursday, April 27, at 4:00 p.m. in the lobby of Harrison Cottage. This meeting will continue through the evening. The Secretary requests that chairmen of committees send their written reports to him by April 15, in order that these reports may be discussed by the Council.

Accommodations. All members and guests will be housed in comfortable cottages at the Camp. Most of the cottages have dormitory type sleeping quarters, with single beds. There are about twenty-five units suitable to family groups. The Camp is a pleasant place for small children, and early reservation will insure the care of family parties in these units.

Meals and lodging at the Camp from dinner Thursday evening through breakfast Sunday morning will cost $11.43, with prices for shorter times correspondingly less. This rate includes the Annual Dinner, separate tickets for which will cost $2.75. The rates for individual meals (excluding the Annual Dinner) are breakfast, 65 cents; luncheon, 75 cents; and dinner, $1.25, plus state sales tax. Lodging is charged for at the rate of $1.25 for the first night, 75 cents for the second night, and 50 cents for the third night, all prices plus 2% state sales tax. All meals are served in the Mount Vernon Dining Hall.

The Camp furnishes all bedding. Visitors may bring their own towels and soap, or may secure them at the Camp Office for a small additional charge.

Sports or field clothing will be entirely suitable for all functions at Jackson's Mill. The weather may be cool, and rain clothes should be provided for.

To assist the local committee in planning your accommodations, it is urgently requested that you make advance registration, as early as possible, through Maurice Brooks, West Virginia University, Morgantown, West Virginia. Please state the approximate time of your arrival and departure, and the names of persons in your party.

Transportation. For persons driving to the meeting, Jackson's Mill is reached by marked highway from U. S. Route 19 near the city limits of Weston. Interurban busses which stop at the Camp leave Clarksburg and Weston every hour and one-half during the day. Clarksburg is on the main line of the Baltimore and Ohio Railroad between New York and St. Louis, about midway between Washington and Cincinnati. It is on U. S. Routes 19 and 50, and is served by Greyhound, Blue Ridge, Reynolds, and West Virginia Transportation Company busses. It is a stop for Capital Airlines between Pittsburgh and points south. For private planes there is an excellent landing field on the Camp grounds at Jackson's Mill.

Persons with heavy baggage or other transportation problems may arrange through the local committee to be met in Clarksburg or Weston. All mail, express, telegrams, and telephone calls should be addressed care of the State 4-H Camp, Weston, West Virginia.

Field Trips. There will be a choice of two field trips, both by private cars, on Sunday, April 30.

1. *Cheat-Gaudineer region.* This trip will be into the spruce-clad mountains

at elevations above 4,000 feet. Here the plants and animals are quite boreal, and many northern birds reach their southern breeding limits. Of special interest to those from lowland regions.

2. *Holly River State Park.* This trip is designed for those more interested in Carolinian birds—Blue-gray Gnatcatchers, Carolina Wrens, Hooded and Kentucky Warblers, Summer Tanagers, White-eyed Vireos, Bewick's Wrens, and others. Swainson's Warblers breed in the park, and *may* have arrived at the time of the field trip.

Both trips will leave Jackson's Mill at 8:30 a.m. and permit return by 5:00 p.m.

Hosts. Host organizations for the meeting are the Brooks Bird Club and the Huntington Bird Study Club. The local committee in charge of arrangements is as follows:

MAURICE BROOKS, *Chairman*

I. B. BOGGS	JAMES T. HANDLAN
VIRGINIA G. CAVENDISH	MRS. JOHN W. HANDLAN
CHARLES CONRAD	C. O. HANDLEY
W. R. DEGARMO	EVA HAYS
RALPH EDEBURN	W. C. LEGG
N. BAYARD GREEN	M. GRAHAM NETTING

APPLICATION FOR A POSITION ON THE PROGRAM

Members who have conducted research as yet unpublished or who have movies or slides of special interest, are urged to write for a place on the program. Papers will be selected for their timely interest and their contribution to ornithology. In making these selections, the Secretary will be assisted by the Local Committee and by the other officers of the club. If you do not have anything to present yourself, perhaps you may be able to suggest outstanding papers which the Secretary can secure for this meeting.

If you would like to appear on the program at Jackson's Mill, please write to the Secretary, Harold F. Mayfield, 2557 Portsmouth Avenue, Toledo 12, Ohio, not later than March 1, 1950.

Please note that no more than one paper may be presented by any one member. A paper accompanied by motion pictures must not exceed 30 minutes; a paper accompanied by slides must not exceed 20 minutes; a paper without pictures must not exceed 15 minutes. A limited time for discussion will be allowed following each paper.

In writing the Secretary, please supply *all* of the following information applicable to your paper:

Title of Paper. Give title exactly as you want it to appear on the program.

Abstract. Please give an abstract of your paper—brief, but sufficiently complete so that the local committee may use it for publicity and the Secretary may use it in preparing the proceedings of the meeting.

Time Required.

Position. State if it is essential that you appear at a particular time.

Special Equipment Needed. Blackboard, map hanger, pointer, etc.

Movies. If your paper is to be illustrated with motion pictures, please give the following information: Size (16 mm or 35 mm). Color or black and white. Total footage. Number of reels. Size of reels.

Slides. If your paper is to be illustrated with slides, please give the following information: Size (3 1/4″ × 4″, or 2″ × 2″). Color or black and white. Number of slides.

Name. Please write your name exactly as you wish it to appear on the program. Titles before names will not be used.

Address. Include the name of the institution with which you are associated, if any. The name of this institution will be used after your name on the program.

Suggestions to a Member Presenting a Paper

To assist members in planning their presentations, we offer the following suggestions:

1. A paper should be prepared to come within the time allotted. If your paper runs overtime, you place the presiding officer and possibly the later speakers in an embarrassing position.

2. The paper should contain a concise statement of the problem and the scope of the investigation. A brief summary is important, but a long list of conclusions usually is not necessary.

3. A person giving a paper for the first time is especially advised that very few people are able to keep an extemporaneous address (with or without notes) within the time limit designated. It is ordinarily more satisfactory to prepare a manuscript and to read it slowly in a moderately loud voice. On an average, two minutes are required to read a double-spaced, typewritten page. Fifteen minute papers, therefore, should not be over seven and a half pages in length.

4. A person presenting either motion pictures or slides, or both, must include the time required for showing them in the request for time on the program. Generally, four and one-half to five minutes are necessary to show one hundred feet of 16 mm film at normal speed, while between three and four minutes are necessary for a projectionist to change reels. About one minute is needed to show a picture slide and make a brief comment on it; more time is required for explaining a slide showing a chart, graph, or diagram.

5. When presenting motion pictures or slides, please consider these suggestions: See the projectionist well in advance of the time for your paper, and

explain the order in which the films or slides are to be shown. All reels should be numbered; all slides should be in correct order, thumb-marked. Do not continue a slide on the screen after you are through talking about it. Either signal the projectionist to turn on the auditorium lights, or to turn out temporarily the light in the projector. Visit the speaker's platform before the session begins and learn the position of the signals, how the signals are used, where the pointer is kept, where the speaker's light is located, and how it may be turned on and off.

LIFE MEMBER

Leonard C. Brecher began his acquaintance of birds during his boyhood, and has devoted 35 years to their study—as an avocation. He received an M.S. degree from the University of Louisville, but, instead of following the biological sciences professionally, he joined his father in the manufacture of furniture. He is a member of various scientific societies, and president of Kentucky Ornithological Society. At present he is fieldnotes editor of its journal "The Kentucky Warbler", to which he has contributed a number of articles from time to time. He is now chairman of the Endowment Fund Committee of the Wilson Ornithological Club.

WILSON ORNITHOLOGICAL CLUB NEWS

President Pettingill has appointed the following Nominating Committee to prepare a slate of officers to be voted on at the Annual Meeting in April: R. Allyn Moser, Chairman, S. Charles Kendeigh, and A. W. Schorger. Members are asked to send their suggestions to this Committee.

Barro Colorado Island—Information Wanted

An annotated list of the birds of Barro Colorado Island, Panama Canal Zone, is in preparation. Information is sought bearing on status, distribution and nesting dates. Particularly useful would be additions to or comments on the list appended to Chapman's "Life in an Air Castle", 1938. Eugene Eisenmann, 11 Broadway, New York 4, New York.

Louis Agassiz Fuertes Research Grant

Applications for the 1950 Louis Agassiz Research Grant are now being received by the chairman of the Grant Committee, Dr. Charles G. Sibley, Department of Natural Sciences, San Jose College, San Jose, California. Information concerning the grant may be obtained from the June 1948 *Wilson Bulletin*. Details and application blanks may be obtained from the chairman. Applications should reach the chairman before March 15, 1950.

Ornithologie Als Biologische Wissenschaft

This special volume was published on November 22, 1949, on the occasion of the sixtieth birthday of Erwin Stresemann. It includes among its twenty-eight contributors J. Berlioz, J. P. Chapin, J. Delacour, R. Drost, F. Goethe, O. Koehler, G. Kramer, H. Laven, K. Lorenz, E. Mayr, W. Meise, A. H. Miller, R. E. Moreau, R. C. Murphy, M. M. Nice, P. Palmgren, E. Schüz, H. Sick, N. Tinbergen, H. O. Wagner, H. Weigold, and E. Witschi. Papers in English, French, and German deal with all phases of ornithology: systematics, speciation, general evolution, ecology, zoogeography, embryology, and the study of behavior. This collection of important original papers belongs in the library of every ornithologist.

The price for the bound volume of 350 pages is $5.50. A special price of $3.50 will be allowed to members of the Wilson Ornithological Club provided their orders are received before March 1, 1950. All orders should be addressed to Dr. E. Mayr, American Museum of Natural History, New York 24, New York.

INDEX TO VOLUME 61, 1949

In addition to names of species and of authors, this index includes references to the following topics: food, localities by state, province, and country, migration, nesting, voice, weights.

RECOMMENDATIONS FOR PREPARATION OF MANUSCRIPTS

Manuscripts should be typed on one side of white paper of good quality with title and author's name written on a separate sheet. Everything should be double-spaced and each table should be typed on a separate sheet. Figures, not words, should be used for all numbers (except at the beginning of a sentence). Sex ratios should be calculated as % males. Express data in quantitative and tabular form, wherever possible, and when giving averages, also give the standard deviation. The technical names of the A.O.U. Check List (4th edition), as corrected in the supplements, should be used. Unless specimens have actually been identified to subspecies, only the specific name should be used. Whenever possible a reference for technical names of plants should be listed. Literature should be listed at the end of the article in accordance with the style in previous issues. All articles should have a summary that gives the data in brief form. Authors should avoid footnotes, vernacular phrases, and the use of nouns as adjectives. Illustrations should have good contrast. Printing on charts and maps must be large enough to permit reduction. Cuts of figures will be destroyed unless author requests their return on the reprint order form.

To appear in future issues:

BAROMETRIC PRESSURE PATTERNS AND SPRING BIRD MIGRATION

THE WING MOLT OF THE BOBWHITE QUAIL

CONVERGENT EVOLUTION IN AMERICAN ORIOLES

Date Due