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LIFE HISTORY OF THE OVEN-BIRD IN SOUTHERN MICHIGAN*

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INTRODUCTION

The Oven-bird (*Seiurus aurocapillus*) has attracted more than ordinary attention since first known to science. Its taxonomic position, peculiar nest, "teacher" song, flight song, secretive habits, and heavy parasitism by the Cowbird (*Molothrus ater*), have combined to give it special and sometimes baffling interest.

When the Oven-bird was described by Linnaeus in 1766 (Ridgway '02), it was placed in the genus *Motacilla* (*M. aurocapilla*) with

the Old World wagtails. In 1790 it was transferred to the genus *Turdus* (*T. aurocapillus*) by Latham, and was known as the Golden-crowned Thrush. In 1827 it was placed in the genus *Seiurus* by Swainson, but continued to be called the Golden-crowned Thrush until the publication of the first A. O. U. Check-List in 1886. The name "Oven-bird" was mentioned by Nuttall (1832), and a little later by Audubon (1834), who said, "The nest is so like an oven, that the children in many places call this species the Oven-bird".

Wilson (1831) described the nest, common song, and secretive habits of the Oven-bird, and mentioned the parasitism by the Cowbird. Nuttall briefly described the flight song, which seems to have escaped the attention of Wilson and Audubon. John Burroughs, in *Wake Robin* (1871), likened the common song to "teacher, teacher, . . .", a comparison which is known almost as well as the bird itself. Ornithologists of the following years acquired considerable new data on the species, chiefly by causal observations in the woods.

In late years Mousley ('26) watched a nest from the beginning of incubation until the young left, and Mrs. Nice ('31b) watched two nests of young birds, one until the young left, and the other until the brood was taken by a predator at the age of four days. Both of these observers gained considerable information on the habits of the species.

On July 25, 1932, while studying birds in a forest near Coldwater Lake, Michigan, the writer found an Oven-bird's nest containing four young birds, which proved so interesting that he resolved to make a study of the species when the opportunity was afforded. During the same year a nest was found in a large forest five miles southwest of Ann Arbor. In the spring of 1933 the forest near Ann Arbor was visited a number of times and the study was begun. Five nests were found, two of which contained eggs, and one of these was watched from a blind from hatching time until the young left the nest.

In the spring of 1934, the study was started in earnest. Visits to the forest were begun late in April, and from the time the first Oven-bird was seen on May 2, visits were made daily, or twice daily, with the exception of two days, until August 31. Less frequent visits were made during the first two weeks in September, terminating after the last birds had disappeared. The work was continued during the spring and summer of 1935, daily observations being made from April 25 to September 3, and less frequent visits continuing until October 13. In 1936, a check was made of the returning birds and some time given to nest study, trips being made more or less regularly from the latter part of April until the middle of June.

The number and distribution of hours spent in the forest during the study are shown in the table below. During most of May, June, and July in 1934 and 1935, two trips to the woods were made each day. The first usually lasted from early morning until noon, and the second, two or three hours in the evening, ending at dusk. There was enough irregularity in this program so that the afternoon was not neglected. Relatively less time was given to the work in May than in June and July, during these two seasons, on account of teaching duties, which terminated about June 1.

Table showing the number and distribution of hours spent in the forest during the study.

	April	May	June	July	Aug.	Sept.	Oct.	Total hours
1933 .....	....	2	56	8	....	....	....	66
1934	2	137	250	168	35	4	....	596
1935	16	153	246	209	36	20	4	684
1936	5	67	25	....	....	....	....	97
Total hours	23	359	577	385	71	24	4	1443

During the season of 1934, twenty-five nests were found, nineteen of which contained eggs or young of the Oven-bird, and in 1935, thirty-one nests were found, eighteen of which contained eggs or young. In 1936, eighteen nests were found, thirteen of which contained eggs or young, but for the most part these were not included in the calculations. The number of nesting pairs each season was about twelve. During the study eleven nests were followed from before the first egg was laid until the young left the nest.

One of the large factors in the work from the standpoint of time and labor was searching for nests. Different methods were used in the search as the season progressed. First a careful watch was kept for the females at work building, or flying up from the ground when approached. Later a search was made, especially along the edges of roads or other open spaces, where most of the nests were located. If the above methods failed until after the incubation season began, the area in question was thrashed over with a stick or switch in hopes of flushing the female from the nest. When a nest was deserted, adjacent parts of the territory were searched for a subsequent nest. The singing of the male is an important clue, but only a general one, and the chirping of the parents may be helpful if it occurs.

Adult birds were banded with metal and colored bands from the Biological Survey soon after the young hatched. A drop-trap of the "pull-string" type was set over or near the nest for catching them. The young were banded with metal bands when from three to five days old. Special effort was made to follow parents and young after they

left the nest, and much of the work during the latter part of the season was of this nature. Eight-power binoculars were carried at all times as an aid to vision.

Two green denim tents 1.8 meters square and 1.4 meters high were used as blinds, and were placed from one to six meters from the nests. These were set up dozens of times, for periods ranging from a few minutes up to twenty days, and observations were made from them as early as the egg-laying period.

Weights of young birds were taken with a pair of triple-beam Cenco scales, reading to one-hundredth of a gram. Two permanent platforms were set up in different parts of the woods, on which the scales were set, and young birds were brought to these centers for weighing. Young birds were distinguished by colored threads until they were large enough to band.

Where weighing was being done, wire netting was placed around the nests when the young were about ready to leave, so that the final weight could be obtained. In two cases a trap was placed over the nest and the parents allowed to go in and out to feed the young. These enclosures were found to be a hazard to the young birds, however, and should be used with great care.

Temperatures were taken by means of a thermocouple and potentiometer-indicator of Leeds and Northrup manufacture, accurate to about two-tenths of a degree Fahrenheit. An itograph, made by the writer, and patterned largely after the one made by Kendeigh and Baldwin ('30) was used at two nests in 1934, one in 1935, and one in 1936 (Plate XI, D and E).

Persistent watch was kept throughout the study for data on the flight song. During more than ninety evenings the author remained in the woods until after singing ceased, and in a majority of cases was stationed at favorable places, listening for songs and watching for the spiral flight, which he never saw.

The area studied was from fourteen to sixteen hectares (thirty-five to forty acres) in extent, being a little larger in 1935 than in 1934. This was about half of the available territory for study, but it was thought better to restrict the work to an area that could be covered thoroughly. The woods was exceptionally free from molestation by people, the only damage done being the crushing of a nest by a truck. The absence of intruders was due in no small degree to the mosquitoes which infested the woods. As a protection against these pests the writer wore thick clothing, leather gloves and a covering over the back of the head and neck, even in hottest weather. Mosquito dope

was used on the face with some success, and a brush of twigs was used a great deal when it did not interfere with the work.

I wish to express my appreciation of the helpful criticisms and suggestions received from Mrs. Margaret M. Nice and Dr. L. E. Hicks, of Columbus, Ohio, who read the manuscript, and of aid received from different members of the biological teaching staff of the University of Michigan, particularly Professor E. C. O'Roke, of the School of Forestry and Conservation, and Professor F. G. Gustafson of the Department of Botany.

TERRITORIAL AND SEXUAL RELATIONS

Arrival of Males. The first male Oven-birds arrived from nine to fourteen days before the first females. The arrival of the males was spread over a longer period of time, however, and the average time between the arrival of all males and females was about seven days (Fig. 4). In 1934, the first male was seen on May 2. On May 4 and 5 there were several more, and by May 6, all appeared to be in their places. They took up territory and defended it as soon as they arrived, and later checking showed that the choice of territory was permanent except for minor changes.

In 1935 the first male was seen on April 28, and two more on the 29th. The last two were banded birds, which went immediately to their old territory, and it is probable that the first was an old resident, since the male in that territory in 1934 was not banded. Cold, wet weather followed the arrival of the first males. During this time no new birds came, and little was seen of those already present. On May 8, fair weather came, and with it most of the remaining males, including two that were banded, one old one, and one yearling.

In 1936, three males, two of which were banded, were seen on April 29, and two unbanded birds were seen first on April 30. Other males, banded and unbanded, were seen for the first time from May 3 to 5, and one male which hatched in the woods two years before was seen first on May 7.

My records for former years gives additional data on the time of arrival. In 1930 a male was recorded at the University Forestry Farm four miles west of Ann Arbor on May 2, and on the following day one was found in the Arboretum at the east edge of the city. Both of these birds were migrating, as they do not nest in either place. On May 10, 1931, and May 4, 1932, males were found in suitable nesting ground in the Ann Arbor region, and doubtless were established in their territory.

Arrival of Females. In watching for the first females, one is faced with the problem of distinguishing females from non-singing males that may be trying to acquire or extend territory. The first females of 1934 which were identified with certainty were seen on May 14, when five were found already mated. As early as May 11, however, I saw a bird which I strongly suspected was a female. In 1935, the first female was found mated on May 12, and others were seen on the 13th and 14th. In 1936, four mated females were seen on May 8, and a bird seen on May 7 probably was a female. Practically all of the remainder were present and mated by May 11. Most of the matings occurred about the same time, indicating that the females arrived almost simultaneously.

For the relation of migration and nesting to temperature, see Figure 4.

Territory. The size of territories in the area studied ranged from 0.2 to 1.8 hectares (0.5 to 4.5 acres) in extent, and the average population was about one pair of birds to each 1.2 hectares (three acres) (Figs. 1 and 2). Variation in size of territory depends apparently upon the desirability of the area, the number of birds to be accommodated, and the pugnacity of the males. The first males to arrive wander about some, but as others come they narrow their ranges.

From the time the males come there is much contention, chasing, and fighting until the females arrive, and sometimes afterwards. Fighting is never very serious, and no injury was ever noted as a result. After the females arrive, two pairs of birds may enter into a dispute over territory, but this is less common. Females in this case are probably no more than interested observers.

When the nesting site is chosen, the territory usually undergoes some change, due to the shifting of the center of interest from the male's favorite singing place to the region of the nest. There is little change after this unless later nests are built. Subsequent nests are usually built well within the territory, but in one instance one was built at the border within a few meters of an earlier nest which belonged to a neighboring pair. There was no friction here, however, since the nests were not occupied at the same time.

When boundaries are once established, they are usually recognized by the birds concerned. One male under observation wandered into neighboring territory to get away from me, but hastened back immediately when he heard the female there objecting. The mating call of a female, or an object of curiosity such as a young bird, is apt to cause a male to cross a boundary line, but he is usually chased

back immediately. As far as I have observed, nesting material and food are gathered in home territory.

Banding and Returns. In 1933, one pair of adults and three young birds were banded. The male (No. 10) returned the following year, and occupied a territory adjacent to the old, and perhaps overlapping it some (Fig. 1). It is probable that he was crowded over by a stronger male. This was the only male observed which moved his territory appreciably upon returning the following year.

In 1934, ten additional males and eleven females were banded, making twenty-two adults in all. This number consisted of ten pairs, plus one male whose mate I could not catch, and one female which was a second mate. The young were banded also, and about forty of these lived to leave the nest.

In the spring of 1935, three males and seven females returned, also a yearling male which was banded in the nest (Fig. 2). The male banded in 1933 was not among those that returned. The adult males of 1934 were banded with a metal band on each leg, and colored bands in addition. Fearing that the weight of the extra band might have caused the death of some of the males, I placed only one metal band on each male during the following season.

The three old males that returned (Nos. 5, 9, and 10A) went immediately to their former territories. The final size and shape of the territories for the season were different from those of the previous year, however, due to surrounding males, and to the location of the nest, or nests, within. It may be significant also that the size of the territory of each male was a little larger, suggesting greater activity and pugnacity on the part of the older males.

Of the seven females that returned, three occupied their former territory, and four, adjacent territory. A strong attachment to the old location was shown by the three females (Nos. 6, 12, and 15), which built their nests 3.9, 6.6, and 24.5 meters respectively from their nests of the previous year (Fig. 3). Of the four that occupied adjacent territory, two (Nos. 10 and 2) lost the young of the first brood after they were out of the nest, then went back to the territory of the previous year, mated with the males there, and built nests 2.6 meters and forty-six meters respectively from the previous nests (Figs. 1 and 2). One of the above males (No. 23) already had a mate, and the other (No. 5) apparently had lost his young after they left the nest. No birds had the same mates during the season of 1935 that they had the year before, although two pairs of the previous year were in the woods.

The yearling male (No. 32) took up a territory 300 meters from the nest where he was hatched, and mated with the female that had been there the year before. His mother (No. 2 ♀) was in the woods, but she remained near her old territory. For a time after his arrival, he had to carry on continual warfare to keep another male from entering his territory, but he defended it successfully.

In 1935, five males and four females were banded, in addition to those which had returned, making a total of nine males and eleven females banded. This number consisted of eight mated pairs, plus one male with two mates, and a female whose mate I did not catch. In addition to the adults, about twenty-five banded young left the nest.

In 1936, seven of the nine banded males, including the three banded in 1934, returned and occupied their former territories (Fig. 2). Two of the third year males were among the first three to arrive, on April 29, but the two year old male banded in the nest was not seen until May 7.

Six of the eleven banded females returned in 1936 (Fig. 2). Three returned to their former territories, and two of these remated with their mates of the previous year. The remaining three found mates in territories adjoining those of the last year, although the former mates of two were present. The females returning to the same territories (Nos. 12, 35, and 23) built nests 7, 16, and 48 meters from the nests of the previous year. Four of the six returning females were present for the third season, and their nesting history is shown in Figure 3.

Table showing returns of banded birds.

	Males	Females	Males and females
1934	1 out of 1—100.0%	0 out of 1—00.0%	50.0%
1935	3 out of 11— 27.3%	7 out of 11—63.3%	45.5%
1936	7 out of 9— 77.8%	6 out of 11—54.5%	65.0%
Total for three years.....	11 out of 21— 52.4%	13 out of 23—56.5%	54.5%
Birds returning in '35 and '36..	3 out of 11— 27.3%	4 out of 11—36.3%	31.8%
Total returns on young.....	1 out of 68— 1.5%		1.5%

Mating. It is evident from the foregoing data that both male and female adult birds return to their old breeding grounds, if possible. Old males have a good chance of obtaining their former territory either by arriving early or by driving out the other males. Returning females have more difficulty, however, since females probably return at more nearly the same time, and there is the additional factor in their adjustment, the male. It seems obvious, though it was not actually observed, that the female goes first to the old territory, and if the

male there already has a mate, she goes to an adjoining territory. The particular male in the territory seems to be of no consequence.

With both males and females attempting to return to the same place, there would seem to be a strong tendency for pairs to remate in subsequent years, and this has happened twice with banded birds, but it is by no means the rule.

From their first arrival, the females spend much of their time on the ground, feeding leisurely, and apparently surveying the ground, looking for a favorable place to nest. The male usually remains near, either walking on the ground or singing from a tree above. In several cases the female objected to his coming too close, and kept retreating as he came near. Other females, however, gave the mating call and seemed to desire copulation almost from the start. No courting performances were seen other than males chasing birds which were suspected of being females.

Sexual Relations. Copulation may take place either on the ground or up in the trees, on the ground being the more common. When it occurs in the trees, the male may mount and dismount quickly, with his head held high in the air, or he may hold to the female's crest and the two have a struggle. It was not an altogether uncommon sight to see a female perched on a limb, and a male hanging to her crest while fluttering and dangling in the air. When copulation takes place on the ground, it is practically always accompanied by a struggle, which looks more like a mortal combat than sexual intercourse. The fact that the female does not flee, and may even court the procedure, however, dispels any doubt as to her willingness. When they emerge from the struggle, the male usually flies to a nearby perch with an evident feeling of satisfaction, and the female, after shaking her ruffled feathers, proceeds with her eating or nest building. Copulation takes place ordinarily during the nest-building and egg-laying periods, though there was evidence of it occurring in exceptional cases both earlier and later.

Perhaps as a rule mated birds go about their nesting duties without undue attention to neighboring birds of the opposite sex, but there are plenty of exceptions. One female was seen copulating with a neighboring male three times, and a second neighboring male once, in the space of a few minutes. This took place in the female's home territory, and her mate was not present to object. She ate and gave the mating call between times. The female and both of the males wore colored bands from the previous year. About three hours later

I saw her copulating with an unbanded bird, presumably her mate. This female lost the young of her first brood and mated with one of the above neighboring males for a second nesting. Her sexual desires proved too much for him, and once as she approached him with fluttering wings wanting copulation, he turned and flew in the opposite direction. Just previous to this she had been in adjoining territory with a neighboring male, with whom she apparently copulated, and following the incident she went into a third territory, that of her former mate. Her second mate tried to follow her there, but the first chased him back. Twice the female uttered a mating call and flew toward the former mate when he sang, but as far as I could see, he paid no attention to her. He at this time was taking care of a young bird by their former mating. Several days later, after the female had begun to incubate her eggs, I found her again in adjacent territory, in company with the neighboring male. Her eggs and young did not suffer from her escapades, for her five eggs hatched, the birds left the nest, and later I found her caring for at least one bird twenty-six days old.

In another case where I was watching a female building a nest, a neighboring male slipped in and copulated with her, or attempted to, but finally was driven out by her mate. She went on with her building, and did not seem disturbed in the least.

Subsequent Matings. Two cases of bigamy were observed, and in both cases the male took on an extra mate while the first female was incubating. The procedure was probably no more than the male copulating with an extra female, and her settling down and nesting within his territory. One male, No. 9, helped care for his first brood until they were attacked by a predator at the age of six days and only one young bird escaped (Nest 9-3, Fig. 2). The female, No. 2, apparently took this bird, but it did not survive. The second brood (Nest 9X) hatched two days later, but the male failed to help feed the young until they were five days old. Meanwhile female No. 2 had lost her young bird and mated with a neighboring male (No. 23), while his mate was incubating. She laid four eggs and began incubating, but the nest (23X) was robbed by a red squirrel before hatching. Male No. 9 was near this last nest at times, and may have copulated with the female. The nest was on the border line between the two territories, but the males seemed to bear no ill feeling toward each other.

Oven-birds regularly start nesting anew if a nest is disarranged or the contents destroyed (Figs. 1, 2, and 3). Parents separate, however, when the young leave the nest, each ordinarily taking a part of

the brood, and they may then no longer be considered as mates. If a parent receives no young or loses them, it will mate again if opportunity is afforded and it is not too late in the season. In only one instance have I found a bird raising a second brood, after raising a part of the first brood successfully. This male raised a young bird to at least thirty-five days of age, and late in the season was found caring for another young bird out of the nest.

Literature. Records of first arrivals in the literature must be considered as those of males, since the females do not arrive until later. Wood's ('06) records from 1880 to 1905 and Wood and Tinker's ('34) records from 1906 to 1930 for the Ann Arbor region show first arrivals twice before April 28 (April 3 and 18); four times from April 28 to 30; seventeen times from May 1 to 3; six times from May 4 to 6; and fourteen times after May 6. The first records, April 3 and 18 must be considered as accidentals, and some of the late records were probably cases where the birds were not found promptly upon their arrival. The fact that they were reported seventeen times from May 1 to 3 seems very significant, and this may be taken as the normal time of first arrival of males in the Ann Arbor region.

Cooke ('13) considered the variation from year to year in the average arrival time of the Oven-bird at Lanesboro, Minnesota, and Grinnell, Iowa, as only 1.4 days, which he thought was due to the fact that it arrives late when the weather is settled. Cooke ('04) concluded also after studying several species of birds that "the southern-most breeding birds constitute the van in spring migration". Allen ('14), however, in studying the Red-winged Blackbird, and Friedmann ('29), the Cowbird, found that "vagrant" males were the first to arrive, and they were followed by the migrant males.

The data on the Oven-bird show that the local nesting males are among the first to arrive, and that, practically the entire population of males arrives within a few days unless delayed by weather conditions. There are no records in the literature on the arrival of the females, other than nesting time.

Howard ('20), speaking of certain British passerine birds, says that the male migrant remains in his territory from the time he arrives (p. 34). The boundaries, he says, are not definite lines, but areas wandered over by this owner at one moment, and by that at another (p. 153). He considers the choice of mates merely a matter of chance (p. 12). Howard ('29) states further of the birds under his

observation that the stealing of a mating by a male is by no means uncommon, despite the efforts of the owner of the territory to prevent it (p. 42).

Baldwin ('21) traced the genealogy of the House Wrens which nested on his farm, and found adults returning regularly. One pair only remated the second year, and only one young bird returned to nest. Birds as a rule changed mates for the second brood.

Mrs. Nice ('31a, '33a, and '34) found that male Song Sparrows usually retained their old territory during the following season, but a few were crowded out or deliberately went elsewhere. Females usually returned to their old territory if possible, yet a check showed that comparatively few remated with males of the previous year. Males welcomed the first females that came at mating time, and pairs usually remained mated for the second brood. Copulation started shortly before the beginning of nest building, and lasted until incubation began. There was no copulation between non-mated birds, but two males had two mates each. Returning young birds nested from 100 to 1550 yards from their birth place. Mrs. Nice ('30) in a review of the literature found that seven pairs of three species of passerine birds changed mates for the second brood in the same season, and twenty pairs of eleven species made no change.

Micheners ('35) found that Mockingbirds would go into neighboring territory to get food, or an unmated male would cross a line to try to win a mate, but no case of abduction of a mated female was noted.

Gibbs ('35) gives a very graphic description of a male Oven-bird's performance at mating time, in which it flew about the female, performing various capers and singing the flight song, but suddenly left when a second male appeared. This observation was made near Grand Rapids, Michigan, but the date was not given.

SINGING

"Teacher" Song. The common song of the male Oven-bird is the well known "teacher" song. In the woods where the study was made singing could be heard in some part of the woods at almost any time of day, but was especially strong during the morning hours and in the evening. Low temperatures, approaching frost, in the morning reduced the amount of singing, as did also excessive heat in the middle of the day. There was some reduction in the amount of singing at mating time, and again at hatching time when feeding duties began.

Songs are given in series, and the time between different series is frequently spent on the ground in search of food. Songs of a single series come at more or less regular intervals, especially in the morning when the singing is strong. The intervals of one series for example, from the beginning of one song to the next, in seconds, were as follows: 23, 17, 22, 21, 25, 22, 22, 21, 23, 29, and 23.

Individuals vary somewhat in the length of the song, ranging usually from seven to ten double notes or "teachers". One series had the following numbers: 10, 10, 10, 10, 10, 10, 9, 10, 9, 10, 9, 10, and 10. Another series ran: 10, 8, 6, 8, 8, 8, 7, 7, 8, 7, 7, 8, 9, 7, and 7. One male was heard giving exceptionally long songs on a single evening, when the counts ran as follows: 14, 15, 13, 19, 20, 19, 17, 19, 23, and 18.

The first note of the double syllable of the song ends with an upward inflection, and the second with an accented, downward inflection, as *téa chér*. The song ends with the accented syllable, ordinarily, but may not if the song is fragmentary, as it frequently is. The male starts the song holding his head in the normal position and with the tone almost inaudible, then as the song grows louder, raises his bill until it reaches an angle of about thirty degrees with the zenith. He opens his mouth once for each syllable, and the time between the "teachers" is only slightly greater than the time between the first and second syllables. The song does not grow gradually louder to the end, but reaches its full volume on about the sixth double note, in an eight or ten note song. In the single case above where the male sang as high as twenty-three "teachers", the full volume was reached at the eleventh or twelfth. I have not been able to note any variation in time or pitch as the song progresses.

There is some variation in the songs of different individuals. Some males sang exceptionally fast, and others very slowly. One male sang slowly and rather harshly, and another had a lisp which distinguished his song from others. These variations were very useful in distinguishing individuals in neighboring territories.

The male usually sings while sitting on a perch from five to ten meters from the ground. He changes perches from time to time, and has his "headquarters" in a local area, or areas, rather than a particular tree. When the female arrives, she may build the nest some distance from the original singing place, and in that case a male sings a part of the time near the nest, and the remainder at his original place. If a second nest is built, he spends some of his time singing near that. One male did much of his singing at a distance of 100

meters from the nest, but this was unusual. The male sometimes sings from the ground, but this is uncommon. One male started to sing the "teacher" song while on the wing and finished it after alighting on a perch, and another was seen singing with food in his mouth.

The significance of the song is at least two fold. First, of course, it is a proclamation of sovereignty of territory. Males seem to be continually conscious of the songs around them. They sing in alternation even in peaceful times, but do so more strikingly when there is a quarrel over territory. Secondly, the song is an "all's well" or recognition call to the female and young. Sometimes the female while incubating will turn her head and listen when the male sings. Many times when a female was disturbed on account of my presence and was chirping, the male would sing as if trying to quiet her. Frequently the male would join the female in a general chorus of disapproval chirps while I was at the nest, but would sing a "teacher" song as soon as I was fifteen or twenty meters away. Sometimes he gave the "all's well" song without knowing the facts, for I have heard a male singing merrily at a distance while I was banding his mate.

Young birds learn the meaning of the song by the time they leave the nest. Young that have been hushed up by the chirp of a parent will begin moving about and calling again when they hear the song of the male. Once when I was following a male and a young bird, the male sang repeatedly from the ground while trying to lead the young one away.

Singing continued during the season without much change until the males began to leave the woods, which was as early as July 5. Males which remained continued to sing until about July 20, but after that were seldom heard. The last song heard in 1934 was on July 27, though one male remained until July 31, and another until August 27. In 1935 two songs were heard in August, one on the fifth, and another on the seventh. One of these songs, and probably both, were sung by males which were caring for young. The cessation of singing by males which remain late is presumably due to molting.

Flight Song. The season for the "flight song" was practically the same as that for the "teacher" song (Table 1). The earliest flight song was heard on April 28, on the day the first male arrived in 1935, and the last, on July 26, 1935, when the singing of the "teacher" song had practically stopped. There was an increase in the number of songs beginning around July 1, and continuing until about July 20.

Table 1 shows the distribution of the flight songs during the day. The earliest song occurred at 4:26 A. M., on May 24, before it was

light enough to see the lines on my note-paper, and the latest in the evening was at 8:28 P. M., on May 26. There was a light concentration of songs around 8:30 in the morning, but by far the greatest number, 74 per cent, came in the evening after seven o'clock. This distribution of songs heard was influenced to some extent by the fact that I was in the woods less in the afternoon until late, and also by my being on the watch for songs in the evening. Both flight and "teacher" songs stopped sharply about ten or fifteen minutes after sunset, while it was still light enough to take notes, and no singing was heard thereafter. In fact, I found that the Oven-bird stopped singing comparatively early, for the Crested Flycatcher, Wood Pewee, Wood Thrush, and Cardinal were heard regularly after the Oven-bird had quit for the day.

The flight song usually starts with a few sharp chirps, which accelerate in speed and end in a warble in which one can recognize notes similar to the first notes of the "teacher" song, but without their rhythm. Often there are one or more "teachers" inserted, or added, which dispels any doubt as to the author. The song is never very loud, and lacks the carrying qualities of the "teacher" song, which doubtless accounts in some degree for the rarity with which it is heard. Some males are inclined to sing the flight song more than others. One male gave an elaborate song for a number of evenings at almost the same time. On the evening of July 7, 1934, I heard eight flight songs in sixteen minutes, but two males seemed to be involved in the singing. The fact that the male may move quickly from one place to another between songs may leave some uncertainty as to the author, but this is true of the "teacher" song as well.

Only relatively few times did I see the males while they were singing the flight song, and in most of these cases they were in pursuit of intruding males. One pursuing male finished up his song after he gave up the chase and lit on a limb, and another passed by me so closely that I could hear his wings fanning. Two males were seen flying late in the evening as they sang, and probably were not in pursuit. Two others were heard giving the flight song while they flew slowly with quivering wings, just after copulation. Another gave the song repeatedly while feigning injury, apparently as a part of the ruse. One male which I was watching flew nearly to the top of a tall tree and sang, apparently from a perch. A few singers which were not seen seemed to move some and others may have moved, but in the majority of these cases the song seemed to come from a single place, well up in the trees. The "spiral" or "soaring" flight described by

various observers was not seen a single time, though I remained in the woods until dusk, or later, more than ninety evenings, and in the majority of cases was stationed at favorable places watching for this behavior.

Call-notes. The most common of the Oven-bird calls is the ordinary chirp, given by both the male and female. The chirp of the female is slightly lower in pitch than that of the male, and may be distinguished under favorable circumstances. The female usually chirps more than the male, perhaps because she can not sing. I have sat in a blind for three hours waiting in vain for a female to stop chirping and resume her feeding duties, but this was unusual. Individuals vary greatly in the tendency to chirp, and the male sometimes exceeds the female.

The chirp indicates worry or fright, and is commonly heard when one approaches the nest, especially if the nest contains young which are about ready to leave. The female may use the call to stop the male from singing when danger seems near, and parents use it to warn the young to "lie low" on account of danger. The warning to the young may be uttered in very emphatic, whistling calls, if the parent is much disturbed.

The parent uses a chirp similar to the one above, but of a higher pitch, to attract the young when out of the nest, or perchance in trying to coax them out of the nest, if danger is near. Also a low, crooning call of one or two notes is given to get the attention of the young birds in the nest, if they do not open their mouths when the parent arrives with food. This call is so faint that it is barely audible when one is in a blind very close to the nest.

The "mating" call of the female is a sort of drawn out chirp, or a series of chirps given in close succession, and seems to indicate that the female wants to copulate. The call may be accompanied by a quivering motion of the wings, and advancement toward the male. A similar call given occasionally by both sexes indicates displeasure or approaching danger, and is used especially during the early part of the nesting period.

Literature. Wilson (1831) seemed to underrate the "teacher" song somewhat when he said of the Oven-bird, "It has no song; but a shrill, energetic twitter, formed by the rapid reiteration of two notes, *peche, peche, peche.*"

Burroughs ('71) rendered the song as "teacher, *teacher*, TEACHER, TEACHER, *TEACHER*", with the accent on the first syllable. Later ob-

servers, however, have not supported his idea of the accent (Jones, '00) (Eaton, '14). Burroughs, Mathews ('04), Saunders ('35) and others state that the song grows gradually louder to the end, and Howell ('24) and Roberts ('32) say that the song becomes faster as it progresses, but I have not been able to verify either statement. Saunders states that he did not note any variation in time and pitch, and this is in accordance with my observations.

Howell ('24) says that "In the south the Oven-bird seems to clip the first syllable, thus giving the song quite a different character from that of the northern birds." Such variations in songs are well known (Howard, '20, p. 159), and perhaps some of the differences of opinion concerning the Oven-bird's songs are due to actual differences in the songs themselves.

Mrs. Nice ('31b) noted the series of Oven-bird's songs, and timed the intervals within the series. Saunders ('35) gave July 20 as the date for the cessation of singing, the same as I observed here, but this obviously would vary in different places. Howard ('20) called a male bird's singing place his "headquarters" and Mousley ('19) called it the "singing tree". The first name is more appropriate for the Oven-bird.

Much has been written about the "flight" song or "passion" song. Nuttall (1832), Burroughs ('71), Samuels ('75), Jones ('00), Mathews ('04), Thayer (Chapman '07), Saunders ('29), Forbush ('29), and Roberts ('32) all have heard and described it, and most of them have seen the soaring flight, which the male may make while singing it. Seton ('90), Thayer, Saunders, and others have heard the song at night.

Jones says of the soaring flight, "I have seen the Oven-bird suddenly vault into the air, mounting to the tree tops on quivering wings, then dart back and forth in a zigzag course swift as an arrow, and finally burst into song as he floated gently down."

Roberts says of the same performance that he "has frequently seen the Oven-bird early in July thus disporting itself of an evening above the cathedral-like, terraced spires of the tall spruces on the shores of Lake Itasca." Roberts also noted an increase in the number of songs from July 1 to 20.

Seton says of the song, "that it may be heard at almost any hour of the night in the grove where a pair of these birds have settled for the love season."

Thayer says, "Here in southwestern New Hampshire, its full flight-song, delivered often from a height of a hundred or more feet

above the tree-tops, is one of the commonest night-sounds from early May to September."

Boardman (Baird '74) believed that the bird sang from a perch, for he says, "When it gets into the top of a tall tree, its strain is so rare and beautiful that but few know it as from that bird." Torrey ('95) heard it sing the flight song from a perch, and also from the ground.

Bolles' poem concerning the Oven-bird (Ball, '16) (Roberts, '32) seems to correspond with the observations of some, but not with mine. Only once was the last flight song heard as late as the Whip-poor-will's "clucking", and that was just as a Whip-poor-will began calling. Bats were seen with their "canvasses unfurled", but this was after the last songs of the Oven-bird had ceased.

After months of diligent watching, I have concluded that there must be considerable variation in the singing of the flight song in different parts of the country. Perhaps the song varies in the different kinds of forests. Further study must be made to clear up this point.

The common chirp of the Oven-bird was noted by Audubon (1834) and by practically all observers of the species since. Eaton ('14) correctly stated that it indicates worry or fright, and Mrs. Nice ('31b) noticed that it was given by both sexes.

THE NEST

General Habitat. The present study was made in a forest where white oak (*Quercus alba*), black oak (*Quercus velutina*), sugar maple (*Acer saccharum*), shagbark hickory (*Carya ovata*), and basswood (*Tilia americana*) were the predominating large trees, while ironwood (*Ostrya virginiana*), and flowering dogwood (*Cornus florida*) were numerous as smaller trees below. The most conspicuous trees in the forest were large white oaks, of which there was a goodly number, some of them as much as a meter in diameter. The forest was open below, for the most part, but in places there were thick patches of small trees and shrubs (Pl. XI, C).

Among the herbaceous plants, the common wild flowers, spring beauty (*Claytonia virginiana*), yellow adder's tongue (*Erythronium americanum*), and trillium (*Trillium grandiflorum*) were common when the birds arrived. Later in the summer among the conspicuous herbs, were black snake-root (*Sanicula gregaria*), grasses (various species), bed-straw (*Galium* sp.), maidenhair fern (*Adiantum pedatum*), rattle-snake fern (*Botrychium virginianum*), May apple (*Podophyllum peltatum*), false Solomon's seal (*Smilacina racemosu*), small

Solomon's seal (*Polygonatum biflorum*), great Solomon's seal (*P. commutatum*), Aster (sp.), white snake-root (*Eupatorium urticaefolium*), goldenrod (*Solidago* sp.), tick trefoil (*Desmodium grandiflorum*), and rattlesnake root (*Prenanthus* sp.).

The more common birds, given in the general order of their frequency, were the following: Oven-bird (*Seiurus aurocapillus*), E. Crow (*Corvus b. brachyrhynchus*), E. Robin (*Turdus m. migratorius*), Black-capped Chickadee (*Penthestes a. atricapillus*), White-breasted Nuthatch (*Sitta c. carolinensis*), Red-eyed Vireo (*Vireo olivaceus*), N. Crested Flycatcher (*Myiarchus crinitus boreus*), N. Flicker (*Colaptes auratus luteus*), N. Downy Woodpecker (*Dryobates pubescens medianus*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), E. Cowbird (*Molothrus a. ater*), Wood Thrush (*Hylocichla mustelina*), N. Blue Jay (*Cyanocitta c. cristata*), E. Hairy Woodpecker (*Dryobates v. villosus*), Cerulean Warbler (*Dendroica cerulea*), E. Whip-poor-will (*Antrostomus v. vociferus*), E. Cardinal (*Richmondena c. cardinalis*), Scarlet Tanager (*Piranga erythromelas*), Tufted Titmouse (*Baeolophus bicolor*), Red-eyed Towhee (*Pipilo e. erythrophthalmus*), Indigo Bunting (*Passerina cyanea*), Acadian Flycatcher (*Empidonax virescens*), E. Wood Pewee (*Myiochanes virens*), N. Barred Owl (*Strix v. varia*), and the N. Red-shouldered Hawk (*Buteo l. lineatus*).

The larger mammals known to be in the woods were as follows: Chipmunk (*Tamias striatus lysteri*), red squirrel (*Sciurus hudsonicus loquax*), fox squirrel (*Sciurus niger rufiventer*), gray squirrel (*Sciurus carolinensis leucotis*), woodchuck (*Marmota monax rufescens*), and the skunk (*Mephitis nigra*). Doubtless the racoon (*Procyon l. lotor*) was present also, but no direct evidence was noted.

The only reptiles seen were a few garter snakes (*Thamnophis s. sirtalis*), and only one of these had reached mature size.

The surface of the ground was rolling, and the area was crossed through the middle and at one side by small creek beds, which were dry except following freshets. (Figs. 1 and 2). A few ponds had water early in the season, but were dry in the summer. In 1934, which was a dry year, the ponds were dry by July 1, and the nearest open water was more than a mile away.

The woods, for the most part, had not been disturbed much in recent years, and the ground was well covered with a thick carpet of old leaves. Several old roads told of some early logging, and some of the roads were still in occasional use. Fallen timber had been kept well cleaned out. A boundary lane about three meters wide was partly grown up with small trees and shrubs. About August 15, 1934.

this lane was cleared out, and a wire fence placed in it, then sheep were turned into that portion west of the fence. The pastured part, which comprised about one-third of the area studied during that season, was soon cleared of all green leaves and edible plants within reach of the sheep. This had no particular effect on the Oven-birds for the season, however, for the few that were left kept in the unpastured part.

In 1935, but few Oven-birds went to the portion of the woods where the sheep had been, and only one successful nest was found in that area. Sheep were turned in again late in summer, but not until nesting was over. In order to find a sufficient number of birds for study in 1935, it was necessary to extend the area somewhat farther north, as shown in Figure 2. Much more available territory lay to the north and northeast, and the limits were determined largely by convenience. The area under observation in 1936 was about the same as that of 1935.

Nesting Site. With a few exceptions all of the nests were located where they could be approached by bird or man from any direction. Ease of approach and a certain amount of light are undoubtedly important factors in the choice of the location. All nests seemed to get a little sunshine each day, but in most cases the amount was small. None was located among dense shrubbery, but some were well surrounded by herbaceous plants.

With reference to small trees and bushes, the nests were located as follows:

	Number of nests
With small tree at back of nest.....	4
With small tree at side of nest.....	4
Nest by a shrub or bush.....	8
Nest by, or under, loose, scattered brush.....	9
Nest in the open.....	35 (58%)

The trees mentioned above consisted of six ironwoods, one dogwood, and one white oak. All were small, the largest being about eight cm. in diameter.

There was a very positive correlation between the nesting sites and the roads, creek bed, boundary lane, or other open spaces in the woods (Figs. 1 and 2). Four nests were located in the boundary lane, two in old roads, and one in a space where fallen trees had been cleared away. The remainder, except seven, were located less than ten meters from a road or other open space. The average distance of all nests from such open spaces was 4.4 meters. Omitting the seven farthest, which were from twelve to twenty meters away, the remaining

fifty-three on which I had data averaged 2.8 meters distant. No nests were located nearer than twenty meters from the edge of the woods. The female obviously is responsible for locating the nest near the open space, since she chooses the exact nesting place.

The significance of locating the nests near the roads or other spaces is not very clear. In some cases the birds habitually approached the nest from the roadway when feeding the young, and at times used the space for a landing place, but neither of these was by any means universal. There is the possibility too that the space might be used as a landmark, but this has not been proved. I have examined the light above to see whether additional overhead lighting might be obtained, but this was not usually the case, since the roads were ordinarily little more than wagontracks through the woods.

A careful examination was made to see whether the position of the entrance was associated with any external condition. Overhead lighting and the position of the road or other open space showed no correlation whatever. The directions which the nests of 1934 faced with reference to the compass seemed significant, since none faced the south or southwest, but the 1935 data filled up the gap until the distribution was quite uniform in all directions.

The slope of the ground was examined, and considerable correlation was found between the slope and the facing of the nests. Many nests were located nearly on the level, or on slight elevations, and these were omitted from the comparison. Out of thirty-six nests located where there was appreciable slope, thirty-one (86 per cent) faced downward at some angle. Nests suffered but little, if any, from lack of drainage. One nest containing an Oven-bird's egg and a Cowbird's egg was found with water in the bottom after a heavy rain, but the water soon disappeared. The Oven-bird's egg failed to hatch, but it is doubtful whether this was due to the water.

Subsequent nests of the same pair of birds were built within the territory or at the border. The distance of fifteen known nests from the preceding ones, ranged from eighteen to sixty-six meters, averaging forty-two meters.

Structure of Nest. All of the nests found in the present investigation were arched over and quite uniform in structure (Pl. XI, A and B). One nest which was found after incubation began, and had but little top to it, evidently had caved in during a rain, and the female had made another opening higher up. Two nests which were well covered by sprigs of dry leaves had the usual top. As nests grow old

with use, the top frequently is pushed back, giving somewhat the appearance of an open nest.

The materials of which the nests are made are well represented by the analysis of a nest shown below, with the addition of a lining of horse hair:

Grass	2.7 gms.	11.3 per cent
Slender weed stems.....	3.1	12.9
Woody stems .....	.6	2.7
Fibrous bark .....	.9	3.8
Rootlets .....	.4	1.6
Dry leaves of trees, chiefly oak.....	16.3	67.7
Moss	small fragments	
Total	24.0	100.0

Other nests were compared with the one analyzed, and, for the most part, were quite similar. Some had a little more or less of the different components, the most variable materials being grass, moss, and rootlets.

All of the nests which were examined carefully when they were finished were found to contain long horse hair as a lining, with the exception of one, which contained short yellow hair. The number of horse hairs varied from one to several, and both white and black hairs were used. Horse hair, of course, has been used only in the last century or two, and supplants other material. The benefit derived from it is doubtful, as it frequently forms snarls, and sometimes the young birds attempt to swallow the hairs. The materials other than horse hair most commonly found in the lining were macerated leaves consisting of the fine veins, together with moss, rootlets, and fine plant stems.

Nests as a rule rested on the ground and were partly covered by the leaf bed. Examination of the ground beneath nests which had stood for some time showed that in practically every case there was a slight depression. Examination of fresh nests, however, usually failed to show any depression in the ground, and those found later were, to some extent, a result of the nest itself. A few nests rested on pieces of twigs which lay beneath the leaves. The leaves of the leaf bed ordinarily extend up over the edge of the nest at the sides and back, concealing it and shedding off the water. Leaves are commonly placed over the top also, so that the camouflage is complete. The threshold varies in height from the level of the leaf bed to three centimeters above it. The opening is a little wider than high, and as a rule is slightly smaller than the inner cavity.

The side walls of the nest are a continuation of the top and bottom parts, and the whole is united into a single mass. The side walls

at the front are the weakest parts, but the nest usually stands up well as long as it is occupied. Parents frequently step on the nest, and one male under observation did so repeatedly when he left the nest after feeding the young. When nests are no longer used, they often cave in at the door, but some remain intact for weeks. Most old nests under observation disappeared completely over winter.

The average measurements of the Oven-bird's nests are given below. These figures were compiled from measurements ranging from a few, in case of inside measurements, to more than twenty-five for outside measurements.

	MINIMUM	MAXIMUM	AVERAGE
Width, including loose leaves.....	18 cm.	30 cm.	23 cm.
Width of main part of nest.....	12	18	16
Front to back, over all.....	15	26	20
Front to back, main part.....	11	17	15
Height above leaf bed.....	7	17	12
Width of opening.....	4.7	8	6
Height of opening.....	3.5	7	4.5
Width of cavity inside.....	7	8	7.5
Height of threshold above leaf bed.....	0	3	1.1
Depth of cup.....	3	7	4.8
Thickness of bottom.....	1	2	1.6

Building of Nest. The nest of the Oven-bird is built by the female, and the male does not come to the nest often until after the eggs hatch. The time between the arrival of the female and the beginning of the nest was from one to six days, being a little longer in 1935 than in 1934, due apparently to the weather (Fig. 4). The main body of the nest is built rather rapidly, requiring only about two days, and the lining is put in a little more leisurely. The total time of building requires about five days for first nests, but may be shortened to four or a little less for second nests. The work is done chiefly in the forenoon.

The earliest nests found already had the framework up, but the procedure from the start is fairly obvious. The female clears the leaves from a circular spot, by pushing them back, raising up the edges, and perhaps removing some. She then, in some cases, digs up the ground, leaving fresh soil on the surface, and may remove some soil or push it aside. The digging must be done with the bill, for I have never seen an Oven-bird scratch. Nesting material is then carried and placed around the edge of the hole, chiefly on the back side, and the covering is extended over the top. The work is done almost entirely from the inside, but evidently a few leaves are placed on top and arranged from the outside.

I have watched a number of females building after the framework was up. One nest was so thin that one could see through it. In all cases that I have seen, the material was carried inside. One could see the whole nest move as the female arranged the material and shaped the nest.

Material was obtained at distances ranging from a few centimeters up to forty meters. The female walks while making the shorter trips, and flies during the longer ones, but even when resorting to flight she walks three or four meters in arriving and leaving. One female carried nearly all of her material from a creek-bed twenty meters away, where the material was more moist than that near by. This female made thirty-six trips in a little over three hours, averaging a trip about every five minutes, but she made several pauses of ten minutes or more each. She remained in the nest from a half minute to a minute each time. This was a first nest. Another female working on a second nest and gathering her material near by, worked much faster, making thirty-three trips in forty-eight minutes, or a trip about each one and one-half minutes. She remained in the nest from three seconds to two and one-half minutes, averaging twenty-four seconds. Her trips for material were from one-half meter to six meters distant, averaging 3.1 meters, and she flew only a few times.

The last material to be added to the nest is the hair, and the presence of this indicates a finished nest. The hair is often added a day or more after the remainder is finished, and doubtless causes the female considerable searching.

While the female is building, the male sings and keeps watch. If there is supposed danger approaching, he gives an alarm call, or may fly at the female to drive her away. Most birds are rather tolerant of an observer while they are building. I watched one female at a distance of twenty meters, and another at thirteen meters without serious objection, and one female which was especially tame worked away at her building while I was standing in plain sight 2.6 meters from the nest.

Literature. Concerning the Oven-bird with respect to its habitat, Audubon (1834) said, "its breeding places are in the interior or along the margins of shady woods watered by creeks and rivulets, and seldom seen by man." Baird ('74) "found them rather more abundant in woods upon high and dry ground, usually upon slopes of wooded hillsides." Chapman ('07) reported finding them in "dry rather open deciduous woods", also in "low swampy forest lands with heavy under-

growth." Burns (Chapman, '07) said in a sweeping statement "the wooded upland, hillside, or lowland are all alike to this bird." The studies of Mousley ('26) and Nice ('31b) were made in evergreen forests.

Audubon said concerning the location of the nest, "I have found it always on the ground, sometimes among the roots of a tall tree, sometimes by the side of a fallen trunk, and again at the foot of some slender sapling." Norris ('92) reported a nest in the end of a large pine log, and another beneath some fallen branches. Chapman ('07) said "The site selected may be at the foot of a bush or tree, or simply among dead leaves in more open spaces." The nest studied by Mousley ('26) and one studied by Mrs. Nice ('31b) were located in open spaces in the forest. Roberts ('32) noted the relation to roads, etc., when he said it "is usually in a little opening in the forest or along a trail or abandoned wood road." Burns (Chapman, '07) could find "no particular significance in the position of the entrance in relation to the exposure." Jones ('88) noted the relation of the facing of the nest to the slope, saying that the opening was always on the downhill side.

Mousley ('21) noted concerning birds in general that the female chooses the exact nesting place, though the male chooses the locality. Mousley ('17) also found in his study of subsequent nests that eighteen nests of fourteen species were located from 0 to 268 yards (average, 66 yards) from the previous nests.

The Oven-bird's nest was described by Wilson (1831), Nuttall (1832), Audubon (1834) and practically all writers since who have had occasion to discuss the bird. Wilson said of the nest, "This is formed of leaves and dry grass, and lined with hair. Though sunk below the surface, it is arched over, and only a small hole left for the entrance." Nuttall spoke of the "curious oven-shaped nest" whose surface was "scattered over with leaves and twigs so as to match the rest of the ground."

Baird ('74) said of the nest, "When placed under the shelter of a projecting root, or in a thick clump of bushes, the nest has no other cover than a few loose leaves resting on, but forming no part of it." He found one nest under vines and wild flowers which had no top or covering other than those plants. He described the usual nest as having "the appearance of two shallow nests united at the rim", a statement which bears some qualification. He also gave measurements for two nests, which fall within the limits of the above measurements.

Mrs. Nice ('31b) and Stanwood ('11) found pine needles as a part of the nest material, and Roberts ('32), slender weed stalks and rootlets. Roberts also gave the shape as sometimes "short cylindrical", which I have found true.

Burns (Chapman '07) found the width of the opening definitely greater than the height, and the chief difference in nests lying in the quantity of grass and leaves. He gave the lower edge of the entrance as being even with the leaf bed.

Concerning the building, Burns stated that the outside of the nest was built first, and in one case a nest was completed in two days after the "frail straw arch" had been constructed. He thought that both sexes helped in the building.

THE EGGS

Egg-laying. The first Oven-bird's eggs were laid on the first, second, or third morning after the lining of hair was placed in the nest. The tendency was toward a longer period of time at first nests, and a speeding up at subsequent nests. Where eggs or broods were destroyed and subsequent nests built, the first egg in each of three nests was laid five days after the first nest was deserted. At another nest the first egg was laid four days after the first nest was deserted, but a complete clutch was not laid in the first nest. At still another nest which was not found until after incubation had begun, calculation indicated that the first egg was laid about three and one-half days after the first nest was deserted. This female had incubated over time on an infertile egg at the first nest, and probably the new eggs had started to develop in the ovary while she was still incubating.

All eggs were laid in the morning, usually before seven o'clock, and sometimes before six. One female went on the nest at 5:25 o'clock, and remained forty-two minutes in laying, and on the following morning went on at 5:04, remaining fifty-two minutes. Another female went on at 5:05, and remained one hour. Sunrise at this time was about 5:20. One female was seen on the nest three successive mornings before laying.

In all cases observed except two, the eggs of a clutch were laid on successive days. In one exception, I frightened the bird off, and no egg was laid in the nest that day, but a full clutch of five eventually appeared. In another exception there is a strong probability that the egg was removed by a Cowbird.

The dates of laying of first eggs in first nests, obtained chiefly by direct observation, but in a few cases by calculation, are shown in

Figure 4. In subsequent nests, the dates of the first eggs were as follows: In 1934, May 23, 25, 27; June 2, 17, 18, 28; and July 10. In 1935, May 26; June 1, 3, 4, 16, 25, 26; July 2 (third nest), and July 3. Only one female laid more than two clutches of eggs, though several built as many as four nests.

Eggs. The number of eggs in clutches where the nests were not disturbed by the Cowbird, or where all eggs were checked as they were laid, was as follows:

Number of eggs	Number of nests
3	2
4	6
5	18
6	1
Average 4.7	Total 27

The clutches with three eggs, and all with four except one were late nests, and were laid by females which had laid clutches previously. Two females laid two clutches of five, and another laid three, four, and three eggs respectively in three nests. The data show that first nests nearly always have five eggs, and subsequent nests from three to five. The largest number laid by any one female during a season was ten.

A number of clutches of eggs were measured and some of the results which seem significant are given below:

	Average length in millimeters	Average thickness in millimeters
Forty-eight eggs from sixteen clutches.....	20.3 (18.7 to 23.1)	15.6 (14.5 to 16.8)
Clutch of five eggs from No. 10A female in 1934 (first clutch)	21.5	15.7
First clutch of five eggs from No. 10A female in 1935	21.3	15.6
Second clutch of five eggs from No. 10A female in 1935	22.4	16.0
Clutch of five eggs from No. 12 female in 1934 (first clutch)	20.4	15.3
Clutch of five eggs from No. 12 female in 1935 (first clutch)	19.6	14.9
Clutch of six eggs from No. 2 female in 1934 (first clutch)	19.6	15.7
Three eggs from first clutch of five from No. 2 female in 1935.....	19.9	16.5

The eggs of the No. 10A female were above the average in size, in both 1934 and 1935. The second clutch in 1935 ran larger than the first, indicating that additional eggs are not characterized by a reduction in size. Eggs of the No. 12 female were considerably smaller

in 1935 than in 1934, and there was also a corresponding reduction in the size and vitality of the young. The No. 2 female laid six eggs in 1934, and only five in 1935, but the latter clutch ran a little larger in size.

Incubation. At all nests where accurate observations were made, incubation began on the day before the last egg was laid. This rule held good for clutches of three, four, five, and six eggs. At most nests, incubation did not begin until late afternoon or evening, or if it began earlier, it was more or less irregular.

The incubating is done entirely by the female. While on the nest she usually sits with her side toward the front, and her tail doubled off short toward the opening. Frequently one or two white spots show on the side of her rump where the feathers are ruffled. She changes position frequently, and heads in the opposite direction, always turning with her head toward the back of the nest. She sometimes pulls a leaf up in front of her, and may cover the opening of the nest with a leaf when she goes away. She is restless for a minute or two before leaving, moving her head about, or reaching out to look around. She always walks in leaving, unless badly frightened, and walks when returning to the nest. When entering the nest she sits down quickly, without any preliminary adjustments.

The male spends his time singing and watching, or perchance courting another female. He may come to the nest, but does not do so frequently (See p. 180). One male that approached too closely to the nest received a sharp rebuke from the female. Once a male came to a perch a few meters from the nest and chirped, whereupon the female left. Another time he called for her, but she only moved a little and did not leave.

The female Oven-bird is well known as a "close sitter", and may actually allow a person to step on the nest before she leaves. When flushed from the nest, she commonly feigns injury, walking about with her wings and tail dragging, and with the feathers raised on her back and rump. After a few minutes she usually hops to a perch and begins chirping.

Females under observation were flushed from the nest repeatedly, and most of them became reconciled more or less, allowing me to place my foot within a few centimeters of the nest before leaving. Some rarely feigned injury or chirped, and seemed disturbed but little at having to leave, often stopping to eat when only a few meters away. When flushed more than once a day, females, as a rule, left the nest sooner the second time than the first.

The time which three different females spent off of the nest daily was recorded by the itograph, and is shown in Tables 2 and 3. (See also Figures 5, Pl. XI, D and E). The time of one female, No. 15, was recorded in 1935 and again in 1936, thus making a total of four nests checked. This female was off fewer times, but for longer periods, in 1936 than in 1935 (Table 2). Female No. 6 probably was off of the nest more on account of the extremely hot weather at that time, though this did not affect No. 9. Table 3 shows some hourly tendencies. Soon after daylight, the females left the nest and returned, then left chiefly during alternate hours until noon. The 12 o'clock hour showed the lightest incubation of the day after the 5 o'clock hour, and this was followed again by a return to the nest. Late in the evening there was a tendency to leave again before going on for the night. Grouping the totals into three hour periods shows that the time off during the day was roughly proportional to daily temperature changes. There was no very apparent correlation between the total time off each day and the average daily temperature.

The incubation period was obtained on seventy-six eggs in twenty-one nests. The time ranged from eleven days, twelve hours, to fourteen days, with an average of twelve days, 5.6 hours. The average in 1935 differed only 0.6 of an hour from that of 1934. All of the eggs of a clutch including the last had about the same incubation period, and any variation of more than a few hours usually concerned all. One female, which hatched two clutches, incubated the eggs of the first an average of thirteen days, three hours, and the second, twelve days, two hours. No difference in incubation time was noted in cool and warm weather, or in nests containing Cowbird's eggs.

Hatching. Hatching occurred at various times of the day, and one egg is known to have hatched between dusk and dawn. Both Ovenbird's and Cowbird's eggs were pipped from fifteen to twenty hours before hatching, and the crack was extended about one-fourth of the way around before the shell broke open. After hatching takes place, the female eats the shells. One female was seen eating egg shells as she sat on the nest. She reached under her body for them, and ate at least three large pieces while I was watching. Another female spent four or five minutes eating three large pieces of shells of Cowbird's eggs as she stood in front of the nest. She slowly chewed up the shells, then swallowed them.

Eggs which failed to hatch were left in the nest. At one nest a sterile egg evidently was crowded out by Cowbirds, but on the following day it was back in the nest again.

Literature. Norris ('92) gave data on forty nests and eggs of the Oven-bird, which ranged in location from North Carolina to Maine. The most common number of eggs in the nests which did not contain Cowbird's eggs was five, and the average, 4.25. He gave measurements of the 170 eggs in the forty nests, the average length being 0.5 mm. less than mine, and the thickness 0.1 mm. less.

Herrick ('05) states that birds on the nest nearly always face the same way. The tendency of the Oven-bird to turn frequently may be due to her more or less cramped position in the nest.

The incubation period for the Oven-bird was correctly given by Burns (Chapman, '07) as twelve days. No particulars were given concerning the nest or nests where the data were obtained. Stanwood ('11) and Mousley ('26) also gave twelve days.

Baldwin and Kendeigh ('27), using a thermocouple and recording potentiometer, found that a female House Wren, during incubation, remained at the nest 14.3 minutes and away six minutes on an average. An accompanying graph showed that she was away from the nest at least thirty-five times during one day.

Bussman ('33), by use of the terragraph and by direct observation, found that the number of times per day which four different European birds left the nest were as follows:

Wryneck	40
Tree Sparrow	25, 30, and 13
Pied Flycatcher	90
Song Thrush	21 and 20

All of the above birds showed a greater activity than the Oven-bird.

Wilson (1832) gave one of the best descriptions of the female Oven-bird feigning injury, when he wrote as follows:

"If you stop to examine its nest, it also stops, droops its wings, flutters, and tumbles along, as if hardly able to crawl, looking back now and then to see whether you are taking notice of it. If you slowly follow, it leads you fifty or sixty yards off, in a direct line from the nest, seeming at very advance to be gaining fresh strength; and when it thinks it has decoyed you to a sufficient distance, it suddenly wheels off and disappears."

Friedmann ('34) considers the feigning of injury a result of the inhibition of muscular action, as if the bird were unable to control its movements, but I have seen no indication of helplessness. One fe-

male Oven-bird would feign injury when I was two or three meters from the nest, but would fly at my hand and peck it when it was at the nest. Herrick ('05) considers the feigning of injury "an inherited instinct, the end and advantage of which is to distract your attention from the nest to the moving bird."

Craig ('13) states that a hatching dove chipped the egg one-third of the way around in ten minutes, and later chipped it nearly around. Herrick ('35) says that a Bob-white pricked the shell in a full circle. Cottam and Kelso ('33) found that the eggs of a Woodcock hatched from thirty-six to forty-eight hours after the first cracks appeared.

Bigglestone ('13) saw a pair of Yellow Warblers eating a shell after hatching, the female eating most of it. Gabrielson ('13) reports that a female Catbird ate small bits of shell, and carried away two large pieces. Mrs. Nice ('32) saw a female Black-throated Green Warbler eating the shell of a newly hatched egg.

According to Herrick ('35), birds' eggs which fail to hatch are sometimes removed and at other times left in the nest.

THE NESTLING STAGE

A. Young Birds in the Nest.

Day of Hatching. Average weight, 2.1 grams. Dark gray natal down covers the young bird as follows: Coronal tract, seven mm. long; occipital, ten mm.; dorsal, twelve mm.; femoral, nine mm.; humeral, twelve mm.; and alar (secondary), eight mm. This down grows but little after hatching. The primaries and secondaries of the juvenile plumage show as a faint, dark line beneath the skin. The eye slit, which is two mm. in length, can be pulled open, but does not open of its own accord. The edge of the mouth is cream colored, and the inside of the mouth very red.

The young bird uses its wings and feet for righting itself, if it is not lying properly, a behavior probably common to all young passerine birds. When opening its mouth, it may rise on its wing tips (Herrick, '05, Fig. 121), or may merely raise its head. The action of its feet tends to draw them out of a tangle, and a foot is readily slipped out of a loop of thread when one is tying it, unless the thread fits very snugly. The young bird will open its mouth in response to a noise as soon as its head is out of the shell. Some of the young birds give audible peeps, but most of them only a snapping noise.

One Day Old. Weight, 3.3 grams. The juvenile plumage shows beneath the skin in the various tracts, except the caudal, the primaries

and secondaries making a prominent dark streak. There is a marked increase in size.

Two Days Old. Weight, 4.9 grams. The young bird reaches toward the opening of the nest for food, and raises the rear, turning it toward the door, or attempting to, when voiding excrement. Evidently it can discern light from dark, though its eyes are still closed. It is beginning to discern between noises also, and does not open its mouth readily at all times.

Three Days Old. Weight, 6.9 grams. The feathers are coming through the skin, except in the caudal tract, and the eyes of some birds are beginning to open. The young bird tries to creep when taken from the nest, but does poorly. It does not seem to right itself much better than when it was hatched. The toes work vigorously when the bird is handled. The young grow restless in the nest when the mother is brooding, causing her to stand up.

Four Days Old. Weight, 9.0 grams. The feathers cover the surface of the tracts. The eye-slits are three mm. long, and can open some. The edge of the mouth is more yellow than at first. Birds can peep distinctly, and can do so with their mouths open. One can see the glottis open and close as they peep. Birds can sit up on the tarsus, and can crawl awkwardly on a surface; also they pick at themselves, and can scratch the head with a foot. They may creep around to the back of the nest after voiding excrement, thus causing a slow rotation in the nest. Young birds open their mouths for food, as soon as the female gets off of the nest, having learned that they are fed at that time, for the male is usually there with food. When the young are alone and a parent approaches the nest, they may hear it coming, and open their mouths before the parent comes in sight. The young are now large enough to band, and a brood of five just nicely fills the bottom of the nest.

Five Days Old. Weight, 11.0 grams. The tail feathers show as a transverse line. The eyes open readily, and peeping may be heard several meters away. A young bird may rise as if going to excrete, then act as if it was afraid of missing some food, and continue to face the parent. Such a bird settles down as soon as the parent leaves, for the stimulus to excrete is then removed.

Six Days Old. Weight, 12.8 grams. The young birds will open their mouths when out of the nest, but they fail to respond readily to noises to which they have been responding. They can hop if removed from the nest, and may leave the nest at this age in case of emergency.

They thrust the rear end over the threshold in voiding excrement, and may stand on top of other young birds while doing so. They stand up in the nest and struggle for room, especially when food is brought.

Seven Days Old. Weight, 13.6 grams. Young birds stretch their wings and legs for exercise, a leg and a wing on the same side of the body being stretched at once. Presence of the parent is no longer necessary for voiding excrement, and young birds sometimes back over the threshold and deposit the excrement in front of the nest. Fear is developing. If birds are touched, or pushed around with the fingers, they act as if they are dead, or if disturbed too much, they may leave the nest. Some leave the nest normally at this age. When out of the nest, they travel by hopping.

Eight Days Old. Weight, 14.1 grams. The primaries are 20 mm. long, and extend out of the sheath over half their length. The greater coverts are unsheathed for three-fourths of their length, and the middle and lesser coverts for nearly the entire length. The tail feathers are two or three mm. long, and the ends project from the sheaths. Feathers on the back, breast, and abdomen are unsheathed for more than half of their length, and form a buffy covering for the body. The top of the head and breast are streaked with patterns resembling those of the adult. This is the juvenile plumage previously described (Ridgway, '02).

The young are now ready to leave the nest, if they have not already done so. They are very active when the parents come with food, jostling each other in the nest and peeping loudly but never fighting. Two or three sit or stand in the front row, and the others stay behind in the second row. As the parent approaches, they reach forward with mouths wide open, and give a rapid buzzing call. The food disappears at a gulp, and the young bird calls loudly for more. The birds in front usually get the food, and if one excretes, it then may creep around toward the back of the nest, giving place to one from the rear row. The birds in the back crowd forward, also, as they get hungry, and may stand on the backs of those in front. Between feedings the birds usually lie quietly in the nest. A brood of five now completely fills the nest, so that the female could scarcely brood if she tried. When the young are out of the nest, they can flutter and run, as well as hop.

Weight and Growth. Young birds at hatching time varied greatly in weight, ranging from 1.46 grams to 2.29 grams. The heaviest one had not been fed, for it hatched in my hand. The growth of young

birds is shown by the curves in Figures 6 and 7. Weighing was not done at just the same time each day, but this was largely corrected in plotting the curves. The average daily weights given above were taken from the growth curves, and probably are accurate to within one-tenth of a gram. The feeding and excreting of the young birds make the weights of a single bird quite variable. An Oven-bird weighed again after it had excreted showed a loss of 8 per cent in weight, and a Cowbird under similar conditions lost 21 per cent. Broods vary considerably in the rate of growth, depending on the food supply. One brood which grew especially well seemed to owe its success to the extra large loads of food brought by the male. If young birds are very hungry, they may hasten the feeding by calling when the parents are away. This obviously is an emergency measure however, and not resorted to much in ordinary routine, though the young in later stages always call when the parents approach the nest. When the young leave the nest, they weigh approximately 73 per cent as much as the adults.

The weights of six adult birds, taken while the young were in the nest, were as follows: Males, 18.65 gm., 19.93 gm., and 19.78 gm.; average, 19.45 gm. Females, 19.45 gm., 19.40 gm., and 18.18 gm.; average, 19.01 gm. Average of males and females, 19.23 gm.

Temperature Control. Temperatures were taken by placing the thermocouple down the throats of the young birds while they were in the nest. Figure 8 shows the average temperature of a brood of four young birds, taken at five minute intervals (except one day) through a thirty minute period each day, for seven days, beginning with the day of hatching. During the first five days, or as long as the female brooded regularly, readings were taken following twenty minute periods of brooding. Outside temperatures follow the dates at the right.

As shown by the chart, the temperature dropped rapidly on the day of hatching when the female left the nest. On the second day there was less drop, and by the time they were three days old, there was little drop, though there was some fluctuation. The drop, of course, would depend to some extent on outside temperature, but fortunately the temperature was not very high during the entire period. Birds at the front of the nest cooled more rapidly at first, but later this made little difference. Birds holding their mouths open showed from one to two degrees Fahrenheit lower temperature, though the thermocouple was well down the esophagus. The female brooded the four day old birds, more or less, through the day, thus continuing the brooding at least one day after the young were able to keep warm

without her. Figure 9 shows temperature variations during a single day.

B. Parental Care of Young Birds in the Nest.

For several days after hatching, the female broods the young with much the same rhythm that she incubated the eggs. The brooding instinct reaches its maximum when the young are about one day old. One female at this time allowed me to stroke her breast and back, and finally push her out of the nest before she would leave. As the young birds get older, the female stands up a good deal in response to their wriggling, especially if the weather is hot. One female while standing over a young bird that was lying on its back, touched it under the chin three different times with her bill, causing it to struggle and finally right itself. When the female leaves the nest, she may act stiff, and perhaps stop to stretch. She never looks back when she leaves, but there is little danger of her throwing the young out of the nest unless she is greatly frightened.

When the young are hatched, the male aids with the feeding. Until near the close of the study, it was believed that the male never came to the nest until after the eggs hatched, but the itograph record in 1936 indicated that the male had come to the nest each morning on the ninth, tenth, and eleventh days of incubation. On the morning of the twelfth day I watched, and at 6:05 the male came with a mouthful of food. He went directly in over the triggers, and remained about three minutes, leaving without the food. The female apparently did not get out of the nest, though I could not see clearly, and do not know which one ate the food. This male was accustomed to the itograph triggers from the previous year, and his behavior probably represents that of the normal male. Another male was found in front of a nest containing a newly hatched Cowbird, at 8:27 A. M. At a third nest containing a newly hatched bird and another hatching at 7:26 A. M., the male was singing some distance from the nest, and probably knew nothing about it.

Food is usually found at some distance from the nest, though some is picked up in the immediate vicinity. When the young birds are small, the parents always walk from five to eight meters in approaching and leaving the nest. They have routes or runways which they prefer, but the route in leaving is not necessarily the same as the one used in approach. The birds generally avoid open spaces, keeping under the cover of vegetation.

The male and female usually approach the nest somewhat differently at first. The female, being more accustomed to going to the

nest, walks up quickly, feeds and broods. The male approaches more slowly, frequently taking five or ten minutes to come a few meters. He may stand motionless for several minutes, or may advance a few steps at a time, rather quickly. In this method of pause and approach, he is not easily seen. The streaked breast also aids in hiding the male as well as the female, by giving him protective coloration. As time goes on, the male gets bolder, and may surpass the female in his courage and speed of approach.

When the male reaches the nest, the female gets out, so that he can feed the young, and frequently she leaves at the sound of his footsteps, before he comes in sight. Males and females alike feed from one to three young birds at a time, the usual number being two when the young are small, and either one or two when they are older. Care is taken never to waste any food, and any portions dropped are always picked up and refed. When the food has disappeared, the parent waits to see if any excrement appears, remaining at the nest usually from one to three minutes.

When the female leaves the nest, she may "stand by" while the male is feeding, or may go away for food. Sometimes she opens and closes her mouth, as if she would like to have the food herself, and occasionally takes some and aids in the feeding. One female took a large green larva from the male, and he took it back again, then she took it a second time, and fed it to the young. There was no indication of irritation on the part of either parent during the performance. Another female, which insisted on doing the feeding stood in the way of the male, but he cleverly reached around her, and did some of the feeding himself.

A male that I was watching, after feeding the young, came straight to the tent where I was concealed, and walked under the edge. When he saw me, he started out, then came back, and finally flew through the door at the rear. During the next three days he came into the tent, or to the edge of it, seven more times while I was there, and undoubtedly passed through regularly when I was away. This behavior was apparently due to a desire to keep hidden while near the nest.

The excreta are swallowed by the parents at first, but after the second day some are carried away. The swallowing continues to some extent, however, as long as the young are in the nest. The male is perhaps more prone to carry the excreta away than the female. Parents usually carry these a considerable distance from the nest, but occasionally one may be seen alighting on a tree, within twenty or thirty meters, and wiping its bill.

About four or five days after hatching there is a marked change in the behavior of the parents. In place of brooding, quietness, and tolerance, there are increased feeding, chirping, and defiance. At this time temperature control has developed enough so that there is little need of brooding, while feeding has increased gradually and become the important factor. In approaching and leaving the nest the parents have shortened the walking distance until finally they may alight and take off within a meter of the nest. When approaching in this manner, however, they alight on a perch near by, before going to the nest. Time spent at the nest is shortened also, and on the last day or two parents may remain only long enough to deliver the food, and perhaps grab up an excretion that may be in front of the nest.

The food of the young Oven-birds, following hatching, consists chiefly of green and brown geometrid larvae. Parents carry these transversely in their bills, usually two or three at a time. Small earthworms also form a part of the diet. These are grasped at several places and folded into loops which protrude from the sides of the bill. As the young birds grow, adult insects, including crane-flies, moths, ants, and beetles are added.

A fairly accurate record of the feeding at four nests was obtained by the itograph (Tables 4 and 5). Table 4 shows an hour by hour record of the feeding at nest No. 9, which contained four Oven-birds and two Cowbirds, from the day of the first hatching up to the evening before the Oven-birds left the nest. Totals at the bottom show a rather constant rate of feeding throughout the day. There was an extra number of feedings between 5:00 and 6:00 A. M., obviously on account of not having food over night, and an easing up in the afternoon, perhaps due to the high temperature. The middle of the feeding day fell at 12:10, quite near the noon hour. The increase in the number of daily feedings is quite significant. Beginning with twenty-eight on the day of hatching, there was a gradual increase up to 160 on the day before the Oven-birds left. This brood was the largest found during the study. Each Cowbird required at least as much food as two Oven-birds, hence the brood was equal to about eight Oven-birds. All left the nest successfully, in spite of the fact that the nest was badly infested with mites.

At nest No. 6, which contained but two Oven-birds, the number of daily feedings increased from sixteen to sixty-seven (Table 5), but the young birds did not grow especially well. At nest No. 15 of 1935, containing five Oven-birds, the number of daily feedings increased from about twenty-seven to 123, and the young grew well. At nest

No. 15 of 1936, containing three Oven-birds, the feedings increased from twenty to sixty-one. The increase here was irregular, and it is doubtful whether this represents a usual condition. With some allowance made for the last nest, the data indicate that a larger number of birds receive more feedings, but not necessarily in proportion to the number of birds. The increased demand for food as the birds grow apparently is met by carrying larger loads of food as well as more of them. Furthermore, a small number of birds in a nest do not grow any better, and perhaps not as well as a full brood.

The relative amount of feeding done by the male and female varies with the pairs, and also with the time. Males usually feed more at first, because the females spend much of their time brooding. During the latter part of the period, males and females feed about the same amount, on the average, though with some pairs one may exceed the other. One male, which had two mates, let the second female do all the feeding of a brood of five until they were five days old, but the young fared well and grew at almost the normal rate. The males and females, when approaching the nest with food at the same time, frequently quicken their pace, each trying to reach the nest first.

Parents begin activities quite early in the morning. On June 8, I arrived at a nest at 4:30 A. M., when it was just light enough to see the lines on my note paper, and the itograph showed that the female had been off twelve minutes. Feeding stops in the evening about the time singing ceases, when it is still light enough to take notes without difficulty.

During the early days of the nestling period, parents leave in search of food with little apparent regard for the safety of the young during their absence. A few times parents were found standing quietly in front of the nest or near it, but in only one case was it obvious that the purpose was to guard the nest (Pl. XI, B). On this occasion a female remained near the nest almost constantly during the fifth and sixth days after hatching, leaving as a rule only when the male was near the nest, and returning when he left. She did very little feeding during this time, but the male brought large mouthfuls of worms, and the young had plenty to eat. Later the female helped with the feeding, and brought as much food as the male.

During the latter part of the nestling period, the parents become more alert, and spend considerable time watching from perches near by. If any danger comes in sight, they begin chirping, and do their utmost to protect the nest. Squirrels were sometimes attacked by the birds flying at them, if they approached too near, and a Blue Jay near

one nest caused considerable chirping, but the Oven-birds did not dare to attack it. An Acadian Flycatcher which lit in front of a nest was immediately driven away by one of the parents, presumably the male. A female on one occasion drove a strange Oven-bird away from the nest, by approaching it slowly with her mouth wide open. While the young of one nest were detained in a trap for study, the parents were annoyed greatly by two Barred Owls which were in the vicinity. When one owl perched within twenty meters of the young, the parents approached it and chirped for an hour, while the young were quiet for the most part. Finally I had to leave the blind, and the owl flew, putting an end to the disturbance. Later during the same day, two Hairy Woodpeckers came within two meters of the young Oven-birds, but the parents paid no attention to them.

Adult birds seem to be very much afraid at night. One evening when it was quite dark I went with a flashlight to a nest where the young Oven-birds were six days old, to see if the female was there. When I was about six meters from the nest, the female left in great haste and confusion, running noisily through the vegetation. When I arrived at the nest I found one young bird partly out of the nest, and another on its back. The female must have been badly frightened to leave in such a manner. At two other nests, where the young were seven days old, I watched from the blind until dark, and the females remained away.

Adult birds were banded when the young were from one to six days old. The best time is when the young are from one to three days old, after the feeding routine is established and before the parents grow defiant. Females could be distinguished from males by the large brood spot on the breast, frequently a convenient mark, since males and females were banded differently. Catching the parents made them more shy, but did not ordinarily interfere seriously with the care of the young. I dropped the trap over one female while she was sitting on the nest, and she did not move until I approached within a meter of her. The other extreme was a male which fluttered around in the gathering cage, and finally leaned backward with his tail doubled under him, and slowly tilted over on his back. His eyes were half closed and he lay there as if in a trance, but when I shook the cage he got up and seemed to be all right. Usually when one parent was being banded, the other chirped frantically until the mate was released. When a parent was disturbed by banding, or by the presence of the blind, camera, or other apparatus, it approached the nest with

some caution, frequently holding the tail high and giving it a quick flip backward at each step.

Opportunity was offered in the latter part of the nestling period to study the ability of the parents to learn. At one nest a sparrow trap with the second funnel moved back into the place of the first, and a hole made in the top for escape, was placed over a nest. This was to allow the parents to go in and out for feeding, but to retain the young for study, when they left the nest. Parents at first refused to go up the steep incline of the funnel, but when I turned the funnel over, offering an approach which was less steep, they entered readily. Later the funnel was turned back to the original position. A hole fifteen centimeters square in the top proved of no use as a place of escape, but when I loosened the netting over one-fourth of the top at the back end, the arrangement worked very well. Parents entered and fed regularly, usually going in at the funnel and out at the top, but sometimes reversing a part of the route. When the young were out of the nest, parents often attempted to feed through the netting, but this was not very successful.

At several other nests, a circular netting fifty centimeters in diameter and twenty centimeters high was used to retain the young for weighing. Parents were unable to enter this at first, because of the tendency to remain on the ground. A twelve centimeter piece was substituted for the higher one with the same result, but when a pile of sticks was placed by the netting, the parents would walk around the netting and mount the pile of sticks, from which they would then enter. Males seemed to find the entrance a little more readily than the females. After a few trips the birds entered with no hesitation. The 20-centimeter strip was then substituted for the lower one, and the birds entered with but little notice of the change.

In a similar manner, though earlier, the female was trained to enter over the itograph triggers. First the triggers and the netting were placed near the nest, so that she could become familiar with them, then the triggers and the side walls of the netting were gradually moved up to the nest. Lastly the netting was extended out over the top. From three to four days were required for the training. Dummy triggers were used at first, so that the itograph would not be kept in the woods unnecessarily. When the young hatched, the males learned the route apparently from the females and by trial and error. One male refused to enter the nest for three days, but with no serious results. The itograph was used on the same pair in 1936 as in 1935. and little training was necessary the second year.

C. Leaving the Nest.

Young Oven-birds leave the nest approximately eight days after hatching. The average time for fifty-seven birds in sixteen different nests was seven days, 22.5 hours, and ranged from six days, thirteen hours, to eight days, twelve hours. The average was not changed appreciably by omitting birds which left the nest on account of fright.

In the normal method of leaving the nest, the young hop out one at a time, and several hours may elapse between the leaving of the first and last birds. Frequently a bird will leave the nest, go a few centimeters, and then return, so strong is the attachment for the nest. In such cases the remaining birds in the nest set up the food call as the young one returns, showing that they cannot distinguish it from a parent. Sometimes young birds in leaving will turn around facing the nest, and then hop over the side of it.

When the first young bird leaves the nest, one of the parents leads it away and cares for it, leaving the remainder of the brood largely or entirely to the care of the mate. In two cases observed the male took the first bird, and in two the female took the first. The last two or three birds are apt to leave about the same time. Young birds leaving subsequently may be cared for by either parent, but the parent left with the nest is likely to be left also with more than its share. The first birds out of the nest receive plenty of attention, but by the time the last one goes the parental desire for young is well satisfied, and it may have trouble in getting a parent to claim it. The last bird or two are apt to be less mature than the first ones, also, making it more difficult for both parent and young.

Parents are always interested in the young leaving the nest, but I have not seen a parent deliberately trying to coax young out, under normal conditions. On the contrary they approach and leave the nest quickly from the side or rear, which tends to prevent the young from following or coming to meet them. As a result young birds usually leave after a parent has gone, perhaps stimulated to some extent by hunger, and a subsequent desire to follow.

One female left in care of a nest obviously stalled, somewhat, as she waited for the young to leave. She went through the motions of feeding when she had no food and walked around near the nest, though out of sight of the young. Finally she stepped on top of the nest and looked over, which was too much for the three remaining birds, and they hopped out.

When a young bird is once out of the nest, the parent leads it away very skillfully. It walks ahead, stopping frequently to hold

food in front of the young, to feed it, or to go through the motions of feeding when it has no food. In case the young bird goes ahead, or in the wrong direction, the parent follows up and again takes the lead. Young birds at first are led away from the nest from fifteen to twenty-five meters, if they travel well, then when the excitement of leaving the nest has quieted down, they are taken farther.

When the parents have divided the brood by each taking some of the young, their home life is ended, and each goes its own way. Delay in separating, or any excitement, such as the flushing of a young bird, may cause both parents to appear on the scene any time for a day or two, and one pair was seen together on such an occasion, five days after the young left the nest. Such excitement, however, may draw in neighboring birds as well. When separating, the male remains within the home territory unless it is late in the season, and then he may go outside. The female usually goes into neighboring territory, and may wander about to some extent. A female and young going into neighboring territory are treated kindly by the male of that territory, which frequently takes a lively interest in the visitors.

Young birds will jump out of the nest on account of fear, when they are six or seven days old. At one such nest, containing seven day old birds, I started to band the young, and when I took the first one out of the nest, they all jumped out. I tried to keep them in until I could get at least one parent banded, but it was of no use. I covered the opening with a chip, and finally with a heavy piece of wood, but they crept out over the top, or pushed the top of the nest back and escaped. The parents called frantically and this excited the young birds all the more. I succeeded in banding three of the young, but by that time the other two could not be found.

At two other nests this "emergency method" of departure operated under natural conditions. At the first, which had contained five birds, seven days old, the top of the nest was gone when I arrived and could not be found. The young birds were gone, but a later check showed that at least one survived. There were two excretions in the nest, and one in front, showing that the young had not been attended for some time before the nest was destroyed. Perhaps one of the Barred Owls known to be in the vicinity had come near and drawn the attention of the parents, then later attacked the nest. The parents were chirping when I arrived, but the male sang while I was examining the ruin.

At the second nest, which had contained three Oven-birds and a Cowbird, I heard the parents chirping, and upon investigation found

the nest empty. The bottom of the nest was disarranged, where the Cowbird had hung on as it was being unceremoniously dragged from the nest, perhaps by a red squirrel. Eight hours later I found one of the Oven-birds attended by a parent only twenty meters from the nest, but it finally perished also. Birds leaving the nest before eight days, are at a decided disadvantage, for they do not travel well, and are apt to fall prey to an enemy.

D. Literature.

Passerine birds when hatched are blind, helpless, and covered only by natal down. Specific cases are the Cedar Waxwing (Herrick, '05), the Bluebird (Allen, '30), and the Oven-bird (Nice, '31b). The eyes begin to open at varying times, examples being as follows:

Brown Thrasher	one day	Herrick ('35)
Magnolia Warbler	two days	Stanwood ('10)
Yellow Warbler	three days	Bigglestone ('13)
Cedar Waxwing	four days	Herrick ('05)

The development of natal and juvenile plumage in passerine birds has been studied carefully by previous workers (Jones, '07) (Boulton, '27), and appears to differ only in minor details in the various species. The natal down of the Oven-bird is distributed over more tracts than that of the House Wren, described by Boulton, resembling more closely that of the Cowbird (Friedmann, '29). The juvenile plumage develops much in the same manner as that in the House Wren, but a little more rapidly, corresponding to a shorter period in the nest. One exception in the comparative rate of growth is in the appearance of the primaries and secondaries, which show in the Oven-bird as a dark line at hatching, and similarly in the House Wren, three or four hours later.

The young of the Yellow Warbler (Bigglestone, '13) and the Prairie Horned Lark (Pickwell, '31) open their mouths at any noise until about five days old, then begin to discriminate between sounds. The Prairie Horned Lark, soon after this, learns to withdraw at the touch of the hand, but does not develop fear in the full sense until nearly time to leave the nest.

Mousley ('26) noted the increased activity of young Oven-birds in the nest just before time to leave, and also found that young Goldfinches ('30) stood up in the nest at eight days, when they were only half old enough to leave the nest. Bigglestone ('13) saw young Yellow Warblers fighting over food while they were in the nest, a behavior unknown to young Oven-birds. Mrs. Nice ('31b) described the

food call of the young Oven-birds when they were old enough to leave the nest.

Young Long-billed Marsh Wrens (Welter, '35) could peep audibly at hatching time, but did not open their mouths for food unless touched. Evidence of fear appeared as soon as the eyes were open, which was on the third day. Young wrens bore their weight on the tarsus on the fourth day, but kept the toes doubled up until the ninth day. The young learned to expect food at the sound of the approaching female without first seeing her. They also learned to turn the rear toward the door in excreting, and later to eject the feces clear of the nest.

Herrick ('10) found the Black-billed Cuckoo a little more precocial than the passerine birds. It could work its toes vigorously when hatched and soon was able to eject excreta over the edge of the nest. Young birds learned to associate the food reaction with the nest, and at seven days would not open their mouths when removed from the nest. Young cuckoos, when fed regularly and otherwise undisturbed, slept much of the time between feedings. Fear developed just before the young left the nest.

Growth of passerine birds in the nest, as determined by weight, has shown considerable variation. Some of the relative gains in weight while in the nest are as follows:

Species	Ratio of final weight to hatching weight	Time in nest	Reference
Cedar Waxwing	11-17	11 days	Herrick ('35)
Song Sparrow	11	10	Nice ('33-'34)
Prairie Horned Lark	6	11	Pickwell ('31)
Long-billed Marsh Wren	11	12	Welter ('35)
Barn Swallow	12	11 (not full time)	Stoner ('35)
Oven-bird	6.7	8	

The relative gain in weight of the Oven-bird while in the nest corresponds well with that of the Prairie Horned Lark, but the relative gain per day corresponds more nearly with that of the Long-billed Marsh Wren. The Oven-bird apparently is more precocial than most passerine birds, since it leaves the nest at eight days, and weighs at that time only 73 per cent as much as the adult. The young Barn Swallow, an extreme in the other direction, weighs more than its mother when it is eleven days old, and 89 per cent as much when it leaves the nest a week later. A slower growth rate, or an actual loss in weight, when the birds are about to leave the nest, is usually attributed to feather growth.

Baldwin and Kendeigh ('32) found that temperature regulation in the House Wren was established at nine days, but in their former work (Kendeigh and Baldwin, '28) their figures show that under natural conditions it was well established at six days. The young House Wrens studied ('28) remained in the nest fifteen days and were brooded for thirteen days. This showed an overlapping of from four to seven days, of the brooding period and the period when temperature control became established.

Stoner ('35) found that temperature control became established in young Barn Swallows about the ninth or tenth day.

Mousley ('26) watched a nest containing two young Oven-birds and observed the following parental behavior: Parents walked to and from the nest, keeping under cover of the vegetation, and the female left the nest when the male arrived with food. The male sang in reduced amount and was shy at the beginning of the period. The average brooding periods and the time between feedings decreased as time progressed. Both the brooding periods and the time between feedings were greater than for a number of other species studied. This statement would not apply to his later findings on the feeding of Goldfinches, however. Food consisted of soft, green larvae, small flies, moths, and other insects. He observed a "battle royal" between two males when a near-by pair of Oven-birds approached too close to the nest during the latter part of the nesting season. The young left the nest at eight days. He found the male caring for a young bird just out of the nest, and the female caring for the remaining one still in the nest. The female under excitement "poked the youngster out of the nest", and it fluttered off attended by both parents. This interest shown by the male during the excitement was, in all probability, only temporary.

Mrs. Nice ('31b) watched two Oven-bird's nests during the nestling stage and observed the following characteristic behavior: Parents walked to and from the nest at first, favoring certain routes, and keeping hidden as much as possible. Later they lit nearer the nest and flew sooner in leaving. The female left the nest and stood at one side while the male fed. The female's feeding was followed by brooding. The nestling period was divided into two rather distinct parts, the first four and one-half days showing brooding, slow rate of feeding, and indifference on the part of the male. During the remaining part watching was substituted for brooding, feeding was increased, and the male (at one nest) took a more active part in feeding and caring for the young. When one brood of two had left the nest, the male cared for

the one the farther from the nest, and doubtless as Mrs. Nice believed, the first one out, while the female cared for the other. Mrs. Nice noted also the slow rhythm of the Oven-birds in feeding, as compared with other warblers. Later ('32) she tabulated the brooding periods and the feeding rate of ten species of warblers, and found that the Oven-bird had the longest brooding period and slowest feeding rate of any.

Herrick ('10) states that the Black-billed Cuckoo's brooding reaches a climax when the young are about three days old, then shades off into intermittent brooding. In great heat the parent will sometimes stand instead of sitting on the nest. Also the parent will rise to accommodate the strenuous young, which seem never to rest, but burrow about constantly, uttering their low grating notes in chorus and poking out their heads. He states ('05) of feeding in general that strict economy is practiced, not a crumb being allowed to go to waste. One young Black-billed Cuckoo climbed a foot or more from the nest and returned. After the first young bird had left the nest, the male seldom if ever visited the nest, but gave his attention to the bird outside.

Sanitation, as observed in various species of passerine birds, is quite uniform. Herrick ('05) says, "The instinct of inspecting and cleaning the nest is mainly confined to the great passerine and picarian orders. . . . Shortly after being fed, the nestling becomes very uneasy, and raises its body as if to drop the sac over the edge of the nest. The old bird follows every movement, snaps up the package as it leaves the body, and either swallows it immediately or carries it off." He thinks that parents eat the feces to satisfy hunger, an idea supported by Pickwell ('31), who found that the Prairie Horned Lark ate more feces in early spring than later when food was more plentiful.

According to the observations of Howard ('07-'14), McClintock ('10), Gabrielson ('13), Bigglestone ('13) and others, there are from three to six feedings for every excretion, and excreting in nearly every case follows feeding. Mousley ('26) noted the tendency of the male Oven-bird and the males of several other species to carry the excretions away rather than eat them. Birds which carry excretions away have a habit of wiping their bills afterwards.

According to Kretschmer ('26), the behavior of the male Oven-bird that fell over backward in the receiving cage would be a "sham-death reflex", which he defines as a reaction in which the animal remains rigid and motionless until stimulated by touch or shaking.

The method used in training the Oven-bird to use the itograph was essentially the same as used by Kendeigh and Baldwin ('30), except

that they studied only birds with young in the nest, while in the present work recording was begun as early as the second day of incubation.

Stanwood ('11) found that young Oven-birds remained in the nest approximately eight days. Excreta which she found in front of the nest indicate that the young had not been attended previous to their leaving.

Gabrielson ('13) noted that when two young Brown Thrashers were in the nest and two out, the parents exchanged duties in caring for the young. The female did most of the feeding at the nest, however.

Pickwell ('31) says of the young Prairie Horned Larks that they leave usually by following a parent which has just brought them food. In one case he saw a female coaxing a last young bird out of the nest by holding food before it.

Young birds leaving the nest on account of fright and their unwillingness to remain in the nest after once out are well known. Examples are the Chestnut-sided Warbler (Herrick, '05), Black-billed Cuckoo (Herrick, '10), and the Goldfinch (Mousley, '30). This method of leaving must save the lives of a few birds, but the loss is necessarily heavy.

YOUNG BIRDS AFTER THEY HAVE LEFT THE NEST

From the time the young emerge from the nest until they are ready to leave the woods, they pass through four rather distinct stages, which are as follows:

- I. Hopping Stage, 8-11 days of age.
- II. Early Flying Stage, 11-20 days of age.
- III. Semi-dependent Stage, 20-30 days of age.
- IV. Independent Stage, 30-40 days of age.

Hopping Stage, 8-11 days. Young birds hop when leaving the nest, going nearly as fast as a person walks. They stop frequently, often under any slight cover of vegetation that is at hand, but they do not creep under any object. They sit so closely, and their color so nearly resembles that of the leaf carpet, that the finding of a young bird at this stage is difficult. The chirping of the parent is a good general clue, but parents will not go to the young if a person is near, unless the young get hungry and begin to peep. One female kept on the opposite side of me from where a young bird was located when I was looking for it. If the young is flushed, the parent tries to lead it away, but leaves it the moment it becomes quiet. Young birds are kept separate at this time, if the parent is caring for more than one,

and the parent remains with the young bird only long enough to feed it, unless perchance he tries to lead it out of danger. Under favorable conditions young birds, especially those attended by males, may remain in practically the same place for several days after leaving the nest.

A brood of four young birds, which left the nest at seven days, were detained in a trap for three days, so that their behavior might be studied (See page 185). The trap was placed over the nest several days before the young left the nest, and the parents learned to enter and leave readily. When I arrived one morning all of the young were out of the nest, and the parents were trying frantically to lead them away. Failing in this, the parents gradually settled down to routine feeding. They tried repeatedly to feed the young through the netting, and sometimes succeeded, especially at the funnel where the mesh was a little larger.

The young were unable much of the time to distinguish their parents from their brothers or sisters, and consequently often refused food from the parents, or begged it from the other young. This confusion resulted from the young being kept together when they naturally would have been separate. The parents fed those which were calling perhaps more than those that were still, but sometimes seemed to go deliberately to those that were tired and quiet. When the young did not take the food readily, the parent would square itself around in front of the young bird and move its mouthful of food from side to side, as a Robin does, to attract attention. If this failed, the parent went to another bird.

The female once dropped a bit of food through the netting in the bottom of the trap and spent about two minutes trying to get it. She turned quickly from side to side, sometimes describing nearly a complete circle. Later the male spied the same morsel and spent about a minute trying to get it, but finally gave it up.

Parents as a rule paid no attention to excrement. Once a young bird, after being fed, turned around and excreted, whereupon the male took the excrement and flew out. The behavior on the part of both was apparently the result of confusion on account of the trap.

The young hopped at first, and when resting, placed the tarsus flat on the ground. By the third day they took steps about half of the time. They were quite agile, and could easily hop over their fellows. Sometimes one would hop completely over its astonished parent, as the parent approached with food. Much of the time the young birds seemed more concerned with escaping than obtaining food. One

favorite action was to jump and flutter up the side of the trap in an effort to escape. On the first day they could jump fifteen centimeters, the second day eighteen, the third day twenty-five, and on the morning of the fourth day they flew over the top, which was thirty-three centimeters high. Three of them were gone when I arrived, and in a few minutes the fourth flew to the top of the trap, poised for a moment and flew down outside, where it was led away by the female.

Early Flying Stage. 11-20 days. Young birds are still kept separate at this stage. They are able to fly, due to the unsheathing of the wing feathers, and when flushed they fly from five to thirty meters at a time. They usually alight on the ground, often behind a tree or stump from the observer, but may alight as much as four or five meters from the ground, on a limb or the side of a tree. If a person follows one of these birds, it flies readily when one comes within two or three meters of it, and eventually goes around in a circuit, coming back near the original location. This habit was noted first in 1934, and during the following season it was tested several times, always with the same result. One young bird but eleven days old flew, ran, and hopped for seventy meters, over the edge of a hill into the creek bed, then returned to within two meters of the place where it started. The female followed a part of the time and tried to entice it with food, but it paid little attention to her.

If the birds are not crowded too much when the young is flushed, the parent will walk along and the young one follow, being encouraged by an occasional feeding and by the parent calling. One male used the "teacher" song repeatedly when trying to coax the young bird away. If the young bird alights in a tree under such conditions, the parent will endeavor by calling and by example to coax it down. One male flew two different times from near a young bird to the ground, trying to get it to follow.

Semi-dependent Stage. 20-30 days. This stage begins when the young bird starts to pick up food for itself. The typical scene at this time is one or two young birds accompanied by a parent, walking about within a few meters of each other, picking up food. The young bird's efforts are supplemented by those of the parent, which occasionally gives the youngster an extra feeding. A person can usually approach to within a few meters of the young, but the parent gradually leads away from the supposed danger. If crowded too closely the parent will fly away without the deep concern exhibited earlier, and the young will follow. Although the parent and young are fre-

quently found together at this time, the association is not a constant one, and parents, especially singing males, may often be seen alone in trees, and an occasional young bird may be found alone. Early in this period the young birds begin the post-juvinal molt, which is quite conspicuous around the neck.

Independent Stage. 30-40 days. This stage begins when the parents leave the young, and the young must shift for themselves. The time may vary as much as several days, since it is dependent on the parent as well as the development of the young. Parents ordinarily leave the woods at this time, but one and perhaps two exceptions were noted. The time of leaving is apparently more variable with the males, since it is associated to some extent with the defence of territory. In one case where no apparent pressure other than migration influenced the parents to leave, a male and female, each caring for two birds in different territory, remained with the young until they were twenty-eight days old. The fact that they left the woods at the same time indicates that the physiological cycle was well timed. (See p. 196 for time parents leave).

Independent young birds wander about picking up food, and appear to be perfectly contented. They may be alone, or two or three together, or one or more may follow another parent with semi-dependent young. The parent in this case pays no attention to the extra birds. Young birds associated together do not necessarily represent members of the same brood, as banding has shown. These birds sometimes show a playful spirit where two will pursue each other and describe small circles as they whirl rapidly through the air.

The stage ends when the young have attained their full first year plumage, which makes them look exceedingly prim compared with the molting adults. The young birds are now physically ready to migrate, and some may do so, but others remain for some time.

Literature. Pickwell ('31) noted that young Prairie Horned Larks did not run but hopped, a performance which he thought might be an ancestral trait. Young Prairie Horned Larks can not fly when they leave the nest, but at five days can fly 100 yards. Parents find the young out of the nest by seeing them rather than by hearing them.

Welter ('35) says that young Long-billed Marsh Wrens, when they first leave the nest, run along the ground, and hop or half fly from one flag to another. The male aids in the feeding, though he does not help while the young are in the nest. Parents feed the young for at least two weeks, but the young help secure their own food after

the first ten days. Young birds of a brood remain together as late as September, and wander about in search of food.

DEPARTURE IN SUMMER AND AUTUMN

The adult Oven-birds disappeared from the woods in nearly every case, as soon as the young were old enough to care for themselves. The disappearance of the males was much more noticeable, since they began leaving before singing ceased, and because they more commonly remained in their own territory until time to leave the woods.

There was a great variation in the time the parents left the woods, due to difference in success in rearing young. The earliest record for leaving was that of two males which were seen last on July 5. On that day one of these males entered the other's territory, perhaps attracted by a wandering female caring for a young Oven-bird and a Cowbird. The owner of the territory sang, but made no effort to expel the intruder. The young of the intruding male were twenty-eight days old, and that of the owner, twenty-six days. Apparently the instinct to defend the territory had become so weak that it no longer functioned, and to remain without defending it was undesirable. Neither of these males was seen again.

Another male was seen last on July 9, in his own territory, caring for a young bird, thirty-one days old. A female was seen last on July 10, at the south end of the woods, in company with a young bird thirty-one days old. Still another male was seen last on July 18, when a neighboring male entered his territory. His young at this time were thirty-seven days old. The male and female mentioned on page 195 were seen last on July 31, when the young were twenty-eight days old.

The latest adult seen in the woods was the male which reared young of two broods to the independent stage. He was seen last on August 26, caring for a belated young bird about twenty-six days old. This male had not sung since July 25, and was in the midst of molt, with all of his tail feathers out. He was the only adult seen after July 31, in the 1934 season. The last adult seen in 1935 was a female seen on August 15, caring for a young bird twenty-seven days old.

The earliest of the young Oven-birds attained their first year plumage about July 15, and were then able to migrate. Those of later broods matured during the latter part of July and in August, and one as late as early September. In 1934, which was a hot, dry season, young birds left the woods almost as soon as they were able, and the last two of the season were seen on September 2. In 1935, however,

the weather was more nearly normal, and some appeared to be in no hurry to go. Four birds in first year plumage were seen on September 3, one of which wore a band, and was at least forty-five days old. A part of this group remained and one or two birds were seen frequently through September in the same locality. When I would come upon them, they would usually fly up to a perch and perhaps approach to satisfy their curiosity, then go on with their feeding, or, if crowded too much, they would fly off some distance and light in trees at considerable height. Young birds were seen occasionally in other parts of the woods, and the last of the season was seen on October 2.

There was little direct evidence as to the course the birds took when they left the woods. In a few cases birds appeared to go to the south end of the woods then disappear, but the evidence was not very conclusive. When the first birds began to disappear in 1934, I looked carefully around a small lake a mile away which was the nearest body of water, but no Oven-birds were found. It was obvious that no large number of birds were migrating through the forest, for the birds from the remainder of the immediate forest would easily account for all of the unbanded birds seen. It is probable that birds leaving the forest start immediately on their southern journey, and that they keep in the open rather than in thick forests during migration.

Literature. Butler ('97) noted the early disappearance of the Oven-birds in July and August, during dry seasons, and stated further that they might be seen singly or in little flocks, making their way southward during August, and occasionally in September and early October.

Wood and Tinker's records for the Ann Arbor vicinity from 1907 to 1930 show that the Oven-bird was recorded for the last time in the season at various times in September, on October 2, 4, and 9, and on November 13. The last record was probably of a bird which had been unduly delayed, and the three October records may be regarded as the last normal ones of the season. All of these late birds were probably young ones.

REPRODUCTION AND SURVIVAL

Success and Loss. In calculating the success and loss in reproduction, it was necessary to count the females only, since double and subsequent matings made the relation of pairs too complicated for practical consideration. The number of males involved was known to be one less than the number of females in 1935, and perhaps was one less in 1934. Males and females doubtless occur in about equal

numbers in the species, but this ratio did not quite hold true for the area studied.

The table below gives the data and the calculations in percentages for cases followed through the season. The numbers given for the eggs and young are approximately correct, but were estimated in a few cases. The estimation of the number of young birds that left the woods was based on the number of young birds seen accompanying the various parents, and is believed to be fairly accurate.

	1934	1935	Total number	Total per cent
Breeding females	13	11	24	
Eggs laid	80	81	161	100
Young hatched	57	45	102	63.4
Young fledged	42	28	70	43.5
Loss of eggs and young from nest.....	38	53	91	56.5
Taken by predators.....	13	25	38	23.6
Lost to Cowbirds.....	13	16	29	18.0
Broken eggs	3	3	6	3.7
Infertile eggs	3	3	6	3.7
Interference of study.....	3	1	4	2.5
Crushed by truck.....	...	2	2	1.3
Apparent suffocation in nest.....	1	...	1	.6
Unknown cause	2	3	5	3.1
Loss of eggs per day (15 days).....	...	...	...	2.5
Loss of young per day (8 days).....	...	...	...	2.5
Loss of young after leaving the nest.....	18	13	31	19.3
Young leaving the woods.....	24	15	39	24.2
Young per female leaving the woods.....	1.8	1.4	1.6	
Theoretically perfect production of five young per female leaving woods.....	65	55	120	100.0
Success of season in relation to perfect production	24	15	39	32.5
Females unsuccessful in rearing young.....	1	4	5	20.8

Although the 1934 season was hot and dry, it proved to be a better season for the Oven-birds than the following one. The increased loss in 1935 was due chiefly to the Cowbird and predators, and apparently was not correlated with weather conditions. The 1934 season was perhaps better for insect food, but this did not seem to be a determining factor.

Enemies. (See list of animals, p. 164). The adult Oven-birds under observation escaped rather well, considering the potential dangers. One female was caught on the nest, near the close of the study in 1936. Many feathers were found in front of the nest, but the eggs were not disturbed, except one was cracked.

Many nests were disarranged or torn out, often before they were finished. In 1936, three nests built by the same female were torn out in one part of the woods, and in another part four nests built by one female were destroyed in succession, and the female mentioned above

was caught on her second nest, after having the first nest torn out. This tearing out of nests was believed to be the work of the Barred Owl, which probably discovered the nests by seeing the females enter. Barred Owls were seen at different times in the woods, and aroused great excitement and fear in the parents when they were near a nest. (See p. 184). A fluffy feather of an owl was found a meter or so from a freshly destroyed nest.

The loss of many eggs and young was attributed to the red squirrel. In a number of cases a part of the contents of a nest disappeared, and later the remainder was taken at one or more visits. At one nest, three out of four eggs disappeared just before noon, and I decided to watch for the robber to return. I remained until dark, and returned again early the next morning. About 6:00 A. M. a red squirrel came to the nest, got the remaining egg and started off with it. When I approached, it ran up a tree and ate the egg, holding it in its paws as it ate. At another nest which contained only a Cowbird nearly ready to leave, a red squirrel suddenly appeared on a tree, head downward, just above the nest. It hesitated a moment until the Cowbird gave the food call, then seized it by the head and ran away with it. Red squirrels evidently discover the nests by accident, as they run about looking for food. The Oven-birds often chase them away from the vicinity of nests, or the loss would be much greater.

One nest was robbed of young by a mammal which left hair resembling that of a gray squirrel. Another was robbed just before hatching by a larger, nocturnal animal, which mashed down the grass as it came and left. This may have been a skunk or raccoon. One skunk was seen within the area, walking about in search of food, and perhaps this species was responsible for some of the losses. There was little evidence during the study that any predator, such as the skunk, followed my trail from one nest to another.

A house cat was seen watching for birds a few times at the edge of the woods, and once was seen walking along a road within the woods. It passed within two meters of a female Oven-bird on a nest, whereupon the male set up a chirp and followed it, but stopped and sang when it was twenty-five meters away. It is doubtful whether it took any Oven-birds.

Two nests were badly infested with mites. In one of these, which contained two Cowbirds and four Oven-birds, the infestation was especially heavy, but apparently all of the young left the nest safely. Mites, pale in color instead of red, were still in the nest forty-six days

after the young left. In the other nest two of the young died, but their death may have been due to other causes.

Snakes, which in some cases are enemies of birds, probably did no damage here. A few garter snakes were seen in the woods, only one of which was mature in size.

Little is known of what became of the young birds which were lost after they left the nest. I once saw a red squirrel spring toward a young bird, but whether or not it was springing at it was not clear. The bird was old enough to fly well and lost no time in getting out of the way.

The Cowbird of course is an enemy, but it will be discussed under a separate heading.

Literature. Mrs. Nice ('33b) found that the loss of adult Song Sparrows during the nesting season was 12 per cent for the males and 20 per cent for the females. The percentage of eggs hatched was 66.5, and the percentage fledged, 41.5, comparing favorably with the success of the Oven-bird, but the number of young per pair during the season was much greater for the Song Sparrow (4.3), due to additional broods. The greatest loss, 36 per cent, was due to predators, the Cowbird accounting for only 5 per cent. The loss of eggs per day was slightly less than the loss of young (2 per cent and 2.5 per cent). In her review of the literature, Mrs. Nice gives other data for nesting successes, which range from 61.1 per cent to 77.4 per cent for hatching, and from 40.5 per cent to 45.1 per cent for fledging. The data on the Oven-bird as well as that of the Song Sparrow come within these ranges. It is interesting, though perhaps not very significant, that the success of fledging in all of these cases falls within the narrow limits of 4.6 per cent of the number of eggs laid.

Barrows ('12) states that, "The Oven-bird suffers much from squirrels, skunks, weasels, snakes, and other prowlers, so that the first nest is often broken up and the bird compelled to lay a second or even a third time. Doubtless this accounts for the fact that the young, or even eggs, may frequently be found late in July or occasionally in August, for we do not think the bird rears two broods as a rule." This observation is true in general, but as shown in the figures above, the Oven-bird has about the same percentage of losses as other species.

THE COWBIRD

Finding the Nests. Cowbirds frequented the woods but little until the arrival of the male Oven-birds, but after that they were seen and heard often. This may have been due to the fact that the Oven-birds

are among the first hosts to enter the woods, and their arrival puts the Cowbirds on the watch for nest building.

On two different occasions a female Cowbird was seen intently watching an Oven-bird building a nest. Once the writer was sitting in an automobile watching an Oven-bird building, and suddenly a Cowbird appeared on a perch near the nest. She flew successively to the ground, to another perch, and finally to the ground twelve meters away, opposite the opening of the nest. She then approached slowly, taking a few quick steps at a time, and lowering her head as she walked. She stood on a rock ten centimeters high for several minutes watching, then moved gradually forward, remaining so quiet between moves that one had trouble in following her. Only once did she waver from her one purpose of spying on the nest, and that was when she picked up a morsel of food. When she had watched for twenty-two minutes, and had reached a point 4.5 meters from the nest, she suddenly rose, and with the customary call for the male, flew off to a distant part of the woods. She showed no fear of me as I sat in the automobile, though I was but ten meters away, nor did her presence or leaving seem to bother the unsuspecting Oven-bird in the least.

On another occasion a female Cowbird was seen watching a nest which was under construction, and the male Oven-bird sang from a perch just above her. Two facts seem obvious from the above behavior. First, the Cowbirds discover the nests by seeing the female building, and secondly, the Oven-birds do not recognize the Cowbirds at sight as enemies. (See p. 207).

Egg Laying. The Cowbird's eggs were laid early in the morning, and on two occasions the writer witnessed the laying. On May 23 a Cowbird's egg was laid in a nest with a first Oven-bird's egg, and during the day the Oven-bird's egg disappeared. Expecting a second egg, I set up a blind five meters away, and was in it dawn the next morning. At 4:55, still twenty-seven minutes before sunrise, I heard a flutter of wings, and two minutes later a female Cowbird flew to the ground not far from the nest. She looked all around, walked to the nest and paused for a minute, then quickly entered. She turned her head to the left, then outward, and sat down, but her body more than filled the nest. In a few moments she raised up and, half standing, spread her wings slightly as if straining. She flew from the nest immediately after this, about one minute after she entered, leaving an egg. Six minutes later I looked up from my note writing, and the female Oven-bird was on the nest. She remained one hour in laying, as opposed to the Cowbird's one minute.

On the following morning while watching from a blind at another nest, I saw a female Cowbird depositing an egg, within two minutes of the same time of day as the first. She likewise lit on the ground near the nest, this time about three meters away, but while she was hesitating, the female Oven-bird came and entered the nest. In a few moments the Cowbird approached the nest from the rear, walked around the side and appeared in front of the entrance. The Oven-bird left with a screech, and the Cowbird, not dismayed in the least, entered the nest. She had more room in the nest than the previous Cowbird, and was entirely inside except her head. She left in about thirty or forty seconds, being hurried in laying perhaps by the Oven-bird, which tried in vain to frighten her off. This nest then contained two Cowbird's eggs, but the Oven-bird had not laid yet, though she had sat on the nest on the previous morning. She did not return that day, but sat on the nest again on the following day, and laid on the next day after.

The time of day of laying at a third nest corresponded closely with these two cases. On July 4, I arrived at a nest at just 5:00 A. M., and a Cowbird's egg had already been laid. The data indicate that the Cowbird is in the habit of laying before the Oven-bird lays, and does not hesitate to drive the Oven-bird off if she gets in the way.

Usually the Cowbird's eggs were laid during the laying period of the Oven-bird (Figs. 10-20). Extreme cases, however, were three days before the first Oven-bird's egg was laid, and three days after incubation began (Figs. 18 and 20). Only a single Cowbird's egg was laid in any nest during one day.

The number of Cowbird's eggs laid in nests varied from one to four, with an average of 1.8. Ten nests received one egg each; eight nests, two eggs; two, three eggs; and two nests, four eggs. However, not more than two eggs hatched in any one nest. The entire number of nests parasitized was twenty-two out of a total of forty-two which received eggs, or 52 per cent. Early nests were parasitized more than late ones. (See table, p. 206). This was due apparently to the early laying period of the Cowbird, and also to the presence of more nests of other species later in the season. The most common other probable hosts in the woods, in the approximate order of their frequency, were the following: Red-eyed Vireo, Wood Thrush, Eastern Cardinal, Red-eyed Towhee, Scarlet Tanager, and Indigo Bunting.

Removal of Eggs. Time after time I noticed the disappearance of eggs during the day, from nests in which Cowbird's eggs had been laid in the morning, or were laid on the following morning (Figs. 10-

20). On two different occasions when conditions seemed right for the disappearance of an egg, I went to get a blind so that I could watch, only to find on my return that an egg had already been taken. At one of these nests upon my return, a female Cowbird called from a perch near by, as if scolding me for encroaching on her domain. At the third nest, I was more successful (Fig. 13). The first Oven-bird's egg was laid there on May 26, and on the following morning another Oven-bird's egg and a Cowbird's egg were laid. Conditions being favorable here for the taking of an egg, I set up a blind 4.5 meters from the nest and began the watch at 7:45 A. M. At 9:01 a female Cowbird lit at the side of the nest and paused a moment standing on the edge of the nest. She then walked around in front, reached deeply into the nest, secured an egg and flew away with it. I looked out at the side window and saw her still going, about thirty meters away. Her bill appeared to be sunk deeply into the shell. As usual none of the egg contents was found in the nest.

At another nest, I happened upon a female Cowbird accidentally, as she was taking an egg. I was about fifteen meters away as the Cowbird approached a nest, which contained two Oven-bird's eggs and a Cowbird's egg. She flew nervously to three or four perches, then down to the ground within a meter or two of the nest. She was then behind the shrubbery from me, and I approached to within ten meters of her. After twenty or thirty seconds she flew from the region of the nest with an Oven-bird's egg in her mouth, and alighted in a roadway fifteen meters from the nest, where she proceeded to eat the egg. I watched her through binoculars as she chewed up the shell, and I approached to within ten meters of her before she finally grabbed a piece of shell and flew. A small amount of egg-white was found in the nest and on one of the remaining eggs, but the nest was not deserted. Two other nests in which some of the egg contents leaked out were deserted by the Oven-bird.

On one occasion while I was watching for an egg to be taken, the female Cowbird arrived at 8:22 A. M., lit on a perch within four meters of the nest, then flew to a second and third perch in a semi-circle around the nest. She apparently was disturbed by the blind, however, and left without going to the nest. I watched a little longer, then removed the blind, but she did not come back. This was the only parasitized nest under observation where the full clutch of Oven-bird's eggs was retained for incubation. One egg failed to hatch, however, and a full brood was not obtained (Fig. 14).

During the investigation approximately thirty Oven-bird's eggs disappeared from nests during the laying period, under circumstances which indicated that the Cowbird had taken them. Nor was the Cowbird always discriminating, for in addition to these, four eggs of her own species were missing under the same circumstances. The number of eggs of the host taken was 75 per cent of the entire number of Cowbird's eggs laid, or if the four Cowbird's eggs are included, the number was 85 per cent of the number laid. In nests not parasitized only a single egg was known to disappear during the laying period, and a Cowbird may have taken that.

Concerning the relative time when eggs were taken, as nearly as could be calculated in twenty-three known cases, ten eggs disappeared on the day before the Cowbird's eggs were laid, ten on the same day, and three on the following day (Figs. 10 to 20). Data in eight instances all show that the eggs were taken in the forenoon. The earliest was before 7:15 A. M., and the latest between 9:30 and 11:15. One other disappeared after 10:35, and may have been taken in the afternoon. In no case was there any evidence that an egg was taken at the time a Cowbird's egg was laid.

Incubation and Hatching. The incubation period of the Cowbird's eggs ranged from approximately 11.1 days to 11.8 days, with an average of 11.6, which is 0.6 of a day less than the average for the Oven-bird's eggs. This difference in incubation time gives the Cowbird a slight advantage over the Oven-bird from the start.

When a Cowbird's egg hatches, a half shell sometimes slips over the end of an Oven-bird's egg and remains there. This, however, does not interfere with the hatching of the Oven-bird's egg. The female Oven-bird usually eats the shells, but in this case she leaves them.

Young Cowbirds. Cowbirds are easily distinguished from the Oven-birds at hatching time by their large size, light colored down, and characteristic shape of the beak. Difference in size is more noticeable as they grow older. At hatching time the weight of the Oven-bird is 81 per cent of that of the Cowbird, but when they leave the nest it is only 53 per cent, the Cowbird averaging at that time 26.6 grams.

A difference in activity and instinctive behavior between the species is evident quite early. Cowbirds are able to peep as well when hatched as Oven-birds are at three days, and can call more loudly throughout the period in the nest. They also vibrate the head more while calling for food, which gives them some advantage. In other ways, however, the Cowbirds are slow or poorly adapted. They

continue to reach toward the top of the nest for food for two or three days after the Oven-birds are reaching toward the door, and they do not turn the rear toward the door in excreting, or rotate in the nest. They continue to sit firmly after the Oven-birds are able to stand up and move about, and remain in the nest about one day longer than the Oven-birds.

The foster parents, as far as they are able, give the Cowbirds as good care as they do their own young. In fact they seem to give them more attention about the time of leaving the nest, perhaps on account of their awkwardness and greater size. The inability of the Cowbirds to obey the alarm call of the parents may account for the fact that if predators begin taking young from the nest, the Cowbirds are among the first to go, however, size and position in the nest may be factors here also. After the young leave the nest, the Cowbirds are prone to fly up to a perch above the ground. This is quite disconcerting to the foster parents, which like to keep the young on the ground until they are able to care for themselves.

Injury to Host. The loss of Oven-bird's eggs and young, attributed to parasitism, was about 18 per cent of the entire number of eggs laid, but as some nests were deserted and later replaced, the loss was only about 13.5 per cent of perfect production. Since a loss of twenty-nine eggs and young was attributed to the Cowbird in cases followed through the season, and only ten Cowbirds were fledged, the loss was approximately three Oven-birds for each Cowbird fledged. The chief loss was in the removal of eggs from nests, and sometimes in prolonging the nesting period, thereby increasing the danger from other sources.

There were five cases of nest desertion by the Oven-bird directly traceable to the Cowbird. Two of these apparently were due to broken egg contents, two to the Cowbird's laying first, and one to the excessive taking of eggs. Desertions under these conditions do not necessarily mean losses, for the females ordinarily build other nests and lay again.

Strangely enough, with only one exception, the growth of the Oven-birds in parasitized nests was approximately equal to that in normal nests, as shown in Figure 7. In the one exception a single Oven-bird in a nest with two Cowbirds appeared weak from the start, and when it was of the age that it should have left the nest, it was found on its back in front of the nest dead. It is possible that if a greater number of broods were weighed, a slight difference would appear, since the non-parasitized broods which were weighed did not

do especially well. With the Cowbirds consuming large amounts of food, it is obvious that the rate of feeding must be increased if the Oven-birds are to hold their own. The parents usually provide the necessary increase, and also distribute the food well, so that the Oven-birds suffer but little if any. Nests with two Cowbirds fared approximately as well as those with one, and one nest fledged two Cowbirds and four Oven-birds, in spite of the fact that it was badly infested with mites.

Reproduction and Survival of the Cowbird. The table below shows the seasonal time of laying for the Cowbird. The dates for 1935 and about one-third of those for 1934 are exact, and the remainder in nearly every case are within one or two days of the exact date. The laying in 1935 was later on account of the Oven-bird's season being delayed by weather conditions. The figures, especially those of 1935, show that at least three females were involved in the laying each season, since at different times three eggs were laid on the same day. It is quite possible that there were more than three, since eggs are known to have been laid in the nests of at least one other species, but the Oven-bird, nesting comparatively early, doubtless received most of the first eggs.

		1933	1934	1935			1933	1934	1935
May	20	---	2	---	June	14	---	---	---
	21	---	3	---		15	---	---	---
	22	---	1	---		16	---	---	---
	23	---	3	1		17	---	---	---
	24	---	3	2		18	---	---	1
	25	1	1	2		19	---	---	---
	26	---	1	---		20	---	---	---
	27	---	2	3		21	---	1	---
	28	---	1	3		22	---	---	---
	29	---	---	1		23	---	---	---
	30	---	---	1		24	---	---	---
	31	---	---	1		25	---	---	---
	June	1	---	---		1	26	---	---
2		---	---	1	27	---	---	---	
3		---	---	---	28	---	---	---	
4		1	---	---	29	---	---	---	
5		---	---	1	30	---	---	---	
6		---	---	---	July	1	---	---	---
7		---	---	---		2	---	---	---
8		---	---	---		3	---	---	---
9		---	---	---		4	---	---	1
10		---	---	---		5	---	---	---
11		---	---	---		6	---	---	1
12		---	---	---		---	---	---	---
13		---	---	---	Total	2	18	20	

From the forty eggs laid, twenty-two young were hatched, ten left the nest, and at a liberal estimate not more than five left the woods.

This leaves a survival of only 12.5 per cent of the number of eggs laid, compared with the 24.2 per cent of the Oven-bird. If each female laid eight eggs, which is about the highest number one could allow according to the table, the production at the same rate would still be only one young bird per female, compared with the Oven-bird's 1.6. One must conclude from the data that the survival rate of the Cowbird in Oven-bird's nests, either for the number of eggs or the number of parents involved, is rather low.

It probably is significant that in each of the two cases where a female Cowbird was seen watching an Oven-bird building a nest (p. 201), a Cowbird's egg was laid just five days later. These eggs might well have been laid sooner, as far as nest conditions were concerned, for in each case the egg was laid on the same morning as the third Oven-bird's egg. At another time two females were seen near a nest where a female Oven-bird was building, and a Cowbird's egg was laid four days later in the empty nest. At a fourth nest a Cowbird, whose sex was not ascertained, was flushed from a bush near where a female was building, and four days later an egg was found in the hole from which the nest had been torn. There is a possibility that this egg might have been laid on the previous day but probably not. This data showing the relation between the watching of the nest building and the laying of eggs, lends support to the view that the development of eggs in the ovary of the Cowbird is stimulated by the sight of nest building, and indicates that the first eggs are laid four or five days later. In fact I can see no other way to explain the delicate timing between the parasite and host, for the maturing of the eggs of the two species at the same time from May 23 to July 6 by mere chance is incredible. Moreover, the nest parasitized in July was bounded on three sides by nests parasitized in May, and probably one of the same females did the laying. A more plausible explanation seems to be that just as the Oven-bird, when the occasion demands, can produce additional eggs in five days, so can the female Cowbird, upon seeing a nest under construction, produce eggs to lay in that nest, and perchance other nests that may be in the right stage. For the cause of egg production in either case, we must look to the endocrine glands, which appear to be stimulated first by the mental condition of the bird, and later, no doubt, by copulation.

Literature. The heavy parasitism of the Oven-bird by the Cowbird was noted by Wilson (1831), and has been mentioned by many observers since. Jones ('88), Norris ('92), Hess ('10), Hicks ('34), and others have given data showing the extent of the parasitism, which

ranged from 20 per cent to 100 per cent of the nests observed. Hess found a female Oven-bird incubating seven Cowbird's eggs only. He states also that he repeatedly found as many eggs of the rightful owner lying on the ground under the nest, as he found Cowbird's eggs in the nest, referring here to nests of species in general.

Friedmann ('29) noted that Cowbirds remained in their territory more closely after the first of May, when other birds began to nest. He observed them watching nest building, and saw one lay an egg, but doubted whether they took eggs regularly from nests. He thought that each female laid four or five eggs on successive days. He gave the incubation period as ten days, the time in the nest as nine and one half days, and the average weight at leaving as thirty-three grams. He described the young and their inability to obey the danger calls of the foster parents, and found the presence of young Cowbirds in nests usually fatal to the young of the hosts.

Mrs. Nice ('33-'34) found that when Cowbirds came near a Song Sparrow's nest, the sparrows became alarmed, so that if there was any watching of nest building it was necessarily done from a distance. She concluded from the egg types that each female Cowbird laid three series of eggs, with from six to twelve day intervals between. The first series contained five or six eggs, and later ones perhaps less. In about one-fifth or one-fourth of the nests where Cowbird's eggs were laid, an egg of the host was removed, and twice she saw a female Cowbird take an egg and eat it. The incubation period of Cowbird's eggs in Song Sparrow's nests is eleven or twelve days. One Cowbird can be raised with little effect on the Song Sparrow's brood, but two Cowbirds greatly reduce it. Each Cowbird was raised at the expense of about one Song Sparrow. The number of young Cowbirds fledged was 36.8 per cent of the total number of eggs laid, as compared with the 25 per cent in the Oven-bird's nests.

Hicks (Mss) thinks that the female Cowbird lays as many as sixteen eggs in a season, that the number of young per pair is much greater than I have figured, and that the Oven-bird accordingly is a favorable host.

Craig ('13) found that ovulation could be induced in doves and pigeons by various means. Chance ('21, '22) believed that it was induced in the European Cuckoo by the sight of nest building, and that an egg matured five or six days later. Friedmann states that ovulation is induced in "some of the Cowbirds" in the same manner. It seems quite likely that the Cowbird has regular cycles of laying that

it goes through where nests are numerous, and this condition may be modified where the number of nests is limited. Probably in either case ovulation may be stimulated by the sight of nest building.

SUMMARY AND CONCLUSIONS

The male Oven-birds which breed locally are among the first to arrive in the spring, and practically all of the males of the vicinity arrive within a few days unless delayed by weather conditions. Old residents ordinarily go to their former territory, and the new ones occupy the remaining space. The first females noted in the study arrived from nine to fourteen days after the first males, but their arrival was spread over a shorter period, and the average time between the arrival of all males and females was about seven days. Females go to their old territory if possible, and the choice of mates appears to be only a matter of chance. The number of breeding birds returning in the following year was twenty-four out of forty-four banded (54.5 per cent), and the number returning the second year was seven out of twenty-two (31.8 per cent). Only one young bird out of sixty-eight which left the nest returned to breed in the area.

Territories varied in size from 0.2 to 1.8 hectares (0.5 to 4.5 acres), and the average population in the area studied was about one pair to each 1.2 hectares (three acres). There is some contention and fighting between males, but no injury was ever noted as a result. Copulation between non-mated birds is common, and in two cases observed males had two mates each.

"Teacher" songs usually have from seven to ten double notes each, but in exceptional cases run higher. The first note ends with an upward inflection, and the second with an accented, downward inflection. The song ends with the accented syllable unless it is fragmentary. The song does not grow gradually louder to the end, but reaches its full volume on about the sixth double note, in an eight or ten note song. No variation in time or pitch could be noted as the song progressed. Singing continued with little change until the males began to leave the woods, which was as early as July 5. Males that remained continued to sing until about July 20, but after that were seldom heard. Only two songs were heard in August.

The season for the "flight" song was practically the same as that for the "teacher" song, or from the time of arrival until July 20. There was an increase, however, about July 1, continuing until July 20. Flight songs were heard occasionally throughout the day, but by far the greater part came in the evening, with a strong concentration

about sunset. Both flight and "teacher" songs stopped sharply ten or fifteen minutes after sunset, and the Crested Flycatcher, Wood Pewee, Wood Thrush, and Cardinal were heard regularly after the Oven-bird had quit for the day. Males were seen only a few times while giving the flight song, and in most of these cases they were pursuing other males. The majority of these songs seemed to come from single places well up in the trees. The "spiral" or "soaring" flight was not seen, though a continuous watch for it was maintained throughout the study.

Nearly all nests were located in or near old roads or other open spaces, and 58 per cent of them were in the open, away from any tree, shrub or bush. There was no correlation between the facing of nests and the points of the compass, over-head lighting, or roads, but there was a tendency for nests to face down slope where the ground was not level.

The female builds the nest, working chiefly in the forenoon, and completes it in four or five days. Nesting material is secured at distances ranging from a few centimeters up to forty meters, and nearly all of the building is done from the inside. Subsequent nests were located from eighteen to sixty-six meters from previous nests, and were built a little more quickly than the first. Several females built four nests in a season, and two probably built at least five.

All eggs were laid in the morning, usually before 7:00 o'clock, and sometimes before 6:00. The number of eggs in a clutch was commonly five for the first, and from three to five for subsequent ones. Females laid as many as ten eggs in a season, but only one laid as many as three clutches. Subsequent nests regularly received the first egg five days after the desertion of the previous nest.

Incubation began on the day before the last egg was laid, and was done entirely by the female. The females were quite regular in their incubating habits, as shown by the itograph records, though different individuals showed considerable variation. The average incubation period was twelve days, 5.6 hours, and differed but 0.6 of an hour in 1934 and 1935. All of the eggs of a clutch had about the same incubation period, and any variation of more than a few hours usually concerned all. No difference in incubation time was noted in cool and warm weather, or in nests containing Cowbird's eggs.

Eggs were pipped from fifteen to twenty hours before hatching, and the crack extended about one-fourth of the way around before

the shell broke open. The female ate the shells, but left the eggs which failed to hatch, in the nest.

Young Oven-birds are more precocial than most passerine birds, leaving the nest regularly at eight days. They learn to reach toward the opening of the nest for food, and turn the rear toward the opening in voiding excrement, at the age of two days. At four days they begin creeping toward the back of the nest after voiding excrement, causing a slow rotation in the nest. Weight increases from 2.1 grams at hatching time to 14.1 at eight days, which is about 73 per cent of the adult weight. Temperature control is developed enough at three days to maintain a constant temperature in the absence of brooding, under usual conditions.

During the first few days after hatching, the female broods with much the same rhythm that she incubated, the brooding instinct reaching the maximum when the young are about one day old. The male comes to the nest after hatching to aid in the feeding, and one male was known to visit the nest four mornings in succession just before hatching. The male is very shy when coming to the nest at first, but the shyness wears off in a few days.

Parents walk from five to eight meters in approaching and leaving the nest at first, but the distance grows less as time passes. They have routes which they prefer, but the one used in leaving is not necessarily the same as the one used in approach. They generally avoid open spaces, keeping under the cover of vegetation.

Food for the newly hatched young consists of geometrid larvae and small earthworms, but later adult insects are added. There was a rather constant rate of feeding throughout the day, but the records showed a marked increase early in the morning, and a slight drop during the afternoon. The increased demand for food as the young birds grow is met by an increase in the size of the feedings, and a gradual increase in the number of feedings.

The relative amount of feeding by each parent varies considerably with different pairs. The male usually feeds more at first while the female is brooding, but later they feed about the same. As a rule each parent delivers its food to the young, but sometimes the female takes food from the male and aids in the feeding.

Parents continue to swallow the fecal sacs to some extent as long as the young are in the nest, but after the second day, they carry some of them away to a distance.

About four or five days after hatching, there is a marked change in the behavior of the parents. In the place of brooding, quietness and tolerance, there are increased watching, chirping and defiance. As the young grow more active, the anxiety of the parents increases, reaching a climax when the young leave the nest.

Young birds normally leave the nest at eight days, on an average. When the first young bird leaves, one of the parents leads it away and cares for it, leaving the remainder of the brood largely or entirely to the care of the mate. Young birds leaving subsequently may be cared for by either parent. When the parents have divided the brood, their family relations are ended, and each goes its own way. The male remains in the home territory, unless it is late in the season, and the female goes into neighboring territory. Young birds may leave the nest on account of fright as early as six and one-half days.

From the time the young emerge from the nest until they are ready to leave the woods, they pass through four rather distinct stages, which are as follows:

I. The Hopping Stage, 8-11 days. Young birds hop at first, but gradually learn to flutter and run. They are kept separate during this stage and the following one, and, if undisturbed, may remain in approximately the same place for several days.

II. The Early Flying Stage, 11-20 days. The young can fly for short distances, up to thirty meters, and if followed will finally make a circuit, returning to the approximate place where they started.

III. The Semi-dependent Stage, 20-30 days. They now begin to pick up food for themselves, but the parent continues to feed them. Young birds may be kept together if the parent is caring for more than one. The post juvenal molt begins early in this period.

IV. The Independent Stage, 30-40 days. The young are left to shift for themselves at this time. They may remain alone, or two or three together, or may follow another parent with dependent young. The stage ends when the young have attained their first year plumage and are ready to migrate.

Adult birds usually left the woods as soon as the young were able to take care of themselves, which was as early as July 5. The last adults to leave the woods were a male seen last on August 26, 1934, and a female seen last on August 15, 1935. Some of the young birds left the woods as soon as they were able, which was as early as July 15, but others remained for some time. The last of the two sea-

sons, 1934 and 1935, were seen on September 3, and October 2, respectively.

Of the total number of eggs laid, 63.4 per cent hatched, and 43.5 per cent produced young which left the nest. The greatest loss was due to predators, and the next greatest to Cowbirds. The number of young leaving the woods was estimated to be 24.2 per cent of the number of eggs laid, or 32.5 per cent of perfect production (five young per pair).

About 52 per cent of the Oven-bird's nests which received eggs were parasitized by the Cowbird, and from one to four eggs were laid in a nest. Female Cowbirds discover the Oven-bird's nests by seeing the females building. Furthermore, it is probable that the development of eggs in the ovary of the female Cowbird is stimulated by the female watching the building of nests, and that the first eggs mature in four or five days. The Cowbirds lay early in the morning before the Oven-birds lay, and on two occasions they were observed from a blind, as they entered and deposited their eggs. They remained in the nests about forty and sixty seconds respectively, and one frightened off the Oven-bird which had entered just ahead of her. Oven-birds do not recognize the Cowbirds as enemies, unless they are very close to the nest.

The female Cowbird usually visits the parasitized nest on the day before, or soon after the laying of an egg, and removes an egg of the host. As nearly as could be determined in known cases, ten eggs were taken before the Cowbird's egg was laid, ten on the same day, and three on the following day. On two different occasions the Cowbirds were seen taking these eggs. The number of Oven-birds eggs removed in this manner was 75 per cent of the number of Cowbird's eggs laid, and in addition four Cowbird's eggs were taken, making the total number removed 85 per cent of the number laid. In all cases where an accurate check was made, eggs were taken in the forenoon. From nests not parasitized, only a single egg was known to disappear during the laying period.

The incubation period of the Cowbird's eggs averaged 11.6 days, which is 0.6 of a day less than the period for the Oven-bird's eggs. When a Cowbird's egg hatches, a half shell sometimes slips over the end of an Oven-bird's egg and remains there, but does no harm.

The loss of eggs and young of the Oven-bird due to parasitism by the Cowbird was estimated at 18 per cent of the total number of eggs

laid, or 13.5 per cent of perfect production. Young Oven-birds in parasitized nests grew approximately as well as in non-parasitized nests, due to their activity and early development, and to the favorable distribution of food by the parents. The chief loss to the Oven-bird was in the removal of eggs by the Cowbird, and sometimes in prolonging the nesting period, thus increasing the danger from other sources.

Young Cowbirds remained in the nest about one day longer than the Oven-birds, making the total time in the nest about nine and one-half days, which is the average in the nests of other species. Although the Cowbirds grew relatively faster than the Oven-birds, their weight when they left the nest was about 20 per cent below the average in the nests of other species. The survival rate was low, also, since out of forty Cowbird's eggs, only twenty-two hatched, ten birds left the nest, and probably not more than five birds left the woods. In this light the Oven-bird can not be considered a very favorable host.

TABLE 1.

The number of flight songs heard, and the ten minute intervals in which they were given, during 1934 and 1935. Each dash represents a song.

A. M.				
E. S. T.	4:20 -	12:40		
	4:30 -	12:50		
	4:40	1:00		
	4:50	1:10		
	5:00	1:20		
	5:10	1:30		
	5:20	1:40		
	5:30	1:50		
	5:40	2:00		
	5:50	2:10		
	6:00	2:20 -		
	6:10	2:30		
	6:20	2:40		
	6:30 -	2:50		
	6:40	3:00		
	6:50	3:10		
	7:00 -	3:20		
	7:10	3:30 -		
	7:20 -	3:40		
	7:30 -	3:50 -		
	7:40	4:00		
	7:50 -	4:10		
	8:00 - - -	4:20		
	8:10 -	4:30		
	8:20 - - - -	4:40		
	8:30 - - - - -	4:50 -		
	8:40 -	5:00		
	8:50 - -	5:10 -		
	9:00 -	5:20 - -		
	9:10 - -	5:30		
	9:20 -	5:40		
	9:30 -	5:50		
	9:40	6:00 -		
	9:50 -	6:10		
	10:00	6:20 -		
	10:10	6:30 - -		
	10:20 -	6:40 -		
	10:30	6:50 - - - -		
	10:40	7:00 - - - - -		
	10:50	7:10 - - - - -		
	11:00	7:20 - - - - -		
	11:10	7:30 - - - -		
	11:20	7:40 - - - - -		
	11:30 -	7:50 - - - - -		
	11:40	8:00 - - - - -		
	11:50 -	8:10 - - - - -		
	12:00	8:20 - - - - -		
P. M.	12:10	8:30		
	12:20			
	12:30			

Number of songs heard each month during 1934 and 1935:

April	1
May	43
June	41
July	104
Total	189

Total 189 | 10 | 20 | 30 | 40

TABLE 3.

The total number of minutes which three females spent off of the nest each hour of the day, during the periods recorded by the itograph. The females and hours are the same as in Table 2.

Hour of day.....	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	
No. 9♀ (3 days).....	0	49	0	27	15	45	24	5	49	32	26	49	0	22	50	37	0	
No. 6♀ (5 days).....	38	44	80	67	20	97	78	83	148	22	120	51	103	94	46	69	58	
No. 15♀, 1935 (8 days).....	15	125	26	88	16	107	33	116	66	56	74	59	60	85	64	106	61	
No. 15♀, 1936 (10 days).....	0	179	0	64	146	26	80	107	104	40	77	87	54	80	57	107	60	
Total minutes per hour.....	53	397	106	246	197	275	215	311	367	150	297	246	217	281	217	319	179	
Total minutes in 3 hour periods.....	450			549			801			814			744			715		

TABLE 4.

A summary of the number of feedings, as recorded by the itograph, at nest No. 9, which contained four Oven-birds and two Cowbirds.

Hour of day.....	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	Total feedings
June 3*.....	0	4	1	3	0	2	2	0	1	3	2	2	0	1	2	3	2	28
4**.....	0	3	3	1	1	2	2	3	2	2	1	2	2	2	3	3	2	33
5.....	1	5	4	4	2	3	3	4	2	1	2	4	1	2	2	3	2	45
6.....	1	3	3	4	2	3	3	3	3	4	3	4	3	6	6	5	1	57
7.....	3	9	5	7	5	6	5	6	5	6	7	9	5	7	6	5	2	98
8.....	4	9	9	7	5	8	11	7	10	6	6	6	8	5	7	6	2	116
9.....	2	10	7	9	12	7	6	8	12	11	10	8	4	6	9	7	1	129
10.....	1	12	9	6	20	13	12	10	11	13	8	7	9	6	8	11	4	160
11.....	Oven-birds left nest.																	
Total feedings.....	12	55	41	41	47	44	44	41	46	45	40	39	34	37	44	41	15	666

*All hatched except one Oven-bird.
 **Last Oven-bird hatched.

12:10
 Middle of feeding day.

TABLE 5.

A summary of the approximate number of feedings at four different nests, as indicated by the itograph. The average number of feedings per bird was obtained by dividing the total number of feedings by half the number of birds, assuming that two birds was the average number fed at each trip. In nest No. 9, each Cowbird was counted as two Oven-birds, but this was only an estimate.

Day in nest.....	1	2	3	4	5	6	7	8	Total feedings
No. 9 nest	28	33	45	57	98	116	129	160	666
4 Oven-birds	7.0	8.2	11.2	14.2	24.5	29.0	32.2	40.0	166
2 Cowbirds	14.0	16.5	22.5	28.5	49.0	58.0	64.5	80.0	333
No. 6 nest	16	17	30	34	43	46	51	67	304
2 Oven-birds	16	17	30	34	43	46	51	67	304
No. 15 nest 1935	27	32	40	44	65	103	123	114*	548
5 Oven-birds	10.8	12.8	16.0	17.6	26.0	41.2	49.2	45.6	219
No. 15 nest 1936	20	32	32	30	30	40	44	61	289
3 Oven-birds	13.3	21.3	21.3	20.0	20.0	26.7	29.3	40.7	192

*One young bird was out of the nest in the evening, and probably one parent was doing most of the feeding at this time.

EXPLANATION OF FIGURES

The males found early in the season of 1934 were numbered in accordance with their location, but those discovered later made the numbering somewhat irregular. Females and nests were given the same number as the males. For the birds returning in 1935, the original numbers were retained, and for new males, 20 was added to the number of the male in the territory during the previous year. Where returning males had new females for mates, the females were distinguished by the number of the year. The system of numbers used in the figures is modified somewhat from the original to make it more consistent.

FIGURE 1. Map of the area studied in 1934. The irregular lines not otherwise marked represent old roads through the forest. The dark circles represent nests which produced young Oven-birds, and the open circles, unsuccessful nests. Those connected by lines were built by a single female, in the order indicated by the arrows. The dotted lines show in general the extent of each territory, but they do not necessarily indicate the shape of the territory. One bird, male No. 10, was banded in the previous year near the site of nest No. 13.

The success or fate of each nest was as follows:

No. 2. Six eggs were laid, and all hatched, but only five young left the nest.

No. 2A. The first nest was robbed of first egg, causing desertion. The second nest produced three young.

No. 3. The nest produced three Oven-birds and one Cowbird.

No. 4. The first nest was torn out before it was finished, and the second produced three young.

No. 5. The first nest was found after desertion, and the second produced one Oven-bird and one Cowbird. This Cowbird, according to a later report from the Biological Survey, was killed by a boy with a "nigger shooter" (sling shot) at Crowley, Louisiana, on or about February 24, 1936.

The nests marked X were built by a different female, and it is believed that the male had two mates at the same time. In the first nest the female hatched one Oven-bird, but deserted it when a trap was placed over the nest. The second nest had been deserted when found, and contained a Cowbird's egg. In the third nest, four Oven-birds were hatched, and male No. 5 aided with the feeding, but none of the young lived to leave the nest.

No. 6. The female deserted the first nest after incubating nineteen days, and ending up with a stale Cowbird's egg. The second nest produced two young.

No. 8. The nest was deserted after incubation began, probably on account of a Cowbird's egg, or my presence at the nest while taking pictures. The later history of the pair is not known.

No. 9. The nest produced four Oven-birds and two Cowbirds, the largest brood found during the study.

No. 10. The first nest was deserted on account of broken egg contents left by a Cowbird, and the second nest produced five young.

No. 10A. The nest was torn apart by a predator when the five young were about ready to leave, but at least one young bird escaped.

No. 11. The nest produced five young.

No. 12. The nest produced five young.

No. 13. The nest was deserted on account of the early laying of a Cowbird's egg. The parents apparently left the territory on account of its small size, and their inability to obtain more room.

No. 15. The first brood was taken by a predator, and the second nest produced four young.

No. 17. The nest was found after the brood left.

No. 18. The nest was disarranged and deserted before it was completed. The later history of the pair is not known.

FIGURE 2. Map of the area studied in 1935. About the same number of pairs was studied as in 1934, but the area was extended a little farther into the forest.

Three adult males, Nos. 5, 9, and 10A of the previous year returned and occupied their old territory. Females 5 and 10A returned and mated with neighboring males, though their old mates were present. Females 2 and 10 also moved to other territory, but Nos. 6, 12, and 15 occupied their old territory and mated with new males.

The success or fate of each nest was as follows:

No. 5. The nest produced two Oven-birds and two Cowbirds.

The X nests were built by female No. 10, which mated with male No. 5 after both had lost their young. The first nest was deserted, but the last produced five young. The last nest was but 2.8 meters from the second nest of female No. 10 in the previous year.

No. 9 (No. 2♀). The first nest was crushed by some animal or person, and the second was deserted for a reason which was not obvious. The third was raided by a predator, and one young Oven-bird escaped, but later disappeared. The female then mated with male No. 23 while his mate was incubating on her last nest, but the eggs of the nest (23X) were taken by a red squirrel. The XX nest, found several days later back in No. 9 territory, perhaps was built by this female, but it produced no young.

No. 37. The eggs were taken from the first nest by a predator just before hatching time, and the young were taken from the second nest just before time for them to leave, on July 9. No more nests were found.

The X nest was built by another female while No. 2 was incubating on her third nest, and produced three young. The male was not seen feeding the young of this brood during the first five days, but he doubtless was interested in them, and it was during this period that female No. 2 mated with male No. 23.

No. 10A. The nest produced three young. The X nest was found late, and its history is uncertain.

No. 21. The first nest was disarranged before it was completed, and the second had been deserted when found. The third was abandoned on account of broken egg contents left by a Cowbird, and the fourth was deserted before it was used. The later history of this pair was not followed.

No. 23. The first nest was deserted on account of excessive laying and taking of eggs by the Cowbird (Fig. 18), and the second nest was robbed of its young by a predator. The third was found after it had been deserted, and the fourth was crushed by a truck after some of the eggs had hatched. There probably were no more attempts at nesting, as the fourth nest was destroyed on July 17. For the 23X nest, see No. 9 above.

No. 26. The nest produced two Cowbirds.

No. 31. The first nest was disarranged before completion, and the second produced three Oven-birds and two Cowbirds. The female lost her share of the brood, and mated later with male No. 5.

No. 32. The young of the first nest were taken by a predator, and the second nest was torn out before completion. The third had been deserted when found, and its history is uncertain. Evidently a brood was finally reared, for the male was seen caring for a young bird late in the season.

No. 35. The nest produced five young birds.

No. 36. The first nest was torn out about the time it was completed, and the second was robbed of its young by a predator. The third nest produced four young.

In 1936, seven of the nine banded males returned and occupied their old territories. Six of the eleven banded females returned, and the manner of mating, is shown in the table below. Those *italicized* returned for the third season after being banded.

	Males	Females	
	No. 5	—New	
	No. 9	—No. 6	Adjacent territory for female
	No. 10A	—New	
	No. 32	—No. 12	Same mates as in 1935
	No. 35	—No. 15	Same mates as in 1935
	No. 36	—No. 10A	Adjacent territory for female
	No. 37	—New	
Not banded in 1935	No. 23		Same territory for female. May have been the same male
New	No. 36		Adjacent territory for female

FIGURE 3. Map showing the nests built by the four females which were present during 1934, 1935, and 1936.

The No. 6 female nested two seasons in the same territory, and the third in a neighboring territory, having a different mate each season. The 1936 mate (No. 9 male) was present in his territory during 1934 and 1935. In 1934, the female deserted the first nest after incubating nineteen days and ending up with a stale Cowbird's egg. The second nest produced two young. The 1935 nest produced two Cowbirds only. In 1936, the first nest was torn out before it was completed; the second and third nests were robbed of their eggs; and the fourth torn out probably before it was completed. The later history was not followed.

Female No. 15 nested in the same territory during the three seasons, and had the same mate during the last two seasons. The first nest of 1934 was robbed of its young, and the second produced four young. In 1935 the pair raised five young, and in 1936, three. The itograph was used at the nests of 1935 and 1936.

The No. 10A female changed mates and territories each season, though in both 1935 and 1936 her old mates were present. Her mate of 1936 was present in his territory also in 1935. The nest of 1934 was torn apart by a predator when the five young were about ready to leave, but at least one young bird escaped. In 1935, the eggs were taken from the first nest by a predator just before hatching time, and the young were taken from the second nest just before time for them to leave. In 1936, the first nest was torn out during the incubation period, and at the second nest the female was killed by a predator during the incubation stage. This was the only adult bird killed during the study.

The No. 12 female nested in the same territory during the three seasons, and had the same mate during the last two seasons. The nest of 1934 produced five young. In 1935 the young of the first nest were taken by a predator, and the second nest was torn out before completion. The third was deserted when found, but a brood was finally reared, though the location of the nest was not known. In 1936 the first two nests were torn out about the time of completion, and the third was destroyed during the incubation period. A fourth was destroyed before completion, and the later history of the pair was not followed.

FIGURE 4. This chart shows, by means of graphs, the mean daily temperature during the time of arrival and early nesting of the Oven-birds, for the seasons of 1934, 1935, and 1936, as recorded at the University of Michigan Observatory. The usual signs for male and female show when the birds arrived, those in black (♂) indicating banded birds. The rectangles (□) indicate the beginning of first nests; the open ovals (○), first eggs in first nests; and the black ovals (●), first Cowbird's eggs in first nests.

The records for the arrival of the females and the beginning of nest building are incomplete, since not all cases were observed. Records for first eggs in first nests were diminished considerably in 1935 and 1936 by the destruction of first nests.

In 1934, nearly all of the males arrived during three successive days, in the midst of a warm spell. It was somewhat cooler when the females arrived, but they came close together in point of time, and began nesting in a few days. First eggs in first nests were laid on six successive days, and the time from the arrival of the first male to the laying of the first egg was seventeen days.

In 1935, three males arrived at the beginning of a cold, rainy spell, and no new arrivals were seen for nine days. When better weather finally came, the remaining males arrived, and soon were followed by the females. The weather remained cool, and to a considerable extent cloudy, however, and associated with this were slow nest building and laying. From the time of arrival of the first males to the laying of the first egg was twenty-six days.

In 1936, the arrival of the males was rather gradual, through more than a week of mediocre weather. The females came more at one time, as usual, during a warm spell, and began nesting almost immediately. The time from the arrival of the first males until the laying of the first egg was sixteen days.

FIGURE 5. Copies of the itograph record. The record of nest No. 6 is shown from the time the itograph was set up on June 25 to the evening of July 1. The first young bird hatched on June 30, and the second on July 1, there being only two in the brood. The male apparently did not come to the nest until July 3, on account of the wire netting (Pl. XI, E), but the young suffered no ill effects. The graphs here are shortened, the length of the original being 1.35 meters, or nearly two meters for twenty-four hours. The upper horizontal line shows the time the female was on the nest, and each dip indicates when she left and returned.

The record of nest No. 9 shows the visits of both parents to a nest containing four Oven-birds and two Cowbirds, the largest brood found during the study.

FIGURE 6. Chart showing the gain in weight of two Cowbirds and three Oven-birds in the same nest. The Oven-birds left the nest when eight days old, but were kept inside a netting another day for weighing. One Oven-bird was recaptured and weighed when ten days old, and another when fourteen. The Cowbirds hatched one day before the Oven-birds, and left the nest one day later.

FIGURE 7. Chart showing the average gain in weight of Cowbirds, Oven-birds parasitized by Cowbirds, and unparasitized Oven-birds. There were five Cowbirds in three different nests, distributed 2, 2, and 1, and eight parasitized Oven-birds were in the same nests with these Cowbirds, distributed respectively 3, 2, and 3. There were sixteen unparasitized Oven-birds in four nests, distributed 5, 4, 4, and 3.

FIGURE 8. Chart showing the development of temperature control in young Oven-birds. Temperatures were taken at five minute intervals (except one day) for thirty minutes, during seven successive days, beginning with hatching. During the first five days, readings followed twenty minute periods of brooding. Temperatures given are the averages for four young birds. The numbers following the dates, indicate outside temperatures in Fahrenheit.

FIGURE 9. Chart showing three series of temperature readings taken on July 14, when the young birds were five days old.

FIGURE 10. Chart showing the time of laying and disappearance of eggs from nest No. 5 in 1935. The open circles represent Oven-bird's eggs, and the black circles, Cowbird's eggs. The eggs were numbered as they were laid, and the order is indicated above.

Further explanation of the chart is as follows: On May 26, the first Oven-bird's egg was laid. On May 27, the second egg was laid, and later in the day No. 1 disappeared. On May 28, another Oven-bird's egg and a Cowbird's egg were laid, and later in the day No. 3 disappeared. On May 29, an Oven-bird's egg and a Cowbird's egg were laid, and on May 30, the last Oven-bird's egg appeared. This is a typical case where the eggs were taken on the day before the Cowbird's eggs were laid.

FIGURE 11. An egg disappeared from this nest during the morning of May 27, after the Cowbird's egg was laid, while the writer was away getting a blind to watch for its removal. Two Cowbird's eggs were laid in this nest, but only one egg of the host was taken.

FIGURE 12. Oven-bird's egg No. 1 was removed from this nest while the writer was away getting a blind to watch. Later in the day a Cowbird's egg was taken when no egg of the host was in the nest.

FIGURE 13. Two Oven-bird's eggs were removed from this nest, and only one Cowbird's egg laid. The asterisk (*) marks one of the eggs that the writer saw taken by a female Cowbird.

FIGURE 14. The writer was watching this nest from a blind, expecting the female Cowbird to take an egg, and she came, but was afraid to go to the nest. This was the only parasitized nest under observation which retained the full number of eggs of the host during incubation.

FIGURE 15. The Cowbird's egg marked here with an asterisk (*) was laid while the writer watched from a blind. Later in the day a Cowbird's egg was removed from the nest while an egg of the host was present, but after this the Oven-bird's egg disappeared also. The Oven-bird's egg marked with two asterisks (***) was not seen, but evidently was taken before the writer visited the nest at 8:16 A. M.

FIGURE 16. A small Cowbird's egg was laid in this nest before any eggs were laid by the host, causing the desertion of the nest, and later a normal Cowbird's egg was laid.

FIGURE 17. This nest was torn out by some animal, and two Cowbird's eggs were laid in the hole where the nest was.

FIGURE 18. This nest and the two following ones belonged to the same female. After three eggs of her own and two of the Cowbird were taken, she finally deserted the first nest, but the Cowbird returned and laid another egg.

FIGURE 19. Two Oven-birds and a Cowbird were hatched in this nest, but were taken by some animal, presumably a red squirrel.

FIGURE 20. After two Oven-birds and a Cowbird were hatched here, this nest was crushed by a truck.

This female built four nests, laid ten eggs, was host for seven Cowbird's eggs, was frightened off of the nest once by a Cowbird, shared her mate with another female, and ended the season with no offspring.

PLATE XI.

A. An Oven-bird's nest with four eggs. Early nests usually received five eggs, and late ones from three to five.

B. A female Oven-bird with her nest and young.

C. The habitat of the Oven-bird. The shallow creek bed is shown on the right, near which several nests were located.

D. The itograph. This instrument was built largely after the pattern of Kendeigh and Baldwin, but differed in two respects. First, there was a mechanism below, made from an alarm clock with the balance wheel removed, which kept a tension on the paper and wound it up. Secondly, needles placed in the spool which was attached to the minute hand of the clock perforated the paper once every fifteen minutes, and twice at the end of the hour. Magnets were taken from door-bells, and the triggers were patterned after those used by Bussmann with his terragraph. The instrument worked very well when the weather was dry, but poorly when it was wet.

E. The triggers of the itograph with their cover of netting at the nest, and the female Oven-bird leaving.

PLATE I

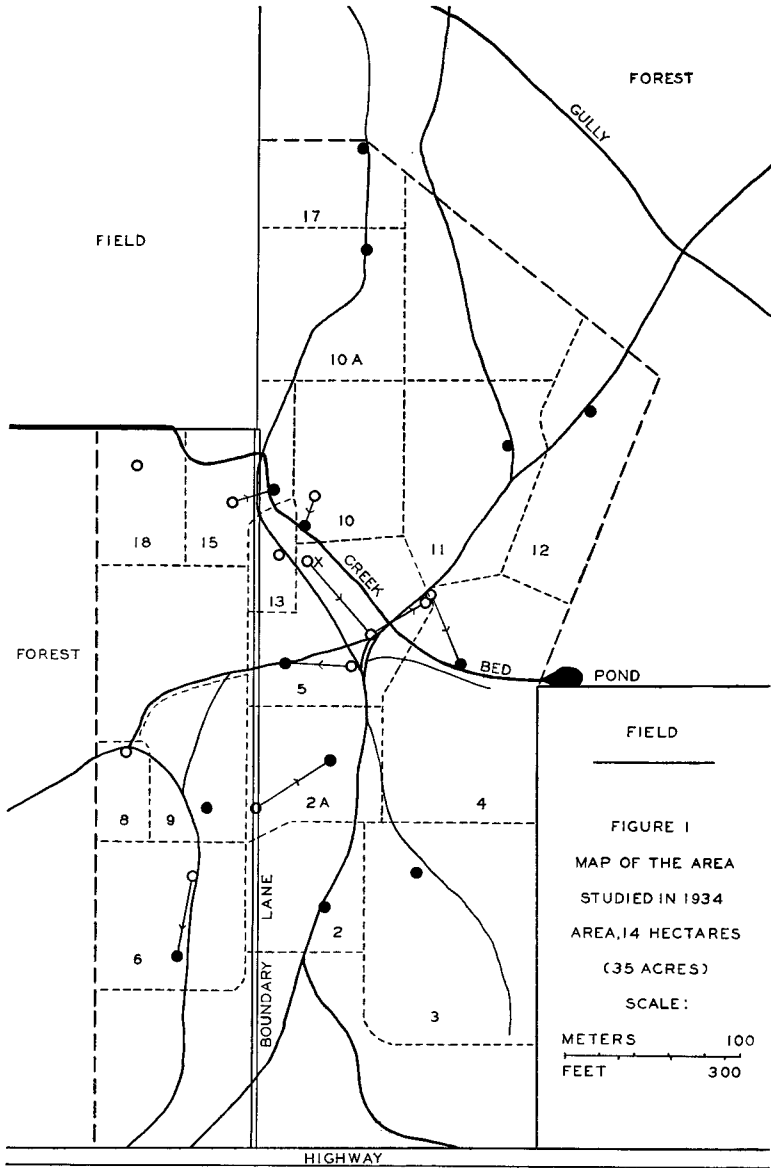


PLATE II

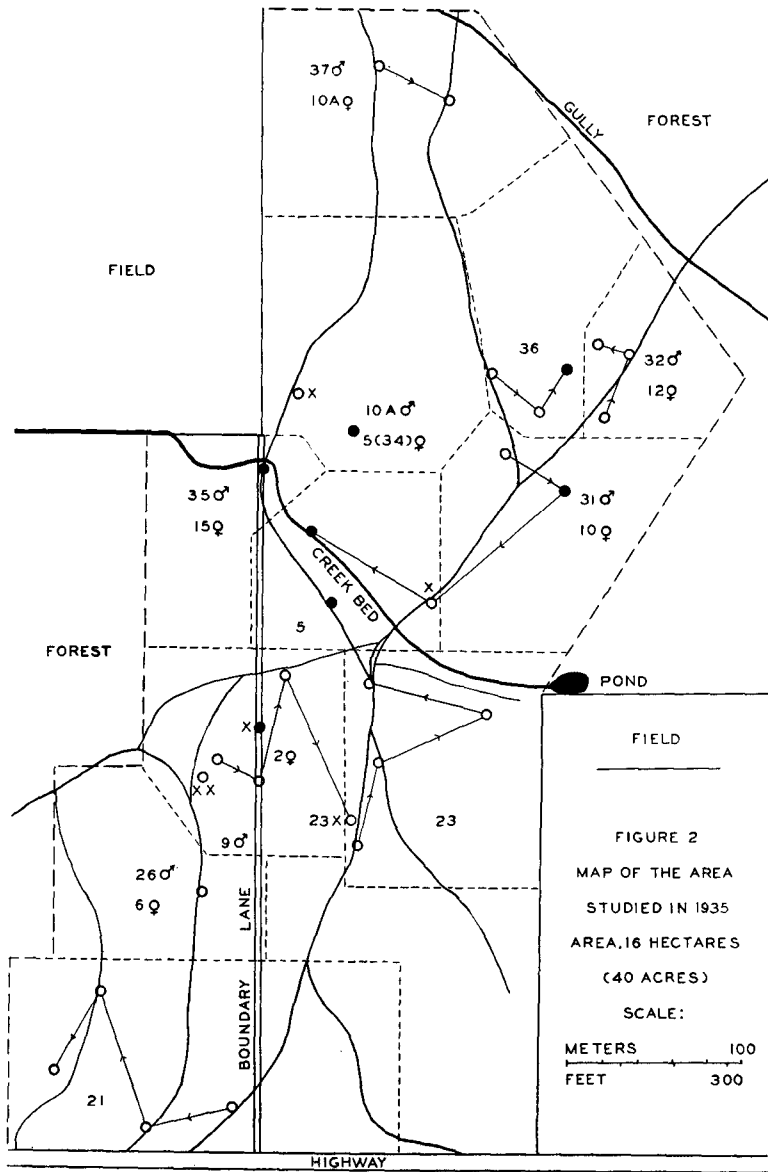


PLATE III

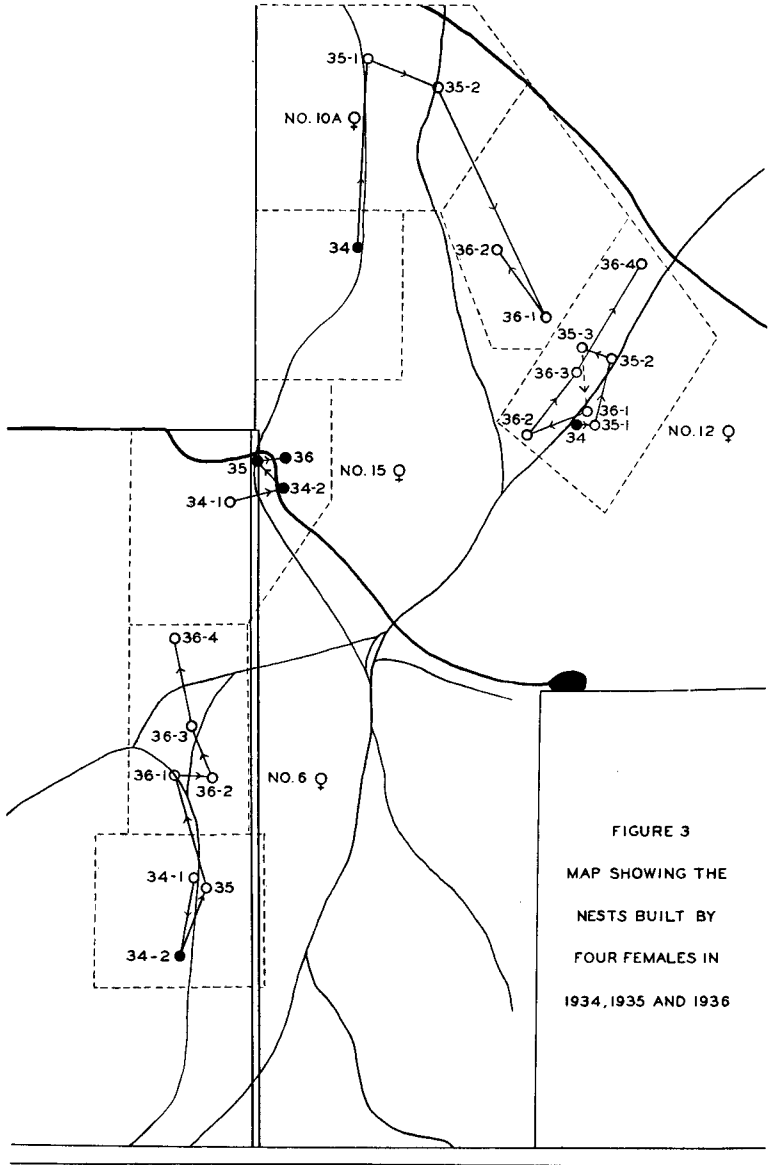


FIGURE 3
MAP SHOWING THE
NESTS BUILT BY
FOUR FEMALES IN
1934, 1935 AND 1936

PLATE IV

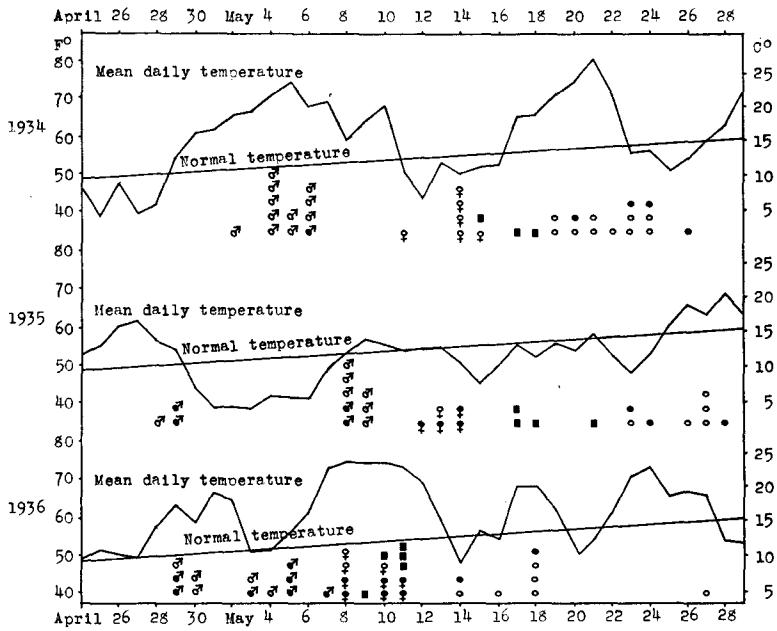
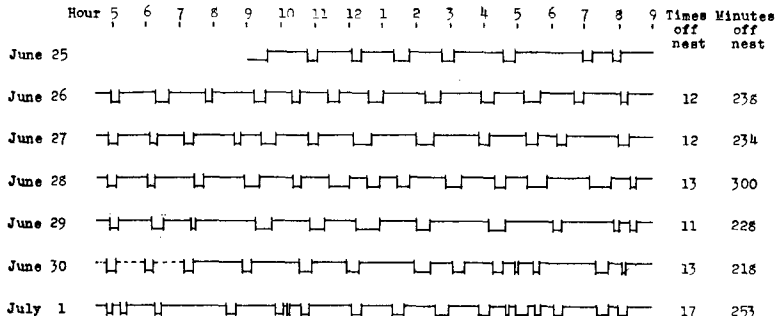
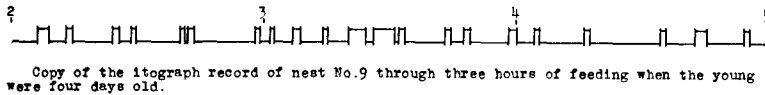


Figure 4



Condensed copy of the itograph record of nest No.6 through the second day of brooding.



Copy of the itograph record of nest No.9 through three hours of feeding when the young were four days old.

Figure 5

PLATE V

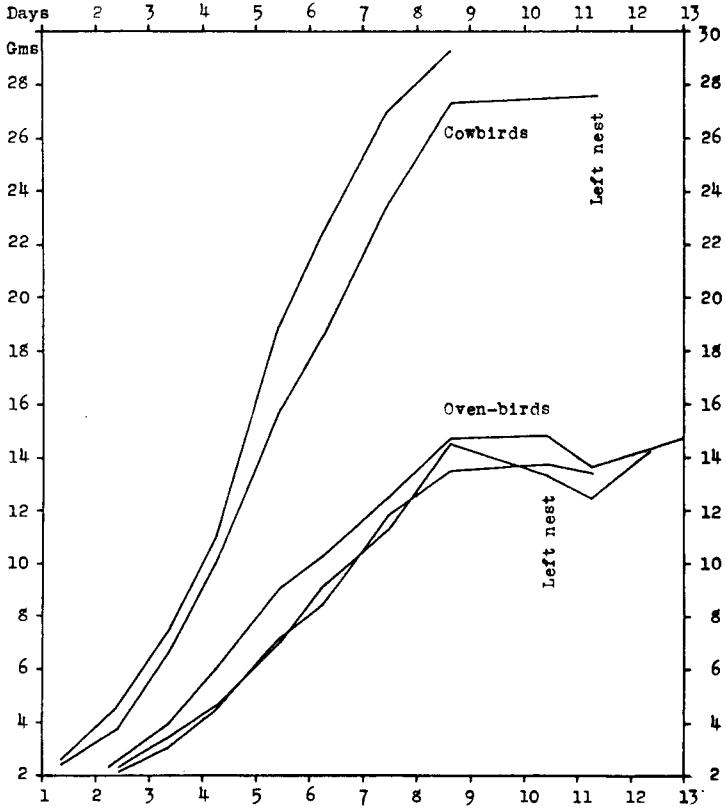


Figure 6

PLATE VI

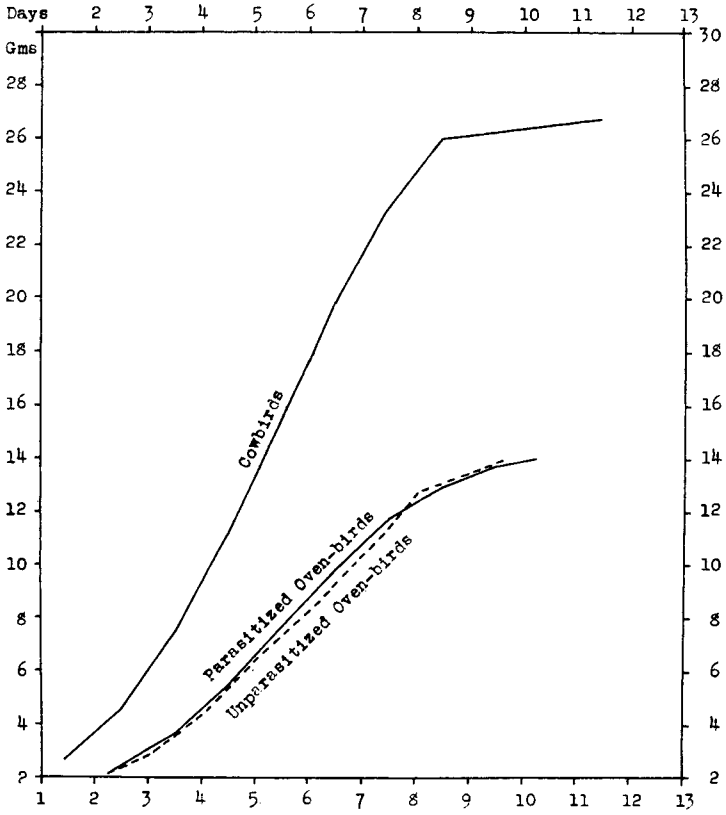


Figure 7

PLATE VII

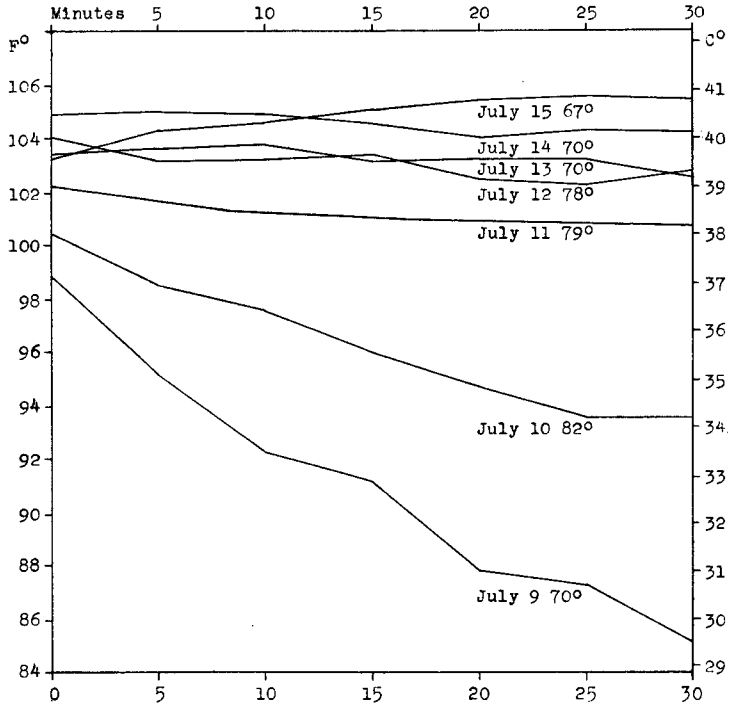


Figure 8

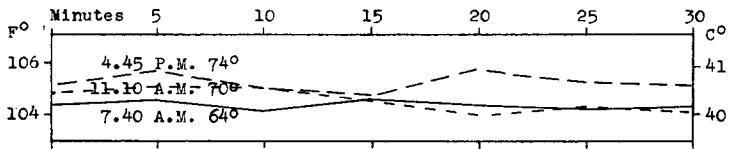


Figure 9

PLATE VIII

Nest #5	1	2	3	4	5	I	II	III
May 26	○							
May 27	<u>○</u>	○						
May 28	—	○	<u>○</u>			●		
May 29	—	○	—	○		●	●	
May 30	—	○	—	○	○	●	●	
			Figure 10					
Nest #31-2								
May 26	○							
May 27	○	<u>○</u>				●		
May 28	○	—	○			●	●	
May 29	○	—	○	○		●	●	
May 30	○	—	○	○	○	●	●	
			Figure 11					
Nest #36-3								
May 31						●		
June 1	<u>○</u>					●	●	
June 2	—	○				—	●	●
June 3	—	○	○			—	●	●
June 4	—	○	○	○		—	●	●
June 5	—	○	○	○	○	—	●	●
			Figure 12					
Nest #9-3								
May 26	○							
May 27	<u>○</u>	○				●		
May 28	—*	○	<u>○</u>			●		
May 29	—	○	—	○		●		
May 30	—	○	—	○	○	●		
			Figure 13					

PLATE IX

Nest #37-2	1	2	3	4	5	I	II	III
June 16	○							
June 17	○	○						
June 18	○	○	○			●		
	Cowbird came but was afraid							
June 19	○	○	○	○		●		
June 20	○	○	○	○	○	●		

Figure 14

Nest #26						I	II	III
May 23	<u>○</u>					●		
May 24	—	<u>○</u>				●	● *	
May 25	—	—	○			—	●	●
May 26	—	—	○	<u>○</u> **		—	●	●
May 27	—	—	○	—	○	—	●	●
May 29	—	—	—	—	○	—	●	●

Figure 15

Nest #13						I	II	III
May 23						●		
	Nest deserted							
May 25						●	●	

Figure 16

Nest 4-1						I	II	III
May 18								
	Nest torn out							
May 20						●		
	Egg in hole where nest was							
May 21						●	●	
	Second egg in hole							

Figure 17

PLATE X

Nest #23-1

	1	2	3	4	I	II	III	IV
May 24	Female sat on nest				●			
May 25	Female chased off by Cowbird				●	●		
May 26	Female sat on nest				●	—		
May 27	○				●	—		
May 28	—	○			●	—	●	
May 29	—	—	○		●	—	●	Incubation begun
								Deserted
May 30	—	—	—		●	—	—	●

Figure 18

Nest #23-2

June 3	○							
June 4	○	○						
June 5	—	○	○		●			
June 6	—	○	○	○	●			

Figure 19

Nest #23-4

July 2	○							
July 3	○	○						
July 4	○	—	○		●			
July 6	○	—	○		●	●		

Figure 20

PLATE XI



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