

GREEN-TAILED TOWHEE (*Oberholseria chlorura*). Noted abundantly at Bly on June 6, the summit of Fishhole Mountain on June 20, Dog Lake July 24, and Spring Creek on August 26. Found from June 28 to September 1 around timberline on Hager Mountain.

NEVADA SAVANNAH SPARROW (*Passerculus sandwichensis nevadensis*). Bly, June 30.

NORTHERN SAGE SPARROW (*Amphispiza belli nevadensis*). Common about Silver Lake from May 31 to September 2.

THURBER'S JUNCO (*Junco oreganus thurberi*). Found throughout the forest from May 31 at Cabin Springs to September 1 on Hager Mountain.

WESTERN CHIPPING SPARROW (*Spizella passerina arizonae*). Noted from June 6 at Bly to August 26 at Spring Creek.

BREWER'S SPARROW (*Spizella breweri breweri*). First noted at Bly on June 6 and then at Silver Lake. Last seen on June 16 on the east side of the Sycan Marsh, where a nest with four eggs was found in the sage.

OREGON WHITE-CROWNED SPARROW (*Zonotrichia leucophrys oriantha*). Seen at Finley Corrals from June 28 to July 1 and again on July 17. One immature bird at Spring Creek on August 21, and a number of adults and several immatures seen at Spring Creek on August 26.

WARNER MOUNTAINS FOX SPARROW (*Passerella iliaca fulva*). Found throughout the forest from June 6 at Teatable Mountain to August 30 on Coleman Point. Near Fishhole Mountain, a partially albinistic bird was seen on June 20.

LINCOLN'S SPARROW (*Melospiza lincolni lincolni*). Noted at Finley Corrals from June 28 to July 1, and again on July 29. One individual was seen at Spring Creek on August 26.

MODOC SONG SPARROW (*Melospiza melodia fisherella*). Noted along water-courses in willows and aspens throughout the area from May 31 at Silver Lake to September 2 at Silver Lake.

Portland
Oregon

A STUDY OF THE NESTING ACTIVITIES OF THE AMERICAN REDSTART¹

BY LOUIS STURM

INTRODUCTION

ALTHOUGH the Redstart (*Setophaga ruticilla*) is one of the common warblers with a wide range throughout the northeastern United States and Canada, its life history, like that of many common birds, has received relatively little attention from investigators. Since Chapman's (1917: 287-295) summary account, Hickey (1940: 254) has described the territorial behavior and display flight of the males, and Mousley (1924: 284-288) and Baker (1944: 83-90) have given short accounts of the nesting behavior. The following study was made on

¹ Contribution from Franz Theodore Stone Laboratory, Ohio State University, Put-in-Bay, Ohio.

South Bass Island in western Lake Erie where data were collected during the summers of 1940, 1941, and 1942. An attempt was made to secure as complete and accurate information as possible from a few nests, and special emphasis was placed on attentiveness and the rôle of the sexes during incubation and feeding of the young. Of a total of about 250 hours of observation, 213 were devoted to two nests.

Rates and percentages of various activities referred to in this paper are based on the time between the first and last occurrence of such activities, not on the total period of observation. The attentive periods referred to represent the actual time spent at the nest by the adults (Pitelka, 1941: 609). The equipment used included an eight-power binocular, notebook, watch, canvas blind, and a mirror mounted on a nine-foot bamboo pole.

NESTING AREA

The site of this nesting area is in the Peach Point region of South Bass Island. It is divided into two distinct sections, one east and the other west of an apple orchard, the borders of which were used by the Redstart.

The section east of the orchard consists of 1.4 acres of second-growth woodland. The dominant trees are sugar maple, basswood, hackberry, black cherry, and elm. The undergrowth consists of stag-horn sumac, hop tree (*Ptelea*), and saplings of maple, elm, and hackberry. In places the trees are matted together with wild grape, bittersweet, and woodbine. A few scattered red cedars, which are fast being crowded out, and the sumacs, most of which are dead except along the borders, doubtless represent the early invaders of a cleared field or pasture.

The second section is a small triangular area that includes the northwest corner of the orchard and a part of the eastern edge of another rather large wood. In the corner of the orchard are a few large trees; otherwise the vegetation is much the same as that of the first section. The orchard and the wood are separated by a footpath. It was along this path that the greater part of the study was made in 1942.

Other species of birds with which the area was shared were: the Red-eyed Vireo, Wood Pewee, Carolina Wren, Downy Woodpecker and Crested Flycatcher.

TERRITORIES

Although I had no opportunity to observe either the establishment of territories or courtship, the behavior of the birds during nest building

and later stages of the breeding cycle agrees with Type A (Nice, 1941: 457) except that territorial boundaries are seldom defended by the time the young are ready to leave the nest.

The territory-establishing behavior of the Redstart has been described by Hickey (1940: 255-256). A similar behavior during nest life was noted in this study.

During nest building and incubation, the male sang almost incessantly. Counts of the number of songs were made at intervals throughout the observation at the nest, both in the morning and in the afternoon, and the average number of songs per minute was 9.6 for short intervals of active singing. During the afternoon of June 29, the sixth day of incubation, the male sang 370 times in one hour; this was an average of 6.2 songs per minute. The morning of June 30 he sang 379 times per hour or 6.5 songs per minute, a rate which was equaled again on July 3.

The male continued to sing during the nestling period, and on 92 different occasions sang at the nest immediately after feeding the young. Mousley (1924: 267-268) observed a similar behavior in the Parula Warbler. He also noted that the male Parula sang with food in his mouth—an activity noted in the Redstart on the second and third day after the eggs had hatched, July 6 and 7.

The male was aggressive toward other male Redstarts. On four different dates he was observed to attack males, and on one of these occasions, during an hour devoted especially to watching this bird, he chased five intruders. To other species he was usually tolerant. Vireos fed almost every day in a near-by cherry tree and on only one occasion, July 6, was he observed to give chase. Carolina Wrens came to the blind, which was about five feet from the nest; Robins, Song Sparrows and a Junco hopped around under the nest tree at different times without being disturbed; but on the afternoon of June 24, when a female Yellow Warbler alighted on a limb near the blind, she was promptly attacked by the male bird, and on June 27 he assisted a male Indigo Bunting in routing a Cowbird. He was never observed to chase a female Redstart, but on July 2 he followed one out of the territory, after watching her feed in a near-by cherry tree.

The female also aided in protecting the territory. Twice on the morning of July 3 and once on the afternoon of July 8 she chased female Redstart intruders, and on June 29 and July 1 she attacked intruding males by flying at them and snapping her beak vigorously. She was always very alert when other species were near, but did not leave the nest to give chase.

The observed territories were smaller than those reported by Hickey

(1940: 256), which averaged one-half to one acre in extent, and were also smaller than those indicated for the species in any breeding-bird census (Hickey, 1941). In 1940, in the northwest corner of the orchard mentioned above, there were six nesting territories. Assuming a complete utilization of this area of 1.43 acres, each territory averaged 0.24 acre. In the eastern section, which contained 1.4 acres, on May 31 and June 1, 1941, nine nesting territories were found with the nests either complete or in the process of construction. These had an average area of 0.16 acre. In 1942, in the same section, there were six territories with an average of 0.23 acre. The boundaries of territory no. 7-42 were definitely known and measured and the territory was found to contain originally 0.14 acre, but after the first change of boundary it covered 0.19 acre. Although no comparable data are available for other areas on South Bass Island, it is my impression that this density is exceptionally high and that it would not be equalled in the larger and more mature forest areas. In the area under study the Redstart was by far the most numerous nesting bird. No other warblers nest in the area, excepting Yellow Warblers which are largely confined to the margins of the woodland and to the orchard.

Territorial boundaries, however, were not permanently established. Two instances of shifting were noted in connection with nest no. 7-42. The first change was during nest building, after the boundaries of two territories were seemingly well established. Female no. 7-42 began getting material from a deserted nest in an oak about twenty-five feet inside the adjoining territory, no. 6-42. On her first trip she was not challenged. On later trips she was chased frequently by female no. 6, and this eventually led to a general fight involving both males and both females—male against male and female against female. During the remainder of the afternoon, when female no. 7 went into territory no. 6, she gave two or three 'cheeps' before flying to the oak, and each time her mate came and followed her, flying in the same general direction and waiting until she returned. Late in the afternoon, the pair from territory no. 7 became involved with two males in a fight near the oak. This fight seemed to settle the question of boundary, for subsequently female no. 7 went back and forth more or less freely.

The second change of territorial boundaries was due to the introduction of a bird bath, fifteen feet from the base of the nest tree and about ten feet north of the southern boundary of the territory. It was promptly discovered and used by male and female no. 7-42 but there were no other observed visitors until July 1 when a strange female Redstart came unmolested. In the afternoon, the male bathed and his mate joined him. Later the same day female no. 7 and another

female Redstart bathed amicably together. Red-eyed Vireos, Carolina Wrens, Robins, Song Sparrows, Indigo Buntings, Juncos, and other Redstarts came to the bath unmolested. On July 3, there were four species at the bath at one time; a Song Sparrow, Carolina Wren, Vireo, and Redstart. Birds, including male and female Redstarts, could sit on the fence south of the bath without being disturbed but were promptly chased if they came a little beyond it.

The territorial boundaries were defended less frequently as the nestlings grew older. For example, on July 4, when a strange Redstart fledgling fluttered noisily to the fence near the nest tree and was followed by its parents, neither male nor female no. 7-42 gave the invaders any attention. The last observed instance of aggressive behavior was on July 8, the fourth day after hatching, when female no. 7-42 attacked an intruding female. On July 10, when a strange female came to a limb near the nest and fed, she was not attacked. Lack of territorial defense while adults were engaged in feeding young was also noted by Baker (1944: 84).

NEST BUILDING AND NEST SITES

In 1940, three nests in the process of construction were found on June 18. In view of the late date and the absence of fledged young, it seems probable that these represented re-nestings after unsuccessful earlier attempts. Most of the nests for this year were completed by June 23. The first nests of 1941 were found on May 21, and there were no data on the completion of the last nests. In 1942, one completed nest and one in the process of construction were observed on June 5 by Dr. Charles Walker. Most of the nests were completed by June 18 and the last nest for which we have records was completed June 22 or 23.

The nests, like those described by Sutton (1928: 223), were ordinarily built in small saplings or shrubs where there were upright forked branches, usually at least three in number. Of the twenty nests studied, nine were between ten and fifteen feet above ground; the lowest was three feet from the ground and the highest, twenty-five feet.

The construction or partial construction of three nests was observed. The building was done exclusively by the female. The male sometimes followed her as she gathered nest material but at no time did he assist with building as did the Black-throated Green Warbler watched by Pitelka (1940: 5) and the Prothonotary Warbler studied by Walkinshaw (1938: 38; 1941: 4).

Female no. 7-42 was observed to make 517 trips to the nest with

building material in twenty-seven hours, or an average of nineteen trips per hour. It took this bird between two and one-half and three days to construct the nest, and on the second day she made trips almost continuously for fourteen and one-half hours. Assuming that the bird began work on the morning of June 17, she worked about thirty-six hours and made between 650 and 700 trips in building the nest. The materials were collected from the ground in the territory and from a deserted nest in an oak about ninety feet away.

EGG LAYING

Nest no. 3-40 was completed on June 21 and the first egg was laid on June 22; the second, early in the morning of June 23 and the third and last on June 24.

Nest no. 7-42 was completed during the morning of June 19 and the first egg was found the morning of June 21 (the laying of the rest of the complement was observed from a blind). The second egg was laid on June 22 at 5:00 A. M.; the third, June 23 at 5:12 A. M.; the fourth and last, June 24 at 5:03 A. M. Apparently the Redstart, like most small passeriform birds, lays early in the morning on successive days.

Although Sutton (1928: 224) and Chapman (1917: 295) report occasional five-egg sets, none was observed during this study. In South Bass Island nests, the complement ranged from two to four; the average was 2.9.

ATTENTIVENESS OF THE FEMALE DURING INCUBATION

Incubation was performed exclusively by the female. Studies of the Black-throated Green Warbler by Pitelka (1940: 6), the Yellow-breasted Chat by Petrides (1938: 188), the Oven-bird by Hann (1937: 173), the Prothonotary Warbler by Walkinshaw (1938: 41), the Yellow Warbler by Schrantz (1943: 376), and the Redstart by Baker (1944: 86) all report a similar behavior.

According to the data obtained from two nests, there was but slight variation in the attentiveness of the female during the incubation period. Nest no. 3-40 was observed for a total of thirty-three hours during five days and nest no. 7-42 had a total observation time of sixty-three hours during a period of ten days. The data for the latter nest are much more complete and are cited more often.

On the second day after completion of the set, female no. 3-40 incubated 95 per cent of the time; this was the highest rate during her incubation period. The minimum for this bird was 84 per cent on the eleventh day, July 4.

Female no. 7-42 is known to have incubated during the laying

period. No records were made on June 21, the day the first egg was laid; however, on June 22, following the laying of the second egg, she incubated 39 per cent of the time during a five hour period. On the night of June 22, she stayed on the nest and continued to do so each night thereafter until the young were fledged. In studies of the Prothonotary Warbler (Walkinshaw, 1938: 41) and of the Oven-bird (Hann, 1937: 173) incubation began the day before the last egg was laid. It is not altogether clear, however, that these nests were watched closely earlier in the cycle, and there is a possibility that more detailed studies will reveal that this tendency of the Redstart to incubate earlier occurs also among other warblers. On June 23, the percentage of incubation time was 69.8 for five hours, with the attentive periods averaging 23 minutes. Following the laying of the fourth and last egg on June 24, the female incubated 93 per cent of the time during observations of six hours and twenty-five minutes, with attentive periods averaging 35 minutes. On the second day of incubation, June 25, she spent 90 per cent of her time on the nest as compared with 95 per cent for female no. 3-40 on the corresponding day. The Black-throated Green Warbler studied by Pitelka (1940: 6) incubated 81 per cent of the second day.

Incubation attentiveness shows no decisive trend during the cycle. To be sure, the peak of attentiveness as shown by both the daily percentage and average length of attentive periods was clearly reached early in the incubation cycle and if the data for July 2 are omitted there is a tendency for attentiveness to wane. The high values for July 2 were possibly caused by the relatively low temperature which prevailed. However, the fluctuation of attentiveness after the completion of the set until the day of hatching shows a fairly consistent relationship to temperature.

The attentiveness of the female ran in rhythmical periods during the time of incubation. The average for all of the morning periods was 25.5 minutes; for all afternoon periods, 23 minutes. The longest single period of attentiveness was 66 minutes during the morning of June 24, the day the last egg was laid, and the shortest was a three-minute period on the afternoon of the tenth day, July 3.

The average for all inattentive periods for the morning was 3.4 minutes; for all afternoon periods, 3.2 minutes. The longest periods of inattentiveness were 11-minute periods on the afternoon of June 29 and July 1. The shortest were one-minute periods of which there were several. It may be significant that the longest inattentive periods in the afternoons occurred on July 1, when the highest temperature was recorded. On the whole, the temperatures during incubation at this nest were not extreme.

Data concerning attentiveness and inattentiveness during incubation are summarized in Table 1.

As suggested by Nice (1937: 123) in her study of the Song Sparrow, the incubation rhythm seemed to be correlated with hunger, for the female usually fed immediately after leaving the nest. Her appetite and capacity were rather remarkable; for example, in the afternoon of June 29, in three minutes she caught and ate thirteen mayflies and one small dipterous fly. At another time she consumed five mayflies in one minute. There were a few instances when she did not feed

TABLE 1
INCUBATION ATTENTIVENESS AND INATTENTIVENESS AT NEST No. 7-42

Date	Maximum attentiveness	Minimum attentiveness	Daily average attentiveness	Per cent of attentiveness	Maximum inattentiveness	Minimum inattentiveness	Average inattentiveness	Temperature range	Average temperature
6-22									
2nd egg	14	1	9.0	39	47	1	17.4	70-74	72.4
6-23									
3rd egg	41	11	23.0	69	52	2	8.3	62-68	64.0
6-24									
4th egg	66	19	35.0	93	3	1	2.2	60-75	68.5
6-25	52	16	23.5	90	7	1	5.8	65-70	66.7
6-27	46	16	28.0	93	3	1	1.6	66-70	68.4
6-29	45	4	21.9	83	11	1	3.6	70-80	76.5
7-1	32	4	19.5	78	11	1	4.8	71-84	77.6
7-2	38	12	26.0	88	5	1	2.5	60-71	66.3
7-3	44	3	21.9	82	10	1	3.8	66-80	72.3
7-4	35	4	15.9	77	7	1	4.0	67-78	72.7

immediately; on two different occasions she flew directly to the bath, and at another time a squirrel went too near and she slipped quietly off the nest and flew out of sight.

The female, contrary to Mousley's postulated general rule for warblers (1924: 288), left the nest in, and approached it from, every direction, changed her position on the nest often, and faced practically every direction; for example, in two hours and forty minutes, she changed her position thirty-eight times. During these changes she preened herself and turned the eggs. She was observed to turn the eggs a total of 460 times, at a rate of 8.4 times per hour. The maximum rate for this activity was 13.1 times per hour on the day after the last egg was laid. The rate gradually decreased to 6.4 times per hour on the day previous to hatching.

BEHAVIOR OF THE MALE DURING THE INCUBATION PERIOD

During the incubation period, the male bird spent most of his time singing and protecting the territory. However, he seemed to be more attentive than studies of other warblers might suggest. At nest no. 7-42, on fifteen different occasions he fed the female at the nest, coming at least once a day and sometimes two and three times. On June 23, the female gave three low 'cheeps' immediately after returning to the nest. The male came to the nest, placed his bill in hers and held it there a moment, although no food was seen. Once on June 24 and again on June 25, when he fed the female, there was a moment's hesitation as the food passed from one bird to the other. On June 27, immediately after the female returned from feeding, she gave a few soft 'cheeps,' whereupon the male came with food which she accepted. This behavior is suggestive of courtship feeding (Lack, 1940: 169), which apparently is not definitely known to occur in the Redstart. More frequently, however, the female reacted to the male differently when he came to the nest with food. On twenty-six occasions she flew away at his approach. He did not remain long at the nest after she left, but ate the food and flew away. On July 1, he came to the nest six times and on July 3, just before the hatching of the first egg, he came four times. The male at nest no. 3-40 also was observed to feed the female at the nest during incubation. This behavior contrasts strongly with that of the male Black-throated Green Warblers observed by the Nices (1932: 166) and Pitelka (1940: 6).

LENGTH OF INCUBATION PERIOD

The length of incubation was not determined with any degree of exactness. At none of the successful nests were the eggs marked, yet records on three nests give an approximation. At each of these three, it was known to be close to eleven days. The record for no. 7-42, which is the most complete, is as follows:

<i>Time of egg laying</i>	<i>Time of hatching</i>
June 21 —————	July 3—1:42 P. M.
June 22—5:00 A. M.	July 3 to July 4 at 7:06 A. M.
June 23—5:12 A. M.	July 4—8:10 A. M.
June 24—5:03 A. M.	July 4 to July 5 at 5:00 A. M.

Assuming that the eggs hatched in the order in which they were laid, then the intervals between laying and hatching were twelve or more days for the first, eleven or more for the second, eleven days three hours for the third, and between ten days eleven hours and eleven days for the fourth. Since the fourth egg was laid at 5:03 A. M., June

24, and since all eggs had hatched by 5:00 A. M. July 5, it may be concluded that the minimum period required for development was no more than eleven days. Sears (*in* Chapman, 1907: 292) reported a 12-day incubation period.

The incubation periods of eleven days for the Yellow Warbler (Schrantz, 1943: 376) and of twelve days for the Black-throated Green Warbler (Pitelka, 1940: 6) compare closely. In the Oven-bird the period varies (Hann, 1937: 174) from eleven days twelve hours to fourteen days, with an average of twelve days. In his study of the Prothonotary Warbler, Walkinshaw (1941: 11) found in Tennessee an average incubation period of twelve days, ten hours; and in Michigan an average of twelve days and seventeen hours.

CARE OF THE YOUNG

The first egg hatched July 3, and the shell was eaten by the female. The part of the shell too large to be swallowed was broken into smaller pieces by a chewing action of the beak similar to that reported by Nice (1937: 96) in her study of the Black-throated Green Warbler and by Hann (1937: 174) in the study of the Oven-bird.

Approximately forty minutes after the first egg hatched, the male brought food and presented it to the female. She worked the food in her beak and offered it to the young but did not succeed in feeding them. During the remainder of the afternoon the male brought food five different times but succeeded in feeding the young only once. Each time he came the female left; and he stood on the edge of the nest, gave several low 'cheeps,' manipulated the food in his bill, and offered it to the young. When either adult approached the nest it gave several 'cheeps,' and the attending bird usually left the nest immediately, although in some instances it waited until the other arrived.

Following the hatching of the last egg, the male and female coöperated in feeding the young and cleaning the nest. The male Redstarts played an important rôle in the care of the young at all of the nests observed in this study. As was noted by Baker (1944: 86), only the females brooded. This seems to be the general rule among warblers. However, Mousley (1924: 267) records an instance of brooding by a male Parula Warbler.

At nest no. 3-40, data concerning parental care were obtained during three days; and at nest no. 7-42, during eight days. Data concerning brooding are summarized in Table 2. At nest no. 7-42, from the second to the sixth days there was a gradual decrease in the average length of brooding periods and in the percentage of brooding time.

STURM, Nesting Activities of American Redstart

TABLE 2
ATTENTIVENESS DURING NESTING PERIOD AT NESTS No. 3-40 AND No. 7-42

Dates	Number of days after hatching	Number of periods of brooding	Morning				Afternoon									
			Extremes of duration in minutes	Average duration in minutes	Total number of minutes	Per cent of total time	Extremes of duration in minutes	Average duration in minutes	Total number of minutes	Per cent of total time						
7-6-40	2	6	8-24	16.5	99	86.0	74.2	12	2-20	10.0	121	65.4	76.8	73.3	75.0	
7-9-40	5	14	1-9	5.0	61	45.6	80.3	12	1-16	7.8	94	49.5	71.6	47.8	75.4	
7-11-40	7	19	1-14	6.3	120	47.6	70.4	16	1-15	4.2	68	27.3	74.6	37.3	72.5	
7-5-42	1	10	3-16	9.4	94	73.4	69.8	6	4-20	14.8	89	83.7	81.8	77.9	75.8	
7-6-42	2	11	5-24	11.4	126	80.9	61.8	19	3-20	9.9	188	79.7	66.3	80.9	64.0	
7-7-42	3	13	2-15	8.5	111	79.3	65.6	21	1-19	7.0	148	68.2	72.6	72.6	69.1	
7-8-42	4	26	1-28	7.6	197	72.7	69.6	33	1-15	6.2	205	50.7	74.6	59.6	72.1	
7-9-42	5	16	2-14	6.3	102	59.3	67.0	16	1-17	5.9	95	56.9	66.5	58.1	66.7	
7-10-42	6	22	1-16	4.3	98	38.1	68.0	26	1-19	5.4	140	36.2	70.8	37.0	69.4	

Nest no. 7-42

Nest no. 3-40

Afternoon

The average length of brooding period for the total observation time at this nest was 7.2 minutes as compared to an average of 9.1 minutes found by Baker (1944: 86) and 9.5 minutes found by Mousley (1924: 287). The percentage of brooding from the second to the sixth day, at which time this activity ceased, decreased from 80.9 to 37 during daylight, but the female apparently continued to brood during the night as long as the nestlings remained in the nest. Comparable decrease in brooding was noted in the Black-throated Green Warbler by both Nice (1932: 103) and Pitelka (1940: 11). Mousley (1924: 286) states that female warblers in general do more brooding than feeding in the early stages.

At the nest watched by Mousley (1924: 234), the female fed the young more often than the male. In this study the reverse was true, the male did more feeding than the female, although the female also fed actively between periods of brooding. For example, on the sixth day, during a period of eleven hours and ten minutes, the male fed eleven times per hour and disposed of thirty faecal sacs. In the same period, in addition to brooding 37 per cent of the time, the female fed seven times per hour and disposed of twenty-six sacs.

The average number of feedings per hour gradually increased each day from 4.4 for the male and 2 for the female on the first day, to 18 for the male and 10 for the female on the eighth day. On the seventh day, the first day on which there was no brooding, the male fed one and one-half times as often as the female and on the eighth day almost one and three-fourths times as often. The combined feedings by both birds during the first day averaged 5.8 times per hour, or one feeding every 10.3 minutes. On the seventh day the rate was 18.8 per hour or one every 3.1 minutes; and on the eighth day, 28 per hour or one every two minutes.

During the entire nestling period the rate of feeding for the male was 7.6 times per hour, or about once every 8 minutes; and for the female 4.4 times per hour or once every 13.5 minutes. Together they fed the young an average of once every 5 minutes or 12 times per hour. This is a much more rapid rate of feeding than was reported by Mousley (1924: 287) and by Baker (1944: 88), and probably a more truly representative one since it is based on a longer period of observation (52 hours during eight days). The nest observed by Mousley also contained four young; Baker's nest apparently contained only two.

In contrast to other warblers as reported, the male fed more often and also fed larger quantities and to more young at a feeding (Nice, 1930: 343; Pitelka, 1940: 8-9; Baker, 1944: 89). He usually fed a moderate-sized green caterpillar, three or four spiders, or one or two

mayflies. The female usually fed smaller insects or spiders. The male often fed two young at a feeding and on fifteen occasions fed three. The female on six occasions fed two young at one time but at no time did she feed three.

The faecal sacs were disposed of by both the male and the female. During the first three days of the nestling period both birds ate the sacs, which usually were discharged immediately after feeding. As with the birds observed by Baker (1944: 88), they began carrying the sacs away on the fourth day, and carried away thirteen out of fifty-two during eleven hours and forty minutes. Both the male and female carried the sacs to a near-by limb, dropped them to the ground, and then wiped their beaks on the limb. They stopped eating sacs altogether after the sixth day. This behavior varied slightly from that at nest no. 3-40 where both birds ate a few sacs as late as the ninth day, although the majority were carried away. At nest no. 7-42, the average for the fourth day was 4.4 disposals per hour; for the sixth, 5.4 per hour; and for the eighth, 3.5 per hour. The fact that the sacs were larger and that observations were limited may have contributed to the apparent reduction on the eighth day.

The last observations at this nest were made on the eighth day after hatching. An attempt was made to band the young birds, and when the limb was touched the nestlings left in every direction. Only three of the young were found and banded. The female reacted in an interesting manner. She 'cheeped,' fanned her tail, and ran along the ground fluttering both wings, at times coming so near that she touched the observer's clothing.

The male did not become as excited as the female and, after the first few minutes, sat above, among the branches, scolding. He resumed feeding the young almost immediately after they were released, but the female continued to display and scold for several minutes before she began to feed. Thirty minutes later the male was feeding one of the young that was sitting on a wire about twenty feet from the nest tree, and the female was feeding two young that were on the ground 40 to 50 feet away from the same tree. Three days later the male was observed feeding a young bird in a near-by maple and the female was fitting among the topmost branches of another tall tree catching insects.

LENGTH OF NESTLING PERIOD

Since the young left somewhat prematurely at nest no. 7-42, this record does not offer a good basis for determining the normal length of the nestling period. Two other nests, nos. 3-40 and 4-42, afford better data. The last egg of no. 3-40 was hatched on July 5 and the

last young left the nest on July 14, which made the length of this nestling period nine days. At nest no. 4-42 the last egg hatched on June 24 at 11:55 A. M. and the young left on July 3, before 7:00 A. M. This would make a minimum nestling period for the youngest bird of about eight days and nineteen hours. The above figures would indicate that the nestlings of no. 7-42 left the nest about one day earlier than normal. In the studies made by Mousley (1924: 285) and Baker (1944: 87), the young left the nest at the age of eight days, but both nests were disturbed.

The nestling period given by Hann (1937: 178) for the Oven-bird was about eight days. Pitelka (1940: 13) found the nestling period for the Black-throated Green Warbler to be between eight and ten days; and the Nices (1932: 171) found it to be between eight and nine days, in one case, and eight days in another case for the same species. Schrantz (1943: 384) found that the Yellow Warbler left the nest in nine and one-half days. In the Prothonotary Warbler, which nests in cavities, the period is distinctly longer—ten and three-fourths to eleven days (Walkinshaw, 1941: 11).

COWBIRD PARASITISM

Cowbird parasitism of the Redstart nests observed on South Bass Island has been very infrequent in contrast to most observations made elsewhere. At Ithaca, New York, Friedmann (1929: 196, 252, 303) found that the Redstart was one of the five species most frequently parasitized, with twenty-three of thirty-four nests containing Cowbird eggs. Hicks (1934: 336) found Cowbird eggs in seven of twenty-two Ohio nests, but Sutton (1928: 224) found no parasitism in the Pymatuning Swamp area of Pennsylvania. Of the eighteen nests observed in the present study, only one was parasitized. This contained two Cowbird eggs when discovered and the nest had been deserted. One other presumptive instance of parasitism in this species was noted when a male Redstart was seen feeding a young Cowbird.

Reactions of the Redstart toward the Cowbird were noted several times. For example, during the building of nest no. 3-40, when a female Cowbird appeared on the scene, the male Redstart flew at her with his tail spread and his head lowered. He snapped his beak loudly as he flew but the Cowbird did not move. The male gave up the chase after two or three attempts and flew away. The female left at the beginning of the disturbance and did not return to the nest for twenty minutes. In the meantime, the Cowbird had gone. It was the aggressive action of another female Redstart toward a female Cowbird that led to the discovery of nest no. 4-40. During the fourth day of

incubation at nest no. 7-42, a female Cowbird came to the fence near the nest tree and was attacked simultaneously by a male Redstart and a male Indigo Bunting. At the call of a Cowbird the incubating female sank as low in her nest as possible and sat quietly for several minutes. She reacted in a similar fashion to the presence of grackles.

NEST SUCCESS

Of the various factors which adversely influenced nesting success, the most conspicuous was unfavorable weather. Storms destroyed two nests and seemed to be responsible for the desertion of others. One nest was robbed by a small fox snake (*Elaphe vulpina gloydi*) which had swallowed all three eggs when discovered coiled in the nest. Four nests were deserted because of some unknown factor. One of these contained four slightly incubated eggs and another contained only two Cowbird eggs.

In eighteen nests which were observed during the years, 1940 and 1942, a total of fifty eggs was laid. Out of this total there were twenty-eight (56 per cent) eggs hatched, or an average of 1.5 per nest; twenty-six (52 per cent) birds fledged, or an average of 1.4 fledglings per nest. There were eleven successful nests (nests from which at least one young was fledged) and of these, seven were completely successful.

The only other warblers for which there are comparable data are the Yellow Warbler (Schrantz, 1943: 385) in which there was 54 per cent success, the Oven-bird (a ground-nesting species), and the Prothonotary Warbler, which nests in cavities. These differences in the nesting habits of the two last named seem to have considerable bearing on the nesting success. In the Oven-bird, heavy losses in both eggs and young resulted in a low degree of nesting success (Hann, 1937: 198). In the Michigan Prothonotary Warbler (Walkinshaw, 1941: 15), losses were even more severe, both in eggs and young, but in the Tennessee Prothonotary there were moderate losses among the eggs and no losses among nestlings, resulting in a much higher rate of nesting success. The situation in these Redstarts agrees more closely with that of the Prothonotary Warbler than with that of the Oven-bird in that losses occurred principally before hatching. The degree of nesting success (52 per cent), although below that of the Tennessee Prothonotary Warblers, was well above the general average (43 per cent) for small passeriform birds nesting in the open as reported by Nice (1937: 143). Studies throughout the season at South Bass Island might show altered figures relative to success, since many early nests were apparently unsuccessful.

A noteworthy point in connection with the breeding population

was the relative proportion of yellow-plumaged males. In thirty-two pairs with nests, during the three years, twenty-nine of the males were red-plumaged and only three wore the yellow and gray plumage that is supposedly characteristic of first-year males. Two additional yellow males held territories but did not secure mates. If the sequence of plumages as outlined by Dwight (1900: 288) is followed by all individuals, males invariably retaining the yellow and gray plumage into the first breeding season, then less than one tenth of the South Bass Island breeding males were first-year birds. This figure compares closely to the proportion in a population of Redstarts in New York studied by Hickey (1940), who reported that of forty-eight males on territory "only four were in the immature plumage."

SUMMARY

In a study of the nest life of the Redstart at South Bass Island, Ottawa County, Ohio, it was found that:

1. The Redstarts exhibited strongly territorial behavior early in the nesting cycle but defended their territories infrequently after the young hatched.

2. Females as well as males defended territory; one female attacked intruding Redstarts of both sexes.

3. Territories were quite small. On an area of 1.4 acres, there were nine territories in 1941 and six in 1942, yielding averages of 0.16 and 0.23 acres for the two years.

4. At one nest, the territorial boundary was not permanent. Some space was added during nest building and some lost during incubation.

5. Nest building was performed exclusively by the female and required between two and one-half and three days.

6. During nesting, the males sang actively and defended their territories.

7. At one nest, egg laying began on the day following the completion of the nest; at a second nest, after a lapse of one day.

8. The eggs were laid early in the morning on successive days.

9. Incubation was performed exclusively by the females. At one nest, incubation began at a low level on the day that the second egg was laid, attained its full level on the day that the fourth egg was laid, and subsequently fluctuated within rather narrow limits.

10. At one nest, the average length of attentive periods during incubation was 22.8 minutes and the length of inattentive periods averaged about three minutes in duration.

11. The average rate of egg turning per hour during incubation at one nest was 8.4; the greatest rate for this activity was 13.1 on the day

following the laying of the last egg; the rate of this activity decreased on later days of incubation.

12. During incubation at two nests, the male Redstart frequently came to the nest with food.

13. Brooding was performed exclusively by the females. At one nest, the female did not brood during the daytime after the sixth day but continued to brood at night; at another nest the female brooded on the seventh day after hatching.

14. At two nests, the males fed the young more often than the females and fed larger quantities.

15. The rate of feeding gradually increased from 6.4 times per hour, on the first day after hatching, to 29.3 on the eighth day, averaging 12 feedings per hour for the entire period.

16. At one nest, both the male and female ate all the faecal sacs until the fourth day. From the fourth to the sixth days, some were eaten and some were carried away. On the seventh and eighth days all were carried away. At another nest some sacs were eaten as late as the ninth day.

17. At two nests, the nestling period was between eight and nine days.

18. Parasitism by the Cowbird was infrequent; only one nest in eighteen contained Cowbird eggs. Both male and female Redstarts reacted aggressively toward female Cowbirds.

19. In most features, the division of labor between male and female Redstarts during the nesting cycle resembled that in other warblers.

20. Nesting success was higher among these Redstarts than is usual among small passeriform birds which use open nests. Losses were much heavier among eggs than among young.

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