

BIRD-BANDING

A JOURNAL OF ORNITHOLOGICAL INVESTIGATION

VOL. XIX

JULY, 1948

No. 3

SOME NESTING DATA ON THE CAROLINA WREN AT NASHVILLE, TENNESSEE

By AMELIA R. LASKEY

The Carolina Wren, *Thryothorus ludovicianus* (Latham), is a delightful permanent resident of the Nashville area, its ringing songs being one of the most cheerful sounds of all seasons of the year in the woods and about suburban and country homes. Individuals may remain from year to year in a favored location, and, even in the non-breeding season, a pair may forage together during the day and roost together in some warm niche at night. (Tenn. Ornith. Soc., 1943, 1944). One pair lived at our home for at least two years (Laskey, 1938). The female lived to be over five years old (Laskey, 1939).

During 1946, I obtained data on the incubation rhythm and nesting behavior of this species, watching one nest in Percy Warner Park for 6.3 hours during incubation (Laskey, 1946b) and another, at my home for more than 150 hours during the incubation and nestling periods. I have gathered some general information from 37 nests found in 1946 and the previous ten years.

In 1940, after the disastrous heavy snowfall and extremely cold weather of January, no breeding records were obtained for that season as Carolina Wrens were very scarce here (Tenn. Ornith. Soc., 1942). In our garden, a male sang persistently that summer while building a nest but he failed to obtain a mate.

GENERAL DATA ON NESTING IN NASHVILLE REGION

When choosing a nest site, the Carolina Wren shows a decided preference for some type of receptacle or ledge to support and protect the roofed, side-entrance nest which is constructed predominately of dry leaves, stems, leaf skeletons. Green moss and snake scales may be added, and it is lined with soft materials such as fur, short hairs, small feathers, tissue or other bits of paper. When built in a very small receptacle, it is often merely a frail cup-shaped affair

without a roof. This wren has adapted itself well to the habitations of man, but also nests in woods. However, as stated by Monk, the woodland nests are usually skillfully contrived of weathered materials and easily escape detection. A nest in a natural site is not often found here (Tenn. Ornith. Soc., 1942.)

My records were obtained principally about my home and in Warner Parks, a natural park with houses for employees located along the outer boundaries. Among my 37 nesting records, 17 nests were built in bird boxes, either stationary or swinging; nine on shelves or various ledges inside of a building; four among growing plants in window boxes; two within a sack of old clothes hanging in a hen coop; one each in several odd places such as within a paper sack of seeds; an outdoor cupboard, a crevice between a house wall and a down spout, a fold of a quilt hanging in a garage, a wall basket (size of a paper cup) hanging at the front entrance of a house, a tin newspaper cylinder, and a mail box (both of these at the roadside). Most unusual was a nest of 1946, built about six feet from the ground between the divided stem of a young cedar tree in a thicket at the rear of our place. This nest was atypical in having the entrance at the top instead of at the side. After the young had flown, when the nest was removed, it was found that one wall was very thin and the opposite one very heavy and incurved over the entrance. *When placed in the typical position, it was quite evident that the nest was similar to type.* Only its position in the tree had been unusual. Another tree nest of the Carolina Wren near Nashville was reported by Crook (1934), found July 9 with a set of three eggs and one of the Cowbird. It had been built about eight feet from the ground in a three-point fork of an American elm in the woods. Ganier reports having found two nests on steep-sloping ground (Tenn. Ornith. Soc., 1942). Seeman (1946) reports a Carolina Wren with a nest in a hole in the ground.

Ruth Reed Nevius told me (by letter) of finding a nest on April 22, 1944 with two eggs of the Carolina Wren and one of the Cowbird; on the following day there was one egg of the Wren and two of the Cowbird. The nest was unroofed and the moss scattered behind it but the wren incubated, hatching one Cowbird on May 4. The other eggs failed to hatch; the wren egg and baby Cowbird disappeared, and the bird deserted the remaining Cowbird egg.

In late June of 1944, about twenty pupa cases of the parasitic fly, *Protocalliphora*, were found underneath the very small nest in a wall basket at our front door. Four young had fledged but a fifth had died when well developed (it may have smothered as the nest was very crowded).

The egg-laying season may start here in March and extend into August. Among 37 records, I have four for March, three for April,

eight for May, 16 for June, five for July, and one for August. My earliest dates are of a nest on March 29, 1938 with five eggs, and one, found on April 17, 1942, with three young almost ready to leave, from which it was estimated that the set had been completed about March 22. Ganier reports his earliest record as five fresh eggs on March 21 (Tenn. Ornith. Soc., 1942). He also contributes an unpublished report of a clutch of six eggs, well incubated on April 7, 1946, in a nest built close to the ceiling in his camp near Nashville. My latest record is a set of four, laid August 8-11, 1937. This entire brood fledged September 4 (Tenn. Ornith. Soc., 1942).

Clutch size varied from three to six eggs. The five and six egg sets were laid from March into June; the July and August sets consisted of three or four eggs. Five egg sets predominated; of 27 nests in which the number of eggs laid is known, 14 (or 52 per cent) had five eggs.

Clutches of six eggs were laid in April (one set), May (three sets); clutches of five eggs were laid in March (one), April (two), May (seven), June (four); clutches of four eggs were laid in June (three), July (three), August (one); clutches of three eggs were laid in July (three).

Eggs were laid very early, on consecutive days. Incubation apparently usually begins with the laying of the last egg, but in some broods, the difference in development suggests some variation in this phase of nesting. Nice and Thomas (1948) report that the Arkansas Carolina Wren they observed spent the nights in the nest after the laying of the first egg on April 25, 1946.

Among my records, the time involved between the laying of the last egg of a set and the date that the young left the nest varied from 27 to 29 days, but in one instance this incubation-nestling period was only 24 days (August 11-September 4). In six instances where the incubation period is known, it varied from 14 to 15.5 days after the laying of the last egg (14, 15, 14-14.5 in three instances, 14-15.5). In six instances where the nestling (nest-occupancy) period is known, it varied from 12 to 15 days (12-13, 13, 13.5, 13.5, 13 plus, 14.5-15). In each case, these are not the same nests as in the preceding list.

I have one instance of a pair of Carolina Wrens that raised three successful broods in one season at my home. The first brood of four young left the nest on April 20, 1939; the second brood of at least five young (6 eggs) left the nest June 2, and the third brood of three left August 12. The first nest, which was re-occupied for the third nesting, was built in a dust mop on a garage shelf. The second nest was placed under ivy leaves in a window box about one hundred feet from the other (Laskey, 1939).

THE NESTING OF A BANDED PAIR

In 1946, observations on the nesting of a resident pair of Carolina Wrens began on May 8 when a nest was started in our metal mail box at the roadside. As they used the open mail slot for passage to and from the box, the door was wired shut and a substitute box placed for the mail. The nest appeared complete on May 15; the first egg was laid May 16 and the fourth on May 19. At noon (CST) on the latter date, I found a pair of Bewick's Wrens, *Thryomanes bewicki* (Audubon), working diligently carrying loads of nest material into this mail box and the Carolina Wren's eggs completely hidden by a nest of this smaller species. The new nest appeared to lack only the lining and had been built against the side opening of the first nest (Laskey 1946a). Although the nest was watched, there was no indication of any defense of the site by the Carolina Wrens. Apparently, the female had not completed her set, and the nest and eggs were so completely concealed by the interlopers that the stimulus for nest defense was entirely lacking when the original owner returned. Songs were heard from the male Carolina Wren that afternoon from various parts of our grounds.

In previous years in the Warner Parks area, I have found the two species of wrens nesting in close proximity in apparent amity. In two successive years, Bewick's and Carolina Wrens successfully raised broods in boxes hung on opposite ends of a front porch. At another location, a pair of each species occupied ledges on opposite sides of a small hen house. My visits to these sites were short and I have no information on the behavior of these wren pairs toward their neighbors. Nice and Thomas (1948) found that the Arkansas Carolina Wren dominated the Bewick's Wren.

On May 21, two days after the Bewick's Wrens usurped the mail box, the male Carolina Wren was seen carrying nest material into a small box fastened under the eaves at our kitchen entrance. This nest, although near completion, was abandoned and the actual replacement nest was not found until May 27 when it contained three eggs. It was built in the young cedar tree (described previously in this paper) about two hundred feet southeast of the mail box and about seventy-five feet southeast of the box under the eaves. Five eggs completed the set on May 29; the five nestlings, hatched on June 11 or 12, were banded and left the nest on June 25. The family disappeared within a day or two from the garden.

On July 13, the adults (both banded with aluminum bands on the right tarsus) and at least two of the juvenals (banded left), reappeared close to the house. That day, the female brought nest material into the box under the eaves. While she added a few dead leaves and bits of grass or stems to the previously constructed nest,

her mate did not take part in this activity but accompanied her on some of the trips and sang. About 6:30 on the morning of July 14, she flew out of the box. Investigating soon afterward, I found that the nest appeared complete. She added a single stem at 11:00.

This box, measuring five by six inches and four inches deep, had been in place several years but was never used. Last year, I had removed one side of the roof as an inducement for occupancy as the entrance was small. The box, under wide eaves, was never exposed to rain or direct sunlight. It was fastened in one corner of an "air-shaft" arrangement of our one-story house, with the open end of the shaft facing south. The brick wall of the house is on the north. Directly opposite the box, only four feet to the east, are windows of the house, and above it, is the sloping roof of the enclosed kitchen porch.

When building, the wrens had used the open half of the box top for entry and had obstructed the original opening by building against it. The four eggs of the set were laid July 17-20. I did not begin lengthy observations until July 21 but on July 20, I saw the female go into the nest for the night at 5:57 when dusk prevailed in the shadowy recess of the nest site (sunset 7:01).

From the afternoon of July 21 (the second day of incubation), I spent more than 70 hours in observation of the incubation rhythm and the behavior of the pair at the nest. I was seated indoors just beyond the open, screened windows, a few feet from the nest. The slightest movements and vocal sounds at the nest were audible and the pair seemed oblivious to my watching. My visits to the nest were made during absences of adults and caused no disturbance or distrust.

During the incubation period, July 20 to August 3, although temperatures rose to 90° F or over on six days, the daily mean, as given by the United States Weather Bureau, remained at normal, or varied from one to three degrees below normal and one to three degrees above. Data were obtained for three or more hours on all but two days of the incubation period. All incubation was by the female. She spent 41.7 hours (63 percent) on the nest and 24.9 hours (37 percent) off during 66.6 hours of daylight observation. In 33 complete attentive periods, the extremes were 11.5-136.5 minutes, average 57.5 minutes. In 43 complete inattentive periods, extremes were 09-70 minutes, average 33.5 minutes.

On July 10 and July 11, I spent about three hours each day watching a nest of Carolina Wrens in Warner Parks on the 6th and 7th days of incubation. On the first morning, when the box was exposed to the sun, the female was on the nest from 15 to 58+ minutes and off 41 to 85+ minutes. On the afternoon of the 7th day (nest

box in shade), she was on for one period of 87 minutes and off for two uncompleted periods of +28 and 60+ (Laskey 1946b).

From the data on these two nests and the one in Arkansas (Nice and Thomas), it is obvious that the periods of attention and inattention may be unusually long for Carolina Wrens in contrast to the accelerated rhythm of the House Wren, *Troglodytes aedon* (Vieillot), which leaves the nest 27-43 times per day (Baldwin and Kendeigh, 1927).

In 11.5 hours of daylight observation of the nest of a Bewick's Wren between May 30 and June 10, I found that the incubating female spent from 3 to 24.5 minutes (average 17.5) on the nest. However once when she was on the nest when observations started, she remained on for 41 minutes to my knowledge. Her nine complete periods off the nest varied from 12 to 63 minutes, average 29.6 minutes (Laskey 1946a).

This Bewick's Wren, in an exposed box, spent 37 percent of the time incubating. However on account of abnormal weather conditions, it is possible that the rhythm for this particular nest is not typical. During the first few days, she was on the nest 24 percent of the time; from the 6th to the 10th day, with mean temperatures 10° below normal, she was on 53 percent of the observation time and for the remainder of the period when daytime temperatures were above 90° (much higher when the sun shone on the metal mail box) she incubated for 24 percent of the time.

In 6.3 hours of watching, the Warner Parks Carolina Wren, also in an exposed box, spent 43 percent of the time on the nest. In the box on the house, entirely sheltered from rain and sunshine, the Carolina Wren incubated 63 percent of the time. The Arkansas Carolina Wren, in a sheltered nest, was on the nest 73 percent of the 92 hours of observation (Nice and Thomas, 1948). Data show that temperature and weather conditions affected the rhythm to some extent.

A summary of the incubation period of the porch eaves nest is given in Table I (omitting several very short watch periods).

HATCHING AT THE EAVES NEST

On August 3, at the eaves nest box, one of the four eggs had hatched by 6:00 in the morning, the second about twenty-five minutes later, and the third about 8:30, but the fourth did not hatch until about 4:30 in the afternoon. This bird was a weakling and did not survive. I did not see its removal but it was gone when the nest was examined early on August 7, and I assume it died soon after hatching.

At 6:08 a. m. the female carried a small bit of insect food into the nest and soon emerged with a piece of egg shell which she carried beyond my range of vision. She settled on the nest again at 6:12.

TABLE I
INCUBATION PERIOD OF THE CAROLINA WREN

Date	No. of hours of watching	Periods On Nest		Periods Off Nest		Percentage of time on nest	Mean temperature Fahrenheit	Departure from normal	
		Number	Average in minutes	Extremes in minutes	Number				Average in minutes
July 21	6 ¹	2	85	55-136.5	2	52	34.5-70	77°	-2
22	3.9 ¹	2	63.5	60 - 67	3	35	27 - 45	78°	-1
23	5.4	3	53.5	50 - 59	5	31	17.5-47	79°	0
24	3.4 ²	2	28.7	28.5-29	3	36	23.5-58.5	79°	0
25	1.7 ²	2	20.5	11.5-29.5	2	24.2	21 - 27.5	82°	+3
26	7.4	4	58.5	38.5-90	5	36.2	31.5-46	79°	0
27	5 ¹	3	59.3	23 - 92	3	32.8	28.5-38.5	76°	-3
28	4.5 ¹	1	83.5		2	39	34.5-43.5	78°	-1
29	7.5	3	66.3	55 - 84.5	5	31.3	19.5-44.5	78°	-1
30	4	1	27.		3	34.8	21 - 54	80°	+1
31	6.4	4	53.8	38 - 70	4	27.6	09 - 43	78°	-1
August 1	2.9 ¹	1	96		1	58		79°	0
2	8.5	5	57.8	17.5-78	5	26.1	17 - 39.5	76°	-3
Total	66.6	33			43				
Extremes				11.5-136.5			9-58.5		
Average			57.9			33.5		78.6°	

¹. Watched in afternoon only.

². Watched in morning only.

At 6:28, sounds of crushing shell came from the nest. When she left about twenty minutes later, I found the second nestling and no shell. At 8:38, the female became very active in the nest, standing or moving about; at her next absence, nearly an hour later, I found the third nestling. Presumably she had eaten the shell during that period of activity for none had been carried out. At 4:05 p.m. when she left the nest, I found one egg still not hatched. When she returned at 4:35, she perched on the rim of the nest, removed and ate two pieces of shell, then flew with a half shell in her bill. She alighted on the ground some sixty feet from the nest where she ate it. Examination of the nest during her absence, revealed the presence of the fourth nestling, still very damp and no shell fragments.

During 7.2 hours of watching on the hatching day, there were 26 meals brought—eight by the female, one by an unidentified parent, and 17 by the male. Seven of these meals he fed during the absence of the female, and the other ten were delivered to her. She apparently fed them to the nestlings. It was not possible to see how many young were fed per trip to the nest at any time during the nestling period.

Meals averaged 3.5 per hour for the day. The female brooded 68 percent of the time on this cloudy, showery day with a mean temperature of 74°F (5° below normal). At 4:40, she settled for the night (sunset 6:50).

From the hatching date until the afternoon of August 16 when the two surviving young left the nest, data were accumulated from more than 81 hours of watching. Weather was abnormally cool and showery.

Neither adult could be trapped during the nesting season for color-banding. Identifications were usually made by vocal sounds, therefore there were occasions when the parent could not be positively identified, particularly after the brooding ceased.

Details of the care of the young are summarized in Table II.

NESTLING PERIOD

During the first two-thirds of the nestling period, mean temperatures averaged 1.5° below normal. From August 4, when the young were one day old through August 11, their ninth day, three nestlings received 218 meals in 42 hours, averaging five meals per hour or 1.6 per bird (assuming that the youngest died soon after hatching). Food was unusually abundant for this season of the year in the lush green foliage. Both parents brought many plump green or dark-colored larvae from trees close at hand. They also fed spiders, moths and some small, unidentified insects.

Although the female brooded 68 percent of the time on the hatching day, 65 percent on the first day, she was on the nest only 15, 10, 11 percent, respectively, of the daylight time during the next three

TABLE 2
NESTLING PERIOD OF CAROLINA WRENS

Date	No. hrs. of watching nestlings	No. of 1 to 4	Brooding Hours Percent. on nest of time	Feedings Brought By male	Unidentified	Total	No. feedings per hour	Fecal sac	Mean temperature	Departure from normal
August 3	7.5	3	68	17 (10 del.)	8	1	26		74°	-5
4	5.5	3	3.6	17 (12 del.)	5	1	23		78°	-1
5	6 ¹	3	.9	5	4	14	23	5 sw. ²	80°	+1
6	3.7 ¹	3	.4	2 (del.)		15	17		76°	-3
7	6.6	3	.75	11	2 (1 del.)	26	31	3	76°	-3
8	5.9	3	-	3 (1 del.)	4	25	33	8	76°	-3
9	7.1	3	-	6	5	20	31	9	82°	+3
10	2.	3	-	3	3	15	21	10.5	78°	-1
11	5.8	3	-	9	5	25	39	8	72°	-6
12	2.2 ¹	2	-	3	1	3	7	2	71°	-7
13	7.4	2	-	8	8	29	45	13	69°	-9
14	5.5	2	-	8	9	18	35	5	71°	-7
15	7.9	2	-	16	15	30	61	8	80°	+2
16	8.	2	-	14	10	17	41	7	81°	+3
Total Mean	81.1						433	74	76°	

¹. Watched in afternoon only.

². Swallowed.

days. It seems curious that the young were not brooded at all after the morning of August 7 (when four days old) although night temperatures were abnormally low. She went on the nest for her last night of brooding on August 6 at 6:42. The young of the Arkansas Carolina Wren (hatched May 12) were brooded until the 7th night (May 18) and again on May 22 (Nice & Thomas, 1948).

On August 11 (the ninth day of age), the night temperature dropped to 62° F. By morning, one of the three nestlings had died, apparently unable to survive the chilling. I removed it during the day. Baldwin and Kendeigh (1932) have found that at nine days of age, the House Wren has developed a temperature control mechanism which enables it to maintain body temperature constant at a moderate rate of air temperature of 72°F, but rapidly lowered air temperatures cause a corresponding lowering of body temperature. They say (page 159): "For the House Wren, before development of temperature control (up to nine days of age), the low lethal body temperature is approximately 47°F. This is produced by an air temperature slightly lower." "For the nestling Eastern House Wren, ten days or older, a drop in body temperature below 60°F proves fatal." "There is thus with age a decrease in the extent to which body temperature can be lowered without harm."

On the evening of August 12, the temperature was again dropping much below normal. I found that after the last feeding of the day at 6:05 (36 minutes before sunset), no further attention was given to the surviving nestlings. At deep dusk, after the pair had been heard going to roost beyond the house, I feared the babies would not survive another cold night and, for the first time, interfered with the natural course of events by placing a small bit of wool over the nestlings. The following morning before 4:45 in dim twilight, I removed the covering and found them safe. At 5:13, a parent, thought to be the female, arrived with the first feeding of the day, at nine minutes after sunrise.

During the next four days, August 12-15 when the two nestlings were nine to twelve days old, they received 148 meals in 23 hours, averaging 6.4 per hour (3.2 per bird, assuming that the feedings were divided equally).

Feedings were not distributed equally during each hour of the day. In the first hour of the morning, 8-10 meals were brought; during the second hour, the number decreased to 4-5. Around mid-day or early afternoon, feeding would accelerate to approximately equal the rate of early morning; then another decline came in late afternoon.

However, on August 15, the day previous to fledging, the lag occurred in mid-morning; then from noon to 4:00, meals were brought at the rate of 7-10 per hour. The Arkansas pair of Carolina Wrens

averaged nine meals per hour for five nestlings for the entire period or 1.8 per bird (Nice and Thomas 1948).

First feedings for the day were brought on August 8 at 5:00 by the pair (one minute after sunrise); on August 9 at 4:55 by the male (five minutes before sunrise) and by the female one minute later; on August 13 the feeding was brought at 5:13, nine minutes after sunrise and on August 16 at 5:08, three minutes after sunrise.

The final feedings of the day were brought as follows:

Date	Time p. m.	By	*Minutes before sunset
Aug, 4	6:11		38
5	6:11	Male	37
6	6:46		6
7	6:31	Male	15
8	6:34		11
9	6:20		24
10	6:34		9
12	6:05		36
13	6:04	Male	36
15	6:11		26
Average			23.8

*Sunlight is obscured early in the evening on account of the many trees and a hill to the west.

On the final day of nest life, the last meal was given in the nest at 2:14 p.m. One fledgling left at 2:18, the other at 2:26.

Walkinshaw (1935) observed a nest of the Short-billed Marsh Wren, *Cistothorus stellaris* (Naumann), in Michigan. On July 16, from 11:30 a.m. to 12:30 p.m. six nestlings, hatched the previous day, were fed nine times in that hour. This would average 1.5 meals per bird per hour. The Carolina Wrens received 1.4 per bird per hour the day after hatching. On the ninth day, the same brood of Marsh Wrens was fed 17 times between 1:30 and 2:30. This would average 2.8 per hour per bird. The Carolina Wrens gave only 1.6 feedings per bird per hour during my early afternoon watching on the ninth day. However their feedings on the eighth day averaged 2.2 per bird and on the tenth day, three per bird.

The Marsh Wrens left the nest 13 days after the hatching of the last egg. The Carolina Wrens stayed in the nest a fraction of a day longer.

Although sanitation was perfect in the nest of the Carolina Wrens, three to six meals were brought before a fecal sac was voided. During the first two days, it was not possible to obtain data on the voidance of excreta because none could be seen. Doubtless it was swallowed by the female as she leaned far into the nest. After the young were two days old, fecal sacs were raised above the nest rim to be swallowed by the parent in attendance. After the young were five days old,

all excreta were carried away. Near the end of nest life, the young backed to the rim of the nest to drop the sac as the parent waited to remove it.

LEAVING THE NEST

On August 16, when the young were 13 days old, observations began at 4:40 a.m. (sunrise 5:06). The male began singing at 4:53 from shrubs about 150 feet from the nest, continuing for 13 minutes, as the adults gradually drew nearer. Faint notes were given by the young at 4:59. The first feeding was brought at 5:08; seven was the total for the first hour. The parents seemed much excited, chattering at length and using other vocal sounds as they lingered in the vicinity of the nest. No feces were removed in the first hour. In the second hour, only three meals were fed. Twice the female came to the roof near the box, once leaning over the eaves to look into the nest, then moved off to give a series of metallic notes; once the male arrived with food in his bill but remained on the opposite roof in plain view of the young. He sang there but left without feeding. During the third hour, four feedings were given and two fecal sacs removed. The parents were obviously coaxing the young out of the nest. I had seen a pair act similarly on September 4, 1935 when the young were 12 days old. In the present case, the visits, minus food, continued as the parents fluttered about, making various vocal sounds. The female perched on the porch peak for minutes at a time, alternately preening and calling. (She had started this behavior two days previously). The young answered with *tweets* or sibilant food calls as they stretched tall in the nest, apparently now very eager for food but reluctant to leave the nest. At 9:03, the male arrived with a moth and three minutes later with a larva. At both of these feedings, the young were vociferous and active in the nest. Twice the female came with tiny particles of food.

From the first feeding of the morning at 5:08 to the last feeding in the nest at 2:14 (excepting the mid-day hour when I did not watch), 41 meals were fed in eight hours, averaging 5.1 per hour, but some were very small. Seven fecal sacs were removed. During this period, the parents made at least twenty-five trips to the vicinity of the nest without food. Sometimes they landed on the nest-box, sometimes going to the eaves to look into the nest, or to some other perch within a few feet of the nest.

Although both nestlings stood up a number of times as if preparing to leave the nest, they always settled again until 12:22 when one hopped to the rim of the nest-box but returned in a minute to the nest. At 2:02 the male came to the nest; one baby hopped to the nest rim, uttering *tweets*. The male flew a few feet to a perch and

sang but the youngster again settled. For eight minutes, the male hopped about, using various vocal sounds, then the female arrived, using metallic notes. The male again flew to the nest and a baby responded by hopping in and out of the nest, *tweeting*, but finally settled. At 2:14, the male fed a tiny insect, leaving immediately. Once more a nestling hopped back and forth from the nest or box rim. By 2:16 it had hopped to the rough brick wall adjoining the box and the other baby was on the rim. No. 1 progressed to the eaves of the porch above the box and hopped along leisurely, holding the bill open and flicking the wings. No. 2 squatted on top of the nest box; both were *tweeting*. At 2:18, No. 1 made its first flight of approximately six feet, going upward diagonally from the porch roof to the higher eaves of the house above my observation windows. One of the parents was heard on the house roof then, using metallic notes. In a half minute, No. 2 made a motion as if to fly to the brick wall but settled back in the corner farthest from the box edge as if too timid to leave. The male had appeared with a larva, but had flown off in the direction the first fledgling had taken. The mother bird flew about, apparently trying to induce the second fledgling to make a flight. At 2:21, No. 2 moved to the edge of the nest box top and stretched upward. In two minutes an adult came to the box but flew groundward immediately. Then the baby left the box top to cling to the rough stucco wall of the enclosed porch, the opposite side of the box from which the first one had left. No. 2 fluttered to various spots on the wall where the rough finish gave toe-hold. Each of these moves was preceded by a *tweet* and followed by a grunt. It dropped excrement once during its slow progress. At 2:26, No. 2 attempted its first flight in the same general direction that No. 1 had taken, but this one misjudged, and instead of gaining the house roof, it came toward one of the house windows, hovering in the air a few inches from the wire screen, finally dropping to the house wall below the window. While the baby clung there, both adults appeared nearby; they were vociferous and the mother bird flew to the porch eaves opposite the youngster. At 2:29, No. 2 flew back about four feet to cling again to the foundation wall of the porch. It stayed there and on the vines until after 3:00, sometimes preening. During this interlude, the parents came several times. At least three times, a parent went to the empty nest, once carrying a larva in its bill. That evening the young were heard some thirty feet south of the house.

The empty nest weighed 49.2 grams. It was very clean and was built of dry leaves, leaf skeletons, stems, grass, weed stalks, a twig one and a half inches long, a few sprays of green moss, small strips of cellophane, and maple seeds. It was lined with hair, strands of rope fibre, and a bit of cellophane.

JUVENALS

The five young of the cedar tree nest, fledged June 25, 1946, disappeared within a day or two from the immediate vicinity of the nest and were not seen until July 13 when at least two of them reappeared close to the house with the parents. At this date, the adults were interested in the box under the eaves. On July 20, when 37 days old, two of the youngsters were seen dust-bathing in depressions that they had made in the sand of our gravel-surfaced driveway. One was trapped and its band number verified on July 24. The two foraged together near the house until July 29. On the 27th, both came to the house roof near the nest box while their mother was incubating. She left the box about a half minute later but whether they met is unknown. On July 31, three days before the next brood hatched, one of the juvenals, age 48 days, hopped on the porch roof just above the nest box during the absence of the incubating mother. This was the last appearance of any of that brood.

On August 11 at 4:00 p.m., the three nestlings of the eaves-box brood, age eight and a half days, were removed for a few minutes for banding. Their eyes were fully open and the primaries were unsheathed 5-11 mm. The smallest, No. 505, tarsus measuring 20 mm. weighed 14 grams; No. 506, tarsus 22 mm. weighed 14.8 grams, and No. 504, tarsus 25 mm. weighed 17.9 grams.

No. 506 was the one found dead the following day, and that afternoon weighed only 11.3 grams.

When the two survivors of this brood left the nest box on August 16, they also became very inconspicuous after the second day, although the adults returned soon to use the same roosting place in the shrubs that they had occupied during nestling time.

On September 20, No. 504, the largest, was trapped. At 48 days of age, it weighed 21 grams; the flattened wing measured 68 mm. It was not seen again. (Weights of 16 adults averaged 19 grams.)

BEHAVIOR OF THE PAIR DURING NESTING.

Voice. The male sang frequently at various distances from the nest. He had a variety of songs and calls; the call that was heard most frequently could be called *churr*, *thurr*, or *teer*. His songs were heard at all hours of the day and were particularly noticeable near dusk when he usually sang for some minutes from trees north of the house, some twenty feet from the nest. Then, as he sang, he gradually moved toward a dense shrub planting about one hundred and fifty feet from the nest. There he apparently roosted for the night, accompanied by his mate after she ceased night brooding. On July 22, he began his evening songs at 6:14, singing for four minutes

at a time. His mate had settled on the nest at 5:35; his last song was given at 6:54 (sunset 7:00).

On July 26 at 6:18 p.m. as I sat on the steps near the nest box, the pair arrived together. She carried nest material in her bill. Both perched in shrubs nearby; the male, disturbed by my proximity, started rasping notes, bouncing up and down as he bent and straightened the tarsal joints. I hurried indoors to watch from the window; the rasping ceased and the female went into the nest with her bill full of fibres and settled to brood for the night. These rasping notes were used at various times by both birds as scold or alarm notes.

On August 3, the hatching day, the male sang evening songs at 6:36 (sunset 6:50) and his mate twittered in response from the nest; August 4, last songs were heard at 6:30; August 8, the final evening songs were given in loud tones from the roosting shrubs at 6:41, four minutes before sunset. On August 12, final songs from the shrubs were heard three minutes before sunset; August 14, he sang from there at 6:24, fifteen minutes before sunset and on the following evening, the final notes were *churr* at 6:20 (sunset 6:37).

When my watching started before dawn, songs, *churrs*, and other notes could be heard from the roosting shrubs as the male or both birds gradually moved toward the nest. On August 8, vocal sounds began at 4:42 (sunrise 4:59); August 13, they started at 4:45 (sunrise 5:04), continuing at intervals until 5:13; August 16, the last day of nest life for the brood, songs started at 4:53 (sunrise 5:06). At 4:59, faint notes came from the young in the nest, apparently in answer to the loud songs of the male beyond the house. However, the wrens were not the first birds to give vocal notes. Earlier that morning a Mourning Dove *Zenaidura macroura* (Linnaeus), cooed; a Brown Thrasher, *Toxostoma rufum* (Linnaeus), "sputtered"; a Wood Thrush, *Hylochicla mustelina* (Gmelin), gave "quit"; a Cardinal *Richmondia cardinalis* (Linnaeus), "chipped". At 4:45 a Mockingbird, *Mimus polyglottos* (Linnaeus), "chucked"; a Blue Jay, *Cyanocitta cristata* (Linnaeus) called. At 4:47 a Yellow-billed Cuckoo, *Coccyzus americanus* (Linnaeus) started a lengthy series of "cow, cow" and five minutes later a Crow, *Corvus brachyrhynchos* Brehm, "cawed" in the distance. But excepting the Dove and the Cuckoo, the Carolina Wren was the earliest singer on this cloudy mid-August morning.

Very often his songs seemed to be a signal to the female to leave the nest. When feeding young, his appearance with food was often preceded and followed by songs at some distance from the nest.

Both adults used a short rather metallic note that was somewhat musical, a series of these notes giving a tinkling effect. The female never was heard using the *churr*.

At the nest, both used soft *tweet* notes. A twitter was often used

which seemed to be a series of *tweets* given in fast time with no pause between the syllables. The *tweet* and the twitter were used by the pair during the entire nesting period and the former by the baby birds in the latter part of nest life. As the male approached the nest during incubation, he used *tweets* and was answered in kind by his mate from the nest. Often as he sang or called from a distance, she twittered in answer although it is very doubtful that he could hear her. *Tweets* were used by both parents as they perched on the nest with food.

On August 14, two days before the young left the nest, the twitter became a loud chatter as the female began a different type of behavior, perching on the porch peak, stretching and preening between the chattering. These louder notes, a few feet from the nest and easily heard there, seemed to be the beginning of an attempt by the female to interest the large nestlings in sounds beyond the nest. On the fledging day, this behavior was exaggerated as the adults came back and forth, definitely coaxing the young to leave.

Up to August 14, the male had made no sounds at the nest except the *tweets*, but on that day he uttered a fairly loud *churr* at the nest when the female was chattering and stretching on the porch peak.

During Nest Building. In 1940, a male built what appeared to be a complete nest while singing for a mate in late June and July but he was unsuccessful in securing one.

On August 5, 1937 I saw the female of a pair gathering dog hairs beneath our garden chairs and carrying them by beakfuls to a window box on the house. They were used for lining the nest among the ivy vines. The male sang as she worked, from distances of a hundred feet, as he flitted about. Once he joined her at the chairs but did not carry any material to the nest. She used soft *tweets* while he was near her.

In 1946, the nest in the porch eaves box was built by the male in May, but not used by his mate then. After her successful nesting in the cedar tree, the female accepted the eaves box nest, adding some material. The male accompanied her on some of those occasions but brought no material. During the first week of incubation, the female brought small amounts of fibrous material or short hairs, and a bit of cellophane. On six occasions, July 22, 23, 26, 27 she returned with material in her bill after a period off the nest and remained to resume incubation. On July 23, after three days of incubation, she brought material that morning on three return trips, approximately an hour apart (two small loads of fibrous material and the small strip of cellophane).

From these data, it appears that the male will start the nest but the female completes it. Nice and Thomas (1948) report that their Carolina Wrens worked together on the first two days of nestbuilding

but after that, he brought no more material but she carried in lining for four mornings and continued to take hair or grass blades occasionally until the eighth day of incubation.

In January 1933, I saw a Carolina Wren (sex unknown) carrying old material out of a martin house and dropping it over the platform edge.

During Incubation. The male showed interest in the nest during this period by occasional short visits to it. Eggs had been deposited daily during the first hour of daylight and apparently neither bird went to the nest during the day during this period. During incubation I saw the male there eight times between July 26 and August 2. On July 26 and 31, the female was absent when he came. On the former date, he approached with short musical notes, perched on the rim of the box and looked into the nest for a few seconds. On the latter date (incubation eleven days), I found him at 6:24 a.m. perching on the rim of the nest box, again looking into the nest. Then he changed his position to face the opposite direction. He leaned far over the outside of the box (front) as if to inspect the original entrance which was not usable as the nest had been built against it; then he flew. His other visits occurred at various hours of the day as his mate sat in the nest.

On July 27 at 2:08, the male Carolina Wren came from the porch peak, using rasping notes as he hopped down the roof to the eaves to look into the nest, using soft *tweets*. Before he was visible to her, his mate responded with soft twitters. On July 29 about 11:00, he came to the porch peak, uttering soft twitters; she answered with twitters. He squatted on the peak briefly in the sun, then flew a few feet to a tree where he sang loud songs. She left the nest, hopped up the roof and joined him in the tree. Later that day, after a period off the nest, he returned with her to a tree near it, where he remained to *tweet* as she resumed incubation and answered him. Then he flew to the porch peak, hopped down the roof and looked over the eaves, using soft notes as she twittered to him. On August 1, the pair arrived together about 10:00 but the male preceded her to the rim of the nest box to look into the nest, then flew to another perch as she settled. August 2 about 6:00 a.m. after loud songs, he hopped about on the eaves above the box and she left the nest to join him. On all of the visits of the male near the box, there were soft conversational *tweets* or twitters between the pair.

It was quiet evident from the behavior at this nest and the one in Warner Parks in 1946 that pairs of Carolina Wrens habitually forage together during the incubation period, that the male often calls his mate from the nest, and that he often returns with her, waiting on some inconspicuous perch until she settles on the nest. This was not true of the 1946 pair of Bewick's Wrens (1946a) for

he arrived several times with food for her while she was absent, and he was never seen accompanying her to or from the nest.

Wight (1934) states that a Carolina Wren brought food into the nest box while his mate incubated and that this same bird fed Crested Flycatcher, *Myiarchus crinitus* (Linnaeus), nestlings in a nearby box.

In observations at two nests of the Bewick's Wren (Lack, 1941; Laskey 1946a), I have seen the male carry food into the nest to the incubating female. But at the two July 1946 nests of the Carolina Wrens, neither male brought food to his incubating mate. The Arkansas Carolina Wren brought food to his mate through the entire incubation period, April 29-May 12 (Nice and Thomas, 1948). It is possible that, when there are fledglings from a previous brood, male wrens, like the male Cardinal, devote their attention to the young and do not feed the mate (Laskey, 1940).

Like the female Bewick's Wren, the Carolina Wren had a favorite route to and from the nest during the entire nesting period. It was used at least 60 percent of the time. She hopped from the nest to the box rim, to the brick wall adjoining, up the wall a few inches, then a flight of a few wing beats to the porch eaves, hopping up the roof to the peak and flying from there. When returning, she used the same route but hopped directly into the nest from the porch eaves. Her alternative route was a direct flight from the box edge through the open end of the "airshaft".

The male never was seen in, or on the rim of, the nest. He always perched on the edge of the box adjacent to the nest rim.

Defense of the Nest. Neither of the pair was pugnacious or unduly excitable at the nest. In the many hours that I watched, the only occasions when they scolded me were when I was out of doors in the vicinity of the nest when the pair arrived. They used rasping notes.

Occasionally a small dog slept on the ground about ten feet below the nest. During incubation and the early part of the nestling period, the female merely spent several seconds, or more than a minute, looking down at him before going into the nest. After the young were six days old, the presence of the dog caused the adults, on several occasions, to use the rasping and metallic notes. One adult, bringing a larva to the eight-day old nestlings, used *tweets* for two or three minutes, then without feeding, flew to a higher perch and swallowed the food. Then rasping notes were directed to the dog.

Twice during incubation, the two young of the earlier brood were ignored as they hopped on the roof near the nest as their mother sat in it. On the seventh day, the incubating female ignored a House Sparrow, *Passer domesticus* (Linnaeus), that she met on the roof just above the nest. On the tenth day as she slowly left the nest in answer to the loud singing of her mate, she encountered a "mud dauber" hovering near the box. She thrust her head forward in a

peck gesture toward it, but moved on with no further notice of it. On the eleventh and twelfth days, several truck loads of coal were put into the basement by means of an exceptionally noisy automatic chute. This terrific racket seemed to be tolerated without unduly disrupting the incubation rhythm. She remained on her nest a portion of the time, and slipped in and out as quietly as usual.

On August 6, when the nestlings were three days old, a Ruby-throated Hummingbird, *Archilochus colubris* (Linnaeus), flew to the box while both parents were absent but left immediately as one of the adults arrived with food. Each ignored the other. A week later, a Hummingbird again came near the nest box while the young were alone but rose immediately to disappear over the house.

During Nestling Period. Both parents brought food and participated in nest sanitation. After the first few days, it was not possible to identify each parent on all trips to the nest. On the first two days when the female brooded for lengthy periods, the male assumed the greater part of the food-gathering task. When she was on the nest, he passed the food to her for feeding. Occasionally as he arrived, she left the nest and he fed the young. When they were one day old, he delivered 12 or half of the total number of feedings to her but four days later, he delivered only one to her. After that, each fed individually.

Tabulations show that the male brought at least half of the meals after the female ceased brooding. Walkinshaw (1935) found that during his observations, the female Short-billed Marsh Wren did most of the feeding while the male spent his time singing.

Some of the fecal sacs were swallowed by the attending parent in the early days of nest life but at five days of age, all were carried from the nest to an undetermined distance beyond the house for disposal. Adults usually waited briefly after a feeding, but always several meals were brought before voidance took place. One instance of substitute activity was observed when the female waited in vain for a sac. Hopping up the wall when leaving, she encountered a dry brown leaf that had lodged against the rough brick. She picked it up and left with it in her bill as if she were disposing of a fecal sac.

SUMMARY

Some general information is given for 37 nests of the Carolina Wren at Nashville, Tennessee (1936-1946). Details are given for more than 150 hours of watching of one nest at my home (July-August 1946).

Of 37 nests, 17 were built in bird boxes, one in a small cedar tree, and the others in various receptacles or on ledges.

Among 27 nests, where clutch size is known, sets consisted of three to six eggs, with five eggs sets predominating (52 percent).

Six eggs sets were laid in April and May; the July and August clutches contained three to four eggs. Egg laying may start in March.

In two nests noted, the males started building. The females completed the nests and were accompanied part of the time by their mates but the males did not participate in the final part of the work. The female added material to the lining after incubation had started.

Incubation and brooding was by the female. The male showed interest by brief visits during incubation. In two nests that were watched, the male called his mate from the nest by songs and call notes, accompanied her on foraging trips, and returned to the vicinity of the nest with her. At these July nests, the males did not feed the incubating female on the nest.

In six instances where incubation period is known, it varied from 14 to 15.5 days after laying of the last egg.

In six instances where the nestling period is known, it varied from 12 plus to 15 days. The shortest incubation-nestling period was 24 days, August 11-September 4.

One pair is known to have raised three successful broods in a season.

At one nest, built in a mail box, Bewick's Wrens usurped the box when the Carolina Wren had laid four eggs of her set, completely covering the eggs.

For the nest at my home, data are given on weather, behavior of adults, incubation rhythm, hatching of eggs, brooding, feeding, nest sanitation and fledging of young.

In 66.6 hours of watching during incubation, the female spent 41.7 daylight hours on the nest (63 percent) and 24.9 hours off (37 percent). The attentive periods ranged from 11.5 to 136.5 minutes, averaging 57.5. The inattentive periods ranged from 09 to 70 minutes, averaging 33.5 minutes.

The set of four eggs was completed on July 20; three eggs hatched by 8:30 a.m. on August 3. The fourth egg did not hatch until 4:30 in the afternoon. The baby was a weakling and did not survive.

When the nestlings were one day old, the female brooded 65 percent of the time, decreasing the daytime brooding to 11 percent when they were four days old, and none after that.

The parents shared about equally in feeding the young and in nest sanitation. August 4 through August 11, when the young were from one to almost nine days of age, three nestlings received 218 meals in 42 hours, averaging five per hour or 1.6 meals per bird per hour.

On the night of August 11, temperatures dropped to 62°F (or lower) and one nestling died. Despite abnormally chilly nights, the female did not brood after the young were four days old.

For the last four full days of nest life (August 12-15), two nestlings received 148 meals, averaging 6.4 per hour or 3.2 per hour per bird.

Feedings were brought more often at certain periods of the day with the lag occurring in late morning and late afternoon. First feedings of the day (on four days) started at one, three, nine minutes after sunrise and five minutes before sunrise.

Final feedings for the day (on ten days) varied from six to 38 minutes before sunset.

The two surviving nestlings left the nest at 13+ days of age on August 16, one flying at 2:18 and the other at 2:26 p.m. The parents coaxed the young from the nest, coming many times without food, using vocal notes, and perching near the nest with food in the bill.

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