

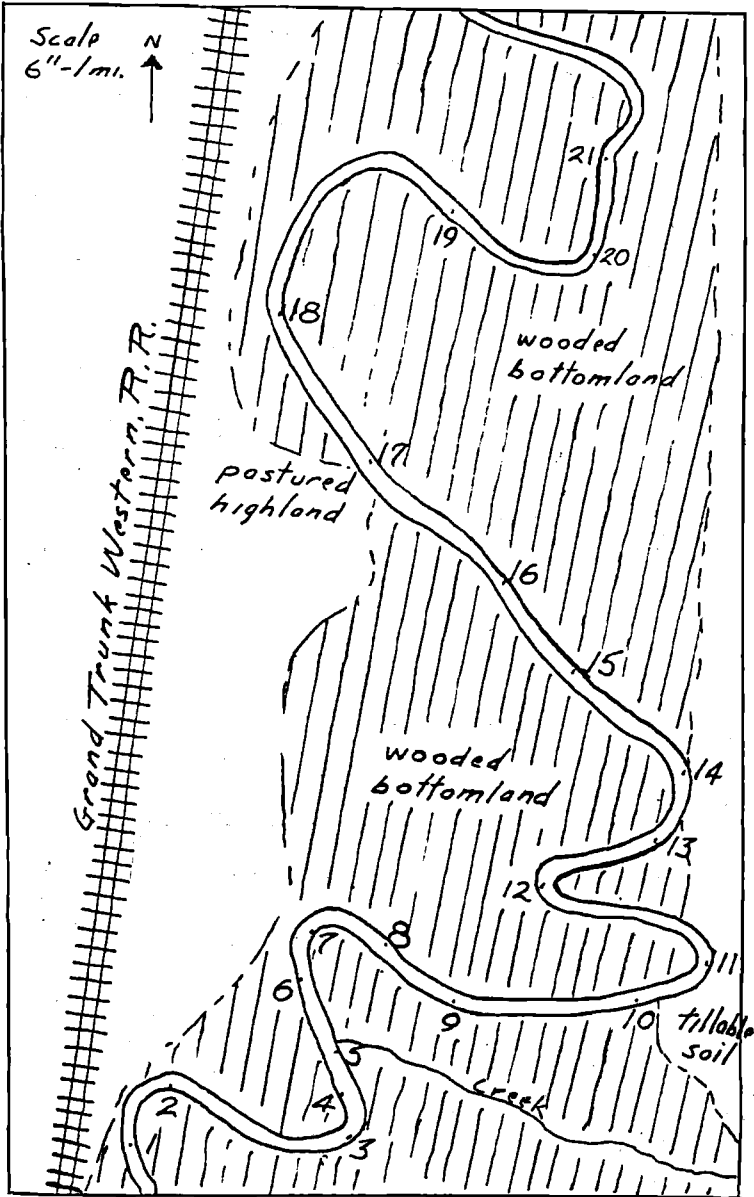
NESTING STUDIES OF THE PROTHONOTARY WARBLER

By LAWRENCE H. WALKINSHAW

Winding streams, bordered densely with oak, maple, ash, and elm, shallow ponds with groups of protruding willows and flooded, heavily shaded bottom-lands are favorite nesting habitats for the Prothonotary Warbler (*Protonotaria citrea*). Such habitats occur along the banks of the Kalamazoo River and its tributary the Battle Creek River in Calhoun County, Michigan.

During several years of observation, this species was found to be abundant during the breeding season in Convis Township, ten miles northeast of the city of Battle Creek, with the result that this area was selected for the study of the Prothonotary's nesting habits. Twenty-two bird-houses were erected on an area of between one and a quarter and one and three quarters miles in extent (see map). C. J. Henry and I had previously (in 1933) placed five nest-boxes along the Kalamazoo River west of Battle Creek and had spent much time in constructing them with the exception of one made merely by nailing a piece of bark around a round block of wood, then turning the top over a little on one side as a protection against rain. Of the five houses, the Prothonotaries had selected only this one as a nesting-site. During 1936, two houses made merely by nailing a few old boards together had proved attractive to the species when placed about two feet above the low-water river-level. These houses were in place before the winter months had raised the river to its accustomed higher level. By the first of May the flooded boxes were all again above the water level with the exception of box number 1, which had been washed out, another house which was destroyed during May by wood-cutters, and a third, number 13, which was never sufficiently above the water to be of any use. The following preliminary report deals with the nesting studies of the remaining nineteen houses during 1937 and the additional nests on or near this area. The accompanying map shows the situation of the houses in relation to one another.

From May 16th until July 3d, the hours from 5 to 7.45 A.M. were spent in a canoe along this area inspecting the contents of the nests and studying the behavior of the adults. In addition, every Thursday afternoon, every Sunday forenoon with few exceptions, and often Sunday afternoons were spent in the canoe or photographing from a blind. From July 4th through July 15th two young men, Wayne Tice and Carleton Akers, examined the few remaining nests. Twenty-one miles were driven by motor-car on each trip to this area, and an estimated four miles paddled by canoe. An approximate total of 1463 miles were driven merely to the area, without including several hundred-mile trips to study additional nest distribution in adjacent counties. An estimated 232 miles were paddled by canoe. Approximately 204 hours were spent



Battle Creek River, Convis Twp.,
Calhoun County, Michigan.
1937

studying the species during 1937 in addition to the many hours spent during previous years, especially during 1930 and 1933. At all times it was necessary to wear hip-boots, a heavy mackinaw, hat, and a neckerchief to keep away the hordes of mosquitoes. A set of Eastman Studio Scales graduated to one tenth of a gram were used in taking weights and a millimeter rule, dividers, and calipers for taking measurements.

The river, at the place where the study was made, was normally about one hundred feet across, having a variable depth, and many jams of old fallen trees. The banks were covered with a heavy growth of trees.

ARRIVAL DATES

The arrival dates of the first birds observed, during eight years, 1930-1937, and the last date of observation for each year follow:

Year	First	Sex	Second	Common	Last
1930	May 11	both	May 13	May 13	August 27
1931	May 10	male	May 14	May 16	August 16
1932	May 7	male	May 8	May 11	August 21
1933	April 30	male	May 2	May 14	September 4
1934	May 2	both	May 4	May 4	September 9
1935	May 11	male	May 12	May 12	
1936	May 6	both	May 7	May 9	July 30
1937	May 11 ¹	male	May 15	May 16	July 25

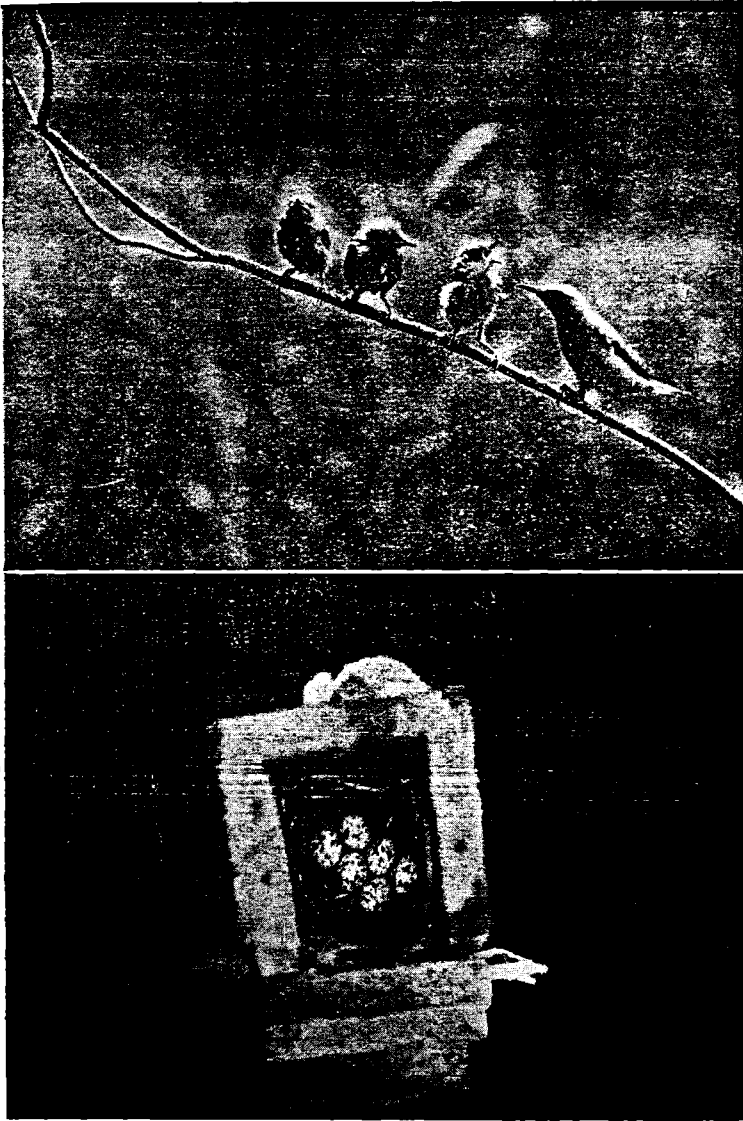
In spring observations the males are easily discovered because of their songs. The male Prothonotary Warbler certainly does not precede the female by many days. The earliest date for the arrival of the male was April 30th and that for the female May 2nd. Evidently the males are two or three days earlier. At Ann Arbor, Washtenaw County, seventy eight miles east of Battle Creek, in an area drained by the Huron River, the Prothonotary has been noted as much scarcer. Observations by Wood and Tinker (1934), covering a period of fifty years show April 11, 1916 as the earliest date. This is an exceptional date, their next earliest being May 8, 1896, when a pair was found nesting near Ann Arbor (Barrows, 1912).

Prothonotary Warblers, both males and females, do not become abundant, however, until May 10-15, when their voices can be heard from most any vantage point along the river, the males in song and both sexes with their sharp call-note. Almost immediately upon arrival the birds select their territories and nest-building begins.

SONG

The song of the Prothonotary Warbler is very distinctive, a rather loud *tweet-tweet-tweet-tweet-tweet*, uttered in the vicinity of the nest. The male usually has several perches from which the song is given.

¹ Observation by Mr. and Mrs. N. T. Peterson.



Upper Photograph: Male Prothonotary Warbler and Young
Lower Photograph: Nest and Eggs of the Prothonotary Warbler

Rather than definite singing-perches it is more accurate to say singing-trees or regions, for the male is a very active bird, and in guarding his territory he continually moves from one position to another in the vicinity of the nest, giving his song several times from each place. Usually these places are in certain definite trees or shrubs but not necessarily, as I have said, from definite perches. Yet on approaching the nest when feeding the female or young he usually follows through these trees with food in his mouth, uttering as he goes, the song which so enlivens these southern Michigan rivers. Uttered at the rate of five or six times per minute, the song lasts slightly over one second. It is given all day long from the time of arrival until the young have left the nest and has been heard as late as the 16th of August (1931). The frequency is much greater during the early nesting season and during the earlier hours. During midday on warmer days the number of times per hour seems much less. Later, from four until near sundown, it again increases. During late nesting, when the young are about to leave the nest, the rate again decreases, but it is heard several days after the young leave the nest. The songs of the various males differed somewhat. One male could be easily identified for some distance along the river. Another song, a flight song which I have never heard, has been described by Roberts (1932) as follows: "Now and then the male darts up above the tree-tops and, with drooping tail, fluttering wings, and head thrown back after the manner of the Maryland Yellow-throat, delivers a love-song consisting first of the usual rapid monotone of five or six notes and ending with a pleasing, varied warble, full and strong in some of its notes and far sweeter than the usual utterance."

The Prothonotary defends his territory with vicious flights at an opposing male or a bird of any other species that approaches too close. I have never seen any offender remain long after this procedure starts.

The call-note is a strong, sharp rather metallic *chip* resembling somewhat the call-note of the Louisiana Water-Thrush (*Seiurus motacilla*), which is also found along the same river-banks.

NESTING

Of the 28 nests found during 1937, 19 were in bird-houses over running water, 6 were in stubs over water, (2 of which were over running water), and the other 3 were in natural holes back from the river-bank. Of 44 nests found from 1930 through 1937, excluding the 21 in bird-houses, six were over running water in old woodpecker holes, one in a bridge-support in a slight depression, and nine in natural holes over standing water. Seven were in old woodpecker holes from two to a hundred and sixty feet back from the river-bank.

The height of the nests above the water varies considerably, especially with an increase in rainfall. The June rainfall during

1937 was 8.12 inches, the average for the past six years being 3.70 inches in June. Consequently rivers became swollen and bottom-lands flooded. Once during a period of forty-eight hours in late June the river rose between fifty four and sixty inches. Such an increase, of course, was fatal to most of the low-nesting species in the area along the river, and the Prothonotary Warbler was no exception. Although the houses were examined each morning, occupied houses being continually shifted to two or three feet above the water-level, this sudden and extensive rise surprised us, and one morning every occupied bird-house was under water. Many parents returned as soon as the houses were raised above the water-level, and the eggs were incubated, but these eggs, with one exception, failed to hatch, the parents finally deserting the nests. Sixteen nests over water in natural stubs were from one to twelve feet up, averaging 5.6 feet, above the normal water-level. Seven nests over the land were situated from four to fifteen feet above the ground averaging 6.75 feet.

Moss constituted the bulk of the nesting material in nearly all cases, completely filling the nest space whether it was large or small. On top of this the nest proper was shaped and a rough lining of coarse grape-bark, dead leaves, black rootlets procured from the river-banks, and poison-ivy tendrils was added. Above this a lining of much finer rootlets, leaf-stems, and very fine grasses was used. The nest proper measured from 55 to 65 mm. in diameter at the top, averaging 59.3 mm. while the depth varied from 29 to 65 mm., averaging 42 mm. One nest with the whole front open, bordered by a wreath of poison-ivy vines and leaves, had a thickness of 50 mm. Another nest found in a similar stub, not protected at all above except by poison-ivy leaves, was merely a lining with a few coarse rootlets. Still another nest, built in a natural hole in a willow stub, had an entrance in a rotted section at least fifteen inches above the nest. The floor of the chamber was four or five inches across, and sunk to the rim in one corner was the neat nest of the Prothonotary, appearing much different from the regular type of nest.

The weight of six nests varied from 3.1 to 68.3 grams, averaging 28.6 grams. These weights were taken after the nests had been used. If one nest was destroyed, often when the same bird or another nested in that house the old material was left and the new nest constructed immediately over it.

Nesting during the years 1930-1937 began from the middle to the last of May and continued until late June or early July. The earliest nests each year were May 24, 1930, nest with three eggs; May 16, 1931, nest under construction; May 20, 1932, nest with four eggs; May 24, 1933, nest under construction and May 31, with six eggs; May 22, 1934, nest under construction; May 24, 1936, two nests, one with seven eggs, the other with six eggs; and May 16, 1937, four nests under construction. [During 1937 the first eggs were

laid in eight nests as follows: May 22d, 23d, 23d, 25th, 26th, 28th, 29th and 31st. Nesting continued from May 16th until July 14th, when the young were destroyed in the last nest. This also was the latest nesting record of the species, and if the young had lived until fully fledged, they would have left the nest July 22d-23d.

The time required in the construction of nests varied, first nests requiring longer than second or third nests. During 1937 ten nests, evidently all the first constructed, required 7, 6, 11, 8, 2, 3, 2, 4, 6, and 4 days to build, averaging 5.3 days. These were listed from May 16th to 31st. Nine nests built during June, (probably all second nests but possibly one first nest) required 6, 1, 1, 1, 4, 1, 1, 1, and 1 days to build, averaging 1.8 days. However, these later nests often had some lining material added after one or two eggs were laid.

The female was observed to do most of the work usually, but males were occasionally observed carrying moss sometimes in green bulky mouthfuls to the nesting-site.

A resting period, after early nest-construction, varied from one to five days averaging nine nests, for 3.2 days. In case of later nests, as mentioned above, the first egg was laid almost invariably the day after the nest was started.

THE EGGS

The eggs of the Prothonotary Warbler as a rule are laid one each day until the set is complete. This is not always the case, however, for in 1937 nest No. 1 contained the first egg on May 23d and the second was not laid until May 26th, the third being laid on May 27th.

The eggs are usually laid during the early morning hours. Nest No. 1 (nest-box 10), when visited May 27th at 5.30 A.M., contained only two eggs, but the female was flushed from the box, and when I returned at 7.00 A.M., it contained three eggs and the female was gone. In most nests this was the usual hour for deposition of the eggs, but occasionally, as in nest 5 (nest-box 12) twice the additional egg was found as early as 5.30 A.M. with the female still on the nest. Sometimes the female would enter the nest at this hour in the morning, but the nest would not contain an additional egg until the following morning. One female, at nest-box 16 (nest No. 11), when caught at 5.30 A.M. on June 5th, laid an egg in the canoe while I was banding her. Incubation evidently began the day before the last egg was laid, as in all cases on late afternoon observations no parent remained on the eggs at night until that time.

In three nests during 1937 Cowbirds' eggs were laid. In No. 1 (nest-box 10) one egg was laid on May 18th, four days before the first Prothonotary egg; in nest 5 (nest-box 12) one egg was laid the same morning as the first Prothonotary egg; and in No. 28, the nest contained, when found, one Cowbird egg, two Cowbirds three or four days old, one Prothonotary egg, and one runt Prothonotary young about two days old.

The exceedingly heavy rainfall during 1937, although taking

considerable toll of the young produced, brought out some interesting habits. On May 29th, when the water rose about two feet, two or three boxes were partially under water. These were immediately raised two or more feet above the water. Nest No. 3 (nest-box 2) had lost one egg (No. 2), but on the following morning at 6 A.M. it contained two additional eggs. Nest 5 (nest-box 12) was almost under water on May 28th, one day after the last egg was laid, and was the only flooded nest to later contain young when three hatched. If a nest had been under water more than twenty-four hours the birds immediately began another nest. If not, in every case but one they returned and continued incubating.

The eggs were white or nearly white in ground color, very glossy in all but two nests; these—nests 11 and 19 (boxes 16 and 19)—had sets of eggs very chalky and rough with very few dark spots.

HISTORIES OF BANDED RENESTING FEMALES, 1937

Band No.	Nest No.	Nest Box	Nest Built	Eggs Laid	Eggs Hatched	Young Left	No. Eggs
37-103950	12	natural hole		2 before May 30 May 30, 31, June 1	Destroyed June 4		5
37-103950	17	natural hole 20 feet from nest 12		Last egg June 12	Destroyed June 16		4
37-103949	5	12	May 18-21	May 22-27	June 10, 3 eggs	Destroyed June 13	6
37-103949	24	natural hole $\frac{3}{4}$ mile upstream		June 20, 21, 22	Deserted July 8		3
37-103948	9	21	May 21-25	May 29- June 3	June 14 (2 and 3) June 15 (4 and 5)	Destroyed June 15	6
37-103948	23	21	June 17-18	June 19	Destroyed June 19		1
37-103948	25	21	June 21		Nest box flooded June 22		
37-103947	2	7	May 16-27	June 1, 3, 4	Destroyed June 4		3
37-103947	22	6	June 14-16	June 17-21	Flooded June 22		5
37-103946	11	16	May 29-30	May 31, June 1-5	June 16 (2 and 4) June 17 (5)	Young drowned June 22	6
37-103946	27	16	June 27	June 27-30	July 12 (1, 2, 3)	Destroyed July 12	4
37-103945	10	8	May 23-31	June 3-7	Destroyed June 11		5
37-103945	20	8	Used same nest	June 15, 16, 17, 18 and 20	Flooded June 22 Deserted		5

The spots were also larger than normal. Usually the spots covered the entire egg and were reddish brown in color, often very fine and with a concentration around the larger end, but sometimes with a heavier wreath around the widest part of the egg. In some eggs only a few fainter lavender spots were noted. In one set of eggs (1937 nest 24) laid by female No. 37-103949, who had laid a normal-colored set in nest-box 12 (nest 5), the spots were much coarser and of a much lighter shade of reddish brown and were almost evenly splotched over the entire egg. Most sets were uniform in color, yet the same bird did not always have consecutive sets alike. No. 37-103946 (at nest-box 16, nests 11 and 27) laid a first set with a rough appearance. Later, after the young had been drowned in the nest on June 23d, this bird laid a second set in the same house June 27th to 30th which were perfectly normal in appearance. These are summarized in the table shown on page 39.

Five other females were banded, but they were observed at only one nest so are not included in the above list. No. 37-103944 was the only banded female to raise a brood during 1937. She evidently did not renest.

One notes in the above list that after a nest of eggs or young were destroyed there was only a short period before the first egg was laid in a new nest. These periods for the different birds ranged from 4 to 7 days. The number of eggs known to have been laid by these same females during the summer was respectively 9, 9, 7, 8, 10, and 10.

The sizes of the sets of eggs which have been recorded by months are as follows:

	<i>May</i>	<i>Early June</i>	<i>Late June</i>
3 eggs	none	none	2 sets
4 eggs	1 set	2 sets	1 set
5 eggs	1 set	4 sets	1 set
6 eggs	6 sets	1 set	none
7 eggs	2 sets	none	none
Average	5.9 eggs	4.8 eggs	3.75 eggs

The sets in May, including nests in which the first egg was laid on or before May 31st, are larger. The next classification included nests in which the first egg was laid before June 16th, while the third column includes nests in which the eggs were laid between June 16th and 30th. No nests were found in which eggs were laid in July.

The measurements of 78 eggs averaged 18.47 by 14.55 mm. The smallest of these was 17 by 13 mm.; the largest 20 by 15mm.; another measured 19 by 16 mm., giving the widest measurement. The average weight of 74 eggs taken when fresh was 2.07 grams, the heaviest being 2.35 grams and the lightest 1.2 grams. The weights of eleven eggs when fresh and at hatching time were as follows: Fresh weight (total) 21.5 grams; Weight at hatching time

(total) 18.2 grams; loss 3.3 grams, or 15.38 per cent loss during incubation.

INCUBATION

Incubation started in all nests the day before the laying of the last egg. It was performed entirely by the female. The male often came near the nest and made a faint *chip* that attracted the female, whereupon she would leave her nest-box to get insects that he brought her. At one nest he came to the entrance and fed her. In shallow nests she often peered out through the opening, but usually she was entirely out of sight and did not leave until something touched the entrance of the cavity.

Female Prothonotaries are easily caught while incubating, even if considerable noise is made in approaching the nest. They are very close sitters. However, if they have been once captured, they depart much quicker, leaving, sometimes, at the least swish of the canoe paddle. Some were not bothered in the least when caught; they were just as easy to catch the second time. When flushed from the nest the female usually began a persistent chipping. At one or two nests the bird leaving the house would flutter down and just above the surface of the water feigning injury until she reached the bank, where she would rise directly to a branch and start scolding.

Incubation required a period of thirteen days for eggs 1, 2, 3, 4, and 6 in nest No. 4 during 1937, and for egg No. 5 slightly over 13 days. For nest 9 the incubation period for eggs 2 and 3 was 13 days, while for eggs 4, 5, and 6 it was over 12 days. In nest 11, the incubation period for eggs 2, 4, and 5 was slightly under 13 days. At nest 27 the incubation period for eggs 1, 2, and 3 was 13 days. The incubation period of this species, as observed on these marked eggs, was between twelve and one-half and thirteen and one-half days, averaging for the 17 eggs about 12 days and 18 hours.

Out of a total of 36 eggs known not to have been flooded 34 hatched. During 1937, only 24 of 98 eggs hatched. Of these only 9 young lived to leave the nest, a very poor record chargeable mostly to the high-water conditions. A total of 123 eggs examined between 1930 and 1937, carefully checked, produced 41 young which is 33 percent. Of these, 26 lived to leave the nest.

THE YOUNG

The average weight of 16 young on the day of hatching was 1.84 grams. The average length of the wing was 6.24 mm.; the tarsus 5.55 mm., and the culmen 3.52 mm. The color of the skin was rather a slaty light gray with dark gray to nearly black natal down. When lying in the nest the young, early in life, have the head curled down underneath the body. They raise the head at the slightest noise and open the mouth for food. The eyes are closed, showing a prominent area of deep venous blue beneath the surface.

The average weight when one day old was 2.77 grams; average measurements of 13 young were: wing 8.05 mm., tarsus 7.23 mm.,

and culmen 4.0 mm. The primaries and secondaries showed through the skin in a dark line.

Average weight when two days old was 4.07 grams and average measurements of 10 young gave: wing 11.4 mm., longest primary 1.37 mm., tarsus 9.2 mm., and culmen 4.5 mm. In some of the young at this age the eyes were beginning to open. At this time the male does most of the feeding.

The average weight of 11 young when three days old was 6.05 grams. Measurements: wing 14.54 mm., longest primary 2.2 mm., tarsus 10.72 mm., culmen 5.18 mm. The eyes are now fully open and the feather-tracts well defined. The female now spends more time away from the young and aids the male much more with the feeding. Both parents remove excrement. At some nests they were observed to swallow it occasionally, at others to carry it off to some distant spot. This latter procedure was noted oftener as the birds became older. In approaching the nest the parents often followed a certain definite route; then, as they alighted near the nest-site, they peered about as though looking for enemies. When leaving they usually-left direct for some distant spot. The food at this age was always small insects.

Average weight of 12 young when four days old was 7.91 grams, the measurements were: wing 20.83 mm., longest primary 5.3 mm., tail trace, tarsus 13.66 mm., culmen 6.16 mm. The color of the breast feathers now shows clearly.

Average weight of 12 young when five days old was 9.83 grams. The measurements were: wing 25.77 mm., longest primary 10.6 mm., tail 1.0 mm., tarsus 15.55 mm., culmen 6.72 mm. Feather-tracts well defined; the occipital, frontal, mid-dorsal, tail, scapular, humeral, primaries, secondaries, mid-throat regions are covered with slaty-gray sheathed feathers. The femoral region and an adjoining dorsal area are covered with mixed slaty-gray and yellow sheathed feathers. The ventral tract, extending in an inverted Y separates at the upper breast, changing from slaty-gray on the throat and upper breast to yellow on the two areas on the sides of the abdomen.

The average weight of 11 individuals when six days old was 11.6 grams. The measurements were: wing 30.75 mm., longest primary 15.8 mm., tail 2.41 mm., tarsus 17.25 mm., culmen 7.86 mm., and the longest primaries unsheathed 2 mm. Feathers on the tracts named above are longer.

The average weight of 9 individuals when seven days old was 12.29 grams. Measurements: wing 37.1 mm., longest primary 20.88 mm., tail (slightly unsheathed) 3.77 mm., tarsus 18.44 mm., and culmen 8 mm. Young show first slight signs of fear.

The average weight of 8 individuals when eight days old was 12.37 grams. Measurements: wing 42.0 mm., longest primary 25.87 mm., unsheathed 6.1 mm., tail 5.75 mm., unsheathed 1.0 mm., tarsus 18.99 mm., culmen 8.37 mm.

The average weight of 6 individuals when nine days old was 12.55

grams. Measurements: wing 45.3 mm., longest primary 30.1 mm., unsheathing primary 14 mm., tail 10.8 mm., unsheathing 1.3 mm., tarsus 19 mm., culmen 9.1 mm. A few birds left the nest at this age when disturbed. Feathers are well unsheathed.

The average weight of 3 individuals when ten days old was 12.06 grams. Measurements: wing 48.6 mm., longest primary 33 mm., unsheathed 19 mm., tail 12 mm., unsheathed 3.3 mm., tarsus unchanged, culmen, 9.5 mm. Young leave the nest at this age in nearly fifty per cent of cases and are able to fly about one hundred yards. In leaving the nest the young fly up towards the lower branches of the neighboring trees. One young at nest 4 when leaving the nest accidentally flew into the river and immediately began swimming toward shore. He used the wings in propelling himself and was able to cover the distance easily.

The weight of one individual when 11 days old was 12.7 grams. Measurements: wing 51 mm., longest primary 37 mm., unsheathed 21 mm., tail 14 mm., unsheathed 4 mm., tarsus unchanged, culmen 9.5 mm.

At this stage each day shows a more rapid development of the feathers. Unsheathed feathers extend out over the unfeathered tracts with a few of the dark mouse-gray natal feathers protruding above the occipital region.

Both the male and female fed the young as they left the nest. A faint chip made by the young from their perches was heard. Larger insects were fed when the young were out of the nest and the last few days in the nest. Once a male was observed to bring Mayflies, which he stripped of the wings before feeding them to the young.

The above data are summed up in the table following:

PROTHONOTARY WARBLER GROWTH RATE, 1937

No. of Individuals	Age in Days	Weight in Grams	Wing in mm.	Longest Primary	Unsheathing of Primary	Tail	Unsheathing of Tail	Tarsus	Culmen
16	1-	1.84	6.24	0	0	0	0	5.55	3.52
13	1--	2.77	8.05	0	0	0	0	7.23	4.0
10	2	4.07	11.4	1.37	0	0	0	9.2	4.5
11	3	6.05	14.54	2.2	0	0	0	10.72	5.18
12	4	7.91	20.53	5.3	0	.5	0	13.66	6.16
12	5	9.33	25.77	10.6	0	1	0	15.55	6.72
11	6	11.6	32.75	15.3	2	2.41	0	17.25	7.86
9	7	12.29	37.1	20.88	4.3	3.77	.5	18.44	8.0
8	8	12.37	42.0	25.87	6.1	5.75	1	18.99	8.37
6	9	12.55	45.3	30.1	14	10.8	1.3	19	9.1
3	10	12.06	48.6	33	19	12	3.3	19	9.5
1	11	12.7	51	37	21	14	4	19	9.5

The juvenal plumage has been well described by Roberts (1932). In general the young appear much different from their bright-colored parents, having a brownish color above and yellow below.

The parents feed the young at least two weeks after they leave the nest, and the small family groups can be found until the middle

of August during some years, evidently long after the young have left their nest. Whether the adults are in these flocks I cannot say.

The majority of the Prothonotaries leave our rivers by the second or third of July. One may canoe some years a good many miles during the latter part of July or the early part of August without finding a single Prothonotary, whereas in other years many groups can be found. The majority evidently are early migrants. Very few remain until late August or early September, the latest date being September 9, 1934, at Battle Creek. At Ann Arbor (Wood and Tinker, 1934) the only fall date was September 6, 1919, covering a period of twenty-five years, 1906-1930.

Eleven adult females were caught in making this study. The weights and measurements of ten are summarized as follows:

<i>Number</i>	<i>Date</i>	<i>Weight</i>	<i>Wing</i>	<i>Culmen</i>	<i>Tarsus</i>
103940	6-18	13.6 gr.	65 mm.	13 mm.	19 mm.
103941	6-16	17.6 "	70 "	15 "	18 "
103942	6-13	18.5 "	70 "	15 "	19 "
103943	6-10	19.6 "	69 "	13 "	19 "
103945	6-6	17.3 "	69 "	15 "	19 "
103946	6-5	16.4 "	70 "	13 "	18 "
103947	6-4	18.9 "	70 "	15 "	18 "
103948	6-1	19.0 "	65 "	13 "	18 "
103949	5-30	17.4 "	67 "	14 "	17 "
103950	5-31	15.8 "	71 "	13 "	18 "
Average		17.41 "	68.6 "	13.9 "	18.3 "

103944 escaped before weights and measurements were taken.

The males are very hard to catch at the nest. Instead of entering the nesting-box or cavity, they stand at the entrance, bending down and in to feed the female or young, occasionally raising themselves to peer about, then resuming the feeding. They do most of the feeding during the first two days after the young hatch, the female doing the brooding. In one nest with three young, two one day old and one just hatched, the male fed the young eight times during a period of two hours. The female, although occasionally leaving the nest for periods of one to twelve minutes, did not offer to feed the young. The male did not remove any excreta, but the female was noted to swallow some on one occasion.

At another nest, with six young just out of the nest, aged nine and ten days, the parents were observed for a period of four hours, the male feeding four young 38 times, the female feeding 2 young 10 times. She, however, was somewhat frightened by my presence.

In removing excreta from the nest, the male was observed to carry it in his beak to a place somewhat distant from the nest, flying as he did so in a slow, deliberate manner as though he had a heavy load.

Concerning the enemies of the Prothonotary Warbler during the breeding season, I have never actually seen any destroy a nest and

eggs or the young, yet out of 27 nests on the area studied during 1937, only two were productive. Seven nests failed because of high water. Four nests met with violent terminations as they were found torn to pieces. All four of these nests were on trees along the river-bank and possibly squirrels were the culprits. Seven destroyed nests had House Wrens nesting in the same box within three days, and almost invariably a male wren was singing at the box when the eggs were gone. On several occasions a pair of House Wrens had begun building over an unfinished nest of the Prothonotary Warbler, but when it was next visited the Prothonotaries would be back in possession. Such nests met with failure in every case, the eggs usually disappearing during laying time when left unguarded. In two nests the eggs disappeared and the nest left intact but in these cases also House Wrens may have been responsible. One was in a nest-box on a pole extending out over the river, fifteen feet from the bank. Nothing could climb to it from the water, and the offender must have come by flying. Two other nests were in a neighborhood where English Sparrows were abundant.

SUMMARY

The Prothonotary Warbler nests rather abundantly along southwestern-Michigan rivers. Ten or eleven pairs nested on an area of one and one-quarter to one and three-quarter miles in extent during 1937. Nineteen out of twenty-eight nests were in bird-houses. They prefer nesting over running water wherever possible.

Construction of nests in May required an average of 5.3 days for 10 nests; later (June) nine nests averaged 1.8 days. Both parents help, the female doing by far the most of the work. Rest periods for nine May nests averaged 3.2 days. In later nests, the first egg was invariably laid the day following the beginning of its construction.

The eggs were laid usually before 7.30 A.M. daily until the set was complete. They were white or chalky-white, covered with reddish-brown and a few lavender spots. Ten sets averaged 5.9 eggs during May; seven sets (June 1-15) averaged 4.8 eggs; four sets (June 16-30) averaged 3.75 eggs. No nests were found in which eggs were laid in July. The rest periods between destroyed nests and the first-laid egg in the succeeding nesting for five females ranged between 4 and 7 days, averaging 5 days. Average egg measurements were 18.47 by 14.55 mm. Seventy-four newly laid eggs averaged in weight 2.07 grams. Incubation started the day before the laying of the last egg and was performed entirely by the female. The incubation period for 17 eggs averaged between twelve and one-half and thirteen and one-half days.

During 8 years of observation out of 123 eggs, 41 hatched (33 per cent) and 26 young left the nest (21.14 per cent of the eggs).

The average weight of 16 young newly hatched was 1.84 grams; that of 3 young ten days old, 12.06 grams, and 1 young eleven days

old, 12.7 grams. Most of the young left the nest when 10 days old, but some not until 11 days of age.

The female broods the young for two or more days while the male feeds them almost entirely. Later both parents feed them until they have been out of the nest at least a week.

The majority of the Prothonotaries leave for the South during late July or early August, a few sometimes remaining until early September.

Ten females averaged in weight 17.41 grams (13.6 to 19.6). No males were weighed.

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Battle Creek, Michigan.

DETERMINING SEX IN BREEDING BIRDS¹

By EDWIN A. MASON

THE value and importance of being able to determine the sex of banded birds is obvious to all coöperators. When the sexes are dissimilar in plumage, no difficulty arises, but with those species in which the plumage of the two sexes are always, or at times, alike, a real difficulty presents itself.

Through handling many adult breeding birds over a long period, and actuated by the thought that there must be some differences between the sexes, however slight, the writer eventually formulated a system which has decided values in determining sex.

Feeling that perhaps this discovery was not new, although no reference to the ability of being able to determine sex in living birds except by plumage and measurements had ever come to the writer's attention, the subject has been broached on many occasions to workers in the banding field. Among those with whom the subject has been discussed, only Mr. James L. Peters, of the Harvard Museum of Comparative Zoölogy, indicated having a prior knowledge of the subject, and it is desired here to acknowledge the helpful criticisms and suggestions made by Mr. Peters during the preparation of this paper.

It is, therefore, in the hope of bringing the matter to the attention

¹ A contribution from the Wharton Bird-Banding Station, Groton, Massachusetts.