A STUDY OF TWO NESTS OF THE BLACK-THROATED GREEN WARBLER[1]

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PART I

IN the summer of 1931 in Pelham, Massachusetts, we had the privilege of watching two nests of the Black-throated Green Warbler from incubation to the leaving of the young. Ninety-four hours were spent in the study of the first nest, which was found July 9th, and forty-six hours at the second nest, located July 26th.

CHRONICLE OF THE JULY NEST

Early in the morning of July 9th a female *Dendroica virens virens* was met a half-mile south of my mother's house; she gave a few chirps and disappeared. I followed the direction she had taken and soon discovered her sitting on her nest, in a hemlock (*Tsuga canadensis*), fifteen feet from the ground and six feet from the trunk. The nest was well protected by sprays above, but was easily seen from below. To the east stood a grove of hemlocks and one primeval white pine (*Pinus Strobus*); in other directions the trees were largely hardwoods with considerable undergrowth. We watched the nest from a point twenty feet to the north and in full view of the bird.

Incubation. The length of the periods on and off the nest from 8:10 to 11:40 A.M.[3] July 9th were as follows (the absences being in parentheses): 26+, (24), 50, (16), 49, (26), 19+; from 2:00 to 5:00 P.M. 17+, (19), 44, (21), 42, (17), 20+. On July 10th from 8:57 to 11:57 the figures stood: 33+, (9), 34, (12), 45, (10), 37+. The average of four full incubation periods on the first day was 46 minutes, and of six absences 20 minutes. The following morning the average of two full incubation periods was 40 minutes, and of three absences 10 minutes. On the 9th the periods on the nest varied between 42 and 50 minutes, those off from 16 to 26 minutes. The next day the absences were much shorter and less irregular, ranging from 9 to 12 minutes. The percentage of time spent away from the

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[2]Part of the watching on July 16th, most of it on July 17th and 19th, and all of it on July 18th was done by L. B. N.; the rest of the field work and the writing of the paper were done by M. M. N.

[3]All hours are given in Eastern Standard Time.

nest on the 9th was 31.4, on the 10th, 17.2. One possible explanation of the shortened absences lies in somewhat cooler weather on the second day, in the afternoon of which there were heavy showers. The fact that the 10th was the last day of incubation may also have had an influence.

The female sat quietly on the nest, but left it very quickly, darting down nearly to the ground and thence flying rapidly out of sight. She left most often towards the south, but at times chose any other direction except east. She usually chipped before she returned to the nest. If she came to it from the west, she faced east during the following incubation period; if she approached from the east, she settled down facing west.

The male appeared at 9:46 on July 9th, apparently to see what was disturbing his mate, who was chipping at me, but left again at once. He sang incessantly from various positions in the grove to the east, usually from 40 to 45 yards away from the nest, occasionally coming nearer, and occasionally going so far away that we could not hear him. He gave 860 songs during the first three and a half hours in the morning, 431 songs during three hours in the afternoon, and 928 songs from 8:57 to 11:57 A.M., July 10th. Once the female left as he started to sing, and three times she did so when he came nearer than usual. Three times out of the nine he stopped singing as soon as she left the nest, probably joining her in her search for food, but twice he started singing again before her return. Although there evidently was some coöperation between the pair, the female appears on the whole to have regulated her conduct independently of her mate.

Care of the Young. On July 11th at 8:13 A.M., three minutes after my arrival, I was delighted to see the female rise and eat half an egg-shell; the last little bird had just hatched. She now sat higher than when incubating and was far more restless, often rising and digging down into the nest. At 8:25 she left, returning in five minutes with a small insect. She always "billed" the morsels before giving them to the young. All the objects that she brought were small until 4:26 and 4:46, when long caterpillars were offered, the last one finally being eaten by the female herself. During seven hours that day she brooded 63 per cent of the time in sessions of 9 to 31 minutes; she was absent from 5 to 19 minutes at a time and delivered 15 meals. The male in the meantime sang 1445 songs and never once came near the nest.

On July 12th the male's absorption in singing to the exclusion of all other duties was strikingly shown by his failure to chase off a Blackburnian Warbler (*Dendroica fusca*) that sang very

near, and also a strange male of his own species which came within a yard of the nest and which the female had to drive away, his singing in the meantime going serenely on. At 9:40 as she was brooding and her mate was singing rather near, she chipped in response to his songs four times in succession. The next day this happened on five occasions: at 7:48 she chipped 15 times, at 9:28, 3 times, at 3:05, 18 times. On July 14th she chipped twice at 9:04 and twice at 2:03; and on July 16th at 10:50, when her mate was singing very near, she gave almost an explosion of chips on the nest. It seemed to me she was trying to call him to the nest. Five times in these five days she left as his singing drew near, five times he stopped abruptly as soon as she left, but on all but one of these occasions he started again before she returned. On July 15th we climbed the tree and found the young were three in number, but still the male continued to sing, oblivious of any danger to his family.

On the 12th the female brought 17 meals in 8 hours at intervals ranging from 3 to 17 minutes; she brooded 63 per cent of the time in periods lasting from 6 to 30 minutes. Several large objects were brought in the afternoon, and once two larvæ at the same time. On the 13th, 14th, and 15th the course of events was much the same except that the female brooded less each day, 46, 31, and 8 per cent respectively of the 6 to 8 hours we watched. Meals were brought at long intervals—28 and 32 minutes on the 13th and 15th, 21 minutes on the 14th—but surprisingly large insects were brought, while two or three or four items at one feeding were often recorded. On the afternoon of the 15th a baby's head was visible above the rim of the nest for the first time. And still the male did nothing but sing. Indeed, he sang so very much that we resolved to watch the nest for a whole day, hoping to set a world's record for the number of songs counted from a single bird in one day.

It was pitch dark in the woods at 2:15 the next morning, and it was not until after 3:00 that I began to see the outline of the bushes around me. The first bird-note came at 3:28, a Scarlet Tanager's (*Piranga erythromelas*) proud song, which lasted for almost an hour. At 3:52, 33 minutes before sunrise, my Warbler started singing; 6 minutes later I noted that I could begin to see colors. He sang 201 songs and then suddenly stopped at 4:20, but began again 4 minutes later, giving 379 songs during the first hour.

The female darted off the nest at 4:14, returning in 4 minutes with a green larva. During her first hour she outdid herself by bringing 5 meals, but after that she fell back into her old rhythm with one to four meals an hour and 5 again just before

bedtime, a total of 46 during the 16 hours. Sunset came at 7:26, the male's last song and also that of the Tanager at 7:38, while the female settled down at 7:44 when it was so dark I could barely see her.

And what of our world's record? By some perversity of fate that annoying little bird hardly sang at all—or probably happened to sing too far away for us to be sure it was he—only 1313 songs in 16 hours, whereas on the 14th he had given 1519 songs in 6 hours, and on the 15th, 1680 songs in 7 hours. A really typical day should have resulted in over three thousand songs.

The 17th and 18th progressed much the same as before, the male singing a fair amount, 737 and 919 songs in five and a half hours each day, the female doing no brooding, and feeding every 23.6 and 27 minutes respectively. But on the 19th came a remarkable change. Things had been going about as usual, when at 10:30 the observer mounted the tree to inspect the infants and two hopped out; one could not be found, but the other was replaced, only to jump out again when the mother returned at 10:50, greatly exciting her. Her behavior altered at once; instead of bringing food from a distance at long intervals, she gathered it in the vicinity and fed all three babies at short intervals. During the first two hours of observation she had brought 7 meals at average intervals of 17 minutes; during the last seven and a half hours she gave 63 meals at average intervals of 7.1 minutes. From 10:00 to 11:00 Baby 1 was fed 12 times in 36 minutes, Baby 2 none during the hour, Baby 3, the one that stayed in the nest, once; from 11:00 to 12:00, Baby 1 received 2 meals, Baby 2, 6, and Baby 3, 5—again a total of 13 meals. After that the first fervor of feeding abated somewhat, and in the afternoon, the female fed from 6 to 9 times an hour, sometimes gathering food within four feet of the observer. In seven and a half hours Baby 1 received 27 meals, the others 18 meals each.

The excitement incident to the launching of two infants into the world brought the male to the scene at 11:44; instead of welcoming him, his mate rushed at him twice. Nothing daunted, 11 minutes later he reappeared with a caterpillar in his bill. Whether or not he fed at that time is not known, as the observer left at 12:00 and did not return until 1:13. It was not until 3:52 that the male was again seen; at 4:01 he fed Baby 3 in the nest—a great moment. He was back again 7 minutes later with another morsel, and at 4:40 both parents fed side by side—a charming sight. The male fed three more times, and, interestingly enough, he brought very small insects and put them far down in the throat as if he were dealing with newly hatched young,

whereas his mate popped the food into the open bills very quickly. The female gave her last meal at 7:01, the male his last song at 7:30 (4 minutes after sunset), while the Tanager sang until 7:42.

At 4:28 the next morning the male was busily singing in his favorite grove, while the female was just as busily caring for her scattered family. Baby 1 had moved to the east and could no longer be watched. The female at 4:35 went to the nest, but, instead of feeding, took the morsel to Baby 2 in the small hemlock where it had spent the night, 15 yards from the nest; at 4:42 she reversed the process, and at 5:40 repeated her first tactics. Five minutes later the male brought a green caterpillar to Baby 3 and carried away a sac, his mate in the meantime coming to the nest without food and looking at the little bird. In a few minutes she returned to the nest with a small insect, offered to feed but instead darted off to Baby 2. Soon she got this infant to follow her 30 feet to the north into the lower branches of a large hemlock. The male fed the nest baby again, and so did the female. Immediately afterwards, at 7:13, the baby stepped out of the nest, walked unsteadily along the branch, nearly losing his balance every other moment, and settled down 8 inches away. The mother, who had been chipping at the other side of the tree, suddenly spread her wings and tail and had a fight with a Red-eyed Vireo (*Vireo olivaceus*).

At 7:25 the female came to Baby 3, gave him a small insect and removed a sac from the limb, she chipped again and again, got a small insect, came to him, hopped over him, came back, then disappeared, all the time chipping. He was excited and tried to follow, but nearly fell three times. He then began to preen himself. At 7:39 she brought him a caterpillar, hopped on top of the nest, and carried off the last sac. She then came with a small insect, chipping and chipping, while he made frantic efforts; she did not give it to him, but hopped onto the nest, looked into it and left. At 7:54 the male came to the nest with a caterpillar, hopped onto the east rim, and then to the west rim, apparently at a loss what to do. The baby sat with his bill wide open, expectant but silent. When nothing happened, he gave a little chip, and his father went to him and fed him. Between 8:10 and 9:24 the female fed this baby four times, after the first trip returning to the nest, examining it, and perhaps finding a louse.

A curious incident took place soon after. The male came with two little insects and tried several times to give the food *to the nest;* the baby called gently; he went to him and tried to feed him like an infant, putting his bill in and out of the little bird's

throat, but without success. The female came below the baby and quivered her wings; the male descended to her with his bill still full and gave her a small morsel. He then went to the nest, and she followed; both stood on the rim, she quivering her wings. She took the food from him, picking it out of his bill; he left and at once began to sing; she went to Baby 3, but did not give him the food, taking it to Baby 2 instead.

Both babies called vigorously before their mother returned from an hour's absence. At 10:24 she fed Baby 3 with considerable chipping, and he tried to come to meet her. Three minutes later she brought him a green larva, but stood up very straight, holding it out of his reach, and then flew six feet to the west. He hurried after her as best he could, giving one little flight; she repeated the process, this time going only a foot further, then rewarded him. At 10:32 the male came to the nest, tried several times to feed his insect there, looked about for the little bird, and went to feed him. Seven minutes later the female brought a caterpillar, but again held it up out of reach; the baby, however, appeared satisfied and did nothing. She left, and he took a nap with his head under his wing. At 11:08 the female came, looked at the nest, and fed the baby.

At 11:33 she chipped again and again, and the baby answered; she came into the home tree with no food, constantly chipping. She found a caterpillar in the tree, came to the baby, but flew off a little way, still chipping. Baby started out, making progress mostly by hops but sometimes by tiny flights; after several tumbles he landed on a limb six feet below the nest. His mother chipped near by with an insect, but would not feed. Baby made a mighty effort and fell to the ground; mother darted down beside him and then flew north. Baby started after her, she keeping near him, usually above, chipping and dangling the worm before him. At 11:43 she fed, but immediately got another caterpillar, and the same play was reënacted. He had grown more expert and climbed into a little pine tree fifty feet from his starting point, where he rested on his laurels.

I left and did not return until 2:15, when we caught both babies to band them, putting the band on the right leg in one case, the left in the other. At the first excitement the female dashed about near by, holding her wings straight up and her tail spread, but displayed only a little the second time. She tried to entice each baby to safer perches by following it, chipping, showing it a caterpillar, and mounting bushes as if encouraging it to do likewise. She fed Baby 2 when only two yards from us. The latter made one flight of about 12 feet.

The male sang but did not appear, and the same was true

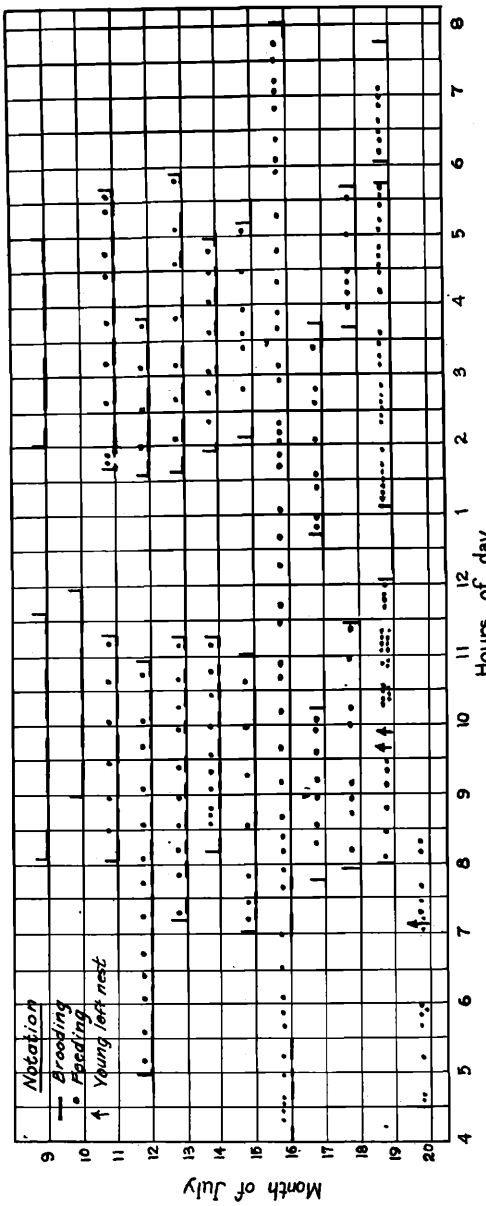

CHART I

INCUBATION, BROODING AND FEEDING OF THE FIRST FEMALE

TABLE I

ACTIVITIES OF THE PARENTS AT THE JULY NEST

			THE FEMALE							THE MALE	
			BROODING		FEEDING		EXCRETA		FEEDING	SINGING	
July	*Hours*	*Per cent of time on nest*	*Average length brooding*	*Average time off*	*Number times fed*	*Rate feeding in minutes*	*Eaten*	*Carried*		*Total number of songs*	*Average per hour*
9	6.5	68.6	46.	20.5						1291	198
10	3.	82.8	40.	10.0						928	309
11	7.	63.1	20.2	11.1	15	28.0	2	0	0	1445	207
12	8.	62.7	18.7	11.0	17	28.2	4	0	0	1067	134
13	8.	46.0	14.3	16.0	17	28.2	11	0	0	873	109
14	6.	31.4	8.6	13.8	17	21.2	8	4	0	1519	253
15	7.	7.8	8.2	22.3	13	32.3	3	5	0	1680	240
16	16.	7.6	14.5		46	20.9	3	19	0	1313	82
17	5.5				14	23.6	0	6	0	734	134
18	5.5				13	27.0	0	2	0	919	167
19	10.				70	8.6	0	4	6	748	75
20	8.5				23		0	3	5	943	111
21	1.									293	293
22	1.									70	70
25	1.									182	182
Total	94				245	19.7	31	43	11	14005	149

during hour visits on three later dates. The female fed Baby 3—banded on the left leg—in the hemlock 22 feet west of the nest on July 21st (10:27 to 11:27 A.M.) and in another hemlock about 30 feet farther west on July 22d (10:10-11:10 A.M.). On the 25th from 9:07 to 10:07 I saw none of the family but the male gave 293 songs; on the 29th late in the afternoon I heard nothing from him. We believe he took no further interest in his family after Baby 3 left the home tree.

Discussion of Brooding and Feeding. The course of events at this nest is graphically shown in Chart I, while the main features are summarized in Table I.

Since this study offered the unusual opportunity to observe the rhythm of brooding without the disturbing factor of visits from the male, the length of the periods on and off (the latter in parentheses) will be given for the first five days.

July 11, A.M. (5) 15 (10) 23 (8) 26 (10) 23 (14) 21 (9); P.M. 31 (16) 21 (10) 21 (15) 21 (19) 11 (9) 20 (14) 9 (5).

July 12, A.M. (10) 19 (3) 22 (9) 13 (5) 6 (15) 23 (9) 19 (8) 12 (11) 17 (12) 17 (15) 21 (13) 14 (8) 30 (13); P.M. (9) 29 (7) 19 (17) 21 (15).

July 13, A.M. 13 (19) 12 (10) 10 (12) 13 (10) 14 (12) 12 (22) 13 (9) 12 (9) 12 (18); P.M. (13) 16 (18) 16 (12) 20 (20) 23 (23) 17 (17) 12 (31).

July 14, A.M. 15 (4) 6 (7) 6 (11) 13 (13) 11 (16) 9 (10) 7 (18); P.M. 8 (18) 4 (32) 8 (16) 12 (14) 4 (15).

July 15, A.M. 3 (7) 11 (14) 11 (34) 8 (34).

To summarize, the periods on the nest ranged as follows: July 11, 9 to 31 minutes; July 12, 6 to 30; July 13, 12 to 33; July 14, 4 to 15; and July 15, 3 to 11. The periods off: July 11, 5 to 19 minutes; July 12, 3 to 17; July 13, 9 to 23; July 14, 4 to 32; and July 15, 7 to 34.

On July 11th the female brooded after all but one of her 15 feedings, on the next two days after every one of her 34 feedings, on the 14th after 13 of 17, on the 15th after 4 of 13, and on the 16th after 5 of 46.

Her brooding showed a gradual and consistent decrease from 63.1 per cent of the time on the first day to 7.8 per cent for the sixth. If the nest had been watched from dawn to dark every day these percentages would have been higher, especially after the second day, as the young are naturally brooded more in the cool mornings. With the exception of the 16th, when brooding was at its very end, the average length of the periods decreased each day, while the average length of periods off correspondingly increased, except that the figure for the 13th is larger than that for the 14th.

The female fed at practically half-hour intervals on the first three days and also on the fifth, at 21-minute intervals on the fourth and sixth days (at 24-minute intervals if the first two and last two hours are omitted), at 24-minute intervals on the seventh day, 27 minutes on the eighth day, and 8.6 minutes on the 9th day.

The slow feeding at first was the natural consequence of uninterrupted brooding, a 20-minute period on the nest and 11 minutes off bringing the feedings during the first two days at half-hour intervals. As the young grow older, they need less brooding and more food. Since the female's instinct to brood after every feeding still held during the third day, she might have met the situation by very much shorter individual broodings and more numerous meals; instead she shortened her brooding periods by about a fourth, lengthened the absences correspondingly, and brought *much larger meals at the same slow pace as before*. Evidently this was a simpler adjustment than the other would have been. The next day she did increase her rate markedly.

So far we can see reasons for her conduct, but why the slowest feeding of her whole career should have occurred on July 15th is a mystery. During the first two days but one meal with two items was recorded, 5 large items and 8 small ones were noted; during the next 6 days at 30 of the 120 meals two items were brought, at 20 three, and at 3 an even larger number; only two small items were noted and 55 large ones. On the last two days, on the contrary, of 93 meals only one was double and one triple, while small objects were recorded more often than large ones.

The revolutionary change that took place in this female's feeding behavior on July 19th was evidently due to the extraordinary stimulus afforded by the greatly increased movement and sound of the young that had just left the nest. It is well known that parental devotion is at its peak just before and after this event. Could this be in response to the lively reactions of the young?

The number of seconds spent at the nest in feeding and inspection (the occasions when she stood from 2 to 4 minutes delousing being omitted) was measured by stop watch in 122 cases. In general the time decreased, but not always consistently. The medians for the ten days were as follows: 47, 35, 53, 27.5, 23, 28, 20, 15, 25, 5. If the first nine days are grouped in threes, the results are: July 11th to 13th, range 20 to 167 seconds, median 47; July 14th to 16th, range 13 to 100 seconds, median

28; July 18th to 20th, range 11 to 45, median 23. On the 20th there were but three visits timed, each 5 seconds long.

On leaving the nest the female went most often to the south (67 times), then to the north (32 times), then the west (22 times), and finally the east (15 times). She returned most often from the west and north. The direction in which she left had no relation to that in which she returned. On the nest she faced east and west about equally often.

(*To be continued*)