A STUDY OF THE LIFE HISTORY OF THE RED-EYED VIREO

Kathryn Ann Grave

Introduction

This study of the life history of the Red-eyed Vireo, Vireo olivaceus (Linnaeus) was conducted at the University of Michigan Biological Station situated on Douglas Lake, Cheboygan County, Michigan. The field investigations were begun during the summer of 1947, June 25 to August 16, and were continued in greater detail in 1949, June 17 to August 16. Three occupied nests and one uncompleted nest were located in 1947, and nine occupied, two uncompleted and four deserted or destroyed nests were found in 1949. A summary of the statistics from these 19 nests is compiled in Table I. Detailed data were obtained daily from eight of the 19 nests, six of which were closely observed from tower blinds. The information thus obtained was supplemented by a review of the literature on the family Vireonidae which was made at Carleton College, Northfield, Minnesota, February 2 to May 31, 1948.

The study of nest building activities was made from a ground blind, consisting of a metal framework covered by olive-drab canvas, placed 12 feet from the nesting sites. Observations were facilitated by the use of 7 X 35 millimeter Bausch and Lomb binoculars. The majority of

nests were built within eight feet of the ground so that by standing on a chair the observer could reach them for purposes of closely inspecting their structure and later their contents. However, several nests were located between nine and 27 feet from the ground. At such nests daily records were made with the aid of an adjustable mirror fastened to a bamboo pole which could be extended by adding sections. The activities of the Vireos during egg-laying, incubation, brooding and feeding were closely observed from sturdy wooden tower blinds placed an average of four feet from the nests. Nest observations from the blinds totaled 48 hours in 1947 and 92 hours in 1949. In addition, in 1949, approximately 32 hours were spent measuring eggs, weighing young, and studying territory and the activities of the Vireos away from the actual nesting sites.

I am deeply indebted to Dr. Olin Sewall Pettingill, Jr. of the University of Michigan Biological Station and Carleton College for the valuable guidance he gave me during the course of this study and for his helpful suggestions and advice in the preparation of the manuscript. I also gratefully acknowledge his generosity in allowing me the use of his excellent library of ornithological literature.

Environment

The nesting study was made in the forested regions of the sandy uplands between Douglas Lake and Burt Lake. This forest is located in the northern part of the zone of mixed vegetation between the central deciduous regions and the northeastern coniferous forests. Originally the uplands supported a climax vegetation of either pine (northeast coniferous) or beech-maple (central hardwoods). However, owing to a history of lumbering operations beginning in the 1870's and subsequent burnings and often reburnings, the region today supports extensive areas dominated by aspens. These aspen associations represent stages in the development of the climax vegetation and are being invaded by pines and hardwoods to varying degrees, depending upon the date of the last fire in the particular area.

The characteristic deciduous trees of this breeding habitat of Vireo olivaceus in the order of their relative abundance were Large-toothed Aspen (Populus grandidentata), Quaking Aspen (P. tremuloides), Red Maple (Acer rubrum), Paper Birch (Betula papyrifera), Beech (Fagus grandifolia), Red Oak (Quercus borealis), Red Ash (Fraxinus pennsylvanica), and Basswood (Tilia americana). In addition, two conifers, the White Pine (Pinus strobus) and the Red Pine (Pinus resinosa) occurred commonly throughout the deciduous area.

The forest floor was largely open, although scattered

areas supported a thick growth of such shrubs as Round-leaved Dogwood (Cornus circinata), Red-osier Dogwood (C. stolonifera) and June-berry (Amelanchior canadensis). The Bracken-fern (Pteris aquilina) and the following ericaceous plants: Wintergreen (Gaultheria procumbens), Bearberry (Arctostaphylos Uva-Ursi), Huckleberry (Gaylussacia baccata) and Low Black Blueberry (Vaccinium pennsylvanicum) formed the more common and more uniformly distributed ground vegetation.

The forest floor had a leafy cover. Several trails through the area were kept cleared, and fallen timber and dead trees were removed from the forest. Photographs taken in 1949 show the habitats of Nests 9 and 11 (Plate I, Figs. 1 and 2).

The area around Douglas Lake is located in a region of moderate temperature and rainfall. The growing season for vegetation and the mating and breeding seasons for animals ranges over a three to four month period.

During the breeding seasons of 1947 and 1949, the Red-eyed Vireo was one of the more common birds of the developmental forests of mixed deciduous and coniferous vegetation which surrounded the Biological Station and by far the most frequent member of the family Vireonidae. The breeding avifauna of this area also included the Oven-bird (Seiurus aurocapillus), American Redstart (Setophaga ruticilla), Robin (Turdus migratorius), Cedar Waxwing

(Bombycilla cedrorum), Least Flycatcher (Empidonax minimus), Chipping Sparrow (Spizella passerina), Eastern Cowbird (Molothrus ater), Eastern Kingbird (Tyrannus tyrannus), Nighthawk (Chordeiles minor), Whip-poor-will (Caprimulgus vociferus), Song Sparrow (Melospiza melodia), Hermit Thrush (Hylocichla guttata), Baltimore Oriole (Icterus galbula), Scarlet Tanager (Piranga olivacea), Eastern Phoebe (Sayornis phoebe), Wood Pewee (Contopus virens), Black-capped Chickadee (Parus atricapillus), Myrtle Warbler (Dendroica coronata), Yellow-billed Cuckoo (Coccyzus americanus), Crested Flycatcher (Myiarchus crinitus), Blue Jay (Cyanocitta cristata), Crow (Corvus brachyrhynchos) and Ruffed Grouse (Bonasa umbellus).

The larger mammals which inhabitad the woods were the Striped Ground Squirrel (Citellus tridecemlineatus), Eastern Chipmunk (Tamias striatus), Red Squirrel (Tamiasciurus hudsonicus), Gray and Black Squirrels (Sciurus carolinensis), Northern Flying Squirrel (Glaucomys sabrinus), Woodchuck (Marmota monax), Striped Skunk (Mephitis mephitis) and Racoon (Procyon lotor).

The reptiles found commonly in the region were the Milk Snake (Lampropeltis triangulum), Ribbon Snake (Thamnophis sauritus) and Garter Snake (Thamnophis sirtalis).

Territory

According to Barrows (1913:565), the Red-eyed Vireos arrive in the southern parts of Lower Michigan around the first of May (April 28 to May 7 in Detroit), and reach the northern regions of the state two or three weeks later. Eggs may be found in the first nests of the season as early as May 20. At the time of my arrival at the Biological Station, June 21, 1947 and June 16, 1949, the Vireos had established territories, the pairs were mated, and the activities at the first nests of the season had begun. Therefore, the behavior of the males during territorial establishment, and the activities of both sexes during courtship and mating were not observed. Since the boundaries had previously been established, no active interspecific clashes in defense of the territories on the part of either sex was noted. Nevertheless, that territorial relationships existed between the various pairs of Red-eyed Vireos was made apparent by the vigorous singing of the males throughout the summer, as well as by the isolation of the pairs. The Vireos did not range widely throughout the woods but limited their activities to restricted areas within which they could be seen or heard at any time of the day.

The size of these territories was determined following the method of Kendeigh (1944). Locations where singing of the males, and flights and feeding activities of both sexes occurred were marked on rough maps of the region. These observations were facilitated by the males' habit

of singing softly as they searched for food among the trees, and by their custom of establishing favorite perches from which they consistently sang. Each male had several of these singing perches within his territory. For the most part, they were located in aspens averaging 40 feet in height. At the conclusion of the study the significant locations from each observation were plotted on a composite map, and the extent of each territory was roughly determined by drawing a line through the extreme points where the Vireos had been noted. The territories which were thus successfully outlined were found to average 0.8 of an acre. In numerous instances the boundaries were determined to be contiguous, but never to overlap.

In general, the nests were found to be more or less centrally located within the established territories. However, Nests 11 and 13 were situated near the periphery of the territories. Nest 11, which was never completed, was located only three feet from the natural boundary formed by Douglas Lake. Although several other territories likewise extended to the water's edge, this was the only known instance of nest building occurring near the water. Nest 13 was located very close to the southern boundary of the territory, for the male was never heard singing south of the nest. Additional evidences pointing to the peripheral location of this nest were the fact that the female, when leaving the nest, always flew toward the north and the

fact that an additional pair of Vireos was observed feeding their three fledged young in a tree only six or seven feet south of the incubating female on Nest 13. The proximity of these other Vireos had no apparent effect on this female.

Eastern Kingbirds, Least Flycatchers, Wood Pewees, Robins, Cedar Waxwings, Myrtle Warblers, Oven-birds, American Redstarts, Chipping Sparrows and Song Sparrows maintained territories which frequently overlapped those of the Red-eyed Vireos and in several instances built close to the nests of the latter. In 1947, a pair of Kingbirds raised a brood in a tree less than 25 feet from Nest 1. The Kingbirds often perched in the top of the Vireo's nesting tree and fed continuously in the air around the nest. In 1949, a Ruby-throated Hummingbird, a pair of Wood Pewees and a pair of Red-eyed Vireos all chose the same Paper Birch as a nesting site. In no instance were intraspecific clashes between the Vireos and any of these birds noted. This mutual tolerance was probably due to the fact that the ecological niche which the Vireos occupy does not overlap those of the above mentioned species.

The Red-eyed Vireos of the Douglas Lake region commonly rear two broods in a season. The building of second nests was found to take place about the middle of July and many nests still contained young in August. Exact data on these

second nests are presented in Table I. Instances of still later nestings are contained in the literature. Miller (1904:201-202) found a nest of the Red-eyed Vireo containing fresh eggs on September 8 in Philadelphia County, Pennsylvania, and Wilson (1919:115-116) reported a fledgling of this species still dependent upon the adults for food on September 25 in Detroit, Michigan. It is therefore not surprising that proclamation of the territories by song was continued throughout the summer. No changes in the extent of the territories during the second nestings of the season were determined.

The claims of Trautman (1940:343) that in Ohio the song of the Red-eyed Vireo begins to wane as early as June 15 and is practically gone by July 15 were not substantiated by this study. A slight decline in song was first generally noted throughout the Biological Station area between June 28 and July 1. Singing remained subdued until about July 11 at which time vigorous songs began to be heard again. By July 20 the majority of males were in full song once more. There is a correlation between the dates of this decline in song and the appearance of young in the first nests of the season and between the dates of the subsequent increase in the volume of song and the start of the second nestings (Table I). It was noted in general that the males sang most vigorously during the periods of nest building, egg laying, and especially incubation. When

young appeared in the nests and the males began their feeding activities, the decline in song was noted. The latter statements are based entirely on general observations since no data on the number of songs given per minute nor on the duration of singing periods were obtained.

Fry (1916:35-36) in his study of the seasonal decline of bird song in New York did not observe a mid-seasonal wane and subsequent rise in song. He noted that the song of the Red-eyed Vireo began to decline about July 20 and that it gradually lessened in volume after that date. In the Douglas Lake region a second decline in song became apparent about August 2. The last territorial observations at the Biological Station were made from August 13 to 16, 1949. On these days it was observed that while songs for the most part were infrequent and subdued, several males were still singing vigorously. It seems probable that in the Douglas Lake region singing ceases only when the second brood is independent and breeding activities for the season have been completed. The range of dates of the second broods (Table I) might then account for the variation in the final decline of the song of the various males observed.

According to Barrows (op. cit.:565), in northern Michigan the Red-eyed Vireos begin their southward migration early in September. At the time of my departure from the Biological Station on August 16, 1949, no evidences of the disintigration of the territories had become apparent.

The various pairs were as yet restricting their activities to the territories, and, as before stated, the majority of males were infrequently singing and several were apparently in full song. Thus, the behavior of the Vireos during and following territorial disintegration and the subsequent changes in the interspecific relationships of these birds were not observed.

The First Morning Song

According to Forbush and May (1939:406), the Red-eyed Vireo begins to sing "....with the Robin at early dawn....". This statement was not substantiated by my brief study of the first morning song, sometimes referred to as the awakening song, of the Red-eyed Vireo in Lower Michigan. The male Vireo did not sing as early as the Robin, Kingbird, Oven-bird, Scarlet Tanager, Chipping Sparrow, Song Sparrow or Least Flycatcher, but he was always heard earlier than the Phoebe, Baltimore Oriole, Yellow-billed Cuckoo and Cedar Waxwing.

The early morning song of the Red-eyed Vireo was heard throughout the nesting season, including the interval between broods. The time that the song came was closely correlated with light. Records for six clear and three cloudy mornings are presented in Tables II and III and in Graph I. The male's awakening song on the six clear mornings was heard 30 to 36 minutes (average: 33 minutes)

before sunrise; on cloudy mornings, 25 to 30 minutes (average: 28 minutes). At Douglas Lake, civil twilight, the time at which the sun is six degrees below the horizon, occurred 43 to 46 minutes before sunrise during the course of this study. The first song on the clear mornings came 10 to 15 minutes (average: 12 minutes) after civil twilight; on the cloudy mornings, 13 to 18 minutes (average: 16 minutes). Thus, the first morning song of the Red-eyed Vireo in relation to sunrise was heard an average of five minutes earlier in clear weather than in cloudy weather; in respect to civil twilight, the difference averaged four minutes. Nice (1943:106) found the same thing to be true of the awakening song of the Song Sparrow. Her records on cloudy days ranged from three to six minutes (average: 4.5 minutes) later than on clear ones.

Light is the major factor influencing the time of awakening and subsequent singing of the male Red-eyed Vireo. Bright moonlight, however, which was present on the mornings of July 14 and 15, had no effect on the time of the birds' first morning songs. This is undoubtedly due to the fact that the Vireo is not sensitive to such faint light as is emitted by the moon. Apparently, the moon is only of importance to birds which begin to sing earlier in the morning than does the Red-eyed Vireo and to nocturnal birds. Pettingill (1936:301-302) in his

monograph on the American Woodcock (Philohela minor) stated that "Almost invariably, during the height of its breeding season, the Woodcock gives its flight songs and peents when the moon is in the sky. .... Dark nights, when the sky is heavily overcast, are generally not conducive to any sort of courtship display."

During this brief study, other environmental factors such as temperatures and winds remained constantly moderate so that their effects on the awakening song of the Red-eyed Vireo could not be determined. The minimum temperatures during the course of the study ranged from 52 to 63 degrees Fahrenheit; no strong winds occurred.

Nests

The nest of the Red-eyed Vireo is a beautifully constructed nest of the cupped-pensile type, typically suspended from a lower branch of a young tree. A summary of the locations, measurments, and component materials of the nine occupied nests is compiled in Table IV.

In the open aspen-dominated woods where this study was made, the Red-eyed Vireos built their nests most frequently in young Red Maple trees. All of the nests found, with two exceptions, were located in Red Maples. The exceptions were Nest 13 which was built in a Beech, and Nest 19 which was situated in a Paper Birch. This preference for nesting trees varies with the locality.

Trautman (op. cit.:343) found that at Buckeye Lake, Ohio, in a beech-maple association, the Red-eyed Vireo preferred the Beech trees as nesting sites, choosing Silver Maple (Acer saccharinum), Red Maples, White Elms (Ulmus americana) and Slippery Elms (U: fulva) less frequently.

For the most part, the Red-eyed Vireos suspended their nests from the lower branches of saplings, and the majority of nesting sites were within nine feet of the ground. Nevertheless, as is seen in Table IV, Nests 18 and 19 were built relatively high. The range in height of the nine occupied nests was 5 feet, 6.50 inches and 36 feet, 3.35 inches, the average elevation being 6 feet, 11.50 inches. In his law governing the elevation of the nesting site, Averill (1923:58) stated that "....to range high and nest high is the perogative of the long-winged birds. In no case does a short-winged species nest high." He found that in the family Vireonidae, the pointed-winged Red-eyed Vireo was among the high rangers, also frequently nesting high, nests of that species occurring from five to 40 feet from the ground (ibid.:59). Therefore, in my study, neither the instances of relatively high nest building nor the height of the favorite singing perches of the males, discussed on page 7, were unexpected phenomena.

The occupied nests were built on the average of 3 feet, 8.22 inches from the trunk of the nesting tree, the extremes in this distance being 6 feet, 9 inches and 0 feet, 0 inches. The latter extreme was represented by Nest 18, which was

suspended from a crotch formed by the small main trunk and one of the uppermost branches of a sapling Red Maple.

With one exception, the occupied nests were remarkably uniform in size as shown by their measurements (Table IV). The inside depth of the nests ranged from 41 mm. to 54 mm. (average: 47 mm.); the outside depths measured from 56 mm. to 73 mm. (average: 61 mm.). From these measurements the average thickness of the bottom of the nests was computed and found to be 14 mm. The bottom of Nest 5 was markedly thicker than that of the average nest, measuring 39 mm. This thickness was explained by a closer examination of the nest which revealed a Cowbird egg buried beneath the lining materials (Plate II, Fig. 1; Plate XIII, Fig. 1). The inside diameters of the occupied nests ranged from 54 mm. to 61 mm. (average: 57 mm.); the extremes of the outside diameters were 61 mm. and 68 mm. (average: 64 mm.). The average thickness of the walls of the nests was determined to be 7 mm.

Although some of the component materials of the nests of the Douglas Lake region, such as strips of inner and outer bark of Basswood, pieces of outer bark of Paper Birch, spiders' egg cases and a cottony plant fiber from seeds were constant factors present to more or less the same degree in all of the nests studied, other materials varied from nest to nest (Table IV). The variation in some nest components was found to be largely due to their availability.

The birds obtained all of their nesting materials within their respective territories, and thus an examination of each area explained the differences in materials used.

The nesting materials were not of a particularly flexible nature and therefore not easily woven together. This fact probably accounts for the consistent use of large amounts of spiders' egg cases and cottony plant fibers from seeds as binding materials. The former have remarkable strength and adhesive qualities.

An analysis of the materials of Nest 15 to illustrate their relative abundance is presented in Diagram I. The percentage of each component material was computed in the following manner: The nest was carefully taken apart and each kind of material placed in a separate pile. A photograph shows these piles of nesting materials (Plate III). A paper, measuring 8½ X 11 inches, was ruled into 20 equal squares. In turn, each pile of material was spread to a thickness as uniform as possible over the paper, and the number of squares which it covered was determined. From these numbers, the percentages of the nest components were derived.

In the nine Vireo nests which I carefully analyzed, the greatest variation in the amount of the component materials was found in the trimming. Nest 5 was trimmed with an extraordinarily large quantity of outer bark of Paper Birch. From the ground it appeared as a beautiful,

silvery white nest, seemingly composed entirely of the birch bark. On the other extreme, the trimming of Nest 9 was scanty and composed almost entirely of spiders' egg cases. The few pieces of birch bark which were present were loosely attached by threads from the spiders' egg cases, giving the nest a ragged appearance. Photographs of these nests illustrate the variation in amount of the trimming materials (Plate II).

Protection of the Nests

The majority of the nests studied were situated in a crotch of a limb having a sub-horizontal slope. The leaves of such branches hung about the nests concealing them beautifully. In addition, the instinctive trimming of the nests with pieces of outer bark of the Paper Birch and spiders' egg cases rendered them less conspicuous. The irregular patches of white materials against the darker background of the bulk of the nest material simulated the patterns and shadows cast by the sunshine passing among the leaves. Nests of the previous year which had lost their white trimming stood out as dark masses among the leaves and were far more easily detected. Thus, owing to the instinctive choice of both nesting sites and materials, the concealment of the majority of the Red-eyed Vireo nests was striking.

Selection of the Nesting Site

No direct information on the participation of the sexes in the search for the nesting site was obtained. However, this selection frequently appeared to proceed according to a trial and error method, nests being partially completed and then abandoned at one or more sites within the limits of the territory before the permanent site was selected.

Nest Building

Duration of Nest Building

The beginning of nest building activities was observed in only one instance. At about 9;30 A.M., July 12, 1947, a few fibers of inner bark of Basswood and some small pieces of outer bark of Paper Birch were found bound by threads from spiders' egg cases to a slender forked branch in a young Red Maple. These materials represented the beginning of Nest 3. A ground blind was hastily set up 12 feet from the nesting site during one of the inattentive periods of the birds. The nest building activities of the pair were observed both during the morning and the afternoon of that day. However, attentive and inattentive periods of the sexes were not timed. Most of the nest building occurred in the morning. Although new material was added in the afternoon, the periods of inattentiveness gradually lengthened and no activity was

observed after 3:50 P.M. At 5:30 P.M., I left the blind and closely examined the nest. By the end of the first day of activity, the nesting materials had been extended outward from the fork 60 mm. along one twig and 47 mm. along the other. They had likewise been extended downward so that the nest consisted of two partially free-hanging walls, composed of strips of inner and outer bark of Basswood, pieces of outer bark of Paper Birch, and coarse grasses bound together by threads from spiders' egg cases and cottony plant fibers. These walls were not of equal length, one measuring 78 mm. and the other, 61 mm. They were partially joined at the side under the fork formed by the two supporting twigs, the side opposite the fork and having no supporting twig remaining open. The bottom of the nest was as yet largely open, although three or four strips of inner Basswood bark, evidently the beginning of its framework, were extended between the suspended walls.

Observations were resumed the following morning, but the nesting site had been abandoned by the Vireos. They were never again seen near the sapling maple and the nest was never completed. Why the birds deserted this nest is not known. The presence of the blind did not noticeably disturb or interrupt the pair during the first day of nest building activities. It may be that when I examined and measured the nest at 5:30 P.M., I inadvertently disturbed

the component materials. Stoekard (1905:280) found in Mississippi that whenever an unfinished nest of the Red-eyed Vireo was disturbed in any way, the birds abandoned it.

Nest 4 was found when it was only partially completed on July 16, 1947. When discovered, this nest closely resembled Nest 3 at the end of its first day of construction. Nest 4 likewise consisted of only two walls and a few strips of Basswood bark stretched across the bottom; the side having no supporting twig was entirely open and no rim was present. Judging from its stage of construction, this nest was estimated to have been started on July 15, the day prior to its discovery. If this estimation is correct, nest building lasted four and one-half days, for the last building activities of the Vireos were observed at 1:20 P.M., July 19. This information agrees with that of Herrick (1935:237) who observed a pair of Red-eyed Vireos complete their nest in four and one-half days. Forbush (1929:18), on the other hand, stated that a week's time is usually required and that if weather conditions are unfavorable even more time may be needed.

Participation of the Sexes

The nest building activities at Nest 4 were also followed from a ground blind placed about 12 feet from the nesting site. The sexes could be distinguished with relative certainty during this period since the male sang

steadily with only short pauses during the hours when nest building occurred. He was even observed to fly to the uppermost branches of the nesting tree and sing vigorously. The latter behavior did not continue into the periods of egg laying and incubation; although the male continued to sing vigorously at a distance from the nest during these periods, his song was very subdued or absent when he was in the nesting tree. Both the male and female participated in the construction of the nest, the female assuming the more active role. She did all of the actual weaving and molding of the nest, as well as gathering most of the nesting materials. The male usually accompanied the female to and from the nest, occasionally carrying nesting material on his return. The female always began to weave her material into the nest immediately upon returning. During this interval, the male usually sat on a nearby branch of the nesting tree watching his mate and singing softly. At times he would hop about the branches, still singing. On the occasions when he had brought nesting material, he would attempt to pass it to his mate before she was ready to accept it. Several times, the female, having incorporated her material into the nest, was observed to fly away without waiting to accept her mate's offerings. At such times, the male would follow her, both presently returning with full bills. Whether the

male gathered new material or merely returned with his previous load was not known. After passing the material to his mate, the male frequently perched in the top of the nesting tree and sang vigorously and steadily. At other times, he immediately flew away alone, presently returning with more bark or other material. The latter type of behavior was seldom seen.

Mechanics of Nest Building

At 9:30 A.M. on July 16, Nest 4 was beginning to take shape, the bottom being woven in by the female. All the weaving movements were executed quickly and precisely with her bill while she remained standing on the forked branch. The bottom was formed by working the free-hanging ends of the two walls into its then scanty framework as well as by the addition of fresh materials. By 11:45 A.M., the bulk of the bottom of the nest was apparently complete. At this time, the side of the nest with no supporting branch was still open and the bottom of the nest sloped downward in that direction. When observations were resumed at 1:30 P.M., the female was working on the open side of the nest opposite the crotch. This wall was completed largely by laying long strips of Basswood bark across the opening and weaving either end into the two previously completed walls. By the end of the day the bulk of the entire nest was complete, the walls measuring approximately 3 mm. in thickness and the bottom,

5 mm. It was composed almost entirely of inner and outer Basswood fibers, pieces of the outer bark of Paper Birch, coarse grasses and a few needles of White Pine.

On July 17, I first observed shaping movements executed by the female. She settled down into the unlined nest and moved her breast deliberately from left to right. She then changed her position so that she faced the supporting crotch and repeated the performance. Similar molding movements were regularly repeated during the day. Unfortunately, an exact record of their frequency and duration was not kept. Herrick (op. cit.:230) observed a female Red-eyed Vireo attempt to mold the nest on the first day of nest building activities. Similar movements may have occurred at Nest 4 on July 15 and 16 in my absence. After this time, the female when adding or rearranging material usually settled onto the nest, and leaning over the side, worked at the walls with her bill. Also on this day, the female was frequently observed winding fine strips of inner Basswood bark and cottony plant fibers from seeds around the supporting twigs and securing them with threads from spiders' egg cases. By the end of the day, a well formed rim had become evident, and the walls and bottom of the nest averaged 6 mm. in thickness. No lining material was present.

On July 18 and the morning of the 19, more trimming of birchbark and spiders' egg cases was added to the outside, and the nest was lined with fine strips of inner

bark of Basswood, fine grasses and needles of White Pine. The pine needles were frequently fastened in place with spiders' egg cases. No activity was seen at the nest after 1:30 P.M. on July 19, until the female came to lay on the following morning. The walls and bottom of the completed nest measured 8 mm. in thickness.

No new material was added to Nest 4 during the following periods of the breeding cycle. In contrast, at Nest 9 fresh material was added to the trimming during the incubation period. I observed the female return to the nest after an inattentive period 28 times during the first three days of incubation; fifteen of these times she brought spiders' egg cases. Plate IV illustrates the characteristic actions of the female during the latter fifteen instances. Standing on the rim, she reached far down the outside of the nest, and, after securing one end of the egg case between the fibers of Basswood bark, she drew it out along the side of the nest as far as it would reach, there weaving its other other end into the nest wall. On four occasions, the male was seen bringing trimming material to his incubating mate which she took from his bill and placed on the nest in a similar fashion. Several of these drawn-out egg cases are illustrated in Plate II, Fig. 2.

No instances of the re-use of old nests were observed

in the Douglas Lake region. The pairs of Red-eyed Vireos which I studied always built new nests to receive the eggs and young of the second broods of the year. In addition, I obtained no information on the re-use of the component materials of nests which were abandoned before their completion. Erichsen (1919:390) reported that a pair of Red-eyed Vireos removed the material from an unfinished nest and utilized it in the construction of another nest which they had started nearby. During my study, four nests (3, 11, 12 and 14) were found which were never completed by the Vireos. Nest 15 was built approximately 27 feet from Nest 14. At no time were the birds which had started and then abandoned these nests observed in the deserted nesting trees. Also, these unfinished nests were carefully examined at the termination of the study. At this time, although some of the trimming materials had disappeared, probably washed away during a rain, each nest appeared much as it had when discovered, and no evidences of the deliberate removal of any material could be found.

Egg Laying

The behavior patterns of three pairs of Red-eyed Vireos (Nests 4, 13 and 15) during the entire egg laying period were closely observed. At each of these nests, the first egg was laid the morning after the nest building activities had ceased; an additional egg

was laid on succeeding mornings until the clutch was completed. Coues (1878:95) reported the finding of an uncompleted nest of the Red-eyed Vireo on which the female was incubating three eggs. "Thus," according to Coues' report, "the female had begun to lay some time before the nest was ready for the reception of eggs."

At Nests 4 and 15, the females characteristically began to incubate only after the last egg was laid. During the egg laying period they did not attend the nest either day or night and were observed on the nest only when they came to lay. At Nest 13, the female's behavior varied from the average in that incubation was begun after the first egg had been laid. Other instances of this unusual behavior, in which the female began to incubate before the last egg was laid, were reported by Petrides (1944:398) and Brackbill (1945:148). These incidences must be considered as exceptions to the general rule, although they may occur more frequently than was formerly supposed.

Without exception, egg laying occurred in the early morning before 6:30. At this time during the egg laying period, Nests 4 and 15 were regularly visited and their contents examined. Nest 13 was under observation from a tower blind placed 5 feet from the nest at the time the eggs were deposited. Exact data on the egg layings at Nest 13 based on observations from the blind are presented in Table V.

The intervals spent by the female on Nest 13 at egg laying increased successively in length. She remained on the nest 18 minutes at the first laying, 24 minutes at the second, and 37 minutes at the third. The first egg was laid on July 14, and that night was the first that the female spent on the nest. After awakening on the two succeeding mornings, she left the nest for a brief period before returning to lay. This period of inattentiveness began six minutes earlier on July 15 than on July 16. The inattentive periods showed a striking regularity, both being 16 minutes in length. During these absences of the female, I examined the contents of the nest to make sure that an additional egg had not already been deposited.

For a brief period after entering the nest to lay, ranging between six and nine minutes, the female sat quietly, then raised herself off the nest and appeared to be straining. At this time, her breast and anterior region of abdomen became visible. She then fluffed her feathers and settled back onto the nest. She laid her first egg some 18 minutes earlier in the morning than her second, and her second egg was laid eight minutes earlier than her third.

The time spent on the nest after the egg was laid was always greater than that spent immediately prior to the deposition of the egg (Table IV). These post-laying

intervals gradually lengthened, increasing from 18 minutes on the first morning, to 24 minutes on the second, and to 57 minutes on the third. This increase probably coincides with the female's gradually strengthening instinct to incubate. The instinct had undoubtedly become developed in this female prior to egg laying as indicated by her early start of incubation and by the fact that she was observed sitting quietly on the newly-completed, empty nest for 58 minutes (3:19-4:17) the afternoon before the first egg was laid.

At Nests 4 and 15, the male and female Red-eyed Vireo ignored the nest site between layings and spent a considerable amount of time together wandering about the territory and searching for insects. The male sang intermittently and relatively softly while accompanying his mate. However, he frequently left her to fly to the top of a 40 foot aspen where he sang steadily and vigorously. During these periods of uninterrupted song, the female remained relatively near the singing perch, preening or merely resting.

The male always accompanied the female to the nesting site prior to egg laying. He sang intermittently while she was on the nest and seemed to call her to him by approaching the nest and uttering his song softly. The female responded to this song and joined her mate if it was given after the egg had been laid. However, when

it was heard before egg laying or very shortly thereafter, the female became alert, raised her head and looked quickly about in all directions, but did not leave the nest.

The Clutch

The Size of the Clutch

In the Douglas Lake region, the number of eggs laid by the Red-eyed Vireos has been difficult to determine owing to heavy parasitism by the Cowbird. The only accurate data was obtained from the second nests of the season. Four late unparasitized nests containing eggs were discovered, one in 1947 and three in 1949. The numbers of eggs in these nests were as follows:

Nest 44 - - - - - - - - - - - 3 eggs.
Nest 13 - - - - - - - - - - - 3 eggs.
Nest 15 - - - - - - - - - - - 2 eggs.
Nest 18 - - - - - - - - - - - 4 eggs.
Average number of eggs per nest - - - 3 eggs.

These findings essentially agree with those of Forbush (op. cit:180) who states that the eggs are two to four in number, usually three or four.

The Description of the Clutch

The ground color of the Red-eyed Vireo eggs was pearly white. Typically, they were sparsely marked with tiny spots varying in color from black to

cinnamon or rufous brown (Chapman's color chart, 1932) largely concentrated at the larger end. One egg in Nest 4 was found to be pure white, while the other two eggs laid by that female had only three or four tiny markings. The number of eggs examined was too small to draw any definite conclusions, but in general it may be stated that Red-eyed Vireo eggs do vary both in the number and the color of the spots with which they are marked from one individual to another, although those of the same clutch are quite similar. No information on color variation between the clutches of the same female during one season was obtained.

The measurments of 18 eggs ranged from 21 mm. to 24 mm. in length and from 13 mm. to 24 mm. in greatest width. This variation occurred among the clutches of the various females studied, all the eggs of any one bird being remarkably similar in size. The eggs of the female at Nest 15 were the smallest found, both measuring 21 mm. by 13 mm. Weights of the eggs were not taken.

Incubation

Duration of Incubation

At Nests 2, 4, 9, and 15, incubation was begun after the last egg was laid and, therefore, all the eggs in each of the respective clutches hatched on the same day.

The duration of the incubation periods of these clutches is presented in Table VI. The nests containing the clutches were under observation from the time when the last egg in each nest was laid and incubation had begun through the time when young were found, still moist, together with egg shells in the nests. The periods were calculated from the beginning of the first attentive period of the female to the time the young were completely free of the egg shells. The exact time in minutes is not known, because in all the nests observed, the actual hatching occurred at some time during an attentive period of the female. However, the average length of the incubation periods was 13 days, four hours; the extremes ranged from 13 days (Nest 4) to 13 days, 13 hours (Nest 9). The longer period involved at Nest 9 may be due to the chasing of the female off the nest at 7:45 P.M., July 3, in order to weigh a young Cowbird. The female had not returned at 10:30 P.M. when the nest was last visited that night, but she was on when I returned to the nest at 3:45 the following morning. In the interval between 7:45 P.M. and her return, sometime between 10:30 P.M. and 3:45 A.M., the unhatched egg was subjected to the cool night air. The minimum and maximum temperatures reached that night were 62° and 85° F., respectively.

At Nest 13, the female began to incubate after the first egg was laid. This unusual incubation was discussed under the section on egg laying, page 26. The length of the incubation period of this clutch was not determined owing to the destruction of the eggs during an attempt to mark the incubating female. The broken eggs were replaced with rounded stones of approximately the size of the eggs. These stones were accepted by the female and her incubation rhythm was uninterrupted. This will be discussed in greater detail in the section on abnormalities of incubation.

The data I obtained at Douglas Lake concerning the length of the incubation period of the Red-eyed Vireo were found to essentially agree with those of Bergtold (1917:100), Forbush (op. cit.:180), Allen (1932:357) and Oberholser (1938:507) all of whom record the incubation period of these birds as 12 to 14 days.

Participation of the Sexes

The activities of the adult Red-eyed Vireos during the entire incubation period were closely observed from tower blinds at Nests 2, 4, 9 and 13, and for a portion of the period at Nests 1 and 5 which were found after the incubation rhythm had been established.

According to Forbush (op. cit.:180,182), Allen (op. cit.:357) and Oberholser (op. cit.:507) both the male and female Red-eyed Vireo assist in incubation.

Nevertheless, during approximately 78 hours, 49 minutes of observations from blinds placed an average of four feet from the above mentioned nests, incubation was determined to be performed by the female only. Similar conclusions were drawn by Cagle (1938:MS), Warner (1940: MS) and White (1944:MS) all of whom studied the nesting habits of this species at the University of Michigan Biological Station.

My conclusion that incubation is performed by the female Red-eyed Vireo alone is based on three lines of evidence: first, observations of the clearly marked female on Nest 13; second, analyses of the incubation rhythms of the females on Nests 2, 4, 9 and 13, and a comparison of these rhythms with those of other passerine birds; and third, the behavior patterns of both sexes at the six nests mentioned in the beginning paragraph of this section. Each of these three points will be discussed in turn.

At Nest 13, the sexes could be distinguished with absolute certainty since the feathers of the female's back and rump were distinctly marked with black indelible ink. The marked bird was known to be the female, for the songs of the male were heard during 29 of the 36 observed attentive periods. In 28 hours, 33 minutes of observations at this nest, incubation was observed to be performed by the marked female alone. The

unmarked bird was never seen on the nest at any time during the day or night.

The female on Nest 13 was first marked with black indelible ink by quietly approaching the nest at 3:30 A.M. while she was asleep and applying it to the feathers of her back with the aid of a medicine dropper. When, after four days this mark began to fade, further attempts at marking her were made. However, this bird was not at all tame, and after the first marking she became very wary and flushed before I could approach within five feet of the nest, even in the early morning before it was light. Several attempts to catch her in a net proved unsuccessful. Finally, a bottle cap was suspended from one end of a long pole and filled with the ink. A string the length of the pole was attached to the rim of the bucket, and the pole was pushed out through a hole in the blind until it was directly over the female on the nest. The bottle cap was then tipped by pulling the string, thus allowing the ink to fall on the dorsal feathers of the incubating bird, clearly marking her.

The Rhythm of Incubation

Observations on the incubation rhythms of the female Red-eyed Vireos at Nests 2, 4, 9 and 13 are summarized in Table VII. At each of these nests the observations presented in the table extended over

the entire incubation period; however, the number of days on which the incubation activities were observed from blinds were 6, 7, 12 and 13, respectively.

The incubation rhythms recorded at these nests were found to be remarkably similar to those published by Nice (1943:221) of ten other passerine species, including 21 individual birds, in which incubation was performed by the female alone. The average length of the periods spent ~~off~~ on the nests by the Red-eyed Vireos of the present study ranged from 25.4 minutes to 30.6 minutes. According to Nice's table (Ibid:221), the range of the attentive periods of the 23 other passerine birds was 12 minutes to 49.1 minutes, with a median of 29.8 minutes. Omitting the two tropical species, Nice determined the minimum length of the attentive periods of the 19 temperate zone birds to be 19.3 minutes, the median, 30 minutes.

As for the inattentive periods, my records in Table VII show the extremes in average length to be 7.4 minutes and 17.2 minutes. According to Nice, the periods spent off the nest by the 23 passerine birds ranged from 5.7 minutes to 16.5 minutes, with a median of 8.5 minutes.

The percentage of daylight time spent on the nest by the Red-eyed Vireos ranged from 63 per cent to 82 per cent, while Nice's table shows this percentage in the ten other passerine species to range between 60 per cent and 85 per cent, with a median of 75 per cent.

The comparison of my records of the incubation rhythms of the Red-eyed Vireos with those published by Nice of ten passerine species in which the female alone incubates revealed a striking similarity. This similarity between the two sets of records was presented as further evidence that the Red-eyed Vireo is also a species in which incubation is performed by the female alone.

Tables VIII and IX and Graphs II through V give detailed records of the attentive and inattentive periods of the females at Nests 4 and 9 on the third, seventh and tenth days of their respective incubation periods. Graph V indicates that at Nest 9, the female's instinct to incubate reached its peak the third day of incubation. Her inattentive periods were the shortest on the third day, becoming longer as the period progressed. The average length of time spent off this nest increased from 7 minutes on the third day to 13 minutes on the seventh and to 15 minutes on the tenth day of incubation. However, for no apparent reason, the records of the female at Nest 4 do not corroborate these findings. At Nest 4, the inattentive periods were the longest at the beginning of the period, and they consistently decreased in length, becoming very short as the day of hatching approached (Graph III). The time spent off the nest by this female decreased from an average of 19 minutes on the third day to 13 minutes on the seventh day and to 6 minutes on the

tenth day, when the instinct to incubate had reached its peak (Graph III).

No correlation could be found between the length of the attentive periods and the stage of incubation at either of the nests studied in detail. The averages of the attentive periods ranged from 30 minutes to 39 minutes throughout the incubation periods. In addition, the temperatures during the incubation periods at both nests remained remarkably uniform and moderate so that no positive correlation between the length of the periods and the weather could be made. However, the very long periods, 75 minutes on Nest 4 and 65 minutes on Nest 9, both occurred during severe thunder and rain storms.

Probably the most interesting point brought out by Graphs II and IV is that long periods of attentiveness consistently occurred at both nests between 9:30 A.M. and 11:30 A.M. Similar lengthy periods on the nests occurred with equal persistence between 3:30 P.M. and 5:30 P.M. A possible explanation for the long attentive periods which occurred daily in the middle of the morning may be the increase in air temperature which had become apparent by 9:30 A.M.; also, by that time the female's early morning hunger had probably been appeased and she was satisfied to remain for longer periods on the nest. The mid-afternoon lengthy periods corresponded with the times the sun shone directly on the nests.

The females covered their eggs during these intervals protecting them from the rays of the sun (Graphs II and IV).

Behavior of the Sexes

The following general statements apply to all of the pairs observed unless specific birds are referred to.

Although in 78 hours, 49 minutes of observations from blinds a male Red-eyed Vireo was never observed sitting on a nest, one was sometimes seen accompanying his mate on her return to the nest after an inattentive period. Also, at times a male was observed to visit a female while she was on the nest, usually bringing food which he passed to her. Plate VI illustrates this courtship feeding at Nest 9. On a few occasions at Nest 9, the male did not approach the female immediately, but sat on a nearby branch singing softly with his bill full of food. At such times, the female begged for the larva by opening and closing her bill as well as uttering soft "chips". All of the vocal exchanges between a pair of Red-eyed Vireos at the nest during this period were very subdued, often barely audible to the observer in a blind only four feet distant. On some of the males' visits (Nests 9 and 13) they brought nesting materials which the incubating females accepted from their bills. This was an especially common occurrence at Nest 9. The female (Nest 9) after taking the material always held it in her

bill for a few seconds, and then, leaning over the rim, worked it into the wall of the nest with her bill (Plate IV). Her movements were always quick and precise. On one occasion (Nest 13), the male was observed to place a piece of outer bark of Paper Birch on the limb supporting the nest, about one inch from the nest, and to secure it to the branch with a thread from a spider's egg case. This example of symbolic building was the only instance in which a male was observed weaving materials. A male was never seen working materials into a nest.

During the period of incubation, the males did not approach the nests at regular intervals and, therefore, a rhythm of their attentiveness and inattentiveness could not be worked out. The pairs were never observed to exchange positions on the nests.

While incubating, a female Red-eyed Vireo consistently took a position in a nest so that she faced the crotch of the supporting branch (Plate V, Fig. 1 and Fig. 2). This position was never observed to vary. While on a nest, a female ordinarily sat quietly looking about, at times preening her feathers. For the most part, she remained alert, but occasionally she closed her eyes and appeared to be sleeping. Intervals of restlessness commonly occurred toward the ends of the attentive periods. During these moments of restlessness, the

female raised herself off the nest, turned the eggs with her bill, fluffed her feathers and then settled back onto the nest. When leaving a nest, a female flew quickly and quietly away, always in the same direction. The method of return varied somewhat with the individual. At Nests 1, 2 and 5, the females flew directly to the nesting sites as quietly and deliberately as they had left. However, at Nests 4, 9 and especially 13, the females followed a winding course to the nesting site, flew into the nesting tree and there hopped about the branches, looking around and uttering soft, Catbird-like "Quree" calls before entering the nests. The latter birds may have sensed my presence in the blind which would account for their wariness.

Reactions to Intruders

The reactions of the various pairs of Red-eyed Vireos to my intrusions varied markedly with the individuals. The females on Nests 5 and 15 permitted my close approach before flushing, while the female on Nest 13 flew off while I was still several feet distant. My experiences in attempting to mark this female have previously been discussed (Page 34). Nest 5 was located at the back of two of the Biological Station cabins and much human activity took place directly below it. The female was seemingly undisturbed by this activity, and the presence of humans very close to her did not cause her to flush.

The fearlessness of this female became increasingly evident toward the end of the incubation period, at which time she allowed my hand to touch the nest before leaving her eggs. Herrick (1900:113) reported experiences with a female Red-eyed Vireo which showed remarkable tameness, allowing her feathers to be stroked. In addition, Perkins (1911:206) and Baynes (1922:257-259) recorded instances of incubating females of this species not only accepting food from their fingers but also water from silver spoons. No such striking examples of fearlessness were obtained with the Vireos of the Douglas Lake region.

The female Red-eyed Vireos of the present study assumed the more active role in defense of the nest, although the males always assisted them. On numerous occasions, the female, sometimes accompanied by her mate, returned to the nesting site while I was near the nest measuring eggs or examining them to determine whether or not they were pipped. At such times, the pair or the female alone, whichever the case happened to be, loudly protested my presence, flying excitedly about the nearby branches with their tail feathers widely spread, uttering their loud, nasal, Catbird-like "Quree" calls, and snapping their bills together in rapid succession thus producing several loud "clicking" sounds. If the female were alone when she returned

to find an intruder at the nest, her loud protests quickly attracted her mate. The closer the time of hatching approached, the more violent the birds' reactions toward intruders became. Toward the end of the incubation period, the females became far more aggressive than their mates and darted quite close to any intruder who was nearby. The males protested as loudly as their mates, but they always kept their distance, at least from human intruders.

Incubation at Night

At all of the nests observed during the incubation period, the eggs were covered throughout the night by the Vireos. At Nest 13, where the female was clearly marked, it was determined with certainty that the female, not the male, remained on the nest at night. The incubating females slept snuggled well down into the nests with their heads placed under the scapulars of their shoulders (Plate XII).

Abnormalities of Incubation

The female at Nest 13, whose eggs were destroyed and replaced with rounded stones, accepted the stones. Her last egg had been laid on July 16, and calculations, based on the known incubation periods of other Red-eyed Vireo eggs in the Douglas Lake region (Table VI) indicated July 28 to be the normal date of hatching for

her eggs. However, this persistent female continued to incubate the stones until August 2, five days beyond the normal incubation period.

Hatching

Four nests (2, 4, 9 and 15) were under observation from blinds at the time hatching occurred. These nests contained a total of eight Red-eyed Vireo eggs, one of which disappeared from Nest 2 on the second day of incubation. The time of day when the eggs were pipped was not determined. In addition, the length of time involved in the hatching process is not known, because in all these nests, it occurred during an attentive period of the female. However, it was definitely determined that the seven young Vireos were completely free of the egg shells, and that the females had removed some of the broken pieces of shell by the following times:

Nest 2 (7/8/47) - - - - -	1 egg:	5:45 P.M.
Nest 4 (8/4/47) - - - - -	2 eggs:	6:30 A.M.
	1 egg:	8:30 A.M.
Nest 9 (7/4/49) - - - - -	1 egg:	8:00 P.M.
Nest 15 (8/2/49) - - - - -	1 egg:	9:00 A.M.
	1 egg:	10:00 A.M.

Newly Hatched Young

The condition of development of a Red-eyed Vireo at hatching was found to be altricial, the nestling being

completely dependent upon the adults for both food and warmth.

A newly hatched young was completely naked except for some sparse, short, dark gray neossoptiles on the following dorsal pterylae: the capital tract, the dorsal and pelvic regions of the spinal tract, the humeral tracts and the alar tracts. This gray down was more prominent on the capital and spinal pterylae. Ventrally, the bird was entirely free of down feathers.

The coloration of the naked skin was pinkish-orange (Chapman's color chart, 1932), somewhat darker dorsally. The viscera were clearly visible through the thin, transparent skin of the abdomen. The egg tooth was prominent and the latter as well as the laterally protruding rictal region of the bill were whitish in color in striking contrast to the bright chrome yellow (Chapman: Ibid.) lining of the mouth.

The head and abdomen were large in comparison with the rest of the body, especially the wings which were short and undeveloped. The claws on the feet were likewise undeveloped and blunt. A remnant of the former yolk sac and allantoic stalk was apparent on the abdomen. The eyes were not open.

The young nestling was cold blooded and entirely dependent upon the adult bird for the regulation of its body temperature.

Graves

The only apparent reflexes were those related to feeding and maintaining an upright body posture in the nest. The newly hatched bird had the ability to lift the head and open the mouth for about 7 seconds. When defecating, the caudal end was oriented toward the top of the nest. During the inattentive periods of the adult Vireos, the nestling assumed a reptile-like posture in the nest, using the undeveloped wings and enormous abdomen as supports, the head resting on the nest bottom. The wings were also used as crawling appendages when the young attempted to move about within the nest. The reflex related to grasping the bottom of the nest with the feet had not yet become apparent.

Only one nestling (Nest 9) was weighed immediately after hatching. This young Red-eyed Vireo weighed 1.75 gram.

Development of the Young

Although the weights of the three nestlings in Nest 4 were taken daily, the course of development of the young Red-eyed Vireos was closely followed only at Nest 15. The following day-by-day account of the development of the young birds is based entirely on data obtained at Nest 15.

The First Stage of Development

Plate VII shows a nestling Red-eyed Vireo 24 hours

after hatching. By this time, the first macroscopic evidences of the growing teleoptiles had appeared along the alar tracts, the papillae enlarging and darkening (Plate VII, Fig. 1). The gray neossoptiles which were present at hatching had increased slightly in length, and similar gray down feathers had begun to appear on the crural pterylae. In addition, white down feathers were present to a lesser degree on the ventral pterla in the regions of the breast and abdomen.

With the exception of a slight lengthening of these down feathers, no further change was noted in the plumage of the developing Vireo until the third day of nest life. On that day, the sheaths of the primaries began to emerge from the papillae on the alar tracts, and down feathers appeared on the last of the dorsal pterylae: the femoral tracts, the caudal tract, and the cervical and interscapular regions of the spinal tract. Ventrally, the capital and cervical regions were still naked and the circlet of feathers surrounding the anus was not yet visible.

By the fourth day of nest life, all of the feather tracts had become evident owing to the enlargement of the feather papillae both ventrally and dorsally. Dorsally, the sheaths of the teleoptiles were beginning to emerge from the papillae along the spinal tract and the humeral tracts. No down feathers were present at any

time on the ventral capital tract or the cervical region of the ventral tract.

The first stage of development included the first four days of nest life, the day of hatching being designated as 0 day. This was a period of rapid growth, the young bird increasing considerably in size and weight. Although exact measurements were never taken, the weight increased from 3.73 grams at the end of the first day to 8.57 grams by the end of the fourth day. The head and abdomen remained proportionately larger than the rest of the body. The eyes remained closed. By the fourth day, the remnant of the yolk sac had shriveled considerably and the egg tooth had decreased in size; however, both were in evidence throughout this first stage.

The nestling was as yet a cold-blooded, reptile-like creature. The body temperature quickly dropped to that of the surrounding air when the young was removed from the nest to weigh or photograph. When placed on its back to photograph, it attempted to right itself but was unable to do so. In the upright position, the wings were still used as supports and appendages in crawling movements.

Up until the fourth day of nest life, the only reflexes were those of feeding, defecation and maintaining an upright posture. The reflex related to grasping the nest bottom with the feet was first evident on the fourth day.

The Second Stage of Development

The second stage of development embraced the fifth and sixth days of nest life. It was a period of rapid feather growth. Dorsally, the sheaths of the teleoptiles protruded from the papillae of all the feather tracts. The sheaths were especially prominent along the alar pterylae where they were beginning tc break open on the sixth day. The white feather sheaths were also beginning to emerge from the papillae of the ventral tract (Plate VIII). By the end of the sixth day, the ring of feathers surrounding the anus had become apparent.

This was also a stage of rapid body growth, the weight of the nestling increasing from 10.88 grams on the fifth day to 13.51 grams by the end of the sixth day. The head and abdomen were still large but no longer enormous in relation to the rest of the body. The wings showed rapid development. There was a noticeable slit in the eyes on the fifth day and they were well opened by the sixth day of nest life.

Temperature control was seemingly established by the end of the sixth day although the apteria were still evident, especially ventrally. On that day, the body temperature did not noticeably drop while the nestling was being weighed.

The first food calls were heard on the fifth day, although they may have occurred on previous days in my absence. On the fifth day when the young was placed on

its back to photograph, it was still unable to right itself; however, by the sixth day it was able to do so. The grasping reflex was well developed throughout this stage. The young clung to the bottom of the nest and was difficult to remove. It could grasp my finger securely, but the legs were as yet too weak to maintain the body in a vertical perching position. The nestling still used the rapidly developing wings as supports, and allowed the head to rest on the nest bottom when not begging for food. Preening movements were first observed at the end of the sixth day, at which time the young ran its bill over the opening feather sheaths of both alar pterylae. Warner (op. cit.:15) stated that nestling Red-eyed Vireos began to preen on the fourth day of nest life.

The Third Stage of Development

The third stage of development included the seventh, eighth and ninth days of nest life. During this period, the appearance of the nestlings underwent a marked change owing to the rapid lengthening and opening out of the feather sheaths. This occurred first on the dorsal and subsequently on the ventral pterylae. By the end of the eighth day, the dorsal teleoptiles had lengthened and expanded so as to completely obscure the dorsal apteria. This was also true ventrally by the morning of the ninth day. Many of the down feathers remained attached to the

distal ends of the teleoptiles (Plate IX).

At the beginning of this stage of development, the egg tooth was entirely gone and the whitish rictal region of the bill had become horn colored. Also, the brilliantly colored lining of the mouth had faded somewhat.

Throughout this period, the young bird maintained a vertically upright position in the nest, often allowing its head to rest on the nest rim. It was far more active than during the previous stages, frequently preening its feathers and scratching itself. It stretched both its wings and legs at frequent intervals and rapidly fluttered its wings when begging. It was tame and seemingly fearless, never cowering when being removed from the nest, weighed or photographed.

The weight of this nestling decreased from 13.97 grams on the seventh day to 13.46 grams on the ninth day just prior to nest leaving. This decrease in body weight is undoubtedly correlated with the increased activity of the bird.

All of the young Red-eyed Vireos observed left the nests at some time during the ninth or tenth days of nest life.

The Fourth Stage of Development

Very little information pertaining to the fourth stage of the Red-eyed Vireo's development was obtained. However, one young which had been fledged for three days

from Nest 19 was found. This fledgling was being fed by the adult Vireos at the time it was discovered. It was able to fly a total distance of about 30 feet and was following its parents through the trees as they searched for insects. In attempting to fly across a 50 foot clearing in the trees, it fluttered to the ground. There, I picked it up and placed it on a low branch of a nearby tree to photograph (Plate X). It showed no signs of fear as I approached and took it in my hand.

The dorsal feathers of this young bird were a drab grayish olive-green color; the olive-green color was especially bright on the edges of the tail and wing feathers. The ventral feathers were white, those of the sides and flanks being washed with a bright yellow. The broad white line above the eye and the dark line through the eye were evident, but not distinct. Down feathers could still be seen attached to the distal ends of the teleoptiles, especially those of the capital tract. The tail feathers were as yet quite short and undeveloped, which probably accounts for the fledgling's inability to fly over 30 feet. The feathers of the wings were well developed.

The bill and feet were horn colored. The iris of the eyes was not red, but rather a dark brown color. The weight of this fledgling was not determined.

A fledgling Red-eyed Vireo slept in the typical perching posture of the adult bird, maintaining itself in a vertically upright position and tucking its head under the scapulars. Plate XII shows the young Vireo from Nest 5 asleep only two hours after leaving the nest.

Daily Weight Increase

The daily increase in weight of four nestling Red-eyed Vireos (three in Nest 4; one in nest 15) are presented in Graph VI. The four young whose weights were graphically recorded belonged to second broods of the season and were reared in nests which were unparasitized by the Cowbird.

The graph shows that the weight of the young in Nest 15 increased most rapidly during the first stage of development, the nestlingsgaining an average of 2.04 grams per day. The increase in weight dropped to .96 gram and .67 gram on the fifth and sixth days of nest life, respectively. During the third stage of development, the average weight increase was .47 gram. Probably owing to the increased activity of the young, its weight decreased .55 gram on the eighth day. The following day, immediately prior to nest leaving, the young had regained only .03 gram.

The weight increases of the nestlings in Nest 4

followed much this same pattern (Graph VI). All of the nestlings showed the most rapid weight increase during the first stage of development, and all showed a slight drop in weight on the eighth day of nest life. In only one instance (Nestling No. 3, Nest 4) was the lost weight regained completely before the young was fledged.

Parental Care

Removal of Eggshells

At Nests 3, 4, 9 and 15 the females were observed to remove the empty egg shells. In each case, the female, after an attentive period, raised herself off the nest, peered into it, and then took a piece of eggshell in her bill. At Nest 9, the female always dropped the broken shell over the edge of the nest. However, at the other nests, the females flew away with the shells. Whether these birds ate the shells or merely dropped them somewhere is not known.

Care of the Young

The feeding of the three young in Nest 9 when they were two, three and five days old was watched from a blind placed four feet from the nest. These observations were interrupted on the sixth day of nest life when the nest was robbed by a Red Squirrel. A summary of the results is presented in Table X. This information is supplemented by observations made by Dr. Olin Sewall Pettingill, Jr.

in 1934. His observations began when the young were six days old and extended up to the day the young were fledged. A summary of his observations is presented in Table XI.

For the first three days after hatching, the activities of the female on Nest 9 were very similar to those during incubation. She brooded the young much and rarely fed tehm. The percentage of daylight hours spent on the nest was 73 per cent and 65 per cent on the second and third days, respectively. The percentage of daylight time spent on the nest during incubation by four females (Table VII) ranged from 63 per cent to 82 per cent.

Brooding, like incubation, was done by the female alone. The male frequently came to feed the young, but he was never observed to settle onto the nest. This finding agrees with that of Herrick (1904:113) who stated that the female alone brooded almost continuously for the first four days of the nestling period.

The number of nights that the females covered the young varied with the individual bird. The female at Nest 9 spent the nights on the nest up to July 9, when the nest was robbed. At Nests 2, 4 and 5, the females brooded every night that young were present in the nests. In contrast, at Nest 15, the young were not covered during the night after they were six days old.

The female at Nest 9 showed a steady increase in her

feeding rate, from 0.47 times per hour on the second day to 5 times per hour on the fifth day; the nest was robbed by a Red Squirrel on the sixth day. Pettingill's observations made in 1934[43] extended from the sixth day to the tenth day of nest life. After the sixth day, on which the female fed 2.46 times per hour, he did not observe her to feed the young again, the job being performed by the male alone.

At Nest 9, the male's rate of feeding also gradually increased, from 1.25 and 1.17 times per hour on the second and third days to 4.33 times per hour on the fifth day. Pettingill's records show a marked increase in the male's feeding rate, 12 and 10.5 times per hour on the seventh and eighth days, when the female was no longer observed to feed her young. However, for no apparent reason, the male made only 3.75 trips with food per hour on the tenth day, the day prior to nest leaving. This decrease in feeding rate may partially account for the slight drop in the weight of the young on that day (Graphs VII and VIII).

Whereas the female assumed the more active role in incubation, the male outdid his mate during the feeding period. My observations and those of Pettingill show the female feeding more frequently than her mate only once (Nest 9, second day), when the male fed 0.47 times per hour, the female making 1.24 trips per hour.

At Nest 9, the feeding rate of the pair increased consistently from the second day until the nest was robbed, from 1.72 times per hour to 9.33 times per hour, averaging 4.65 times per hour for these first five days. Pettingill's observations show that the height of the feeding rate was reached on the seventh day of nest life.

The Red-eyed Vireos on the whole fed their young quite infrequently, their rate ranging from 1.72 times to 12 times per hour and averaging 6.52 at both nests. The feeding rates per hour of eight passerine species presented by Nice (op. cit.:235) ranged from 39.7 to 11.4. According to Nice and Thomas (1948:151), the Robin fed 6.5 times per hour and the Oven-bird, 3.7 times per hour.

Food

The Red-eyed Vireos of the Douglas Lake region were observed to be highly insectivorous. The young were fed entirely on insects, especially Lepidopterus larvae (Plate XI, Fig. 1). No evidence that this species eats any animal food other than insects was obtained.

The food habits of the family Vireonidae have been thoroughly studied by members of the United States Department of Agriculture. The conclusion drawn by these experts is that economically the Vireos are among the birds most useful to man. Collectively, Vireos take large

numbers of several species of caterpillars, scale insects, weevils, leaf hoppers, and borers. The study of Chapin (1925) was made by examining the contents of the stomachs of 1951 individuals of North American Vireos. Beal (1907) had previously made a similar study.

While hunting for insects, the Red-eyed Vireos were observed to hop slowly along the branches deliberately searching both sides of the leaves. Thus, they did not overlook protectively colored insect species.

Nest Sanitation

The sanitation of the nest was carried out by both the male and female Vireo. Plate XI, Fig. 2 shows the female Vireo at Nest 9 with a fecal sac of one of the young in her bill. At all of the nests observed, a portion of the sacs of excreta were eaten by the adult birds, the others being carried away and dropped.

Leaving the Nest

The young in all of the nests except Nest 5, left at some time during the daylight hours. I approached Nest 5 at 7:30 P.M. on July 7 and caused the young Vireo inside it to become alarmed. It fluttered out of the nest, and although I placed it back in the nest several times, it refused to stay. Apparently, the adult Vireos remain near their young for a period after they are fledged, for that night the female slept in the empty

nest near the fledgling which was perched on a branch (Plate XII).

Enemies

The disappearance of several young as well as eggs was attributed to the Red Squirrels which were abundant throughout the woods. These rodents probably happen on nests by chance in their search for food. At Nest 9, two young, a Vireo and a Cowbird, had disappeared by 10:30 A.M. when I visited the nest. The remaining Cowbird nestling disappeared shortly thereafter. Apparently, the young were carried away one by one by the predator. In an attempt to discover the identity of this enemy, a Least Flycatcher nestling was placed in the robbed nest as bait. At 3:32 P.M. a Red Squirrel ran up the maple tree and out on the slender branch from which the nest was suspended. Without hesitation it seized the nestling by the head and started back along the branch the way it had come. However, it lost its footing on the slender limb and fell to the ground. It was last seen running off into the woods still carrying the young bird in its mouth. The nest itself was undamaged by the squirrel. It is believed that the squirrel killed the nestling upon seizing it, for the nestlings calls ceased immediately and its body appeared to be limp. Although it is by no means certain that the squirrel was the

original robber of this nest, that possibility seems likely since the squirrel came directly to the nest without hesitation.

In another territory (Nest 5), the pair of Vireos whose young had already left the nest were observed noisily diving on an Eastern Chipmunk. They steadily drove it farther from the nesting area and finally into its hole. An unsuccessful search for the young was made at the time. On subsequent days, although the adults were frequently seen, they were never observed carrying food and the young were never found. The chipmunk may have been responsible for their loss.

A badly damaged nest (Nest 18), still attached to the crotch of the tree, was discovered. The bottom had been torn away and the lining materials hung down through this hole. The destruction appeared to be the work of a bird, possibly a Blue Jay or Crow, both species being present in the area.

The snakes observed in the region were all ground dwellers and thus probably were not predators upon such birds as the Red-eyed Vireos which build elevated nests.

Nest 4 containing three young Vireos was heavily infested with mites of the family Parasitoidea. These ectoparasites did not prove fatal and the young all left the nest in a seemingly healthy condition.

The Cowbird

The Cowbird must be considered the principal enemy of the Red-eyed Vireos of the Douglas Lake region. The first nests of the season were parasitized by the Cowbird, all containing two or more eggs of that species. Nests 6, 8 and 10 were deserted by the Vireos owing to this heavy parasitism. The most heavily parasitized nest found during this study was Nest 10 which contained four Cowbird eggs (Plate XIII, Fig. 2).

The Cowbird eggs differed a great deal in appearance. The background color varied between white and light buff, and the eggs were thickly marked with spots of cinnamon or rufous brown (Chapman's color chart, 1932). The eggs also varied in size. The measurments of the 18 eggs found in the nests of the Red-eyed Vireos ranged from 18 mm. to 25 mm. in length and from 14 mm. to 21 mm. in greatest width. The eggs within a single nest often differed markedly in appearance. According to Friedmann (1929:180-181), the variation is in the bird and not in the individual eggs. Thus, it seems likely that more than one Cowbird utilized the same Red-eyed Vireo nest.

In all cases observed except one (Nest 3), the Red-eyed Vireo deserted the newly completed nest if a Cowbird egg appeared in it before her first egg had been laid. In Nest 5, however, a Cowbird egg was discovered under the lining. This egg was probably deposited before the nest was completed, and the Vireo merely buried it while lining

her nest (Plate XIII, Fig. 1).

The first part of July, the female Cowbirds were still laying and were apparently desperate for nests in which to deposit their eggs. An additional Cowbird egg was found in Nest 8 on July 3, about 12 days after that nest had been abandoned by the Vireos. The egg had not been present on the previous day. In addition, at the beginning of this study, it seemed that the Cowbirds did not lay in nests where incubation had begun. However, at 10:30 A.M. on July 2, while I was observing the incubation activities at Nest 9, a female Cowbird flew into the nesting tree, looked about, and then flew off. The incubating female Vireo did not seemed alarmed by the proximity of the Cowbird. When I returned to the nest at 1:15 P.M. and examined its contents, one of the Cowbird eggs had disappeared. On the chance that this female Cowbird might come to lay the following morning, I entered the blind at 4:45 A.M. At 5:49 A.M. the female Vireo left for an inattentive period. At 5:54 A.M. a female Cowbird appeared quietly at the nest, looked about and hopped onto the nest. She remained sitting on the nest until 5:55 A.M., exactly one minute, at which time she flew away with a noisy flapping of her wings. An immediate examination of the nest contents revealed a fresh Cowbird egg among the previously marked eggs.

A study of the development of the young Cowbird was carried on at Nest 9 until it was interrupted by a predator Red Squirrel. The weights of the one Vireo and two Cowbird nestlings during their first days of nest life are presented in Graph VII. A more complete set of weights from a similarly parasitized nest was taken by Pettingill in 1934 and is recorded in Graph VIII. The weights of the latter three birds shows their comparative growth rates as follows:

Cowbird No. 1	Cowbird No. 2	Vireo No. 1
3.21 gm.	3.54 gm.	
4.89 gm.	3.81 gm.	
6.62 gm.	5.35 gm.	1.8 gm.
9.63 gm.	7.97 gm.	1.88 gm.
12.82 gm.	9.5 gm.	2.19 gm.
16.66 gm.	11.8 gm.	2.56 gm.
19.52 gm.	14.6 gm.	2.27 gm.
21.64 gm.	15.51 gm.	
22.73 gm.	17.58 gm.	

The above weights were taken on succeeding evenings beginning on July 19, 1934. Pettingill stopped weighing the nestlings on July 27 to allow a normal ending to nest life.

The weights of the Cowbirds tended to increase much more rapidly than that of the Vireo which was found dead on July 26, 1934. Considering the greater weight,

strength and voraciousness of the Cowbirds, the fate of the young Vireo is not surprising. Herrick's statement (1911:351) that every Cowbird raised entailed the loss of from one to four other birds seemed to hold true among the Red-eyed Vireos of the Douglas Lake region.

The statement of Forbush and May (op. cit.:478) summarizes the conditions as I found them very well. "The Cowbird sometimes deposites several eggs in the nest of the Red-eyed Vireo, and where Cowbirds are plentiful the first brood often consists of one or more Cowbirds, so that if they are to raise any young of their own, they must nest again later in the season."

Summary

This paper on the life history of the Red-eyed Vireo (Vireo olivaceus) represents the work done from June 25 to August 16, 1947 and from June 17 to August 16, 1949, at the University of Michigan Biological Station, Cheboygan County, Michigan. Three occupied nests and one uncompleted nest were located in 1947, and nine occupied, two uncompleted and four deserted or destroyed nests were found in 1949.

The behavior of the Red-eyed Vireos during territorial establishment, courtship and mating were not observed. The size of the individual territories was determined to average 0.8 of an acre. No interspecific clashes in defense of the territories on the part of either sex were

noted. The territories were maintained by the singing of the males throughout the summer. With two exceptions, the nests were found to be more or less centrally located within the territories. Nests 11 and 13 were peripheral in location. No intraspecific clashes between the Vireos and the other breeding species of the region were observed.

The Vireos commonly rear two broods in a season. The building of the second nests was found to take place about the middle of July. No changes in the extent of the territories during the second nestings of the season were determined.

In general, it was noted that the males sang most vigorously during the periods of nest building, egg laying, and especially incubation. When young appeared in the nests and the males began their feeding activities, a slight decline in song was noted.

The first morning song of the Red-eyed Vireos was closely correlated with light. The male's awakening song was heard an average of 33 minutes before sunrise on clear mornings; on cloudy mornings, it averaged 28 minutes before sunrise. The first song on the clear mornings came an average of 12 minutes after civil twilight; on the cloudy mornings it was heard an average of 16 minutes after civil twilight.

In the open aspen-dominated woods where this study was made, the Red-eyed Vireos built their nests most frequently in young Red Maple trees. However, Nest 13

was built in a Beech and Nest 19 was situated in a Paper Birch. The average elevation of the nests was 6 feet, 11.50 inches. They were built on the average of 3 feet, 8.22 inches from the trunk of the nesting tree.

The nests were remarkably uniform in size. The inside depth of the nests averaged 47 mm.; the outside depth averaged 61 mm. The inside diameters of the nests averaged 57 mm.; the outside diameters, 64 mm.

Some of the component materials of the nests were present in all of the nests studied. Other materials varied from nest to nest. The latter variation was found to be due largely to their availability.

The building of Nest 4 was estimated to have taken four and one-half days. Both the male and female participated in the construction of the nest, the female assuming the more active role. She did all of the actual weaving, the male occassionally bringing nesting materials.

The first egg was laid the morning after the nest building activities had ceased; an additional egg was laid on succeeding mornings until the clutch was completed. Without exception, egg laying occurred in the early morning before 6:30.

Characteristically, the females began to incubate only after the last egg was laid. However, at Nest 13, incubation was begun after the first egg had been laid.

The average size of the clutch was found to be 3 eggs.

The ground color of the eggs was pearly white. Typically, they were sparsely marked with tiny spots varying in color from black to cinnamon or rufous brown. The measurments of 18 eggs ranged from 21 mm. to 24 mm. in length and from 13 mm. to 24 mm. in greatest width.

The average length of the incubation periods was 13 days, four hours. The exact time in minutes is not known.

Incubation was determined to be performed by the female Red-eyed Vireo alone. The average length of the periods spent off the nests by the females ranged from 25.4 minutes to 30.6 minutes. As for the inattentive periods, the extremes in average length were 7.4 minutes and 17.2 minutes. The percentage of daylight time spent on the nests ranged from 63 per cent to 82 per cent.

The condition of development of a Red-eyed Vireo at hatching was found to be altricial. The first stage of development covered the first four days of nest life. During this stage, rapid body and feather growth occurred. The second stage of development, also a period of rapid growth and feathering, embraced the fifth and sixth days in the nest. The third stage included the seventh, eighth and ninth days, during which the young became fully feathered. All of the young Vireos observed left the nests at some time during the ninth or tenth days of nest life. Flight is attained during the fourth stage of development.

The female Red-eyed Vireos removed the empth eggshells from the nests. Brooding, like incubation, was performed by the female alone. For the first three days after hatching, the female brooded the young much and fed little. The percentage of daylight time that the young were covered was 73 per cent and 65 per cent on the second and third days, respectively.

Both sexes assisted in feeding the young. Whereas the female assumed the more active role in incubation, the male outdid his mate during the feeding period. My observations and those of Pettingill show the female feeding more frequently than her mate only once (Nest 9, second day), when the male fed 0.47 times per hour, the female making 1.24 trips per hour. At Nest 9, the feeding rate of the pair increased consistently from the second day to the fifth day, from 1.72 times per hour to 9.33 times per hour, averaging 4.65 times per hour for these first five days. Pettingill's observations made in 1934 showed that the height of the feeding rate was reached on the seventh day of this period.

The Red-eyed Vireos of the Douglas Lake region were found to be highly insectivorous. The young were fed entirely on insects, especially Lepidopterus larvae.

The sanitation of the nest was carried out by both the male and female Red-eyed Vireo.

During the summer of 1949, the chief enemies of the

Vireos were the Red Squirrels, Eastern Chipmunks and the Cowbirds. Blue Jays may have destroyed one nest. The snakes of the region were all ground dwellers and thus probably were not predators upon the Red-eyed Vireos which build elevated nests. The young in Nest 4 were heavily infected with mites.

The first nests of the season were parasitized by the Cowbird. The most heavily parasitized nest (Nest 10) contained four eggs of that species.

In all cases observed except one, the Vireo deserted the nest if a Cowbird egg appeared in it before her first egg had been laid. In Nest 5, however, a Cowbird egg was found buried beneath the lining materials.

In the parasitized nests, the weights of the young Cowbirds tended to increase far more rapidly than those of the Vireos. The majority of the Vireos in such nests failed to survive. Considering the greater weight, strength and voraciousness of the Cowbirds, the fate of the young Vireos is not surprising.

Table X.

Parental Care at Nest 9

of One Cowbird

Date 1949	Hours watched	Brooding Periods (Average lengths)			Feedings					
		On	Off	Time on nest (%)	Total			Per hour		
					By male	By female	By both	By male	By female	By both
July 5	6.41	35	13	73.4	3	8	11	0.47	1.25	1.72
July 6	6	26	14	65	11	7	18	1.83	1.17	3
July 8	3	13	27	32.5	15	13	28	5	4.33	9.33
July 9	Nest robbed									

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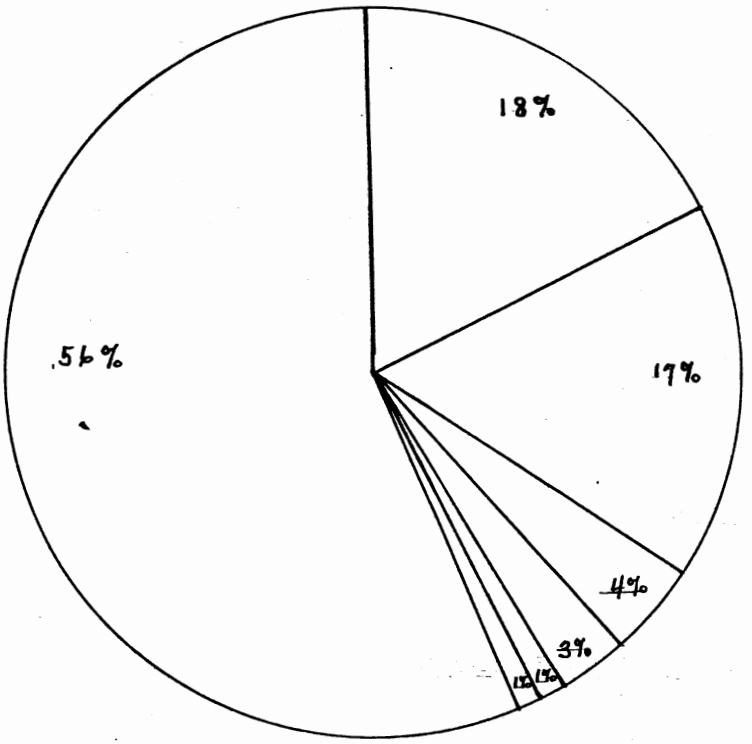
Graves

DIAGRAM 1

The Relative Abundance of the Component Materials of Nest 15



LEGEND

56% Inner and outer bark of Basswood (Tilia americana)

18% Outer bark of Paper Birch (Betula papyrifera)

17% Needles of White Pine (Pinus strobus)

4% Spiders' egg cases

3% Cottony plant fibers from seeds

1% Peduncles of Pin Cherry (Prunus pennsylvanicum)

1% Small Twigs of Hemlock (Tsuga canadensis)

PLATE I

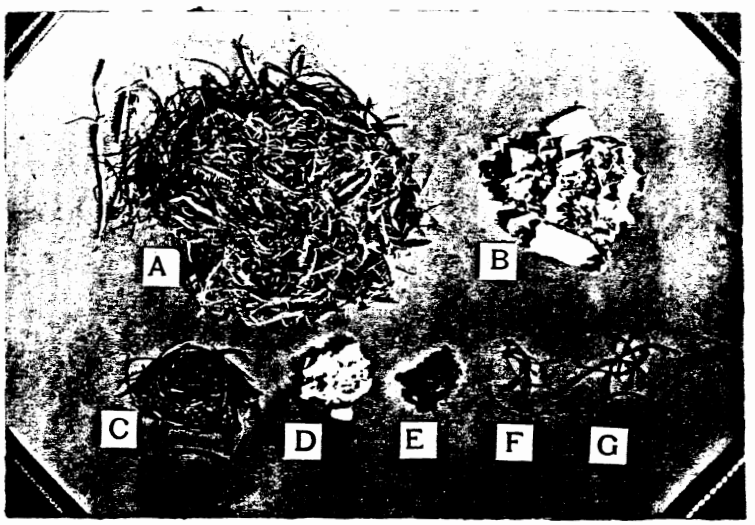
July, 1949. Grace Blanchard.

Fig. 1. The Habitat of Nest 9. The nest (arrow) was located in a young Red Maple.

July, 1949. K. A. Grave.

Fig. 2. The Site of Nest 11. The nest (arrow) was situated in a Red Maple. Note the local growth of Dogwood below the nest.

PLATE III



July, 1949. K. A. Grave.

Fig. 1. The materials of which Nest 15 was woven to show their relative abundance (Diagram 1).

A Inner and outer bark of Basswood (Tilia americana)

B Outer bark of Paper Birch (Betula papyrifera)

C Needles of White Pine (Pinus strobus)

D Spiders' egg cases

E Cottony plant fibers from seeds

F Peduncles of Pin Cherry (Prunus pennsylvanicum)

G Small twigs of Hemlock (Tsuga canadensis)

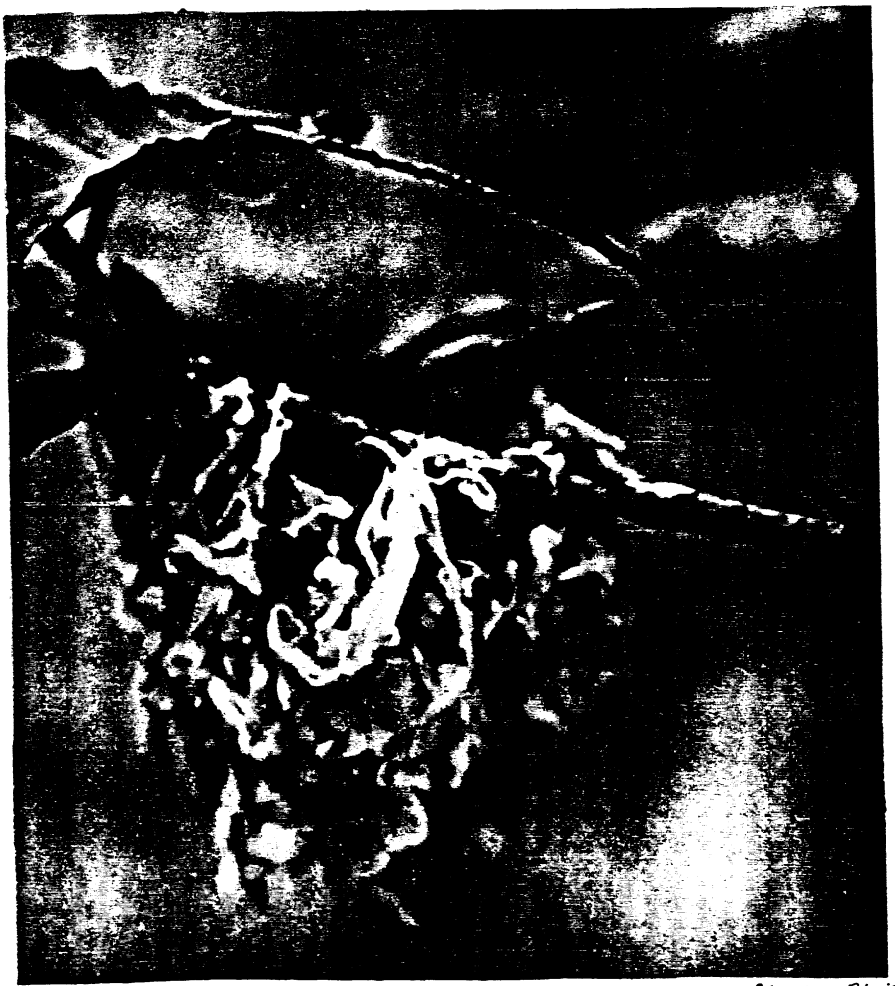
PLATE IV

June, 1949 K.A. Grave.

Fig. 1. The female Red-eyed Vireo at Nest 9 adding fresh material to the trimming of the nest during the incubation period. Standing on the nest rim, she reached down the distal side of the nest and worked the material into the wall with her bill.

PLATE V

July, 1949. Fig. 1. Incubating female on Nest 9. H. A. GRAVE.



July, 1949 Fig. 2. Incubating female on Nest 13. CHARLES BLAIR.

PLATE VI

July, 1949. K. A. Grave.

Fig. 1. Courtship feeding at Nest 9. The male Red-eyed Vireo had just passed a larva to his incubating mate when this picture was taken.

PLATE VII

The First Stage of Development

A young Red-eyed Vireo one day old

August, 1949. Margaret Feigley.

Fig. 1. Dorsal view.

August, 1949. Margaret Feigley.

Fig 2. Ventral view.

PLATE VIII

The Second Stage of Development

A nestling Red-eyed Vireo five days old

August, 1949. Margaret Feigley

Fig. 1. Dorsal View.

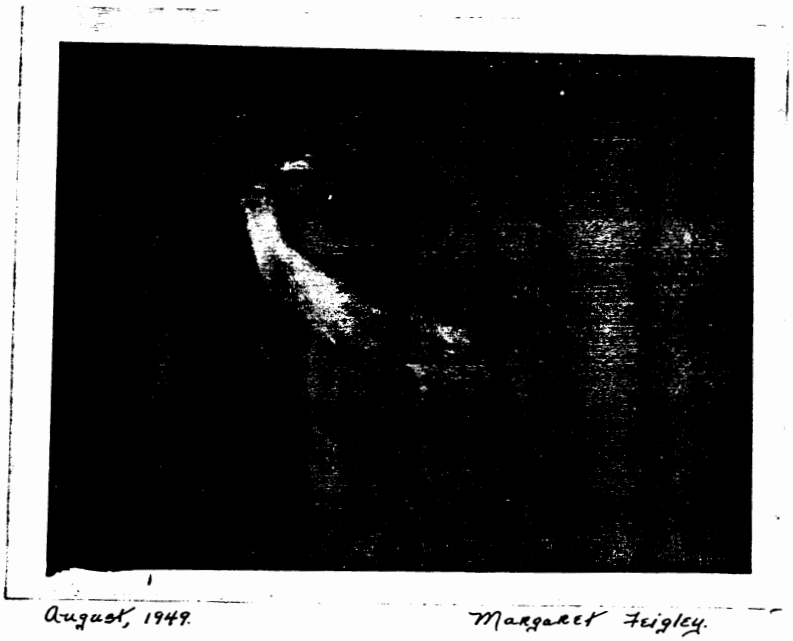
August, 1949. Margaret Feigley.

Fig. 2. Ventral view.

PLATE IX

The Third Stage of Development

A nestling Red-eyed Vireo 10 days old



August, 1949. Margaret Teigley.

Fig. 1. Lateral view.

August, 1949. Margaret Teigley.

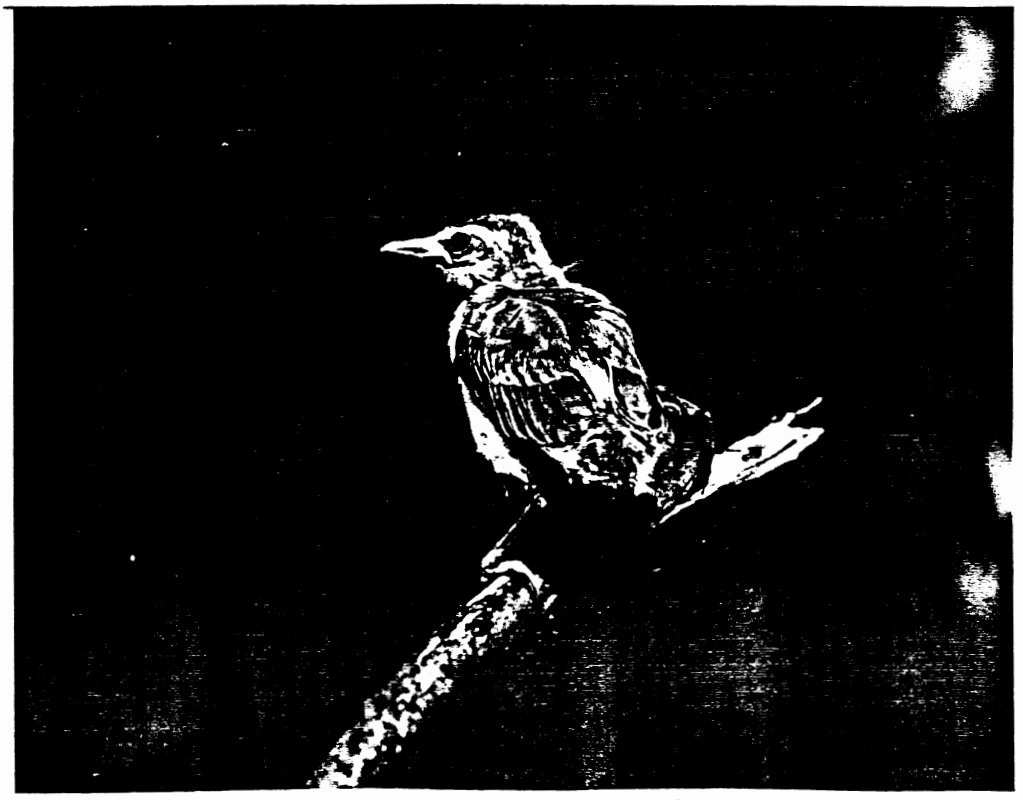
Fig. 2. Dorsal view.

PLATE X

The Fourth Stage of Development

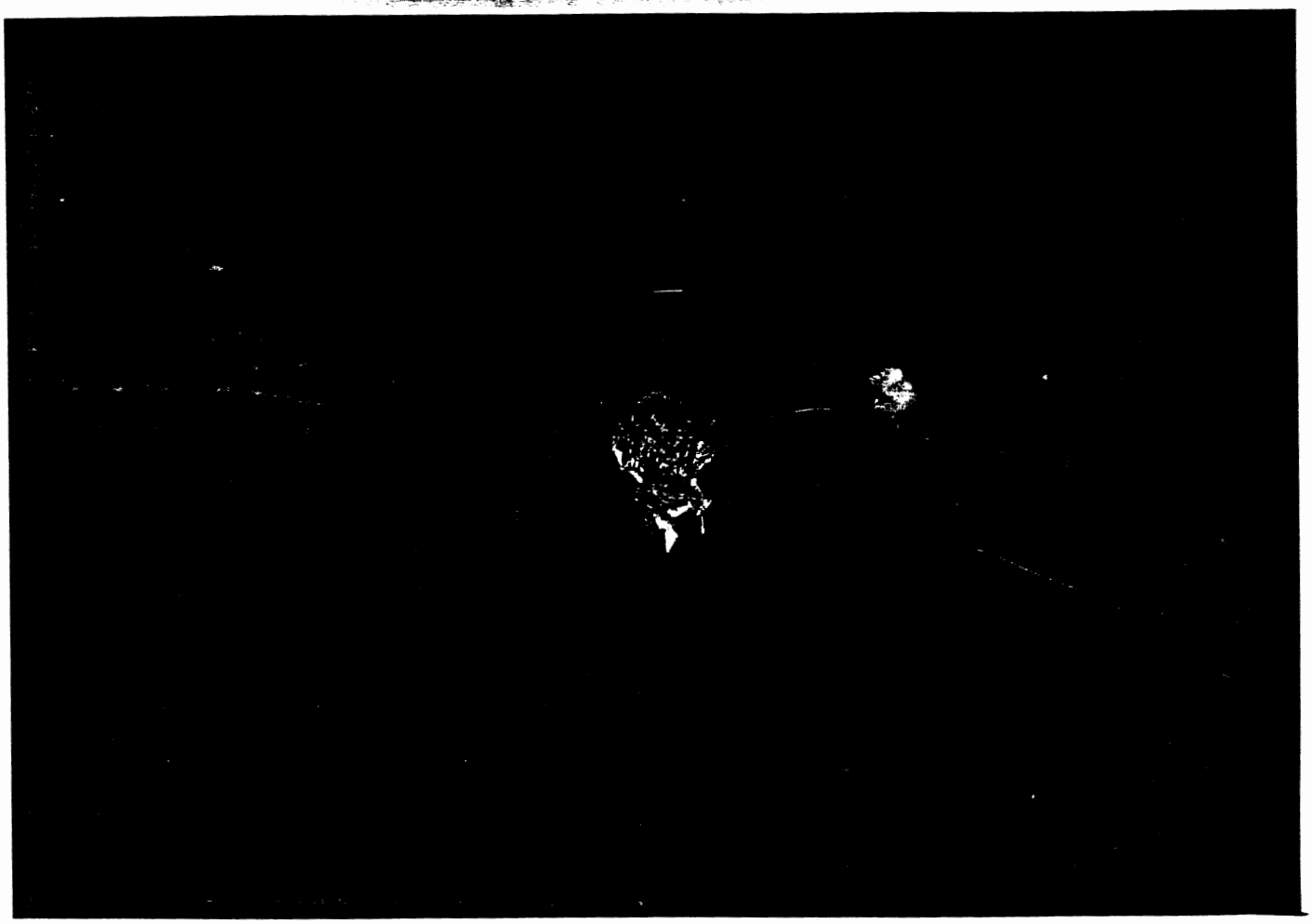
A fledgling Red-eyed Vireo 12 days old, 2 days out of the nest

August, 1949. Fig. 1. Lateral view. K.A. Grave.



August, 1949. Fig. 2. Dorsal view. K.A. Grave.

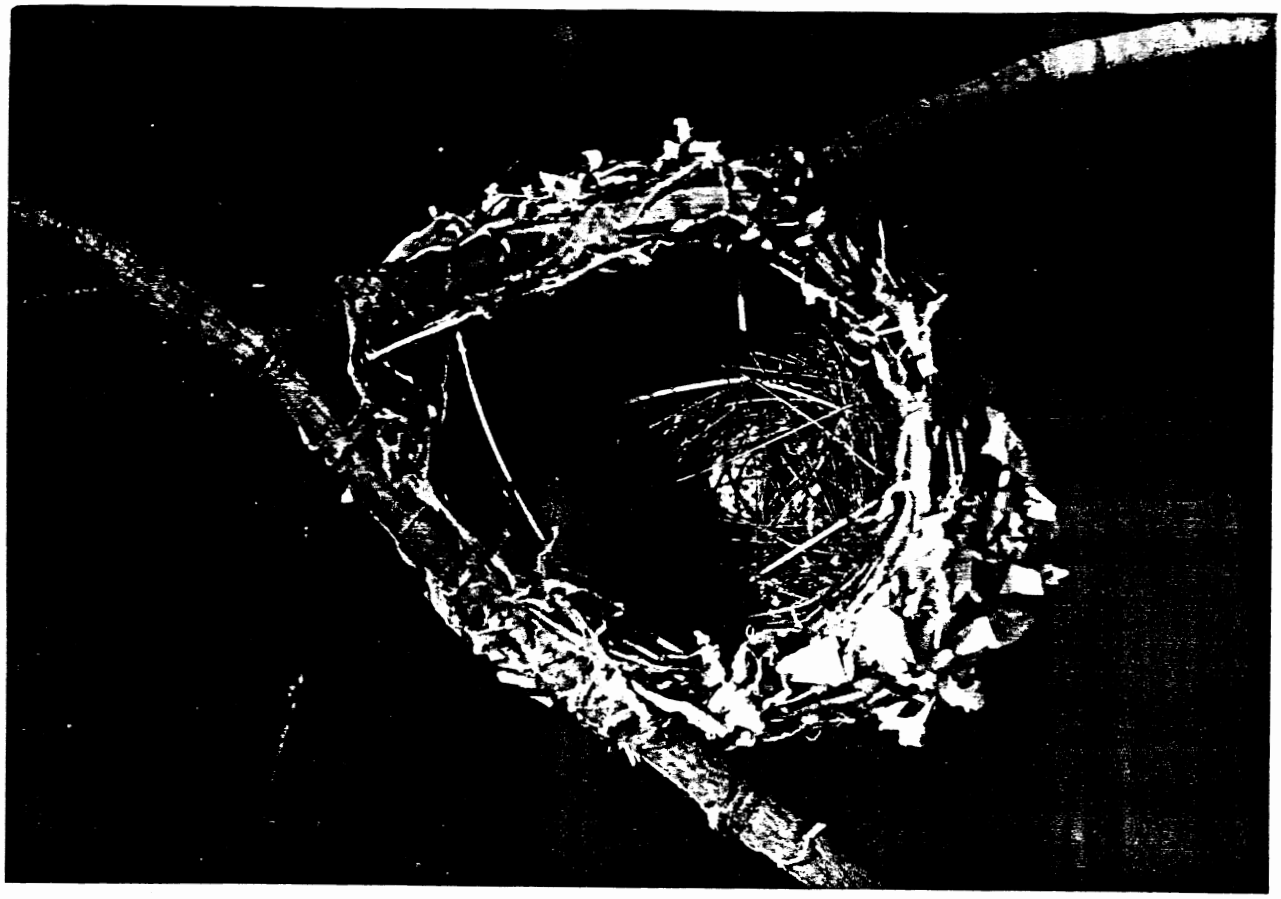
PLATE XII



July, 1949. Grace Blanchard and K.A. Greene.

Fig. 1. A fledgling Red-eyed Vireo, the last to leave Nest 5, asleep on a branch. The adult female slept in the empty nest near her young.

PLATE XIII



July, 1949. Charles Blair.

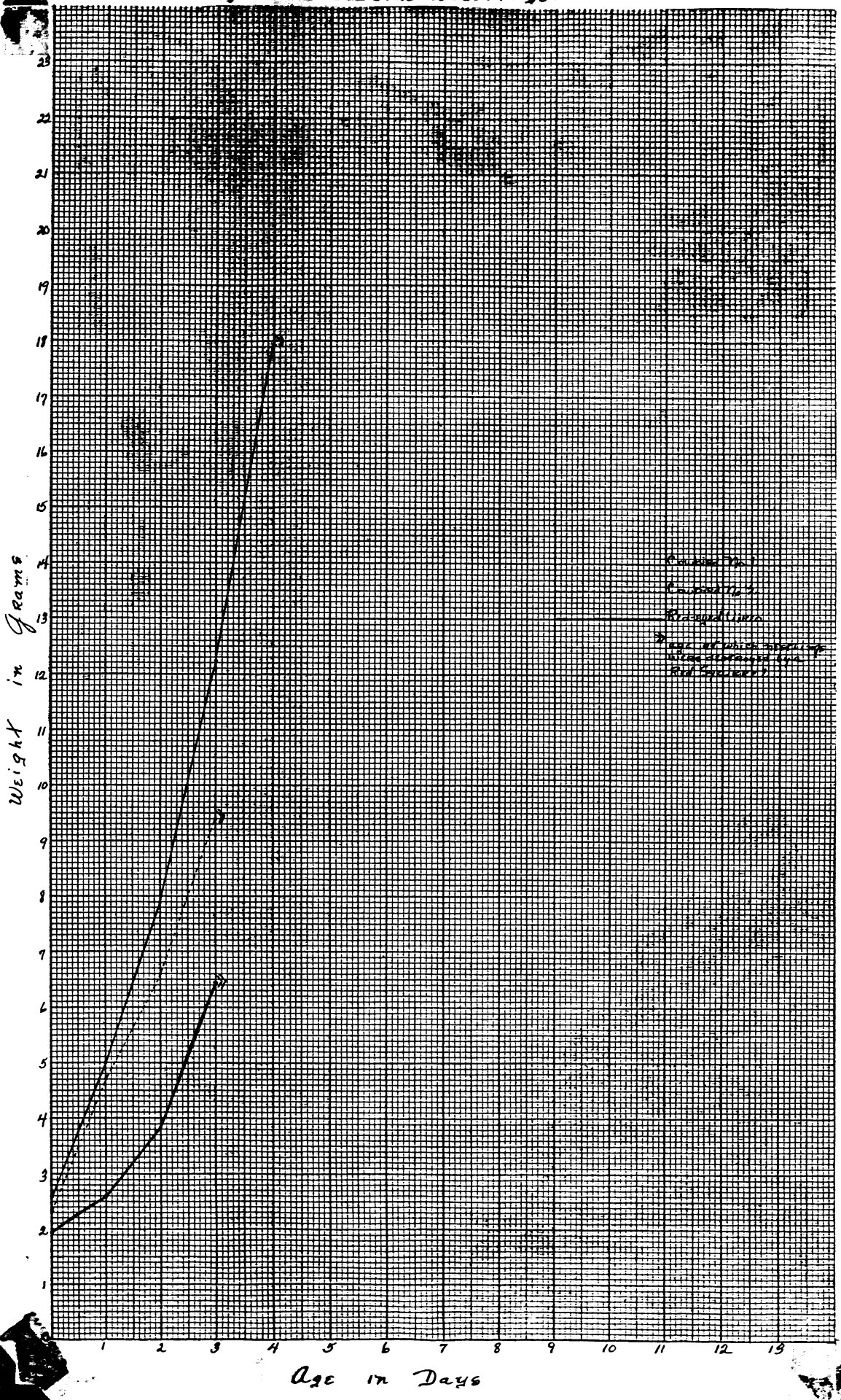
Fig. 1. A Cowbird egg burried beneath the lining of Nest 5 by the Red-eyed Vireo.

June, 1949. Margaret Feigley.

Fig. 2. Nest 10 containing four Cowbird eggs. The nest was deserted by the Red-eyed Vireos owing to this heavy parasitism.

GRAPH VII

The Daily Increases in Weight of One Red-eyed Vireo and Two Cowbird Nestlings.



GRAPH I

The First Morning Song of the Male Red-Eyed Vireo

in Relation to Sunrise and Civil Twilight

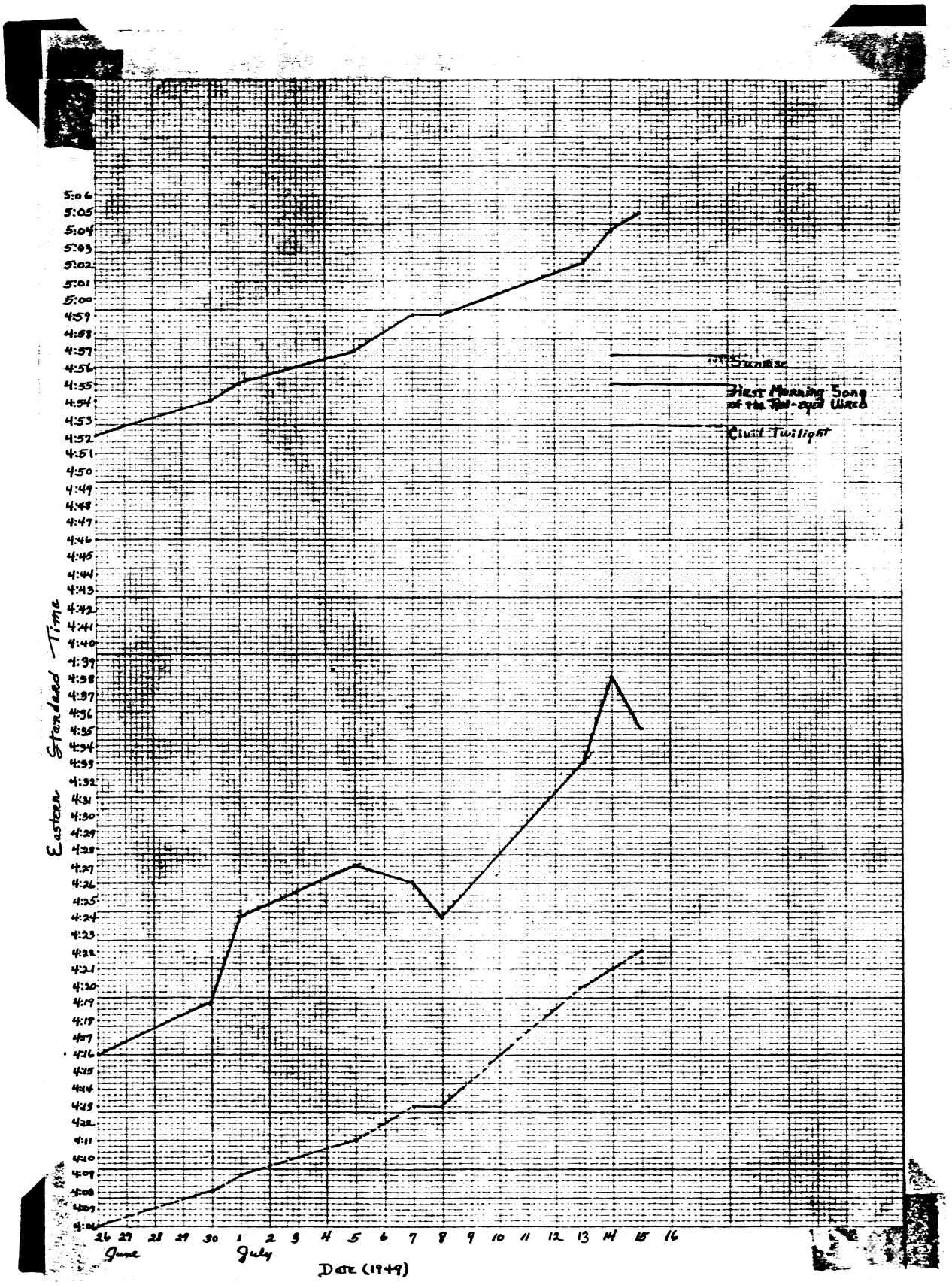


TABLE II

The First Morning Song of the Male Red-Eyed Vireo in Clear Weather in Relation to Sunrise and Civil Twilight

Date (1949)	Sunrise	Civil Twilight	1st Song	Minutes Before Sunrise	Minutes After Civil Twilight
June 26	4:52	4:06	4:16	36	10
30	4:54	4:08	4:19	35	11
July 1	4:55	4:09	4:24	31	15
7	4:59	4:13	4:26	33	13
8	4:59	4:13	4:24	35	11
13	5:03	4:20	4:33	30	13
Average	4:57	4:12	4:24	33	12

Time is Eastern Standard. Hours of sunrise and civil twilight from USWB at Alpina, Michigan.

TABLE III

The First Morning Song of the Male Red-Eyed Vireo in Cloudy Weather in Relation to Sunrise and Civil Twilight

Date (1949)	Sunrise	Civil Twilight	1st Song	Minutes Before Sunrise	Minutes After Civil Twilight
July 5	4:57	4:11	4:27	30	16
14	5:04	4:21	4:39	25	18
15	5:05	4:22	4:35	30	13
Average	5:01	4:18	4:34	28	16

Time is Eastern Standard. Hours of sunrise and civil twilight from USWB at Alpina, Michigan.

Table XI

Parental Care

Observations by Dr. Olin Sewall Pettingill, Jr.

Date 1934	Hours watched	Brooding Periods (Average lengths) On	Off	Time on nest (%)	Feedings Total By male	By female	By both	Per hour By male	By female	By both
July 7	2.43	0	0	0	6	7	13	2.46	2.88	5.34
July 8	0.50	0	0	0	0	6	6	0	12	12
July 9	2	0	0	0	0	21	21	0	10.5	10.5
July 11	1.50	0	0	0	0	4	4	0	3.75	3.75

TABLE VI

The Incubation Period of Seven

Red-Eyed Vireo Eggs

Nest No.	No. of Vireo Eggs	Date of Start of Incubation	Date of Hatching	Time of Hatching (Approx)	Length of the Incubation Period Per Egg*
2	2**	6/26/47	7/8/47	5:45 PM	1 egg: 13 days, 10 hrs.
4	3	7/22/47	8/4/47	6:30 AM	2 eggs: 13 days, 0 hrs.
				8:30 AM	1 egg: 13 days, 2 hrs.
9	1	6/22/49	7/4/49	8:00 PM	1 egg: 13 days, 13 hrs.
15	2	7/20/49	8/2/49	9:00 AM	1 egg: 13 days, 2 hrs.
				10:00 AM	1 egg: 13 days, 3 hrs.
				Average	13 days, 4 hrs.

*Accurate to the nearest hour; the exact time in minutes is not known.

**One Vireo egg disappeared on the second day of incubation.

Nest No.	Dates of Observations	No. of Days Watched	Average Temperature		No. of Hours Watched	Attentive Periods			Inattentive Periods			Per Cent of Time Spent on Nest
			Max	Min		No. of Periods	Average Length	Range in Minutes	No. of Periods	Average Length	Range in Minutes	
2	6/27/47-7/ 8/47	6	84°	61°	10 hours, 28 minutes	12	30.6	10-50	12	13.5	5-30	69
4	7/22/47-8/ 4/47	7	81°	62°	13 hours, 40 minutes	22	25.4	5-75	20	7.8	4-15	78
9	6/28/49-7/ 4/49	12	88°	66°	18 hours, 8 minutes	27	27.75	5-85	26	17.2	4-32	63
13	7/20/49-8/ 2/49	13	82°	61°	28 hours, 33 minutes	36	29.3	12-58	32	7.4	4-11	82

Date (1949)	Sky	Left Nest Prior to Laying	Returned to Lay	Length of Inattentive Period	Time of Laying	Left Nest After Laying	Time Spent at Each Laying			Interval Between Layings
							Before	After	Total	
July 14	cloudy; no moon		5:52		5:58	6:10	6 min.	11 min.	18 min.	
July 15	cloudy; occasional moonlight	5:53	6:09	16 minutes	6:16	6:40	7 min.	16 min.	24 min.	12 hrs., 18 min.
July 16	clear; bright moonlight	5:59	6:15	16 minutes	6:24	7:21	9 min.	47 min.	57 min.	12 hrs., 8 min.

The Incubation Rhythm at Nest 9 During the Third, Seventh and Tenth Days of Incubation

Date (1949)	Day of Incubation	Hours Watched	Temperatures (Fahrenheit) Minimum	Temperatures (Fahrenheit) Maximum	Attentive Periods (Minutes)	Inattentive Periods (Minutes)
June 24	3	7:35 A.M.–11:36 A.M.	65°	81°	23	4
					36	7
					12	5
					29	4
					58	7
					56	
		1:02 P.M.–4:59 P.M.			18	5
					26	11
					30	9
					15	10
					16	8
					14	8
					59	8
			Range		12–59	4–11
			Average		30	7
June 28	7	7:10 A.M.–11:33 A.M.	61°	84°	32	13
					23	10
					14	10
					30	13
					53	15
					42	
		1:25 P.M.–5:25 P.M.			10	12
					26	17
					32	12
					24	14
					23	17
					53	
			Range		10–53	10–17
			Average		31	13
July 1	10	7:10 A.M.–	67°	90°	22	13

TABLE VIII

The Incubation Rhythm at Nest 4 During the Third, Seventh and Tenth Days of Incubation

Date (1947)	Day of Incubation	Hours Watched	Temperatures (Fahrenheit) Minimum	Temperatures (Fahrenheit) Maximum	Attentive Periods (Minutes)	Inattentive Periods (Minutes)
July 24	3	7:40 A.M.-11:19 A.M.	53°	84°		17
					33	20
					32	18
					75*	24
		1:40 P.M.-5:40 P.M.			[illegible]	20
					15	20
					37	13
					33	20
					14	24
					56	
			Range		14-75	13-24
			Average		37	19
July 28	7	8:47 A.M.-12:14 A.M.	59°	83°		13
					20	13
					42	11
					51	12
					33	12
		3:33 P.M.-5:42 P.M.				13
					34	14
					56	12
			Range		20-56	11-14
			Average		39	13
August 1	10	7:30 A.M.-12:09 A.M.	47°	74°	30	5
					15	5
					30	5
					20	5
					30	4
					40	5
					38	7

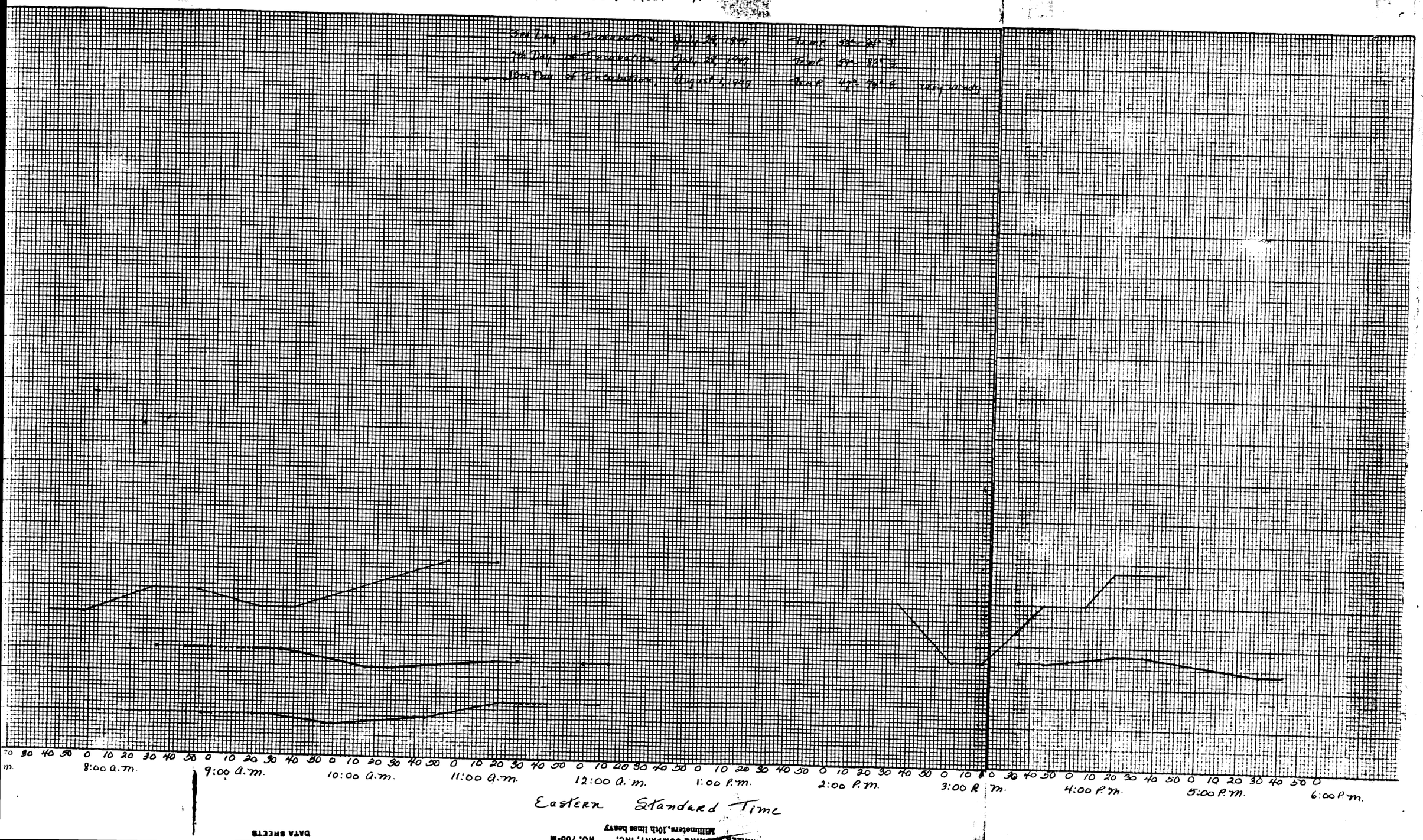
TABLE VIII

The Incubation Rhythm at Nest 4 During

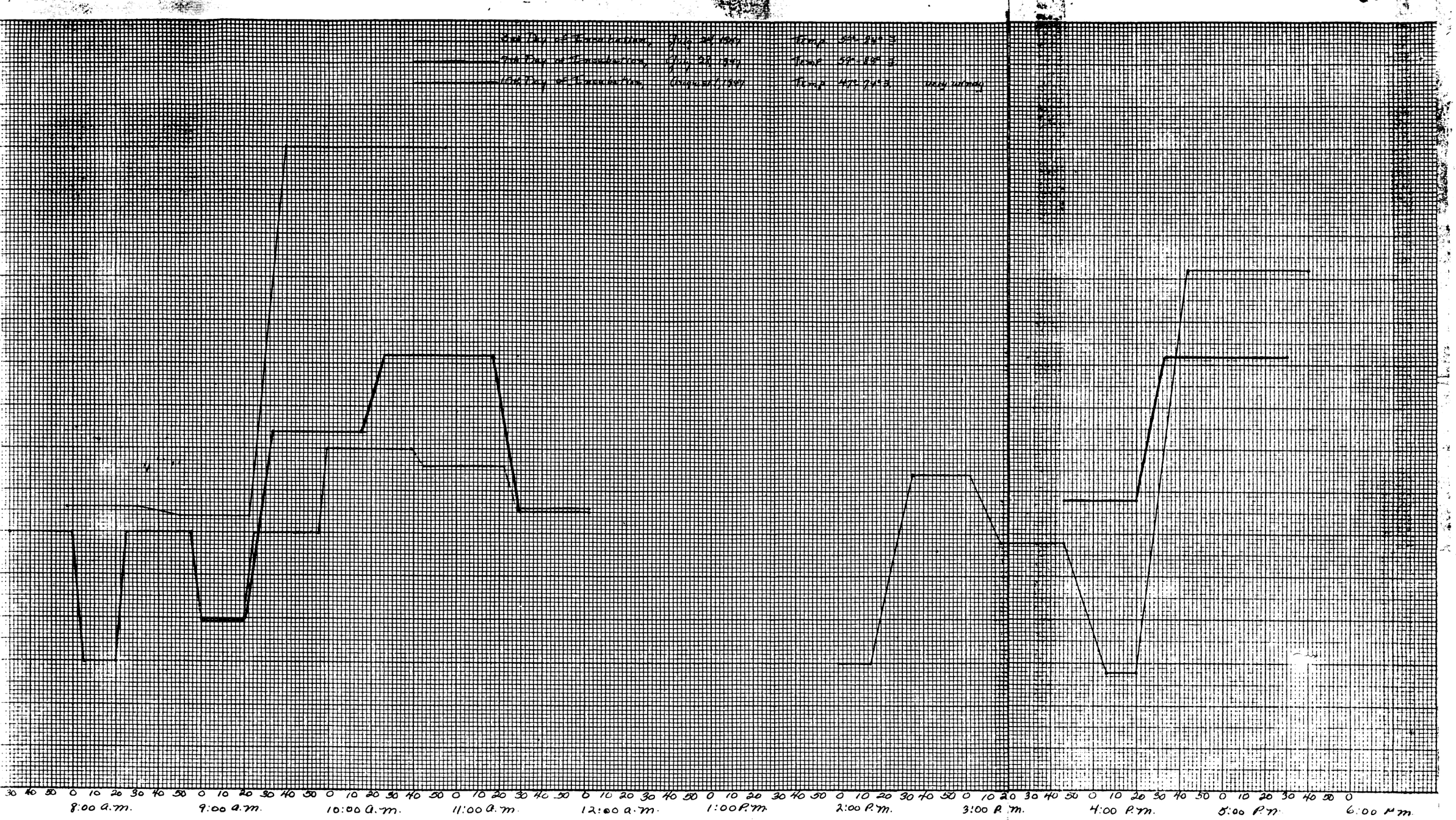
the Third, Seventh and Tenth Days of Incubation

Date (1947)	Day of Incubation	Hours Watched	Temperatures (Fahrenheit)		Attentive Periods (Minutes)	Inattentive Periods (Minutes)
			Minimum	Maximum		
July 24	3	7:40 A.M.-11:19 A.M.	53°	84°		17
					33	20
					32	18
					75*	24
		1:40 P.M.-5:40 P.M.			15	20
					15	20
					37	13
					33	20
					14	24
					56	
			Range		14-75	13-24
			Average		37	19
July 28	7	8:47 A.M.-12:14 A.M.	59°	83°		13
					20	13
					42	11
					51	12
					33	12
		3:33 P.M.-5:42 P.M.				13
					34	14
					56	12
			Range		20-56	11-14
			Average		39	13
August 1	10	7:30 A.M.-12:09 A.M.	47°	74°	30	5
					15	5
					30	5
					20	5
					30	4
					40	5

Inattentive Periods, Nest 4.

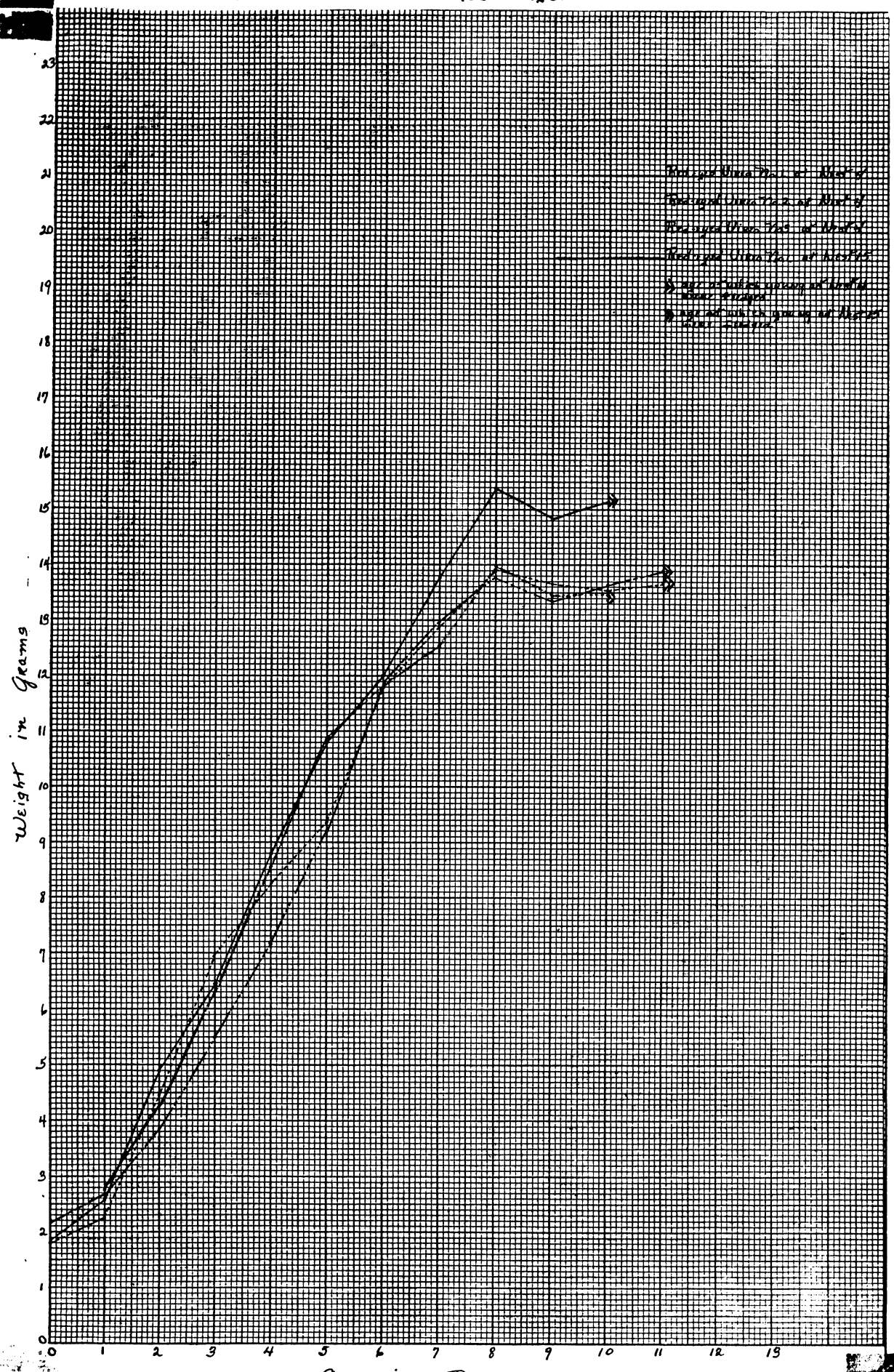


Eastern Standard Time



GRAPH VI

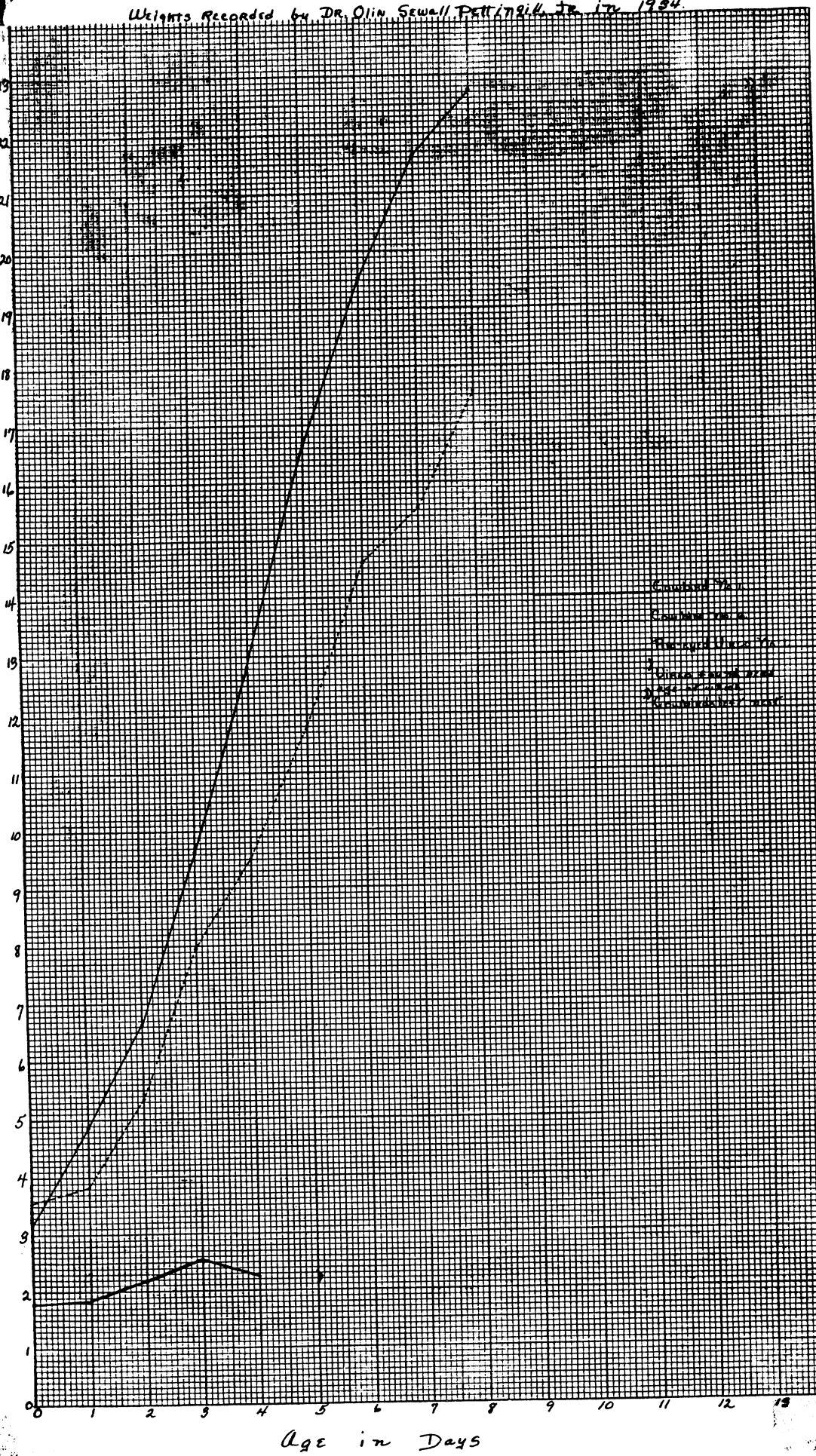
The Daily Increases in Weight of Four Red-eyed Vireo Nestlings.



GRAPH VIII

The Daily Increases in Weight of One Red-eyed Vireo and Two Cowbird Nestlings.

Weights Recorded by Dr. Olin Sewall Pettingill, Jr. in 1934.

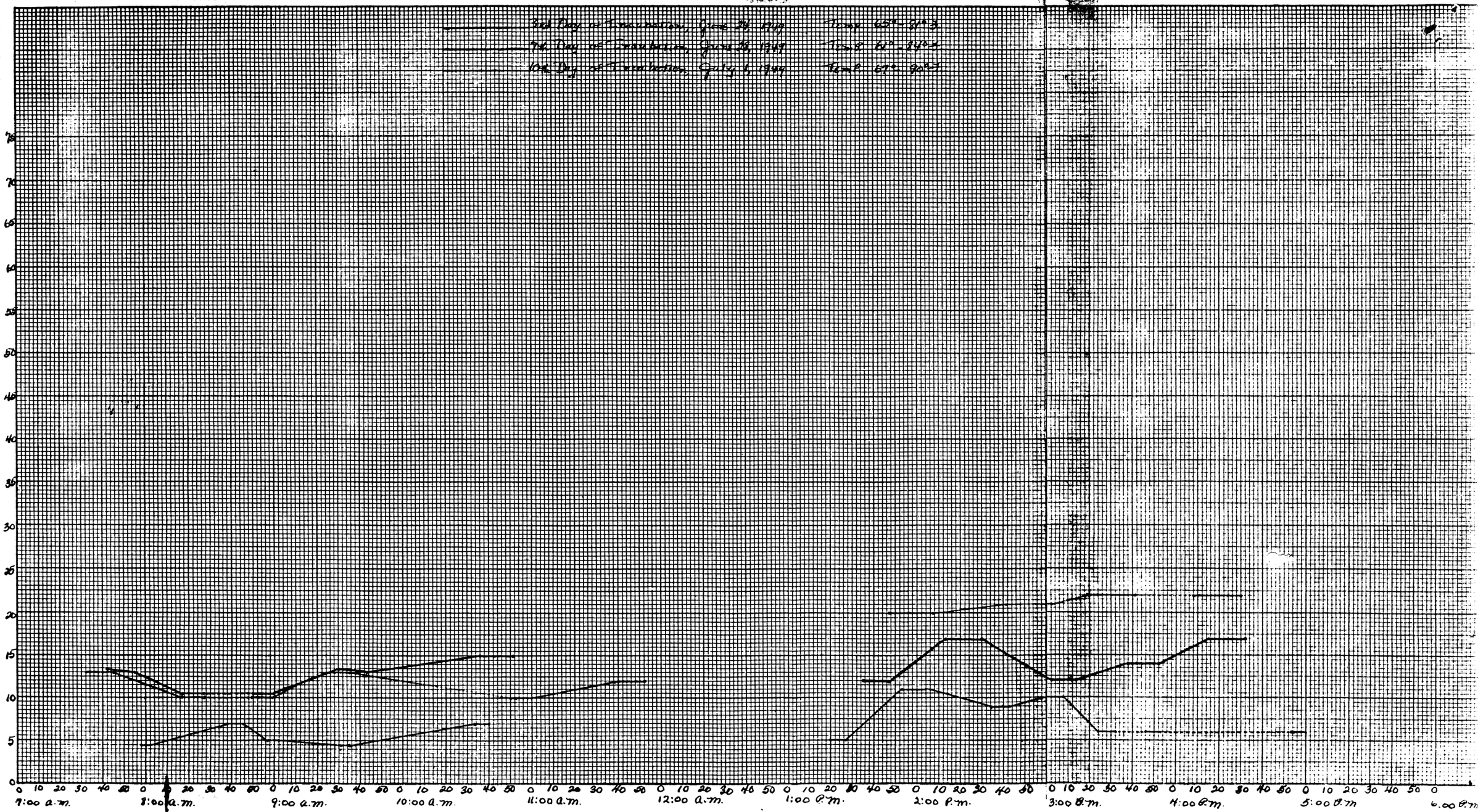


Inattentive Periods, Nest 9

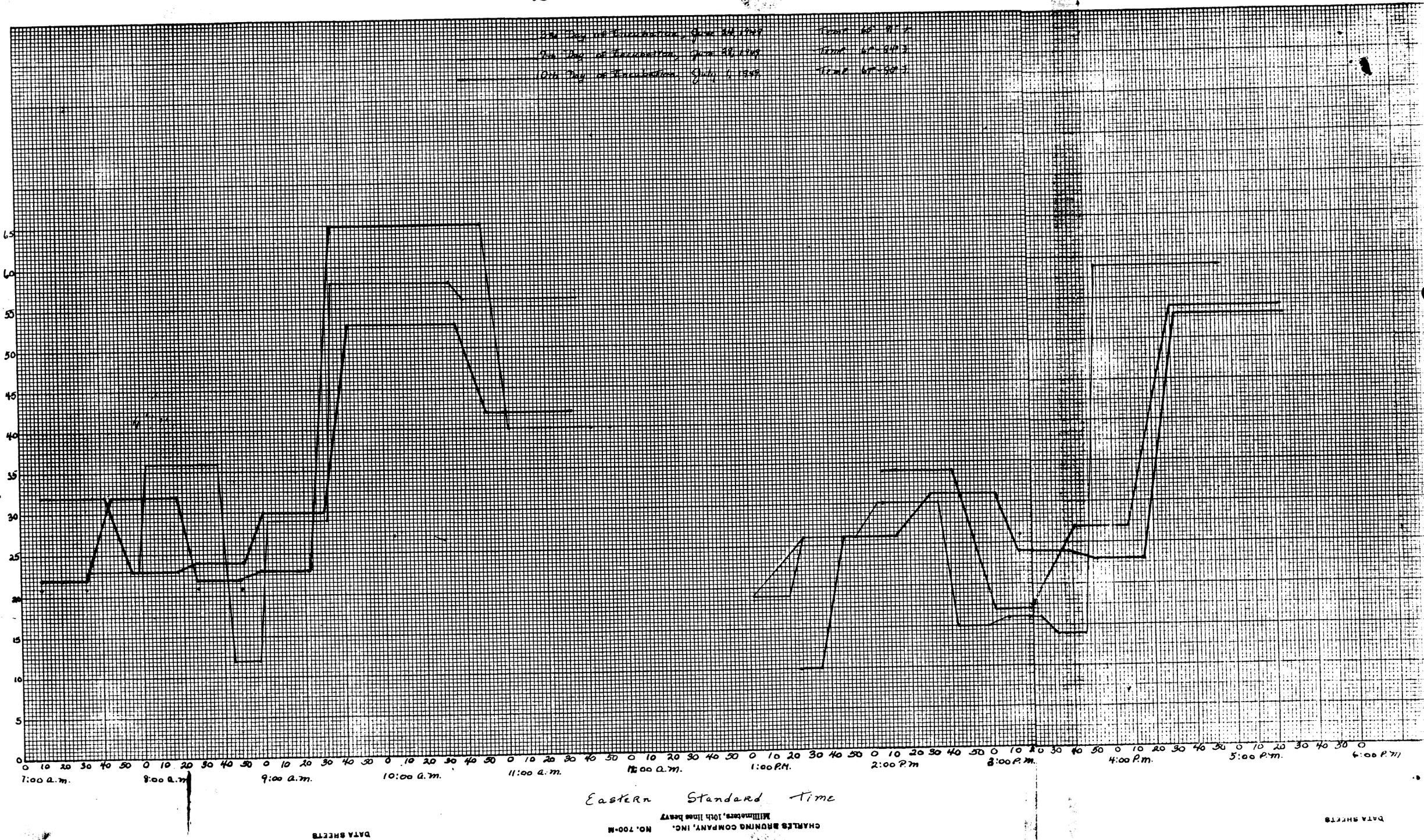
3rd Day of Incubation, June 16, 1949 — Temp. 60°-91°F.

7th Day of Incubation, June 19, 1949 — Temp. 62°-84°F.

10th Day of Incubation, July 1, 1949 — Temp. 62°-90°F.



Attentive Periods on Nest 9.



Eastern Standard Time