

SOME OBSERVATIONS ON THE NESTING HABITS OF THE
EASTERN GOLDFINCH (SPINUS TRISTIS TRISTIS)

by

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A report of an original field study conducted
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TABLE ON CONTENTS

Introduction- - - - -	1
Habitat - - - - -	2
Territory - - - - -	4
Nests - - - - -	9
Nest Construction - - - - -	10
Egg Laying and Incubation - - - - -	13
Hatching - - - - -	15
Brooding - - - - -	16
Development of the Young - - - - -	18
Post-Nesting Experiments - - - - -	21
Summary - - - - -	27
Bibliography - - - - -	29

This study of the Eastern Goldfinch Spinus tristis tristis was conducted in the vicinity of the University of Michigan Biological Station, Cheboygan County, Michigan, during the summer of 1942. The study was begun during the second week of July and continued until the close of the Station on August 22. Approximately 100 hours were spent in the field in connection with the study, this total including the time spent in observation at the nest, which was recorded to the exact minute, as well as much less-precisely recorded time in nest location, weighing of young, territory observation, and experimenting in the field of territory.

The general purpose in conducting this study was to become acquainted with the procedure involved in carrying out a life history investigation of a common species of bird. Specifically, an attempt has been made (a) to learn the exact incubation period of the Goldfinch, (b) to observe feather development of the nestlings from hatching until nest-leaving, and (c) to try out some experiments in the field of territory.

The term 'attentiveness' when used in this study means the period of time when the parent bird's feet are in actual contact with the nest. 'Inattentiveness' is the period when the bird is not in contact with the nest.

Time, when mentioned in the following pages, refers to Eastern War Time, which is one hour earlier than the Eastern Standard Time of pre-war times.

Grateful acknowledgment is given to Dr. O. S. Pettigill for his guidance throughout the entire study, to Dr. Theodora Nelson for her advice on the rearing of birds in captivity, and to Clifford Davis and Gilbert Mouser for their assistance in placing the blind at the Riggsville Corners nest.

HABITAT

Of the four nests discovered, two were located at the Biological Station, a third was found in an abandoned orchard near Riggsville Corners some three miles east of the Station, and the fourth was discovered at the edge of a wooded area near the shore of Burt Lake, about two miles to the south of the Station (See Maps 1 and 2).

The two Station nests, which were the objects of rather intensive observation, were located along the main drive of the Biological Station, which is located on the shore of South Fishtail Bay of Douglas Lake (See Map 2). The drive is lined with sugar maples, Acer saccharum; white birches, Betula papyrifera; large toothed aspen, Populus grandidentata; quaking aspen, Populus tremuloides; and white oaks, Quercus alba; with a sprinkling of small pin cherries, Prunus pennsylvanica; juneberries, Amelanchier canadensis; and sumac, Rhus typhina. An

especially large group of birches is located near the laboratories (See E, Map 2), and serves as a common feeding ground for both the Goldfinches and Purple Finches, Carpodacus purpureus purpureus, during the time when other food is not plentiful. After a level or gently sloping area of from 100 to 200 feet width paralleling the shore, on which the cabins are located, there is an abrupt rise southward to some 75 feet above lake level, which in turn gradually slopes to the south and ends in a gorge which extends to Burt Lake. Here one finds a typical maple-aspen association, the trees being generally smaller than those of the cabin and laboratory area. Goldfinches were observed flying from the nesting areas along the lake to this higher elevation constantly, probably to feed on the catkins, berries, and various weeds which furnish ground cover for this open woods.

The Riggsville Corners nest, hereafter designated as Nest Number 3, was located at the edge of an unused field of several acres extent, the field being surrounded and dotted with maples, old apple trees, and a few pin cherries.

The Burt Lake nest, referred to as Nest Number 4, was found on the field side of a rather thick woods of beech, Fagus grandifolia, sugar maple, and white pine, Pinus strobus. This nest was destroyed before incubation was completed and therefore was used only for checking nest type, size of clutch, and type of habitat.

TERRITORY

The term 'territory' in ornithology has been given various interpretations and limitations through definition. According to Mayr (1935): "Territory is an area occupied by one male of a species which it defends against intrusions of other males of the same species and in which it makes itself conspicuous."

Crawford (1939) explains territorialism thus: "A limited geographical area is settled upon and defended by an animal, usually a male, and is used by him for mating and rearing a family."

Nice, who has done a notable territorial work in her paper "The Role of Territory in Bird Life", prefers Noble's definition (1939) that "a territory is any defended area."

With a number of birds territorialism is an obvious and accepted trait. The Song Sparrow, Melospiza melodia, Kingbird, Tyrannus tyrannus, and Least Flycatcher, Empidonax minimus, are included in this group. In the case of the Goldfinch, however, the matter seems to be a controversial one. Drum (1939), in her paper on "Territorial Studies on the Eastern Goldfinch", reports the following observations: "The males do not allow Goldfinches to alight in their territory. I have observed males defend their territories on many occasions and in four different territories. I have seen females drive out other females if the males are absent. The males usually have favorite

perches from which they dart out at the intruders. Often after the intruder leaves, the male will circle above his territory and sing. While in a tower blind, I saw a fight which took place but a few feet from me. Two males were tumbling over each other making mouselike squeaks. The intruding male soon left and the other male came back to his tree."

Nice (1939), in commenting upon mating and nesting territory, says: "The Eastern Goldfinch (Spinus t. tristis) sometimes comes under this category according to Drum (1939), but other observers can find no evidence of territory."

Walkinshaw (1939) comments upon Goldfinch territory as follows: "Although I have spent many hours in the field, I have never observed any conflict between birds. Nests, after construction, have been found occupied at the same time, only fifty feet apart and in one place there were seven nests on a small triangular area, the sides of which were 370, 150 and 240 feet distance.

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"Many times from a blind, foreign males were seen very near to an occupied nest without causing any disturbance on the part of the rightful owner but these were usually when nesting was advanced. It would require more work on my part to call the Goldfinch as a typically strong territorial species."

During my own periods of observation I found nothing to indicate aggressiveness on the part of one male against

another male entering his nesting area, although my time in the field was insufficient for me to make a generalization in this matter.

In connection with territory two experiments were conducted which I consider interesting if not conclusive, and which may lead me to further study along this line. A captive male, one which had been caught earlier in the season and was well adjusted to captivity, was placed at varying distances to occupied nests at different stages of incubation and brooding, to determine the reactions of the defending birds. The responses observed follow:

NEST	STATUS	PLACEMENT	RESPONSE
3	Third day of incubation.	20 feet from nest	Female on nest answered captive male's call, but continued to incubate. Free male did not appear.
3	Third day of incubation.	Six feet from nest.	Both male and female investigated box, male continuing to carry food to female on nest, then preening on nearby limb. No pugnacity.
3	Eleventh day of incubation.	20 feet from nest.	No response, although captive male called frequently.
3	Eleventh day of incubation.	12 feet from nest.	No response.
3	Eleventh day of incubation.	Two feet from nest.	Female darted from nest four times in half hour period, beating at cage of captive male. Free male did not appear.
1	Eighth day of brooding.	30 feet from nest.	Male and female visited box, together and separately. No conflict.

NEST	STATUS	PLACEMENT	RESPONSE
1	Eighth day of brooding.	Six feet from nest.	Both birds visited box. Male looked at box each time he came to nest, but continued to feed young in usual way.
2	Twelfth day of brooding.	30 feet from nest.	No response.

The following detailed account, recorded at Nest Number 3 at the third day of incubation, is typical of the response received:

1:00 p.m.. Box was placed on small maple about four feet from ground and 20 feet from nest. Female was on nest at the time. For 25 minutes, no response either way.

1:25 p.m. Captive male began little "Chee-ta!" and "Per-chee!" sounds. Female answered with "Per-r-r-eeeeee!", after which the captive male sang loudly and distinctly for a few minutes, acting very excited. Soon he calmed down and ate, calling without response at brief intervals.

2:05 p.m. Box placed in nest tree, six feet from nest. during changing female was frightened off nest. She returned immediately, calling "Per-r-r-eeeeee!" She made a quick inspection of the box, hardly pausing before going to the nest. Captive male called out vigorously, but with no response.

- 2:28 p.m. Captive male heard free male flying overhead and gave his "Per-r-r-eeee!" and "Per-chee-cha-cha!" calls, loudly and excitedly, several times over. When free male did not answer, captive went about eating.
- 2:33 p.m. Female left nest, paying no attention to captive.
- 2:36 p.m. Female returned, going directly to nest.
- 2:38 p.m. Free male came singing, both female (on nest) and captive male answering his call. Male came to box, sat and looked a moment, then went to nest and fed female. Returned and looked at captive, sat on limb about two feet from box, and preened feathers. When male finally flew away, female left nest, looked at captive, and returned to nest.
- 3:23 p.m. Male came singing, answered only by captive male. Free male came directly to box, watched a moment, and flew to nest to feed female. He then flew away at once without looking at box. Female then inspected box briefly and returned to nest.

On the eleventh day of incubation at Nest Number 3 a stuffed specimen of Goldfinch was secured to a tall pole and placed within 20 feet of the nest, at nest height. Although the male flew in and out of the nest within ten

feet of the specimen, he took no notice of it. Later it was moved to a position only two feet from the nest. The female came to the nest first, gave a few "Chee-chee-chee!" calls, and uneasily began to incubate. When the male came he first lit in the top of the nest tree; then he flew directly to the stuffed specimen and viciously attacked it, pulling out a feather, pulling strands of cotton from the eyes, and giving it a general pummeling.

Further study along this line may reveal the extent of territory in Goldfinches, if it does exist.

NESTS

Although a variety of tree species was used even in so small a group as the four nests studied, nevertheless they presented several factors of similarity in materials used in construction, placement in the tree, and the relationship of the nesting tree to the adjacent territory (See Table 1).

Two of the nests were found in maple trees, one was in an oak, and the fourth was in a beech. Each was located on an upslanting lateral limb where one or more small branches forked, between three and six feet from the end of the branch, and fairly well concealed by the foliage. Three of the four were approximately 12 feet from the ground, the fourth (that in the beech tree) being only seven feet high. In each case the nest was placed on the side of the tree facing an opening.

NEST NUMBER	1	2	3	4
LOCATION	Faculty Row	Blissville	Old Orchard	Burt Lake
DATE FOUND	July 10	July 10	July 22	July 25
STATUS WHEN FOUND	Almost finished	Two eggs	Partially finished	Five eggs
KIND OF TREE	Oak	Maple	Maple	Beech
HEIGHT OF NEST	12½ feet	11½ feet	12 feet	7 feet
PLACEMENT	Lateral limb	Lateral limb	Lateral limb	Lateral limb
MATERIALS	Bark; Thistle down; Weed stalks; Webbing; Cedar fibres; Grasses.	Bark; Thistle down; Grasses; Weed stalks; Webbing.	Bark; Thistle down; Grasses; Weed stalks; Webbing; Cloth.	Bark; Thistle down; Grasses; Weed stalks; Webbing; Pine stalks; Horsehair.

Table 1 - Comparison of four Goldfinch nests.

The nesting materials were almost identical in spite of the variety of habitat in which they were located. In each case the main structure consisted of bark fibres, grasses, and small weed stalks, well interwoven and bound with webbing. The nests were lined with the soft down of thistle, and the rim was made particularly strong by weaving tougher and longer strands of bark along this rim. Some small and insignificant variations were noted, caused by differences in materials at hand. Nest number 3, which was in an old orchard near a farm, contained small fragments of gauzy cloth. Nest number 4, near a farm on the pine-covered shore of Burt Lake, had pine stalks woven into the basic structure and around the rim, and the lining of the nest contained several strands of horse hair. One of the Station area nests, number 1, had fine strands of cedar fibres probably pulled from a nearby telephone pole.

NEST CONSTRUCTION

Although none of the nests was discovered at the beginning of construction, both number 1 and number 3 were only partially completed when found. Of these, number 1 was in the final day of construction, while number 3 had about three days work remaining to be done. Work on the latter nest proceeded as follows:

The female, who did all of the work on the nest, brought two grasses and left without placing them. At this time only one side of the nest had its basic structure

built up to the rim level solidly, and light could be seen through the bottom. Throughout the afternoon the female continued to bring grasses, cobwebs, and strands of bark. The construction was done entirely from within the nest, the female sitting in the partially completed cup and weaving loose strands from the inner wall over the rim and into the outer wall. With each tuck of the loose end, she gave a vigorous vibration of her head, reaching far over the small branch and securing the strand. Webbing was woven into the structure in the same manner, fastening one end on the inner wall and stretching the rest over the rim and tucking it into the outer wall. Every few minutes the female would sit deeply in the nest, swelling out her breast, and turn slowly, giving firm shape to the interior. Once a heavy strand was completely placed. Then, with seeming dissatisfaction, the bird removed it and began in a different way. After several hours of this same kind of work, during which time the male made no appearance, a bit of inner lining was placed. This silky fibre was dropped into the nest bottom by the female on her return from one of her many trips. Then she snuggled in the nest and turned round and round, occupying herself otherwise by tucking at tiny strands of fibre and webbing along the rim as she turned.

Five days later, when the nest was inspected again, it was completed and had one egg in it.

The chart below shows in brief form the nest-building activities of the particular afternoon described above:

TIME	MATERIAL	ACTIVITY
1:30	Grass.	Left without placing it.
(At this point I left for telescope, returning at 2:40)		
2:50	Web.	Female sat in nest, pushing out with breast. Tucked web over rim to outside wall.
3:31	Grass stem.	Tucked along rim. Adjusted a few bits of web already in nest. Turned in nest to shape interior.
3:53	Web.	Tucked large supply of web in inner wall. Then stood up and stretched long strand far over rim and supporting branch, tucking into outer wall with vibrating motion of head. Turned some in nest.
4:00	Yellowish fibres.	Stretched from inside over rim to outside, then pulled finer strands back across rim to inner wall.
4:12	Bark fibres.	Tucked vigorously into outer wall. More sitting in nest, pushing out breast, slowly turning, tucking at loose ends of webbing at the same time.
4:15	Bark fibres.	Same activity as above.
4:18	Soft downy material.	Dropped into nest bottom, turning on it while adjusting pieces of rim material.
5:02	Web.	Found no place to put it, so she flew away with it.
5:06	Large amount of web.	Placed it along inside of nest, then stretched it over the rim and tucked into the outer wall with vibrating motion. More turning and pushing with breast.

EGG LAYING AND INCUBATION

Of the eight eggs whose laying times were checked, all were found to have been layed before 8:00 a.m. Nest Number 1 was checked very frequently during the early hours of the day, and the following times were recorded for the five eggs of the clutch:

NUMBER OF EGG	DATE	EGG LAYED BETWEEN:
1	July 12	7:15 - 7:45 a.m.
2	July 13	6:00 - 7:15 a.m.
3	July 14	6:15 - 7:15 a.m.
4	July 15	6:20 - 7:15 a.m.
5	July 16	6:45 - 7:45 a.m.

Nest number 2, which had two eggs when it was found, was checked at 8:00 a.m. for the following three mornings, each morning the egg for that day having been layed before the checking time. Nest number 3 was checked and marked at various times of the day, so no exact egg-laying time was determined.

In all three nests, eggs were layed on consecutive days, one egg per day, until the full clutch was layed.

Although continuous observation was not begun until all of the eggs were layed, numerous visits to the various nests at varying times of the day were made. At no time was the female found on the nest during egg laying time except during early morning hours. The nests were not checked at night.

Once incubation began, the female spent the majority

of the day on the nest throughout incubation. Tables 2 and 3 show that for six sample periods, taken at varying stages of the incubation periods on two nests and representing 17 hours and 35 minutes of observation, the following percentages of attentiveness were recorded: third day, nest 2, 83.8%; fourth day, Nest 2, 82.7%; fifth day, nest 2, 75.5%; eighth day, Nest 2, 86.7%; eighth day, Nest 1, 81.7%; tenth day, Nest 1, 96.6%.

The female did all of the incubating at each nest, the male making no recorded appearance until the day before hatching at nest number 1 (when he began feeding the female), and none until hatching day at Nest Number 2 (when the male came only to the nest tree, then left, to be seen no more). At Nest Number 3, however, the male was observed feeding the female regularly on the third day of incubation.

During the last few days of incubation the female fussed increasingly with the eggs, turning them over again and again with her bill. During the hours previous to hatching this operation was performed every few minutes.

Dating from the time of laying of the last egg, the eggs hatched in periods varying from 10 to 12½ days (See Table 4). This variation is undoubtedly attributable to the fact that in many cases the female starts incubating before the full clutch has been laid.

The exact incubation period on only one egg was obtained (egg number 5 in nest number 1). It was found to be 12 days

Date	July 24	July 26
Stage in incubation	Eighth day	Tenth day
Time	2:00-5:00 p.m.	1:00-3:30 p.m.
Total hours	3	2½
Attentiveness of female:		
a. Number	8	3
b. Extreme	31 min.	65 min.
c. Average	18.4 min.	48.3 min.
d. Percentage	81.7%	96.6%
Inattentiveness of female:		
a. Number	7	2
b. Extreme	8 min.	4 min.
c. Average	4.7 min.	2.5 min.
d. Percentage	18.3%	3.4%
Male fed female	0	1

Table 2 - Incubation data for Nest 1.

Date	July 15	July 16	July 17	July 20
Stage in incubation	Third day	Fourth day	Fifth day	Eighth day
Time	1:55-5:00 p.m.	9:00-11:30 a.m.	1:30-6:00 p.m.	3:30-5:30 p.m.
Total hours	3 1/12	2 1/2	4 1/2	2
Attentiveness of female				
a. Number	6	7	10	2
b. Extreme	48 min.	38 min.	32 min.	87 min.
c. Average	25.8 min.	17.7 min.	20.4 min.	52 min.
d. Percentage	83.8%	82.7%	75.5%	86.7%
Inattentiveness of female:				
a. Number	5	6	9	2
b. Extreme	8 min.	8 min.	13 min.	10 min.
c. Average	6 min.	4.3 min.	7.3 min.	8 min.
d. Percentage	15.2%	17.3%	24.5%	13.3%

Table 3 - Incubation data for Nest 2.

(The male made no visits to this nest other than a brief one just after the first egg hatched, at which time he approached to within four feet of the nest and then left. He never returned, or at least not during an observed period.)

Nest	First egg	Last egg	No.	Eggs hatched	Days from last egg	Young hatched
1	July 12	July 16	5	July 27-28	11-12 $\frac{1}{2}$	5
2	July 9	July 13	5	July 23-24	10-11	3
3	July 27	Aug. 1	6	August 12	11	5

SUMMARY

Hatching time figured from last egg. 10-12 $\frac{1}{2}$ days \checkmark ¹
Total number of eggs in three nests. 16
Total number of young in three nests 13
Percent of eggs hatched 81%

\checkmark ¹ In the one case in which the actual incubation period was obtained (Egg Number 5, Nest Number 1), the time was found to be 12 $\frac{1}{2}$ days.

Table 4 - Summary of incubation data.

and approximately 12 hours. The egg, the last in the clutch, was laid between 6:45 and 7:45 a.m., July 16, and was hatched between 7:45 and 9:00 p.m., July 28.

Of 16 eggs observed, 13 (81%) were hatched.

HATCHING

The actual hatching procedure was observed for five eggs at three different nests (Numbers 1, 2, and 3), and the procedure was essentially the same in each case. The detailed procedure as observed at Nest number 2 follows:

For more than two hours previous to hatching time the female alternated between incubating and tucking at the eggs with her bill, turning them every few minutes.

1:23 p.m. A crack appeared in one of the eggs, at right angles to the length of the egg and slightly nearer to the small end of the egg. At first the crack did not extend completely around the egg, but with the gentle tugging which the female gave with her bill, the crack soon widened to about 1/16 of an inch and circled the egg. As it widened, the parent bird reached into the crack with her bill and pulled pieces of lining membrane from the inside of the shell, eating it as she pulled it out. This apparently helped to loosen the chick from the shell.

1:25 p.m. With the combined efforts of the wriggling chick and the mother, the small half of the shell

dropped off, revealing the upper parts of the chick. This half shell was immediately picked up by the mother, who held the entire piece in her bill and slowly broke off and swallowed small pieces until the piece was entirely gone.

1:26 p.m. The larger half of the shell dropped off, and this also was soon eaten by the female, in the manner described above.

1:33 p.m. The female began feeding the newly-hatched chick only ten minutes after the first crack appeared in the shell. This first feeding was by regurgitation.

During the hatching of another egg in the same clutch a few minutes later, the female picked up the shell before the chick had become free of it, lifting chick and all about half an inch above the nest floor. The chick immediately fell to the nest floor while the female proceeded to eat the shell in the manner described above.

In another nest (Nest Number 3) during the hatching of one of the eggs, the female gave no help after the top half of the shell had been removed, leaving the posterior half of the chick "in the half-shell". Here it remained for twelve minutes, receiving its first feeding while still partly encased in shell.

BROODING

From the first hours of hatching the female began brooding most of the time. At Nest Number 1 a three hour

and 15 minute observation on the day of hatching shows an attentive percentage of 100.0%, while a three hour and 30 minute period at the same nest the following day showed an attentiveness of 89.5% (See Table 5). At Nest Number 2 a one hour observation on the evening of the hatching day showed an attentiveness of 85% (See Table 6).

As the nestlings grew older, periods of attentiveness grew shorter and farther apart. At Nest Number 1 the following record proves the point, the percentages being percentages of attentiveness: hatching day, 100%; first day, 89.5%; four days old, 46.2%; six days old, 41.1%; ten days old, 7.9%; 11 days old, 1.1% (See Table 5).

Throughout the brooding period the young were fed only regurgitated food. At first it had a pure white, thick milky appearance. Later, traces of dark substance were visible in the feeding material, particularly in that which the male brought.

It is interesting to note that feedings averaged about three per hour (See Table 7), which is infrequent compared with many birds. However the amounts fed were enormous, the parents regurgitating as many as 38 servings of food to the brood at one feeding. There seemed to be no methodical rotation in feeding, the most convenient mouth getting the helping. Over a period, this appeared to get the young quite equally served.

Nest sanitation was achieved by the adults swallowing the fecal sacs which always appeared immediately after

Date	July 27	July 27	July 28	July 31	Aug. 2	Aug. 6	Aug. 7	Aug. 7
Number of nestlings	2	2	4	5	5	5	4	4
Age of nestlings	1-3 hrs.	$\frac{1}{4}$ day	1	4	6	10	11	11
Time	2:30 5:45 p.m.	7:25 9:30 p.m.	8:25 11:55 a.m.	9:40 11:50 a.m.	2:15 5:15 p.m.	7:30 3:45 a.-p.	5:30 7:00 a.m.	7:00 9:00 p.m.
Total hours	3 $\frac{1}{4}$	2 $\frac{1}{2}$	3 $\frac{1}{2}$	2 $\frac{1}{6}$	3	8 $\frac{1}{2}$	1 $\frac{1}{2}$	2
Attentiveness of female:								
a. Number	1	3	4	5	3	11	1	1
b. Extreme	195 m	85 m.	70 m.	22 m.	52 m.	18 m.	1 m.	1 m.
c. Average	---	38.3"	47 "	12 "	24.7"	3.6"	---	---
d. Percentage	100%	92%	89.5%	46.2%	41.1%	7.9%	1.1%	.8%
Inattentiveness of female:								
a. Number	0	2	3	4	4	11	2	2
b. Extreme	---	7 m.	10 m.	22 m.	52 m.	63 m.	58 m.	88 m.
c. Average	---	5 "	7.3"	17.5"	26.5"	41.6"	44.5"	59.5"
d. Percentage		8%	10.5%	53.8%	58.9%	92.1%	98.9%	99.2%
Male fed female	2	1	3	2	1	1	0	0
Male fed young	0	0	0	3	3	7	0	1

Table 5 - Parental care data for Nest 1.

Date	July 23	July 23	July 24	July 24	July 25
Number of nestlings	2	2	3	3	3
Age of nestlings	About $\frac{1}{4}$ day	About $\frac{1}{2}$ day	1	1	2
Time	10:00 6:00 a.-p.	8:06 9:06 p.m.	7:00 8:30 a.m.	3:00 4:35 p.m.	9:50 11:50 a.m.
Total hours	8	1	1 $\frac{1}{2}$	1 $\frac{7}{12}$	2
Attentiveness of female:					
a. Number	10	2	5	7	5
b. Extreme	95 min.	37 min.	18 min.	16 min.	21 min.
c. Average	42.4 "	25.5 "	11.2 "	5.7 "	13 "
d. Percentage	88.3%	85%	62.2%	43.2%	54.2%
Inattentiveness of female:					
a. Number	9	2	5	6	5
b. Extreme	15 min.	7 min.	10 min.	15 min.	20 min.
c. Average	6.2 "	4.5 "	6.8 "	9 "	11 "
d. Percentage	11.7%	15%	37.8%	56.8%	45.8%

Table 6 - Parental care data for nest 2.

(Male at no time took part in rearing family.)

Date	July 27	July 27	July 28	July 31	Aug. 2	Aug. 6
Time of observation	2:30 5:45 p.m.	7:25 9:30 p.m.	8:25 11:55 a.m.	9:40 11:50 a.m.	2:15 5:15 p.m.	7:30 8:30 p.m.
Number of hours	3-15	2-5	3-30	2-10	3	8-30
Age of young	1	1	2	5	7	11
Number of male feedings	0	0	0	3	3	10
Number per hour	0	0	0	1.4	1	1.2
Number of female feedings	2	5	6	5	3	11
Number per hour	.6	2.4	1.7	2.3	1	1.3

TOTALS FOR NEST 1

Number of hours of observation. 22 hours, 30 min.
Number of male feedings observed. 16
Number of female feedings observed. 32
Average number of feedings per hour
(Male and female combined) 2.1

Table 7 - Feedingsummaries for Nest 1.

(Also see Table 7 a, next page)

Date	July 23	July 23	July 24	July 24	July 25	Aug. 2
Time of observation	10:00 6:00 a.-p.	8:06 9:06 p.m.	7:00 8:30 a.m.	3:00 4:35 p.m.	9:50 11:50 a.m.	10:18 11:48 a.m.
Number of hours	8	1	1-30	1-35	2	1-30
Age of young	1	1	2	2	4	11
Number of male feedings	0	0	0	0	0	0
Number per hour	0	0	0	0	0	0
Number of female feedings	29	5	5	8	8	3
Number per hour	3.6	5	3.3	5.1	4	2

TOTALS FOR NEST 2

Number of hours of observation. 15 hours, 35 min.
Number of male feedings observed. 0
Number of female feedings observed. 58
Average number of feedings per hour
(Male and female combined) 3.77

Table 7 a - Feeding summaries for nest 2.

DATE	1	2	3	4	5
July 27	1.40 gm.	1.15 gm.	unhatched	unhatched	unhatched
July 28	2.20 gm.	1.98 gm.	1.80 gm.	1.64 gm.	unhatched
July 29	2.77 gm.	2.70 gm.	2.77 gm.	2.30 gm.	1.76 gm.
July 30	3.50 gm.	3.20 gm.	3.10 gm.	3.54 gm.	2.40 gm.
July 31	4.55 gm.	4.58 gm.	4.98 gm.	5.02 gm.	3.50 gm.
Aug. 1	5.58 gm.	5.94 gm.	6.14 gm.	6.14 gm.	4.64 gm.
Aug. 2	6.32 gm.	6.52 gm.	6.90 gm.	7.02 gm.	5.55 gm.
Aug. 3	7.85 gm.	8.55 gm.	8.60 gm.	8.70 gm.	6.95 gm.
Aug. 4	8.48 gm.	8.86 gm.	9.05 gm.	9.40 gm.	7.75 gm.
Aug. 5	9.35 gm.	9.40 gm.	9.15 gm.	9.60 gm.	8.55 gm.
Aug. 6	10.44 gm.	10.30 gm.	10.50 gm.	10.75 gm.	10.00 gm.
Aug. 7	11.40 gm.	10.95 gm.	11.30 gm.	Left	10.85 gm.
Aug. 8	12.05 gm.	11.65 gm.	12.05 gm.	"	11.55 gm.

Table 8 - Individual weight records, Nest 1.
(Five nestlings, numbered 1, 2, 3,
4, and 5 in the above Table.)

DATE	1	2	3
July 23	1.44 gm.	1.28 gm.	unhatched
July 24	2.00 gm.	1.87 gm.	1.57 gm.
July 25	3.00 gm.	2.60 gm.	2.60 gm.
July 26	3.90 gm.	3.30 gm.	3.50 gm.
July 27	4.96 gm.	4.43 gm.	4.60 gm.
July 28	6.43 gm.	6.00 gm.	6.32 gm.
July 29	7.14 gm.	7.00 gm.	7.54 gm.
July 30	8.42 gm.	8.40 gm.	9.27 gm.
July 31	9.42 gm.	9.45 gm.	10.40 gm.
Aug. 1	10.48 gm.	10.10 gm.	11.55 gm.
Aug. 2	10.90 gm.	11.05 gm.	12.15 gm.
Aug. 3	11.30 gm.	12.00 gm.	12.75 gm.
Aug. 4	11.65 gm.	11.85 gm.	12.90 gm.

Table 9 - Individual weight records, Nest 2.

(Three nestlings, numbered 1, 2,
and 3 in the above Table.)

feedings. (The procedure was observed regularly at nests 1 and 2.) After about four days the nestlings aided in the procedure by elevating the anal region to the nest edge and expelling the fecal sacs, the parent bird sitting patiently by to receive each sac as it was expelled. Thus the nests were kept remarkably clean until the ninth day of brooding, when it appeared that the fecal sacs no longer were encased in a membrane covering and therefore did not hold together. At this stage the parents began carrying the sacs instead of swallowing them, but the nest rim became a messier and messier place each day as the activity of the nestlings caused the expelled droppings to become spread around and pressed into the soggy nest material.

DEVELOPMENT OF THE YOUNG

At the time of hatching, each of the young at Nests 1 and 2 weighed between one and two grams. They were weighed daily throughout the brooding period and were found to gain slightly less than one gram per day (See Tables 8 and 9).

Although two important variations in factors occurred between the two nests, there being five young and an attentive male at Nest number 1, and three young and no male at nest number 2, Graph 1 shows how closely the two broods gained in weight. Records were not kept for the size growth.

Feather development was carefully observed and recorded. Beginning as almost naked little animals at hatching, clothed only in damp tufts of natal down along the future

feather tracts, the nestlings developed in 13 days to well-feathered, alert and strong creatures capable of attempting flight---although as yet incapable of achieving it. The detailed record of the feather development (based on observations of the eight nestlings of nests 1 and 2 over the 12 day period when the young remained in the nests) follows:

- FIRST DAY natal down outlines all feather tracts, or pterylae.
- SECOND DAY Dark area shows on manus of wing. Other areas as before.
- THIRD DAY Tiny black dots show along all feather tracts beneath skin. Tiny spines are evident along posterior edge of brachium and manus of wings. No specks are as yet visible on head.
- FOURTH DAY Secondary covert sheathes are visible on the wings, and sheathes of ventral tract, particularly at anterior section, can be felt as dull stubbles. Spines of retrices now visible. Black specks under skin now visible on capital tract.
- FIFTH DAY Primary and secondary feather sheathes are about 1/8 inch long. Feather sheathes of the alulas now visible. Humeral tract is still a dark area under skin. Ventral tract sheathes are now entirely out, varying in length from

1/16 inch to barely perceptible. Specks are visible under skin in front of auricular region of the head. A few sheathes are in view along dorsal tract. Crural tract is discernable as black lines under skin. Marginal coverts dark under skin.

SIXTH DAY

Primary and secondary sheathes, as well as their coverts, about $\frac{1}{4}$ inch long. Humeral tract sheathes are now visible, as well as some of the marginal coverts. Sheathes of spinal tract out for entire length, varying in length from $\frac{1}{8}$ inch to $\frac{1}{16}$ inch. Longest sheathe of alula about $\frac{1}{4}$ inch. Still no sheathes visible on the capital tract.

SEVENTH DAY

Sheathes on capital tract now visible, although long natal down persists here as well as along all other tracts. Secondary covert sheathes are splitting open at distal end, as are a few spinal tract sheathes. Also many of the sheathes of the ventral tract, particularly those closest to the medium apterium, are splitting open.

EIGHTH DAY

Ear covert sheathes visible now. Sheathes at central area of spinal apterylae split about $\frac{1}{3}$ open, with others of this tract less so or not at all. Retrises and tail coverts now beginning to open, as are the

sheathes of the humeral tract. All primaries and secondaries are now tufted with partially opened feathers.

NINTH DAY Capital tract sheathes have begun to split open. Ventral tract looks completely feathered although sheathes are only about 50% open.

TENTH DAY Nearly all of the capital tract sheathes have begun to open. Spinal tract appears to be completely feathered, although sheathes are not entirely split open as yet.

ELEVENTH DAY Almost all sheathes are now opened for half of their length or more, giving the bird a fully feathered appearance when it is crouched.

TWELFTH DAY Natal down is gone from wings, but persists at ends of feathers of other tracts. No sheathes are as yet completely opened.

POST-NESTING EXPERIMENTS

The three nestlings from Nest Number 2 fluttered to the ground when I attempted to weigh them on the evening of the twelfth day of brooding. They were not returned to the nest, but were taken to Blanchard Laboratory where an attempt was made to rear them in captivity by hand-feeding. Pablum mixed with milk, a formula successfully used with several other species, was offered at frequent intervals but the birds failed to respond satisfactorily, and died after three days of captivity.

Since Nest Number 1 was a normal nest in which both adults were feeding regularly, I decided, at Dr. O. S. Pettingill's suggestion, to attempt to keep the entire family in captivity for the remainder of the session. Normal nest-leaving time was agreed upon as being the time to bring in the family.

By Friday, August 7, which was the eleventh day since the first egg hatched, the nest had become so broken down with the activity of the large brood that it was little more than a flat, soggy platform. To prevent the young from falling off before they were old enough to leave the nest normally, I constructed a rustic box some six inches square and six inches deep, and fastened it a few inches below the branch on which the nest had been. Into this box, which I lined with the remains of the original nest, went the brood of five. The change apparently did not upset normal family activities, for within a few minutes of the time of the change both parents had come to the new home and fed the young.

That evening one of the nestlings was gone, having escaped in some manner over the six inch wall of the box.

On Sunday morning, the thirteenth day of brooding, the parents were observed making a great effort to lure the remaining four chicks from the nest. Realizing that waiting would probably result in the loss of the rest of the family, I rigged up a hairnet snare ¹ and captured

the male within ten minutes. But instead of coming to the nest to feed as the male had done, the female spent the rest of the morning calling chicks from the nest. As one by one they ventured over the edge of the box and fluttered to the ground, I captured them and housed them some distance away with their father.

When the last chick had been lured away without the female once returning to the nest box, I found it necessary to tether the chick to the nest bottom as a bait. Nearly three hours after the male had been so easily trapped, the female cautiously entered the box and the hairnet ensnared her immediately.

The family of six was placed in a screen cage $2\frac{1}{2}$ feet by $3\frac{1}{2}$ feet by 4 feet, and a cafeteria table of the following foods was set out: bread and milk, pin cherries, June berries, Graham crackers, Pablum, bird seed, lettuce leaves, and sumac. By midafternoon the adults were observed feeding the young by regurgitation!

Meanwhile Dr. Pettingill had investigated the plaintive "Chi-pee!" of a young bird near the base of my blind, and discovered the young goldfinch which had escaped two days

✓ Mr. Bernard Baker, a student at U.B.S. in 1942, devised the hairnet trap in connection with the banding of Redstarts. The trap resembles a waste paper basket in shape and is made of two wire loops covered with dark-colored hairnets. The closed end was secured to a limb just above the box, with the open end set at the edge of the nest. When the bird entered the nest, a quick tug at the lower loop caused the nest to be completely covered, with the bird ensnared. The material of the net is of such softness that there is little chance of injury to the bird.

before. It was reunited with the rest of the family in the cage.

Sunday evening was cold and wet, and by Monday morning two of the chicks had died. The others seemed dumpy and listless, and although the parents tried to give nourishment by regurgitation, the chicks seemed to be suffering from lack of food. An attempt to feed the young by hand was quite unsuccessful.

That noon the family was brought from the outdoor aviary to the heated laboratory and another series of foods was offered. On the list was a commercial preparation for feeding brooding tame canaries^{2/}, and it gave immediate results. Within an hour the parents were consuming large quantities of the cereal-like food, and were in turn feeding the three remaining chicks almost constantly.

During the remaining weeks of the session little time was available for close observation of the growing family. The adults almost immediately became accustomed to the nearby presence of people working in the laboratory, and went about their business of feeding the offspring with great enthusiasm^{3/}.

^{2/} "Nestling Food", Hartz Mountain Products, New York. Contains egg yolk, defatted milk solids, zweiback, flax, and cod liver oil. Minimum protein, 17.00%; minimum fat, 3.00%; minimum fibre, 2.00%. Supplies vitamins A, B, D, E, and G.

^{3/} The female had displayed unusual indifference to human presence throughout incubation and the first half of brooding, permitting me to lift her from the nest, stroke her back, and take movies from a distance of two feet. In order to see the young it was sometimes necessary to push her gently from the nest to the nest rim, where she would sit and watch for an opportunity to hop down and hover her nestlings again.

Courtship activity continued between the adults even in captivity, as evidenced by the female's frequent attempts to beg food from the male as he was feeding one of the young. On the rare occasions when she was successful she always passed the food on to one of the chicks immediately.

Frequently both parents would show concern for the same chick and would sit on either side of it on a limb and ply it with tiny morsels of regurgitated food from both sides.

A close examination of feather development on the ninth day of captivity, when the chicks were 21 days old, revealed that the wing and tail feathers were still partly encased in sheathing, although the other feather tracts were now in their complete juvenal condition---light, fluffy, and uninterlocked.

On Wednesday, August 19, just 23 days since the first egg of the brood hatched, the chicks were first observed feeding themselves, and in the remaining few days of the session they became more and more capable of securing their own nourishment. One of them was even successful in its first observed attempt to crack a seed. Regurgitation by the parents continued with as much regularity as previously, however.

The above described experiment is of importance chiefly because it reveals the relative ease with which young goldfinches of nest-leaving age can be raised and observed in captivity. Previously hand-raising had been

the only method used here at the Station, and it involved a tedious continuity of hourly or semi-hourly feedings, and with uncertain results. With the parent birds doing all of the feeding, it became necessary only to provide fresh food and water four or five times a day.

Whether or not other species will respond and thrive in captivity as a complete family unit is a matter for further investigation. Also, the question as to which stages of the life cycle of the Goldfinch can be observed in captivity is one which deserves continued experimentation. Along with this is the question of comparative development of caged and non-caged birds. Such possibilities as breeding, egg laying, brooding of newly-hatched nestlings, etc., are fascinating suggestions for future summers of patient care and resourcefulness.

SUMMARY

TERRITORY:

1. There is considerable controversy as to the territorial traits of the Eastern Goldfinch.
2. Experiments with a caged goldfinch and a stuffed goldfinch revealed some indications of a very restricted type of territory.

NEST BUILDING:

1. Nests are built entirely by the female.
2. There appears to be no species or type of tree most preferable for Goldfinch nests.
3. Nests are constructed chiefly of grasses, web, bark fibres, and rootlets, and are lined with soft silky fibres of milkweed or thistle.

INCUBATION:

1. The female does all of the incubating.
2. Sometimes, but not always, the male feeds the female at the nest during incubation (this was observed at two nests of three observed).
3. The incubation period as checked on a specific marked egg was found to be $12\frac{1}{2}$ days.
4. During the incubation period the female stays on the nest more than 75% of the time.

PARENTAL CARE:

1. The young are fed within fifteen minutes of hatching time.

2. Attentiveness is above 90% at the beginning of brooding, diminishing gradually to about 1% on the twelfth day, just prior to nest-leaving.
3. Young are fed at first by the female only, the male feeding the female at the nest. From the fifth day the young are fed by both parents. All feeding throughout brooding is by regurgitation.
4. Fecal sacs are swallowed by the adults until the ninth day of brooding. Some are then carried away, while others remain to clutter up the nest.
5. The young stay on the nest 13 days (based on the record of the young of Nest Number 1).

REARING BIRDS IN CAPTIVITY:

1. An entire family of Goldfinches can live and thrive in captivity if properly fed.
2. The parents soon adjust to being caged, and will feed the young amply by regurgitation.
3. The captive young will begin to feed themselves after they are about 23 days of age.

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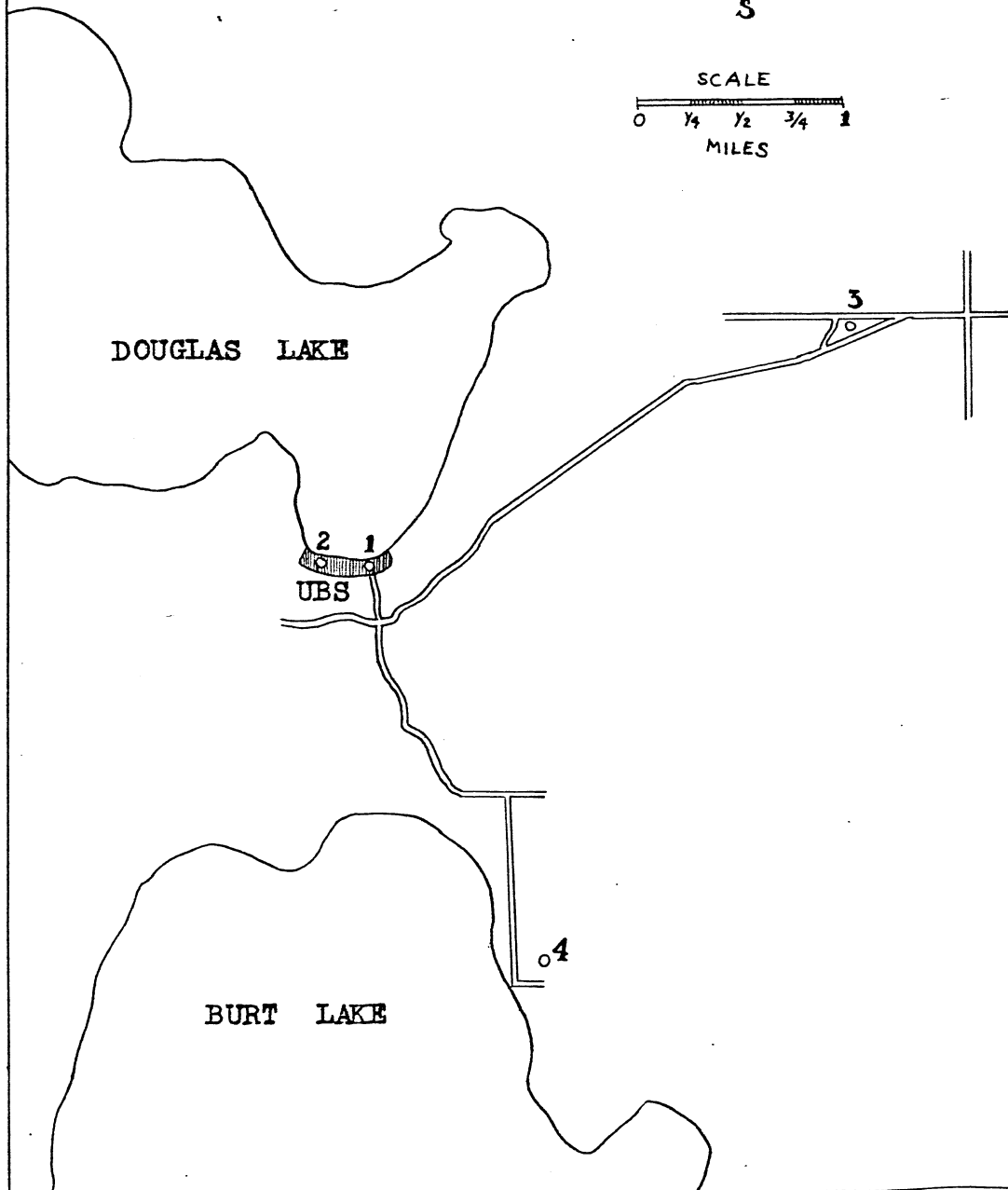
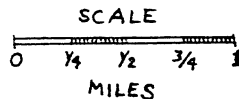
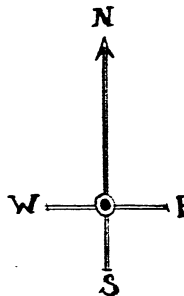
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LEGEND

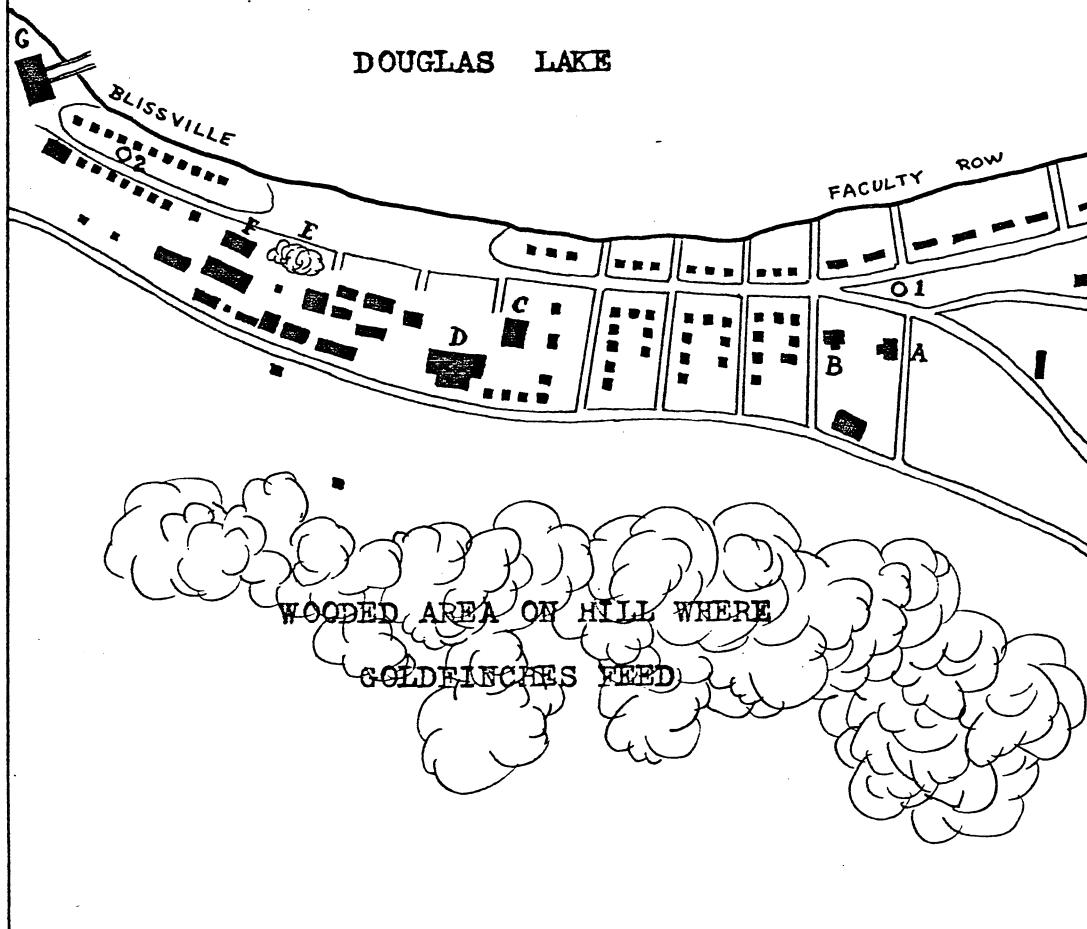
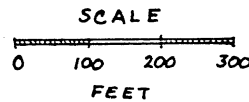
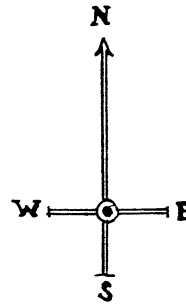
- 1. Faculty Row Nest
- 2. Blissville Nest
- 3. Riggsville Corners Nest
- 4. Burt Lake nest



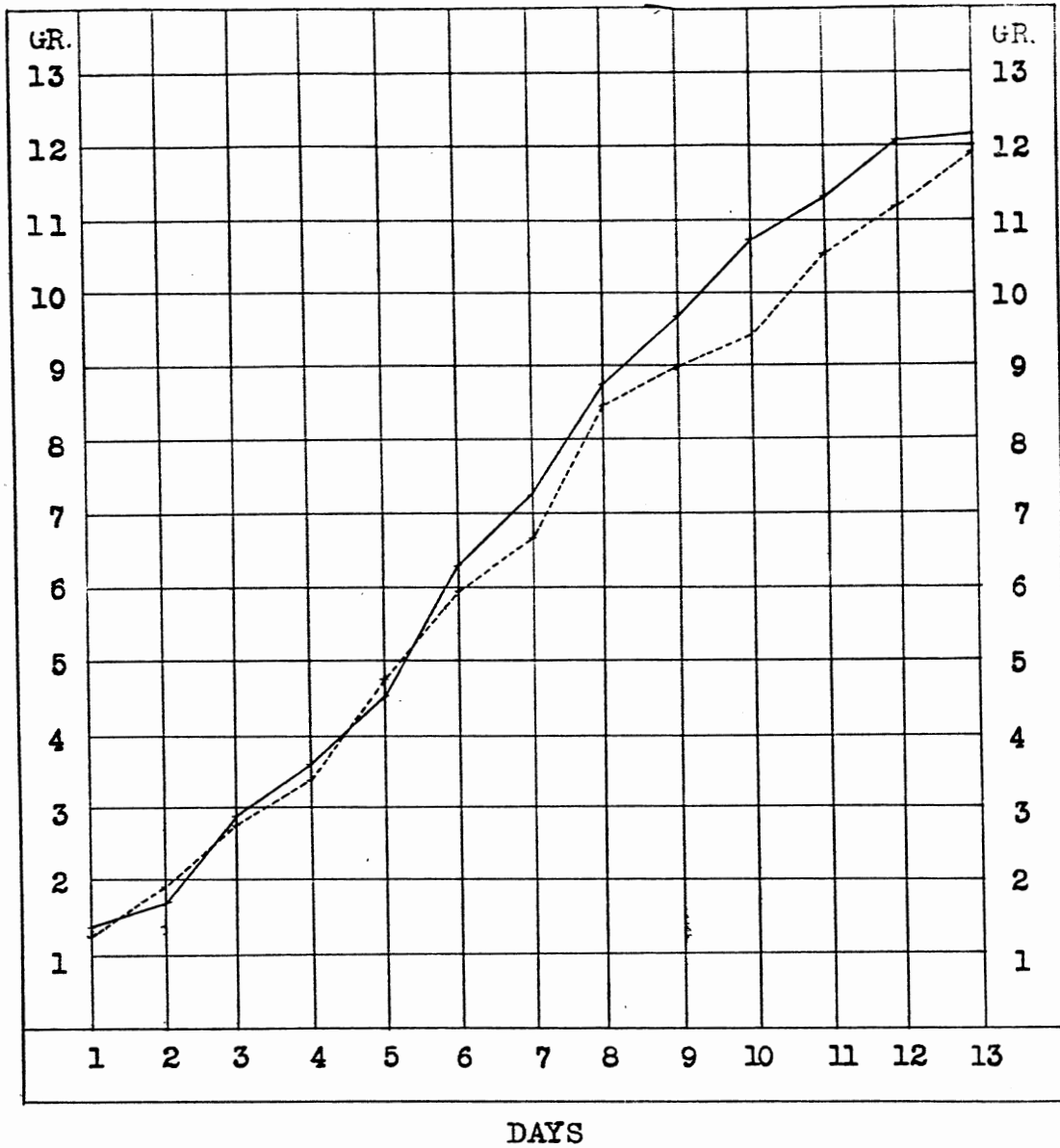
MAP 1 - Location of nests used in study.

LEGEND

- 1. Faculty Row Nest
- 2. Blissville Nest
- A. Director's Cottage
- B. Forester's Cottage
- C. Clubhouse
- D. Dining Hall
- E. Goldfinch Feeding Area
- F. Aquarium
- G. Boathouse



MAP 2 - Nests of the Station area, showing feeding grounds.



----- Nest No. 1
 _____ Nest No. 2

GRAPH 1 - Comparison of average growth rates of nestlings of Nest No. 1 with those of Nest No. 2 (Weights shown in grams).