

A STUDY OF THE BREEDING BEHAVIOR
OF THE CEDAR WAXWING (Bombycilla cedrorum)

by
Douglas A. James
Huntington Woods, Mich.

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INTRODUCTION

The breeding behavior of the Cedar Waxwing (Bombycilla cedrorum) was studied in order to investigate in more detail this species nesting activities in northern Michigan and to determine some of its ecological relationships to the environment of the area considered.

The study was accomplished during the 1946 summer session (June 22 to August 17) at the University of Michigan Biological Station. The Biological Station is located in Cheboygan County, Michigan on South Fishtail Bay of Douglas Lake.

While conducting the project 54 hours observation were spent in the field during which time 11 nests were found on 10 acres of the campus area. Tower blinds were erected next to two nests from which more concentrated observations were made. Much time was devoted to measuring the wings and weighing the nestlings so as to gauge their development. (The wing measurements were taken from the shoulder to the tip of the phalanges).

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Nest	Date Found	LOCATION					Nest	Me	
		Species of Tree	Height of Nest	Nest Dist. + Direc. from Trunk	Kind of Crotch	Height of Tree			Dia. of Tree
1	Jun. 23, '46	Red Oak (<u>Quercus borealis</u>)	3.2 m.	3.3 m. SE	horizontal (1 branch) (4 twigs)	8.2 m.	20.0 cm.	Comparatively large straw, fine rootlets, tiny twigs, some plant fiber (very little), alot of grass (not too fine).	Not much different lining + certainly no cotton line from it. (6 larger twigs on outside 1 of it same size as lining rootlets, twigs, straw)
2	Jun. 23, '46	Red Oak (<u>Quercus borealis</u>)	5.2 m.	3.1 m. N	horizontal (3 branches one very large)	10.4 m.	32.2 cm.	Pine needles, grasses, cotton	straw, twigs, root grass (see above)
3	Jun. 28, '46	Red Pine (<u>Pinus resinosa</u>)	4.6 m.	against trunk W	Vertical (tree trunk) (3 branches) (Pine Needles)	5.5 m.	13.6 cm.	Straw, a few grasses, a few fine twigs, bark strips, strip of paper, some cotton, and some pine needles	grass, straw, a few t and a few rootlets (see above)
4	Jun. 28, '46	Red Maple (<u>Acer rubrum</u>)	5.5 m.	0.2 m. SW	Vertical (2 branches) (1 twig)	6.7 m.	9.0 cm.	straw, rootlets, plant down, cotton, pine needles	straw, twigs, rootlets, (see above)
5	Jun. 28, '46	Red Pine (<u>Pinus resinosa</u>)	8.2 m.	1.2 m. SW	Vertical (2 branches) (pine needles)	9.8 m.	25.4 cm.	pine needles, straw, rootlets	straw, grass, and some twigs (see above)
6	Jul. 1, '46	Sugar Maple (<u>Acer saccharum</u>)	7.3 m.	4.1 m. N	Horizontal (1 branch) (2 twigs)	11.6 m.	30.1 cm.		
7	Jul. 2, '46	Red Maple (<u>Acer rubrum</u>)	4.9 m.	4.4 m. S	Vertical (3 branches)	8.6 m.	38.7 cm.		
8	Jul. 2, '46	Sugar Maple (<u>Acer saccharum</u>)	6.1 m.	2.4 m. E	Horizontal (2 branches) (1 twig)	9.2 m.	25.4 cm.		
9	Jul. 2, '46	Sugar Maple (<u>Acer saccharum</u>)	6.1 m.	3.8 m. E	Horizontal (3 branches)	11.3 m.	26.4 cm.		
10	Jun. 21, '46	Red Elder (<u>Sambucus racemosa</u>)	3.1 m.	1.8 m. NW	Vertical (3 branches) (1 twig)	4.6 m.	Shrub with many main branches		
11	Jun. 22, '46	Red Oak (<u>Quercus borealis</u>)	3.6 m.	1.8 m. NE	Horizontal (2 branches)	9.2 m.	25.4 cm.		
			5.3 m.	2.4 m.		8.6 m.	22.4 cm.		

Material	Date Nest Begun	Date egg laying began	No. of Eggs	No. of young	Date Eggs Hatched	Date Young Left Nest	young that left nest	incubation period in days	time period in Days	Nesting Success	Weight of	
from demer- k has out most Grass,	Birch bark peelin ^g s, large twigs, roots, straw, and grass, dried leaves, string, twine, + dried flowers with seed pods.	June 23, '46	Jun. 29, '46	6	6	Jul. 14, '46	(2) Jul. 26, '46 (1) Jul. 28, '46 (3) Jul. 29, '46	6	10	(2) 12 (1) 14 (3) 15	100%	38.46
ets,	Big twigs, roots, grass, + straw, string, cotton, + dried plants with seed pods	probably June 22, '46	Jun. 27, '46	5	5	(4) Jul. 12, '46 (1) Jul. 13, '46		5	11		100%	44.81
wigs,	string, seed pods, + a feather		probably Jun. 26, '46	4	4	July 12, '46	Jul. 27, '46	4	11	15	100%	15.45
grass	big twigs, roots, grass, straw string, cotton, and dried leaves.			5	4	(3) Jul. 14, '46 (1) Jul. 15, '46	Jul. 27, '46	4		13	80%	29.59
	roots, string, dried plants with seed pods, and straw.			5	0	—		0			0%	15.48
			July 1 or 2, '46	1+	1+			1+				
			June 29, '46	5	5		Jul. 27, '46	5			100%	
			June 29, '46	5	5	(4) Jul. 12, '46 (1) Jul. 13, '46	Jul. 28, '46	5	11	(4) 16 (1) 15	100%	
				?	4 or 5		Were almost fully feathered Jul. 18, '46	4 or 5				
		Jun. 23, '46	—	0	0	—	—	0	—	—	(0% Nest not completed)	
		Jun. 23, '46	—	0	0	—	—	0	—	—	(0% Nest not completed)	
		Jun. 23, '46	June 29, '46	5	5	Jul. 13, '46	Jul. 29, '46	5	11	15	53% (65%)	28.95

DESCRIPTION, RANGE, AND SONG

The Cedar Waxwing is often called the Beau Brummell of the birds because of its emaculate appearance. It has a black bill and a cinnamon brown head which is lightest in the region of the auriculars and forehead. Beginning in back of the eyes and running across the forehead by the base of the culmen is a narrow black mask. The chin is also black and fades into the brown of the throat. Between the black mask and chin is a narrow band of white which runs to the posterior edge of the mask. On top of the head is a crest which can be erected but is usually ^{is} lying flat on the head. The iris of the eye is dark red. The throat and breast is a light olive brown which gradually washes into the ^fulvous yellow of the abdomen. The under tail coverts in contrast to this are white. The tail is black below and above with each feather tipped with chrome yellow at the distal end. The wings grade from a dark gray near the body to black at the tips of the flight feathers. The leading edge of the primaries and the trailing edge of the tertiaries are whitish. The secondaries may or may not be tipped with a short thin scarlet red aftershaft which have a waxy appearance. The female is no different from the male as described above except for a little less black on the chin. For the juvenile plumage see the section on development of the young below. (The colors used in this description were taken from the color chart in Chapman's "Birds of Eastern North America").

The song of the Cedar Waxwing has been contested many times as to its validity. It is a song in relation to the fact that it is used during courtship. Yet it is not a true song when it

is given during other activities such as when the birds flock before, after, and ^{ever} during the breeding season or when the bird is outside its territory and separated from its mate. Therefore, it is all a matter of definition as to whether the Cedar Waxwing has a song. In one sense the same sound is a song part of the time and not a song the remainder of the time. The particular note that initiated all this controversy is the trilled high pitched and not too audible "eeee" which is not long in duration (not abrupt, however). The Cedar Waxwing also gives another note which serves as its call note, distress note, etc. This is an "eeee" of a higher pitch without the trill but of the same other qualities as the song. There is not, however, a clear cut distinction between the song and the call note. At the time their nest is disturbed the waxwings will first give the non-trilled call when close to the nest and actively excited but will later retire ~~to~~ ^{for} some distance to a perch and give the trilled note while motionlessly observing the intruder's activities (this of course is the behavior pattern before a strong attachment to the nest has been established). The female Cedar Waxwing seems to sing as loudly with the same quality and as repeatedly as the male. The female also has a special modification of the song during courtship when she imitates the behavior of a young bird being fed. This is merely the song given in very rapid succession. Not too much time ever passes when the Cedar Waxwing does not give one of its calls. In other words it is practically always giving a call note or song. One can quickly determine when one is in the vicinity of waxwings by the way they continually call to each other. The sounds given are not too intense and the frequency does not

seem to be correlated with any particular part of the day.

According to Chapman ("Birds of Eastern North America"), the Cedar Waxwing "breeds from central British Columbia through Ontario to the Cape Breton Islands south to northwestern California across through Kansas, northern Arkansas, North Carolina, and northern Georgia. Its winter range extends throughout nearly all of the United States and south to Cuba, Mexico, Lower California and Panama." From the great extent of its range over varying climatic and vegetational environmental factors it can be concluded that the Cedar Waxwing is an extremely plastic and successful species. Further proof of its wide range of adaptability will be demonstrated later in this paper.

ENVIRONMENT

The habitat type of the campus area is an open woodland with almost no underbrush and is essentially man made. The small trees and underbrush has been largely cleaned away leaving only the taller trees standing. Man has also constructed many buildings throughout the camp site. This and the concentrated human population have an influence upon the fauna inhabiting the area. The lake front extending the length of the northern boundary of the campus too has its effect on the community. The soil type is sandy mixed with very little loam and clay. Judging from the bird population here and the rather open habitat with scattered trees the area would be considered an edge association even though the underbrush characteristic of such a community is largely absent except for scattered places.

The climate of Cheboygan County is within the temperate zone.

Gates describes it more specifically in writing, "the temperature is moderate, the rainfall likewise is moderate but amply distributed throughout the year. Snow is usually abundant, ~~throughout the year~~, and remains on the ground for a long time." For further information concerning the climate at Douglas Lake consult table 1. (Gates 1926:171).

To describe more specifically the ground flora of the region studied, the ground cover consists mostly of various grasses over most the area with scattered places of blueberries (Vaccinium canadensis and pennsylvanicum), huckleberry (Gaylussacia baccata), and some strawberry (Fragaria virginiana). In the locality bounded by Lower Road and East Street, and the one south of the married student's cabins (see map) which are uncleared a typical bracken fern (Pteris aquilina) ground association with some tree seedlings occur. The dominant trees in the area are red maple (Acer rubrum), sugar maple (Acer saccharum), red oak (Quercus borealis), white birch (Betula alba), white pine (Pinus strobus), red pine (Pinus resinosa), and scattered aspens (Populus grandidentata and tremuloides). Of the above mentioned trees the maple and oak are the most abundant. On the whole the ground offers little protection, but the trees give much shelter even though they are not close enough together to provide a continuous canopy.

The birds found associated with the waxwings in this area are typical boarderland birds or birds that will tolerate the conditions of a boarderland although not exclusively found in that habitat. A few of the more characteristic types are the Kingbird (Tyrannus tyrannus), Robin (Turdus migratorius), Chipping Sparrow (Spizella passerina), and Cowbird (Molothrus ater). For a complete list of species seen on the campus while

studying the Cedar Waxwing see table 2. Of these species only the Cowbird has any effect on the success of the Cedar Waxwing. Although I found no nest where parasitism had taken place, James Watson and Byron Harrell reported an incident where they observed a pair of waxwings actively chasing a Cowbird out of their territory. In previous years, however, a few nests have been found that contained Cowbird eggs (Iea 1942), but there was a tendency for the waxwings to remove them. Friedman (1929:234) explained that the late nesting of the Cedar Waxwing is beyond the height of the laying season of the Cowbird and thus the waxwing is relatively free from parasitism. The other species of birds seemed to present no problem and were perfectly tolerable to the Cedar Waxwing. In fact the waxwings of nest #2 (henceforth the nests will be referred to as indicated on the map) allowed a Robin's nest to be built in the same tree a few feet away. Actually the waxwings are more detrimental to the other nesting birds rather than ~~the~~ vice versa. To illustrate this, a pair of waxwings were witnessed pulling straw from a Robin's nest for nesting material.

Of the birds of prey only two were seen in the study area. One was an adult Bald Eagle (Haliaeetus leucocephalus) observed flying over and probably has no effect on the waxwing population. The other was the Great-Horned Owl (Bubo virginianus) that was heard one night in the vicinity of nest#5. It may have been responsible for the ~~abundant~~ abandonment of that nest since it was caused by predation which was proven by the discovery of only the two wings of an adult Cedar Waxwing on the ground below the nest. This nest was placed extremely high above the ground (8.24 m. high which is

the highest nest found) in a red pine tree. The distance was much higher than one imagines the predatory mammals of the campus area climbing. Besides more of the bird was ~~seen~~ without a trace than is characteristic of the predatory mammals here.

Because of the invasion of civilization into the area the larger mammals are absent leaving only the deer mouse (Peromyscus maniculatus), chipmunk (Tamias striatus), ground squirrel (Citellus tridecemlineatus), and an occasional skunk (Mephitis nigra). The chipmunk is very common and probably a source of predation upon the eggs of the Cedar Waxwings. In one instance at nest #9 the pair of waxwings of that territory were observed very actively forcing a chipmunk out of a tree near their nest. The adult waxwings would perch just above the chipmunk and swoop down upon it coming in contact with it and almost knocking it off the branch supporting it. They actually succeeded in forcing the chipmunk to the ground.

I noticed no effects caused by man that decreased the Cedar Waxwing's breeding success. Because of the usually relatively inaccessible position of the waxwing's nest I doubt whether man ever disturbed a nest except of course every now and then when someone carries on an investigation of the breeding behavior.

The remainder of the vertebrate kingdom is relatively rare on the campus. Even the snakes are very uncommon thus eliminating them as a serious factor in predation.

Because of the extreme sanitary precautions taken by the adult waxwings the nests were not infested to a great extent by bird lice (Malophaga). I found very few of them upon investigation of the vacated nests.

TERRITORY

In previous writings it has been the opinion that the Cedar Waxwing has no territory. I found, however, that it does have a small territory which it defends. Upon studying the map showing nests locations one becomes suspicious that the bird does maintain some sort of a territory by the fact that the nests are placed at fairly regular intervals apart from each other. The maximum distance is 95.2 m. and the minimum is 47.3 m. and the average is 67.32 m. or an approximate average territorial diameter of 67.32 m. which is 1292 sq. m. in circular area. This size is larger than what actually exists, however, since there are neutral feeding areas between the nests that are a greater distance apart. Nest #1 and #2 were close enough together (47.3 m.), however, to initiate some territorial disputes. Early in the waxwing's nesting season a adult from nest #2, presumably the male, entered the tree that served as the nest site for nest #1. The male of nest #1 actively and ferociously chased the intruding bird from the tree by flying at it with fluttering wings and pecking it on the body. Nor was this the only instance of territorial defense around nest #1. Later two intruding waxwings appeared in the same manner nest site tree and were evicted in the same manner described above. Not only the tree supporting the nest was defended but the male of nest #1 also forced invading waxwings from a white birch tree located 6.1 m. south of the nest and from an oak tree 7.3 m. to the west. These figures may indicate somewhat the size of the radius of the waxwing's territory around the nest. If it does the territory at nest #1 amounted to approximately 113

sq. meters. The female even joined in to help chase other waxwings from the territory but the male was the aggressor. Perhaps the female's only interest in the matter were along the lines of unfaithfulness.

Some people may argue that this forcing of birds out of the territory was actually the joining of a flying flock and only appeared to be territorial defense. The partial flocking of the Cedar Waxwing is common even during the breeding season. If this were true the defending waxwing would not have been so brutal toward the others and he would have followed them if they took flight which he didn't but returned to his singing post and sang (more will be said about singing posts later).

More should be said about the flocking of waxwings, however, because this habit seems to disprove the territorial theory. Before and after the breeding season rather large flocks of waxwings can be seen but even during the breeding season small ones are fairly common especially when the young ~~are~~ have hatched. The explanation of this all hinges upon the fact that the territories are used in mating and nesting only while the main constituent of its diet, berries, occurs in fairly localized areas outside the territory, ~~and this is not a case~~ Since there are no feeding territories defended by the waxwings I believe a chance coefficient artificially produces these small breeding season flocks by the mere fact of the localized distribution of the berry ~~producing~~ producing trees. That is there is a large area over which breeding waxwings are distributed and only localized small areas where berries grow. Now when the adults of this large area go after food in a small area there is bound to be a certain

amount of crowding in these small areas thus the formation of flocks. The birds fly out of the feeding grounds together and drop off in their respective territories. The fact that the flocks are smaller in the breeding season demonstrates that it is not purely a case of aggressive behavior but that some other mechanism is controlling it (of course nesting duties have a partial effect). These same food gathering flocks are smaller before the eggs hatch because they consist largely of males gathering food to give to the incubating female. Later when the eggs do hatch the female becomes more and more active in feeding the young and the feedings become more and more frequent as the season advances thus producing an increase of size and frequency of the flocks. The occurrence of high flying waxwings over another waxwing's territory seems to have no effect upon the defending male. These flocks, however, were never seen to occur within the vegetation stratum adjacent to waxwing nests which tends to disprove that they represent a condition indicating the absence of territory.

It also seems that the male waxwing has a song post. After he had chased an intruding male out of its territory it would return to the same ~~twig~~ dead twig half way up in the nesting tree and give its trilled song (referring to the male at nest #1). This song was often initiated by a singing male in the neighboring territory. This same perch was utilized as an observation post by the male when I or anything else disturbed the nest. The presence of a song post is also an indication of an established territory.

Further indications of a territory has been described above; 1) at nest #9 the waxwings ~~of~~ of the area were chasing a chipmunk ~~around nest #9~~

out of a tree 6 m. from the nest site tree, 2) and the observation where waxwings were chasing a Cowbird out of the nest vicinity.

The territorial fighting between nest #1 and #2 was the only case of active territorial defense against another waxwing. This may have been because these nests were the two closest in the area and the territories possibly ^{joined} overlapped. Nest #11 was as close to #2 as #1 was to #2 but it was not completed for unknown reasons. Perhaps territorial pressure had an effect on it,

In conclusion the Cedar Waxwing does have a small territory for mating and nesting purposes which it does defend. It also sings from a song post and announces its territory. The fact that the waxwing has a song low on the scale of audibility probably accounts for the small size of the territory because it cannot be heard for a great distance.

MATING

The Cedar Waxwing's mating behavior is wholly a symbolic one. It consists largely of the male feeding the female which represents the future feeding of the female when she will be incubating the eggs and the feeding of the young in the nest. The male will give the female straw during the ceremony which signifies the building of the nest. Also the two will pull on each other's bills during the mating antics.

The part of the ceremony that foreshadows the feeding of the female on the nest is indicated by the male catching an insect or picking a berry and giving it to the female. The female will often pass it back to the male and then the food will be passed back and forth between the two until one eats it (usually the

female).

The phase of the mating ceremony that depicts the feeding of the nestlings is performed when the female imitates the actions of the juvenile bird when receiving food from the male. The female will flutter her wings rapidly and repeatedly give the food ~~to~~ cry as if begging the male for food. The male often will toy with the food in front of the female. This causes the female to cry louder and beat her wings faster thus increasing the tempo of the courtship. Finally the male gives the food to her. The female will even follow the male while he is collecting the food which reminds one of a young bird just out of the nest.

The courtship of the waxwings is not limited to the time before nest construction but will continue through the egg laying stage. The pair of birds from nest #3 were still executing the fullest display of courtship when there were two eggs in the nest.

NESTS AND NEST BUILDING

The waxwing prefers to nest in the open woodland habitat where there is a little open area. The campus area studied, therefore, offers an ideal situation for waxwing nesting. The preference of the occurrence of open areas between the trees is illustrated by the fact that most of the nests in the area were along the lake where the trees were less numerous and where the lake itself provided a large open expanse (see map). In Peggy Muirhead's Icarus Flycatcher study she found only three pairs of Cedar Waxwings per ten acres in an aspen forest area (Muirhead 1946), James Watson found only one pair per ten acres in the ~~open~~ aspen-conifer area of North Fishtail Bay, (Watson 1946), and

Byron Harrell found only ~~two~~ pairs per ten acres in the dead timber-conifer forest in the Gorge (Harrell 1946). (These areas are also located in Cheboygan County, Michigan.) All these habitats have a more dense flora than the campus area which supports a ~~density~~^{population} of nine waxwings per ten acres. (excluding nests #10 and #11 which were not completed). The comparisons of the more closed areas with the open woodland above further exemplifies the waxwing's nesting niche requirements.

The nest itself is located at an average of 5.25 m. from the ground and on the outer extremities of the branches of the chosen tree. One nest, #3, was placed in a red pine right next to the main trunk, but it was so near the top of the tree that no branches extended much further out from the trunk than did the nest. The highest nest found had an 8.24 m. elevation and the lowest 3.05 m. Because of their rather high position and their distance out on the branches the Cedar Waxwing's nest is relatively inaccessible even though it is easily discovered.

The tree preference for nesting sites seems to be limited to those species which offer secure forks, either horizontal or verticle, or other means of support (such as pine needles in pine trees) at the tips of branches. Due to this factor the oaks, maples, and pines are suitable while the aspens are shunned.

The nest is placed in a ~~horizontal~~ horizontal or vertical fork with little or no fastening ^{to} of the fork itself. This indicates a need for a rather secure fork framework of three, four, or more branches. It is a wonder that some of the nests were not lifted out of the trees during wind storms because when I collected them after they were vacated I could lift them right out of the fork with no more trouble than is involved in lifting an article

off a table.

The material put into the construction of the nest gives it a bulky appearance. The lining and the bulk are not essentially different except that the lining usually has a greater variety of materials and the bulk is made of larger constituents near the periphery. This lining usually consists of grasses and straw, rootlets, twigs, and some additional material in small amounts such as pine needles, plant down, cotton, or strips of paper. The bulk is made of the same major materials that exist in the lining except increasing in size outward. The trimmings of the nest, which occur in great abundance, is what gives it its characteristic appearance. Large twigs, roots, straws, & grasses, birch bark, peelings, dried leaves, dried plants with seed pods, feathers, string, rope, paper, and cotton all were used. The waxwing is very versatile in regards to the nest material used and will utilize those things close at hand. Nest #2 had a great quantity of cotton in it which was ^{obtained} ~~gotten~~ from the camp health service nearby and nest #3 located in a pine tree contained many pine needles. The nests located in pine trees (#3 and #5) were less bulky than those on deciduous trees because the added support of the pine needles held the shape of the nest without the need of copious quantities of material.

In regards to the demensions of the nests the inside depth averaged 4.4 cm., the outside depth 8.4 cm., the inside width 7.4 cm., and the outside width 12.5 cm. Of course these measurements are greatly distorted by the time the young leave the nest because of the force on the nest due to the crowded conditions within it. The average weight of the nests is 28.75 gms. (See table 3).

During the actual nest construction both adults share the work involved but the female does a greater portion of it. They fly to the ground a few feet away from the nest and gather the materials in their bills. The male often will bring the material to the female who stays at the nest and weaves them into the structure with her beak or he will do the building himself. This phase of the breeding cycle will often be interrupted by displays of courtship. When the nest has reached an advanced stage of development it will be constructed from the inside. That is the adult bird stands in the cup of the nest and incorporates the new material to the inside of it. The bird will often sit down and twirl inside the nest to give the cup the desired shape. Nest building is begun around the last week of June (approximately June 23 this year) and the structure is completed after five or six days when egg laying begins. At nest #3, however, the adults were still ~~completing~~ completing the lining after two eggs had been laid.

The Cedar Waxwing will build only one nest a year ~~except~~ except when the first one is destroyed. Because of its habit of nesting later in the summer it would not have time to efficiently raise two broods a year under normal conditions.

EGGS AND INCUBATION

The average clutch of the Cedar Waxwing equals five pale bluish-white eggs with scattered dark brown irregular spots more concentrated at the large end. The weight of the eggs average 2.74 gms. while the dimensions average 15.8 mm. at the widest part and 21.4 mm. in length. There may be as much as two mm. difference in the lengths and one mm. difference in the widths

of different eggs. The eggs are usually laid around the end of June of the first of July (approximately June 29 this year), and the incubation period lasts eleven days. One egg per day is the waxwing's rate of laying, and the eggs are laid in the morning hours. Usually incubation begins after the clutch is completed but at nests #2, #3, #8 it began the day before the last egg was laid. The eggs' positions in the nest are such that the small ends ~~of the~~ point inward thus occupying the least amount of space possible (usually arranged more or less in two rows). As was mentioned earlier in this paper no evidence of parasitism by the Cowbird was discovered.

The female does all the incubation and the male feeds her while she is on the nest. The female's attentiveness is not as great at first as it is just before the eggs are hatched. She will leave the nest more often and more easily at first than she will later. Likewise she is more easily flushed off the nest at first.

When the male feeds her on the nest he will come to the nest ~~the nest~~, give a call, and then caught up four or five Amelanchier berries (Amelanchier canadensis) and gives them to her. The female will then stand on the rim of the nest as if showing the eggs to the male.

While the female is incubating ~~on the nest~~ the eggs she moves around on the nest, preens herself, looks around, and turns the eggs. When she turns the eggs she stands up in the cup of the nest and draws her bill through the center of the eggs from one side of the cup to the other (the motion is toward her). This not only results in the turning of the eggs but also some of the

eggs interchange positions with one another.

When the female is disturbed on the nest she will raise her crest, open her mouth, stretch her neck, and look around. This was a characteristic stance even during the time the young were in the nest.

The male busied himself with providing food for the female during the incubation period.

DEVELOPEMENT OF THE YOUNG

After eleven days incubation the eggs of the Cedar Waxwing break open at the large end and the naked altricial young emerge head first. The young are in the nest about 15 days before they leave during which time those from nest #1 developed an average of 2.44 gms. to 32 gms. in weight (32 gms. was also determined as about the average weight of the adult bird from the skins in the collection at the Biological Station) and from 17.0 mm to 70.5 mm in wing length. The weight increases at the rate of approximately two grams per day the first ~~three~~^{two} days, 3 gms./day on the ~~fourth~~^{third} and ~~fifth~~^{fourth} days, 4 gms./day on the fifth and sixth days, three grams on the seventh day, 2 gms./day on the eighth and ninth days, one gram on the tenth, and then remains fairly constant but slowly gaining until they leave the nest at about 32 gms. Although the weight increase is only 2 gms./day on the first two days it is very great in proportion to its size. An increase from 2.44 at hatching to 4.05 gms. a little more than a day later is almost doubling its weight. The wing length increases approximately 4 mm/day the first four days, 7 mm/day the fifth sixth and seventh days, 8 mm/day on the eighth day, 4 mm/day on the ninth day, 2 mm/day on

on the tenth day, and remains fairly constant after that up to the time it leaves the nest.

The development of the young will be described according to the significant features of each day excluding weights and wing measurements which have already been described. The data is taken particularly from nest #1 which was watched more closely than the others and which contained six young. (Also see Graph 1 and 2 and table 3).

1st Day: The young upon hatching are completely naked and the feathers tracks are represented by slight pores beneath their flesh colored skin. The bill is soft and flesh colored except for bluish-white edges. The legs are also soft and flesh colored. The abdomen is bloated and the visceral organs are visible beneath the thin tender skin. The uropygeal gland is present. The bird is slightly longer than the egg, and their eyes are closed.

The young at this stage are weak but they can lift their head, move their wings, and open and close their feet to some extent. Because of their weakness the begging for food behavior is not shown very often. When it is given it consists of raising their neck, opening their mouth, and disclosing a bright red buccal cavity. No noise accompanies this action.

The nestlings at this stage show no fear and could not discriminate between their parents and my finger or any other object. The mere shaking of the nest would initiate the begging reaction.

2nd. Day : The skin is a little darker which appears to be caused by dirt. They are a little stronger but not appreciably so. They are still naked but the pterylae are darker which is probably caused by the feathers developing in the sub-dermal region.

3rd and 4th Days: The feathers are just ready to break through the skin and already have penetrated it a little on the wing in the region of the primaries. The feathers tracks on the dorsal part of the body are raised more and consequently further developed than the ventral tracks. Defecation is a more common occurrence now. The process of defecation is accompanied by the raising of the posterior end of the body. The fecal deposits are not surrounded by a fecal sac. The nestlings strength and activity has further increased.

5th and 6th Day: The voice of the parents as well as the vibration of the nest will now bring the begging reaction. The eyes are just beginning to open by means of a narrow slit. The quills of the primaries have protruded 0.9 mm. The secondaries, spinal tract, humeral tract, and posterior part of the abdominal tract also have quills slightly protruding.

7th Day: By now the young are very active and can hold their heads in the air for a considerable time while standing ~~the~~ in the nest when begging for food. They can ~~also~~ even move about a little under their own locomotion by using their hind legs and wings in a sort of crawling motion. They also continually hold on to the lining of the nest with their feet which aids in giving them support in the nest and reduces the possibility of falling out. This behavior later proves to be a fortunate one when the nest becomes very crowded due to the increased size of the nestlings.

The middle part of the bill is now rather hard while the sides are still soft. The feather quills are long enough so that the tips are unsheathing and the feathers are spreading out. The longest quills are in the alar tract. The outer primaries are 7 mm. long. The body feathers are the least developed in the capital pteryge and the anterior portion of the abdominal tract, while they are the most advanced in the spinal and femoral tracts. Of particular interest is the absence of the protoptyle downy feather in the Cedar Waxwing. The eyes are now completely open.

8th Day: There is little change from the seventh day except that the feathers of the tracts are now partially unsheathed and the primaries are 13 mm. long.

9th Day: There is little change except for the increase in length and unsheathing of the feathers. At this time the lengths of the different feathers (measuring unsheathed and sheathed parts) are; primaries 15 mm., secondaries 13.9 mm, spinal tract 8 mm, caudal tract 4 mm, back of neck 4.7 mm, capital tract 3.5 mm, and the posterior abdominal tract 8.6 mm.

The ninth day also marks the development of the voice used in begging for food. The note is similar to the trilled song of the adults but it is very faint now and will increase later.

10th Day: The young are now attempting to unsheath their own feathers by scratching and preening. When they are sitting quietly in the nest they close their eyes. About every 15 minutes, however, they get restless and open their mouths for food whether the adult is there or not. This is probably an automatic response resulting from the parents feeding frequency of approximately 15 minute intervals. The young also now give the food response at the sight of the adults as well as from the voice and the shaking of the nest. My finger will still initiate that response after a little while, however.

In regards to the plumage, the feathers of the back have now been unsheathed enough to cover that whole area. In fact the only portions of the bird that are not covered with feathers are the areas on the body beneath the wings and in the middle of the abdomen. The black mask that is characteristic of the waxwing is now beginning to appear.

11th Day: The flight feathers are almost half unsheathed by this date.

The nestlings show a slight crouching fear response at first but it is soon overcome and changed into a food response.

The young are now able to perch on a twig but have to stretch

their necks in order to maintain their equilibrium.

12th Day: The fear respose demonstrated by crouching into the bottom of the nest is still more developed but still not to a marked degree. The young can perch very well and hop around a little. The feathers have grown longer and become further unsheathed.

13th, 14th, and 15th Days: Little change takes place throughout these days until they leave the nest except for further motor control and increased development of the feathers. The young constantly preen themselves and exercise their wings though this period.

It is curious to note that the development of the young in nest #1 was a little slower than Lea found to be true (Lea 1940). This may be because there were six young in nest #1 while the average number, which Lea may have measured, is four or five. If this were true it shows that an increased number of young in the nest results in a slower development rate for each individual possibly because each nestling receives less food per day than is normally the case.

The ~~removal~~^{abandonment} of the nest by the nestlings may be caused by one of two mechanisms or both. The nest may be overcrowded and one or two of the nestlings might be forced out accidentally. This mechanism because of its nature can cause only the first one or two of the nestlings to leave the nest. The usual process in leaving the nest is characterised by a slow natural migration of the young from the nest to the branches nearby which is caused by their movement toward the parent birds in their eagerness to receive food.

The description of the juvenile Cedar Waxwing is similar to the adults except that the bill and feet are not as dark, the mask is not as large, there is no black under the chin, the olive brown of the back is duller and the head is the same color,

there is a narrow buffy band around the back of the head at the border of the crest, and the breast, abdomen, and crinum ^{are} ~~is~~ buffy, the breast and abdomen having olive brown streaks more dense toward the anterior end.

PARENTAL CARE

When the eggs hatch the adults remove the shells. All the unhatched eggs, however, are left in the nest.

The female does all the brooding of the young and stays at the nest constantly the first few days after hatching while the male gathers food for her and the young. At first she will brood the young by sitting on them as if they were still eggs. As they grow larger she is forced to stand in the bottom of the nest over them. Later the nest becomes so crowded that it is compulsory for her to perch on the rim of the nest on the sunward side of the nestlings. When brooding the young from the edge of the nest she utilizes the time by almost constantly preening herself. As the young grow the female's attentiveness to the nest becomes less and less pronounced and she soon begins leaving the nest for periods of time and aids the male in feeding the young.

The nestlings are fed berries almost wholly except for an insect now and then which the adults catch in flycatcher fashion. The type of berry is the service berry (Amelanchier canadensis) at first and later the pin cherry (Prunus pennsylvanicus) is utilized when they ripen if they are more easily available than the service berry as was the case in the area studied. The adult carries four or five berries at one time in its mouth which are successively coughed up and provide enough food to feed each young with one trip to the nest. The fact that the adult waxwing can carry more

than one berry at a time undoubtedly saves a lot of energy by decreasing the number of trips to the ~~berry~~ berry trees which are usually rather remote from the nest.

At first the young could not eat all the berries brought to the nest by the male. The usual approach at this time was to fly to the top of the nest site tree and work his way through the leaves (usually by way of dead branches) to the nest. He would always take the same course to the nest when going out the nest branch proper thus showing the stereotyped habit pattern of behavior. The brooding female would go to meet him if she was hungry and he would feed her first otherwise she would get up and stand on the rim of the nest at his approach. The male would then give the female a portion of the berries to feed to the young and keep some so that he could also feed them. The process of feeding these newly hatched birds consisted of standing on the nest's rim and putting the whole large service berry in the first one's mouth by use of the bill and pulling part of it out and putting it in the second's mouth. (The red lining of the nestling's mouth probably serves as a target designating the place to put the food). If the bird did not immediately swallow the food it would be removed by the adults and given to another. After the feeding had been completed both adults would carefully watch for defecation in the nestlings which was accompanied by the raising of their posterior ends which actually facilitated the sanitation of the nest because the adults could observe it more easily. The adults ingest the fecal deposits as they leave the anuses of the young. Defecation seems to be definitely correlated with the period immediately after feeding. When the male leaves the nest he flies directly away out to space giving his trilled call as he does so.

The feeding of the older nestlings is the same as above except that each one can eat a whole berry and that the female more and more enters into sharing the responsibilities of the male. ~~in feeding the young~~ She never does, however, reach as high a feeding frequency as the male. She too uses a stereotyped path to the nest.

The frequency of feeding at the time when the young require the most food is approximately four times an hour or every 15 minutes. The relatively infrequent feedings as compared with other birds is possible because the adults carry numerous berries at one time and do not have to make ~~as many~~ several trips in order to feed all the nestlings. The number of feedings of course is somewhat less when the ^uyoung have just hatched.

As the young get older the female becomes more bold in her defense of the nest. The male on the other hand will never come too close to ~~to~~ the intruder. At first the female is rather easily chased away from the nest. Later she swoops down very close to the intruder and never gets more than a few feet away from the nest. Both birds give the call note when the nest is disturbed.

NESTING SUCCESS

Considering the nests with available data in the area studied, five had 100% success, one had 80% success, and three had 0% success (two of these three nests were never completed and the pairs of birds involved possibly raised a successful brood elsewhere). The per cent of success over the whole area excluding the two uncompleted nests, e.i. presuming the birds were successful elsewhere so omitting their data, amounted to 83%. If the two uncompleted

negts are included the nesting success is reduced to 65%. (The per centages were computed by dividing the number of eggs into the number of young leaving the nests.). This success is rather high in both cases indicating that the summer of 1946 was a very good season in regards to the Cedar Waxwing. This may have been due to the exceptionally abundant crop of berries this summer but that is difficult to determine in just one year's study. Lea (lea 1942) found a much lower per cent of success, 37%, over the same area in the summers of 1940 and 1941. This figure was computed from 12 out of 21 nests found during the two summers and it may be higher with the others included. 40 On the other hand the figure for this summer might have been reduced had the data on the remainder of the nests in the area been known. (See table3).

DISCUSSION

The discussion will deal only with the special relationships between the Cedar Waxwing and its main nutritive constituent, the berry. The other topics of importance were discussed under their respective headings above.

There exists a phenomonally close relationship between the late nesting of the Cedar Waxwing and the ripening of the service berry which serves as the main food for the nestlings. When the nest is being constructed and when the male is feeding the female on the nest the berries are still unripe and red. By the time the young hatch, however, the berries suddenly ripen as if the two occurances were controlled by the same mechanism.

It is puzzling how the waxwing knows when the berries are going to ripen.

Another relationship exists between the serial ripening of first the service berry and then the pin cherry. When the young are small and have just hatched the minutely seeded service berry is the one available for food. Because it has tiny seeds it is easy on the delicate digestive system of the newly hatched organisms. Later when the young have grown larger and the digestive systems have become more durable the large pitted pin cherry ripens. This serves as a blessing to the parents in the area studied because at the time they ripen the young are demanding more food and the pin cherry are much closer to the nests here thus saving the adults energy even with the increased number of trips to the nest. Of course this relationship does not exist in other areas where the service berry is closer to the nests than the pin cherry. In that situation the service berry is probably used right through the breeding season.

Because the waxwing depends upon berries for food it does not have to be as active as the rest of the birds in the early morning. The other birds are required to arise with the sun to carry on their territory defense so that they can catch the insects for food later ^{but with time to spare} ~~but~~ before the heat of the day when the greater part of the insects become less active and retire to obscurity. Since the berries are always in the same place the Cedar Waxwing is probably the last bird to arise in the morning. That is they can always get their food because it cannot hide itself.

It is indeed fortunate ~~that~~ for the numerical successfulness of the Cedar Waxwing that it does not have a feeding territory

because the localized position of the berry trees would immediately limit the number of breeding pairs to a much smaller and scattered number than now actually exists. In other words the breeding males would set up territories around the scattered berry trees thus limiting the number of pairs in an area that could potentially support a larger population from both the standpoints of food supply and available nesting sites. That is there would be large areas between the berry trees that could support breeding pairs ~~***~~ in regards to nest sites but would be blocked by the territorial ownership of the much smaller areas supporting a growth of berry trees.

SUMMARY

1. The study of the Cedar Waxwing (Bombycilla cedrorum) was accomplished during the summer of 1946 at the University of Michigan Biological Station, Ceboygan, County, Michigan.
2. The Cedar Waxwing is an immaculate looking brownish bird.
3. The song of the Cedar Waxwing is rather poorly developed but does exist and is little different from the call note.
4. The Cedar Waxwing breeds in a broad belt covering the southern half of Canada and the northern half of the United States and runs from coast to coast. It winters from the southern boundary of Canada to Cuba and Panama also from coast to coast.
5. The habitat of the study area is an open woodlot where the predators are rather reduced in numbers.
6. The Cedar Waxwing does have a territory which is small and is used for mating and nesting only.
7. The Cedar Waxwing carries on a comparatively elaborate and symbolic courtship.
8. The late nesting Cedar Waxwing builds a rather bulky nest in about five or six days and places it high in trees on the inaccessible crotches at the tips of the branches.
9. The Cedar Waxwing lays one egg each morning until a clutch of about five dark speckled bluish-white eggs are laid which are incubated by the female for approximately 11 days.
10. The Cedar Waxwing nestlings are naked at hatching and pass

through the significant stages in development in about 15 days at which time they leave the nest.

11. The female Cedar Waxwing does all the brooding while the male does ^{most} the feeding of the young, and both the adults assist in the sanitation of the nest.

12. The nesting success of the Cedar Waxwing was rather high in the area studied and amounted to 85% of 65% including two uncompleted nests.

13. There is a remarkable correlation between the waxwing's nesting, feeding, and activity behavior patterns and the berries it uses as food.

BIBLIOGRAPHY

- Chapman, F. M.
1940. Handbook of Birds of Eastern North America., D. Appleton-Century Co., N.Y.
- Davis, C. V.
1942. A Comparative Study of the Growth Rates of the Cedar Waxwing (*Bombycilla cedrorum*) Under Varying Circumstances. MS, Univ. of Mich. Biol. Sta., Cheboygan Co., Mich.
- Dickson, J. M.
1939. A Study of the Nesting Habits of the Cedar Waxwing. MS. Univ. of Mich. Biol. Sta., Cheboygan Co., Mich.
- Dwight, Jonathan, Jr.
1900a. The Sequence of Plumages and Moults of the Passerine Birds of New York. Annals N.Y. Acad. Sci., 13:73-360
- Friedmann, Hebert
1929. The Cowbirds, a Study in the Biology of Social Parasitism. Charles C. Thomas, Springfield, Mass.
- Gates, F. C.
1926. Plant Successions about Douglas Lake, Cheboygan County, Michigan. The Bot. Gazette., 82:170-182.
- Hann, H. W.
1945. An Introduction to Ornithology. Edwards Bros. Inc. Ann Arbor, Mich.
- Harrell, B. E.
1946. The Bird Population in Selected Areas of the Gorge. MS. Univ. of Mich. Biol. Sta., Cheboygan Co., Mich.
- Iea, R. B.
1940. A Life History Study of the Cedar Waxwing (*Bombycilla cedrorum*). MS., Univ. of Mich. Biol. Sta.
1942. A Study of the Nesting Habits of the Cedar Waxwing. Wilson Bul. , 54:225-237.
- Muirhead, P. P.
1946. Population, Territory, and Song of the Least Flycatcher (*Empidonax minimus*). MS. Univ. of Mich Biol Sta.
- Nice, M. M.
1937. Studies in the Life History of the Song Sparrow, 1. Trans. Inn. Soc. N.Y. , 4:i-vi, 1-247.
- Peterson, R. T.
1934. A Field Guide to the Birds. Houghton Mifflin Co. Boston, Mass.

Pettingill, O. S.

1946. A Laboratory and Field Manual of Ornithology. Burgess
Pub. Co., Minneapolis, Minn.

Roberts, T. S.

1944. Manual for the Identification of the Birds of Minnesota
and Neighboring States. Univ. of Minn. Press, Minn-
neapolis, Minn.

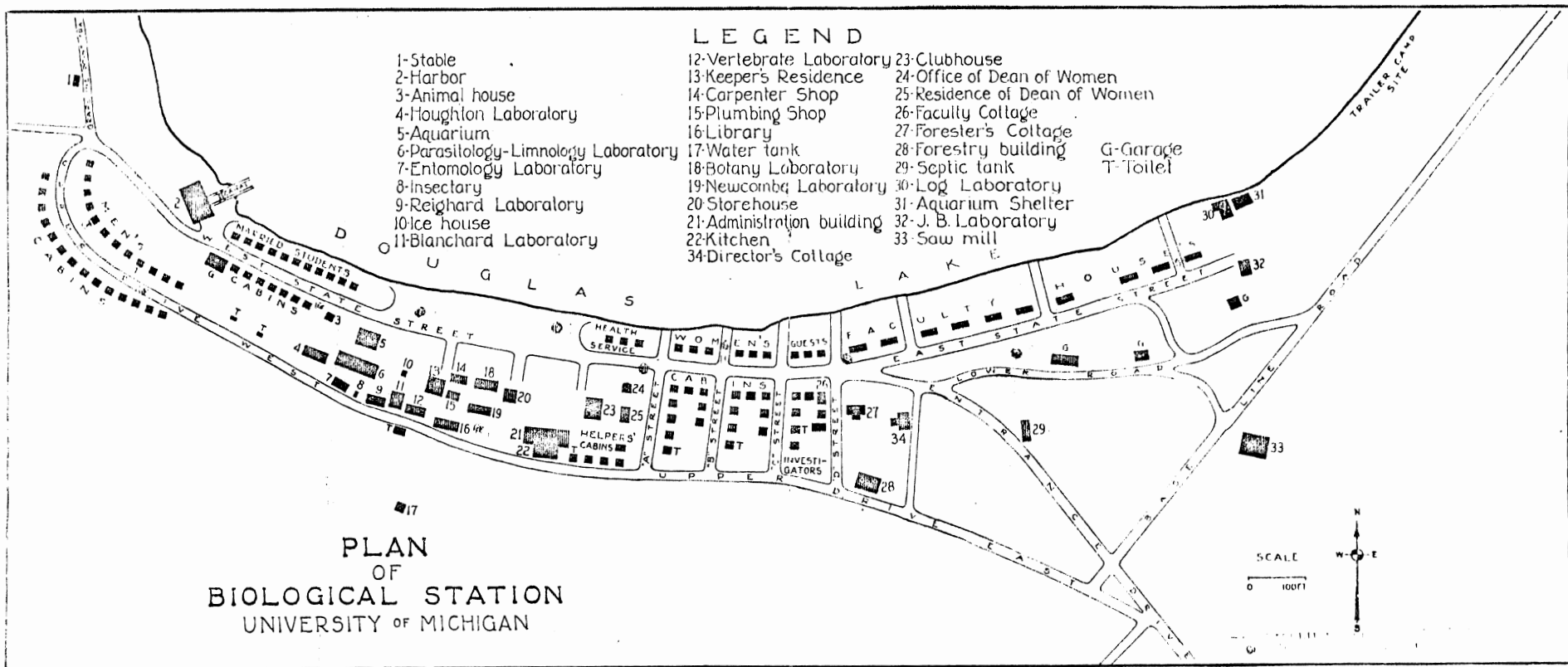
Robertson, W.B.

1944. A Study of Variations in the Development of Nestling
Cedar Waxwings. MS. Univ. of Mich. Biol. Sta.

Watson, J. D.

1946. An Ecological Study of a Mixed Area on the East Shore
of Douglas Lake. MS. Univ. of Mich. Biol. Sta.

APPENDIX



Map of the Study Area Showing Positions of the Nests

Table 1

METEOROLOGICAL SUMMARY CHEBOYGAN, MICH.
 (U.S. Weather Bureau Figures)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Temp:												
Max.	59	51	72	86	89	95	101	95	95	89	73	59
Min.	-20	-38	-22	-2	17	28	33	35	25	15	-6	-18
Mean	19	16	25	39	50	61	66	65	60	48	35	23
Wind	NW	NW	NW	NW	NW	NW	NW	NW	SW	SW	NW	SW
Precip. (in.)	1.7	1.4	1.9	1.8	3.1	1.9	3.1	3.0	2.9	2.5	2.5	1.9
										Total	28.6 ins.	
Snow (in.)	15.6	13.6	9.0	2.3	0.7	-	-	-	T	0.7	6.6	12
										Total	62.0 ins.	
# Days Precip.	9	7	6	7	8	7	8	9	8	8	9	9
										Total	95 days	

Growing Season
 May 20 --- Jun 15 ***** Sep 10 --- Sep 25

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Table 2

BIRDS SEEN IN THE STUDY AREA DURING THE BREEDING SEASON OF THE CEDAR WAXWING

Bald Eagle
Great-Horned Owl
Yellow-billed Cuckoo
Nighthawk
Ruby-throated Hummingbird
Belted Kingfisher
Flicker
Kingbird
Crested Flycatcher
Phoebe
Wood Pewee
Least Flycatcher
Tree Swallow
Purple Martin
Bank Swallow
Robin
Red-eyed Vireo
Yellow Warbler
Redstart
Cowbird
Baltimore Oriole
Purple Finch
Goldfinch
Chipping Sparrow
Rose-breasted Grosbeak

Table 4

FEEDING FREQUENCY

July 18, 1946 (young 5 days old)

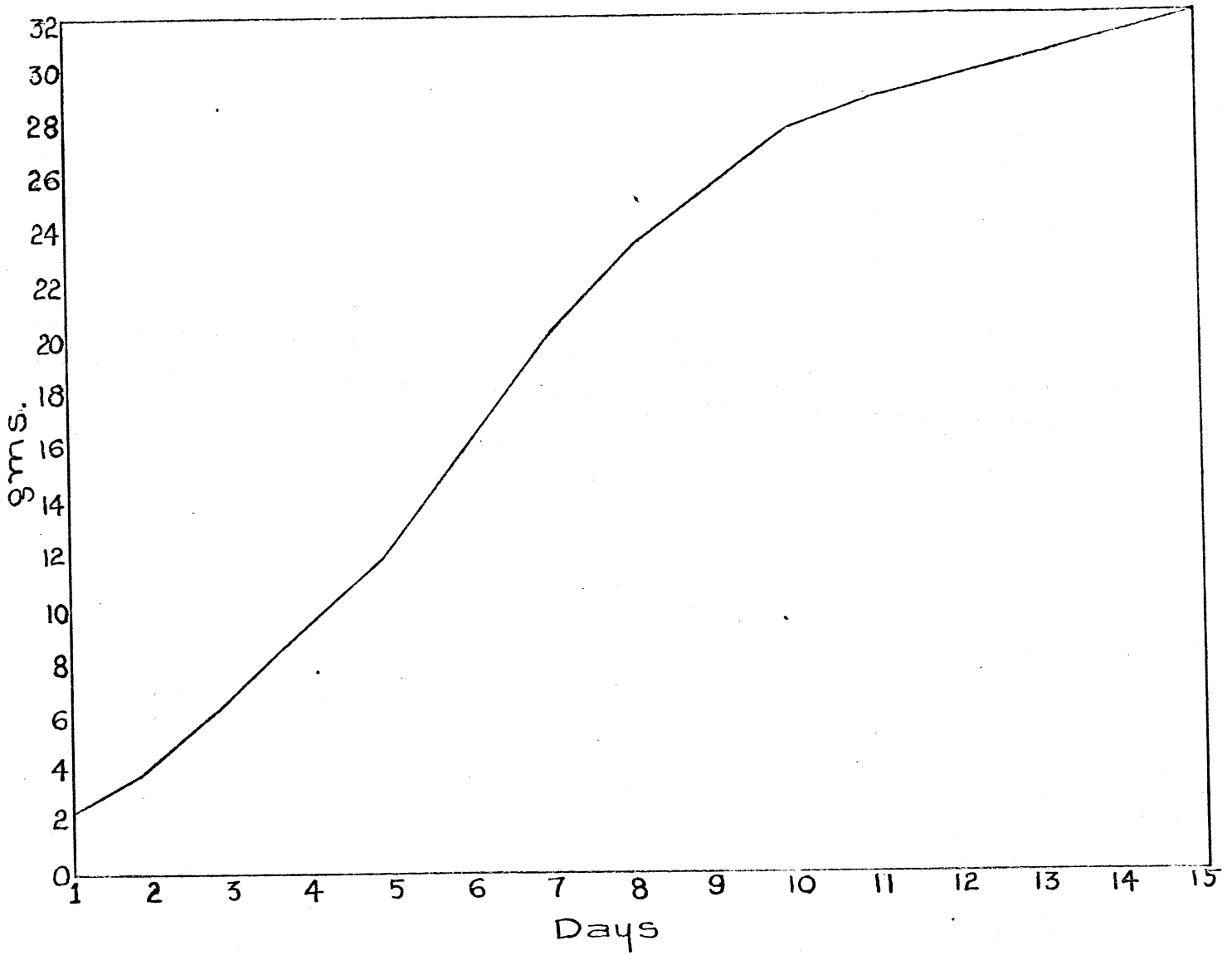
p.m. 2:10---One adult at the nest
2:15---Male came and fed young
2:22---Female came and fed young
2:47---Male fed young
2:48---Male fed young
3:02---Female fed young

July 23, 1945 (young 10 days old)

a.m. 11:02--Female fed young
11:17--Male fed young
11:30--Male fed young
11:46--Male fed young
11:55--Male fed young

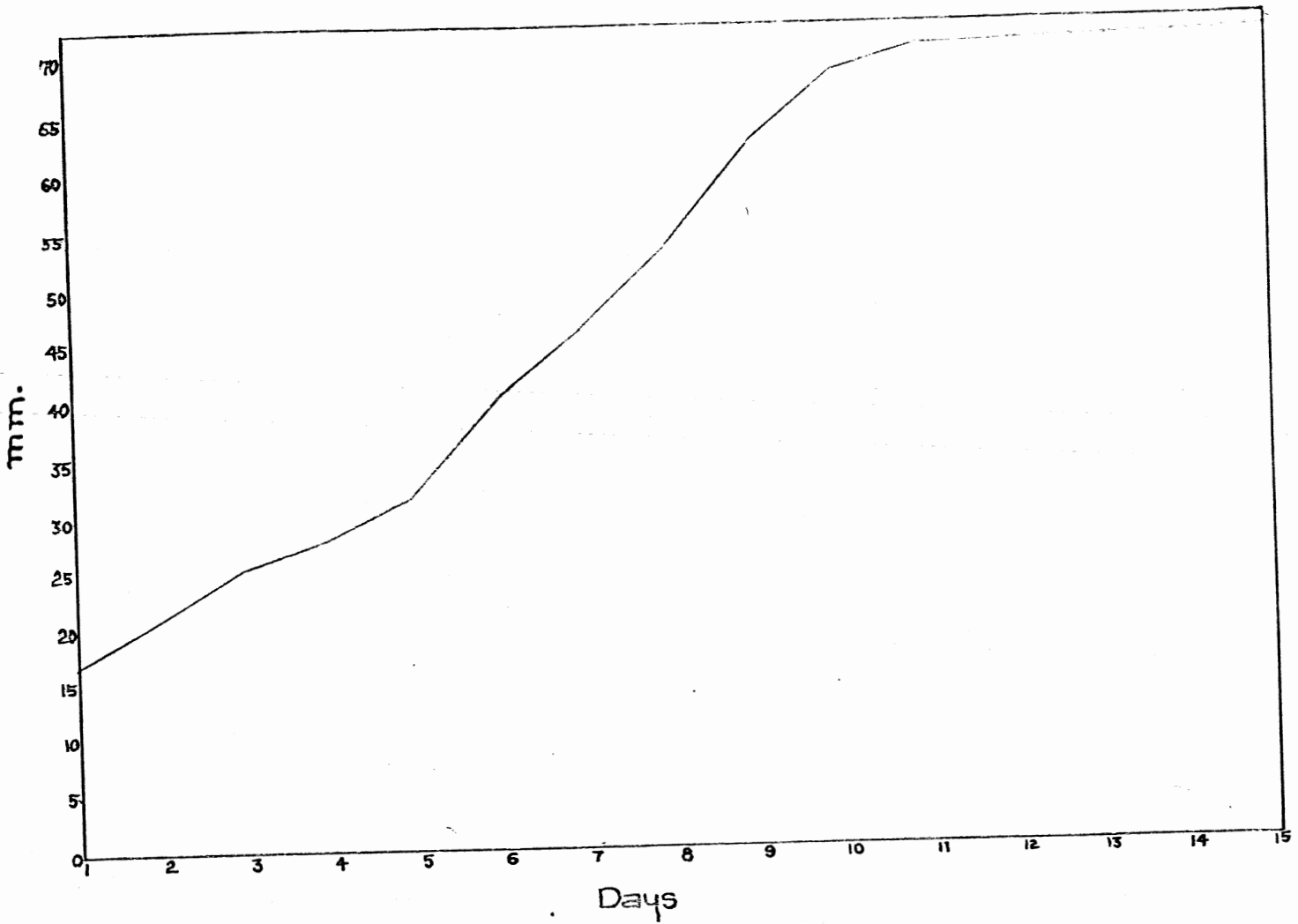
p.m. 1:20---Male fed young
1:37---Female fed young
1:45---Male fed young
2:00---Male fed young

Graph 1



THE INCREASE IN WEIGHT OF THE NESTLING CEDAR WAXWING

Graph 2



GROWTH IN THE RIGHT WING OF THE NESTING CEDAR WAXWING

For a 1953 paper that includes information on Cedar Waxwings,
see Eastern Kingbird folder.