



A STUDY OF THE NESTING OF THE GREEN
HERON (BUTORIDES VIRESCENS) IN
SOUTHERN MICHIGAN

Thesis for the Degree of M. S.
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James Clare Vanden Berge
1960



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By

James Clare Vanden Berge

AN ABSTRACT OF A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
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Department of Zoology
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Approved George J. Wallace

ABSTRACT

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The life history study of a nesting colony of Green Herons in southern Michigan was carried out over a 2 year period.

Thirty-seven nests in the two successive years were located in a small pine stand at the edge of a marsh succession bordering Crooked Lake in Barry County. The plantation consisted of red, Austrian, and white pine.

The average height of the nests was 11.7 feet with a standard deviation of 1.5 feet. The average height in the red and Austrian pine was the same as in the white pine. There was a significant difference in the standard deviations however. Three nests were found in trees or shrubs other than pine. No tree contained more than one nest during the same season.

The average clutch size in this study was 3.5 eggs. The average size of the eggs was 39.1 x 29.9 mm. The only determination of the time of laying was that of a third egg laid between 12:00 and 4:00 PM, May 29, 1959. The incubation period for 10 eggs was 23 days.

The nestling period extends to 10 days after hatching. Weights of the young were taken to show their growth during this period. The young are fed by regurgitation. The food consisted mostly of aquatic insects, some amphibians, and only occasionally fish. Move-

ments from the nest were noted after 10 days; the first attempts to fly, after 2½ weeks.

Behavior patterns of young herons are varied. Those studied included gagging, gular fluttering, vocalization, defecating activities, and climbing.

The mortality rate in this study was high. Twenty-three of the 66 eggs were infertile, stolen or damaged and deserted. Forty-three of the 56 young were found dead or missing from the nests. At least one case of mammalian predation was observed. Other mortality factors are discussed.

Samples of the associated flora were identified, and a list of the associated fauna was kept.

Several tables, a map, and a graph are presented in the text.

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Introduction

The Green Heron is the most abundant summer resident heron in Michigan. However, there has been no detailed life history study of this species published within the last 50 years.

Though the Green Heron is generally considered to be a solitary nester, a small colony of breeding birds was found within a pine stand on the border of a marsh in Barry County. This provided an opportunity not only to study the life history of this species, but also to observe these herons in a nesting colony.

This study was carried out from July to August, 1958, and again from April to July, 1959. It is hoped that this study provides field data which can be used for comparison with similar life history studies of this species.

Methods of Study

During this study, daily field trips were made to the heron nesting colony except for a few weeks in the early part of the 1959 nesting season. Two nests were studied from blinds located on the ground close to the nest trees. Daily records were kept on the progress of these two nests, and in addition, a daily record was kept for each of the other nestings for both seasons, regardless of their stages of development.

The heights of all but 2 of the 37 Green Heron nests found during the 2 years were measured from the base of the tree by means of a 20-foot rope, marked off in inches and feet. Weights were attached to the rope so that it could be suspended from the nest. A certain amount of error in such measurements was thought to have been reduced by the number of measurements taken.

The weights of the nestlings were determined by means of a Pelouze Dietetic Scale, Model YG-500, measuring 500 grams by 1 gram intervals. The birds were weighed on the ground beneath the nest up until 10 days after hatching, after which taking weights became impractical.

Relationships in the genus Butorides

The Green Heron (Butorides virescens) is perhaps the most common of the summer resident herons in Michigan. It has also been called the Little Green Heron, Green Bittern, "poke", "fly-up-the-creek", "chalk-line", and "Skeow" (Bent, 1926), but the common name, Green Heron, is listed in the most recent checklist (A. C. U. Checklist of North American Birds, 5th Ed., 1957).

In North America (not including Mexico or such off-shore islands as the Bahamas, Bermuda, and the West Indies), the genus Butorides is composed of a single species (virescens) which in turn is divisible into 3 subspecies: virescens, frazari, and anthonyi. The original generic name assigned to the Green Heron by Linnaeus (1758) was Ardea; the present genus, Butorides, was described by Bonaparte (1855).

Recent investigations by Bock (1956) and Meyerriecks (1958) have disclosed new information as to the stability of the genus and its evolutionary relationship to the other genera of herons. Bock retains the genus Butorides in the Subfamily Ardeinae, the typical herons, whereas Meyerriecks suggests a closer relationship to the Subfamily Botaurinae, the bitterns, especially to the genus Ixobrychus. Meyerriecks further believes that Butorides is somewhat transitional between the Botaurus-Ixobrychus complex and the more "advanced" species of such genera as Ardea, Hydranassa, and others. His conclusions were based primarily on behavioral characteristics. Both authors, however, consider the genus Butorides as a stable taxon, but

admit that its members have interbred for some time, especially B. striatus and virescens.

Distribution of the Green Heron

The most recent A. O. U. Checklist (1957) sets the distributional limits for the Green Heron from northern Colombia (Rio Baudó) and Venezuela (Caracao), northward through Central America and the West Indies, and over nearly all of the United States to southern Canada. The range in Canada is principally from southern Ontario eastward to southern New Brunswick. Green Herons breed over most of their range, but winter chiefly from the United States southward. The eastern form virescens is accidental in Greenland, Bermuda, and Surinam.

Two unusual winter records have been reported from Indiana: at Indianapolis, January 3, 1916 (Wilson, cited in Bent, 1926) and at Goshen, March 18, 1918 (Eby, cited in Bent, 1926). A sight record 10 miles north of Park Rapids, Hubbard County, Minnesota, early in August (Audubon Field Notes, 3, (5); October, 1949) is extremely far north for the species. Bent (1926) states that this form according to Loveland (1895) is a casual visitor as far west as Colorado.

The western form anthonyi occurs chiefly in Washington, Oregon, and California during the breeding season and occasionally eastward to Nevada and Utah. The southwestern form frazari is resident locally in the southern half of Baja, California.

In Michigan the first authoritative listing of the eastern form, virescens, was by Gibbs, 1879 (cited in Wood, 1951). Wood lists the Green Heron as a "common summer resident in the southern 3 tiers of counties, locally northward to Cheboygan County". Barrows (1912) recorded a specimen collected May 2, 1898, in Kalkaska County and

another taken at the St. Mary's River in Chippewa County. A sight record (Kneeland, 1859) at Keweenaw Point is considered doubtful by Wood, although Barrows included it in his book.

A nesting record at Mud Lake, Sections 20 and 21, Grant Township, Cheboygan County, on July 14, 1941, is believed to be the northernmost nesting record for the state (Root, 1941). Other nesting records at Hess Lake, Newaygo County (Ford, 1922, cited in Wood, 1951), and at Gladwin Refuge, Gladwin County (Dockham, 1934, cited in Wood, 1951), indicate that the birds are able to nest successfully farther north than Barrows' arbitrary "Grand Rapids east to Port Huron" limit.

Other northern sight records and collected specimens may well be non-breeding birds, either adults or young wandering northward during the post-breeding period, a trait not uncommon to the herons (Coffey, 1943). However, the abundance of nesting records for the southern portion of the state seems to indicate a heavier concentration of breeding birds there.

Arrival and departure dates in Michigan

The Green Heron arrives in Michigan during the period from mid-April to early May, the heaviest migratory flights occurring about the first of May. Early arrival dates include April 1, 1959, at Midland (Kenaga, cited in Black, 1949) and April 3, 1953, 2 in Jackson County (Wolcott, cited in Wickstrom, 1953). A record of a Green Heron reported on March 19, 1904, is considered doubtful by Wood (1951). In Table 1 most of the arrival dates fall into the period from April 20 to May 1. This is in general agreement with other published references for this latitude (Roberts, 1936; Forbush, 1939; Trautman, 1940).

The migration southward occurs during the period from mid-September through the first part of October, with most of the herons having left the state by October 15 (see Table 2). Late records include October 24 in the Saginaw Bay area (Kenaga, 1956); October 26, 1953, 1 adult (?) at Three Rivers (Bryens, cited in Wickstrom, 1953), and 5 in Wayne County, November 5, 1905 (Swales, 1908).

Data collected during this study agree with these dates. My first record in 1959 was April 30, at Lake Lansing, and, for the nesting colony, May 1 (although I was absent from the nesting colony during the period April 27-May 1). My last record for the year was September 22, 1959, at Knollcrest Farm, Grand Rapids. Data for the 1958 season are incomplete.

The migratory flights of Green Herons occur mainly at night (Audubon, 1840; Griscom, 1923; Weston, cited in Howell, 1932;

Cruickshank, 1942), and particularly during warm spring rains (Beyer and Kopman, 1908). The speed of flight varies from 22 miles per hour (Wood, 1933, cited in Meyerriecks, 1958) to 34 miles per hour (McLean, 1930, cited in Meyerriecks, 1958). Meyerriecks has a personal record of 25 miles per hour.

Allen and Mangels (1940), in their study of the Black-crowned Night Heron (Nycticorax nycticorax), state that the "arrival dates may be counted on regardless of weather conditions and apparently irrespective of temperature, although winds from an unfavorable quarter may retard migration". Weather conditions for most of the week prior to the first sight record in the colony in 1959 were generally unfavorable. Winds were cold and often quite strong, mostly from the east-northeast. Skies were generally overcast and frequent cold rains fell. These weather conditions may have had a "slowing-down" effect on heron migration, at least into the study area. After May 1, 1959, the weather conditions became generally fairer and warmer.

Table 1 Some arrival dates for Green Herons in Michigan

<u>County</u>	<u>Month</u>	
	<u>April</u>	<u>May</u>
Midland (Midland)	1	
Jackson	3	
Kalamazoo (Vicksburg)	10	
Clinton (St. Johns)	11	
Washtenaw (Ann Arbor)	13	
Van Buren	14	
Kalamazoo (Augusta)	17	
Ingham (Haslett)	18	
Ottawa (Allendale)	19	
Tuscola	21	
Bay (Saginaw Bay area)	21	
Kalamazoo (Kalamazoo)	22	
Ingham (Lake Lansing area)	24	
Benzie	24	
Isabella (Mt. Pleasant)	25	
Ingham (East Lansing)	26	
Wayne	26	
Muskegon (Muskegon)	28	
Saginaw (Zilwaukee)	28	
Ingham (Lake Lansing area)	30	
Barry (Crooked Lake area)		1
Grand Traverse (Traverse City)		1

Table 2 Last dates of Green Herons in Michigan

<u>County</u>	<u>Month</u>		
	<u>September</u>	<u>October</u>	<u>November</u>
Oakland	17		
Bay (Saginaw)	18		
Van Buren (Paw Paw)	20		
Kalamazoo (Vicksburg)	21		
Kent (Grand Rapids)	22		
Muskegon (Muskegon)	23		
Genesee	29		
Kalamazoo	30		
Midland (Midland)		2	
St. Joseph (Three Rivers)		5	
Saginaw (Zilwaukee)		6	
Lapeer (Imlay City)		8	
Cheboygan (Cheboygan)		9	
Saginaw (Zilwaukee)		10	
Washtenaw (Ann Arbor)		10	
Ottawa		15	
Macomb (St. Clair Beach)		18	
Lapeer (Imlay City)		18	
Wayne		21	
St. Joseph (Three Rivers)		26	
Wayne			

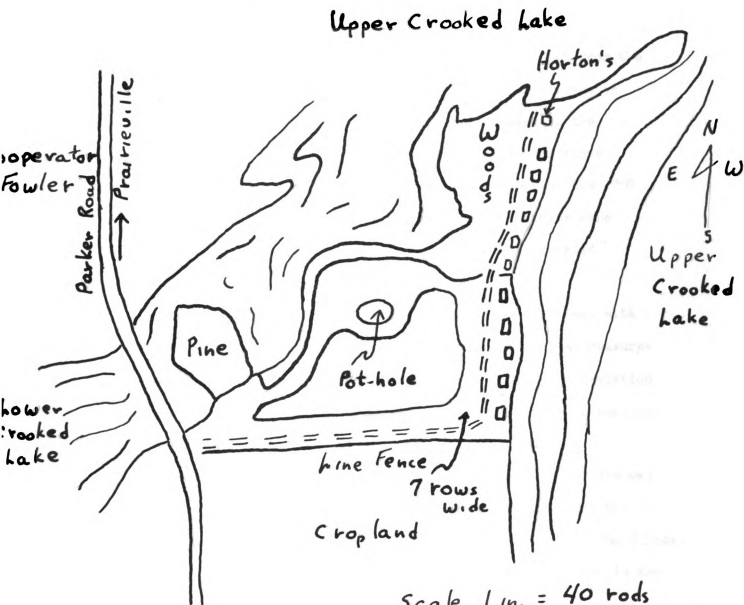
Location and description of study colony

Observations were made from July 4 to August 22, 1958, and again from April 18 to July 17, 1959, except for temporary absences. The study colony of nests was found in a small stand of pine trees (Pinus sp.) located 1° North by 10° West in Section 12, Prairieville Township, Barry County, Michigan.

The stand borders what is now a marsh succession following the drying of a formerly extensive post-glacial lake. The lake remains in two relatively isolated bodies of water, the Upper and Lower Crooked Lakes, connected by way of an extensive marsh (the Bay on Map 1). A peninsula of pines projects in a northeast by southwest direction into the marsh itself. The hatched area on the map has been landscaped and planted in cooperation with the Farm Game Habitat Improvement Project of the Game Division of the Michigan Department of Conservation.

Fifteen or 20 years ago, some 2000 trees, mostly Red Pine (Pinus resinosa), White Pine (P. strobus), and Austrian Pine (P. nigra) were planted on a 2 $\frac{1}{2}$ -3 acre plot. Rising water levels destroyed many of the trees along the edge of the stand during the first few years. The owner also permitted local and scattered removal of trees for use at Christmas time. Natural succession in the area, following these two factors, has kept the stand relatively isolated today.

Map 1 Location of study colony



Scale 1 in. = 40 rods

Used by permission of the owner, William Horton

Height of nests

Within this pine stand, 28 Green Heron nests were located during the 1958 season. Each was labelled and measured for height from the base of the tree. Only 14 of these nests still contained eggs or young when I began the study on July 4 (Table 7); however, the other 14 nests were assumed to have been used that season since shells of heron eggs were found beneath each tree. During the 1959 season, only 9 Green Heron nests were found, but 2 of these were intensively studied. These 9 nests were labelled and recorded in the same manner as the 1958 nests (Table 8).

In 1958, the average height of the 28 nests was 11.7 feet with a standard deviation from the mean of 1.4 feet. In 1959 the measurements were 11.7 feet for the average height with a standard deviation of 0.9 feet. Though the average height was the same for both seasons, there was a wider deviation from this mean during 1958.

The average height of the nests in the Red and Austrian Pine was the same as that in the White Pine, 11.8 feet. However, there was a significant difference in the standard deviations (Table 5). The 2 nests not in pines were 9.2 feet and 12.5 feet. In general, extremes in the height of the nests showed some difference, as much as 5.5 feet between Nest #11-58 and Nest #18-58.

Nesting trees

For this study the percentage of nests in Red and Austrian Pine was 56.8; in White Pine, 35.1 and in other trees and shrubs, 8.1. For the 2 seasons, this percentage showed that during 1953, 64.3 of the nests were in Red and Austrian Pine; 28.6 in White Pine, and 7.1 in other trees and shrubs. In 1959, these percentages were 33.3, 55.6 and 11.1 for the 3 groups respectively. From these data, it can be seen that nests were found 21.7% more in Red and Austrian Pine than in White Pine and that a very small percentage (8.1) were found in other trees and shrubs. This might be expected since this was a pine stand.

Also in this study 2 nestings occurred in the same tree or shrub and, in one case, at the same height (Nest #1-58 and Nest #1-59). Nest #7-59, in the same hawthorne (Crataegus macrocarpa) as Nest #10-58, was not measured for height.

The published literature relating to the species of trees and shrubs in which Green Heron nests are constructed and the height at which they are found is rather extensive. Bent (1926) cites the following types of trees which have been used: roots of mangroves (Maynard, 1896); pitch pine, grey birch, red oak, cedars, sassafras, and hickories (Townsend, 1920). Mrs. Wheelock (1906), in her life history study of the Green Heron, found 4 nests in evergreens, 1 in an apple tree of an orchard, and 1 in a small cottonwood. Root (1941) found a nest in a Black Spruce (Picea mariana), while Rapp (1931) studied a small colony of Green Herons in buttonbush (Cephalanthus occidentalis). Several other authors record nestings in these types of vegetation and

in other types as well (Barrows, 1912; Roberts, 1936; Forbush, 1939; Trautman, 1940). Apparently any tree or shrub which can support the bulky nest can be used as a nest tree.

The height of the nest may also vary. Bent (1926) states that the nest may be found on the ground, in low bushes, and 10 to 20 feet high in trees. Rapp (1931) studied nests from 8 to 10 feet high in buttonbush. Cooley (1942) studied a nest in a willow tree only 37 inches above the water. Maximum heights for the nests are 30 feet in a maple tree in an upland pasture (Roberts, 1936) and 50 feet in a willow tree (probably subspecies anthoyi; Huey, 1915, cited in Bent, 1926). In general, the average height of the nests in this study agree with those published in the literature.

Though generally considered to be solitary nesters, Green Herons sometimes nest in small colonies. One colony studied by Rapp (1931) contained several nests. Townsend (1920) notes that 20-30 pairs nested together in pitch pine some 20 feet from the ground, and also some 20 nests in cedars, sassafras, and hickories, from 3-20 feet in height. Pearson (1923) reported that 6-8 pairs sometimes nest together. Other Green Herons have been known to nest in association with colonies of Great Blue Herons (Ardea herodias) and Black-Crowned Night Herons (Nickell, 1958, pers. comm.; Bent, 1926). Perhaps, as Meyerriecks (1958) states, "there is a tendency toward colonial nestings in favorable habitats".

The data relating to personal observations and records for the nestings are included in the following tables (Tables 3-5).

Table 3 Height of the nests in 1958

<u>Nest Number</u>	<u>Species of Tree</u>	<u>Height</u> <u>(Inches) (Feet)</u>	
1-58	White Pine	127.5	10.6
2-58	Red or Austrian Pine	150.0	12.5
3-58	Red or Austrian Pine	138.3	11.5
4-58	Red or Austrian Pine	156.0	13.0
5-58	Red or Austrian Pine	136.5	11.4
6-58	White Pine	108.0	9.0
7-58	Red or Austrian Pine	140.0	11.7
8-58	Red or Austrian Pine	159.0	13.3
9-58	Red or Austrian Pine	141.0	11.8
10-58	Hawthorne	110.0	9.2
11-58	Red or Austrian Pine	172.0	14.3
12-58	Red or Austrian Pine	144.0	12.0
13-58	Red or Austrian Pine	123.0	10.3
14-58	Red or Austrian Pine	132.5	11.0
15-58	Red or Austrian Pine	130.5	10.9
16-58	Red or Austrian Pine	149.0	12.4
17-58	Boxelder	150.0	12.5
18-58	Red or Austrian Pine	106.0	8.8
19-58	Red or Austrian Pine	140.0	11.7
20-58	Red or Austrian Pine	132.0	11.0
21-58	Red or Austrian Pine	150.0	12.5
22-58	White Pine	137.0	11.4

Table 3 Height of the nests in 1958 (cont'd)

<u>Nest Number</u>	<u>Species of Tree</u>	<u>Height</u>	
		<u>(Inches)</u>	<u>(Feet)</u>
23-58	White Pine	155.0	12.9
24-58	White Pine	165.0	13.8
25-58	Red or Austrian Pine	156.0	13.0
26-58	White Pine	168.0	14.0
27-58	White Pine	136.0	11.3
28-58	White Pine	132.0	11.0
Average height of all nests		$\bar{x}$ = 140.9	11.7
Standard deviation from the mean		$\underline{s}$ = 16.4	1.4

Table 4 Height of the nests in 1959

<u>Nest Number</u>	<u>Species of Tree</u>	<u>Height</u>	
		<u>(Inches)</u>	<u>(Feet)</u>
1-59	White Pine	125.0	10.4
2-59	White Pine	140.0	12.3
3-59	Red or Austrian Pine	144.0	12.0
4-59	Red or Austrian Pine	131.0	10.9
5-59	Red or Austrian Pine	141.0	11.8
6-59	White Pine	- - -	- -
7-59	Large-seeded Hawthorne	- - -	- -
8-59	White Pine	141.0	11.8
9-59	White Pine	156.0	13.0
Average height of all nests		$\bar{X} =$ 140.9	11.7
Standard deviation from the mean		$\underline{s} =$ 10.3	0.9

Table 5 Summary figures for height of the nests, 1958 and 1959

<u>Year</u>	<u>Species of Tree</u>	<u>No. of Nests</u>	<u>% of Nests</u>	<u>Average Height</u>		<u>Standard Deviation</u>	
				<u>Inches</u>	<u>Feet</u>	<u>Inches</u>	<u>Feet</u>
1958	Red and Austrian Pine	18	64.3	142.0	11.8	14.9	1.2
1958	White Pine	8	28.6	141.0	11.8	20.3	1.7
1959	Red and Austrian Pine	3	33.3	138.7	11.6	6.8	0.6
1959	White Pine	5	55.6	142.5	11.9	13.2	1.2
TOTALS	Red and Austrian Pine	21	61.8	141.5	11.8	14.0	1.2
	White Pine	13	38.2	141.5	11.8	17.6	1.5

Nest structure

The nest of the Green Heron is an unlined platform consisting of dead sticks of various shapes and sizes. A shallow depression is usually formed at the center of the nest, but this probably results from the weight of the adult bird as it sits in the nest. The sticks are somewhat interlaced by the adults during the period of nest construction (Meyerriecks, 1958), but even when completed, the nest is still quite porous.

From observations of completed nest construction, I have noted that, in general, the nests placed in the main whorl of branches are larger and bulkier than those placed out from the trunk. The latter are usually constructed at the nodes of the branches where smaller needle-bearing branches diverge. Perhaps the smaller amount of space available prevents the formation of a larger nest in these cases.

The average diameter of the nests was about 8 inches; the total diameter was more difficult to determine because of the protruding sticks. Except for a few sticks which protruded further from the nest, the greatest diameter was some 12 inches.

The nests were not only quite loosely constructed, but also an obvious lack of cleanliness was evident particularly after the young hatched. Feces accumulated on the nest sticks, the bark of the tree, and the surface of the ground. No attempt at cleanliness on the part of the adults or young was seen, and flies and other insects were seen around the nests a good deal of the time. Perhaps, as Wheelock (1906)

has said, "But herons are inured to hardships from their birth, it seems, for no lining of any sort was found in any of the nests, the young reposing on the coarse twigs in the midst of indescribable uncleanness."

No data are available in this study concerning the elaborate stick-presentation ceremony, an aspect of the courtship behavior discussed in meticulous detail by Meyerriecks (1958).

Eggs and egg laying

Clutch sizes in the present study are listed in Tables 7 and 8 in the section dealing with mortality. The average clutch was 3.5 eggs, with a variation from 2-5. This agrees with the clutch size as determined from Rapp's (1931) data (although he assumes the possibility of a second brood in his study), but is somewhat lower than other clutch sizes recorded in the literature (Bent, 1926; Trautman, 1940, and Wickstrom, 1950).

The average size of 20 eggs in this study was 39.1 mm. x 29.9 mm., with extremes of 45.0 mm. x 29.0 mm. and 38.0 mm. x 28.0 mm. These data agree with measurements recorded in the literature (Gentry, 1882, and Bent, 1926).

In my only record of the time of laying, the third egg of Nest #6-59 was laid between 12:00 and 4:00 PM, May 29, 1959.

Incubation

Burns (1915) listed the incubation period of the Green Heron as 17 days. Cooley (1942) determined the incubation period of 4 eggs to be 20 days. In the present study, the average length of the incubation period for 10 eggs was 23 days. The closest determination was that for the third egg in Nest #6-59 (see above) which was laid on the afternoon of May 29, 1959, and was already hatched (less than 1 day old) on the morning of June 22, 1959 (a period of 23 days).

The incubation period for 9 other eggs was determined from the approximate dates of laying and hatching. The data in Meyerriecks (1958), indicated that the average number of days for incubation was likewise 23 days.

In this study it was impossible to determine the relative length of time during which each adult was in attendance or absent from the nest since the sexes were indistinguishable and were not marked. Meyerriecks (1958) recorded that the male incubates mostly throughout the mid-day and mid-night hours, while the female sits during the early morning and late evening hours. Kendeigh (1952) recorded that both sexes incubate alternately at intervals of 2-6 hours during the day and that the female incubates during the night.

Kendeigh (op. cit.) mentions an elaborate replacement ceremony, although Meyerriecks maintains that this ceremony disappears as incubation progresses. I did not see any replacement ceremony during my observations of incubating birds, but rather a simple exchange of the two adult birds at the nest.

Nestling period

Growth--The weights of the young herons increase at a regular rate during the first 10 days after hatching (see graph). After this the young are able to move out of the nest and cannot readily be handled and weighed. All data pertaining to the weights of the young were recorded at approximately the same time of day. The 4 nestlings in Nest #6-59 were marked with red decorative enamel on the feet or legs so that the weight of each could be followed individually. The 2 young in Nest #4-59 could be distinguished by their respective stages of development. The data obtained for the 4 young in Nest #6-59 were calculated by comparison with the other nestlings since the exact ages were not known.

Wheelock (1906) recorded that the increase in weight for young green herons was 1/2 oz. per day (14.2 gms.) and that the average weight at the end of 7 days was 3 3/4 oz. (96.5gms.). No additional data were given. The 4 young in Nest #6-59 had an average gain in weight per day of 8-10 gms. and at the end of 7 days had an average weight of 84 gms.

Development--The young develop rapidly after hatching. Within 2-3 days they are already sitting up in the nest, maintaining their position by gripping the nest sticks with their strong toes. If they are handled, the young flex their toes, grabbing at the nest and often picking up loose twigs from the nest which they continue to hold even when they are being weighed.

At the end of 6-7 days of development the young are actively

moving about on the flat nest. At this time the youngest nestlings are subject to some abuse by the older ones. Often in looking into the nest, I have seen only 3 of the 4 young in the nest, with the 4th one (usually the youngest or smallest) concealed beneath the others.

The typical resting position of the nestlings resembles somewhat a "bittern stance". Their long necks are held vertically, the bill is projected at an angle, and the eyes are directed downward toward the ground. The body is often twitching nervously, probably because of a general alarm in the young. The snapping of the tail, a behavioral aspect of the adult birds associated with "general excitability" (Meyerriecks, 1958), is also a part of this peculiar habit.

After 10 days the young are able to leave the nest and to perch along the branches nearby. Except for the crest feathers which are just beginning to show, the plumage in the young is well developed by this time. Traces of the grey down still cling to the feathers. The bills, feet, and legs are long and very strong. After 10 days, the young become more independent of the nest and soon move away from it into other trees.

Feeding of the Young--The young are fed by regurgitation. Apparently the food material is regurgitated into the nest during the first days of development. My field notes record the following incident involving a less than one-day-old nestling (Nest #4-59):

"In the nest were an unidentified minnow about 1 1/2 in. long and a small frog (Acris crepitans). As I prodded the food with a pencil, the nestling seized the minnow and began to manipulate it until the whole fish could be swallowed head-first. The minnow was almost too large for the young bird to swallow and the meal was not down for about 5 minutes. During this time the eyes were closed and the head and neck were lifted and then dropped again as the bird struggled with the food. . . ."

The feeding activity begins with the first egg hatched. A single unhatched egg was still in this nest.

The young peep almost continuously from the time of hatching. Within 3 days a rapid clicking by the young can be heard in addition to the peeping. Both sounds may be associated with feeding because the sounds continue until after the young have been fed.

The young, when they are able to move about in the nest, usually face in the direction of an approaching adult. This approach of the adult bird is accompanied by a series of low "cucks" which stimulates a louder peeping and clicking by the young. A good deal of gaping also occurs. The young face the approaching adult and open their bills exposing the large mouth cavity. This is not the same as gagging (see section on behavior of young Green Herons) because no attempt is made to regurgitate food material.

As soon as the adult reaches the nest, the young seize the bill crosswise and begin to stroke it. This seizing of the bill probably acts as a "releaser stimulus" which causes the regurgitation of the food material (Lowe, 1954). Both the young and the adult engage in an active struggle which involves a twisting and turning of their heads and bills. This struggle becomes more evident as the young develop.

Not all of the regurgitated food material is swallowed by a young bird. Some of it is picked up by the adult and either swallowed or thrown out of the nest. The young birds also pick at each other following each feeding, although no second regurgitation by the young themselves was seen.

Feedings occur in the branches after the young have left the nest. The young must then maintain their balance while being fed. A peculiar habit of "dancing" with the wings arched high over the back

also occurs just prior to feeding at this stage of development. A captive bird exhibited this same behavior as it begged for food.

No data are available in this study as to the sequence of feeding by each adult bird. Most of the feedings took place during the early morning and early evening. Wheelock (1906) recorded that the young were fed only in the early morning and late afternoons, especially from 4:00-6:00 AM and 5:00-7:00 PM. In this study no feedings were observed after 7:00 PM., although there was a feeding at 6:50 PM, after which the young returned to the nest from a branch and quietly remained there.

The types of food fed to the young were determined from regurgitated food in the nest, from regurgitations of the young, and by means of stomach examinations of dead young. No attempt was made to correlate the types of food offered with the age of the young nor with the environmental conditions for that particular feeding period. Wheelock (1906) has an elaborate arrangement of the type of food fed to the young compared to the environmental conditions for that particular day (for example, crayfish, minnows, snails and slugs on cloudy morning). Cooley (1942) was able to show that certain types of food were regurgitated for the young depending on their ages. Most of this food consisted of fish, which formed little of the food material in this study.

A list of the food material collected and identified is included in Table 6. The young were fed mostly on aquatic insects, amphibians (mostly Acris crepitans and Rana pipiens which were abundant nearby), and occasionally fish. An interesting point here is that large schools of bowfin (Amia calva) were planted in the lake by the Hastings Fish Hatchery as part of a controlled experiment in

lake production. This species was found in several examinations.

Cottam and Uhler (1937) have shown quite conclusively that the food of Green Herons consists mostly of aquatic insects, particularly dragonfly nymphs, predacious diving beetle larvae, and large water bugs of the genus Belostoma. Other authors also record large numbers of aquatic insects in stomach examinations (Gentry, 1882; Bent, 1926; Roberts, 1936; Trautman, 1940).

Graph 1 Increase in weight (gms.) plotted against approximate age in days

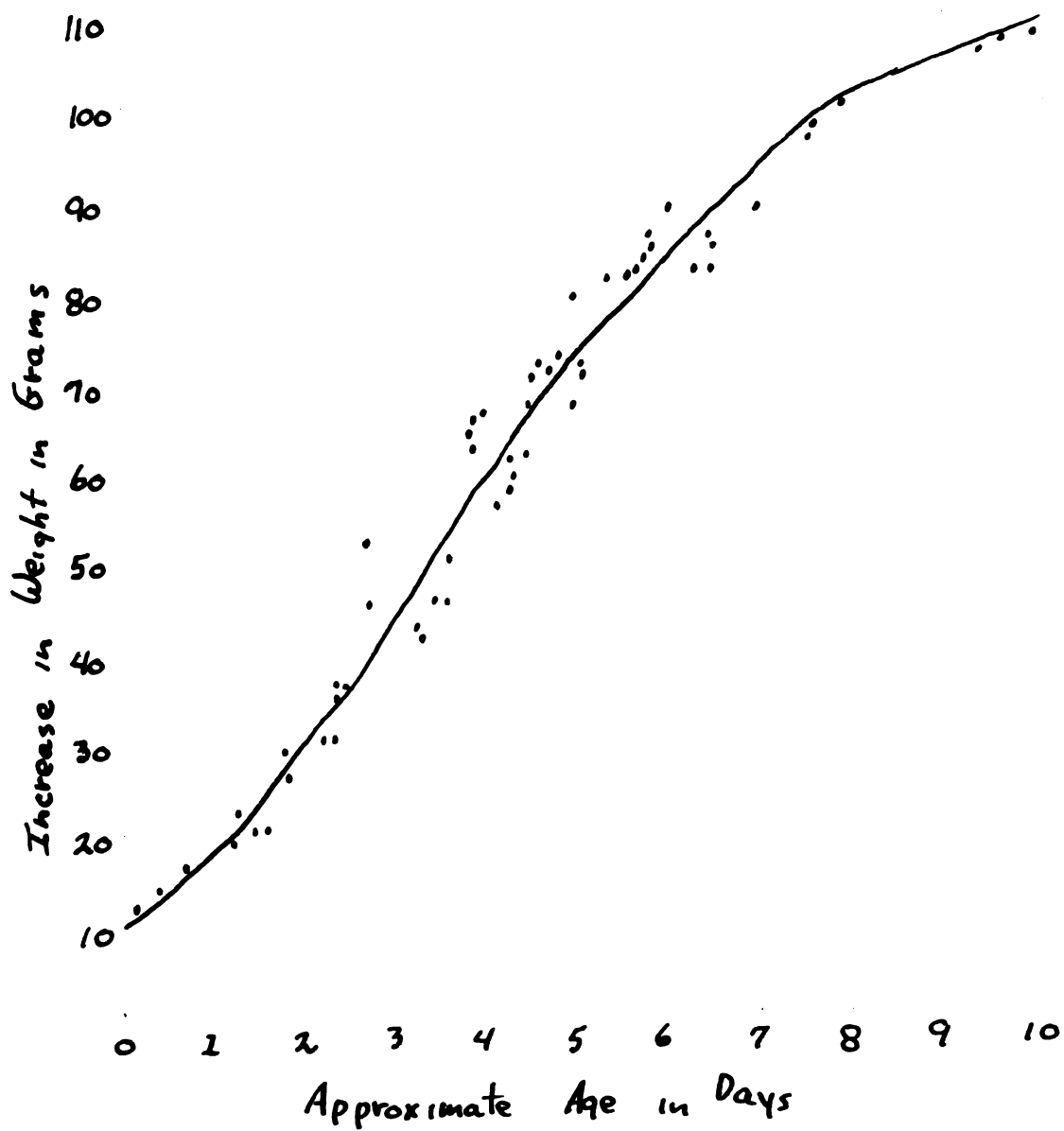


Table 6 Food of young Green Herons

- June 11, 1959, Nest #4-59, a young heron (3 days old) regurgitated a 4 gm. mass of partially digested food, identified as the larva of a dytiscid beetle.
- June 24, 1959, Nest #6-59, the regurgitated food material consisted of two small frogs (Acris crepitans)
- June 25, 1959, Nest #6-59, mostly frog remains in food material
- June 26, 1959, the following were identified in food material which had been collected and preserved earlier:
- dytiscid beetle larvae-2
 - belostomatids
 - Acris crepitans-3
 - remains of others
 - unidentified frog remains
 - bowfin-7 and remains of more
 - centrarchids (Lepomis sp.)-2
- Nest #6-59, tadpoles (just showing legs)
- July 10, 1959, identified food material:
- dytiscid beetle larvae-2
 - belostomatids-1
 - cuculionids-12+
 - odontid naiads-2
 - hellgrammite-1
 - elytra of chrysemelid beetle (Donacia sp.)

Fledging

The young become more independent of the nest after they once venture out of it (about 10 days after hatching). By 2 weeks of age, they are able to jump from branch to branch in the nest tree. They make use of their head, neck, bill, and wings for maintaining their balance when landing in a new position. The young do not return to the nest after they are able to move from branch to branch.

The first attempts at flying are made at about $2\frac{1}{2}$ weeks of age. The first flights are generally just a few feet, usually the distance between two limbs of the tree. At this time the young were difficult to follow except by the movement of the branches as they jumped and/or flew from one to another.

A young heron from Nest #5-59 was seen in a tree about 64' from the nest at 22 days of age. Although the bird was completely feathered (except for traces of the grey down on the crest) and was able to fly for several yards, it was still being fed by the adult birds. Burns (1921) records that fledging takes 4-5 weeks. This young bird was then probably near the end of the fledging period.

Behavior of young Green Herons

Gagging--The young nestlings often appear to gag when an intruder is present. The mandibles are opened very wide, and the sides of the mouth are stretched exposing the mouth cavity which then appears very large. In closing the mouth again, the young extend the head forward. This sequence of events suggests that the young are choking or "gagging". Sometimes this gagging results in the regurgitation of food material.

Gular fluttering--On very warm, sunny afternoons the young show a fluttering of the gular region. This is probably a means of reducing the body temperature since it is often seen when the young are sitting in direct sunlight. A captive bird also drooped its wings while exhibiting this behavior. Similar gular fluttering has been reported in the Lesser Nighthawk (Chordeiles acutipennis) in Texas (Cowles and Dawson, 1951) and in the Poor-will (Phalaenoptilus nuttallii) in California (Brauner, 1952).

Vocalization--The peeping and clicking by young herons has already been discussed as an aspect of feeding. When the young are about 7 days old and are actively moving about the nest, they will give a loud, raspy alarm note ("caack") when approached by an intruder. This call is accompanied by striking movements of the bill and head. No other calls by the young were heard.

Defecation--The young defecate directly into the nest before they are able to move about. However, as they develop and become more active, the young will defecate at the rim of the nest.

The defected material is a white fluid which is voided from the body while the young assume a squatting position. This accumulates on the nest sticks, the tree, and over the ground beneath the nest. The material has a very strong fishy odor and, as it accumulates, the whole nest area takes on this odor.

Falling--The young herons have some difficulty in moving about the nest and the branches. Several times during this study young herons were seen to lose their balance and fall several feet to a lower limb or occasionally to the ground.

However, as soon as the young bird regains its balance, it will begin to climb back to the nest. This is accomplished by placing the bill over a branch and then using the wings for climbing. On at least two occasions young were seen climbing several feet up into a tree. One young (Nest #23-58) was thought to have returned to the nest by itself, presumably having climbed from the ground up to the nest (11').

The adult Green Heron apparently does not desert a young bird when it has fallen from the nest. One nestling was found several yards from the nest perched about 6' up among the branches of a willow. The adult repeatedly flew low into this tree, apparently feeding the young bird.

Post-juvenal migration--Coffey (1943) discusses the dispersal of young herons following the nesting period. Lowe (1954) states that this dispersal in all directions (often northward) is to find good living conditions for the remainder of the season. No family groups or groups of many young together, suggesting post-juvenal migration, were seen during this particular study.

Mortality

Perhaps the most significant aspect of this study was the very high mortality rate incident at the nesting colony. During the 1958 study, 12 of the 14 nests under observation failed completely, while in 1959, 7 of the 9 nests failed. This destruction occurred both to the eggs and to the young.

In 1958, 16 of the 36 eggs (44.4%), and in 1959, 7 of the 30 eggs (23.3%) were either infertile (2), stolen (14), or damaged and deserted (7). This represents a total of 34.8% (23 of 66 eggs).

Mammal predation of eggs was recorded in one instance. On July 12, 1958, an adult heron chased a red squirrel (Tamiasciurus hudsonicus) from Nest #4-56. Subsequent investigation indicated that 3 of the 4 eggs were damaged (the shells were pierced), and 2 days later, July 14, the remaining egg was missing. Although this type of egg destruction was seen but once, other losses were probably due at least in part to predation by the squirrels.

As can be seen from Table 9, several avian predators were seen in the area immediately surrounding the colony. Among those which might have stolen or destroyed eggs are the Common Crow (Corvus brachyrhynchos), Blue Jay (Cyanocitta cristata), and Common Grackle (Quiscalus quiscula). The Brown-headed Cowbird (Molothrus ater) and the Red-winged Blackbird (Agelaius phoeniceus) might possibly take an egg.

Lowe (1954) states that the Hooded Crow (Corvus cornix) and the Carrion Crow (Corvus corone) take heron eggs and young, and that this

may have considerable effect on a heron population. On the other hand, he notes that magpies (Pica pica) and jays (Garrulus glandarius) often nest in the same trees as herons and apparently have little or no effect on heron populations. Wheelock (1906) maintained that Common Grackles served as "watchmen", warning at the approach of other predators, but only occasionally stealing an egg themselves. Crows, hawks, and vultures (Audubon, 1840, cited in Bent, 1926; Baker, 1940; Provost, 1947; and Meyerriecks, 1958), along with blackbirds and Forster's Terns (Sterna forsteri) (Provost, 1947) have been mentioned also as predators on heron colonies.

In addition to the high mortality to the eggs, the loss of young is also significant. Of the 35 young found in the colony during 1958, some 28 (80%) were found dead while only 7 (20%) could have been fledged successfully. During 1959, 15 of the 21 young (71.4%) were found dead; 6 (28.6%) were probably fledged. Combined, these totals show that 76.8% of the young were found dead or missing from the nests and 23.2% were fledged.

The manner in which some of the young were killed seemed to indicate that larger avian and mammalian predators were entering the colony although none except the red squirrel was actually seen. Several young were partially or completely decapitated (owls?), eviscerated, or mutilated in some other way. The proximity of a Cooper's Hawk (Accipiter cooperii), nesting within the pine stand, apparently did not affect this high mortality because repeated checks of the hawk nest did not yield any evidence of heron remains. Lowe (1954) mentions that peregrines nested in 8 out of 18 heronries in the state forests of East Prussia in an apparent state of neutrality, although he does not suggest complete immunity within the same area. Provost (1946) lists

the mink (Mustela vison) as a mammalian predator on herons while other authors list raccoon (Procyon lotor) (Audubon, 1840, cited in Bont, 1926; Baker, 1940) or possibly opossum (Didelphis virginiana) (Baker, 1940).

Finally, weather factors may have played a role. On the night of July 14, 1958, a severe electrical storm swept the colony and in the morning, 5 young were found dead (Nest #9-58). However, the fact that some of these young were again badly mutilated might suggest death by some predator(s) rather than by weather factors. Wheelock (1906) reported the death of many young birds following such a severe storm. Lowe (1954) also states that bad weather is a principal factor affecting nestling mortality.

Other than the data already cited little can be added to explain the very high mortality rate in this study, .Lowe (1954) has dealt with this aspect in his Life history study of the Common Grey Heron (Ardea cinerea) and some of his conclusions are worthy of mention. The two main factors responsible for a decline in heron populations in his study were exceptionally severe winters and man. Citing Alexander, Lowe states that the "decrease in the number of breeding pairs is largely the result of the prevailing lowest temperature of the preceding winter, and as a rather high percentage of victims are young birds, the effect on the heronries is noticeable for the following two seasons (p. 682)." Perhaps the winter season of 1958-1959 took an exceptional toll of potential breeders. If this were the case then the lower number of nesting birds during 1959 would be expected.

The herons as a group have been protected by the Federal Migratory Bird Law (1913) for many years. In Europe, the herons are protected locally, but many herons, particularly the unwary young birds, are shot in the trout angling counties. This factor is probably not important

in Michigan, since the Green Heron is not considered to be primarily a fish eater (Cottam and Uhler, 1937).

There are no known epidemic diseases affecting herons; however, Lowe suggests possible infestation of intestinal trematodes in young herons, probably from the food which is eaten.

Competition with other nestlings for food and space in the nest may have an effect on the mortality rate of nestlings. The younger and weaker nestlings may die from hunger and exhaustion in competing with the others for the attention of the adults. The greatest losses apparently occur during the earliest days; then, if the young survive to the third week of development, another rise in the mortality rate may occur. This latter rise occurs at about the time of active movement of the young about the nest area. At this time, environmental factors, particularly storms and high winds, may have a decimating effect.

Table 7 Nesting success in 1958

Nest no.	No. of eggs laid	No. of eggs that hatched	% of eggs laid that hatched	No. of eggs hatched that fledged	% of eggs hatched that fledged	Successful	Unsuccessful
1-58	3	0	0	0	0		eggs deserted
2-58	4	4	100	0	0		young found dead
3-58	4	4	100	1	25	1 young	3 young missing
4-58	4	0	0	0	0		eggs destroyed by red squirrel
9-58	5	5	100	0	0		young found dead
10-58	3	3	100	3	100	3 young	
11-58	2	1	50	0	0		1 young missing; 1 infertile egg
13-58	4	0	0	0	0		eggs missing
14-58	4	0	0	0	0		eggs missing
15-58	3	3	100	0	0		young found dead
19-58	4	4	100	0	0		young found dead
20-58	4	4	100	0	0		young found dead
24-58	3	3	100	0	0		young found dead
25-58	4	4	100	3	75	3 young	1 young died
Total	51	35	69	7	20	3 nests	11 nests

Table 8 Nesting success in 1959

Nest no.	No. of eggs laid	No. of eggs that hatched	% of eggs laid that hatched	No. of eggs hatched that fledged	% of eggs hatched that fledged	Successful	Unsuccessful
1-59	4	3	75	0	0		3 dead young; 1 egg in nest
2-59	5	5	100	0	0		young missing; presumably dead nest destroyed
3-59	2	0	0	0	0		
4-59	4	3	75	0	0		3 young and 1 egg missing
5-59	4	4	100	at least 1	at least 25	at least 1	1 young dead
6-59	4	4	100	at least 1	at least 25	at least 1	1 young dead
7-59	4	3	75	0	0		3 young dead; 1 egg infertile
8-59	1	0	0	0	0		egg destroyed
9-59	3	0	0	0	0		eggs missing
Totals (1959)	31	22	71	at least 2	at least 9	at least 2 nests	7 nests
Totals (1958 & 1959)	82	57	69	9	16	5	18

Associated vertebrate fauna

Several species of birds were seen within the pine stand or flying about in the open marsh near the stand. Some of these were seen before the herons arrived; others arrived during the nesting season, and a few were present during the whole study, particularly Song Sparrows (Melospiza melodia). A complete list of all the birds seen or heard in the area (approximately 640 square rods centered around the colony) is given in Table 9.

The most common species was the Song Sparrow, but Black-capped Chickadees (Parus atricapillus), Rufous-sided Towhees (Pipilo erythrophthalmus) and Catbirds (Dumetella carolinensis) were seen and heard daily. Of those which were seen overhead, flying between the lakes, the most common was the Black Tern (Chlidonias niger).

A few species were known to have nested within or around the colony. These are indicated by an asterisk in Table 9. Nesting success for some species is known, and this has been included.

The four non-avian species included two reptiles and two wild mammals. These four are a Midland Painted Turtle (Chrysemys picta marginata), a snake (Thamnophis sp.), a muskrat (Ondatra zibethica), and red squirrels.

Table 9 Associated avifauna

- Great Blue Heron, Ardea herodias
- American Bittern, Botaurus lentiginosus
- Canada Goose, Branta canadensis
- ** Mallard, Anas platyrhynchos
- Black Duck, Anas rubripes
- Blue-winged Teal, Anas discors
- Lesser Scaup, Aythya affinis
- Common Merganser, Mergus merganser
- Eastern Turkey Vulture, Cathartes aura
- *** Cooper's Hawk, Accipiter cooperii
- Red-tailed Hawk, Buteo jamaicensis
- Marsh Hawk, Circus cyaneus
- Killdeer, Charadrius vociferus
- Spotted Sandpiper, Actitis macularia
- Herring Gull, Larus argentatus
- Ring-billed Gull, Larus delawarensis
- Black Tern, Chlidonias niger
- * (?) Mourning Dove, Zenaidura macroura
- Yellow-billed Cuckoo, Coccyzus americanus
- Belted Kingfisher, Megasceryle alcyon
- * Yellow-shafted Flicker, Colaptes auratus
- Red-bellied Woodpecker, Centurus carolinus
- Hairy Woodpecker, Dendrocopos villosus

Table 9 Associated avifauna (cont'd)

- * Downy Woodpecker, Dendrocoros pubescens
- ** Eastern Kingbird, Tyrannus tyrannus
 - Great Crested Flycatcher, Myiarchus crinitus
 - Eastern Phoebe, Sayornis phoebe
 - Traill's Flycatcher, Empidonax traillii
 - Eastern Wood Pewee, Contopus virens
- * Tree Swallow, Iridoprocne bicolor
 - Rough-winged Swallow, Stelgidopteryx ruficollis
 - Blue Jay, Cyanocitta cristata
- * Common Crow, Corvus brachyrhynchos
 - Black-capped Chickadee, Parus atricapillus
 - Tufted Titmouse, Parus bicolor
- * Catbird, Dumetella carolinensis
 - Brown Thrasher, Toxostoma rufum
 - Robin, Turdus migratorius
 - Cedar Waxwing, Bombycilla cedrorum
 - Solitary Vireo, Vireo solitarius
 - Warbling Vireo, Vireo gilvus
 - Yellow Warbler, Dendroica petechia
 - Myrtle Warbler, Dendroica coronata
- ** Yellow-throat, Geothlypis trichas
 - Eastern Meadowlark, Sturnella magna
 - Red-winged Blackbird, Agelaius phoeniceus
 - Baltimore Oriole, Icterus galbula
 - Common Grackle, Quiscalus quiscula
- ** Brown-headed Cowbird, Molothrus ater

Table 9 Associated avifauna (cont'd)

Cardinal, Richmondia cardinalis

American Goldfinch, Spinus tristis

Rufous-sided Towhee, Pipilo erythrophthalmus

Field Sparrow, Spizella pusilla

White-throated Sparrow, Zonotrichia albicollis

** Song Sparrow, Melospiza melodia

* Known to have nested around the colony.

** Known to have nested, but unsuccessfully. (The Brown-headed Cowbird parasitized the nest of the Yellow-throat.)

*** Known to have nested successfully.

Associated flora

The dominant vegetation within the colony was a mixture of pine (see Tables 3-5) plus a few other trees and shrubs. In those areas in which the pines had been cleared, common weeds had grown in a succession stage. Beneath the pines, however, there was very little vegetation and most of this was of a species of bramble (Rubus sp.).

Scattered clumps of staghorn sumac (Rhus typhina) and dwarf sumac (Rhus copallina) had developed among the dominant vegetation. Grape vines (Vitis sp.) were entangled in the pine trees in two areas of the stand.

The border vegetation consisted mostly of buttonbush (Cephalanthus occidentalis) and common cat-tail (Typha latifolia) with various grasses and weeds on the drier areas near the pine stand. No nests of the Green Heron were found in this area, although buttonbush is often used for the nest (Rapp, 1931).

A list of the most common plants within the colony and immediately around it has been included (Table 10).

Table 10 Associated flora

Balsam Fir, Abies balsamea
White Pine, Pinus strobus
Red Pine, Pinus resinosa
Austrian Pine, Pinus nigra
Common Cat-tail, Typha latifolia
Iris, Iris sp.
Black Willow, Salix nigra
Quaking Aspen, Populus tremuloides
Large-toothed Aspen, Populus grandidentata
White Oak, Quercus alba
Red Oak, Quercus rubra
Sassafras, Sassafras albidum
Large-seeded Hawthorne, Crataegus macrosperma
Bramble, Rubus sp.
Black Cherry, Prunus serotina
Yellow Sweet Clover, Melilotus officinalis
White Sweet Clover, Melilotus alba
Flowering Spurge, Euphorbia corollata
Staghorn Sumac, Rhus typhina
Dwarf Sumac, Rhus copallina
Red Maple, Acer rubrum
Silver Maple, Acer saccharinum

Table 10 Associated flora (cont'd)

Box-elder, Acer negundo
Virginia Creeper, Parthenocissus quinquefolia
St. John's Wort, Hypericum sp.
Wild Carrot, Daucus carota
Whorled Loosestrife, Lysimachia quadrifolia
Ash, Fraxinus sp.
Indian Hemp, Apocynum cannabinum
Self-heal, Prunella vulgaris
Wild Bergamot, Monarda fistulosa
Bittersweet, Solanum dulcamara
Common Mullein, Verbascum thapsus
Buttonbush, Cephalanthus occidentalis
Common Elder, Sambucus canadensis
Throughwort, Eupatorium perfoliatum
Goldenrod, Solidago sp.
Horse-weed, Erigeron canadensis
Coneflower, Rudbeckia sp.
Common Yarrow, Achillea millefolium
Canada Thistle, Cirsium arvense
Lettuce, Lactuca sp.

Summary

The life history study of a nesting colony of Green Herons in southern Michigan was carried out from July to August, 1958, and again from April to July, 1959.

The genus Butorides is composed of 1 species, virescens, and 3 subspecies in North America. The current taxonomic status of the genus is discussed.

The distributional limits of the species include most of the North American continent north of the Panama Canal Zone as well as scattered areas of northern South America. The eastern form virescens is found chiefly east of the Mississippi River Valley. This form is the most common summer resident heron in Michigan.

The Green Heron arrives in Michigan in the spring during the period from mid-April to early May. The breeding period extends from May to the first weeks of August. Fall migration occurs from mid-September through most of October.

A colony of 37 Green Heron nests was located on the border of a marsh succession in Prairieville Township, Barry County, Michigan. The area occupied was approximately $2\frac{1}{2}$ -3 acres of a pine planting composed mainly of red pine, Austrian pine, and white pine. As a result of natural succession other species of trees, shrubs, and common weeds had grown throughout the stand.

The average height of all the nests was 11.7 feet with a standard deviation of 1.5 feet. The average height of the nests in red and

Austrian pine was the same as in the white pine, 11.8 feet. There was a significant difference in the standard deviations however. Only 3 nestings out of 37 occurred in trees or shrubs other than pine. Two of these nests were in the same tree at the same height on different seasons. No trees contained more than 1 nest at the same time.

Pre-nesting behavior, courtship, and associated activities, such as nest-building, were not studied. These aspects are quite thoroughly covered in a recent publication by Meyerriecks.

The average clutch in the nests studied was 3.5 eggs with a variation from 2-5 eggs. The average egg-size was 39.1 x 29.9 mm. In the only determination of the time of egg-laying, a third egg was laid between 12:00 and 4:00 PM, May 29, 1959.

The incubation period for 10 eggs was 23 days. Incubation periods for several other eggs were determined from the approximate dates of laying and hatching.

The young herons remain in the nest for 10 days. During this time weight determinations for 10 young were made. The young were fed by regurgitation. Examination of regurgitated material and a few stomach examinations indicated that the young were fed mostly aquatic insects, amphibians, and occasionally fish.

Movements from the nest became common after the first 10 days. These were limited to a few feet out on supporting branches in the tree. First attempts at flying were observed at approximately 2½ weeks of age. One young heron was seen 64 feet from the nest at 22 days after hatching.

Behavior patterns of the young are varied and include gagging, gular fluttering, vocalizing, defecating activities, and climbing. Each of these is discussed in the text.

Mortality in this nesting colony was very high. Of the 66 heron eggs found in this study, 23 were infertile, stolen, or damaged and deserted. Forty-three of the 56 young were found dead or missing from the nests. At least one case of predation on heron eggs by a red squirrel was recorded. Other possible factors are discussed.

Samples of the associated flora within the study were collected and identified to species or genus. A list of the associated fauna was also kept.

Several tables showing migration data, height of the nests, collected food material, mortality data, and the associated flora and fauna are presented. A map of the study area and a graph showing weight increase of the young for the first 10 days are included.

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