

Notes on Incubation and Growth of Alligators

By E. A. McILHENNY

I

ON June 18, 1931, an alligator started building its nest in a large clump of Egyptian papyrus (*Cyperus papyrus*) about fifty feet from shore in my wild life refuge on Avery Island, where I had liberated a lot of toe-marked little alligators in 1921.

The place was easy to get to, but there was no suitable location near the nest to put up an observation blind, so the actual construction of the nest was not watched. The builder was a young female, one of the lot I had marked for identification August 22, 1921, with her first nest.

The papyrus growth in which the nest was being built was very thick, about ten feet high, growing in about eight inches of water on the edge of deep water and close against a concrete retaining wall. These heavy, soft stemmed plants were mashed down at the location for the nest, by the alligator crawling over them. When I first saw the spot on June 18 at 8:30 A.M. a clearing had been made about eight feet by eight feet, and a considerable number of papyrus stems had been torn down and were piled in the center. The nest-builder backed into the deep water, which was only a few feet from the nest, on my approach, and watched me, but showed no fear.

At noon on the 19th, the nest was about two feet above the water, and as far as I could see, built entirely of the stems of papyrus. At noon on the 20th, the nest was two feet ten inches above the water with a six-foot four-inch base. The top part was now covered with grass roots, mud and decaying vegetation taken from below the water. At noon on the 21st, the nest was apparently finished. It had been raised a little higher, but the top had not been coned and slicked down, so I knew the eggs had not been deposited. Nothing was done to the nest on the 22nd. The eggs had been laid at eight o'clock in the morning of the 23rd, but the alligator was on the nest and had begun to hollow the center. At noon on the 23rd, the eggs had been laid, the nest coned with trash and mud, taken from below the water surface, and slicked down. At two o'clock on the afternoon of the 23rd, I went to the nest with a couple of men, dropped a noose over the head of the alligator when she came out on the nest to defend it; measured the nest, which was three feet nine inches in height, eight inches being in water with a seven-foot base; measured and weighed the eggs, which averaged 2.61 inches long by 1.60 inch through, and weighed an average of two and one-eighth ounces; counted the eggs, which numbered thirty-four; placed a double registering thermometer with its bulb at the center of the eggs slanted so that its top was six inches below the top of the nest-material; re-covered the eggs and thermometer, firming down the nest-material

so that the nest was exactly as it had been; measured the mother alligator, who was seven feet three inches; turned her loose and departed.

This alligator was one of a lot of young hatched August 22, 1921, and easily identified by the toe-marks made and recorded when it was liberated. This was her first nest, and the first nest made by any of this lot. It is of interest here to note that the first nesting of this lot of alligators was nine years and ten months after hatching, and this under perfectly normal conditions.

During the incubation period this nest was visited almost daily and an exact record made of the maximum and minimum temperature of the nest at the eggs, and a corresponding record of the outside temperature in the shade. A record was also kept of the rain fall. The data thus gathered gives a pretty clear picture of the incubating temperature of an alligator's nest and the development of the embryo under normal conditions.

Some writers state that in alligator eggs, embryonic development starts before the eggs are deposited in the nest. This I have not found to be a fact, and I have examined the fresh eggs from many alligator's nests and the fully developed eggs taken from many killed alligators. The one egg opened from this nest the day laid was without sign of embryonic development. It is possible that should an alligator be kept from laying at the proper time that her eggs should be laid, due to drouth or other unusual causes, she will retain the eggs for a time in her body, and under such conditions embryonic development may start before the eggs are deposited in the nest. I have seen this very thing in the eggs of fresh-water turtles when kept during the laying season for a considerable time on hard surface in which they could make no nests, and therefore retained in their bodies eggs for several weeks past the time when they should have been laid. The embryos in such abnormally retained eggs begin development in the parent, but if the eggs are retained too long the embryonic development ceases and the entire inside of the egg becomes a tough yellow mass. If embryonic development has been found in the eggs of alligators while retained in the mother, it should be considered a most unusual occurrence and due to irregular causes. Having examined fresh eggs from hundreds of alligator nests, and the eggs taken from hundreds of freshly killed alligators without ever finding embryonic development in such eggs I make the above statement with great positiveness.

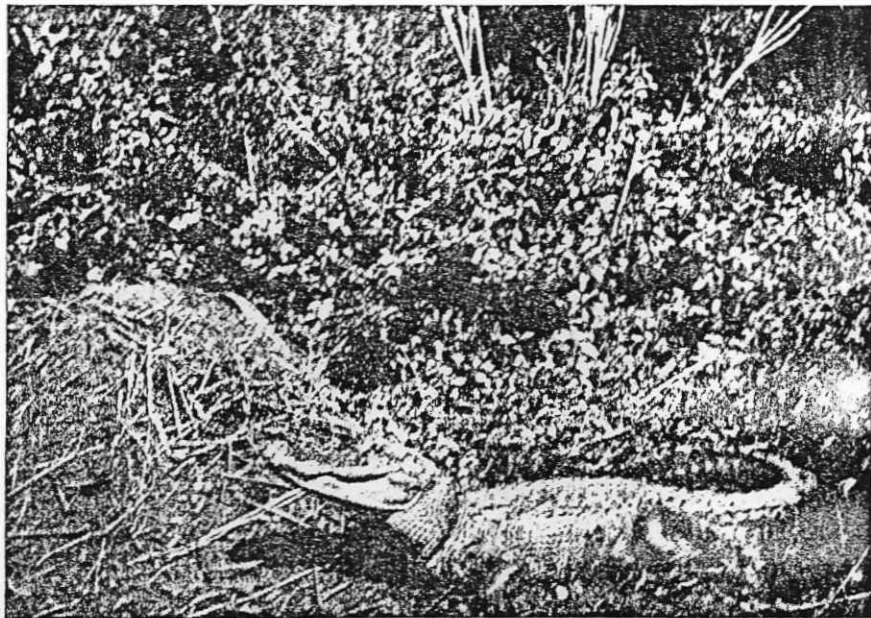
The following temperature records of this alligator's nest taken with the bulb of the thermometer set at the center of the egg clutch is, I believe, the first such record. It is of interest to note that following rain the nest's temperature is usually lowered. On days when there was no rain the mother would liberally wet down the top of the nest in order to prevent evaporation and the drying out of the nest material. There were ten and one-half inches of material above the top of the eggs and much more than this around the sides of the eggs. The eggs were laid in an irregular mass with none of the material from which the nest was built between them. I have opened hundreds of alligator nests and have never found the eggs deposited in layers with a covering of the nest material between them.



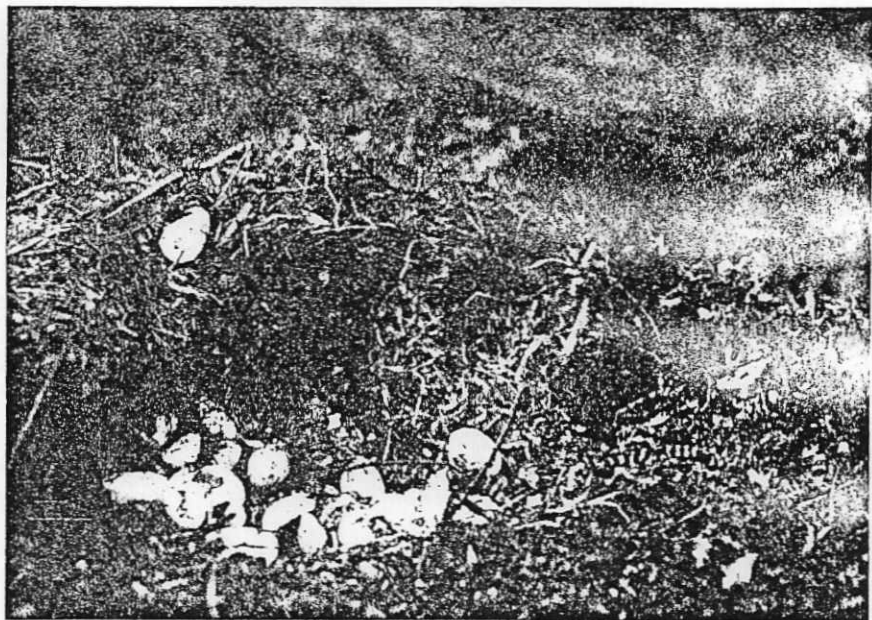
DATE 1931	TEMPERATURE IN NEST		OUTSIDE TEMPERATURE IN SHADE		RAIN FALL IN 100 OF INCH	REMARKS
	Max.	Min.	Max.	Min.		
June 24	102	100	95	75		The eggs were laid between 9:00 A.M. and 12:00 M. June 23
June 25	102	100	95	76		
June 26	102	100	87	77		
June 27	102	100	82	77		
June 28	102	100	86	78	.63	
July 2	99	96	96	77		Opened one of the eggs, found embryo but slightly developed
July 3	99	96	97	78		
July 4	99	96	97	77		
July 5	98	96	93	78		
July 6	98	95	92	76		
July 12	96	93	89	76	.25	
July 13	96	93	90	79		
July 14	96	93	81	76	.72	
July 21	95	92	92	83		
July 22	95	92	93	76	.06	
July 23	95	92	93	77		
July 24	95	92	92	76		
July 28	95	92	95	77		
July 29	90	90	87	77	.82	
July 30	95	92	89	74		
July 31	95	92	94	76		
Aug. 1	92	90	86	76	.42	*Opened one of the eggs
Aug. 2	94	92	88	75	.18	
Aug. 3	94	92	88	76		
Aug. 4	94	92	95	78		
Aug. 5	94	92	95	76		
Aug. 6	94	92	93	76		
Aug. 7	94	91	92	77		
Aug. 8	93	88	92	77	.50	
Aug. 9	93	91	91	78		
Aug. 10	92	91	93	78	.14	
Aug. 11	92	89	97	75		
Aug. 12	92	89	87	66		
Aug. 13	92	88	87	66		
Aug. 14	92	86	88	66		
Aug. 15	92	84	88	68		**Opened one of the eggs
Aug. 20	93	88	83	76	.32	
Aug. 21	92	86	83	74		
Aug. 22	92	86	82	74		
Aug. 23	92	86	83	71		***The hard shell on the egg
Aug. 24	92	86	83	71		
Aug. 25	92	86	85	73		
Aug. 26	92	86	82	75	.46	
Aug. 27	92	86	87	73		
Aug. 28	..	..	..	..		****Young hatching today
Aug. 29	..	..	..	..		Young left the nest last night

*Opened one of the eggs, found the little alligator well developed, fully shaped and fully colored, with black and yellow markings as distinct as if naturally hatched. A considerable amount of the yolk was yet to be absorbed. The girth of the eggs is somewhat enlarged and the hard outside shell is cracked and spread, in many places showing the inside membrane.

**Opened one of the eggs today, the little alligator is fully developed, it can see and opened its mouth when my finger was put near it. The circumference of the eggs has increased and the outer hard shell is much cracked with two openings extending irregularly through it from end to end showing the tough inner covering of the embryo. The young alligator had a sharp point on the top end of its upper jaw pointing up. This point looks like the point on the beak of a young chicken when first hatched, and is undoubtedly for the purpose of puncturing the tough inner shell at the time of hatching. All the egg's liquid except about one-half tablespoon of the yolk had been absorbed. There was an opening in the skin of the stomach just forward



Female alligator guarding her nest.



Alligator nest opened to show eggs just hatching. Photographs by E. A. McIlhenny.

of the vent one and five-eighth inches long. The stomach membrane protrudes from this opening, and surrounds the remaining yolk. The stomach is quite distended. This little alligator moved its body very slowly due to the distended stomach. It was placed in a pan containing a couple of inches of tepid water and kept in my house. In six days the yolk had all been absorbed, the stomach opening closed and it was as normal as if it had not had a premature birth. The egg tooth on the point of the upper jaw disappeared on the seventh day.

***The hard shell on the eggs is now cracked all over, the eggs are much swollen with the hard outer shell crumbling off. The inner flexible shell is also getting soft and flaky and seems to be considerably thickened and disintegrating.

****The young alligators could be plainly heard grunting in the nest last evening, and this morning when I visited the nest the top material had been bitten off and thrown to one side by the mother, the recording thermometer with it, and the head and shoulders of a little alligator were pushed through the loose covering left on the top. On removing this loose covering a number of the newly hatched little ones could be seen, also some unhatched eggs. Eight of the little ones were toe marked, measured and weighed for future reference, put back in the nest which was covered up as it was found. All these little ones had a minute sharp egg tooth on the end of the nose. The mother was very uneasy all the time I was handling her young, and it was necessary to have two men with heavy wooden pitch-forks constantly watching to keep her from getting to me. The young measured from eight and one-half inches to eight and seven-eighths inches in length, and weighed one and one-half ounces to two ounces. On the morning of the 29th I visited the nest and found all the little ones had left.

This nest of alligator eggs took sixty-six days to hatch, several days longer than the average, which is from sixty-two to sixty-four days. This delay in hatching was probably due to two causes. First, the outside temperature chart shows the weather was cooler than usual for this section of Louisiana. Second, in opening the nest almost daily (although the opening was only about three inches square and closed as soon as the thermometer was read) it is possible the nest temperature was reduced slightly. The outside temperature did not seem to affect the inside nest temperature, and on some days the outside shade temperature was greater than the nest temperature, as on August 4 and 5 nest temperature 94°, outside temperature 95°—August 11 nest temperature 92°, outside temperature 97°.

II

On August 22, 1921, I weighed, measured, toe-marked and liberated thirty-eight newly hatched little alligators from a nest (the building of which I had watched) on the edge of my wild life refuge at Avery Island, Louisiana.

My object in marking and liberating these little alligators was to procure accurate data on the growth of alligators under normal conditions. This data was easily obtained by going into the open water of the Refuge in a boat at night and catching the alligators by the light of an electric head-light and with a heavy wire noose on the end of a stiff bamboo pole.

The following data gives an accurate record of their growth and proves conclusively one thing—that alligators under normal conditions in the wild grow much more rapidly than is generally supposed, and that both males and females average a little more than one foot increase in length per year up to and including the fifth year, and this increase in length growth is continued by the males at least to the ninth year, but after the fifth year the females increase in length much more slowly.

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These alligators whose age, weights and measurements are here recorded were liberated at or near the place from which they were caught up to August 26, 1927; those recorded on that date and thereafter were killed, except the female taken June 23, 1931, who was liberated to guard her nest.

DATE	LENGTH	WEIGHT	REMARKS
Aug. 22, 1921	9 to 9½ in.	2½ to 3 oz.	Of the 42 young hatched 38 were liberated with their mother after being marked Eight young were measured today
Sept. 20, 1921	13½ to 14½ in.	.....
June 17, 1922	17¾ inches	8½ ozs.	
Aug. 22, 1922	2 ft. 2½ in.	4 lbs. 1 oz.	
Nov. 8, 1922	2 ft. 8 in.	5 lbs. 3 ozs.	
Nov. 8, 1922	2 ft. 3 in.	4 lbs. 4 ozs.	
Nov. 8, 1922	2 ft. 5½ in.	4 lbs. 6 ozs.	
April 12, 1923	2 ft. 5½ in.	3 lbs. 1 oz.	Very thin, 16 leaches in mouth
May 2, 1923	2 ft. 8¼ in.	4 lbs. 1 oz.	
May 2, 1923	2 ft. 7½ in.	3 lbs. 9 ozs.	
May 2, 1923	2 ft. 7 in.	3 lbs. 10¼ ozs.	
Sept. 10, 1923	3 ft. 3 in.	9 lbs. 9½ ozs.	
Sept. 10, 1923	3 ft. 4½ in.	10 lbs. 6½ ozs.	
Sept. 10, 1923	3 ft. 5½ in.	10 lbs. 4 ozs.	
Sept. 10, 1923	3 ft. 11 in.	12 lbs. 7 ozs.	
Sept. 10, 1923	3 ft. 9½ in.	11 lbs. 8 ozs.	
April 13, 1924	3 ft. 8 in.	9 lbs. 4 ozs.	
April 13, 1924	3 ft. 8½ in.	9 lbs. 7 ozs.	
April 13, 1924	3 ft. 4½ in.	8 lbs. 5 ozs.	
April 13, 1924	3 ft. 9 in.	10 lbs.	
April 13, 1924	3 ft. 7 in.	8 lbs. 1 oz.	
Oct. 3, 1924	4 ft. 3 in.	17 lbs. 4 ozs.	
Oct. 3, 1924	4 ft. 6½ in.	17 lbs. 11 ozs.	
Oct. 3, 1924	4 ft. 9 in.	19 lbs. 1 oz.	
Oct. 3, 1924	4 ft. 2 in.	17 lbs. 4 ozs.	
Oct. 3, 1924	4 ft. 11 in.	21 lbs. 1½ ozs.	
June 13, 1925	4 ft. 3½ in.	16 lbs. 9½ ozs.	
June 13, 1925	3 ft. 10½ in.	11 lbs. 2½ ozs.	
June 13, 1925	4 ft. 5½ in.	15 lbs. 8 ozs.	
June 13, 1925	5 ft. 8 in.	29 lbs. 4 ozs.	
June 13, 1925	4 ft. 3½ in.	16 lbs. 2 ozs.	
June 13, 1925	4 ft. 4½ in.	16 lbs. 9 ozs.	
June 13, 1925	4 ft. 3½ in.	16 lbs. 7½ ozs.	
June 13, 1925	4 ft. 7½ in.	17 lbs. 1 oz.	
Oct. 10, 1925	4 ft. 7 in.	19 lbs. 8 ozs.	
Oct. 10, 1925	5 ft. 2 in.	22 lbs. 11 ozs.	
Oct. 10, 1925	5 ft. 6½ in.	27 lbs. 6 ozs.	
Oct. 10, 1925	5 ft. 1 in.	26 lbs. 9 ozs.	
Oct. 10, 1925	5 ft. 9¾ in.	38 lbs. 10 ozs.	
Aug. 26, 1927	5 ft. 6 in.	30 lbs.	
Aug. 26, 1927	5 ft. 9 in.	36 lbs. 8 ozs.	
Aug. 26, 1927	5 ft. 7 in.	37 lbs. 2 ozs.	
Aug. 26, 1927	5 ft. 8 in.	38 lbs. 1 oz.	
Aug. 29, 1927	6 ft. 7 in.	69 lbs. 4 ozs.	
Aug. 29, 1927	5 ft. 9 in.	43 lbs. 7 ozs.	
Aug. 29, 1927	5 ft. 4 in.	36 lbs. 8 ozs.	
Aug. 29, 1927	5 ft. 9 in.	41 lbs. 8 ozs.	
Aug. 29, 1927	7 ft. 10 in.	124 lbs. 8 ozs.	
Aug. 29, 1927	5 ft. 6 in.	41 lbs.	
Aug. 29, 1927	6 ft. 4½ in.	62½ lbs.	
Aug. 29, 1927	5 ft. 3½ in.	33 lbs.	
Aug. 29, 1930	6 ft. 10 in.	84½ lbs.	
Aug. 29, 1930	8 ft. 1 in.	126 lbs.	
Aug. 29, 1930	7 ft. 8½ in.	126½ lbs.	
Aug. 29, 1930	8 ft. 4 in.	134 lbs.	
Aug. 29, 1930	8 ft. 9½ in.	149 lbs.	
Aug. 29, 1930	6 ft. 7 in.	89 lbs.	



SEX	CONTENTS OF STOMACH
♀	4 herons, 2 garfish
♀	5 herons, 1 garfish, 1 turtle
♀	4 herons, 1 turtle
♀	7 herons, 2 turtles
♂	8 herons, 1 turtle, 1 garfish
♂	7 herons, 1 snake, 1 garfish
♀	4 herons, 2 garfish
♂	5 herons, 3 garfish
♂	9 herons, 1 turtle, 2 garfish
♀	3 herons, 1 rabbit, 1 garfish
♂	5 herons, 1 snake
♀	2 herons, 1 muskrat, 1 snake
♀	5 herons, 1 turtle, 1 snake
♂	8 herons, 2 small turtles
♂	10 herons, 1 turtle, 1 snake
♂	4 herons, 3 turtles, 1 garfish
♂	3 herons, 1 garfish, 1 snake
♀	6 herons, 1 turtle

DATE	LENGTH	WEIGHT		REMARKS
June 23, 1931	7 ft. 3 in.	116½ lbs.	♀	*Has nest near wall. This is the first nest built by the alligators hatched in 1921
July 29, 1931	8 ft. 10 in.	178 lbs.	♂	4 herons, 1 snake, 1 garfish, 2 turtles
July 29, 1931	9 ft. 2 in.	291½ lbs.	♂	7 herons, 2 garfish, 2 turtles
July 29, 1931	9 ft. 5 in.	283 lbs.	♂	5 herons, 4 turtles, 1 snake
July 29, 1931	7 ft. 1½ in.	110 lbs.	♀	1 heron, 1 turtle, 1 garfish
July 15, 1932	8 ft. 8 in.	169 lbs. 8 ozs.	♂	9 herons
July 15, 1932	10 ft. 1 in.	354 lbs.	♂	11 herons, 4 garfish, 4 turtles

This data is interesting from several angles. First, it gives an accurate picture of the normal growth of alligators in the wild state whose ages were definitely known. Second, it shows the difference in growth between males and females of the same age. Third, it shows under identical conditions how similar was the food of the different ones examined. It should be understood that these alligators had been liberated in a Wild-life Refuge in which a great many thousands of herons and other water birds nest, and that the waters of this refuge swarm with all sorts of fresh-water fish, turtles, snakes, and other creatures; thus the available food supply was unlimited and that used was undoubtedly the easiest to procure.

III

The following records of three nestings of alligators at Avery Island, Louisiana, are interesting:

First, because of the actual record of incubation period,

Second, because of actual measurements of the eggs and of the newly hatched young,

Third, because of the record of the length and weight of the mothers of each nest.

NEST No. 1

Eggs laid June 21, 1921

Eggs hatched August 22

Incubation period 63 days

Number of eggs 42

Average length of eggs 2.71 in.

Average width of eggs 1.67 in.

Average weight of eggs 3 1/16 ozs.

Average length of young 9.41 in. the day hatched

Average weight of young 2 5/8 ozs. the day hatched

Length of mother 9 ft. 1½ in.

Weight of mother 163½ lbs.

NEST No. 2

Eggs laid June 23, 1931

Eggs hatched August 28

Incubation period 67 days

Number of eggs 34

Average length of eggs 2.61 inches

Average width of eggs 1.60 inch

Average weight of eggs 2 1/8 ozs.

Average length of ten young 8.75 in. the day hatched

Average weight of ten young 1.75 ozs. the day hatched

Length of mother 7 ft. 3 in.

Weight of mother 116½ lbs.

NEST No. 3

Eggs laid June 2, 1933
Eggs hatched August 7
Incubation period 66 days
Number of eggs 41
Average length of eggs 2.63 in.
Average width of eggs 1.61 in.
Average weight of eggs $2\frac{1}{4}$ ozs.
Average length of young 9.19 in. the day hatched
Average weight of young $1\frac{15}{16}$ ozs. the day hatched
Length of mother 7 ft. 8 in.
Weight of mother $129\frac{1}{2}$ lbs.

IV

I have record of a most unusual alligator nesting in 1933. On June 7, 1933, an alligator started scraping together some dry leaves and dry earth on top of a small point extending from my experimental planting garden into the water garden on the north side of my Wild Life Refuge. No grass or wet material was in the pile, which was about three inches high, on dry ground, when I first saw it. On the 8th, a number of eggs were deposited in a slight hollow in the loose material, the eggs lying on the hard ground, and when I saw the nest about eight o'clock on the 8th the top covering of the eggs was so light that a portion of some of them could be seen. At 10:30 the morning of the 9th about ten inches of dry earth, scooped up by the alligator's jaws from near the nest, had been placed on top of the eggs; the nest then measured fourteen inches high and thirty-eight inches across. This nest was visited every few days, and it was noted that the mother took care of her nest, for after each rain the top was slicked down by her crawling over it, and on dry days the top was made wet as is usual. On August 7th, thinking it was about time for the eggs to hatch, I made a small opening in the nest, took out one of the eggs, and on opening it was surprised to find the embryo only about two-thirds developed. A second egg was then opened with the same result. I was much surprised at the smallness of the embryo as the eggs should have hatched in from two to six days longer, it being sixty days since they were laid. On trying to determine the cause of the slow embryonic development, I noticed there were no grass or leaves or other organic matter used in building the nest and that the eggs were in a solid bed of fairly dry earth. The nest was visited after, and I noticed the mother ceased visiting the nest on August 14, when she evidently believed the time for hatching had passed. On August 31, I again opened the nest and opened a couple of the eggs, finding the embryos about three-fourths developed, and a large amount of the white and yolk yet to be absorbed. The little alligators were apparently normal and when removed from the eggs could see, and would open their mouths when my finger was put near their heads. I closed the nest and did not open it again until September 22, when, while standing near it, I thought I heard the grunt of a little alligator. The first egg I uncovered had the head of the little one sticking through the shell and as soon as the egg was lifted from its packed position the little alligator scrambled out in a lively manner. I then uncovered all of the eggs, and from the thirty-one left in the nest, eight little

alligators popped out as soon as the eggs were released from their packed position. In the rest of the eggs the young were fully developed but dead. The reason that these eggs hatched forty-three days after they should have hatched, was evidently due to the fact that they had had no artificial heat to stimulate embryonic development, as no green plant-material had been used in the nest-building.

AVERY ISLAND, LOUISIANA

The Rate of Growth of the Toad (*Bufo americanus americanus* Holbrook) under Natural Conditions

By W. J. HAMILTON, JR.

FOR many years workers dealing with growth of amphibians have allotted these animals various ages, based solely on size groups. A number of a given species are taken at one time, in the same place, preferably very early in the spring when seasonal growth has but commenced, or late in the fall, when growth has ceased for the year. These are then measured and frequently found to fall in certain length groups, each group of which is assigned an age. Such reasoning is based on purely presumptive grounds, as Wright¹ (1931: 59) has stated. This author has added:

"But what the resident naturalist can do is to mark frogs or keep them in some pond enclosure and get the real growth of an individual or individuals."

Others have kept captive animals and attempted to simulate natural conditions, that the captives might grow as normally as they would in the wild state. Lack of exercise and natural foods, together with an absence of the proper humidity and temperatures, usually result in a failure of an animal to grow as it would in a natural condition.

The only normal method by which we may determine the approximate rate of growth under natural conditions is to mark the animals in some manner that they may be readily recognized at a later date. Recaptures from time to time, and notes made on the increase in length, weight, etc., will add to our knowledge of the rate of growth of these animals under natural conditions.

The data recorded below have been made principally about the author's home, three miles east of Ithaca, New York. Observations on marked individuals were carried on, as often as the toads could be recaptured, from May 12, 1932, to September 20, 1932, and in 1933 from May 20 to September 27. From mid-May until late in September, in central New York, toads are abundant, After the first few frosts they are less frequently

¹ Wright, A. H., 1931. Life Histories of the Frogs of Okefinokee Swamp, Ga.