The Canadian Field-Naturalist

VOLUME 77 APRIL-JUNE 1963 NUMBER 2

NOTES ON THE DISTRIBUTION AND LIFE HISTORIES OF TURTLES IN NOVA SCOTIA

J. SHERMAN BLEAKNEY
Nova Scotia Museum of Science, Halifax, Nova Scotia

THE CENTRAL REGION of the south projecting peninsula of Nova Scotia is the richest area for individuals and species of reptiles in Canada east of southern Ontario. From this climatic pocket, relict populations of the Ribbon Snake, *Thamnophis sauritus* (Bleakney, 1951), and Blanding's Turtle, *Emydoidea blandingi* (Bleakney, 1958 p. 25, 39), have been reported. Recently more information has been gathered on the biology of turtles in Nova Scotia and this paper summarizes some of the data and points out the problems which have come to light.

DISTRIBUTION

All the species of reptiles recorded from Nova Scotia are common and even abundant in the south central area, with the one exception of the Wood Turtle, *Clemmys insculpta.* It has never been reported south of Annapolis County or Halifax County but is widely distributed to the north throughout mainland Nova Scotia and essentially all of New Brunswick. At first, it seemed that habitat preference explained its absence from the lakes and bogs in the granite and slate formation of southern Nova Scotia for it is most commonly seen along slow streams and rivers in fertile valleys. However, it has recently been found in southwestern Halifax County, which is the same rock formation as the rest of the southeastern slope of Nova Scotia. Babcock (1919) also noted its abundance in some areas of New England and its scarcity or absence in others. Competition with other turtles may be a contributing factor, for *Clemmys* is more common to the north where *Chrysemys picta* and *Chelydra serpentina* are less common or absent. In certain valleys, however, such as the Annapolis Valley and the Musquodoboit Valley, *Clemmys* inhabits the streams in company with *Chrysemys* and *Chelydra.* In both Nova Scotia and New Brunswick, *Clemmys* prefers stream and river banks where it escapes by plunging into the water and swimming into the depths. It is not known if the young of this species overwinters in the nest in Nova Scotia as no nests or hatchlings have ever been observed.

The 1958 report of *Emydoidea blandingi* was based on one captured specimen and two sight records; all adult females observed on land during the June egg laying season. Additional data gathered since then has been summarized in Table 1. Each field party had its headquarters adjacent to the Federal Fish Culture Station, New Grafton, Queens County. The Station is only 500 feet from the east shore of Lake Kedgemakooge (also known as

Mailing date of this number: August 9, 1963.

Lake Kejimkujik and Lake Kedge) precisely where the first *Emydoidea* was captured in 1953. The perplexing aspect of the quest for specimens from this relict population of *Emydoidea* centers around the fact that the species was seen only when the females sojourned on land in search of nesting sites. Many hours were spent with binoculars searching Lake Kedge, Grafton Lake, and Snake Lake, the area adjacent to the known nesting sites, with negative results. *Chrysemys* and *Chelydra* were seen in abundance on these occasions. In southern Ontario, where the author used the same survey techniques, the same three species of turtle were located without any difficulty.

During June, 1961, three females were taken, again at the Fish Culture Station, but day and night hunting, bait trapping and swimming with mask and snorkel in the adjacent bodies of water yielded no additional specimens. After eight more days of negative results, the frustrated crew gave up, and went fishing in the West River, a meandering stream five miles away on the western shore of Lake Kedge. Here they discovered basking adult male, female and juvenile *Emydoidea*, as well as the ubiquitous *Chrysemys* and *Chelydra*. A visit to the West River on August 2, 1961, resulted in the capture by hand of a basking *Emydoidea*. This basking behaviour, seemingly confined to the West River, is not due to remoteness from man because this is a favorite fishing and hunting stream. It is difficult to imagine that the West River *Emydoidea* swim five miles of lake to nest with *Chrysemys* and *Chelydra* near the Fish Culture Station when there are suitable egg laying sites in the immediate area. Note that in 1961 two men during June, July, and August spent 17 days on the east side of Lake Kedge and saw no basking *Emydoidea*, but found three nestseeking females. In contrast, two men made only four visits in July and August to the West River and captured basking *Emydoidea* each time. This author is at a loss to explain the apparent basking and non-basking behaviour of respective *Emydoidea* populations on the east and west sides of Lake Kedge; that is, if there is an east-side population!

NESTING

An unusual opportunity arose in 1959 to study the incubation of *Emydoidea* and *Chrysemys* under identical conditions at Lake Kedge. A female *Emydoidea* was captured in the act of digging a nest at the Fish Culture Station. The area had been bulldozed for purposes of damming the stream from Grafton Lake and terracing a slope for a residence. Back of this house is a flat yard and a slope of exposed gravel and sand. It is a favorite site for turtles to lay during late June and early July. In the early evening of June 30, 1959, Mr. Ronald Hawkins, Officer-in-charge, noticed the *Emydoidea* digging and immediately put the turtle in his basement. At 2130 hours, July 1, she was returned to the incompleted nest hole and covered with a box weighted with stones to keep out raccoons. At 2330 hours she was digging rhymically, apparently undisturbed by the unfamiliar dark confines of the box. When checked again at 0900 hours on July 2, she was thrusting against the box to escape. The turtle (carapace length 217 mm) was kept on display at the Nova Scotia Museum of Science and not preserved until November, 1960. The nest was located and dug into to verify the egg laying and the

TABLE 1. Summary of information on *Emydoidea blandingi* from Lake Kedgemakooge, Nova Scotia.

Field Party Dates	Observations and fate of specimens
1950 (author) 1-20 July	— No reason to suspect its occurrence in Nova Scotia. Not looked for, not seen.
1952	— Vacationers capture female on beach 3300 feet southwest of stream mouth at Fish Culture Station. Carved "1952" on plastron. Released.
1953 (author) 7-14 June	— June 8, caught same turtle as above on lake shore at mouth of stream at Fish Culture Station. Preserved.
1955 (author) 4-22 July	— Two adults caught on F.C.S. grounds by Officer-In-Charge the week previous to July 4 and released in adjacent Grafton Lake.
1958	— Report of live adult on display at Annual N. S. Guides Meet. Released.
1959 (author) 23 June-4 July	— June 30, female found digging nest. Female, one egg and five hatchlings preserved.
1959	— Mid-July report of adult found on road, escaped into L. Kedge same day.
1961 (author) 19-23 June	— June 19, two females found in concrete sluiceway of Grafton Lake dam at Fish Culture Station. — June 20, female found digging on beach at mouth of stream at F. C. S.
1961 3-15 July	— July 11, 12, 13, two adult females, one adult male, one juvenile female, and one juvenile male found basking on rocks and logs up the West River, five miles west of F. C. S.
1961 1-3 August	— August 2, basking adult female caught by hand in West River. All 1961 specimens had shells dried and viscera preserved.
1962	— May 28, fishing party caught adult in dip net up the Little River, five miles westnorthwest of Fish Culture Station. Escaped from car near Wolfville, N.S.

uppermost egg removed and preserved. The nest area was covered by a square yard of heavy metal screening and the edges were rocked down to prevent predation by raccoons. The nest site was a south exposure and wind protected on all sides by trees and the house except for a southeast opening to Grafton Lake, which was only one hundred feet away.

The basic characteristic of the microclimate of chelonian nests is day heating and night cooling as is evident in the morning and afternoon temperature profiles of Figure 1, and in the graph of soil temperature profiles in Brooks (1960: 79). Any factor which affects heat transfer to and from the soil will profoundly effect the length of incubation. Breckenridge (1960) feels that screening over a nest shades it and thus lessens the total heat normally received by that microhabitat area. He measured the soil temperature at the five inch depth on two occasions in July and found the temperature to be

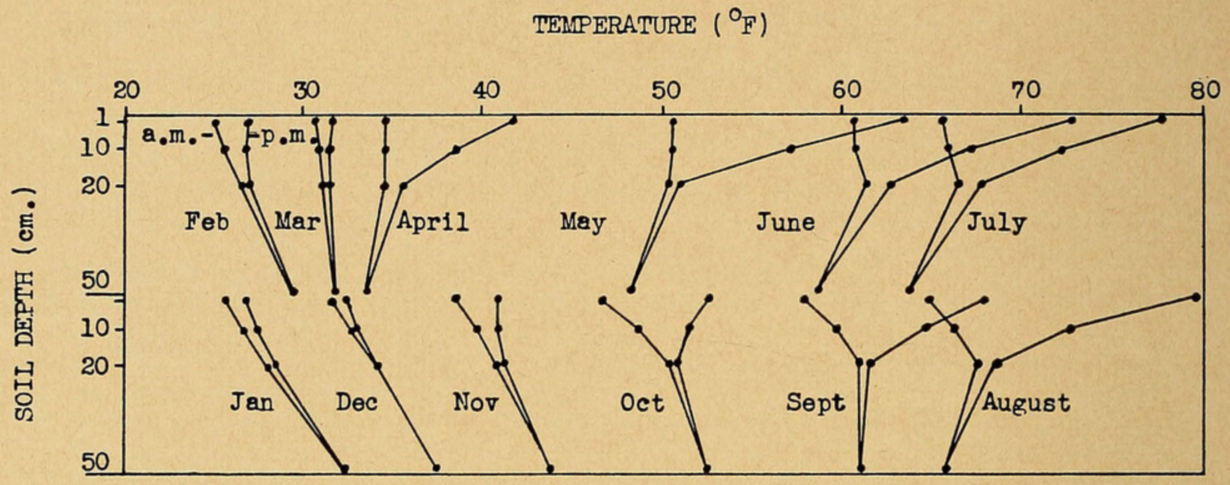

Figure 1. Early morning (0800 hrs) and late afternoon (1700 hrs) soil temperature profiles at Fredericton, New Brunswick, based on monthly means from 1959 to 1962. Turtle nests would be subjected to the environmental conditions of the 10 cm level.

0.5°F and 1.5°F lower under the screening. There is, however, the possibility of the "greenhouse effect" here, where heat loss at night is lessened by the presence of the screen cover. A constant temperature recording apparatus might even show that although less heat was gained during the day under the screen, there was less heat lost at night, so that the total energy gain may be the same over a twenty-four period or the "greenhouse effect" might actually raise the mean temperature of the soil above normal and thus hasten incubation. The screening and the circle of rocks at the *Emydoidea* nest would have considerable effect as wind shield and thus lessen evaporation and cooling. In addition, the angular surfaces of the rocks could reflect additional heat onto the ground and into the air above the nest.

Hatchlings

A *Chrysemys* was observed on the night of July 3, 1959, laying eggs only eight feet from the screened over *Emydoidea* nest and next morning the area was covered with screening. Both nests were kept under observation and on September 27 the *Emydoidea* hatchlings emerged, after a period of 88 days. This is the first time an incubation period has been reported for this species. Hatchlings have previously been found in September by Conant (1938) and Sexton (1957). The *Chrysemys* hatchlings first appeared on April 7, 1960, when three dug out to the surface after a period of 277 days. There had been snow over the nest the previous week, the adjacent Grafton Lake was ice-free only at the margins and this was freezing over each night, and wood frogs, *Rana sylvatica*, and spring peepers, *Hyla crucifer*, were not due to start calling for at least another ten days. The three hatchlings partially reburied themselves as the day cooled. The nest was dug out and seven hatchlings found which ranged in carapace length from 25 to 26 mm. Five were immediately preserved and two committed to an aquarium. Of the five preserved ones, only one has the caruncle. This would indicate that the actual incubation period was probably from June to late September or October

TABLE 2. — Measurements (in millimeters) of hatchling *Emydoidea blandingi* from Nova Scotia

Specimen No.	Carapace		Plastron	
	Length	Width	Length	Width
1	31.25	27.0	27.0	16.5
2	32.0	29.0	28.5	17.0
3	32.0	29.0	28.0	17.0
4	32.0	28.0	27.5	16.25
5	30.5	27.0	27.0	16.25
6	32.0	29.0	28.5	17.0
7	31.0	29.0	27.5	17.0
8	32.0	29.5	28.0	17.0
9	31.5	29.0	27.5	17.0

since for many species of turtles the caruncle is not shed until ten days to four weeks after hatching (Oliver, 1955: 256). Sexton (1957: 230) described a clutch of *Chelydra* hatchlings where shedding of the caruncle varied from four to seventeen days. The *Emydoidea* hatchlings were first seen by Mr. Hawkins on September 27, 1959, when he counted six at 1200 hours and again at 1500 hours. On September 28, nine hatchlings were under the screen and in the nest cavity was an unhatched egg which contained much yolk and a small leathery embryonic disc. As one egg had been preserved on July 2, this brought the clutch to eleven. The nine hatchlings were measured at the nest (Table 2) and then because of the local rarity of the species a hopeful measure of conservation was practiced by releasing four into Grafton Lake. They were buoyant and paddled along the surface away from the dam and into a bed of water lilies. A half-grown Bullfrog, *Rana catesbeiana*, jumped and snapped at one little turtle but missed, whereupon the hatchling lowered its head, released bubbles of air and sank vertically to the bottom ooze and crawled out of sight. Of the remaining five specimens, two were preserved and three maintained in an aquarium until they died on December 29, 1959; March 12, 1960; and May, 1960 respectively. Not until October 13 did these hatchlings show any interest in food. Two of them ate earthworms and whiteworms on this date but the third, still possessing its caruncle, refused to feed. On October 19, its caruncle was gone and it ate readily with the others. During the rest of their winter captivity, various food items were offered the turtles. They fed mostly on worms and beef liver and refused house flies and crushed snails. The same food item was often accepted one day and refused on another. They were always slow and deliberate in their feeding actions and if a piece of liver proved too large, they shredded it with the claws of the forefeet as would an adult turtle. The most interesting behaviour observed was on October 29 when guppy fish were first introduced. A dead guppy finally excited one hatchling to a state where it bit off the fish's head but then spat it out and showed no further interest. Three live guppies were then put into the tank and the immediate reaction was dramatic.

The usual plodding pace of the hatchlings changed to an all out frantic swimming pursuit accompanied by shooting out their necks and snapping when at close range. The live fish were left in the tank overnight but were still swimming free the next day and were removed. On December 6, three guppies were again put in with the turtles and the same pursuit took place. One turtle managed to grab a fish and succeeded in swallowing it whole. The other two fish continued to evade the hatchlings so they were killed and waved in front of the two turtles who immediately seized and swallowed them. The reaction of these hatchlings to actively swimming prey is probably satisfied under natural conditions by the pursuit of aquatic insects which would be more easily caught than fish. Lagler (1943) found that the adult *Emydoidea* in Michigan fed primarily on crustaceans and insects. The major food items found in eight Nova Scotia specimens were dragonfly nymphs, aquatic beetles and snails, with fish remains in but two specimens and one of these was obviously carrion. (The absence of crayfish in Nova Scotia is strikingly evident in stomach analysis reports of our local turtles, Bullfrogs and raccoons).

Two of the *Emydoidea* hatchlings have anomalous central laminae (epidermal scales) on the carapace. On specimen No. 6 of Table 2, central lamina number 2 is continuous with central 3 on the left side, and centrals 4 and 5 are both doubled by diagonal sutures. Turtle No. 7, Table 2, has an extra wedge-shaped central lamina on the right side between centrals 4 and 5.

The illustrations of *Emydoidea* hatchlings in Agassiz (1857, Part III, Plate IV, No. 20) and Conant (1957, p. 24; and 1958, Plate 6) do not depict the spots on the marginal, lateral and central laminae which are distinctly evident in the Nova Scotia specimens. Each lateral lamina has a central pale spot (0.5 to 1.5 mm diameter) usually rounded with an irregular margin, although some are elongate. On the largest hatchling they are as conspicuous as those on the spotted turtle, *Clemmys guttata*, hatchling of Conant's 1958 Plate 6. In addition, three of the five specimens have a pale spot near the posterior margin of the first central. On the marginal laminae of the right side, four specimens have a spot near the medial boarder of numbers 4, 5, and 6, and the other specimen only on 5 and 6. On the left marginals, each animal differs slightly with spots on 5; 4 and 5; 4, 5 and 6; 3, 4, 5 and 6; and 4, 5, 6 and 7. Whether this spotting has any geographic significance cannot be determined until more hatchlings are examined. Smith (1961) says the carapace of hatchlings in Illinois "is uniformly black or is black except for a poorly defined light spot within each carapace shield." The spotting may simply have been overlooked in older descriptions, although Agassiz (1857, p. 442) states very definitely that the young are "entirely black above, without a spot." In all other respects, the Nova Scotia hatchlings agree with the color plate of Conant, 1958.

Developmental Rates

Even when one assumes these April 7 *Chrysemys* eggs actually hatched in October or November, it is apparent that the *Emydoidea* eggs are cold adapted, for under identical conditions they finished development first. When the greater mass of the *Emydoidea* egg and the slightly greater depth they were buried in the soil are both taken into account, one must conclude the embryonic developmental rate of *Emydoidea* is appreciably faster. The range of the species is certainly centered along the northern limit for turtles, and it has been observed swimming under ice and noted emerging from hibernation in Ohio in January (Carr, 1952). The fact that the eggs of *Emydoidea* are adapted for fast development at cool temperature and that the adult can be active under ice further indicates that some factor other than temperature is responsible for the species status in Nova Scotia and New England where its rarity and disjunct distribution indicate a relict species poorly adapted to this area. In fact, *Emydoidea* is so poorly adapted that the southern genera *Chrysemys* and *Chelydra* are far more common and even range considerably farther north. These wider ranging species are probably recent invaders of the northern latitudes as indicated by their emerging from the nest after periods of ten to twelve months.

OVERWINTERING

In Nova Scotia, no hatchling *Chrysemys* or *Chelydra* have yet been observed in the autumn. What few observations there are were made at the Lake Kedge Fish Culture Station where turtle laying is concentrated and where observant adults and children are on the property daily. On July 1, 1954, the Officer-In-Charge, Mr. C. Baxter, was randomly searching for a turtle's nest in the gravel of his back yard and instead turned up a hatchling *Chelydra*. A hatchling *Chrysemys*, coated with earth, was found struggling across the lawn on June 24, 1959, and another on July 4, 1959. Remains of *Chrysemys* hatchlings, apparently picked to pieces by birds, were found at a nest hole on top of the Grafton Lake dam on June 18, 1961. One additional hatchling, with 0.25 mm of new growth evident on its shell was collected in Methall's Lake, Kings County, August 2, 1961, and presumably had emerged some time in July. This spread of the dates of emergence from April 7 to July 4 may simply be the result of late laying and the microclimate of individual nests.

The present author feels that references to overwintering of turtle hatchlings in the nest tend to be superficial because the basic problems involved have not been clearly stated. It is hoped that the following remarks will stimulate more interest in this topic. As adult turtles, and reptiles in general, are believed to hibernate below or at least near the frost line, there seems to be some reluctance to state that turtle hatchlings in a nest are subjected to subfreezing temperatures for long periods of time. Reference to studies on adults of various poikilotherms is of interest. Bailey (1949) found that hibernating snakes in Iowa could not tolerate lower temperatures than about -2°C (28°F) for long periods; this was at a soil depth of eighteen inches where frost penetrated to twenty-four inches. Neill (1948: 114) found that a sudden cold snap in late autumn made box turtles too torpid to burrow and they froze. Under normal circumstances they would burrow into the ground in autumn and deepen the burrow during the winter keeping below the lethal temperatures. Bohnsack (1951, 1952) found that frogs hibernating on land in shallow pockets of forest duff, which has high insulation qualities, are rarely exposed to freezing temperatures. Bailey (1949) makes the point that hatchling turtles overwintering at depths of only three inches are likely to be hibernating above the frost line. There is no doubt of this in Nova Scotia, where a habitat of sand and gravel can have a frost penetration of three or more feet and the lakes can form ice to a depth of over thirty inches. If one assumes that hatchling turtles because of their small size are physically incapable of digging down as the soil temperature lowers, then in a winter of little snow cover, there is no doubt that hatchlings at depths of two to six inches are subjected to temperatures much lower than the minimum generally attributed to adult turtles. The minimum soil temperature recorded at Fredericton, New Brunswick, in February was 1.7°F at 10 cm and 6.8°F at 20 cm. Perhaps the amount of yolk content in their blood and tissues accounts for a lower lethal temperature level than adults of the same species.

There is some evidence (Woolverton, 1961; Hartweg, 1944) that in many nests the hatchlings are out of the shells in the autumn and thus apparently capable of emerging, but for some reason wait until spring to dig out. Hartweg (1944) suggested hard packed autumn soils trapped the young and spring rains were necessary to soften the ground so that the hatchlings could dig out. Sexton (1957) disagreed and pointed out the typical meteorological pattern of spring and autumn rains which certainly soften the soils at both seasons. He went on to suggest that overwintering in the nest is a behavioral adaptation enabling *Chrysemys* to survive in northern regions. But why a behavioral preference for a three inch cover of sand and gravel when a cover of organic rich soil or water would offer far better thermal protection? A better adaptation for survival of hatchlings in northern latitudes should consist of something which frees them from a winter just below the soil surface, such as smaller eggs or a faster rate of embryonic development or a combination of both, or even hyperdevelopment of the forelimbs (as in the opossum) for digging down deeper to keep ahead of the frost penetration. Any hatchlings which emerge in the early days of spring, minus the caruncle, as did the Nova Scotia *Chrysemys* of April 7, must have been equally prepared and capable physically of emerging when hibernation began. Sexton (1957) made the significant observation that the nesting season in 1955, about two weeks in advance of other years, did not effect the average dates of spring emergence and he concluded that *Chrysemys* regularly overwinter whether the nesting season is early or late.

Until we know precisely what stimulus (or stimuli) excites the hatchlings to dig out, we cannot answer the question of what inhibits this stimulus in the autumn and releases it in the spring. Carr (1960, p. 22) has shown that simple negative geotropism is not the answer with sea turtle hatchlings. When the eggs have hatched, the total weight of hatchlings upon the bottom individuals stimulates them to struggle out from under and this precipitates a wave of agitation through the mass to the diggers at the top. The same emergent process may apply to other turtles, but whatever it is, there is some inhibiting factor in the nest in autumn which changes in early spring. Temperature would seem to be the logical variable for in October and November the angle of incidence of the sun's rays is much lower than in April and May when the sun is approaching its summer solstice. Figure 1 is a graph of soil temperature taken at Fredericton, New Brunswick, and even though the absolute values do not apply to southern Nova Scotia, the overall pattern and relative values certainly do. The slope of the temperature gradients is the most interesting aspect. From October to March inclusive the surface of the ground is cooler than its depths so that any emerging hatchlings would be digging upwards into colder soil. This would be a negative temperature gradient as far as the hatchlings are concerned. In April, however, the gradient would be positive with surface temperatures of the soil warmer than at the nest level. Note also that the daily spread between the morning and afternoon temperatures at the 10 cm level (3 15/16 inches) increases greatly in April and begins to lessen in September. It is also apparent by the slope of the morning temperatures that heat loss at night begins to increase in August and by October has pressed the soil temperature gradient to the left of the vertical. For six months only, as far as the hatchlings are concerned, is the mean temperature gradient to the right and thus positive. If hatchlings are reacting to this gradient, this might explain how they can hatch in the nest in October or November but not emerge until the following April or May when absolute soil temperatures may actually be colder but the soil surface is relatively warmer. I would suggest, therefore, that because reptiles in general tend to move towards warmer temperatures when placed below their optimum temperature, this means in northern latitudes a seasonal retreat into the substratum be it land or water. Thus turtle hatchlings in October will not dig upwards when the ground above the nest is colder than below and they are physically unable to dig down and therefore are "trapped" in the nest. They survive any subfreezing temperatures quite accidentally because of their yolk reserve which lowers the freezing point of their tissues beyond that of adults of the same species.

The author wishes to acknowledge financial support from the Nova Scotia Museum of Science and, the invaluable assistance of Ronald Hawkins and Allen Eaves.

SUMMARY

New data have been gathered on *Clemmys insculpta*, *Chrysemys picta*, *Chelydra serpentina* and *Emydoidea blandingi* in Nova Scotia. *Clemmys* is more common where the other three species are rare, and it could not be found in southern Nova Scotia where the others are most common. Specimens of *Emydoidea* from a relict population in southern Nova Scotia have been sought after since 1953 and the results of each field party are summarized in tabular form. Twenty-four specimens have been recorded. Stomach analysis showed aquatic insects and snails as major food items. Evidence for overwintering of the eggs of *Chrysemys* and *Chelydra* is given. This topic is discussed in general and a theory advanced that overwintering of hatched turtles in the nest is due to the fact that ground surface temperatures of

October and November are relatively colder than nest temperatures and the turtles will naturally avoid the colder end of temperature gradient when placed below their optimum temperature. In spring hatchlings move upwards in response to warmer soil surface temperatures. The incubation of a *Chrysemys* and an *Emydoidea* nest were observed under identical conditions and the hatchlings emerged in 277 days and 88 days respectively, indicating a faster embryonic developmental rate in the larger *Emydoidea* eggs.

REFERENCES

AGASSIZ, LOUIS. 1857. Contribution to the natural history of the United States. Boston, Little, Brown and Co. Vol. I.

BABCOCK, HAROLD L. 1919. The turtles of New England. Memoirs of the Boston Society of Natural History 8(3): 1-431.

BAILEY, REEVE M. 1949. Temperature toleration of gartersnakes in hibernation. Ecology 30(2): 238-242.

BLEAKNEY, J. SHERMAN. 1958. A zoogeographical study of the amphibians and reptiles of eastern Canada. National Museum of Canada Bulletin 155: 1-119.

BLEAKNEY, SHERMAN. 1951. A new Snake record for Nova Scotia. Canadian Field-Naturalist 65(3): 118.

BOHNSACK, KURT K. 1951. Temperature data on the terrestrial hibernation of Rana clamitans. Copeia (3): 236-238.

———. 1952. Terrestrial hibernation of Rana catesbeiana. Copeia (2): 114.

BRECKENRIDGE, W. J. 1960. A spiny soft-shelled turtle nest study. Herpetologica 16(4): 284-285.

BROOKS, F. A. 1960. An introduction to physical microclimatology. Davis Campus, University of California Syllabus No. 397.

CARR, ARCHIE. 1952. Handbook of Turtles. Cornell University Press, Ithaca, N.Y.

———, and LARRY OGREN. 1960. The ecology and migrations of sea turtles, 4. Bulletin of the American Museum of Natural History 121(1): 1-48.

CONANT, ROGER. 1938. The reptiles of Ohio. American Midland Naturalist 20: 1-200.

———. 1957. Reptiles and amphibians of the northeastern states. Zoological Society of Philadelphia.

———. 1958. A field guide to reptiles and amphibians. Houghton Mifflin Co., Boston.

HARTWEG, NORMAN. 1944. Spring emergence of painted turtle hatchlings. Copeia (1): 20-22.

LAGLER, KARL F. 1943. Food habits and economic relations of the turtles of Michigan with special reference to game management. American Midland Naturalist 29: 257-312.

NEILL, W. T. 1948. Hibernation habits of amphibians and reptiles in Richmond County, Georgia. Herpetologica 4(3): 107-114.

OLIVER, JAMES A. 1955. The natural history of North American amphibians and reptiles. D. Van Nostrand Co., New York.

SEXTON, OWEN. 1957. Notes concerning turtle hatchlings. Copeia (3): 229-230.

SMITH, P. W. 1961. The amphibians and reptiles of Illinois. Illinois Natural History Survey Bulletin 28(1): 1-298.

WOOLVERTON, ED. 1961. Winter survival of hatchling painted turtles in northern Minnesota. Copeia (1): 109.

Received for publication 24 January 1963