EFFECT OF TEMPERATURE UPON THE DEVELOPMENTAL RATE OF THE EMBRYO OF THE DIAMOND BACK TERRAPIN (*MALACLEMYS CENTRATA* LAT.)[1]

For several summers experiments have been conducted in an effort to discover whether or not the terrapin (*Malaclemys centrata* Lat.) egg follows the general rule of "cold-blooded" eggs in that the rate of development increases with increase of temperatures over a considerable range.

In the earlier studies a number of difficulties were encountered. Among these was the problem of securing freshly laid eggs in sufficient quantity. Although hundreds of eggs were available in the breeding pens, the terrapins were more or less sensitive to observers unless the oviposition had already been started, in which case the terrapin usually completed the act. When a terrapin was observed in the act of egg-laying, she was allowed to complete the process and was removed from the nest as soon as she began to "fill in." In numerous cases, however, the eggs were so thick in the pen that other nests were disturbed and eggs of an earlier laying became mixed with newly laid eggs. This problem was ultimately solved in the following manner. Parts of the laying pens were fenced off and opened 24 hours before the time for the collection of the eggs. The egg bed was closed off after the 24-hour laying period and thoroughly dug. This procedure was repeated at intervals during the laying season. By this means eggs were secured within 24 hours after laying. These were supplemented by eggs taken from uncovered nests. By this method a rather definite beginning point has been established. In some of the experiments a 48-hour period was used, since it gave many more eggs than two 24-hour periods, due apparently to the fact that terrapins lay better in a territory which they have been permitted to explore for a day or two.

Although taken from a single nest, the eggs show a considerable variation as to the degree of development. In a single oviduct of *Chrysemys cinerea* (Cunningham, 1922) stages from early cleav-

[1] The experiments were conducted at the U. S. Fisheries Laboratory at Beaufort, N. C., and the author expresses appreciation to the bureau for the use of its facilities and to Dr. H. F. Prytherch, director, and Mr. Charles Hastel, foreman, for their cooperation.

quired between setting and hatching for the 4 groups is shown here.

Pen A. 61 days. All eggs not hatched at this time were used for other purposes.
Pen B. 64–68 days.
Pen C. 62–68 days.
Pen D. 60–66 days.

It is quite evident that in nature, under as nearly identical temperature conditions as possible, there is a considerable range of variation as to the time required for the newly laid egg to hatch.

In the second experiment a relatively high temperature of approximately 98° F. was maintained. The temperature never exceeded 105° F. nor fell below 95° F. The upper temperature is well below the maximum tolerance, since the beds in nature have been known to reach a temperature of 115° F. at the egg level without the death of any considerable number of the embryos. The lower level is considerably above the low level of the outdoor beds.

As in all our previous experiments on high temperatures the eggs failed to develop. Although having plenty of moisture, but not an excess, the eggs shriveled as if they were desiccated. From these experiments, which can not be considered conclusive, it would appear that terrapin eggs can not survive continued high temperatures, although they are lower than the maximum to which such eggs are exposed during normal incubation. If the embryos died without desiccation of the egg, one might attribute death to high rate of humidity, since terrapin eggs are rather sensitive to excess moisture.

In the third experiment the eggs were subjected to a fairly constant temperature of 85° F. There were 24 eggs in this lot, of which 23 hatched. The time required was from 61 to 68 days.

The fourth experiment consisted of two sets of eggs run at fluctuating room temperature ranging from 65° F. to about 92° F. The eggs were placed in battery jars without sand and in one experiment provided with distilled water, in the other with tap water (artesian well). The details of this experiment are described elsewhere (Cunningham, Woodward and Pridgen, 1939). There were 24 eggs receiving distilled water, all of which hatched. The range of hatching time was from 61 to 68 days. There were also 24 eggs receiving tap water, two of which were probably

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infertile, the others all hatching. The hatching time was from 61 to 68 days.

In earlier experiments, which were not as well controlled, eggs which were never allowed to reach a temperature of 80° F. hatched in approximately the same time as those under normal conditions. Earlier experiments also indicated that development once started could be completely inhibited at ice box temperatures (approximately 55° F.) and embryos could be held in this condition for a period of at least two months. When returned to normal incubation temperatures such eggs develop in an apparently normal manner.

From the data presented it is evident that the rate of development of the diamond back terrapin does not fluctuate with environmental temperature, but that the rate is more or less constant through a wide range of temperatures. This is contrary to the generally accepted idea that in cold-blooded animals the rate of development is relative to the environmental temperature.

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LITERATURE CITED

Cunningham, B.
1923. *Jour. Elisha Mitchell Sci. Soc.*, 38: 51–73.
Cunningham, Woodward and Pridgen
1939. AM. NAT., 73: 285–288.