TEMPERATURE VARIATION IN NESTS OF THE AMERICAN ALLIGATOR

ROBERT H. CHABRECK

ABSTRACT: Continuously recording thermometers were used to determine the temperature inside three alligator nests and the air temperature at each nest site. Differences in nest and air temperature were compared between years, periods of the nesting season, and hour of the day. Significant differences were found in practically all comparisons.

The nest material provided excellent insulation for the eggs. Although the mean hourly air temperature fluctuated 9.3 C daily, the mean hourly nest temperature fluctuated only 1.2 C daily.

Nest temperatures averaged 1.4 C warmer than air temperatures. The nests were constructed of plant material and the mean difference in nest and air temperatures probably resulted from the heat released with the decomposition of the nest material.

A STUDY was initiated in 1961 to determine the temperature of alligator (*Alligator mississipiensis*) nests and to evaluate the factors causing variation in nest temperature. The study was conducted on Rockefeller Wildlife Refuge in southwestern Louisiana, an area supporting one of the largest alligator populations in the state. The refuge consists of coastal marshland with an average elevation of .33 m above mean sea level. Alligator nests studied were from 5 to 7 km inland from the Gulf of Mexico in marsh dominated by marshhay cordgrass (*Spartina patens*). The nests were constructed with plants growing in the immediate vicinity of the nest site.

MATERIALS AND METHODS

Nests were instrumented in 1961, 1964, 1965, 1967, and 1968, but only data from

HERPETOLOGICA 29:48–51. March, 1973

TABLE 1.—Analysis of variance of air and nest temperature and nest minus air temperature at different time intervals.

Variance source	Degrees of freedom	Mean square values		
		Air temp	Nest temp	N-A temp
Year (Y)	2	901.67[1]	8967.33[1]	4891.60[1]
Period (P)	3	529.67[1]	1213.50[1]	407.96[1]
Y × P	6	596.68[1]	353.57[1]	169.68
Error A	48	103.58	54.11	82.36
Hour (H)	23	2409.67[1]	25.99[1]	2225.16[1]
Y × H	46	64.94[1]	1.80	63.22[1]
P × H	69	33.33[1]	1.20	32.30[1]
Y × P × H	138	37.54[1]	1.94	40.38[1]
Error B	1104	12.16	1.56	12.19

[1] $P < 0.01$.

the 1961, 1965, and 1968 nests were used. The 1964 nest was destroyed by raccoons (*Procyon lotor*) and the 1967 nest was flooded early in the nesting season. The 1961 nest was flooded by Hurricane Carla on 10 September; however, hatching was in progress at the time of the hurricane. Hatching was successful in the 1965 and 1968 nests.

The nests monitored were located early in the nesting season, and a remote thermocouple of a continuously recording thermometer was placed in the cavity of each nest soon after egg deposition. The temperature within each nest cavity and the air temperature outside each nest were recorded. The nesting season was subdivided into 4 periods for determining temperature variation at different intervals during incubation. The date of each period was: period 1 (22 June to 11 July), period 2 (11 July to 1 August), period 3 (1 August to 19 August), period 4 (19 August to 6 September). Within each period, nest and air temperature values were tabulated at hourly intervals for five consecutive days.

The data were tested statistically using a split plot arrangement of treatments in a completely randomized design (Snedecor, 1956). The main source was a 3 by 4 factorial (3 years × 4 periods) with 5 days per year by period combination. The subplot factor was hour (24 hourly readings per day).

TABLE 2.—A comparison of mean air temperature and mean nest temperature by period and year (°C).

Period	1961		1965		1968	
	Air	Nest	Air	Nest	Air	Nest
1	26.7	26.8	28.4	32.1	30.1	30.7
2	29.6	29.9	30.2	33.1	28.1	30.2
3	26.1	27.1	28.2	32.6	29.2	29.8
4	27.6	26.6	28.6	31.7	27.4	27.3
Mean	27.5	27.6	28.8	32.4	28.5	29.5

RESULTS

Statistical analysis of the data on air and nest temperature showed highly significant difference ($P < .01$) among years, periods of the nesting season, and hours of the day (Table 1). Tests on the differences between nest and air temperature for the various time intervals were also indicated as highly significant.

The mean air temperatures recorded at alligator nests ranged from 27.5 C in 1961 to 28.8 C in 1965 (Table 2), representing only a 4.3% difference among years. The mean temperature inside alligator nests showed greater variation among years than did air temperature. The temperature inside the nest monitored in 1961 averaged 27.6 C, but the nest checked in 1965 averaged 32.4 C.

During the 4 periods of the nesting season, the mean air temperature ranged from 27.9–29.3 C (Fig. 1). Temperatures were highest in period 2, but declined in period 3 and remained about the same in period 4. Mean nest temperatures varied between periods but followed the same general trend as mean air temperature. Nest temperatures increased from period 1 to period 2, then gradually declined throughout the remainder of incubation.

Hourly air temperature readings were averaged during three nesting seasons and ranged from 23.8–33.2 C. The mean hourly nest temperature during the same time ranged from 29.3–30.5 C (Fig. 2). The mean hourly air temperature fluctuated 9.3 C over a 24-hr period, but the mean hourly nest temperature varied only 1.2 C. Joanen (1969) reported temperature ex-

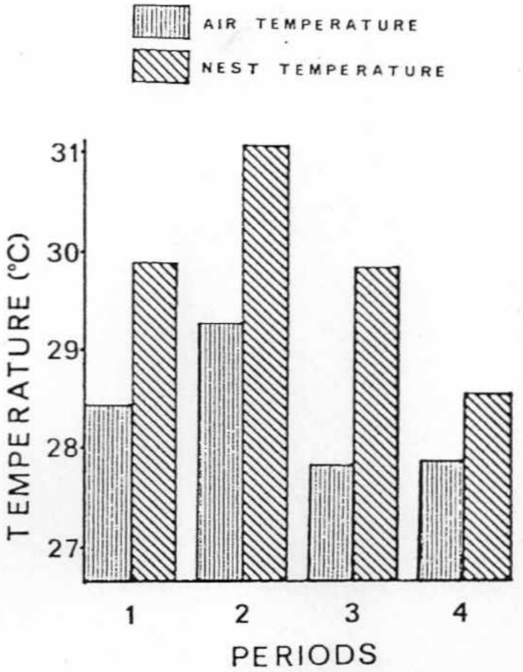

FIG. 1.—Mean air and nest temperature at alligator nests during different periods of the nesting season for three separate years. The periods are: period 1 (22 Jun–11 Jul), period 2 (11 Jul–1 Aug), period 3 (1 Aug–19 Aug), and period 4 (19 Aug–6 Sep).

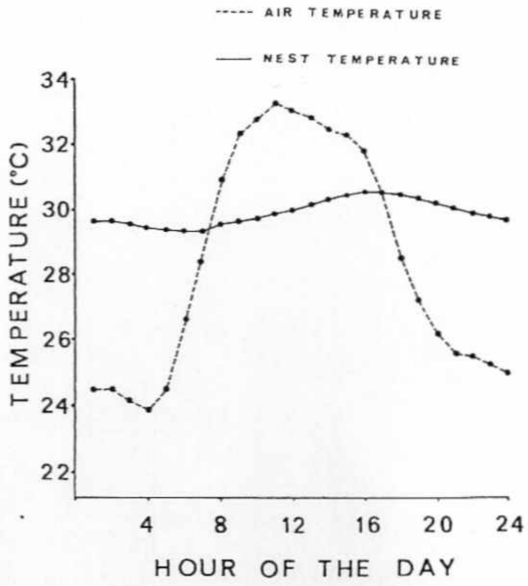

FIG. 2.—Mean hourly air and nest temperature at alligator nests for three separate nesting seasons and 20 days per season.

tremes of 23.2 and 32.7 C within the egg cavity of alligator nests, and during the same time interval air temperatures ranged from 20.4–41.5 C.

Mean differences between nest and air temperature for the 4 periods of the nesting season (Fig. 1) indicated only slight variation among periods, and in most cases nest temperature was greater than air temperature. Differences between nest and air temperature varied greatly when considered on a 24-hr basis. Nest temperature changed only a few degrees during a day, but air temperature fluctuated considerably, moving above and below nest temperature over a 24-hr period (Fig. 2). At 0400 hr the mean air temperature was 5.6 C below the mean nest temperature, but at 1100 hr the mean air temperature was 3.4 C greater than the mean nest temperature.

Regression analysis was made to determine the relationship between air temperature and nest temperature. The coefficient of determination (r^2) was 0.108 indicating only 10.8% of the variation in nest temperature was accounted for by the regression of nest temperature on air temperature.

DISCUSSION

The nest of the American alligator is constructed from vegetation and soil collected adjacent to the nest site. McIlhenny (1935) described the nest building activity and stated that the leaves and twigs were an essential part of the nest, and the heat later released through decomposition was essential for incubation. He used maximum-minimum thermometers to determine temperatures within an alligator nest and air temperature outside the nest. He found nest temperatures considerably above those recorded during this study. A mean temperature (midpoint between maximum and minimum) of 33.9 C was reported by McIlhenny, whereas the temperature of 3 nests monitored during this study averaged 29.8 C.

Air temperature appeared to be the main factor influencing temperature within alligator nests. Mean values were similar; however, regression analysis indicated that nest temperature could not be accurately predicted from air temperature measurements. The nest material proved to be an excellent insulator, and caused fairly stable temperatures within the egg cavity. In most instances, air temperature increased and decreased with no noticeable effect on nest temperature. Air temperature was highly variable, changing rapidly from one hour to the next (Fig. 2); however, nest temperature changed slowly and varied only a few degrees daily. The effects on nest temperature were delayed by the insulating effect of the nest material; consequently, regression analysis did not show the true response of nest temperature to changes in air temperature.

The response of nest temperature to changes in air temperature is shown in Fig. 2. Air temperature began rising after 0400 hr, but nest temperature did not rise until after 0700 hr. The rise in nest temperature began at the time when air temperature rose above the level of nest temperature. Air temperature began declining after 1100 hr, but nest temperature continued to rise and did not decline until after 1700 hr. The decline in nest temperature followed the time when air temperature dropped below the level of nest temperature.

The difference in nest and air temperature varied between nests. The nest checked in 1965 averaged 3.6 C warmer than air temperature, but the temperature of the 1961 nest averaged only 0.1 C greater than air temperature (Table 2). The variation apparently resulted from differences in the nature of the nest material. Nests constructed largely from green plant material would have a higher temperature, as a result of decomposition, than nests having a higher ratio of partially decomposed vegetation or mineral soil. The mean difference in nest and air temperature appeared to be a measure of the amount of heat added to the nest by the decomposition of nest material.

Acknowledgments.—Special recognition is due Ted Joanen and Clark Hoffpauer, Louisiana Wild Life and Fisheries Commission, for the collection of field data and Prentiss Schilling, Louisiana State University, for assistance in statistical analysis.

LITERATURE CITED

JOANEN, T. 1969. Nesting ecology of alligators in Louisiana. Proc. 23rd Ann. Conf. Southeast. Assoc. Game and Fish Comm. p. 141–151.

MCILHENNY, E. A. 1935. The alligator's life history. Christopher Publishing House, Boston.

SNEDECOR, G. W. 1956. Statistical methods. Iowa State College Press, Ames.

Received: 17 April 1972
Accepted: 18 July 1972

School of Forestry and Wildlife Management, Louisiana State University, Baton Rouge, Louisiana 70803

A SECOND SPECIMEN OF THE COLUBRID SNAKE *BOIGA PHILIPPINA*

CHARLES KROON

THE colubrid snake *Boiga philippina* (Peters) has been recognized since 1867 only from the holotype. Collected in Ylaces (= Ilocos Province), Northern Luzon, Philippine Islands, the type is now in the Zoologisches Museum, Berlin, East Germany. Since that time two major studies of the snakes of the Philippine Islands,