

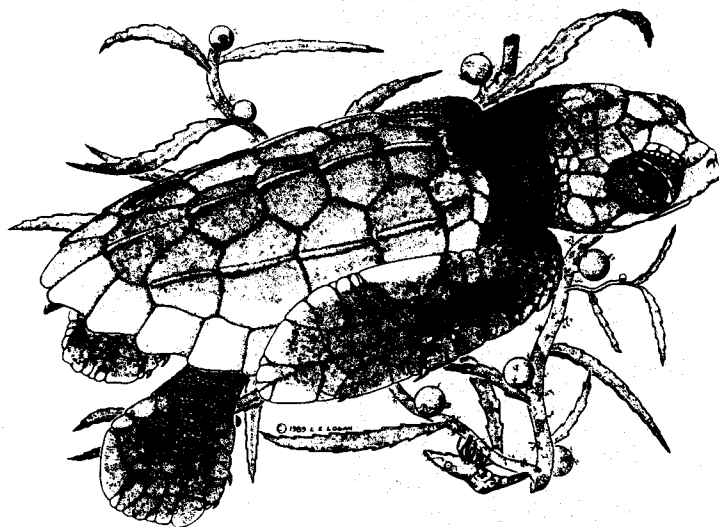
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NEST TEMPERATURES AND DURATION BETWEEN PIPPING AND EMERGENCE IN THE LOGGERHEAD SEA TURTLE IN SOUTHEASTERN NORTH CAROLINA

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The interval between pipping and emergence has been reported to be 1-14 days with an average of five days (Kraemer and Bennett 1981, Demmer 1981, Mrosovsky 1988, Neville et al. 1988, Webster and Gouveia 1988), but no field methodology has been developed to document when pipping occurs. Demmer (1981) monitored the behavior of hatchlings in nests using a glass cover and noted that most hatchlings in the clutch pip together. Neville et al. (1988) compared nest temperatures at the top and middle of the nest to soil temperatures at similar depths. The temperature in the middle of the nest was parallel to and consistently warmer than the temperature at the top of the nest once metabolic heat became evident, usually mid-way through incubation. Five days before emergence there was an unexpected change in temperatures where the top became warmer than the middle. This fluctuation was believed to signify the onset of emergence due to the additional metabolic heat generated by the upward movement of hatchlings in the nest cavity.

The purpose of this investigation was to develop a field technique base on nest temperatures that would predict when pipping occurs. Data were collected on Bald Head Island, North Carolina, during the 1988 nesting season. Four randomly chosen control "nests" (containing no eggs) were equipped with thermocouples at the soil surface and at depths of 5-65 cm at 10 cm intervals. They were monitored twice daily (5-7 AM and PM) from June to October with a Bailey Bat-12 microprobe thermometer calibrated to the nearest 0.1°C. Thermocouples were placed in the top and middle of 18 loggerhead nests laid between 2 June and 22 July and were monitored twice daily (5-7 AM and PM) throughout incubation. When top and middle nest temperatures did not react predictably to changes in ambient soil temperatures at similar depths, a small vertical hole was dug adjacent to the nest in the AM to confirm that pipping had commenced, following the procedure of Kraemer and Bennett (1981).

The period of time between pipping and emergence is shown in Table 1. Variation between AM and PM observation is usually one day and probably represents the time of day when pipping begins and variability among nests. Inasmuch as sea turtles use temperature as the cue for emergence from the nest (Mrosovsky 1968, Neville et al. 1988), it seems reasonable to believe that the pipping process would be cued by temperature also. Demmer (1981) indicated that pipping was not related to ambient soil temperature, but he did not relate pipping to daily variation in nest temperatures. The mean interval between pipping and emergence, based upon AM and PM analyses, is 5.7 and 5.9 days, respectively, in North Carolina, almost a full day more than has been previously recorded (Mrosovsky et al. 1984, Neville et al. 1988, Webster and Gouveia 1988). There is distinct seasonal variation in these data as well. The time interval between pipping and emergence is greater in nests with longer incubation durations and less in nests with shorter incubation durations, as predicted by Webster and Gouveia (1988).

In conclusion, nest temperatures can be used to determine the time interval between pipping and emergence in loggerhead sea turtle nests because of intrinsic variations in nest temperatures.

ACKNOWLEDGEMENTS

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Table 1. Predicted interval (in days) between pipping and emergence based on changes in nest temperatures on Bald Head Island, North Carolina.

DATE LAID	NEST NUMBER	INCUBATION DURATION	NUMBER DAYS BEFORE HATCH	
			AM TEMP.	PM TEMP.
1 June	6	75	12	11
3 June	9	75	8	6
6 June	12	69	4	7
13 June	25	64	8	9
19 June	32	67	9	7-9
20 June	34	63	3	4
25 June	51	61	6	5
26 June	53	63	3	2-4
29 June	57	60	4-6	6
2 July	65	58	3	4
5 July	82	58	-	-
6 July	87	53	4	5
13 July	100	63	6	6-8
13 July	106	65	-	5
16 July	107	64	3	4
17 July	109	60	3	4
18 July	117	64	7	-
22 July	132	63	7	7
MEAN=		63.6	5.7	5.9