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MOVEMENT INDUCED MORTALITY OF LOGGERHEAD EGGS

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ABSTRACT: Significant decreases in hatching rates of the eggs of the loggerhead (*Caretta caretta*) can result from gentle inversion of the egg between about 12 hr and 14 days after the eggs are laid. Since movement of large numbers of sea turtle eggs probably has the potential for killing a large proportion of the eggs, such movements should be undertaken with extreme care.

Key words: Reptilia; Testudines; Cheloniidae; *Caretta*; Eggs; Mortality

DURING the ten summers since December 1968 there has been continuous monitoring of sea turtle nesting populations at Mon Repos and adjacent beaches in south Queensland, Australia, as part of the Queensland Sea Turtle Project (part of the Queensland National Parks and Wildlife Service). Each summer on Mon Repos beach many hun-

dreds of clutches were observed being laid by loggerheads (*Caretta caretta*), flatback turtles (*Chelonia depressa*), green turtles (*Chelonia mydas*), and leatherbacks (*Dermochelys coriacea*). Even though a sea turtle egg can survive the bumping and rolling associated with being laid, our experience has indicated that gentle rotation may kill the egg a few days later. However, we also observed that in the days just prior to hatching the eggs were again able to survive gentle movement. These observations suggested that there could be a critical period during the incubation of sea turtle eggs when movement of the egg is likely to cause the death of the embryos. Experiments to more precisely define this critical period were commenced since the movement of thousands of sea turtle eggs for purposes of research and conservation has been and continues to be a common practice (Marquez, 1966; Bustard, 1972; Anon, 1978; Cherfas, 1978).

METHODS

Four clutches of eggs were chosen from four different female loggerheads nesting at Mon Repos during the 1977–1978 nesting season. After each turtle finished laying she was removed immediately from the pit and a sample of 20 eggs was taken. As each egg was removed its vertical orientation in the nest was maintained and the top marked with an oil pen. The remaining eggs of the clutch were covered with sand to continue normal incubation. The 20 eggs were carried with minimal rotation and vibration to a hatchery area less than 150 m from the nest. This hatchery was in another section of the vegetated dune used by turtles for nesting. The 20 eggs were reburied as a compact group at a depth of 50 cm. (Depth measurements from a sample of natural loggerhead nests from the 1977–1978 nesting season at Mon Repos were: depth from beach surface to bottom of eggs—$\bar{x} = 58.61$ cm, SD = 7.93 cm, range = 44–85 cm; vertical thickness of egg mass— $\bar{x} = 22.9$ cm, SD = 6.54 cm, range = 10–40 cm [Limpus,

unpubl. data].) Thus the eggs were relocated to an area where clutches occur naturally and buried at a depth where clutches successfully incubate. As each egg was transferred to the hole it was gently rotated 180° about a horizontal axis. At specified time intervals measured from the completion of laying, each original nest was reopened and additional samples of 20 eggs were removed, transferred, rotated, and reburied in the same manner as the above. Each transfer of 20 eggs took 15–30 min to complete. The time intervals at which the eggs were transferred were: clutch I (laid 30 November 1977)—0, 0.5, 1, 2, 3 days; clutch II (laid 11 December 1977)—0, 2, 4, 6, 8 days; clutch III (laid 14 December 1977)—0, 7, 14, 21° days (°21 eggs moved); clutch IV (laid 14 December 1977)—0, 7, 21, 35 days. Only the transfer at 0.5 days was made during daylight.

After the hatchlings from each sample had emerged, each of the artificial nests was excavated and the number of successfully hatched eggs was counted. For each egg sample absolute hatching success was determined by the formula

Absolute hatching success = $(h/n) \times 100\%$

where n = number of eggs in the sample and h = number of eggs hatched. Relative hatching success for each clutch was determined by the formula

Relative hatching success = h/h_0

(calculated from samples within the same clutch) where h_0 = number of eggs hatched from the sample moved immediately after completion of laying and h = number of eggs hatched in a given sample. Within each clutch the number hatched from each sample was separately compared using a chi-square test to the number hatched from the sample moved immediately on completion of laying.

RESULTS

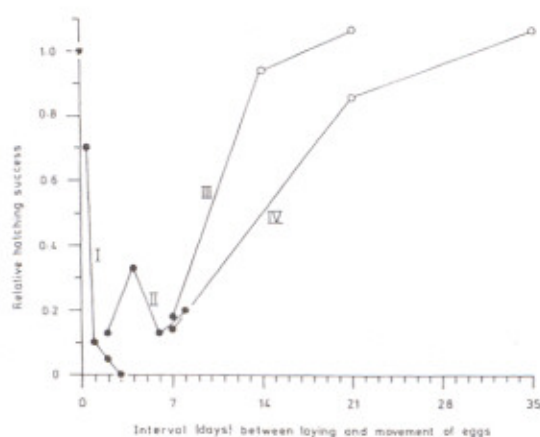The egg samples moved immediately after completion of laying had an absolute

Fig. 1.—Relative hatching success from groups of 20 loggerhead eggs removed from 4 clutches at measured times after laying and then inverted while being transferred to artificial nests to continue incubation. Connected circles denote egg samples from the same clutch. Closed circles denote those egg samples for which the number of eggs hatched was significantly different (x^2, $P <$ 0.05) from the number hatched in the sample which was moved on completion of laying (both samples from the same clutch). Clutches are identified by roman numerals. By definition, the relative hatching success of the egg sample moved immediately after the clutch was laid = 1.0 (denoted by an asterisk in Fig. 1).

hatching success ranging 70–100% ($\bar{x}$ = 81.25%, SD = 13.14, n = 4). This is similar to variation in absolute hatching success of undisturbed clutches laid on Mon Repos beach from 10 November–14 December 1977 ($\bar{x}$ = 83.8%, SD = 17.34, range = 10.6–100%, n = 90—Limpus, unpubl. data). In clutch IV the unmoved remnant of 35 eggs had an absolute hatching success of 69% which was not significantly different from the absolute hatching success of 70% for eggs moved immediately after laying. The relative hatching successes of moved eggs is summarized in Fig. 1. Twelve hours after completion of laying of clutch I the movement applied to the eggs caused a significant decrease (30%) in relative hatching success. The same movement applied to the eggs between 1 and 8 days after laying caused an even greater reduction (67% or more) in relative hatching success. There

was no significant difference in hatching success between eggs moved after 14 days and eggs moved immediately after the turtle finished laying. Thus there was a critical period of from less than 12 hours to about 14 days after laying during which the hatching success of loggerhead eggs was significantly decreased by movement of eggs.

DISCUSSION

Movement of eggs during incubation may not be detrimental to all turtle species. Drajeske (1974) found that turning small samples of eggs every 11 to 29 days during incubation did not adversely affect the hatching of *Chrysemys scripta, Chrysemys picta,* and *Terrapene carolina.* Bustard (1972) reported a decrease by 23% or more in hatching rate when 77,057 green turtle eggs were moved to a hatchery on Heron Island off the coast of Queensland. Thus for loggerheads, green turtles, and possibly other species of sea turtles any large scale movement of eggs into hatcheries for conservation or research purposes or for commercial exploitation has the potential for killing large numbers of eggs.

Large scale movements of sea turtle eggs as are contemplated in Mexico (Cherfas, 1978) and southeast Asia (Anon, 1978) to conserve species should only be undertaken when alternatives to shifting the eggs are not practicable. Until better information is available it is recommended that if sea turtle eggs must be shifted, this should be done immediately after laying or as close as possible to the end of the incubation period. The eggs should be handled gently and unnecessary movement, especially rotation, should be avoided. If very large numbers of sea turtle eggs are to be moved into hatcheries, it is recommended that part of the planning should include experiments to determine the critical periods during which hatching success may be significantly reduced.

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PREDATION ON REPTILE EGGS BY AFRICAN SNAKES OF THE GENUS *PROSYMNA*

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Abstract: The literature on shovelsnouted snakes of the genus *Prosymna* suggests that they feed on insects, worms, and small lizards, with one record of a small bird's egg and another of collapsed reptile eggs. During a revision of the genus, examination of stomach contents indicated that these snakes may feed almost entirely on reptile eggs. The eggs are usually soft-shelled, but at least two species of *Prosymna* also take gecko eggs. No evidence of any other form of prey was found in *Prosymna* stomachs, but there is one report of hatchling geckos being taken. Literature records indicate that snakes of the genera *Oligodon*, *Cemophora*, *Salvadora*, and *Phyllorhynchus* also eat reptile eggs.

Key words: Reptilia; Serpentes; Colubridae; *Prosymna*; Food; Eggs; Africa

While revising the African snake genus *Prosymna*, I noticed the bloated condition of *P. ambigua* UM 26590 from Mulanje, Malawi. I opened the snake (snout–vent length 278 mm) and found four 20 mm long eggs in the oviducts. In the stomach were five collapsed 19 mm long lizard eggshells, nested one inside the other and each having one or more longitudinal slits (Fig. 1). In the esophagus were two elongate snake eggs, each 25 mm long. The snake eggs are probably those of *Leptotyphlops* or *Aparallactus* and the lizard eggs may be those of *Agama mossambica*.

This discovery suggested that reptile eggs might form an important part of the diet of these small snakes, but perusal of the literature provided little reliable data. Young geckos (*Hemidactylus mercatorius = H.*

mabouia, vide Broadley, 1977) were found in the stomachs of two *P. ambigua* from Mtimbuka, Malawi (Loveridge, 1953) and Liwale, Tanzania (Loveridge, 1958). Loveridge (1956) also reported "collapsed shells of hatched-out snake or lizard eggs" in a *P. pitmani* from Liwale. Sweeney (1961) stated with reference to *P. ambigua* in Malawi: "The food is varied and probably consists largely of termites and other small soil insects, but it will eat young or small lizards and earthworms as well." FitzSimons (1962) stated that *P. sundevallii* subsists "mainly on insects and other small invertebrates" and the diet of *P. ambigua* "appears to consist mainly of insects, worms, etc., while fully adult specimens may also take small lizards." Pitman (1974) reported that C. J. P. Ionides once found a small bird's