HOW NEST TRANSLOCATION-TIME, CLUTCH SIZE AND PRESENCE OF YOLKLESS EGGS AFFECTED HATCHING SUCCESS IN *DERMOCHELYS CORIACEA* (LINNAEUS, 1766) (TESTUDINES: DERMOCHELYIDAE), AT PROJETO TAMAR-IBAMA, ESPÍRITO SANTO, BRAZIL

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RESUMEN. — En este estudio se analizó el manejo de los nidos de la especie *Dermochelys coriacea*, utilizados por el Proyecto Tamar-Ibama entre las temporadas reproductivas de 1989/1990 a 1998/1999, para verificación del éxito de la eclosión en relación a los tiempos de traslación. El estudio se realizó en el litoral norte del Estado de Espírito Santo. Existió tendencia a que el tiempo de traslación influencie el éxito de eclosión de los nidos. Los nidos trasladados entre 6 y más de 24 horas presentaron mayor cantidad de huevos sin desarrollo embrionario. No se encontró relación entre el número de huevos inviables trasladados y el tamaño de la postura, con el porcentual de eclosión. Se sugiere que la traslación sea realizada hasta las 6 horas, o 15 días después de la oviposición.

Palabras claves: Dermochelyidae, tortugas marinas, conservación, traslación de nidos, Proyecto Tamar.

ABSTRACT. — The results of managing *Dermochelys coriacea* (Linnaeus, 1766) nests by Projeto TAMAR – IBAMA, in Northern Espírito Santo, Brazil, during the nesting seasons from 1989/90 to 1998/99 are analyzed. The influence of the translocation time on hatching success of the studied nests is discussed. The time translocation, in relation to natural oviposition, seems to increase the number of non-developed eggs found in each nest if translocated between 6 hours and 15 days post egg-laying. There was no relationship established between either the number of yolkless eggs in a translocated nest or the clutch size, with hatching success. The translocation of *Dermochelys* nests either within 6 hours or after 15 days from natural oviposition is recommended.

Key words: Dermochelyidae, sea turtles, conservation, nest translocation, Projeto Tamar.

INTRODUCTION

Learning how to properly manage the eggs found on the nesting beaches is fundamentally important in the overall planning of protecting marine turtle populations. Although it is known that in general *in situ* nests exhibit a higher hatch rate than translocated nests, in some instances the advantages of leaving the nests untouched in the beach are compromised by several negative factors (Mrosovsky, 1983; Frazier, 1993).

Mrosovsky (1983) stated that objective comparisons and reliable evaluations of the different techniques of management of sea turtles eggs are still needed, and according to Frazier (1993), the conservation of these animals is plagued by the lack of basic information and reliable techniques for their management.

Presently, *Dermochelys coriacea* is included on the official list of Brazilian Threatened Animals of Extinction (Bernardes *et al*., 1990; IBAMA, 2004). This species is also listed on Appendix I of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), and is critically threatened with extinction according to IUCN (The International Union for Conservation of Nature) - Red Data Book (IUCN, 2000).

It is important to know the affect that the human intervention has on the nests, and to implement measures that reduce any negative impact on the eggs. The objective of this study is to analyze the influence that varying times spent relocating nests of *D. coriacea* had on hatching success for a Brazilian population, at the Projeto Tamar-Ibama.

MATERIAL AND METHODS

The study was performed in Espírito Santo (ES) State, in the survey areas of the Projeto Tamar-Ibama. In this State the Project has 5 bases distributed along the North coast. In the order of South to North, they are: Comboios (CB), Povoação (PV), Pontal do Ipiranga (PG), Guriri (GU), and Itaúnas (IA) (for map, see Morisso and Krause, 2001).

The data for this work on *D. coriacea* were collected during 10 reproductive seasons from the years 1989/90 to 1998/99, with coordination from Project Tamar, ES. The first author was present during the seasonal field activities of 1994, 1995, 1996, 1998 and 1999.

Projeto Tamar has two nest management techniques: *in situ* and translocated. As a rule clutches were chosen for translocation when it could be predicted that their hatching success would be zero or very low if they stayed at their original natural sites.

The translocation procedures adhered to the follow outline originally established for the Projeto Tamar. Accordingly, the eggs were removed from the nests keeping their original position; they were set-up in 21 liter styrofoam boxes with sand from original nest on the bottom in an attempt to maintain similar temperature and humidity, hoping to reduce the trauma from movement during transport. The man-made nests were assembled to imitate the natural environment from which the eggs were originally excavated as faithfully as possible (for details, see Morisso and Krause, 2001).

The translocation-time for each nest moved was calculated and classified as follows, according to the interval between the natural oviposition date and egg placement in the artificial nest: A) within 6 hours from oviposition; B) between 6 to 12 hours after oviposition; C) between 12 to 24 hours after oviposition; D) transfer over 24 hours to 15 days from oviposition; and E) transfer over 15 days from oviposition. Nests buried after 09:00 h in the morning following oviposition were automatically classified in time B. The hatcheries followed the husbandry of Marcovaldi and Laurent (1996).

In general, twenty-four hours after the emergence of the first hatchling each nest was excavated to aid liberation of the remaining live hatchlings; to count egg shells and hatchlings, and to analyze eggs that failed to hatch. These unhatched eggs were opened and classified (according to Cratz, 1982; Fowler, 1979; Hirth and Ogren, 1987; Hewavisenthi, 1994; Miller, 1985; and Withmore and Dutton, 1985) as: yolkless – sterile eggs of reduced size and without yolk; non-developed - eggs without development of apparent embryo; small embryo - developed embryo, however, of smaller size than the yolk; medium embryo - embryo of the same size as the yolk; = large embryo - embryo larger than the yolk; pipped embryos – here meaning hatchlings that emerged from the egg, but died before leaving the nest.

Based on analysis of nest excavations the following values were calculated: incubation time, percentage of eggs hatching successfully, total yolkless eggs, total of all yolked eggs, total of eggs with small, medium or large embryos, total non-developed eggs, and total number of all embryos plus eggs pipped.

The criteria for hatching success were calculated as described by Santos *et al*. (2000). For statistical analysis we used the Kruskal-Wallis test and the Pearson and Spearman rank correlations (Zar, 1999). The data were tabulated in Microsoft Excel/97 and analyzed in Windows SPSS 10.0.

RESULTS

Results of the analysis determining the relationship between varying translocation-times and the amount of eggs that fail to hatch in a given nest show the only noted parameter significantly influenced is the number of non-developed eggs (as defined above, see Table 1). This negative affect occurs during the time frames B and D (as defined above), since the number of non-developed eggs in any nest will likely increase when translocation is performed during among these time periods. The other analyzed parameters in our study of translocated nests were not influenced by translocation-time (p <0,05).

With further reference to our analysis of the eggs, no direct relationship was found between hatching success and the number of yolkless eggs both for the natural the beach nests (r_S=0,29; n=13; p=0,842) and for artificially incubated (r_S=0,147; n=58; p=0,271). The translocation of the yolkless eggs with the yolked eggs, and their position within the translocated nests had no influence on hatching success.

Another analysis involved the size of the clutch and its affect on hatching success after translocation. The results from many excavated artificial nests show that the number of translocated yolked eggs varied from 11 to 132 and that there was no discernable relationship between the number of eggs in the nest and hatching success both in the artificially incubated nests (r_S=-0,20; n=58; p=0,879) and those that remained on the beach (r_S=0,273; n=13; p=0,367). Thus, in the studied nesting area of *D. coriacea* in the Espírito Santo, our data show that translocation of smaller clutches will not result in larger hatching success.

DISCUSSION

Our results suggest a direct relationship between translocation time and the hatching success. The percentage of non-developed eggs found in each artificial nest varied depending on the translocation-time of the clutch. Bustard (1972) and Limpus *et al*. (1979) discuss the fragility of early embryonic development. According to Bustard (1972) some

Results of the nests	Kruskal-Wallis Test
Small embryos	(χ^2_{kw}= 3,628; df= 4; p= 0,459)
Medium embryos	(χ^2_{kw}= 4,320; df= 4; p= 0,364)
Large embryos	(χ^2_{kw}= 7,858; df= 4; p= 0,097)
Pipped embryos	(χ^2_{kw}= 7,166; df= 4; p= 0,127)
Non-developed eggs	(χ^2_{kw}= 10,901; df= 4; p= 0,028)*

Table 1. Statistical analysis showing the relationship between translocation-time and the incidence of non-developed eggs in artificial nests. * = statistically significant (p<0,05)

eggs do not develop as a result of shock at the initial moment of the oviposition. Limpus *et al*. (1979) state that, even if eggs survive the initial disturbance of relocation, there is the possibility that even a small rotation of an egg, soon after oviposition, can cause the death of an embryos. In addition, they also state that in the days just before hatching, eggs will successfully tolerate small movements. Our results corroborate these statements, showing that for good hatching success the translocation should occur before 6 hours or after 15 days post natural oviposition. Translocation should thus be accomplished soon after natural oviposition or in the latter half of the incubation period.

Although our statistical test shows translocation-time influences only the number of non-developed eggs in the nests, its affects are actually larger. Wyneken *et al*. (1988) emphasize that the eggs whose embryos had their development interrupted in the first weeks of incubation, thus classified as small embryos, might have disintegrated near the end of the period. However, Bustard (1972) and Whitmore and Dutton (1985) suggest that this interpretation by Wyneken *et al*. (1988) is incorrect.

The role of the yolkless eggs in the nests is still strongly debated (Hirth, 1980; Buitrago, 1984; Pritchard and Trebbau, 1984; Whitmore and Dutton 1985). Hall (1990) and Balasingam (1967), in their studies in Malaysia, observed a hatching success of 74.4% for *D. coriacea* in nests translocated to the hatchery, without including the yolkless eggs in their artificial nests. However, Schwandt *et al*. (1996) claim that hatching success is directly related to the number of yolkless eggs ovipositioned at the top of the clutch. In our work the number of yolkless eggs in relation to the yolked eggs did not influence the hatching success of the translocated nests.

Balasingam (1967) also observed in Malaysia that clutches with a fewer number of eggs exhibited higher hatching success than quantitatively larger clutches. That author states that nests with 46 to 60 yolked eggs would be the ideal number for the hatching process. Our results differ from those found by Balasingam (1967) and Whitmore and Dutton (1985), in that hatching success was not influenced by higher or lower numbers of yolked eggs per translocated nest in Brazil.

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