

Short note | Nota breve

## Reproductive biology of the loggerhead turtle *Caretta caretta* (L., 1758) on Boavista, Cape Verde Islands

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Keywords: loggerhead turtle, *Caretta caretta*, reproductive biology, Cape Verde Islands

*This is a summary of Nuria Varo Cruz's Doctoral Thesis 'Biología reproductora de la tortuga boba (Caretta caretta Linneo, 1758) en la isla de Boavista, archipiélago de Cabo Verde', Universidad de Las Palmas de Gran Canaria, Departamento de Biología, 18 October 2010. The complete thesis can be viewed and downloaded [here](#).*

The Cape Verde Islands are regarded as one of the most important nesting areas for the loggerhead turtle *Caretta caretta* (L., 1758) worldwide. Although different sea turtle species have been reported from this archipelago's seas, it was not until the late 1990s that detailed studies of these animals were initiated. This thesis reports on research carried out from 1998 to 2004 on the nesting population of the loggerhead turtle in Cape Verde. The study area comprised three beaches on the southeastern coast of Boavista island: Calheta, Ervatão and Ponta Cosme. However, data from other beaches were also taken into consideration. The main objective was to describe the loggerhead turtle's breeding biology. To this end, different characteristics of nesting females, clutches and hatchlings were examined.

The duration of the nesting season was determined. The nesting season extends from June to October, reaching its peak in August and September. Occasionally, some females may nest before or after this period or even during the off-season. Loggerhead turtles may not always manage to nest each time they come ashore. Nesting success varied between

nesting localities. Nesting success was defined as the percentage of emergences that resulted in nesting. Significant differences between the surveyed beaches were found, with values of 46.8% at Calheta, 30.2% at Ervatão and 24.0% at Ponta Cosme. These variations could be due to the different physical and ecological features characterizing these beaches.

The number of nests recorded along the 3.1 km of surveyed sandy beach exceeded 1,900 in two out of the four study years (2001 to 2004), with the maximum number recorded being 2,732 nests in 2004. Occasional surveys elsewhere showed that other beaches on Boavista could have similar densities of nests. Since nesting also occurs on other islands, be it in smaller numbers, the total number of nests in the archipelago during each breeding season could be more than 15,000. According to this rough estimate, Cape Verde would be home to the largest loggerhead nesting population in Africa and the second largest (after the southeastern coast of the USA) in the Atlantic Ocean. Mean female body size was  $76.0 \pm 3.8$  cm (straight carapace length). This value is smaller than those found elsewhere in the Atlantic, as well as in the

Pacific and Indian Ocean populations, but is similar to the Mediterranean populations of Greece and Cyprus.

Due to the high energetic costs of reproduction and migration, female loggerhead turtles rarely breed annually. According to capture-recapture data, the most frequent remigration interval was 2 years, followed by a 3-year interval (range = 1-6). Capture-recapture data must be interpreted cautiously, since most of the variables are based on extrapolation from the proportion of individuals monitored on beaches, whereas a large number of nesting emergences were not recorded. Females usually nest several times during a nesting season. The range of observed nesting frequency was 1-6 nests/female, whereas the range of estimated nesting frequency was 1-7 nests/female, with the average values being 1.4 and 1.6 nests/female, respectively. Since many individual nesting emergences were not recorded, these figures could be an underestimate of the real numbers. The average nesting interval was  $15.0 \pm 1.8$  days. The number of loggerheads tagged was 3,920 on Boavista and 273 on Sal. Capture-recapture data confirmed that some turtles may nest on different islands during the same season, as well as in different seasons ( $n = 6$  and  $n = 8$ , respectively).

Different methods were used to assess clutch size, i.e. the analyses of inter- and intra-seasonal variations were made by dividing the total sample into different groups of analysis. Nesting seasons were divided into 14-day periods. During these periods, clutch size varied significantly over different seasons. Early clutches were larger than late clutches. On several occasions, intermediate periods yielded larger clutches than the previous period, although the general trend was towards a decrease in clutch size as the nesting season progressed. Female body size seemed to influence clutch size, with larger females usually laying more eggs per nest than smaller females.

Within the area surveyed, length of incubation fluctuated during each season (2003 and 2004) and was distributed according to a U or V curve that followed the inverse pattern of the mean air temperature recorded at the nearby island of Sal. The longest incubation periods occurred at the beginning and end of the nesting seasons for

each of the three beaches. Incubation duration at Calheta was longer than at Ervatão and Ponta Cosme, but only during the initial period of each season. Due to differences in orientation, beach temperature may be influenced by different air currents, plausibly explaining differences in incubation duration between beaches. Partial surveys in previous years seem to indicate that annual fluctuations existed between 1999 and 2004.

In sea turtles, sex ratio of hatchlings can be estimated using different methods. An indirect method is by conversing the duration of incubation time into percentage of female hatchlings. This is possible because the sex of the hatchlings is dependent on the incubation temperature, which in turn determines the duration of incubation. This method was used to estimate the sex ratio of the hatchlings born on the surveyed beaches of Boavista in 2003 and 2004, showing that *ca.* 65% of the hatchlings were female. When beaches were considered separately, the range was 60-70%. Incubation success, defined as the percentage of eggs in a nest that develop successfully, can be assessed by applying different formulae. These formulae consider that clutch size (denominator) can be estimated either at the very beginning of incubation or by counting the egg shell remains in the nest after emergence of hatchlings has occurred. However, clutch size estimated at the end of the incubation period was significantly lower for the three studied beaches. This was mainly attributed to nest predation by ghost crabs *Ocypode cursor* (L., 1758). Moreover, there were different ways of estimating the number of eggs that hatched (numerator), depending on whether the number of hatchlings born or the number of egg shells in the nests were taken into account. Thus, since both numerators and denominators may vary according to the variables used, the calculated incubation success also fluctuated according to the formula applied.

Results showed that there were significant differences among the beaches in terms of loss of eggs and hatching and emergence success. In 2003 and 2004, the only seasons fully surveyed, Calheta recorded the greatest value for egg loss (median = 20.5 eggs/nest), followed by Ervatão (median = 9.0 eggs/nest) and Ponta Cosme (median = 2.0 eggs/nest). As for hatching success, a distinction has been made between the

number of remaining eggs once incubation ended (Emergence Success by excavation - ESe), and the number of eggs laid. In the first case, the median values were 88.0% at Calheta, 82.2% at Ervatão and 31.9% at Ponta Cosme. In the second case, and depending on the formula used, the median values were: a) Emergence Success mixed: 51.0% at Calheta, 64.5% at Ervatão and 24.2% at Ponta Cosme; b) Emergence Success by observed hatchlings: 39.8% at Calheta, 55.6% at Ervatão and 8.6% at Ponta Cosme. Taking the data as a whole, we may conclude that the characteristics of the substrate at Calheta and Ervatão may be advantageous for egg development (higher values of ESe), but are subject to higher nest predation by ghost crabs than at Ponta Cosme, the characteristics of which are rather inadequate for egg development (lower value of ESe). Despite the adverse conditions that eggs have to face on either beach, nests at

Calheta and Ervatão produced more hatchlings than those at Ponta Cosme.

Human depredation is the main threat to marine turtles in Cape Verde. Throughout all stages (including the survey of loggerhead turtles), the involvement of local communities and authorities was vital for the successful implementation of programmes aimed at biodiversity conservation. Several activities were implemented in order to achieve the loggerhead's conservation. Firstly, local workers were hired to carry out tasks related to surveillance and local people were encouraged to participate in ecotourism schemes. Training and participation of Capeverdean people in field work schemes were amongst the prime objectives. Specific education and awareness activities were aimed at the general public, such as informative lectures, interviews and articles in the media, the 'Day of the Turtle', and the distribution of educational materials.

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Received 26 January 2011

Accepted 2 March 2011