

# SIZE DISTRIBUTION OF PELAGIC-STAGE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE WATERS AROUND THE AZORES AND MADEIRA

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## ARQUIPÉLAGO



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Crews from commercial tuna vessels tagged and measured 731 loggerhead sea turtles (*Caretta caretta*) during the 1990, 1991, and 1992 fishing seasons. Turtles ranged in size from 10 to 82 cm curved carapace length. The size distributions among years were not significantly different. The mean size of 45 loggerheads tagged in Madeira was significantly larger than that of Azores turtles. Results of this work support the hypothesis that small, pelagic loggerheads in the eastern Atlantic are derived from the breeding population in the southeastern U.S. The size range of loggerheads known to inhabit waters around the Azores has been expanded.

BOLTEN, ALAN B., HELEN R. MARTINS, KAREN A. BJORNDAL & JONATHAN GORDON. Distribuição de tamanhos de tartarugas-caretas (*Caretta caretta*) na fase pelágica nas águas dos Açores e Madeira. *Arquipélago. Ciências Biológicas e Marinhas* 11A: 49-54. Angra do Heroísmo. ISSN 0870-6581.

As tripulações de navios atunheiros marcaram e mediram 731 tartarugas-caretas (*Caretta caretta*) durante as safras de 1990, 1991 e 1992. Os comprimentos curvos das carapaças das tartarugas variaram de 10 a 82 cm. A distribuição interanual de tamanhos não foi significativamente diferente. O tamanho médio de 45 tartarugas marcadas na Madeira foi significativamente maior do que o das tartarugas dos Açores. Os resultados deste trabalho suportam a hipótese de as pequenas tartarugas pelágicas desta espécie derivam da população reprodutora existente no Sudeste dos E.U.A. O espectro de tamanhos de tartarugas-caretas que vivem nas águas envolventes dos Açores foi aumentado.

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## INTRODUCTION

The earliest developmental habitats of sea turtle hatchlings, once they leave the nesting beach, are oceanic driftlines (CARR 1986, 1987a, 1987b). In the Atlantic system, loggerheads (*Caretta caretta*), green turtles (*Chelonia mydas*), hawksbills (*Eretmochelys imbricata*), and Kemp's ridleys (*Lepidochelys kempii*) are often associated with rafts of sargassum in these driftlines that provide both a physical refuge and a food resource (CARR 1987b; WITHERINGTON, in press).

BRONGERSMA (1972) carefully catalogued the records of sea turtles in the eastern Atlantic and was the first to draw attention to the large num-

bers of small loggerheads in the waters around the Azores. Based on his collaboration with H. R. Martins, CARR (1986) concluded that the loggerheads in the Azores were part of the population of loggerheads that reproduce in the southeastern U.S. CARR (1986) hypothesized that oceanic currents carry small, post-hatchling loggerheads from the east coast of North America to the eastern Atlantic, where the turtles pass through the waters around the Azores, Madeira, and the Canary Islands, and perhaps the Cape Verde Islands, before returning to the western Atlantic.

To study the biology of these pelagic-stage loggerheads, a collaborative turtle tagging project was established in April 1990 with the commer-

cial tuna fleet in Horta, Azores. This program was continued in 1991 and 1992. The primary method for fishing tuna in the Azores is visually searching for shearwater (Aves: Procellariidae) feeding activity and then using pole and line in the area observed. Turtles are not caught incidental to this fishing method. Because the tuna crews are constantly searching the surface for tuna feeding activity, they are excellent observers of sea turtles. When not busy with fishing activities, the fishermen capture turtles off the ocean's surface with dip-nets.

To evaluate CARR's (1986) hypothesis that turtles travel through Madeiran waters after leaving the Azores, a collaborative tagging project was established with the crew of the "S/Y Song of the Whale", the research vessel of the International Fund for Animal Welfare. This sailboat spent several months in the waters around Madeira in 1990, while the crew studied sperm whales in that region. Turtles were observed while the crew was watching the surface for whale activity, and were captured from the surface with dip-nets.

## METHODS

The captain of each participating vessel was given tags, applicators, a flexible fiberglass tape (Ohaus; 150 cm in 1 mm divisions), and a data book. The crew of each participating boat was given a demonstration on tagging procedures and standard measurements. The data book given to each boat had a summary diagram of correct tag placement and measurement positions. Turtles were double-tagged on the trailing edge of the front flippers, proximally, through the second large scale, using monel metal tags (#681, National Band and Tag Company, PO Box 430, Newport, Kentucky 41072 USA). Each tag has a unique number, a reward message, and a return address.

The primary data included date, tag numbers, latitude, longitude, and curved carapace length (CCL) from the nuchal notch to the posterior marginal notch. The fishermen were not required to identify the species of turtle but rather to determine whether or not the turtle was the common species (loggerhead). Additional notes on natural history, entanglement in debris (e.g., fishing nets, monofilament line), or ingestion of debris were recorded by some of the fishermen.

The observation period coincided with the primary tuna season (generally late April through October) for each year. Boats were visited by a team of researchers from the Department of Oceanography and Fisheries, University of the Azores, throughout the commercial tuna season to determine that the data were being collected correctly and to provide additional tags where necessary.

The crew of the "S/Y Song of the Whale" tagged loggerheads with plastic tags (jumbo-roto, Dalton Ltd., Oxfordshire, England), which bore the same information as the monel tags used by the tuna fleet in the Azores. Curved carapace length (CCL) was measured in the same manner as in the Azores.

## RESULTS

Response by the commercial tuna fishermen was very positive. In 1990, the crews of 20 boats tagged 305 turtles; in 1991, the crews of 22 boats tagged 297 turtles; and in 1992, the crews of 12 boats tagged 129 turtles. All tagged turtles were loggerheads.

Turtles varied in size from 10.0 to 82.0 cm curved carapace length (CCL). The mean, standard deviation and range of turtles tagged in each year are given in Table 1. Figs. 1, 2, and 3 present the size distribution for each of the three years. The size distributions between 1990 and 1991, between 1990 and 1992, and between 1991 and 1992 are not significantly different (Kolmogorov-Smirnov 2-sample test,  $\alpha = 0.05$ ).

Because fishing effort for tuna varied from

Table 1

Curved carapace length (cm) of loggerheads captured and tagged in the waters around the Azores and Madeira. N is sample size; SD is standard deviation.

	N	Mean	SD	Minim.	Maxim.
Azores					
1990	305	32.8	11.3	11.0	82.0
1991	297	34.6	10.6	10.0	65.0
1992	129	33.0	11.3	13.0	60.0
All years	731	33.6	11.3	10.0	82.0
Madeira					
1990	45	36.3	10.4	20.5	56.0

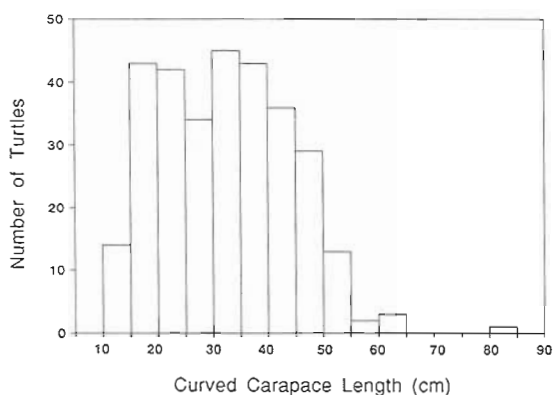


Fig. 1. Size distribution of loggerheads captured around the Azores in 1990 by tuna fishermen. Sample size is 305.

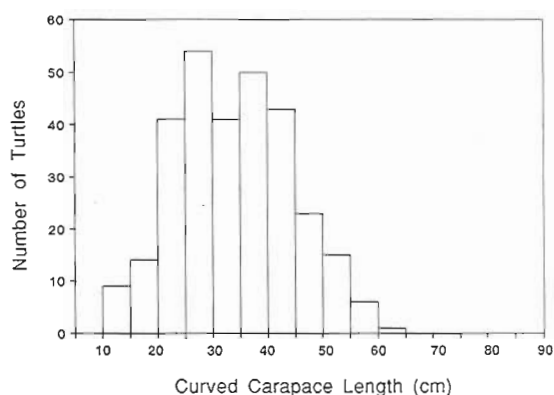


Fig. 2. Size distribution of loggerheads captured around the Azores in 1991 by tuna fishermen. Sample size is 297.

month to month and among years, the effort for turtle capture also varied. Thus, we cannot evaluate relative seasonal or annual abundance of turtles from our data.

The crew of the "S/Y Song of the Whale" tagged 45 loggerheads during May and June 1990 in the waters around Madeira. The size distribu-

tion of these turtles is shown in Fig. 4. The turtles varied from 20.5 to 56.0 cm CCL with a mean value of 36.3 cm (Table 1). The mean size of the Madeiran turtles was significantly greater than that of the 1990 Azores sample (one-tailed  $t$ -test,  $t = 1.957$ ,  $df = 348$ ,  $P < 0.05$ ), but the dispersion of the size distribution of the sample of turtles from

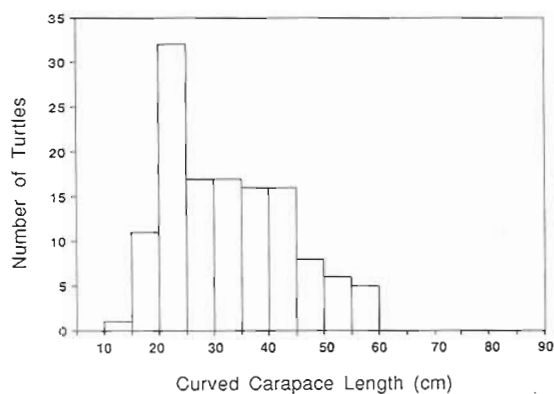


Fig. 3. Size distribution of loggerheads captured around the Azores in 1992 by tuna fishermen. Sample size is 129.

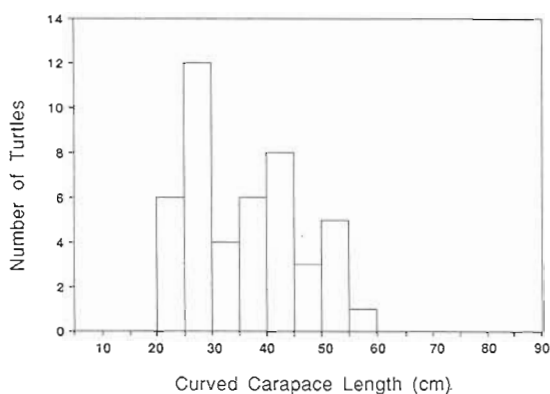


Fig. 4. Size distribution of loggerheads captured around Madeira in 1990 by the crew of the "S/Y Song of the Whale". Sample size is 45.

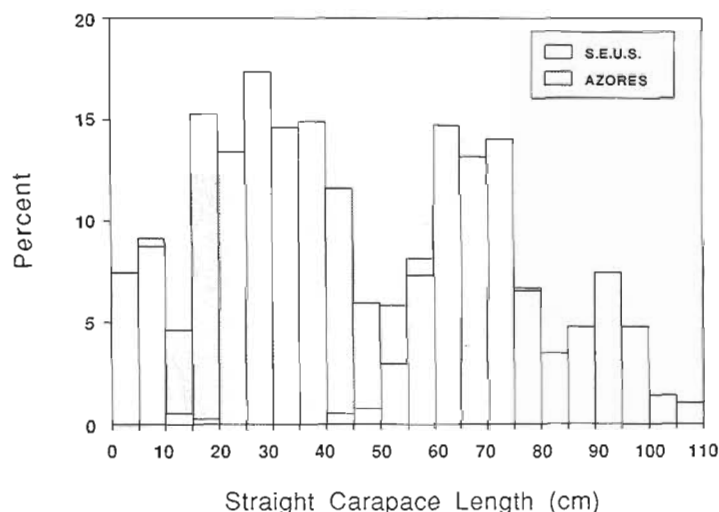


Fig. 5. Size distribution of loggerheads around the Azores (data from this study) and the southeastern U.S. (S.E.U.S.; adapted from CARR (1987b)). The S.E.U.S. loggerheads include post-hatchlings seen off Florida beaches, juvenile and adults captured in benthic habitats in southeastern U.S., and adult females on nesting beaches in Florida. Azores data were converted to straight carapace length (see text).

Madeira was not significantly different from that of the 1990 Azores turtles (Kolmogorov-Smirnov 2-sample test,  $\alpha = 0.05$ ).

The comparison between the data collected by the "S/Y Song of the Whale" in Madeira with that collected by the Azores tuna fleet is valid. There was no significant difference for either the mean or dispersion for the size distributions of turtles captured by the "S/Y Song of the Whale" in the Azores in 1991 compared with those captured by the Azores tuna fleet in 1991 (t-test and Kolmogorov-Smirnov 2-sample test,  $\alpha = 0.05$ ).

## DISCUSSION

CARR (1987b) based his hypothesis that loggerheads in the Azores are derived from the nesting beaches of the southeastern U.S. on two main lines of evidence. First, the size range of turtles in the Azores as measured by H. R. Martins in 1984 and 1985 comprised part of the size range that was never seen in western Atlantic waters. Second, there was no known breeding colony of loggerheads in the eastern Atlantic that was sufficiently large to produce the large number of juvenile turtles around the Azores.

The hypothesis that loggerheads cross the Atlantic from the southeastern U.S. to the Azores, then either move into the Mediterranean or continue down through Madeira and the Canaries before returning to the western Atlantic is supported by our work with the loggerheads in the eastern Atlantic. The lack of a difference in size distribution of loggerheads among the three years supports the theory that small loggerheads are recruited annually, perhaps from the western Atlantic, and that older, larger loggerheads leave the waters surrounding the Azores before they reach minimum breeding size of 88 cm CCL (WITHERINGTON 1986).

The size range of loggerheads now known to inhabit the Azores waters has been expanded, giving more support to the idea that the turtles in the eastern Atlantic represent the size classes missing in the western Atlantic. CARR (1987b) reported a range of straight carapace lengths (SCL) of 15.2 to 38.0 cm with a mean value of 20.6 cm for Azorean loggerheads in 1984 and a range of 11.0 to 38.0 cm with a mean value of 25.2 cm in 1985. Our results demonstrate that SCL of loggerheads in the Azores commonly span 8 to 60 cm (values for CCL collected by tuna fishermen were con-

verted to SCL as in BOLTEN et al. 1992a). The size range of 8 to 60 cm from our study fills completely the size range of turtles never seen in the western Atlantic (Fig. 5), whereas the size range from 38 to 55 cm remained largely unaccounted for in CARR's (1987b) study.

The greater mean size of Madeira loggerheads compared with Azores loggerheads in 1990 supports the theory that turtles move from the Azores to Madeira. Although the dispersion of the size distributions in the two areas are not significantly different, the very small turtles are absent from the Madeira sample (Fig. 4). The question of differential size distribution should be examined with a large number of turtles from all successive points along the hypothesized travel route.

Turtle sightings and tag recoveries from our program also support the hypothesized travel path of Atlantic loggerheads. A loggerhead tagged in the Azores in July 1986 was recaptured off Sicily in August 1991 (BOLTEN et al. 1992a). A loggerhead tagged in Madeira in June 1990 was recaptured in the Canary Islands in February 1993 (BJORNDAL et al., in press). A loggerhead tagged in the Canaries in June 1987 was recaptured in Cuba in November 1987 (BOLTEN et al. 1992b). A large loggerhead (73.1 cm SCL) was tagged in Florida in August 1986 and recaptured in the Azores in 1988 (ECKERT & MARTINS 1989). Although this loggerhead was larger than the size range of loggerheads that travel from Florida to the Azores according to CARR's (1986) hypothesis, this recapture still lends credence to the theory.

Kemp's ridleys have been reported from the eastern Atlantic: Azores (BRONGERSMA 1982; BOLTEN & MARTINS 1990), Madeira (BRONGERSMA 1982), and Malta (BRONGERSMA & CARR 1983). These ridleys must have crossed the Atlantic, probably by a path similar to that suggested for loggerheads, to arrive in the Azores because Kemp's ridleys only reproduce in the Gulf of Mexico. Therefore, these sightings also support the hypothesized travel path.

More research is needed to establish the source and travel path of loggerheads in the eastern Atlantic. The duration of the pelagic stage is also unknown and is critical to our understanding of the demography of loggerheads. We plan to continue our collaboration with the tuna fishermen in order

to address these questions.

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