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Biology of the Early Pelagic Stage—The "Lost Year"

The life history of sea turtle hatchlings from the time they leave the nesting beach, enter the sea, and become part of the pelagic community until they return to coastal, benthic foraging habitats as juveniles, has been known as the "mystery of the lost year" (Carr, this volume). Research efforts to unravel the mystery of this early pelagic stage have focused on the North Atlantic and North Pacific loggerhead populations (*Caretta caretta*). Despite considerable effort, researchers have not found areas where pelagic-stage turtles can be consistently found for any other population or species. The flatback turtle (*Natator depressus*) may not have a true pelagic stage (Walker and Parmenter 1990).

The orientation behavior and sensory cues used by hatchlings first to find the sea and then to maintain direction once in the sea are reviewed by Witherington (this volume). Wyneken and Salmon (1992) have analyzed the swimming frenzy that occurs once the hatchlings have entered the sea. Variation in the Earth's magnetic field may provide the cues for the post-hatchlings to orient while in the pelagic current systems (Lohmann and Lohmann 1994, in press).

Archie Carr (1986, 1987a,b) hypothesized that the lost year turtles were associated with driftlines, convergences, and rips in the North Atlantic Gyre system. Carr (1986) suggested that loggerhead hatchlings from the southeastern USA rookeries become incorporated into the Gulf Stream Current and from there, those post-hatchlings that are in the eastern portion of the Gulf Stream become incorporated into the "Azorean" Current that carries them past the Azores, Madeira, Canary Islands and back again to the western Atlantic. The size frequency distribution of loggerheads in the eastern Atlantic complements the "missing" size classes in the western Atlantic (Carr 1986; Bolten et al. 1993) and was the first line of evidence that the turtles in the two regions belong to the same population. Mitochondrial DNA sequence patterns are being analyzed to confirm this relationship. In addition, the movement patterns that

Carr (1986) hypothesized within the North Atlantic Gyre system have been documented (Eckert and Martins 1989; Bolten and Martins 1990; Bolten et al. 1992a,b; Bjorndal et al. 1994). Satellite telemetry is being used to document specific movement patterns within the North Atlantic Gyre (Bolten et al., unpublished data). Movement of Atlantic turtles into the Mediterranean has been documented by tag returns (Manzella et al. 1988; Bolten et al. 1992a) and confirmed by genetic analyses (Laurent et al. 1993). Transoceanic movements for loggerheads in the North Pacific have been documented using genetic analyses (Bowen et al., in press).

Duration of the pelagic stage has important demographic implications. Preliminary results comparing growth rates estimated from recaptures and those estimated from length-frequency analysis suggest the "lost year" for the Atlantic loggerheads is more likely a "lost decade" (Bolten et al., in press). Zug et al. (in press) using skeletochronology, report a similar time period for the North Pacific loggerheads.

Jellyfish (e.g., *Pelagia noctiluca*) are the major natural diet component of pelagic loggerheads in the North Atlantic; in the North Pacific, the principal food sources are the neustonic coelenterate *Velella velella* and the gastropod *Janthina* sp. Young posthatchlings feed on a variety of invertebrates (including insects) that are associated with the *Sargassum* ecosystem (Richardson and McGillivary 1991; Witherington 1994).

Ingestion of and entanglement in marine debris (e.g., plastics, tar, and discarded fishing gear) have an impact on survivorship of pelagic populations (Balazs 1985; Carr 1987a,b; Witherington 1994). Incidental take in commercial fisheries (e.g., driftnets and longline fisheries) poses another major threat to pelagic turtles (Aguilar et al. 1992 and 1993 as summarized in Balazs and Pooley 1994; Wetherall et al. 1993; Balazs and Pooley 1994; Bolten et al. 1994).

Genetic markers may provide the necessary tools to link pelagic populations with specific rookeries. From this linkage, and through collaborative efforts with oceanographers, factors affecting distribution and movement patterns may be elucidated in the future.

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Front cover: Adult female green turtle, *Chelonia mydas,* at French Frigate Shoals, the major migratory breeding site for this species in the Hawaiian Islands. Photo by G. H. Balazs.