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Differences in diurnal and nocturnal swimming patterns of olive ridley hatchlings in the Gulf of Fonseca, Honduras

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ABSTRACT

Sea turtle hatchlings from Honduran beaches along the Pacific coast must swim more than 30 km through the shallow, presumably predator-rich waters of the Gulf of Fonseca before reaching the open ocean. Olive ridley hatchlings from Punta Ratón, Honduras, were tracked during the first 2 h of their offshore migration to assess aquatic predation rates. No predation events were observed. The absence of rocky bottom areas and reef structures where predators can refuge, and a decline in the number of predators due to overfishing are two possible reasons for this unexpected result. Additionally, diurnal and nocturnal swimming patterns of recently emerged olive ridley hatchlings were compared with regard to their position in the water column while swimming. At night hatchlings swam near the surface 97.5% of the time, with only sporadic brief dives. During daytime, however, hatchlings spent 78% of the time swimming at depth, going back to the surface for brief periods to breathe. Due to the high turbidity of the Gulf of Fonseca waters, this daytime behavior may serve to keep hatchlings out of sight of predatory sea birds. This newly described differential swimming behavior may have adaptive significance in avoiding aerial predation in the specific conditions of the Gulf of Fonseca.

1. Introduction

In the hours after they enter the water and swim offshore, sea turtle hatchlings can suffer high mortality from fish and avian predators (Burger and Gochfeld, 2014; Frick, 1976; Gyuris, 1994; Pilcher et al., 2000). They are therefore generally believed to swim offshore as quickly as possible (Whelan and Wyneken, 2007) and then, once in deeper offshore water, they drift passively (Bolten and Balazs, 1995; Carr, 1987). Several studies have quantified the rate of aquatic predation suffered by sea turtle hatchlings in the nearshore environment (Gyuris, 1994; Pilcher et al., 2000; Stewart and Wyneken, 2004; Whelan and Wyneken, 2007; Witherington and Salmon, 1992; Wyneken et al., 1997). Although recorded predation rates vary greatly among sites, from 4.6% for loggerhead (*Caretta caretta*) hatchlings in South Florida (Whelan and Wyneken, 2007) to 85% for green (*Chelonia mydas*) hatchlings at Heron Island, Australia (Gyuris, 1994), most authors identify nearshore waters as highly threatening for hatchling turtles. Taking into account that observation periods of these studies have typically consisted of approximately 10–15 min, even the lowest observed rates (4.6% by Whelan and Wyneken, 2007; 5% by Stewart and Wyneken, 2004; 7% by Wyneken et al., 1997) are likely to exact heavy losses if hatchlings remain in nearshore environments for long periods of time (Whelan and Wyneken, 2007). Several factors, such as depth, bottom-structures, and release protocols have been shown to affect predation risk, which is especially high in shallow (<10 m) waters (Pilcher et al., 2000; Witherington and Salmon, 1992), and when hatchlings cross reef structures (Frick, 1976; Gyuris, 1994; Pilcher et al., 2000; Witherington and Salmon, 1992). Because high hatchling densities attract aquatic predators (Wyneken et al., 2000), hatchlings released *en masse* from hatchery sites suffer from 50% (Pilcher et al., 2000) to ten times (Wyneken et al., 2000) higher predation rates than those released from natural sites with a low density of nests. Other factors that may affect predation rates are tidal and moon phases (Gyuris, 1994; Harewood and Horrocks, 2008), water clarity, coast-specific predator assemblages, and fish movement patterns (Whelan and Wyneken, 2007).

Sea turtle hatchlings have no active defenses against predators (Gyuris, 1994; Stewart and Wyneken, 2004; Whelan and Wyneken, 2007), and thus their main options for avoiding predation are fleeing or hiding (Bolles, 1970). One general strategy used by green, loggerhead, and leatherback (*Dermochelys coriacea*) hatchlings is to leave predator-rich nearshore waters as quickly as possible, by maintaining a vigorous offshore swimming frenzy during the first 24 h (Carr, 1962; Salmon and Wyneken, 1987; Wyneken and Salmon, 1992), Conversely, hawksbill (*Eretmochelys imbricata*) hatchlings do not show a frenzy period of hyperactive swimming. Instead, they swim for only 6 h a day, employing slow, drag-based gaits, and spend most of the time floating motionless in a “tuck” position helping them remain inconspicuous to predators that

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use movement for prey detection (F. Chung et al., 2009; F.C. Chung et al., 2009). When facing attack or imminent predation threat, behavioral strategies also differ among species. A series of simulated predation experiments by Mellgren et al. (2003) demonstrated that loggerhead and hawksbill hatchlings tended to remain immobile, while green hatchlings responded by actively fleeing via vigorous swimming and diving. Field observations by Hasbún (2002) confirmed that hawksbill hatchlings fold their front flippers along the top of the carapace and remain motionless when approached or attacked by fish. Reactions to an aerial predation threat are similar for both green (Frick, 1976) and loggerhead hatchlings (Witherington and Salmon, 1992), which quickly dive in response to birds overhead.

Besides sporadic dives that usually happen in response to disturbance (Frick, 1976; Martin, 2003) or flying objects (Frick, 1976; Witherington and Salmon, 1992; Witherington et al., 1995), sea turtle hatchlings tend to swim near the water surface during their offshore migration, both during nighttime and daylight hours, likely due to their positive buoyancy (Carr, 1982; Davenport and Clough, 1986). Abe et al. (2000) and Frick (1976) followed green hatchlings during daytime and recorded them swimming at 10 and 20 cm depths, respectively. Liew and Chan (1995) tracked leatherback hatchlings with subminiature radiotransmitters for more than 30 consecutive hours, and described them swimming 5–10 cm just below the surface. Similar results were reported by Witherington et al. (1995) on loggerhead hatchlings and by Hasbún (2002) on hawksbill hatchlings.

To our knowledge, no previous studies on hatchling offshore swimming, in-water predation, or antipredator behavior have focused on olive ridley (*Lepidochelys olivacea*) sea turtles. In Honduras, this species nests in the eastern end of the Gulf of Fonseca, a shallow inlet of the Pacific Ocean with coast shared by El Salvador and Nicaragua (Fig. 1). Olive ridleys have been protected in Honduras since 1975, when the government established a yearly period during which commercial egg collection is forbidden and the eggs are relocated to hatcheries (Minarik, 1985). Currently there are four working hatcheries along the South coast of Honduras located on the beaches at Punta Ratón, El Venado, Boca del Río Viejo, and Cedeño. Punta Ratón (13.26570 N, 87.51228 W), the field site for this study, is the main nesting beach in the country, with an estimated 400–500 nests per season. Hatchlings released from Honduran beaches must swim across more than 30 km of shallow waters before reaching the open sea. The Gulf of Fonseca is an important fishing area for the country and several genera of fishes known to prey on sea turtle hatchlings — *Caranx* sp., *Haemulon* sp., *Lutjanus* sp., *Epinephelus* sp. (Gyuris, 1994; Stewart and Wyneken, 2004; Vose and Shank, 2003; Whelan and Wyneken, 2007; Wyneken et al., 1997) — inhabit its waters (Box and Bonilla, 2009). The Gulf of Fonseca is also home to several species of potential avian predators, such as black vultures (*Coragyps atratus*), turkey vultures (*Cathartes aura*), magnificent frigatebirds (*Frigata magnificens*), Caspian terns (*Sterna caspia*), Forster's terns (*Sterna forsteri*), laughing gulls (*Larus atricilla*), and brown pelicans (*Pelecanus occidentalis*) (Gallardo, 2014). Black and turkey vultures have been reported feeding on olive ridley hatchlings at the Ostional (Costa Rica) mass nesting beach (Burger and Gochfeld, 2014), and frigatebirds, gulls and terns are known to capture hatchlings from the water (Burger and Gochfeld, 2014; Frick, 1976; Gyuris, 1994; Martin, 2003; Stancyk, 1982).

The original goal of this study was to quantify in-water predation rates suffered by olive ridley hatchlings from Punta Ratón, Honduras, during the first hours after hatchlings are released. Taking into account that the mean depth of the Gulf of Fonseca is 15 m and the beaches in South Honduras are contiguous with several kilometers of waters less than 5 m deep, high levels of hatchling in-water predation were hypothesized.

Although abundant work has been done on tracking adult and juvenile sea turtles (Godley et al., 2008), and investigating their swimming patterns and diving behavior (Eckert et al., 1989; Hays et al., 2000; Houghton et al., 2008; Minamikawa et al., 1997), little is known about

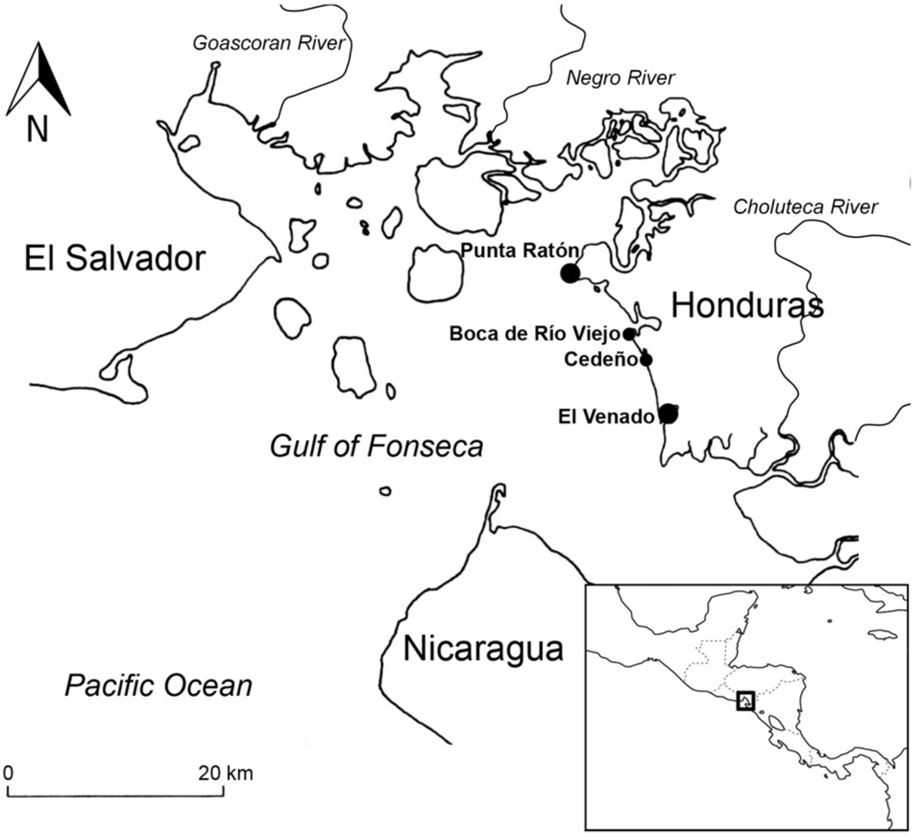

Fig. 1. The Gulf of Fonseca. Black circles indicate the four main nesting beaches for *L. olivacea* on the South coast of Honduras. Inset shows a regional view of Central America.