Regional Magnetic Fields as Navigational Markers for Sea Turtles

Kenneth J. Lohmann,* Shaun D. Cain, Susan A. Dodge, Catherine M. F. Lohmann

Young loggerhead sea turtles (*Caretta caretta*) from eastern Florida undertake a transoceanic migration in which they gradually circle the north Atlantic Ocean before returning to the North American coast. Here we report that hatchling loggerheads, when exposed to magnetic fields replicating those found in three widely separated oceanic regions, responded by swimming in directions that would, in each case, help keep turtles within the currents of the North Atlantic gyre and facilitate movement along the migratory pathway. These results imply that young loggerheads have a guidance system in which regional magnetic fields function as navigational markers and elicit changes in swimming direction at crucial geographic boundaries.

Hatchling loggerhead sea turtles (*Caretta caretta*) from eastern Florida begin a long-distance migration immediately after entering the sea (*1*). Turtles swim from the Florida coast to the North Atlantic gyre, the circular current system surrounding the Sargasso Sea, and remain within the gyre for a period of years (*2–4*). During this time, they gradually migrate around the Atlantic before returning to the North American coast (*5, 6*).

For young loggerheads, conditions within the North Atlantic gyre are favorable for survival and growth, but straying beyond the latitudinal extremes of the gyre is often fatal (*2, 3*). As the northern edge of the gyre approaches Portugal, the east-flowing current divides. The northern branch continues past Great Britain and the water temperature decreases rapidly. Loggerheads swept north in this current soon die from the cold (*2–4*). Similarly, turtles that venture south of the gyre risk being swept into the South Atlantic current system and carried far from their normal range. An ability to recognize the latitudinal extremes of the gyre, and to respond by orienting in an appropriate direction, might therefore have adaptive value.

Previous experiments have shown that hatchling loggerheads can detect magnetic inclination angle (*7*) and field intensity (*8*), two geomagnetic features that vary across Earth's surface and could, in principle, provide positional information to a migrating turtle (*9, 10*). In these initial experiments, one of the two parameters was held constant while the other was varied. This approach was necessary to demonstrate that turtles can detect each field element. In nature, however, these field elements vary together across Earth's surface. Most pairings of inclination and intensity used in previous studies resulted in fields with combinations of parameters that do not naturally occur in the North Atlantic (*7*).

To determine whether hatchlings can distinguish among the magnetic fields actually found in different oceanic regions, we subjected hatchling loggerheads to fields replicating those found in three widely separated

Department of Biology, University of North Carolina, Chapel Hill, NC 27599, USA.

*To whom correspondence should be addressed. E-mail: klohmann@email.unc.edu