Migrating sea turtles have magnetic sense for longitude

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Green Sea Turtles, Chelonia mydas breaks the surface to breathe on the Big Island of Hawaii. Image: Wikipedia.

From the very first moments of life, hatchling loggerhead sea turtles have an arduous task. They must embark on a transoceanic migration, swimming from the Florida coast eastward to the North Atlantic and then gradually migrating over the course of several years before returning again to North American shores. Now, researchers reporting online on February 24 in *Current Biology*, a Cell Press publication, have figured out how the young turtles find their way.

"One of the great mysteries of animal behavior is how migratory animals can navigate in the open ocean, where there are no visual landmarks," said Kenneth Lohmann of the University of North Carolina at Chapel

Hill.

"The most difficult part of open-sea navigation is determining longitude or east-west position. It took human navigators centuries to figure out how to determine longitude on their long-distance voyages," added Nathan Putman, a graduate student in Lohmann's lab and lead author of the study. "This study shows, for the first time, how an animal does this."

It appears that the turtles pick up on magnetic signatures that vary across the Earth's surface in order to determine their position in space—both east-west and north-south—and steer themselves in the right direction. Although several species, including sea turtles, were known to rely on magnetic cues as a surrogate for latitude, the findings come as a surprise because those signals had been considered unpromising for determining east-west position.

The loggerheads' secret is that they rely not on a single feature of the magnetic field, but on a combination of two: the angle at which the magnetic field lines intersect the Earth (a parameter known as inclination) and the strength of the magnetic field.

Near the Equator, the field lines are approximately parallel to the Earth's surface, Putman and Lohmann explained. As one travels north from the Equator, the field lines grow progressively steeper until they reach the poles, where they are directed straight down into the Earth. The magnetic field also varies in intensity, being generally strongest near the poles and weakest near the equator. Both parameters appear to vary more reliably from north to south than east to west, which had led many researchers to conclude that the magnetic field is useful only for latitudinal information.

"Although it is true that an animal capable of detecting only inclination or only intensity would have a hard time determining longitude,

loggerhead sea turtles detect both magnetic parameters," Putman said. "This means that they can extract more information from the Earth's field than is initially apparent."

What had been overlooked before is that inclination and intensity vary in slightly different directions across the Earth's surface, Putman added. As a result of that difference, particular oceanic regions have distinct magnetic signatures consisting of a unique combination of inclination and intensity.

The researchers made the discovery by subjecting hatchlings to magnetic fields replicating those found at two locations, both along the migratory route but at opposite ends of the Atlantic Ocean. Each location had the same latitude but different longitude. The turtles were placed in a circular water-filled arena surrounded by a computerized coil system used to control the magnetic field and tethered to an electronic tracking unit that relayed their swimming direction.

Turtles exposed to a field like one existing on the west side of the Atlantic near Puerto Rico swam to the northeast. Those exposed to a field like that on the east side of the Atlantic near the Cape Verde Islands swam to the southwest.

The findings may have important implications for the turtles, the researchers say.

"This work not only solves a long-standing mystery of animal behavior but may also be useful in sea turtle conservation," Lohmann said. "Understanding the sensory cues that turtles rely on to guide their migrations is an important part of safeguarding their environment."

The discovery may also lead to new approaches in the development of navigational technologies, the researchers added.

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