# Migrating monarch butterflies 'nose' their way to Mexico

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Photo by Derek Ramsey. Via Wikipedia.

The annual migration of monarch butterflies from across eastern North America to a specific grove of fir trees in Mexico has long fascinated scientists who have sought to understand just how these delicate creatures can navigate up to 2,000 miles to a single location. Neurobiologists at the University of Massachusetts Medical School (UMMS) have now found that a key mechanism that helps steer the butterflies to their ultimate destination resides not in the insects' brains, as previously thought, but in their antennae, a surprising discovery that provides an entirely new perspective of the antenna's role in migration.

"We've known that the insect antenna is a remarkable organ, responsible for sensing not only olfactory cues but wind direction and even sound

vibration," said Steven M. Reppert, MD, professor and chair of neurobiology and senior author of the study. "But its role in precise orientation over the course of butterfly migration is an intriguing new discovery, one that may spark a new line of investigation into neural connections between the antennae and the sun compass, and navigation mechanisms in other insects."

In a paper to be published in the journal Science, Reppert and his colleagues Christine Merlin, PhD, and Robert J. Gegear, PhD, have demonstrated that the butterflies' antennae —formerly believed to be primarily odor detectors—are actually necessary for sun-related orientation, a critical function commonly thought to be housed solely in the insect's brain.

"Previous studies have shown that butterflies use their circadian clock, an internal timing device such as the one that controls our own sleep-wake cycles, to correct their flight orientation and maintain a southerly course even as the sun moves across the sky," Reppert said. The time correction factor of the sun compass mechanism was assumed to reside in the brain, where the sun compass itself is located, although this presumptive role of brain clocks had never been tested directly.

Recalling an observation from 50 years ago—made even before the discovery that millions of monarchs fly to specific wintering grounds in Mexico—when it was noticed that migrating butterflies became lost in free flight when their antennae were removed, Reppert and colleagues sought to unravel the role of the antennae in migration.

In their studies, the investigators removed the antennae of a number of butterflies and tested their ability to fly south while tethered in an outdoor flight simulator rigged to calculate the insects' flight direction. They found that the antennaeless migratory butterflies could not orient themselves to the proper southerly direction, while butterflies with intact

antennae could orient correctly. They also showed that the molecular cycles of the brain clocks were not altered by removing the antennae and that the antennae actually contain circadian clocks that function independently of those in the brain.

The researchers next covered the antennae in black paint, effectively blocking light sensing by the antennal clocks. Those butterflies homed in on an incorrectly fixed direction: the insect's brain could sense light but couldn't adjust the timing of the sun's movement across the sky in order to steer towards the proper destination. However, when the team used clear paint—which did not alter antennal light input—the butterflies accurately established the southerly flight orientation, indicating that the antenna's reading of light is key to navigation.

The *Science* paper, "Antennal circadian clocks coordinate sun compass orientation in migratory monarch butterflies," will be published September 25. Reppert, who is also the Higgins Family Professor of Neuroscience at UMMS, has been a pioneering force in the effort to understand monarch butterfly navigation and migration and hopes to trace the neural connection between the antennae clocks and the brain's sun compass. In addition, his team is investigating other functions of the antennae that they believe are critical for successful migration.

Source: University of Massachusetts Medical School (news : web)