Monarch butterflies reveal a novel way in which animals sense the Earth's magnetic field

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Photo by Derek Ramsey. Via Wikipedia.

Building on prior investigation into the biological mechanisms through which monarch butterflies are able to migrate up to 2,000 miles from eastern North America to a particular forest in Mexico each year, neurobiologists at the University of Massachusetts Medical School (UMMS) have linked two related photoreceptor proteins found in butterflies to animal navigation using the Earth's magnetic field.

The work by Steven Reppert, MD, professor and chair of neurobiology at UMMS; Robert Gegear, PhD, research assistant professor of neurobiology; Lauren Foley, BS; and Amy Casselman, PhD, is described

in the paper, "Animal cryptochromes mediate magnetoreception by an unconventional photochemical mechanism," to be posted on-line in the journal *Nature* January 24.

The research team used fruit flies engineered to lack their own Cryptochrome (Cry1) molecule, a UV/blue-light photoreceptor already known to be involved in the insects' light-dependent magnetic sense. By inserting into those deficient flies butterfly Cry1, a homolog of the fly protein, or the related butterfly protein Cry2, the researchers found that either form can restore the flies' magnetic sense in a light-dependent manner, illustrating a role for both Cry types in magnetoreception. "Because the butterfly Cry2 protein is closely related to the one in vertebrates, like that found in birds which use the Earth's magnetic field to aid migration," states Dr. Reppert, "the finding provides the first genetic evidence that a vertebrate-like Cry can function as a magnetoreceptor."

An interesting feature of the team's work disproved a widely held view about how these proteins can chemically sense a magnetic field. "These findings suggest that there is an unknown photochemical mechanism that the Crys use instead," says Dr. Gegear, lead author on the paper, "one that we are hotly pursuing."

One of the most exciting aspects of the work was showing that each of the two forms of butterfly Cry have the molecular capability to sense magnetic fields. Reppert's group is now developing behavioral assays to show that monarchs can actually use geomagnetic fields during their spectacular fall migration. "We believe we are on the trail of an important directional cue for migrating monarchs," states Reppert, "in addition to their well-defined use of a sun compass."

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. Earlier this year, he and colleagues demonstrated that a key mechanism of the sun compass 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 provided an entirely new perspective of the antenna's role in insect migration.

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