Genetic basis for migration

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Scientists studying Eastern North American monarch butterflies (*Danaus plexippus*) have uncovered a suite of genes that may be involved in driving the butterflies to migrate towards Mexico for the winter. Their research, published in the open access journal *BMC Biology*, describes 40 genes that are linked to the butterflies' compulsion to orientate themselves by an internal 'sun compass' and begin the 4000km journey southwards.

Steven Reppert led a team of researchers from the University of Massachusetts Medical School who performed behavioral and genetic analyses on summer and migratory monarch butterflies. He said, "Our data are the first to provide a link between gene expression profiles in the brain and migratory state in any animal that undergoes long-distance migration. Moreover, our results also provide the first insights into gene expression patterns that may underlie sun compass orientation, a complex process involving the integration of temporal and spatial information".

Monarch butterflies begin flying south in the fall, using their internal clock and a sun compass to orientate themselves. After spending the winter in the warmer climes of Mexico, they begin moving northwards again through the Southern United States, breeding as they go, and spending the late summer in a non-migratory state in the Northern US. Unlike summer butterflies, some of whose offspring become fall migrants, the fall insects are not reproductively active - they have smaller reproductive organs and exhibit reduced sexual behavior. This dampening of their ardour is caused by a reduction in levels of Juvenile

Hormone (JH), which allows the butterflies to live longer as well as stopping them from having sex and laying eggs during their long journey south.

The authors tested whether JH levels are also responsible for flight orientation. By treating fall butterflies with a potent JH analog, they induced a summer-like reproductive state, and then looked at their oriented flight behavior in a flight simulator, and gene expression profiles in their brains. Repperts said, "We found that orientated flight behavior was independent of JH activity. Furthermore, in contrast to the non-migratory summer butterflies, the fall butterflies showed significantly different activation patterns in a suite of 40 JH-independent genes, showing that seasonal changes in genomic function help define the migratory state".

Defining behavioral and molecular differences between summer and migratory monarch butterflies, Haisun Zhu, Robert J Gegear, Amy Casselman, Sriramana Kanginakudru and Steven M Reppert, BMC Biology (in press), www.biomedcentral.com/bmcbiol/

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