University of Florida Book of Insect Records
Chapter 35 *Longest Regularly Repeated Migration*

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Every autumn the eastern North American population of monarch butterflies, Danaus plexippus *(Lepidoptera: Danaidae), migrates from as far north as southern Canada to overwintering sites in Central Mexico. This journey may cover 4000 km or more for some individuals and take as long as 75 days. The following spring these same individuals remigrate to the southern United States to produce the first of two to four successive generations that repopulate their summer range.*

Almost every author who has written about insect migration has defined the term to suit his particular theory. C.G. Johnson (1969) divided insect migration into three classes of complexity. He placed monarchs in Class III defined as "Emigration to hibernation or aestivation sites and return flights by the same individuals after imaginal diapause." Seventeen years later L. R. Taylor (1986) described four kinds of migration, two of which he applied to the movements of insects. He described *dynamic migration* as one-way single migration actively initiated by the insect but dependent for the most part on wind or tides with no navigation or directional control by the individual. The vast majority of migrating insects falls into this category, and the desert locust, *Schistocerca gregaria* holds the record for longest distance traveled (Tipping 1995). Taylor's *homeostatic migration* is two-way migration which may take advantage of wind but is directed by the navigational ability of the insect and includes a return to the point of origin by the same individual or its progeny. The distinguishing characteristic of Taylor's homeostatic and Johnson's Class III migration is that the insect directs its travel to a predetermined destination. This type of navigation is usually associated with mammals, birds, fishes, reptiles, and amphibians that live long enough as adults to make at least one round trip, and is rarely observed in insects. Homeostatic migration is a valid topic for this book because it is distinctly different from dynamic migration.

Methods

Discussion with my colleague Chris Tipping first confirmed my choice of the champion homeostatic migrating insect. I searched AGRICOLA and WebLUIS for primary literature. A posting to ENTOMO-L on the Internet led to the web site of Monarch Watch, a valuable resource.

Results

Almost all the homeostatic migrating insects are lepidopterans. Their flights range from a few kilometers up and down the side of a mountain to hundreds of kilometers across continents (Williams 1930, Urquhart 1960, Johnson 1969, Baker 1978). None of the other lepidopterans are close runners up to the records for monarchs. In 1937, F. A. Urquhart began marking monarchs with wing tags to study migration, and from 1952 to 1976 more than 3,000 volunteers in his Insect Migration Association participated in the study (Urquhart and Urquhart 1977). L. P. Brower (1996) reported flights of over 3600 km based on his own extensive research and overwhelming circumstantial evidence. The longest documented one-way record for a monarch is 1,870 miles (3,009 km). This butterfly was tagged 18 Sep 1957 in Highland Creek, Ontario, Canada, and recaptured 25 Jan 1958 in Estacion Catorce, San Luis Potosi, Mexico (Urquhart 1960). Monarch Watch lists the longest known flight as 2880 miles (4635 km) tagged in Brighton, Ontario, 10 Sep 1988 and recaptured 8 Apr 1989 in Austin, Texas. This butterfly is assumed to have overwintered in Mexico and been recaptured after remigration. It is important to remember that these insects are unlikely to have flown in straight lines from the point of tagging to recapture. They must make navigational corrections for unfavorable winds, fly over or around obstacles, and follow uneven coastlines. Consequently, they probably traveled much farther.

Discussion

Special physiological adaptations of the south flying fall generation make these annual journeys possible. First, they are in reproductive diapause and do not sexually mature until just before the spring migration. Thus, they conserve energy required for egg development and can fly the great distances without heavy eggs. Second, they have large fat reserves, which give them a longer life span than the summer generations. As they fly south, they nectar from flowers to provide energy for the migration. During overwintering, the fat is conserved until they reach sexual maturity and begin the spring migration. At this time of year there are few nectar sources available and the stored fat must be utilized for the return trip (Urquhart and Urquhart 1977). Both males and females return to the southern U. S. in spring to mate, lay eggs, and die. A third physiological adaptation is a lowered metabolic rate after they reach overwintering sites. This is accomplished as they hang in dense, quiescent clusters in the cool, high altitude Oymal fir forest of the Neovolcanic Belt Mountains in Central Mexico from mid-November to mid-March (Brower 1996). Finally, this migration could not occur without sophisticated innate navigational ability.

Behavioral and physiological experimental evidence both gives clues about monarch navigation. Researchers at the University of Kansas tested the monarch's ability to orient themselves by the direction of sunlight. By holding butterflies of the September generation in the dark for six hours they caused a "clock shift." When these individuals were released they flew a mean heading that was 75º clockwise from the direction of the controls thus demonstrating a Sun compass in monarch butterflies (Perez, Taylor, and Jander 1997). On cloudy or overcast days monarchs still find their way (though they are not known to fly after dark) (Schmidt-Koenig 1979); therefore, there must be a "back up" system. Monarch adults contain magnetic particles, which may be part of a geomagnetic detection system though this is as yet unproven (Jungreis 1987).

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