

Photo credit: National Geographic Society

## A Natural History of the Monarch Butterfly (Lepidoptera: Nymphalidae *Danaus plexippus*)

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I have some friends who spend the winter in Mexico. They don't own a house there and they don't spend their time visiting museums or soaking up sun at the beach. Instead, these friends pass most of their time burning fat and resting in the mountainous forests of Oyamel or Sacred Fir (Abies religiosa) trees in the state of Michoacán.

These friends aren't dieters as they only weigh about half a gram. And although they pass hours, days and weeks barely moving amongst the Sacred Firs they aren't quite new age meditaters either.

If this all sounds a bit strange wait until you hear that our friends have a genetic memory of place and a navigation system to arrive at their wintering grounds inherited from the great-great grandparents they never met.

If you're still a bit perplexed here's a hint: these friends also have orange & black wings, six legs and a pair of antennae. In the spring and summer months they are seen throughout many areas of North America as eggs, adolescences and adults in fields and gardens as far north as southern Canada.

These "friends" are of course Monarch Butterfiles, known also by their Latin binomial of *Danaus plexippus* which was conferred by Carl Linnaeus in 1758.



Photo credit: Journey North, Monarch Butterfly section

Let's go back a few generations from that winter in Mexico in order to better understand how this species makes its way in the world.

In the proverbial "spring of the year", in this case during February or March, adult Monarchs who have survived the sometimes cold or rainy weather as well as the bird and mammal predators of winter fly as far north as Texas or Oklahoma to find the milkweed (species of the genus Asclepias) and a select few other plants their offspring will depend on for food.

There, after mating, the females place, one at a time and often one per leaf, about 8 dozen tiny eggs usually on the undersurface of milkweed plants. If milkweeds are in short supply females may "egg load" multiple eggs on individual plants.



"Egg loading" on an emergent milkweed leaf. Photo credit: www.learner.org/jnorth/

These ridged eggs are approximately the size of this "0" or about 0.9mm wide and 1.2mm tall.



Mature Monarch (*Danaus plexippus*) egg. Photo credit: BugGuide.net

After as little as three days the eggs hatch and tiny caterpillars emerge into the world.



First instar caterpillar emerging from egg. Photo credit: BugGuide.net



First instar feeding machine looking for its first meal. Photo credit: BugGuide.net

One of the first things these tiny (circa 2mm) friends do is consume the cases they just emerged from.



First instar caterpillar using its chewing mouthparts to devour it s own egg shell. Photo credit: www.learner.org/jnorth/

Over the course of the next 2 weeks monarch caterpillars will feed like insatiable guests at a cruise ship buffet, except that throughout their range their buffet consists of only about 20 species of milkweeds and a handful of other plants. Monarch caterpillars are also known to feed on the leaves of Crown Flower (Calotropis gigantea), Apple of Sodom (Calotropis procera), Sand Vine (Cynanchum laeva) and White Vine (Sarcostemma clausa). During those two weeks or so the caterpillars will shed their skin five times and engorge themselves to the amazing size of about 5 centimeters, approximately 3,000 times larger than that of the egg from which they emerged!



Monarch caterpillars of each of the five "instars" (left to right: 2<sup>nd</sup>, 3<sup>rd</sup>, 5<sup>th</sup>, 4<sup>th</sup> and 1<sup>st</sup>). Photo credit: East Bay Regional Parks District

Each time a caterpillar sheds its skin or "molts" it grows into a new caterpillar stage or "instar".



Late instar caterpillars feeding on Common Milkweed in Northern Michigan (Asclepias syriaca). Photo courtesy of Ceini Smith

When a caterpillar becomes a fifth or final instar it prepares for big change, its rite of passage into adulthood, by leaving it's host plant and finding a nearby surface, often a tree branch from which to begin its metamorphosis.

There it exudes a silky substance from its mouth and uses this to attach its hind prolegs and hang from its perch in a "J" shape.



Fifth instar caterpillar preparing to pupate. Photo courtesy Ceini Smith

Shortly thereafter a black attachment rod known as a "cremaster" forms and the caterpillar sheds its skin a final time. Underneath that skin is a soft chrysalis which soon hardens into a reasonably sturdy protective case for the metamorphosing insect inside. The chrysalis starts out a light jade green color and progresses through shades of blue-green to gray-green. A band of black lines the area of the abdomen and spots of elemental gold trim the abdomen and appear at the bases of the wings, along the thorax and at the eyes.



Young Monarch chrysalis. Photo courtesy Ceini Smith

Within the chrysalis the caterpillar melts down and becomes what some have dubbed a "living soup" of genetic material. In just nine to fourteen days these genes and hormonal changes reorganize this material into a functional adult butterfly.

In order to tell the sex of a Monarch while it is still in the pupa take a look at the area just below the cremaster at the black dots and series of rings (indicating the forming abdominal sternites). Within the topmost ring, which is the 9th abdominal sternite, you will find a series of paired dots. In female pupae there is a vertical line below the lowest two dots.



Female Monarch pupa. Photo credit: BugGuide.net

Male pupae do not exhibit this character.



Male Monarch pupa with a dot but no line beneath lowest black dots. Photo credit: BugGuide.net

Before the butterfly emerges from the pupa stage, also known as eclosing, the chrysalis becomes completely transparent and shows the brilliantly contrasting colors of orange, black and white wings and a black body with white spots. Its head is at the bottom of the chrysalis, its wings fold around its thorax and its abdomen fills the top.



Monarch pupa just before adult emergence. Photo courtesy Ceini Smith

With a little shake the pupa case splits and our brush-footed friend begins to emerge.



Monarch adult emerging from chrysalis case. Note the crumpled wings and enlarged abdomen. Photo courtesy Ceini Smith

How is this butterfly ever going to fly? Its wings are so small and its abdomen is so large! Fortunately it's all part of nature's design. For about an hour she pumps hemolymph from her abdomen into her wings making them larger, stiffer, stronger and fit for flying. She also knits the two sections of her tongue or proboscis together so that she will now be able to feed on nectar at milkweed and other flowers. Just before taking flight she expels a few drops of unneeded orangey-brown fluid known as meconium, waste products from the process of metamorphosis. She then opens and closes her wings until they are dry and rocks back and forth with her four hind legs. The front pair of legs are greatly reduced and used primarily for

sensing the physical and chemical world around her.

As adults, the males and females feed on nectar of milkweed but also other plants including: Asters, Thistles, Alfalfa, Golden Rods, Lilac, Red Clover, Wild Carrot (*Daucus carota*), Teasel (*Dipsacus sylvestris*), Spotted Joe-Pye Weed (*Eupatorium maculatum*), Boneset (*Eupatorium perfoliatum*), Tall Ironweed (*Veronica altissima*) and Dame's Rocket (*Hesperis matronalis*).



Monarch butterfly after emerging or "eclosing" from its chrysalis case. Note the fully expanded wings. Photo courtesy Ceini Smith



Monarch Adult feeding at Swamp Milkweed (Asclepias incarnata) Photo courtesy of Cindy Mom (Little Traverse Conservancy)

In as little as four days adult Monarchs are ready to mate. Males Monarchs can be distinguished from females by the presence of a single dark spot in each of the hind wings. These spots are more than just for show however. Biologists have determined that the males use these spots, known as androconia (singular androconium) to release pheromones. While females have thicker dark veins on their wings the males tend to be slightly larger in size. Adult wingspans range from 8.6 to 12.4 centimeters.



Photo credit: www.butterfliesonflowers.com

Mating amongst Monarchs involves both areal courtship and ground based copulation. Males locate, chase and nudge females before ultimately taking one down the ground. On the ground the pair stay attached while he transfers to her a spermatophore containing both sperm and energy resources thought to assist her in producing healthy offspring. This ground phase of the mating process typically lasts 30 to 60 minutes.

Once the female fertilizes and oviposits fertile eggs on the surface of leaves her sons and daughters will need as caterpillar food the Monarch life cycle continues. This first generation will eventually die as the season's second generation continues this life cycle in a similar fashion by migrating northward within the range of their required larval host plants and themselves reproducing before perishing. It takes four or five generations for individuals of this species to reach the northern limit of larval host plants.

Come late summer (August to November) unmated adults born in the fall begin to orient themselves south with thoughts of mass migration and mass diapause ,sort of like "communal butterfly hibernation", within the protection of the Sacred Fir forests of Michoacán.

This precise migration of several thousand kilometers to the wintering grounds, while not completely understood, is thought to be inherited and dependent upon a precise "circadian clock" located in their antennae.

The sun's position and a "time-compensated sun compass" also combine to accurately guide our 3<sup>rd</sup>, 4<sup>th</sup> or 5<sup>th</sup> generation friends south to their ancestral winter resting place, a place they themselves have never actually been.

Early Monarch generations live for about 30 to 40 days. The generation that migrates south to the wintering spot will live through the fall, winter and into the following spring before they return north to continue their species, as many as seven months later!



North to south migration patterns for Monarchs. Photo credit: wwww.MonarchWatch.org



Satellite image of Mexican wintering locations. Photo credit: Journey North, Monarch Butterfly section

To be fair, not all Monarchs winter in Mexico. Populations west of the Rocky

Mountains in the U.S. and Canada winter along the central and southern coast of California amongst the conifer forests in areas including Santa Cruz and Pacific Grove.

There are also non-migratory populations of Monarchs on Hawaii and several of the Atlantic Islands including the Canary Islands, Azores and Madeira. Monarchs were also introduced to Australia and New Zealand in the late 19<sup>th</sup> century. Monarchs are sometimes also found in Western Europe if they wander or are blown off course during migration.

Since the Monarch lifecycle is so unique and multigenerational and because they cluster together literally by the millions in just a few locations each winter habitat destruction and modification threatens to disrupt the viability of the entire species.



Photo credit: Tia Stephanie Tours (www.tiastephanietours.com/facts)

Monarch overwintering has come to be considered by many an "endangered phenomenon" worthy of appropriate natural and legal protection.

There is so much more to Monarchs, so get

out there and get to know these beautiful and unique friends for yourself!

Additional sources of information on Monarch biology and migration as well as topics such as butterfly mimicry, logging and wood use within Monarch wintering areas and establishing your own butterfly attracting garden can be found at the

**Monarch Watch** based at the University of Kansas: www.monarchwatch.org

websites for:

The Monarch Monitoring Project at the Cape May Bird Observatory in New Jersey: www.birdcapemay.org/monarch.shtml and

Journey North, a Global Study of Wildlife Migration and Seasonal Change including also information on people and Monarchs sharing the forest: www.learner.org/jnorth/

Matt Pierle is a naturalist and natural history writer who when not traveling by bike, thumb, paddle or boot with hand lens, binoculars, bug net and camera in hand lives in and explores the Upper Great Lakes Bioregion.

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