Monarch Butterfly – Life and Migration

The awesome sight of hundreds of monarch butterflies flying across a vast expanse of land inspires a feeling of wonder in all who are lucky enough to see such a beautiful sight. Monarchs are especially noted for their lengthy annual migration. The monarch butterfly migrates over 3,100 km from Canada to Mexico without training or navigational assistance – without ever having been to its destination. For scientists, this annual migration is one of nature's greatest mysteries.

Monarch butterflies are incredibly fascinating creatures. Only recently have their life and migratory cycles been studied and recorded. Little was known of their enormous struggle for survival against such forces as nature and humans. We hope that this glimpse into the life of the monarch butterfly has helped you to appreciate more than just their breathtaking appearance.
The Monarch butterfly is a milkweed butterfly. It is perhaps the best known of all North American butterflies. In North America, the Monarch ranges from southern Canada to northern South America. By being transported by U. S. ships or by flying if weather and wind conditions are right, it has also been found in Bermuda, Hawaii, the Solomons, New Caledonia, New Zealand, Australia, New Guinea, Ceylon, India, the Azores, and the Canary Islands and as far away as western Europe and Greece. Monarch butterflies are one of the few insects capable of making trans-Atlantic crossings. They are becoming more common in Bermuda due to increased usage of milkweed as an ornamental plant in flower gardens. Monarch butterflies born in Bermuda remain year round due to the island's mild climate.

Description

The monarch butterfly’s wings feature an easily recognizable orange and black pattern, with a wingspan of 8.9–10.2 centimetres (3½–4 in). (The Viceroy butterfly has a similar size, color, and pattern, but can be distinguished by an extra black stripe across the hind wing.). Female Monarchs have darker veins on their wings, and the males have a spot called the "androconium" in the center of each hind wing from which pheromones are released. Males are also slightly larger. A recent study examined wing colors of migrating monarchs found migrants had darker orange (reddish colored) wings than breeding monarchs. Like all insects, the Monarch has six legs, however it uses only four of its legs as it carries its two front legs against its body.

The eggs are creamy white and later turn pale yellow. They are elongate and subconical, with approximately 23 longitudinal ridges and many fine traverse lines.

The caterpillar is banded with yellow, black, and white stripes. The head is also striped with yellow and black. There are two pairs of black filaments, one pair on each end of the body. The caterpillar will reach a length of 5 cm (2 in).

The chrysalis is blue-green with a band of black and gold on the end of the abdomen. There are other gold spots on the thorax, the wing bases, and the eyes.

Life – Reproductive Cycle
The life cycle of a monarch includes a change of form called complete **metamorphosis**. The monarch goes through four radically different stages - egg, larva (caterpillar), pupa and adult.

1. The eggs are laid by the females during spring and summer breeding months as they migrate north. After laying about 400 eggs, the mother monarch abandons her young to look after themselves.
2. The eggs hatch after 4 days, revealing worm-like larvae, the **caterpillars**. The caterpillars consume their egg cases, and are then totally dependent upon on **milkweed**. During the caterpillar stage, monarchs store energy in the form of **fat** and **nutrients** to carry them through the non-feeding **pupa** stage. The caterpillar stage lasts around 2 weeks. The monarch butterfly caterpillar sheds its skin four times within two weeks of hatching. When the monarch butterfly caterpillar is two weeks old, it weighs 3,000 times as much as it did when it was born.
3. In the **pupa** or **chrysalis** stage, the caterpillar spins a silk pad on a twig, leaf, etc., and hangs from this pad by its last pair of prolegs. It hangs upside down in the shape of a 'J', and then molts, leaving itself encased in an articulated green **exoskeleton**. At this point, hormonal changes occur, leading to the development of a butterfly (metamorphosis). The chrysalis darkens (the exoskeleton becomes transparent) a day before it emerges, and its orange and black wings can be seen.

4. The mature butterfly emerges after about two pupal weeks and hangs from the split chrysalis for several hours until its wings are dry and hard (often in the morning). Meanwhile fluids are pumped into the crinkled wings until they become full and stiff. Some of this orangey fluid (called meconium) drips from the wings. Finally (usually in the afternoon) the monarch spreads its wings, quivers them to be sure they are stiff, and then flies away, to feed on a variety of flowers, including milkweed flowers, red clover, and goldenrod. Monarchs can live a life of two to eight weeks in a garden having their host **Asclepias** plants and sufficient flowers for nectar. This is especially true if the flower garden happens to be surrounded by native forest that seems to be lacking in flowers.

The mating period for the overwinter population occurs in the spring, just prior to migration from the overwintering sites. The courtship is fairly simple and less dependent on chemical pheromones in comparison with other species in its genus. Courtship is composed of two distinct stages, the aerial phase and the ground phase. During the aerial phase, the male pursues, nudges, and eventually takes down the female. Copulation occurs during the ground phase where the male and female remain attached for about 30 to 60 minutes. A spermatophore is transferred from the male to the female. Along with sperm, the spermatophore is thought to provide the female with energy resources that aid her in carrying out reproduction and remigration. Monarch butterflies that breed early in the summer die within a few weeks. If a monarch butterfly does not breed before late August, however, its reproductive maturity will be postponed and it will live for up to nine months. It is these "late bloomers" that migrate from Canada to Mexico. The goal of this initial population is to survive the trip to the overwintering sites in Mexico.

After their season in the migratory site, the female monarch reproductive organs become fully developed and mating takes place. As they migrate north in the spring, they lay eggs on milkweed along the way. These larvae appear in the southern return path in March and early April. This generation will also migrate North following their parents. The reproductive cycle continues and by August to early September, three to four generations will have evolved. So losses which have occurred throughout the migration cycle will be replenished by this population buildup.

It would be nearly impossible for an individual monarch butterfly to complete this entire migratory cycle. Because of this, their rapid system of reproduction is of great importance to the survival of the species and the completion of the migratory cycle from year to year.

**Migrational Pattern/ Behavior**
Overwintering Monarchs clustering on Ovamel trees in a preserve outside of Angangueo, Mochoacan, Mexico. Note that one tree is completely covered in butterflies.

Each fall starting in August until the first frost in November/December, the millions of monarchs migrate south. The destination of the butterflies is the pine oak forests on a few small mountain peaks in an approximately 60-square-mile (155-square-kilometer) area in the volcanic highlands of Central Mexico. This place serves as the butterflies’ winter retreat. As many as 300 million spend the winter there. A northward migration takes place in the spring. The monarch is the only butterfly that migrates both north and south as the birds do on a regular basis.

No single individual makes the entire round trip. Female monarchs deposit eggs for the next generation during these migrations. It takes 3 to 5 generations to make the migration, to Mexico. So the butterflies that make it are the great, great grandchildren of the previous generation to have made it.

During the migration, monarchs encounter many dangers. These dangers include such things as storms, predators, humans (more accurately, their cars), and simple fatigue. Many butterflies are the casualties of storms and are eaten by birds. Hundreds are crushed by cars crossing the highways, and still many more can be seen limply trying to keep aflight, ready to collapse at any moment. Even after the monarchs arrive at their winter retreats, the danger of storms is still a major factor on the survival. The danger is greater, particularly in Mexico, where temperatures, strong winds, and snow kill thousands.

During the migration, the monarchs feed extensively on flowers to gain carbohydrates from
nectars which fuel daily activities and contribute to the build up of the fat body in the abdomen. This fat supply gives energy to the monarchs on their long journey. Monarchs travel distances as great as 3,100 miles during their migration, traveling roughly 50 miles per day. Monarch flight speeds have been measured at 12 miles per hour. Once they have reached their roosting site, they cluster in large numbers in the branches and trunks of the oyamel trees. While clustering they remain quiescent (they stay relatively still and maintain low metabolic rates). In mid-February, the monarchs at the roost sites become more active and mating behavior begins. By the end of February, some of the monarchs begin moving northward and by mid-March, the roost is usually depleted.

This initiates the start of the spring migration. The spring migration starts out with only about half of the original roosting population. Forty to sixty percent of the monarchs die during their stay in Mexico. During the spring migration, the monarch butterflies return to their homes in Canada and the northern most parts of the United States. Along the way, they roost and reproduce, giving rise to new butterflies that will continue the spring flight back.

The last generation of the summer enters into a non-reproductive phase known as diapause and may live seven months or more. During diapause, butterflies fly to one of many overwintering sites. The generation that overwinters generally does not reproduce until it leaves the overwintering site sometime in February and March. It is thought that the overwinter population of those butterflies east of the Rockies may reach as far north as Texas and Oklahoma during the spring migration. It is the second, third and fourth generations that return to their northern locations in the United States and Canada in the spring.

Migration Mysteries

There are many mysteries associated with monarch migration. The butterflies, which can fly as far as 4,000 kilometres to their winter homes, always have to find the way anew. The generation of butterflies that flew the same route the previous autumn (and back again in the spring) are long gone - between three and five generations pass during the summer. For example, given that the migrating butterflies are the great-grandchildren of the last ones to make the trip, how do they know that southwest is the right way to go? And how is it that great flocks of monarch butterflies go, not just in the same general direction, but even to the same trees as their predecessors?

They must have an instinct that leads them to Mexico -- and they probably use other clues, like landmarks and the direction of the sun, to help them on their way. And as every boy scout knows, you should always take a compass on a long trip. Monarch butterflies, which find their way from their breeding grounds in the northeastern United States and Canada to the warmer mountains of central Mexico every autumn, appear to use their own compasses to guide them.
Jason Etheredge of the University of Kansas, Lawrence, Kansas, and colleagues have discovered that monarch butterflies can detect the magnetic field of the Earth, and use it to find their way. The researchers collected wild butterflies in the autumn, when they were due to migrate. They tested the butterflies under three conditions: no magnetic field at all, the natural magnetic field of the Earth, or an artificial magnetic field that was the reverse of the Earth’s. Etheredge’s team watched the butterflies to see in which direction they flew under each of these conditions.

When there was no magnetic field at all, the researchers noticed the butterflies flew in random directions. In the Earth’s normal magnetic field, however, most of the butterflies flew towards the southwest -- just as they would when migrating in the wild. Under a reversed magnetic field, they flew towards the northeast, confirming that they were using the direction of the field to decide where to go.

How can butterflies 'feel' magnetism? Along with other migratory animals like birds, it appears that monarch butterflies may use a magnetic substance, 'magnetite', to sense the Earth’s magnetic field. New research has also shown the antennae contain cryptochrome a photoreceptor protein that is sensitive to the violet-blue part of the spectrum. In the presence of violet or blue light it can function as a chemical compass, which tells the animal if it is aligned with the earth’s magnetic field, but it is unable to tell the difference between the magnetic North or South. The complete magnetical sense is present in a single antenna.

How the species manages to return to the same overwintering spots over a gap of several generations is still a subject of research; the flight patterns appear to be inherited, based on a combination of the position of the sun in the sky and a time-compensated Sun compass that depends upon a circadian clock that is based in their antennae.

The exact migratory path is still being plotted today. Scientists are tagging the butterflies, and recording their locations during the months of the fall migration.

A common question that most people wonder about is why the monarch butterflies migrate in the first place rather than stay where they are and breed? Unfortunately, there is no one simple answer to this question. Researchers in this field are trying to uncover this mystery.

Monarchs collected during the summer months, when they would not normally migrate, flew in random directions when tested in the laboratory regardless of the direction of the magnetic field. The butterflies, then, must detect changes in the environment -- perhaps in the temperature or the length of the day -- that tell them when it is time to head for the sun. The first and most simple explanation is that like migratory birds, monarch butterflies migrate to warmer climates to escape from the upcoming cold weather and the food shortage that will result from the temperature fall. But how do the butterflies "know" that the winters are cold? They don't. What the monarch butterflies sense is the changing amount of light present and the variability of day and nighttime temperatures. With the change of seasons from fall to winter comes the inevitable shortening of the days, longer nights, and also colder nighttime temperatures. Once these characteristics show up, the monarchs leave for their overwintering sites. The migrational pattern presently observed originated in the distant past when the monarchs were following the milkweed species which were spreading westward. This east-west movement was eventually incorporated into the monarch’s genetic code to produce a cyclical migration related to some as yet unknown response to seasonal changes on the planet.
Habitat

The Monarch can be found in a wide range of habitats such as fields, meadows, prairie remnants, urban and suburban parks, gardens, and roadsides. It overwinters in conifer groves.

Adult Monarchs have been seen on a number of different nectar plants. A list of nectar-resources exploited by Monarch butterflies is as follows:

- **Apocynum cannabinum** - Indian Hemp
- **Asclepias californica** - California Milkweed
- **Asclepias incarnata** - Swamp Milkweed
- **Asclepias syriaca** - Common Milkweed
- **Asclepias tuberosa** - Butterfly Weed
- **Aster** sp. - asters
- **Cirsium** sp. - thistles
- **Daucus carota** - Wild Carrot
- **Dipsacus sylvestris** - Teasel
- **Erigeron canadensis** - Horseweed
- **Eupatorium maculatum** - Spotted Joe-Pye Weed
- **Eupatorium perfoliatum** - Common Boneset
- **Hesperis matronalis** - Dame's Rocket
- **Medicago sativa** - Alfalfa
- **Solidago** sp. - golden rods
- **Syringa vulgaris** - Lilac
- **Trifolium pratense** - Red Clover
- **Vernonia altissima** - Tall Ironweed

Males will also take in moisture and minerals from damp soil and wet gravel, a behavior known as mud-puddling. The Monarch has also been noticed puddling at an oil stain on pavement.

Host plants

Here is a list of host plants used by the Monarch caterpillar:

- **Asclepias amplexicaulis** - Clasping Milkweed
- **Asclepias asperula** - Antelope Horns
- **Asclepias californica** - California Milkweed
- **Asclepias cordifolia** - Heart-leaf Milkweed
- **Asclepias curassavica** - Scarlet Milkweed
- **Asclepias curtissii** - Curtiss' Milkweed
- **Asclepias eriocarpa** - Woollypod Milkweed
- **Asclepias erosa** - Desert Milkweed
- **Asclepias exaltata** - Poke Milkweed
- **Asclepias fascicularis** - Narrow-leaf Milkweed
- **Asclepias humistrata** - Sandhill Milkweed
- **Asclepias incarnata** - Swamp Milkweed
- **Asclepias meadii** - Mead's Milkweed
- **Asclepias nivea** - Caribbean Milkweed
- **Asclepias physocarpa** - Swan Plant
- **Asclepias purpurascens** - Purple Milkweed
Swamp milkweed, one of many species of **Asclepias** milkweeds used by the monarch

**Threats**

**Predators**

Monarch butterflies and their larava are poisonous or distasteful to birds and mammals because of the presence of cardiac glycosides that are contained in milkweed consumed by the larva. It is thought that the bright colors of larva and adults function as warning colors. Although monarchs feed on milkweed, variations in the quantity of cardiac glycosides exist between species, individuals and even parts of the host plant. The levels of toxins in adult monarchs reflect the levels in their host plants. Some species of predators have learned to measure the toxins by taste and reject butterflies with high cardiac glycosides contents, eating only the ones with low cardiac glycosides contents. In the butterfly, the cardiac glycosides are concentrated in the abdomen and wings. Some species of predators differentiate these parts and consume only the most palatable ones. Bird predators include Brown Thrashers, Grackles, Robins, Cardinals, Sparrows, Scrub Jays and Pinyon Jays. Some mice are also able to withstand large doses of the poison. Over time, overwintering adults become less poisonous, thus making them more vulnerable to predators. During hibernation monarch butterflies sometimes suffer losses because hungry birds pick through them looking for the butterflies with the least amount of poison, but in the process killing those that they reject. In Mexico, about 14% of the overwintering Monarchs are eaten by birds and mice.

**Beetles**

In North America, eggs and larvae of the monarch are eaten by larvae and adults of the Asian lady beetle.

**Parasites**
Parasites include the tachinid flies. Parasitized monarch larvae complete their moult, suspend, but die before pupation. At that time, one white maggot comes out of the larvae, suspended by a silken thread. The maggot then forms a brown pupa on the ground.

The bacteria also infects the larvae and causes “black death”. As usual, just before pupation the larvae migrate to a horizontal surface. They die a few hours later, attached only by one pair of prolegs, thorax and abdomen hanging limp. The body turns black shortly after.

Other parasites infect the subcutaneous tissues and propagate by spores formed during the pupal stage. The spores are found over all of the body of infected butterflies, with the greatest number on the abdomen. These spores are passed, from female to caterpillar, when spores rub off during egg-laying and are then ingested by caterpillars. Severely infected individuals are weak, unable to expand their wings, and have a shortened lifespan.

Confusion of Host Plants

A problem in North America is the black swallow-wort plant. Monarchs lay their eggs on these plants since they produce stimuli similar to milkweed. Once the eggs hatch, the caterpillars are poisoned by the toxicity of this invasive plant.

Deforestation

Recent illegal deforestation of the monarch’s overwintering grounds have led to a drastic reduction in the butterfly's population. Efforts to classify it as a protected species and to restore its habitat are under way.

Conservation

"No other animal is more typical of a healthy environment, nor more susceptible to change, than a butterfly" (Feltwell 1986). It is easy to see why this statement rings true. Monarchs have no control over what happens to their environment, they can only respond to what changes occur, which usually means either surviving or dying. Humans are the ones who have the most control over what will happen to the monarch butterfly population and the biggest problem that the monarchs face is the loss of habitat.

Monarch populations are particularly vulnerable in their overwintering sites in the high-altitude fir forests of the Transvolcanic Range of Mexico; only two of the eleven known roosting sites are well protected from logging (Brower and Malcolm 1991). The oyamel trees on which the monarchs cluster are valuable lumber sources, and local people need additional sources of income. If the roost sites are destroyed, monarch populations are likely to decline precipitously. Protection of the roost sites will be difficult since preservation of the sites and the monarch butterfly, will conflict with the increasing needs and changing priorities of a growing Mexican population.

Milkweed, the host plant of the monarch, is also a concern. In Canada, milkweed has been declared a noxious weed. This means that the plant is considered illegal and cannot be allowed to grow on private or public lands in Canada. Although not labeled noxious in the states, farmers consider the plant a nuisance to crops and often use herbicides to control it along with other weeds. More and more roadsides are being planted in grass instead of being allowed to
overgrow with wildflowers and weeds. The result is that butterflies have fewer places in the wild to find nectar and lay eggs.

So what can be done to help preserve the monarch population? The most important issue is to stop the destruction of the monarch's habitat. And the best way of doing that is to set up butterfly reserves, especially in Mexico where monarchs overwinter.

**Montes Azules** is a good example of a butterfly reserve that has been established. This reserve's purpose is to not only preserve butterfly habitat, but to provide the human residents with their economic needs. The motto of Montes Azules is, “Conservation Through Management.”

The Monarch Butterfly Model Forest (Bosque Modelo Mariposa Monarca) was established as part of the international network of model forests for the protection and conservation of the butterfly's habitat in Mexico. The Monarch Model Forest covers more than 790,000 hectares and 22 different municipalities; 12 in the State of Michoacan, and 10 in the State of Mexico. A strategic plan developed with technical assistance from Canada addresses the three basic areas of ecotourism, community development, and natural resource management. In 1998, the Monarch Model Forest requested technical assistance from USDA Forest Service International Programs primarily in ecotourism.

In a sanctuary in Angangueo, Michoacan in Mexico, there are thousands, or even millions, of Monarch Butterflies. From morning until about 1:00pm, you can see them flying around and almost obscuring the sky. You will hear the fascinating sound of their wings flapping.

In following Mexico's lead, Canada has taken steps to protect the summer homes of the monarchs. Hundreds of thousands of monarch butterflies spend their summers along the shores of Lake Ontario and Lake Erie and in southern Quebec. Presently, three sights along Ontario's great lakes have been designated as butterfly reserves.