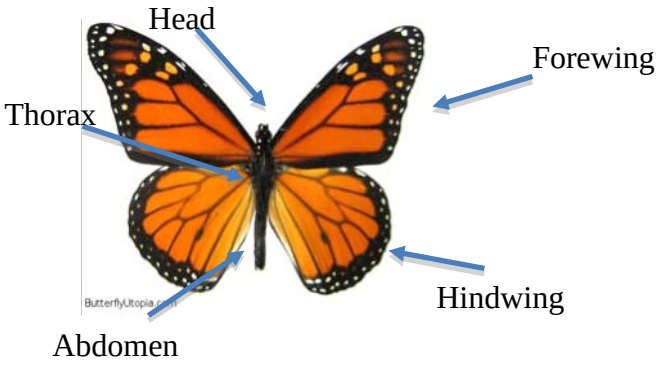
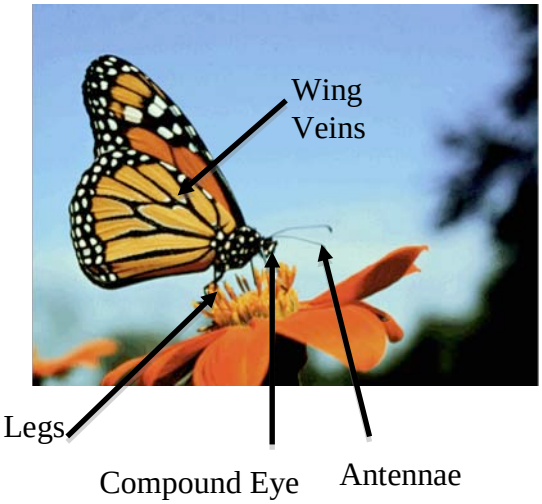
The Biology of Butterflies

Compiled by Emily Kearny, Cornell University 2010

Background and Identification

Butterflies are in the order Lepidoptera which are insects with scaled wings. Moths are also in the order Lepidoptera. Butterflies are invertebrates, which means that they do not have a backbone, instead they have an exoskeleton, a shell that encases their soft body and protects their vital organs. Butterflies undergo metamorphosis, so that the immature and adult forms are very different.





An adult butterfly has two wings, six legs, and a long body that has three segments: the head, the thorax and the abdomen. The two wings are divided into the forewing and the hind wing and attached to the thorax.

Butterflies also have two compound eyes and two antennae. The compound eyes are made up of thousands of ommatidia (cluster of light receptor cells that could be thought of as very small, simple eyes) that can each detect light and images. The two antennae and the two palpi (located underneath the head close to the proboscis) are covered in scales that detect molecules in the air to give the butterfly a sense of smell. At the bottom of the antennae there is also an organ called the Johnston's organ which helps the butterfly maintain its balance. This organ is used especially while the butterfly is flying because it detects gravity and wind. It is used to identify potential mates because it reacts to wing beat frequencies as well.

Butterflies have a very long, straw-like tongue called a proboscis that is usually curled up underneath their head. The proboscis is used to drink nectar and water and is only extended when the butterfly senses sugar. The thorax has three segments and contains the heart and most of the digestive system. A butterfly's circulatory system is composed of a long vessel that pumps blood (the heart) and a hemocoel or a series of spaces between organs through which blood can pass. Their circulatory system is very inefficient and so it limits the size of a butterfly. The respiratory system of a butterfly consists of nine spiracles or pores open to air and a series of tubes that carry air through the body, the trachea. The six legs

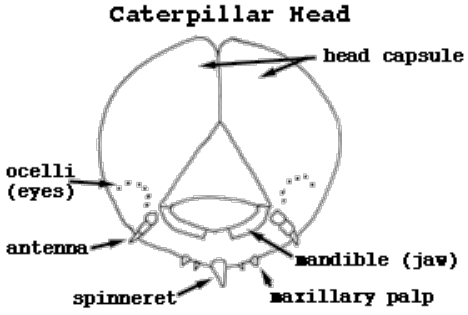
and the four wings are all attached to the thorax. On an adult monarch butterfly (like all other nymphalid butterflies), the first pair of legs (which are attached to the first segment) are curled up at the start of the thorax and are not visible. The next two pairs of legs are attached to the last two segments of the thorax and have six segments. On the top of the last segment of the legs, there are tarsi, sensory organs that detect sugar. When a butterfly lands on a flower, it uses its tarsi to detect the presence of sugar and then it extends its proboscis.

The wings of the butterfly are also attached to the last two segments of the thorax; the forewings are attached to the second segment and the hindwings are attached to the third segment. A butterfly's wings are supported by the veins that pass through them and operated by the muscles attached at the base of the wing connected to the thorax. A butterfly's wings are covered in scales to protect them and besides veins they have tubes with harden walls and trachea for more support. The abdomen is composed of eleven segments and contains the end of the digestive system and areas to store fat bodies for energy.

The Life Cycle

A butterfly starts its life as a small egg on a leaf or a branch of a host plant, a plant that will provide appropriate nutrition for the caterpillar to eat and thrive upon. Eggs of different species of moths and butterflies can vary greatly in size, shape and color. All eggs have a hard shell, or chorion, to protect them. A Monarch butterfly's egg is pale yellow to off-white and shaped like a tiny chicken's egg.

After several days to a week, the egg hatches and from the casing, out comes a tiny caterpillar. In order to emerge from the egg, the caterpillar must eat through the chorion. Caterpillars look like small worms with very few differences between their front and their back. However, caterpillars' bodies can be divided into three different segments just like an adult butterfly's body, the head, thorax and abdomen.



The head has simple eyes or ocelli, two very short antenna, a jaw or mandible, two palpi (which are sensory feelers) and a spinneret. The thorax has six very small real legs while the abdomen has ten prolegs (four pairs) that have tiny hooks on them that help the caterpillar to attach itself to a leaf or stem. The tentacles at the front and rear of the caterpillar are not real antennae; instead, the front tentacles are used as feelers (just like a blind man's cane) and the rear tentacles are used for defense to confuse predators about which end of the caterpillar is the head. The thorax and the abdomen also have holes in their sides (9 pairs) or spiracles that allow the caterpillar to breath. These holes are connected to tubes that run through out the rest of the caterpillar's body to provide its tissues with oxygen.

Monarch caterpillars go through five instars or stages as a caterpillar. Each instar is marked by the caterpillar shedding its outer skin and growing into it's new, larger skin. The shedding of the skin is called molting and the old skin is usually consumed after being shed. It takes a monarch caterpillar 10 to 14 days to go through all five instars.

In the caterpillar stage, the only purpose of the butterfly is to gain weight, especially fat. This is accomplished by eating large amounts of leaf material. In fact, some caterpillars can gain more than 20 times their original weight in less than a week. In the picture to the left, two large Monarch butterfly caterpillars are shown eating their favorite plant, the milkweed.

During the pupae stage, the transformation from larvae to adult is completed in a little less than two weeks. Before pupation, the caterpillar spins a silk pad on the bottom side of a branch, leaf or stem and then hooks itself to the silk pad by its cremaster which a spiny appendage at the end of its abdomen. The caterpillar hangs upside down and starts to "jay" or twist, swinging and bending upward in order to split and shed its skin. At first the green shell that appears underneath the old skin is soft but it soon hardens to form a chrysalis that will remain motionless on the branch (unless disturbed) until the adult butterfly starts to emerge. A monarch's chrysalis is green with a "crown" of gold and black and gold spots encircling it towards the bottom. However, all butterfly chrysalides are different. The Monarch chrysalis is much more camouflaged than the rest of the life stages of the Monarch butterfly because it is motionless and so defenseless. It is this life cycle stage in which a caterpillar completes it metamorphosis into an adult butterfly.

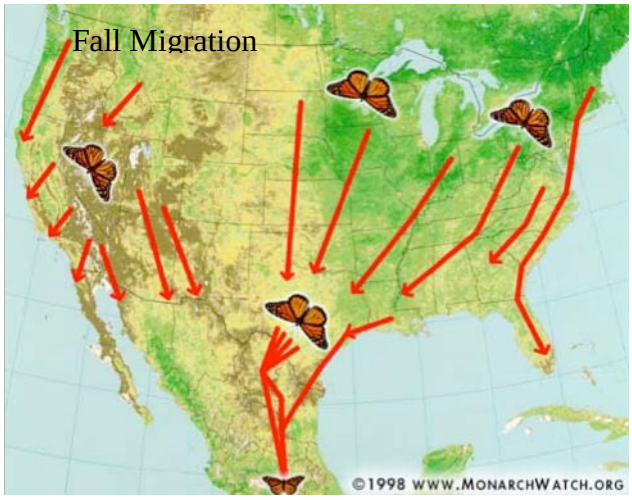
Once the chrysalis starts to change colors, the outer covering breaks open to reveal a very squished adult butterfly. The butterfly climbs out of the casing and once it is on the outside, it stops and starts to fill its crumpled wings up with fluid that is stored in its abdomen. This process can take several minutes and even after the wings are fully inflated, the butterfly needs to rest and let its wings dry before it takes flight which can take up to three hours. After taking flight, the butterfly uses its vision to find suitable flowers from which to drink. Most butterflies drink the nectar of flowers but some can even get their energy from different types of nutrient rich soils. Butterflies do not grow as adults and only eat enough to maintain their energy.

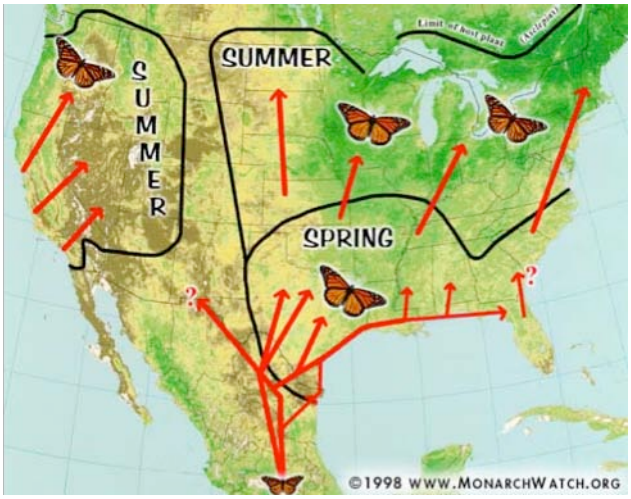
As adults, the butterflies mate and the females, once they have mated, search for suitable plants to lay their eggs on, to start the cycle over again. Some butterflies die immediately after laying their eggs but

Monarchs can live for many months after laying all of their eggs; they die of old age or physical trauma. Monarchs usually only live two to five weeks.

Migration of The Monarch Butterfly

Monarch butterflies are extraordinary. They travel over 2,000 miles every year to get from their summer mating areas to their wintering areas. There are two populations of monarchs, one in the East and one in the West. The eastern Monarchs summer in the northeastern United States, the Great Lakes region and southern Canada. Then they migrate over two thousand miles south to pine groves in central Mexico in the fall months and stay there until the next spring. Monarchs west of the Rockies spend the summer northeast of the Rockies and winter in southern California. The journey every fall from southern Canada to central Mexico for the eastern monarchs takes 75 days to complete. They make this journey because it is too cold for them to survive in their summering grounds over the winter.





However, they can not stay in the pine groves of central Mexico all the time because there are no milkweed plants for their larva to eat there. Thus, they have to migrate back and forth between these two areas. In the spring time, the butterflies fly north until they find suitable habitats to mate and lay eggs in the southern United States and the butterflies that survived the whole winter mate, lay their eggs and then die from old age. The new generation grows up into adult butterflies and continues the journey north. Again, when they find suitable habitat they mate, lay their eggs and stop migrating. The next generation will continue the journey north in search of new milkweed and so it is the third or fourth generation that reaches the northern most parts of the Monarch butterfly's range.

Monarch butterflies are facing serious threats to their survival because there is logging happening in their wintering grounds in Mexico. Since Monarchs return to their maternal tree or grove, if that tree or grove is cut down, they will not survive. Also, even if this was not the case, only this pine tree habitat is suitable for over-wintering for Monarchs in Mexico and so if it is devastated, their population numbers will decline rapidly. Thus, deforestation in these groves is a huge problem to the survival of Monarch butterflies.

Another threat to Monarch survival is the conversion of prairies and wildflower fields into agricultural fields in the Midwest. Almost half of the all of the migrating Monarchs breed in the Midwest but as

these areas were converted to agricultural land, Monarchs lost many of their breeding and feeding grounds. In their travel north, Monarchs must be able to breed, lay their eggs and replenish their energy from wildflower nectar. None of these things can be done in agricultural fields. Besides the loss in habitat, Monarchs are also threatened by the application of pesticides to these fields and by the widespread use of Montasanto Round Up Ready® corn and soybeans. Since these strains of corn and soybeans are immune to the herbicide Round Up®, the fields can be sprayed indiscriminately with it without negative effects on the crop plants. Though this system is good for crop yields, it is deadly for Monarchs because it eliminates milkweed plants in and around these fields. Where Monarchs used to have edge habitat around the fields, now they have none. This is happening all over the northern part of the Monarch butterfly range and is even happening in their summering grounds. Development is also a threat to Monarch survival and in many areas, the marginal habitat that Monarchs have been provided, on roadsides or the edges of lawns or sports fields, is now being sprayed with herbicides or mowed which both eliminate milkweed.

Valuable Resources:

Journey North
www.journeynorth.org
This website is a migration tracking website for many different kinds of animals, one of these being the Monarch Butterfly. There are many different resources including life cycle information, migration patterns, real-time migration maps and educational resources for teacher who would like to include more about monarchs in their lesson plans.

Monarch Watch
www.monarchwatch.org
This website is another great resource focused on Monarch Butterfly migration. It also has life cycle information, migration patterns and educational resources.

Monarchs in the Classroom
http://www.monarchlab.umn.edu/mitc/
This website has wonderful resources for teachers looking to include lessons on Monarch Butterflies in their curricula. It offers teacher workshops, lesson plan ideas, and fun games to play. It tries to promote hands-on learning through activities and student-run research.

Learn About Butterflies
www.learnaboutbutterflies.com
This website was created and is run by a butterfly enthusiast. Though it is not connected to any national organizations, it has a wealth of information about butterflies as well as a huge collection of photos from butterflies from all over the world.