

NOTES: THE WORLD OF MONARCH BUTTERFLIES

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A summer monarch's second job is to mate and lay eggs. Monarchs can mate multiple times during their lifetime. A male/female pair remains coupled together throughout the day into early morning hours, and during this time, the male transfers a spermatophore, a package of sperm and protein, to the female during copulation. The female can begin using the sperm immediately to fertilize eggs which are maturing throughout her lifetime. On average, a female lays 500 eggs.

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Eggs are generally laid individually on the underside of leaves toward the top of a milkweed plant. Notice the eggs' distinct shape, color, and longitudinal ridges. The hard outer shell, or chorion, protects the developing larva.

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When an egg is ready to hatch, you will see the black head of the 1st instar larva munching its way through the eggshell, which is the larva's first meal. The larva is 2-6 mm long with a distinct black head. Notice how the caterpillar is dull and gray/white in color and lacks its characteristic yellow, black, and white stripes. The vivid colors appear after the caterpillar has started eating the milkweed leaves.

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Monarchs go through 5 larval instars or periods of growth between molting. Each new instar grows and expands until the outer skin splits, the head capsule falls off, and the new larva is able to crawl out of its skin. In the larval stage, monarchs are eating machines growing to 2000 times their original mass. Development time from egg through the 5th instar stage usually takes about 9-16 days, depending on the temperature.

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Although instars get larger in each new stage, size is not always a reliable way to tell them apart. Pictured here are two second instars, one just molted from a first, and one is ready to molt into a third. A more reliable way to tell them apart is by the length of their front and rear tentacles which remains the same length throughout each instar period.

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This caterpillar has just molted into a third instar (note the old skin trailing behind). This caterpillar will probably turn around and eat the exuvium, or shed cuticle, recycling useful nutrient material. Notice the length of the front and rear tentacles which have almost doubled in size from the 2nd instar.

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Milkweed provides larvae with a toxin called a cardiac glycoside, making the caterpillar unappealing to vertebrate predators. The color of the caterpillar and the adult warns predators of this toxicity. Milkweed also contains a white, gummy latex that protects it from herbivores. Here you see the characteristic crescent feeding pattern that small

monarch instars use to avoid gumming up their mouthparts. Caterpillars will cut off the flow of latex sending it back into the larger vein and mid-vein, and then continue to eat the material on the outer edges of the leaf.

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Larger instars use another feeding technique to get around the milkweed's natural defense mechanism. This 5th instar has chewed a notch in the plant's mid-vein sending the flow of latex back to the stem. Again, the caterpillar will begin eating the outer edges of the leaf.

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At the end of the larval stage, the caterpillar spins a pad of silk from the spinneret under its mandibles, and secures its two hind prolegs into the pad hanging in a "J" form. It is suspended this way for about a day, getting ready for the final molt. Slitting the outer cuticle along the back, it pushes the skin up to the silk pad, revealing a green caterpillar underneath. Slowly this outer cuticle hardens to form the pupa, just like the one seen in the background.

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The monarch chrysalis is well camouflaged in its environment. Monarchs rarely pupate on milkweed, but walk several meters away to find a desirable spot. They remain in the pupal stage for about 8-15 days.

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In the pupa, the body parts are transformed to those that will be used during the adult stage. A day before the adult is ready to emerge, you can see the developing scale pigmentation through the transparent cuticle of the chrysalis.

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Monarch Butterflies typically eclose, or escape from their pupa cuticle, in the early morning hours. When the adult butterfly first emerges from the chrysalis, its abdomen is very large. It pumps the fluid, or hemolymph, from its body into its wings, and the wings take shape over a period of several minutes. It takes several hours of drying for the wings to become hard enough for the butterfly to fly.

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A male has just eclosed and is pumping the fluid through the veins in his wings.

Slide 15:

Male monarchs can be distinguished from females by a dark spot on a vein on each hindwing. This androconial patch is made of specialized scales which contain pheromones used in courtship by some butterflies in the Nymphalidae family. The female has wider veins than the male and is duller orange in color. Males and females are approximately the same size.

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Monarchs have two main jobs during the breeding season. One job is to nectar for energy. Just like all other butterflies, monarchs rest with their wings folded back, and they uncurl their proboscis to sip nectar. These monarchs are nectaring on common milkweed or *Asclepias syriaca*.

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The proboscis is a straw-like structure that is in two parts when they first emerge from the pupa. Once the adult emerges, the two parts of the proboscis zip together and curl up under their head when not in use. In captivity monarchs nectar on a 20% honey water solution.

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Environmental cues such as senescing milkweed, shorter day-length and fluctuating day/night temperatures signal it's time for the monarchs to move south from their northern breeding range. Most of the monarchs that emerge after mid-August, in the north, are in a state of reproductive diapause and will not mate, but rather use their energy to migrate.

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Many other butterflies and moths can overwinter in various developmental stages during the winter, but monarchs cannot withstand the cold temperatures and must migrate south to survive.

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Summer monarchs only live a few weeks, but those that emerge in the late summer and early fall will migrate to Mexico, stay there all winter, and migrate back into the US in the spring. These migrating butterflies live up to 9 months. Many people have been working together for several decades tagging monarchs to learn the path and destination of their migration. Each tag has a unique number, and taggers record the time and location of each release.

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The eastern population of monarchs migrate to Central Mexico, and those west of the Rocky Mountains migrate to coastal California. The fall migration begins at the end of August in the northern regions, but monarchs keep emerging and leaving these areas through September and early October. Another generation may be produced in the south in the fall, when monarchs lay eggs as they move through the southern states.

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The overwintering sites in Mexico are in the Transvolcanic mountains, west of Mexico City. The monarchs select locations high in elevation (about 3000 meters or 10,000 feet) on steep slopes covered with oyamel fir trees. Monarchs begin arriving at the overwintering sites in November and trickle in for most of the month.

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Overwintering monarchs are inactive for much of the winter, clustering tightly on boughs and branches of the oyamel fir tree. Sometime in February, many of the monarchs become more active. Blizzards of butterflies can be seen flying through open areas of the forest in search of warm places to bask or seeking water to drink.

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Some monarchs will be found nectaring on available flowers, and it is thought that these butterflies may not have enough stored energy (fat) to survive the rest of the migration. Most monarchs will drink water from streams or mud patches, and by the end of February, many can be seen mating. Monarchs are also preyed upon at the overwintering sites, mainly by two bird species, the black-backed oriole and the black-headed grosbeak. If the monarchs leave their trees and become too cold to fly back into the branches, they can be eaten by mice also. Some are killed during large snowstorms, although they can usually withstand freezing temperatures if they remain on the trees and stay dry. Smoke from human-set fires often disturbs them enough to make them fly off the trees.

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The spring migration starts in March, when monarchs leave the overwintering colonies where they've spent up to five months. The butterflies that have overwintered migrate as far as the southern states, and their offspring continue the recolonization of northern states in the late spring and summer. Up to three generations are produced in the summer breeding areas, the last generation becoming the fall generation that migrates.

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As monarchs move into new areas in the spring, they find young host plants, just days after the plants emerge from their own winter rest. Females seem to prefer new plant growth throughout the summer.

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Monarchs can be found in a variety of habitats; roadsides, gardens, prairies, corn and soybean fields, and wherever else milkweed may be found is potential monarch habitat. Monarch adults need flowers for nectar, but milkweed is the only plant on which a female will lay her eggs.

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Pictured here are several herbivores found in the milkweed community. Aphids produce honeydew, a sweet substance that attracts ants, who in turn, tend the aphids and protect them from other predators. In the photo on the right, coccinellid larvae are seen preying on the aphids. In the bottom center photo is a milkweed beetle, and on the far left, milkweed bugs. Beetles are found mainly in the spring and summer, feeding on the milkweed leaves, while milkweed bugs are most common in the late summer and fall, feeding in large aggregations on milkweed pods and seeds.

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Several predators are found on milkweed plants. Stink bugs and ambush bugs can be seen preying on monarch caterpillars along with ants, who will attack caterpillars and carry them back to their nests. A common parasitoid of monarchs is the tachinid fly. The adult fly begins its life cycle by laying eggs on the body of the caterpillar. The larvae that hatch, burrow into the caterpillar, develop and eat the tissue inside the monarch. The maggots drop from the caterpillar on a fibrous string (top left), pupate in the ground and finally produce the adult flies. The white maggots, brown pupae and adult tachinid can be seen in the bottom photograph. Only about 10% of the eggs laid by a female monarch survive to adulthood.