

## Grade 7 Lesson 1

# Friend or foe?

You can use monarchs to teach about anything! Stone Mountain Memorial Association (SMMA) uses the monarch butterfly to help students apply their knowledge in other contexts and to different disciplines. The activities relate a grade-level specific GPS to monarch life, habitat, or migration.

GPS correlation: S7L4. Students will examine the dependence of organisms on one another and their environments. d. Categorize relationships between organisms that are competitive or mutually beneficial.

### **Preparation:**

Read the background information and the student worksheets. (Do not read the background information to the students.) Print the worksheets, or make an overhead or display on your Promethean Board. Make copies for each student or group of students.

### **Background information:**

In this lesson, students will learn about the relationship that exists between the monarch (*Danaus plexippus*) and two other organisms, milkweed plants (Asclepiadaceae) and the protozoan, *Ophryocystis elektroscirrha*. They will then categorize these relationships as competitive or mutually beneficial.

### Relationship 1: Monarch and Milkweed

**(Answer: *Competitive as larva, Mutually beneficial as adult*)**

### Interactions with Milkweed

<http://www.monarchlab.umn.edu/Lab/Research/Topics/Milkweed/Default.aspx>

This website contains excellent research references about the relationship between monarchs and milkweed focusing on the following questions:

1. How do chemicals in milkweed benefit monarchs?
2. How do different milkweeds and monarchs vary in the type and concentration of cardenolides that they contain?
3. How do milkweed defenses affect monarch larvae?

Botany 115 Terminology <http://waynesword.palomar.edu/termfl1.htm>

This website includes excellent diagrams of the milkweed flower structure and an explanation of the pollination process. Scroll down the page to the fourth listing entitled "The Remarkable Bisexual Milkweed Blossom."



Relationship 2: Monarch and *Ophryocystis elektroscirrha* (OE)  
**(Answer: Competitive)**

What is OE? <http://www.monarchparasites.org/>

“*Ophryocystis elektroscirrha* (OE) is an obligate, protozoan parasite that infects monarch and queen butterflies. OE is considered an obligate parasite because it must live within a host to grow and multiply. Monarch and queen butterflies are the only known hosts of OE. Between infections, OE survives as spores that are resistant to extreme environmental conditions. OE was first discovered infecting monarch and queen butterflies in Florida in the late 1960s. It has since been found in all other monarch populations worldwide, indicating that this parasite has coevolved with monarchs.”

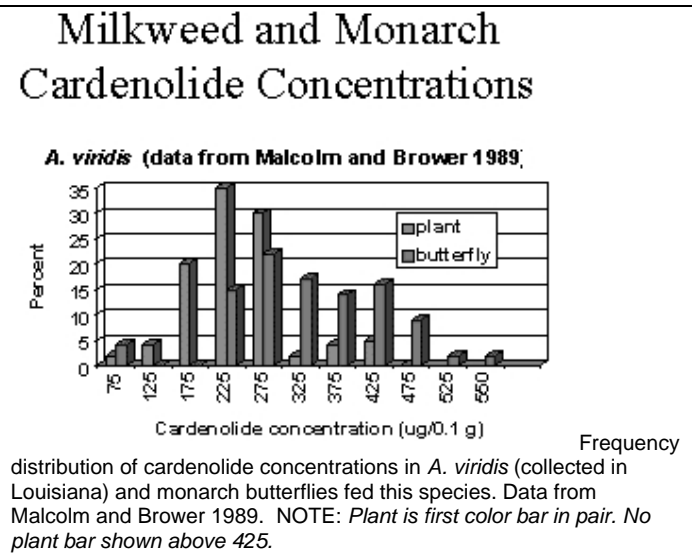
“Adults that are heavily infected with OE either fail to eclose (emerge) fully or fall to the ground, leading to severe wing deformities and relatively rapid death. Mildly infected adults are often smaller, weigh less and have shorter forewing lengths than healthy monarchs. This parasite also damages the cuticle, or outside layer of the abdomen, causing the butterfly to dry out and lose weight faster than normal. This is especially a problem if there is a shortage of nectar or water. Studies have shown that monarchs infected with OE cannot fly as far or as long as healthy butterflies. Since infected males are weak, they are less likely to mate and produce offspring than uninfected males. Infection does not appear to harm the ability of females to reproduce. While these may all be symptoms of OE infection, many infected monarchs look healthy. They emerge normally and are not deformed. The only way to really know if a monarch is infected is to check for spores.”

**Activity:** Hand out worksheets. Emphasize the focus of the lesson. Have students read the information on their worksheets and answer the essential question.



**Essential Question:** After reading about the relationships between the monarch and two other organisms, how would you categorize these relationships? Are they competitive or mutually beneficial?

**Relationship 1:** Female monarch butterflies (*Danaus plexippus*) lay their eggs on their host plant which is in the family Asclepiadaceae (milkweeds). The larvae that emerge are herbivores, feeding on the leaves, flowers, and stems of the milkweed plant.



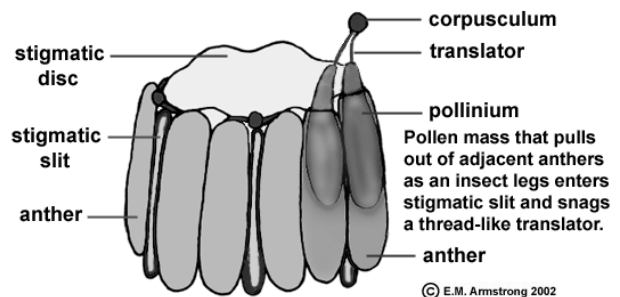
These caterpillars actually sequester the cardenolides, or cardiac glycosides, from the milkweed sap and plant material, and use them as a defense against vertebrate predators. Cardiac glycosides are toxic to vertebrates.

Adult monarchs do not eat milkweed; they simply nectar from the flowers. This graph shows, however, that they are able to store the cardenolides that they ingested as larvae also making them bitter tasting and toxic to most vertebrates.

There is no documented evidence that the milkweed plant actually benefits from this herbivory although new growth is normally stimulated.

Milkweeds have a unique mechanism in which the plant relies on the Orders Lepidoptera (butterflies and moths) and Hymenoptera (bees, ants, and wasps) for pollination.

This diagram shows the translator which can be snagged by the leg of an insect that inadvertently slips down into the stigmatic slit. As the insect flies away, the pollinium, or pollen mass, is pulled out of the anther sacs like a pair of saddlebags, and carried off to another milkweed blossom.



**Milkweed Flower (stigmatic column)**

Monarchs, although not the major pollinators of Asclepiadaceae, are noted in several studies to contribute significantly. Is this relationship competitive or mutually beneficial? (The larval stage can be accessed separately or in conjunction with the adult butterfly.)

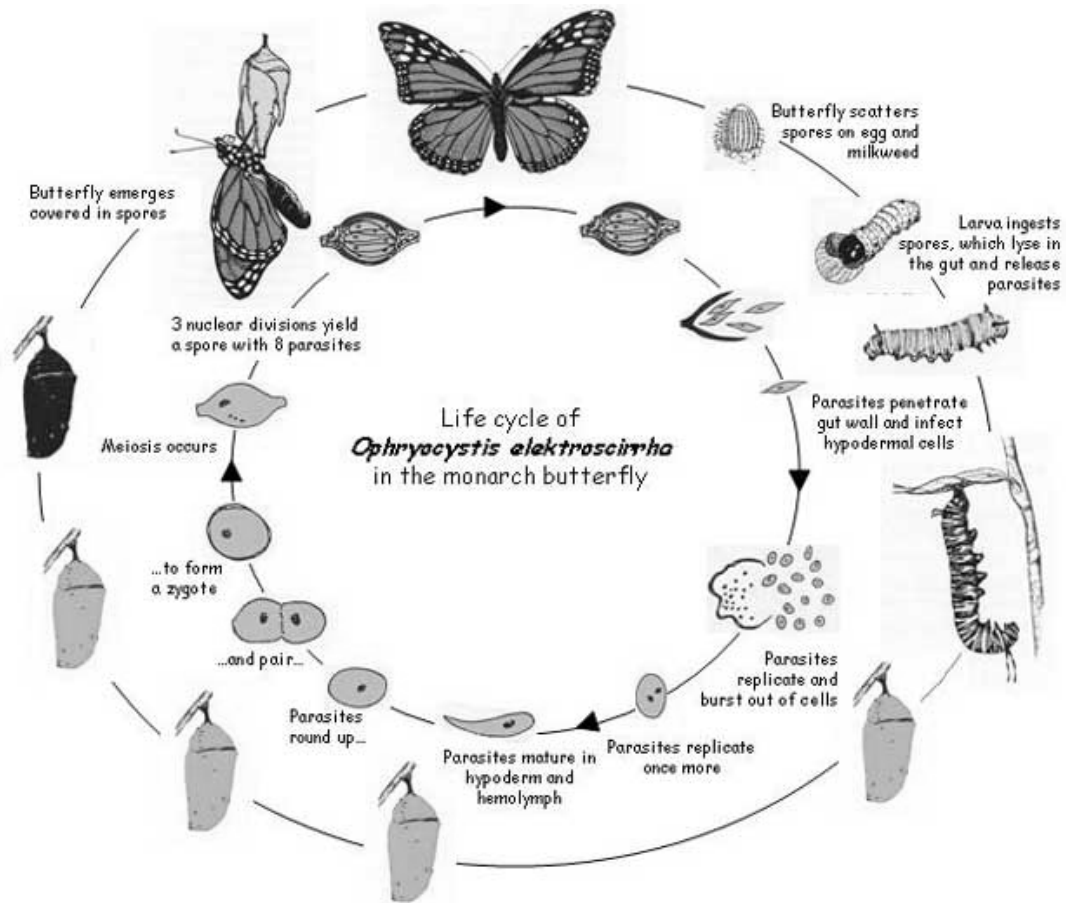


**Relationship 2:** The life cycle of the protozoan, *Ophryocystis elektroscirrha* (OE) is very closely related to the life cycle of the monarch butterfly, *Danaus plexippus*. This protozoan can only reproduce inside the insect's body. (See the diagram below.)

If a female monarch harbors OE, the dormant spores will be on the outside of her abdomen and will be scattered on the eggs and milkweed leaves during ovipositioning. When the caterpillar emerges, it will consume first the chorion, or egg shell, ingesting the spores, and then as it feeds on the milkweed leaves, more spores will be consumed.

The spores will move through the larval digestive system. Digestive chemicals will break open the spores releasing the protozoan which then moves through the intestinal wall to an underlayer of epithelial cells that secretes substances for the overlying cuticle, or exoskeleton. Here OE reproduces asexually, greatly increasing in numbers. Most damage to the butterfly occurs during their pupal stage. OE reproduces sexually inside of the chrysalis, again increasing in numbers. Approximately three days before the adult butterfly ecloses, spores will begin to form. These spores allow OE to survive outside of the monarch's body. The spores can be seen through outside layer of the pupa. Adults harboring OE emerge covered with spores. The spores are inactive, or dormant, until they are eaten by another monarch caterpillar. Is this relationship competitive or mutually beneficial?





Graphics credit: Sonia Altizer, Jaap de Roode and Monarchs in the Classroom

