

FAIRCHILD
Discovery
PROGRAM

SYMBIOSIS: BUTTERFLIES AND PLANTS
PRE- AND POST-VISIT ACTIVITIES
GRADES: 6-12



FAIRCHILD TROPICAL BOTANIC GARDEN

Welcome!

Dear Teacher:

Thank you for planning a field study at Fairchild Tropical Botanic Garden. The tour you have selected, **Symbiosis: Butterflies and Plants**, is designed to teach students about butterflies and their symbiotic relationship with plants as well as the environmental threats to their survival. This multi-disciplinary unit features activities that incorporate art, science, and language arts to provide teachers and students a foundation in ecology and raise environmental awareness. An introduction to mapping and GPS is also included, as students will be using maps, compasses, and GPS units to navigate the garden during their visit.

Included in this document is a packet of activities. It can also be found online at: <http://www.fairchildgarden.org/education/schoolprograms/discoveryprogram/>. This packet contains pre and post-visit resource materials to support and strengthen the learning experience. We encourage you to implement pre-visit activities as they will enhance and prepare students for the field study.

Using pre-visit activities allows students to learn the vocabulary and key concepts. It also gives students time to think about what they will be learning during their field study and to start to formulate questions. Post-visit activities allow students to integrate, reflect, process and deepen their learning experience. The lesson plans correlate with the Next Generation Sunshine State Standards. **Please be sure that each teacher attending the field study receives an activity packet.** Feel free to make additional copies of this packet as needed.

The word list provided is especially important for students to study prior to their visit. An understanding of the vocabulary will be a great asset in comprehending the concepts discussed during the field study.

We look forward to your visit to Fairchild Tropical Botanic Garden and hope that you and your students will have an exciting and educational adventure.

Kind Regards,

Laura Tellez

Discovery Program Coordinator
305.667.1651, ext. 3325

Table of Contents

Introduction to Symbiosis: Butterflies and Plants..... 2

Words for a Day at Fairchild..... 3

Pre-visit Activities:

1. **Metamorphosis**..... 4

 Answer Key 5

2. **Photo-Period and Butterflies** 6-7

Post-visit Activities:

1. **Mental Maps** 8

2. **Long-term Classroom Activities**..... 9-10

 Resources..... 11-12

 Monarch Daily Observation Sheet..... 13

 Individual Monarch Summary..... 14

 Monarch Class Data Sheet 15

Words for a Day at Fairchild

Anther: the pollen-bearing part of the stamen.

Chrysalis: the hard shelled pupa of a butterfly.

GPS: Global Positioning System; a system of satellites, computers, and receivers that is able to determine locations on Earth.

Host Plant: the plant on which a certain species of butterfly lays its eggs, as well the plant that caterpillar feeds on.

Landmark: a prominent or well-known object that serves as a guide for navigation.

Life Cycle: the various life stages through which an organism passes in its development.

Metamorphosis: transformation; an abrupt physical change in an animal's body structure from one stage or form to another.

Migration: movement of a group of people or animals from one location to another.

Navigation: the act or science of directing the course of a traveling object.

Nectar Plant: the plant from which a certain species of butterfly drinks nectar of flowers.

Pistil: the ovule-bearing or seed-bearing female organ of a flower, consisting when complete of ovary, style, and stigma.

Pollination: the transfer of pollen from the flower of one plant to the flower of another plant of the same species.

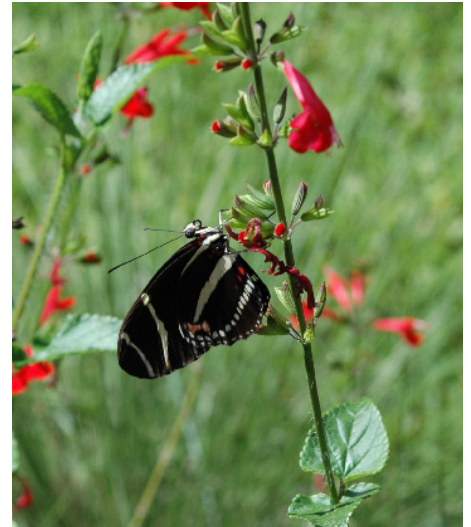
Proboscis: the elongate, protruding mouth part of certain insects, adapted for sucking or piercing.

Pupa: an insect in the non-feeding, usually immobile, transformation stage between the larva and the adult.

Satellite: a device launched to orbit the Earth that collects scientific information.

Stamen: the pollen-bearing organ of a flower, consisting of the filament and the anther.

Stigma: the part of a pistil that receives the pollen.



Zebra Longwing Butterfly

Pre-Visit Activity 1: Metamorphosis

Objectives

Students apply basic algebra to a real-life math problem to calculate growth rate and compare sizes. Students define metamorphosis, butterfly life stages, and the triggers for these insects to undergo metamorphosis.

Next Generation Sunshine State Standards: MA.6.A.1.1, MA.6.A.2.1, MA.7.A.1.1, MA.7.A.1.2, MA.7.G.4.4, MA.8.G.5.1, MA.912.A.1.5; MA.912.A.5.4,

Materials

- Rulers with metric units
- Paper

Monarch caterpillar



Introduction

Butterflies undergo 4 life stages: egg, larva (caterpillar), pupa (chrysalis), and adult (butterfly). The butterfly undergoes metamorphosis, where the insect changes from one life stage to another. These life cycle changes are triggered by hormones, which are in turn triggered by climate and food.

Each time the caterpillar molts, the molting hormone lessens, until it finally reaches a level that triggers the caterpillar to create a chrysalis and undergo metamorphosis.

Scientists think that by transforming from one life stage to another, these insects are better adapted to their environment. One theory is that insects are able to specialize their functions in each life stage (e.g. caterpillars only eat, while a butterfly focuses on mating and laying eggs). Among many insects, the larvae live and eat in different habitats from the adults. This means that insects can often exploit valuable food resources while still being able to disperse into new habitats as winged adults. The potential for adaptation and evolution is greatly enhanced by metamorphosis.

Procedure

1. Ask students if they can hypothesize why certain insects undergo metamorphosis and experience different life stages.
2. Ask students to hypothesize what triggers a caterpillar to undergo molting and turn into a chrysalis.
3. Hand out paper, pencils, and rulers to each student.
4. Have students calculate the following problems:
 - A monarch caterpillar is only 2mm when it hatches from the egg but grows to 2 inches long before it turns into a chrysalis in 18-20 days. What is the average growth rate? (Hint: you must first convert inches to the metric system.)
 - How many times larger is the adult caterpillar than the hatchling?

Metamorphosis Answer Key

Math Formulas and Answers

- The measurements must first be converted to the same measurement system:
 $1\text{ mm} = .039\text{ inches}$.
A ratio must then be created to determine how many millimeters constitute 2 inches:

$$\begin{aligned}x/2\text{ inches} &= 1\text{ mm}/.039\text{ inches} \\x &= (1\text{ mm} * 2\text{ inches})/.039 \\x &= 51.3\text{ mm}\end{aligned}$$

To find the growth rate, we can use the formula: $\text{rate} * \text{time} = \text{length}$.
To calculate the length (change in growth from full grown to size at hatchling), we use the following formula:
 $\text{length} = \text{final length} - \text{initial length}$
 $\text{length} = 41.3\text{ mm} - 2\text{ mm} = 49.3\text{ mm}$

$$\begin{aligned}\text{rate} * \text{time} &= \text{length} \\ \text{rate} &= \text{length}/\text{time} \\ \text{rate} &= 49.3\text{ mm}/20\text{ days} \\ \text{rate} &= 2.465\text{ mm}/\text{day}\text{ (or } .096\text{ inches per day)}\end{aligned}$$

- The full grown caterpillar (49.3 mm long) is 24.65 times the size of the caterpillar that emerges from the egg (2mm). The formula should be $2\text{ mm} * x = 49.3\text{ mm}$.

Resources

<http://www.enchantedlearning.com/subjects/butterfly/anatomy/Caterpillar.shtml>



The Giant Swallowtail caterpillar resembles a bird dropping, which protects it from being eaten by birds.



The Zebra Longwing caterpillar has long spikes as protection from predators.

Pre-Visit Activity 2: Photo-period and Butterflies

Objectives

Students track photo-period (daylight hours) over time and predict how daylight will change during different seasons. Students explain how photo period and seasonal changes in daylight trigger migration.

Next Generation Sunshine State Standards: MA.6.A.3.1, MA.8.A.4.5, MA.912.A.2.1, MA.912.A.2.2, SC.912.L.17.4

Materials

- Chart paper
- Rulers
- Daily newspaper and/or computers with internet access
- Globe (optional) or world map

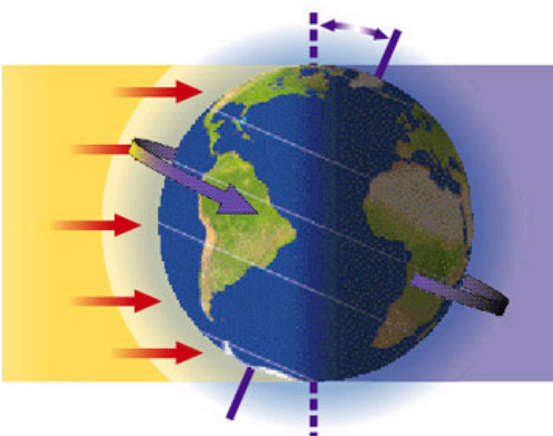
Introduction

You may notice that you see more butterflies on a sunny, hot day than on a cloudy, cold day. This is because butterflies are cold-blooded and require heat to fly. Butterfly activity and migration are triggered by photo-period (the amount of sunlight per day) and temperature, which are season indications.

The rate of changes in daylight hours varies according to the latitude of a location. The greatest and most rapid changes occur farthest from the equator (at the poles).

On the equator, the daylight hours are almost the same year-round. Locations north of the equator have more daylight hours during the summer (between the Spring and Autumn Equinoxes) and fewer daylight hours during the winter (between the Autumn and Spring Equinoxes). Locations south of the equator have the opposite pattern.

These changes in daylight hours through the seasons are caused by the tilt of the Earth's axis as it rotates and orbits around the sun.



Resources

-National Weather Service

-www.usatoday.com/weather/news/2003-11-11-monarch-climate_x.htm

-www.sciam.com/article.cfm?id=changing-climate-may-leav

-<http://www.dnr.state.mn.us/volunteer/mayjun08/butterflies.html>

-<http://climatex.org/articles/climate-change-info/butterfly-map-climate-change/>

Globe Image and lesson adapted from *The Journey North*: www.learner.org/jnorth

Photoperiod and Butterflies Continued

Procedure

1. Introduce students to the concept of photoperiod and seasons by asking the following questions and writing their responses on the board or chart.
 - Which season do you think has the most daylight hours? The least?
 - Why do you think the amount of sunlight changes over the year?
 - Will the amount of daylight (photoperiod) increase or decrease between fall and winter, winter and spring, and spring and summer?
2. Using the web site, <http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html>, have students research and write down the sunrise and sunset times for your location on the equinoxes and solstices.
3. Older students should make charts for 2 additional locations – one north of you and one south of you. A globe or world map would be helpful for this exercise. You can also use any weather website such as <http://www.weather.com>
4. (Optional) Have students track the maximum or average temperatures for each location.
5. Have students calculate the photoperiod (hours of daylight) and high or average temperatures for each date.
6. Have students graph their data.
7. Once the graphs are completed, ask students the following questions:
 - What patterns do you notice?
 - How would you explain the pattern of sunrise and sunset times during the year?
 - Which month has the greatest number of daylight hours?
 - What patterns do you notice between day length and temperatures?
 - If students compared several locations:
 - What patterns do you notice?
 - Explain how latitude is related to day length during different seasons.
 - Which parts of the hemisphere (latitudes) have the most dramatic changes in day length?
8. Ask students why they think certain animals and insects migrate. Ask students to brainstorm how animals and insects know when to migrate. Ask students to hypothesize how climate change could be affecting migrating animals. This could alternatively be a research project topic or a homework assignment.

Answer Key

7. Further away from the equator, seasons are more dramatic; as the Earth's tilt away from the sun increases, temperatures decrease, sunrise times are later, and sunset times are earlier. Photo-period changes less throughout the year at latitudes closer to the equator. Monarchs leave the northeast once the season shifts, when photo period and temperatures decrease.
8. Animals and insects migrate mainly to find food, as plant development is also effected by photo period, seasons, and change according to latitude. Migration among these species is triggered by changes in photo period and temperature, which signal a shift in seasons and therefore a shift in the availability of food. These patterns trigger the animal's internal clocks.

Post-Visit Activity 1: Mental Maps

Objectives

Students learn to correctly use landmarks, icons, and map keys to create maps.

Students create their own maps and learn how to communicate geographic information to others.

Next Generation Sunshine State Standards: SC.6.N.1.1, SC.6.N.1.4, SC.6.N.1.5, SC.7.N.1.1, SC.7.N.1.2, SC.8.N.1.1, SC.912.N.1.1, SC.912.N.1.6, SC.912.N.1.7

Materials

- Paper
- Crayons, markers, colored pencils, or pens
- Topographic maps printed from Google maps or viewed on computers with internet access

Procedure

1. Ask students to hypothesize how monarchs know when and where to migrate.
2. Explain that scientists think that monarch butterflies may use the angle of the sun along the horizon combined with their internal body clock to maintain their flight path. Research also suggests that birds may sense the Earth's magnetic field and that many animals may memorize or recognize landmarks.
3. Now that students have used GPS technology to navigate the garden, have them try to construct a mental map. Ask students to visualize Fairchild Botanic Garden, based on their recent visit, including landmarks.
4. Have students draw a map illustrating their routes through the garden, including landmarks and a map key.
5. Divide the class into pairs. Taking turns, one student should describe his/her mental map while the partner attempts to draw it. When each partner has had a turn, they should exchange drawings.
6. Ask the groups how close their drawing was to their partners' original map.
7. Using a topographic map of your region, prompt students to discuss important landmarks that migratory animals might use as they pass through your part of the world. [mountains, rivers, stretches of forest sounds of the ocean, etc].

Resources

<http://www.learner.org/jnorth/tm/LessonsOriginal.html>

<http://maps.google.com/maps?f=q&hl=en&geocode=&q=miami,+FL&ie=UTF8&t=p&z=11>

<http://maps.google.com/maps?f=q&hl=en&geocode=&q=Florida&ie=UTF8&t=p&z=7>

Lesson adapted from The Journey North: www.learner.org/jnorth

Post-Visit Activity 2:

Long-term Classroom Activities

Introduction

A great way of demonstrating the butterfly life cycle is to rear butterflies in the classroom, allowing students to witness metamorphosis as well as develop scientific skills, including observation, data collection, hypothesizing, and data analysis. This activity could be conducted over a 1-2 month period in the classroom or as a science fair project.

Materials

- Monarch Daily Observation sheets
- Individual Monarch Summary
- Monarch Class Data Sheet
- Clear plastic rulers with mm marks
- Balance accurate to the nearest mg
- Monarch eggs
- Butterfly cages
- Host plant or food for Monarch

Procedure

1. Tell students they will keep detailed records of the growth of their larvae. Hand out Monarch Daily Observations charts and monarch eggs or larvae. Do the first observations together. Lengths can be recorded if an accurate balance is not available.
2. Have students fill in their Monarch Daily Observations chart daily or every other day during the larval stage, and every 4-5 days during the pupal stage. At the end of each stage, fill in the summary section for that stage.
3. If desired, have students try to determine the sex of their monarchs during the pupa stage. When butterflies emerge, summarize all data on the Class Data Sheet.
4. Make copies of the completed Class Data Sheet and give one to each student or group.

Long-term Classroom Activities (continued)

5. Have each student choose one of the questions listed below or think of another question that interests them. For some of the questions they will need to use their own and other students' individual data sheets.
- Do large caterpillars produce large butterflies?
 - Which are larger, females or males?
 - Do males or females emerge sooner from the chrysalis?
 - Do larger caterpillars take longer to pupate?
 - What was the average length of time spent as a larva (or pupa)?
 - How much growth (either mass or length) occurs in a single day in the larval period?
 - How does the rate of growth change over the larval period?
6. Have students answer the questions in a report that includes the following:
- Data table
 - Graph
 - Conclusion that summarizes findings
 - Discussion of how the data do and/or do not answer the question

Resources

Determining the sex of the Monarch:

Pupae

Determining the sex of pupae requires keen eyes or a dissecting microscope. Surrounding the cremaster (the structure from which the pupa hangs) are a series of rings, called abdominal sternites. Within the first ring (9th abdominal sternite) are several paired black dots next to the cremaster; turn the pupa so that you are looking at these dots. If the monarch is a female, the ring adjacent to the 9th sternite will have a line dissecting it; this line (indicated by the arrows on the photo and diagram below) will be centered between the pairs of dots. Male monarch pupae do not have this line.

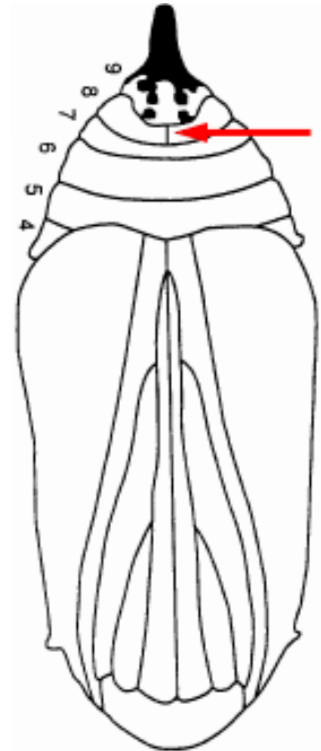
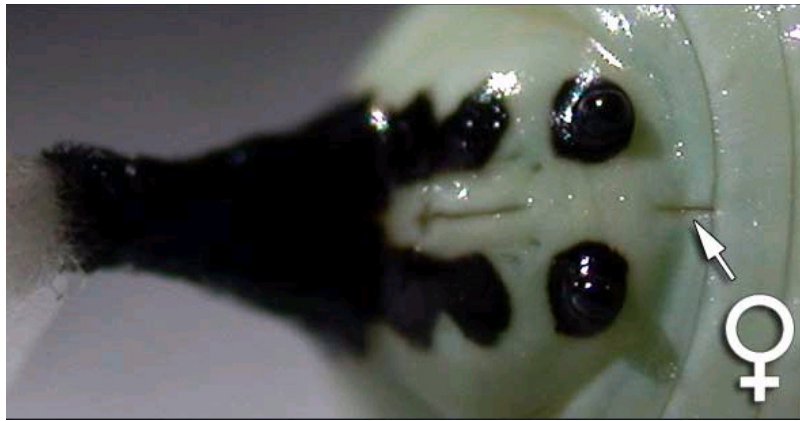


Diagram modified from: Hughes, P. R., C. D. Radke, and J. A. A. Renwick. 1993. A Simple, Low-Input Method for Continuous Laboratory Rearing of the Monarch Butterfly (Lepidoptera: Danaidae) for Research. American Entomologist 39: 109-111.

Adults:

Male Monarch (left): Notice the thin vein pigmentation and swollen pouches on the hindwings. Female Monarch (right): Notice the thick vein pigmentation and no hindwing pouches.



Male



Female

Source: <http://www.monarchwatch.org/biology/sexing.htm>

Resources

Easy Rearing and Observing Instructions

- Eggs and milkweed should be kept in a container lined with a moist paper towel.
- The eggs should hatch within 1-5 days if kept at normal room temperatures. On average 70-90% of eggs hatch and survive to adulthood.
- After hatching, the larva will eat its chorion (eggshell). It may also eat other, un-hatched, eggs if they are nearby.
- Larvae (caterpillars) can be kept in an aquarium, large jar, ice cream bucket, bug cage, or another relatively large cage. The container should be easy to open, since you need to clean it every day, have a screen covering or holes for air flow, and allow you to see the larva inside. It should be large enough for the adult to expand its wings when it emerges.
- Wash and sterilize pre-used butterfly cages.
- Keep the cage out of the sun or other hot places, as high temperatures can kill the larvae.
- Cages must be cleaned and larvae provided with fresh milkweed DAILY. Do not leave your monarchs unattended over the weekend. Milkweed can be found in many places - on roadsides, in parks and gardens. You can pick several days' worth, and keep it in a plastic bag in a refrigerator. Wash it in water before using it. Milkweed stays fresher if you keep the end moist by wrapping it in a wet paper towel and covering the towel with aluminum foil, or use florist water tubes. A moist paper towel in the bottom of the cage helps keep the leaves from drying out.
- Monarchs remain in the larval stage for about 2 weeks after hatching from eggs. During this time, they go through five "instars", which means that they molt (shed their skin) five times. While they are molting, they often crawl up the side of their container, and should not be handled during this time. If you look closely, you will notice when their old head covering is about to come off. You may be able to find this covering in your cage. They will eat the rest of their skin!
- When ready to pupate, larvae will crawl to the top of their cage, attach themselves with silken thread, and form a prepupal "J" before shedding their skin for the last time. This process is fun to watch, but it happens quickly. You can tell they will shed their larval skin soon when their front tentacles hang very limply and their bodies straighten out a little.
- The pupal stage lasts 9-14 days. Pupae turn darker the day before the butterflies emerge, and look black on the day they emerge. At this point, the wings are visible. The butterflies usually emerge in the morning; their wings will be soft, flexible, and wet when they first emerge. If they fall, carefully pick them up by holding the thorax, and place them on the top or side of the cage. They need to hang with their wings pointed down. A pupa that has been very dark for more than a few days is dead.
- Butterflies shouldn't be handled for the first 4 or 5 hours after they emerge, & can be kept in the cage until the next day, when they should be released. They can also be released the day they emerge, especially if it is warm and sunny. Hold the butterflies carefully with their wings closed when you release them, or simply open their cage to let them fly free.

Source: Monarch Lab: <http://www.monarchlab.umn.edu/default.aspx>

Name / Group: _____ Date: _____

Individual Monarch Summary

Larva	Maximum Length	Maximum Weight	Date Formed "J"	Date Butterfly Emerged	# Days in Chrysalis
Chrysalis	Length	Weight	Date of Chrysalis Formation		
Adult Butterfly	Number	Male/Female	Weight	Left Forewing Length	Right Forewing Length

Larva	Maximum Length	Maximum Weight	Date Formed "J"	Date Butterfly Emerged	# Days in Chrysalis
Chrysalis	Length	Weight	Date of Chrysalis Formation		
Adult Butterfly	Number	Male/Female	Weight	Left Forewing Length	Right Forewing Length

Larva	Maximum Length	Maximum Weight	Date Formed "J"	Date Butterfly Emerged	# Days in Chrysalis
Chrysalis	Length	Weight	Date of Chrysalis Formation		
Adult Butterfly	Number	Male/Female	Weight	Left Forewing Length	Right Forewing Length

Larva	Maximum Length	Maximum Weight	Date Formed "J"	Date Butterfly Emerged	# Days in Chrysalis
Chrysalis	Length	Weight	Date of Chrysalis Formation		
Adult Butterfly	Number	Male/Female	Weight	Left Forewing Length	Right Forewing Length

Source: Monarch Lab, http://www.monarchlab.umn.edu/mitc/resources/LessonPlans/MS/Measuring_Larval_Growth_and_Dev.pdf

