

Co-evolution of Plants and Pollinators

Teachers: This lesson contains three classroom activities with discussion questions related to the AFG video clips about insects and pollinators. These parts may be used individually or together, depending on the needs of your class.

Note: You can access and view the video clips used in this lesson in the Teacher Resources section of the AFG Web site: www.pbs.org/americanfieldguide/teachers

Grade Level: 9-12

Background Information

Evolution by natural selection occurs because there are outside forces that act upon individuals in species. These forces can be abiotic (e.g. climate) or biotic (other organisms). Organisms impact each other. Co-evolution is a change in the genetic composition of one species (or group) in response to a genetic change in another. More generally, it encompasses the idea of some reciprocal evolutionary change in interacting species. Co-evolution can be seen in a variety of ecological relationships and can be either negative, as in predator/prey and host/parasite relationships or positive as in the case of mutualism.

In 1862, Charles Darwin visited Madagascar where he saw an orchid that had a tube that was 10 inches long before the nectar was reached. He postulated the existence of a moth with a tongue that was also 10 inches long based on his understanding of evolution. Forty-one years later, the moth was found, exactly as predicted.

Co-evolution can account for much of the great diversity of insects on earth. In this lesson, students will learn about co-evolution of mutualistic relationships while studying the roles of pollinators and plants.

Related National Standards

This lesson addresses the following National Content Standards found at:
<http://books.nap.edu/html/nse>

Content Standard C: As a result of their activities in grades 9-12, all students should gain understanding of

- Biological Evolution
 - Species evolve over time. Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring.
 - The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.
 - Natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms, as well as for the striking molecular similarities observed among the diverse species of living organisms.

- The millions of different species of plants, animals, and microorganisms that live on earth today are related by descent from common ancestors.
- The Interdependence of Organisms
 - Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.
 - Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.

Extension Websites from PBS

- Scientific American Frontiers – Bee Lines
http://www.pbs.org/safarchive/4_class/44_guides/guide_801/4481_bee.html
 How do bees tell each other where to find nectar? This site will illustrate the complex dance that bees use to describe the location of a food source.
- Scientific American Frontiers – Flying High
http://www.pbs.org/safarchive/4_class/45_pguides/pguide_603/4563_air.html
 What good is the nub of a wing? In this activity, students will learn how insects developed the ability to fly in the first place.
- The Living Edens – Namib
<http://www.pbs.org/edens/namib/source1.htm>
 Learn how insects have adapted to harsh conditions in the desert.
- Scientific American Frontiers – Champion Chompers
http://www.pbs.org/safarchive/4_class/44_guides/guide_801/4481_chomp.html
 In this site, students will learn about a co-evolutionary relationship in which ants farm fungi.
- Scientific American Frontiers – Science 911: Panama Protection Racket
http://www.pbs.org/safarchive/4_class/45_pguides/pguide_404/4544_panama.html
 In another example of a co-evolutionary relationship, ants protect caterpillars from wasps in return for nectar.

Activity 1: The Sex Lives of Flowering Plants**Time allotted:**

45 minutes

Materials:

- Students will need to bring 10 flowers in from home. The teacher may want to have extras to supply students who forget.
- A diagram illustrating the parts of flowers, check out one of these two websites for diagrams and a brief introduction to pollination.
<http://www.enchantedlearning.com/subjects/plants/printouts/floweranatomy.shtml>
<http://www.urbanext.uiuc.edu/gpe/case4/c4facts1a.html>

Objectives:

- Students will compare and contrast features of flowers to become familiar with flower morphology
- Students will learn about the mutual benefits of pollination for flowers and pollinators
- Students will predict which flowers are associated with similar pollinators based on their own observations and a basic understanding of co-evolution.
- Students will understand the importance of maintaining **the** diversity of pollinators.

Teaching Instructions:

- Begin the lesson by having students do a short journal writing activity on the following question: Why are flowers so different from each other?



Watch the AFG Video Segment "Plant Reproduction" for an introduction to pollination.

Note: You can access and view the video clips used in this lesson in the Teacher Resources section of the AFG Web site (www.pbs.org/americanfieldguide/teachers).

Discussion Questions for Video Segment

- Why are pollinators so important to flowers?
- Why are pollinators so willing to do all the work of pollinating flowers? What is in it for them?
- Why are a variety of pollinators so important to our ecosystem?

Lab Activity:

1. Students should bring in 10 different flowers from home or from nearby.
2. Students should work in groups of two.
3. Instruct students to look at the flowers, comparing and contrasting features of the different flowers.
4. Discuss some of the similarities and differences that they found.
5. Introduce the concept of co-evolution.

American Field Guide Teacher Resources: Insects

Access this lesson plan online at: www.pbs.org/americanfieldguide/teachers

6. Ask them to make a table listing 5 characteristics of the flower. Some examples might be length of the corona, number of petals, number of stamen, whether there is one flower per stem or many, symmetry, color, smell, size, time of bloom, length of bloom, etc. They should include a blank column in their table for use in Activity 3.
7. Students should then attempt predict which flowers the same types of pollinators pollinate. For instance, flowers with multiple flowers per stem, little scent, and red to orange colors might fall into one category; flowers with long tubular coronae and blue/purple colors may fall into another.

Assessment Suggestion

Have students self-assess their work by completing Activity 3 to identify common pollinators.

Activity 2: Comparing Moths and Butterflies**Time allotted**

20 minutes

Materials

- Projection capabilities for AFG video

Objectives

- Students will understand that insects and flowers are adapted to each other through co-evolution.
- Students will compare and contrast the feeding behaviors of moths and butterflies.

Teaching Instructions

- Discuss: What is the difference between moths and butterflies?
- Tell students to imagine that they are naturalists studying the behaviors of insects. The following video clips show moths and butterflies eating. Students should make visual observations as well as listening to what the video says. A valuable exercise might be to turn the sound off and have students make purely visual observations.
- Students should have pen and paper handy to jot down five characteristics of each as seen in the following videos.

**Watch the AFG Video Segment "Researching the Feeding Habits of Moths – Part 1"**

Start at the beginning and stop after hearing 'we will be able to generate a 3-D reconstruction of the animals movement and analyze it.'

Note: You can access and view the video clips used in this lesson in the Teacher Resources section of the AFG Web site (www.pbs.org/americanfieldguide/teachers).

**Watch the AFG Video Segment "Researching the Feeding Habits of Moths – Part 3"**

Start at 'this is the long coiled up tongue...' and watch through to the end.

**Watch the AFG Video Segment "Paynes Prairie, Florida – Butterflies"**

Start at the beginning and stop after hearing 'an average lifespan for most of the butterflies'

Activity 3: The Secret Lives of Pollinators**Time Allotted:**

45 minutes

Materials:

- Students should have 10 flowers each and a table of flower characteristics from Activity 1.
- A copy of the lab manual of common pollinators for each group. To make a lab manual, go to <http://biology.clc.uc.edu/courses/bio303/coevolution.htm>. About two thirds of the way down through the document, you will find a section that begins with "Adaptations of flowers depend on the type of pollinator on which they depend". Information about the specific behaviors of different pollinators follows. Print out these pages as a lab manual, or make this page available for student use. (note, the whole document is very informative with regards to this topic. In the absence of appropriate text, you might have students read through this entire site.) Janet Stein Carter of the University of California produced this material.

Objectives:

- Students will learn about adaptive characteristics of pollinators
- Students will use their knowledge of co-evolution to predict specific matches between pollinator and flower.

Teacher Instructions

- Brainstorm common pollinators (e.g. bees, wasps, hummingbirds, butterflies, bats, beetles, flies or moths)
- Instruct the students to create a hypothesis, based on their knowledge of insects and other pollinators and their knowledge of co-evolution, about which specific pollinators might be associated with each flower.

**Watch the AFG Video Segment "Wide World of Pollinators"**

Note: You can access and view the video clips used in this lesson in the Teacher Resources section of the AFG Web site (www.pbs.org/americanfieldguide/teachers).

- Using the Lab Manual, students should attempt to determine which types of insects pollinate which flowers.
- Have students select one of their flowers to present to the class. They should explain which type of pollinator they think uses it and why.
- Journaling Activity: Why are flowers so different from each other?

Assessment suggestions

- Compare the journal writes from activity 1 and activity 3 to assess student learning.
- Assess the student presentation to the class using the following scoring guide
OR
- Have the students choose one flower to write a one-page report explaining a co-evolutionary relationship and assess using the following scoring guide:

Scoring Guide for Activity 3

	Well Done	Good	Poor	Absent
Uses vocabulary to explain features of flowering plants and insects	3	2	1	0
Clearly demonstrates adaptive features of a flowering plant to a particular insect	3	2	1	0
Correlation between plant and chosen insect is logical, even if it isn't the 'correct' answer	3	2	1	0
Explains relationship in terms of co-evolution.	3	2	1	0