Lesson Extension: Pollination Pals

Pairing Plants and Pollinators
Pollination is the goal of all flowering plants; it is the process of creating viable seeds that can lead to the next generation. While many plants utilize the wind for their pollination needs, others rely on animal pollinators. This lesson gives students a chance to study the relationship between plants and pollinators and then create a model of invented plant/pollinator relationships. The real-life pollinator/plant relationships described in this lesson plan are highly specialized. This will help your students visualize and appreciate how complex and highly evolved the world of pollination can be.

Objectives
• Students learn about different real-life pollinator/plant relationships.
• Students create a model demonstrating the relationship between an imaginary plant and a pollinator.

Materials
• Plant/pollinator overview
• Computer with internet access
• Markers
• Colored pencils
• Scrap paper
• Scissors
• Glue
• Drawing paper

Activity
• Introduce students to the concept of plant/pollinator relationships.
  ◊ Some plants are wind-pollinated or self-pollinated, but this activity focuses on animal/plant pollination relationships.
• The example of the fig and the fig wasp provides the jumping-off point for the discussion of plant/pollinator relationships.
  ◊ Figs are unusual plants: you will never see a fig tree in flower, because the flowers form inside the fruit. In order for these internal inflorescences, or flowers, to be pollinated, a pollinator needs to actually get inside the fig. This is where the fig wasp comes in.
  ◊ Female fig wasps enter immature figs through a small hole, called an ostiole, at the base of the immature fruit. Once inside the fig, the female wasp deposits eggs and pollen from other fig flowers into the fig’s female flowers. The female wasp dies after she lays her eggs.
  ◊ The male eggs hatch first. Flightless and blind, they mate with the females, who are still in their eggs, un-hatched. Then the males chew escape holes from the fig and die; they are not physically capable of surviving outside of the fig.
  ◊ The female wasps hatch and begin moving through the fig, looking for a way out. As they move about, pollen sticks to their bodies. Eventually, the female wasps find the holes left behind by the males and escape, carrying pollen away with them. Soon they find a new fig to burrow into and the life cycle continues.
◊ It may seem as if a fig filled with wasp larvae and riddled with escape holes would be unable to produce viable seeds, but the fig tree has developed several strategies for dealing with this.
◊ Female flowers have styles, the part of the female flowers that pollen must reach in order for the flower to be fertilized. These styles come in different lengths. The long-styled type of female flowers are set closer to the outer skin of the fig, while the short-styled ones are set closer to the center.
◊ Female fig wasps can only lay eggs in the flowers closer to the center, that is, in the short-styled flowers. Long-styled flowers are pollinated, but since they are too long for the female wasp to deposit her eggs, pollinated long-styled flowers will mature into seeds. The short-styled flowers will bear wasp eggs.
◊ The image below illustrates this unique and fascinating plant/pollinator relationship.

• Keep in mind that the figs we buy at the store do not come from wasp-pollinated trees. Most of the figs we buy are self-pollinating, which means they do not rely on a wasp or any other pollinator to help them pollinate their flowers. Many of the figs that are grown commercially, and available at the grocery store, are sterile and do not produce flowers that are capable of being fertilized and developing seeds.
• After discussing the relationship between the fig and the wasp with your class, consider the following questions:
  ◊ How does this relationship benefit the fig and the wasp?
  ◊ Do the fig and the wasp need each other equally?
  ◊ Is either the fig or the wasp giving up anything to benefit the other?
  ◊ How do you think a relationship like this might have evolved?
Do you think there might be any other pollinator/plant relationships that are similar?
How are most pollinator/plant relationships different than that of the fig and the wasp?

• Now your class is ready to learn about other pollinator/plant relationships. Below you will find descriptions of some that are unusual, complex and highly specific, with links to more information. Choose one or two to describe and research with your class, or choose your own. Based on your class discussion of pollinator/plant relationships, have your students come up with their own pollinator/plant relationships.

  ◊ Each student will invent their own plant with its own specific pollination needs and the logical pollinator for the task.
  ◊ Students will create a short (1-2 paragraphs) description of their plant and its pollinator and combine this with an illustration.
  ◊ Some questions for students to consider before beginning the creation of their pollinator/plant relationships:
    ◆ What will these relationships look like?
    ◆ How will the plants lure the pollinators to their flowers?
    ◆ What will the pollinators take from the plants? Will it be nectar and pollen only? Will your students’ pollinators lay eggs on the plants?
    ◆ How many steps will there be in the pollination process?
    ◆ Will your students’ pollinators make it out alive?
    ◆ How specific will the plant or pollinator’s needs be?

1. **Darwin’s Orchid and the Morgan’s Sphinx Moth**
   • Darwin’s orchid, *Angraecum sesquipedale*, is a beautiful, night-flowering orchid with large, waxy, white blossoms. The nectar of this plant lies at the bottom of a thin spur, or tube, that emerges from the back of the orchid. The spur can be over a foot long! The only animal capable of reaching this nectar is a moth called the Morgan’s sphinx moth, *Xanthopan morganii*.
   • This orchid is named after Charles Darwin. This is because when he received a specimen of the orchid in 1862, he speculated that the long nectar-spur must mean that there is a moth with a proboscis of corresponding length and shape. The moth was discovered in 1903, proving Darwin’s speculation correct, and further supporting his theory of evolution.
   • Sphinx moths have the ability to hover in the air like a hummingbird. Morgan’s sphinx uses its sense of smell to find a flowering Darwin’s orchid, then backs up over a foot and unrolls its proboscis. It slowly moves forward until the proboscis touches the orchid’s nectar at the bottom of the spur. At this point, the moth’s body is almost inside the orchid flower, so pollen naturally ends up all over the moth. From there, the moth moves on to other orchids, spreading pollen as it goes.

**Darwin’s Orchid Links**

2. **Almonds and Domestic Honeybees**
   - Honeybees pollinate many plants, but none with as much economic impact as almond trees. Almond flowers are dioecious; this means that they are either male or female. The male flowers bear the pollen needed to fertilize a female flower, which will then ripen into a seed-bearing fruit—the very almond that we enjoy eating.
   - There are over 900,000 acres of almond groves in California, the main source of almonds grown in the United States. All of these trees need to be visited by honeybees during their brief flowering period in February. Beekeepers from all over the country bring their bees to California during the blooming season, making more money from almond pollination than they do from selling their bees’ honey! It has been estimated that one out of every three bites of food that the average person consumes requires honeybee pollination. Almonds are just one example of a food crop that needs honeybee pollination.

   **Honeybee and Almond Links**
   - [http://entomology.ucdavis.edu/News/Honey_Bees_Are_More_Effective_at_Pollinating_Almonds_When_Other_Species_of_Bees_Are_Present](http://entomology.ucdavis.edu/News/Honey_Bees_Are_More_Effective_at_Pollinating_Almonds_When_Other_Species_of_Bees_Are_Present)
   - [http://www.almonds.com/growers/pollination](http://www.almonds.com/growers/pollination)

3. **Corpse Plant and Flies**
   - Corpse plant is the common name for several different species of plant which use the smell of rotting meat or fish to attract pollinating flies. *Amorphophallus titanum*, the titan arum, is one of the largest and most showy of these plants. The flower looks like a huge, yellow-green cone. The cone is called a spadix, and is surrounded by a fleshy, ruffled, purple, petal-like leaf. The spadix is encircled at its base by twin rings of tiny flowers. The top ring of flowers on the spadix is male, while the bottom flowers are female. The female flowers bloom first, and give off the smell for which these flowers are famous. This smell attracts flies to the titan arum, where they pollinate the female flowers. The pollinated female flowers then close, and the upper ring of male flowers open. As the flies climb up the spadix, they get covered in the titan arum’s sticky pollen and fly on to a new flower.
   - The titan arum blooms for a short time—only about 24 to 48 hours—and must be pollinated during that time. To accomplish this, the titan arum has a few tricks. The first is its pungent odor, a combination of rotting meat, old fish, stinky feet and just a touch of sugary sweetness, which grows stronger as the sun sets. The second is that the tip of the spadix reaches about 99° Fahrenheit when the flowers at its base are in bloom. This heat helps attract the flies that pollinate the titan arum.
4. Vanilla, the Melipona Bee and Humans

- *Vanilla planifolia*, or vanilla, is a vine in the orchid family. It is the only orchid that produces a food crop. The greenish-white flowers of the vine are hermaphroditic, which means each flower contains both female and male pollinating components. The female and male parts are called the stigma and anther.

- The shape and structure of the vanilla flower are such that the male pollen is separated from the female stigma by a lid of flower tissue. This separation of pollen and stigma means that despite being hermaphroditic, vanilla flowers cannot self-pollinate or rely on the wind for pollination. Vanilla pollinators must be large enough to lift up the flap of flower tissue and move through the pollen to get to the stigma and its nectar, but small enough to fit inside the vanilla flower. Due to the cultivation of vanilla as an agricultural product, humans are now the number one pollinator of the vanilla vine. Workers move through the vanilla groves with small sticks, lifting the flap that protects the pollen, collecting pollen on their finger and then moving pollen from the anther to the stigma.

- In the wild, *Vanilla planifolia* is pollinated by a small, stingless, black bee, called *Melipona beecheii*. The Melipona bee is just the right size and shape to pollinate the unique flowers of this orchid.

Vanilla, Melipona Bee and Human Links
- http://www.gourmetvanilla.co.uk/#/pollinating-vanilla/4546873700

5. Milkweed and Monarch Butterflies

- Milkweed is a perennial plant, meaning it grows back year after year from its original rootstock. There are many types of milkweed but most have large, drooping clusters of small, five-petaled flowers. Milkweed plants are known for their bitter, milky-white sap. In the 1960s, scientists isolated substances called cardenolides in the sap. Cardenolides are the chemicals responsible for the sap’s bitterness.

- Monarch butterflies lay their eggs on the underside of milkweed leaves, and their caterpillars eat an exclusive diet of milkweed until they mature and pupate into adult monarch butterflies. By consuming only milkweed, monarchs are able to digest and store the naturally occurring cardenolides from the milkweed leaves. The cardenolides are stored in the flesh of both the caterpillar and the mature butterfly, and make these otherwise tasty insects toxic and bitter. Thus, the protection milkweed offers to monarchs is the reason that the monarchs flock to the plant and pollinate it.
6. **Saguaro Cactus and Lesser Long-Nosed Bats**

- Saguaro cactus or *Carnegiea gigantea* are the instantly recognizable cacti of the Sonoran Desert. Growing over 70 feet tall, saguaros provide food, shelter and shade in a harsh, uninhabitable landscape. The primary pollinator partner of the mighty saguaro is the lesser long-nosed bat, *Leptonycteris yerbabuenae*.

- Saguaro cacti flower from April through June, and each flower stays open for less than 24 hours. The flowers open in the evening and emit a melon-like smell. This attracts lesser long-nosed bats, who subsist on a diet of cacti pollen and nectar for their entire adult lives. These bats have a long snout that turns up at the end, perfect for stretching all the way to the bottom of cacti flowers to reach the sweet nectar found there. In the process, the bats are almost completely covered in sticky saguaro pollen, which they will bring to the next flower and the next.

- Without lesser long-nosed bats, saguaros would rely on daytime pollinators—bees, flies, ants and birds. But these diurnal pollinators are nowhere near as effective as the bats, and they have far less time to reach the flowers and pollinate them before the flowers will close for good.

**Saguaro Cactus and Lesser Long-Nosed Bat Links**

Next-Generation Science Standards

2-LS2-2
Develop a simple model that mimics the function of an animal in the dispersing seeds or pollinating plants.

3-LS1-1
Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

3-5-ETS1-1
Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

4-LS1-2
Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

5-LS2-1
Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Common Core State Standards

CCSS.ELA-LITERACY.W.3.7, 4.7, 5.7
Conduct short research projects that build knowledge about a topic.

CCSS.ELA-LITERACY.W 3.2, 4.2, 5.2
Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
Resources

Books for Students

Books for Teachers

Websites
www.buzzaboutbees.net
http://www.fws.gov/pollinators
http://www.fs.fed.us/wildflowers/pollinators/index.shtml
http://greatpollinatorproject.org/pollinators/bees
http://pollinatorlive.pwnet.org