If Not For the Pollinators

Matching Flowers With Their Pollinators

Skills: Science

Objective: Students match flowers to pollinators and construct models of flowers to demonstrate why different kinds of flowers need different kinds of pollinators.

Background

Every third bite you take would not be there if not for the help of pollinators. Pollination is necessary for the production of seeds and fruits in up to 80 percent of the world's flowering plants. That includes two-thirds of the world's food plants—fruits, many vegetables (or their seed crops) and even legumes such as alfalfa and clover, which are fed as hay to the livestock we eat as meat. The remaining 1/3 of our food come from plants that can be pollinated by the wind—most grasses and some nuts, including pecans and other members of the hickory family.

Pollination is important to the US economy. In the US, pollination by insects contributes to $40 billion worth of products annually. Pollination by honeybees alone is valued at $19 billion, 143 times the total value of the honey produced by bees.

The pollination process works like this: The flowers use nutritious foods (pollen) to attract pollinating insects in hopes they will become dusted with bright yellow pollen and transfer the microscopic pollen grains from flower to flower. The pollen grains contain the sperm cells that must be transferred from the male parts of a flower (the anthers) to the top of the pistil (known as the stigma) which is on the female part of a flower. This transfer of pollen from flower to flower (or even within the same flower) is known as pollination. Once there, the pollen grains send down thin pollen tubes carrying the sex cells needed to unite (fertilize) with the ovules within the swollen ovary at the base of the flower. Once fertilized, these little green ovules rapidly become the seeds within the swollen edible part that we call the fruit, like the white flesh of an apple surrounding the dark brown seeds within the apple core.

There are over 100,000 species of pollinators. Most people know bees are pollinators, but wasps, butterflies, moths, ants, beetles, flies, midges, mosquitoes, and even some slugs do their part as well. Many mammals and birds carry pollen, which they pick up inadvertently while feeding on the nectar of plants.

There are over 3,500 native bee species in the US. Native bees pollinate many Oklahoma crops, including alfalfa, apples, blueberries, cantaloupes,

P.A.S.S.

GRADE 6
Science Process—2.1,2; 3.1,2,3,4,5; 4.1,3,4,5; 5.1,3,4
Life Science—3.2; 4.1,2; 5.2

GRADE 7
Science Process—2.1,2; 3.1,2,3,4,5; 4.1,3,4,5; 5.1,3,4
Life Science—2.2; 4.2; 5.2

GRADE 8
Science Process—2.1,2; 3.1,2,3,4,5; 4.1,3,4,5; 5.1,3,4
Life Science—3.1,2; 5.2

Resources Needed

graph paper

journals

clear straws and coffee stirrers

artificial flower petals

pipe cleaners

construction paper

stiff fabric

12 oz. and smaller clean plastic soda or water bottles in assorted shapes and sizes

colored water

cherries, cucumbers, sunflowers, and watermelon. Native bees nest in thick grass, soil, and wood. are rarely kept in hives, and generally do not make surplus honey or form large colonies. Examples of native pollinating bees are sweat bees, which take their name from their habit of landing on people and licking their skin, squash bees, which collect pollen only from cucurbits like squash, pumpkins, and gourds, and leafcutter bees, which prefer alfalfa, clover and other legume blossoms. Bumblebees and many other native bees perform buzz pollination, in which the bee grabs onto a flower's anthers and vibrates her flight muscles, releasing a burst of pollen from pores in the anther. This behavior is critical for the efficient pollination of tomatoes, peppers, watermelon and blueberries. Bumblebees are used in some greenhouse operations.

Not all pollinators are equal. Some are generalists; some are specialists. Some are brawny; some are feeble. Some have long tongues; some short. Some work at colder temperatures than others. Bees may deliberately collect pollen but have different collection techniques, which can greatly affect their efficiency as pollinators.

Flowers are often specifically adapted to one pollinator or a small group of pollinators because of floral structure, color, odor, nectar guides, etc. One flower, the bee orchid (Ophrys bombyliflora), looks like a female bee and even gives off the "scent" (pheromones) of a female bee. When the male comes to the flower the stamen comes down and taps him on the head, thus putting pollen on him. A collection of the traits in a flower that is aimed at attracting a particular type of pollinator is called a "pollination syndrome."

Background Sources: Carl Hayden Bee Research Center, US Department of Agriculture, Agricultural Research Service; kidsgardening.org; The Xerces Society; University of Florida Extension Service.

Activities

1. Read and discuss background.

ACTIVITY 1

1. Each student selects two foods—one fruit and one above-ground vegetable (such as tomatoes or zucchini).
   —For each food, students research in the library or online to find out what the blossom looks like on the plant that produces the food.
   —Students create simple charts to record information they find about the flower: color, scent, size, shape, rewards (pollen or nectar), etc.
2. When students have completed their research, discuss these questions as a class:
   —What size is your flower? (tiny, small, average, very large)
   —Does the flower open during the daytime or at night? What kinds of pollinators are active by day? By night.
   —What color(s) is your flower? Do certain pollinators visit flowers of a certain color?
   —Does your flower have an unusual shape, such as a long narrow tube, which, for example, a fuzzy fat bumblebee couldn't fit into?
3. Hand out the "Pollinator Syndromes " chart included with this lesson.

Wind Pollination

Most grasses and nuts, including the pecans that grow in Oklahoma, are pollinated by the wind. Plants that can be pollinated by the wind are called anemophilous. Plants pollinated by invertebrates are entomophilous, and plants pollinated by vertebrates are zoophilous. Anemophilous species do not develop scented flowers, nor do they produce nectar.

—Students determine which pollinators most likely pollinate the flowers they have researched.
—Students share information with the class.
—Assign one student to record the information on the chalkboard and tally responses.
—Students vote on the best candidate for the pollinator of each fruit and vegetable.
—Students consult reference books to find correct answers.

ACTIVITY 2

1. Hand out copies of the "Flower Parts" and "Pollination Simulation" pages included with this lesson. Divide students into groups.
   —Review "Flower Parts."
   —Each group follows the directions on the "Pollination Simulation" worksheet to design 3-5 flowers.
2. Students use their flower models and the "Scientific Method Format" included in the "Resources" section to demonstrate the need for different kinds of pollinators by different kinds of flowers.
   —After all the flowers have been matched with a pollinator, discuss the simulation.
3. Students select the appropriate graph type, and graph results. See "Graphs" in the "Resources" section for explanations of the different kinds of graphs.
4. Students answer the following questions in their journals.
   —What did the various parts of the model represent?
   —Why was it specified that the top of the straw must be level with the stigma of the flower?
   —Why must a pollinator hone in on one type of flower and NOT be random about the flower it chooses?

Extra Reading

Buchmann, Stephan L, Gary Paul Nabhan, and Paul Mirocha, *The Forgotten Pollinators*, Island, 1997.

Hauth, Katherine B, and Kay Sather, *Night Life of the Yucca-The story of a Flower and Moth*, Roberts Rinehart, 1996.

Schaefer, Lola M., *Butterflies: Pollinators and Nectar-Sippers*, Bridgestone, 2001.

Souza, DM, *Freaky Flowers*, Franklin Watts, 2002.

Vocabulary

brawny—having muscular strength
feeble—lacking in strength or endurance
invertebrate—an animal (as a worm, clam, spider, or butterfly) that lacks a backbone
generalist—something or someone with skills or interests that extend to several different fields
pollen—a mass of tiny particles in the anthers of a flower that fertilize the seeds and usually appear as fine yellow dust
pollination—placing pollen on the stigma of
pollination syndrome—a collection of the traits in a flower that is aimed at attracting a particular type of pollinator
migratory—having a way of life that includes moving from one country, place, or locality to another
simulation—the imitation by one system or process of the way in which another system or process works
specialist—something or someone with specific skills
vertebrate—an animal that has a spinal column

Pollination Sydromes

Flowers are often specifically adapted to one pollinator or a small group of pollinators because of floral structure, color, odor, nectar guides, etc. A collection of the traits in a flower that is aimed at attracting a particular type of pollinator is called a "pollination syndrome." Below are some of the traits that attract these common pollinators.

Bees

Both honey bees and native wild bees are attracted to flowers with bright lively colors (especially blues and yellows). They can't see the color red so won1t visit blossoms that are red. The flowers may be massed into a group of many smaller flowers or may have a "landing platform" for the bees to stand upon while they drink nectar or collect pollen. Such bee flowers often have pleasing fresh scents that humans find attractive. There is abundant nectar and pollen.

Hummingbirds

Hummingbirds are attracted to flowers with red, pink or orange throats that are narrowly constricted so that only the hummingbird's narrow bill can enter to extract the abundant but dilute nectar. The flowers have no scent that people can detect. There is no landing platform on the flowers.

Bats

Unless you live in the American southwest (Texas, Arizona, New Mexico or southern California) you aren't likely to have picked a flower pollinated by bats. Most of this happens in the tropical rainforests. Bats are attracted to blossoms that are large and very sturdy. The flowers are always presented at night, as in the case of the century plant (the genus Agave). There is plenty of dilute nectar. The flowers are usually not brightly colored and don't smell very good. Some people think these flowers smell musty or fruity. Some bananas are pollinated by bats.

Butterflies

Blossoms built for butterflies have lively colors, especially pinks, blues and yellows. They are often grouped together in small masses. The floral tube is often narrowly restricted to just allow the butterfly's slender tongue (the proboscis) into the opening. These flowers have very pleasant floral scents and abundant nectar.

Moths

Not many of our crop plants are pollinated by moths. These flowers open during the evening or at night, when moths are active. They often have very sweet pleasant scents (like night-blooming jasmine) which we can smell from a long distance away. The flowers are almost always white and have abundant nectar but not much pollen. There may or may not be a landing area.

Flies

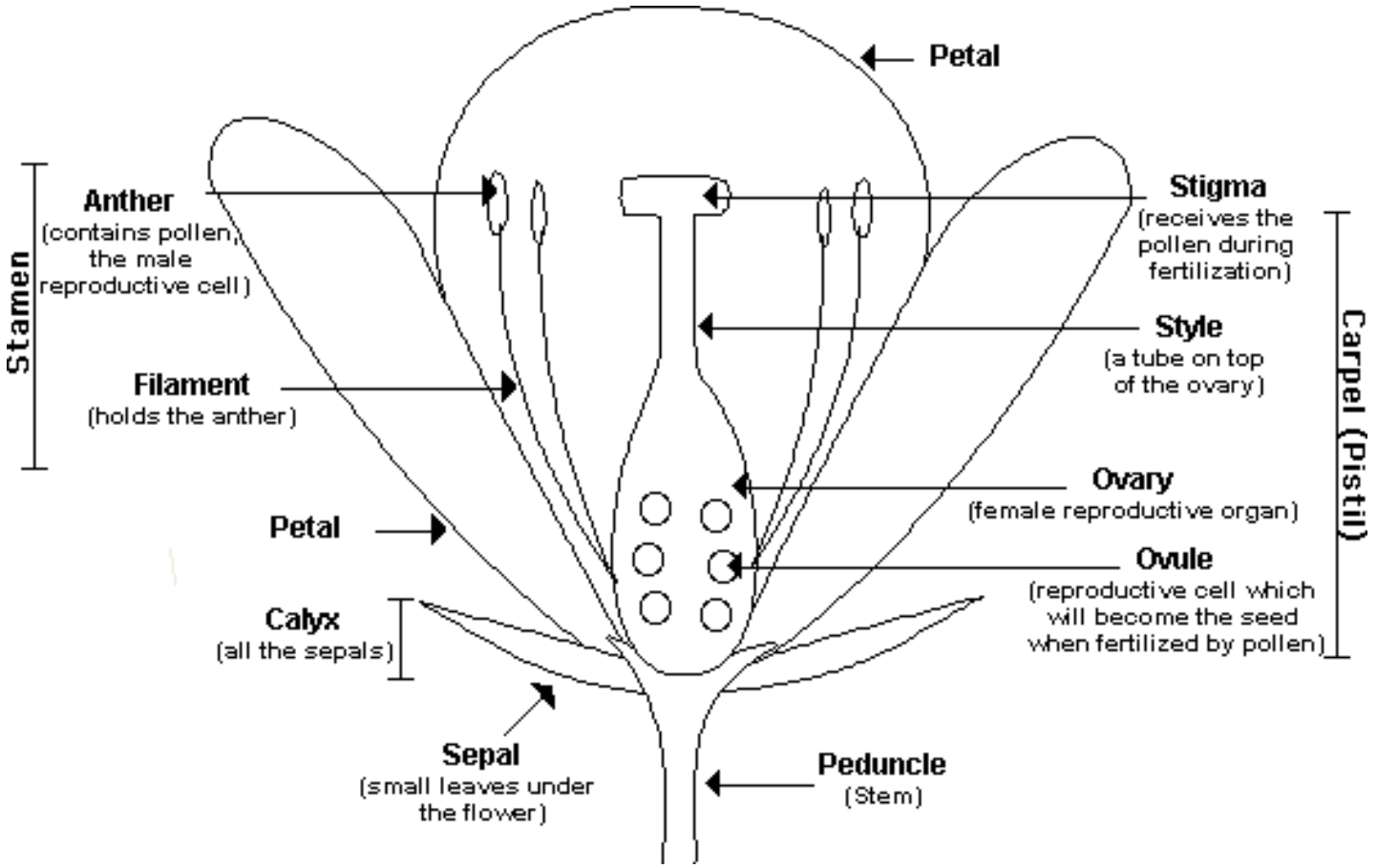
Flies, especially the flower flies in the family Syrphidae, are important pollinators. Their hairy bodies are great for transporting pollen grains around, helping to pollinate flowers and set fruit. Flies may visit many types of blossoms, especially big open masses like goldenrod. Some of the flowers they visit smell like rotting meat. Other flowers (like the Dutchman's Pipe) trap and hold flies inside for pollination. Flies (midges, in this case) are responsible for pollinating the cacao blossoms, whose seeds are ground up to make chocolate.

Beetles

There are more kinds of beetles alive today than any other kind of insects. They are usually generalists and often visit many types of flowers for food, especially in the tropics. They are called "mess and soil" pollinators because they generally wander around on the flower eating and chewing on everything. Very large flowers with numerous parts (such as a Magnolia) are pollinated by beetles. The blossoms often smell like overripe fruit. Beetles are not as important to crop plants as bees are.

Produced by Oklahoma Ag in the Classroom, a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education, 2008.

The Parts of a Flower



anther—the part of the stamen of a flower that produces and contains pollen and is usually borne on a stalk
calyx—the usually green or leafy outside part of a flower consisting of sepals
corolla—the part of a flower that consists of the petals and encloses the stamens and pistil
filament—the anther-bearing stalk of a plant stamen
flower—the reproductive part of a plant . Flowers may be male or female only, or both male and female (complete).
ovary—one of the usually paired organs in the body of female animals that produces eggs and that in female vertebrates also produces sex hormones
peduncle—stem
petals—the inner ring of the flower leaves. Often white or brightly colored to attract pollinators.
pistil—the female flower organ, consisting of the seed-bearing ovary, stigma and style.
sepals—the outermost ring of the flower leaves; often green and leafy in structure.
specialist
stamen—the male part of a flower, usually consisting of the stalk-like filament and the pollen bearing anther.
stigma—the upper tip of the pistil of the flower, receives the pollen.
style—the stalk-like portion of the pistil between the stigma and the ovary.

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Pollination Simulation

Materials needed: clean plastic soda or water bottles, assorted shapes and sizes, 12 oz. and smaller; clear straws and coffee stirrers; artificial flower petals; construction paper; stiff fabric; colored water

MAKING THE FLOWER

Review the parts of a flower. Use your imagination to create flowers, using the materials provided and the following restrictions:

1. The flower (corolla) must sit on top of the bottle.
2. The flower must include an opening for a straw.
3. The bottle (the "nectary") must be covered with material so the quantity of "nectar" (juice) inside cannot be seen.
4. Each flower must have a stamen and a pistil.
5. The distance from the opening of the flower to the bottom of the bottle must be a different length from that of other flowers you or your group have made. (Use bottles of different sizes or fashion the flower so the distance from the opening to the bottom of the bottle is different each time.)
6. Each flower should have a different shape, based on what you have learned about the different kinds of pollinators and different pollination syndromes.

PREPARING FOR POLLINATION SIMULATION

1. Assign a number to each flower.
2. Remove the flower top from the bottle.
3. Pour juice or colored water (to represent nectar) into each container.
4. Replace the flower top.
5. Use a straw to practice removing the nectar from the flower: Use your finger to create a vacuum so you can pull the nectar from the flower.
5. Cut straws in different lengths to represent different kinds of pollinators.
6. Mark straws at 1 ml (10 drops), 2 ml (20 drops), etc.

POLLINATION SIMULATION

1. Select a straw to represent a particular pollinator.
2. Place the straw in the flower, with the top of the straw at the top of the flower.
3. Use the straw to try drawing nectar from the flower. The top of the straw and your finger must start at the stigma.
4. To count as match, nectar must only be in the bottom 2 cm of the straw.
5. If you can produce a drop of nectar from the flower, put the straw aside and tag it with the number of the flower it matched.
6. Select a different straw, and go on to the next flower.

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