The mission of the National Wildlife Federation® is to educate, inspire, and assist individuals and organizations of diverse cultures to conserve wildlife and other natural resources and to protect the Earth's environment in order to achieve a peaceful, equitable, and sustainable future.

As America's largest member-supported conservation group, NWF leads grassroots efforts to safeguard wildlife, wild places and the natural resources on which we all depend.

The National Wildlife Federation has been a leader in environmental education for nearly 65 years. From our Schoolyard Habitats® program and teacher workshops to Ranger Rick™ magazine and our award-winning television shows and films, NWF's dynamic education efforts reach out to help people discover, experience and connect with the wild in our world.

For more about NWF's education programs, visit us at www.nwf.org.

The National Wildlife Federation's *Keep the Wild Alive*™ program is an ambitious endangered species campaign that aims to build support for endangered species, engage the public in species conservation efforts, and move several imperiled species closer to recovery.

For more information about the *Keep the Wild Alive* campaign, or to learn about simple actions you can take to help endangered species, please visit the *Keep the Wild Alive* website at www.nwf.org/keepthewildalive or call (202) 797-6800.

Founded in 1924, the American Association of Zoological Parks and Aquariums, now known as the American Zoo and Aquarium Association (AZA), is a nonprofit organization dedicated to the advancement of zoos and aquariums in the areas of conservation, education, science, and recreation. AZA's vision is to work cooperatively to save and protect the wonders of the living natural world.

The AZA and its accredited zoo and aquarium members constantly strive to maintain the highest standards in wildlife care and conservation. To demonstrate this commitment, AZA members participate in over 700 cooperative conservation and management programs. Through these programs, AZA assists its members in managing their captive populations and conducting and overseeing zoo and aquarium-based and field-based conservation, research and education projects. Since 1991, AZA's Conservation Endowment Fund has awarded over $2 million to support 146 projects benefiting wildlife worldwide.

AZA-accredited zoos and aquariums draw over 134 million visitors each year. With their incomparable commitment to conservation education in living classrooms, AZA zoos and aquariums teach more than 12 million people annually. More than nine million students enjoy on-site education programs at our member institutions each year — over three and a half million receive them free of charge.

We are proud of our dedication to conservation and science and conservation education. In 2000 alone, AZA members supported over 2200 conservation and associated scientific and educational projects in 86 countries worldwide. In the same year, over 58,000 volunteers contributed over five million hours to support AZA member zoos and aquariums. Through projects like the Butterfly Conservation Initiative and other local efforts, AZA institutions are becoming community conservation centers. Contact your local accredited zoo or aquarium to find out how you can get involved. Visit www.aza.org or call (301) 562-0777 to learn more.

ACTIVITY 2

POLLINATION PARTNERS: AN INQUIRY INVESTIGATION

Summary

Students study the role of butterflies in pollination.

Grade Levels: 3-8

Time: several class periods spread out over several weeks.

Subjects: science

Skills: observation, prediction, description, research

Learning Objectives:

Students will be able to:

- ✓ Describe the process of pollination.
- ✓ Identify butterfly roles in pollination.
- ✓ Name several different kinds of butterflies.

Materials:

- ✓ Notebooks
- ✓ Pencils
- ✓ Cut flowers
- ✓ Photos of flowers and butterflies
- ✓ Magnifying glasses

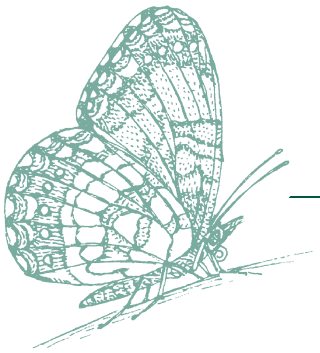
Background

Animals play a key role in the reproduction of many flowering plants. Bees, butterflies, hummingbirds, bats, wasps, moths, beetles and others visit flowers in search of food. In the process, animals pollinate the flowers, bringing reproductive cells (**pollen**) from one plant to another. When animals visit multiple plants of the same species, they transfer pollen from plant to plant. This movement of pollen is called **pollination**. Pollination leads to **fertilization**, the development of new seeds, and, in some plants, fruit. The young seeds (either contained in fruit or not) may be carried by wind, water or animals to a new location where, if all goes well, they will grow into new plants and start this process all over again.

How does the process of pollination work? Flowers contain a plant's reproductive parts, including the male stamen and the female pistil (see diagram, pg. 12.). The structure of the flower forces the male **anther**, holding pollen grains, to brush up against the pollinating species while it is looking for its food, the nectar. The female **pistil** includes the **ovary**, which contains **eggs** or **ova**, **style**, and **stigma**; the stigma is sticky and collects pollen from the bodies of animal visitors. When pollen grains fertilize an ovum, a new seed begins to develop.

Since plants are rooted in one place, they need help transferring pollen to other flowers of the same species. Some flowers rely on wind to carry pollen grains, while others use water. As you might imagine, lots of pollen carried by wind or water never actually reaches flowers of the same species. Animal pollinators, however, give plants an advantage, since they deliver pollen directly to the flower. While collecting nectar from the base of a flower, butterflies brush against pollen from the flower's anther. The butterfly ends up carrying a load of pollen on its body. At the next flower the butterfly visits, some of that pollen reaches the female reproductive parts while the butterfly feeds. This direct contact is what makes butterflies and other nectar-feeding animals great pollinators. The pollination relationship is mutually beneficial to flower and animal — one gets food while the other receives help with reproduction.

Over time, flowers have developed adaptations to ensure that the most suitable pollinator for their species will visit and return often to feed. In fact, flowers' fragrances, bright colors, nourishing nectar and pollen and varied shapes are considered adaptations to attract certain pollinators. For example, the bright colors of flower petals are thought to help flowers stand out against a green background. The shape of



the flower also plays a role in determining the kind of pollinator that can feed from the flower. Butterflies must have a perch to land on while feeding, while hummingbirds can hover near flowers while feeding. Pollinators are also well adapted to ensure that they will have access to flower nectar.
Animal adaptations associated with pollination include sense of smell, color preferences, beak shape (in birds), and tongue length. A butterfly's "tongue," or proboscis is very effective in reaching nectar at the base of flowers because it is long (compared to the butterfly's body) and also very flexible. When not in use, the butterfly proboscis is coiled up. When the butterfly needs to feed on nectar, it will uncoil its proboscis to sip the nectar at the base of the flower.

Pollinators play a critical role in both agricultural and natural systems. Many of the plants that produce the food we eat depend on pollinators — from apples to watermelon. In fact, scientists estimate that every third bite of food humans eat is made possible by the act of pollination. Pollinators are also key to maintaining ecosystem health and biodiversity. Healthy pollinator populations ensure that many plants that help clean our air and water and serve as food and cover for wildlife can reproduce, which in turn sustain our ecosystem functions and a diversity of life.

This activity will allow students to engage in their own student-directed investigation of the relationship between butterflies and their nectar plants.

Procedure

1. Ask students what they know about butterflies and pollination. *How do butterflies help to pollinate flowering plants? What does this mean?*

2. Provide students with several photographs/drawings of butterflies and flowers, including real cut flowers if you have them available. Divide your class into smaller groups and give each group the same materials. Give students time to explore their materials and encourage them to jot down questions they have about butterflies and pollination. Ask them to think about how the flowers are shaped, and then guess what kind of body shape, tongue, etc. would be best for pollinating a particular flower structure.

3. Next, take students outside to observe butterfly/plant interactions in your schoolyard or near-by outside area. Students should bring their notebooks outside with them. Have each student spend about 10 minutes quietly observing on their own and writing questions about their observations. They should write down additional questions that occur to them as they observe. If they don't see any butterflies, have them list possible reasons why.

4. Have students get together in their groups and spend another few minutes observing and writing down questions together.

Butterfly Observation Tips:

1. Wear comfortable clothing without bright colors, since those may startle butterflies. Greys and browns are good colors to wear while butterfly watching.

2. Most butterflies spend the majority of their time in the sun. Butterfly watching is likely to be most rewarding during midday on a sunny, warm day without much wind.

3. Look for butterflies on or near nectar-producing flowers.

4. Take binoculars and butterfly field guides with you to help you identify the different species of butterflies you encounter.

5. When you return to the classroom, have students write their questions on large strips of paper and give them to you. Look at the questions and sort them by category, (determined by the questions themselves), and then post around the room in the categories you have determined. This will give you a chance to eliminate questions that are either inappropriate, irrelevant, or will be impossible to actually investigate given the time and materials and level of students you have available. While you are doing this, students can either take a break, draw illustrations of the butterflies they saw, or focus on something else.

6. Ask students to spend a few minutes wandering through the room, looking at the questions, and picking one they are most interested in studying. Have students form small groups based on which questions they pick.

7. In their groups, ask students to develop an investigation plan for how they will answer their question of choice. *What materials do they need? How much time do they need? What are the steps in their investigation?* Have them lay out their investigation plans in as much detail as possible. Check in with each group to provide them with assistance or make lists of materials they will need.

8. If you have time, have students carry out their investigations — over the time needed to complete them. Assist them as necessary, when they appear stuck, but encourage them to explore as much as possible. Allow students to conduct their investigations into butterfly/plant interactions.

9. Have student groups give presentations on their conclusions, sharing the information they collected through their investigations.

Note: Read the options below for alternative activities.

Option 1: If your time is limited or you are working with younger students and you want to conduct a more structured observation activity, provide students with the Pollination Partners activity sheet, and have them make observations over several class periods.

Option 2: For classes with limited outdoor access, complete Steps 1 and 2 above. After the overview of pollination, have students research locally occurring butterflies (try www.enature.com) and the host and nectar plants the butterflies would need. Have students draw the host and nectar plants along with the butterflies and create a butterfly habitat mural on a piece of butcher paper or a bulletin board. Plants and butterflies can also be created out of art materials such as tissue paper, cotton balls, and fabric scraps. Older students can write a schoolyard butterfly habitat proposal that outlines where on the school grounds a site could go, what native plants they are interested in planting, and what butterfly species the site would attract. The proposal could also include how classes could use the site, what benefits it would provide the school and community, and fundraising ideas. For additional information on creating a Schoolyard Habitats site, visit www.nwf.org/schoolyardhabitats.

Extensions

✔ Have students think about where their investigations led them, and what kind of follow-up they would like to do. Have them design these follow-up investigations and conduct them if time allows.

✔ Explain to students that some butterflies are endangered because the plants they depend on as hosts for the caterpillars are being decimated due to habitat destruction. Have students conduct research to find out if there are any endangered butterflies in your area, and explore the factors leading to their endangerment.

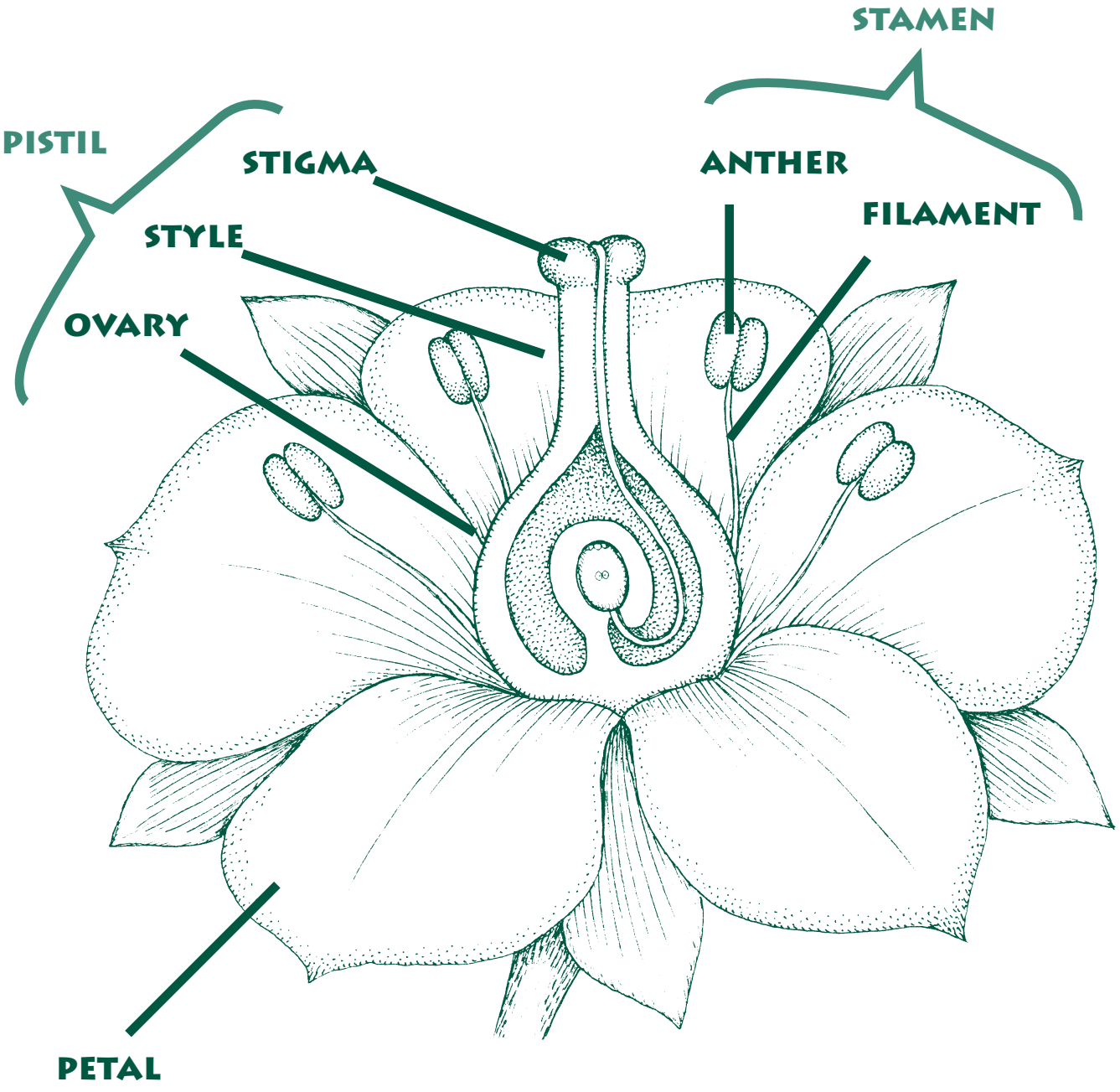
✔ Have students research the characteristics of flowers that attract butterflies (e.g., *How have flowers adapted to make butterfly pollination possible? How are these flowers different from those pollinated by bats, hummingbirds, bees, etc.? Can you tell by looking at a flower how it is pollinated?*). Then, in small groups have students design an "ideal" flower for a butterfly on large poster-size paper, pointing out those qualities that are especially suited for butterflies. (You may choose to have some students research and design flowers pollinated by other animals, so that students can see the different adaptations.)

Assessment

✔ Student presentations can serve as excellent assessments of their work. Develop an evaluation rubric with students prior to their presentations, determining what criteria should be used to assess them.

WORKSHEET

FLOWER DIAGRAM



WORKSHEET

POLLINATION PARTNERS

Name: _____

Date: _____ Time: _____

General weather conditions: _____

Location of plant I will be observing: _____

Name of plant: _____

Sketch it:

Hypothesis: When I observe a butterfly, I will see: _____

Observation: Number of times I saw a butterfly on my plant: _____

Same kind or different species? List the species if you know the names. _____

_____

What did the butterfly do while on the plant? Watch carefully. _____

_____

How long did each one spend on the plant?

Butterfly	Time on Plant
1.	
2.	
3.	

Where did the butterfly go next? _____

Sketch your butterflies:

Conclusions:

Was your hypothesis supported by your observations or not? _____

_____

What other questions do you have about butterflies and plant interactions? _____

_____