Plant and Pollinator Partners

2nd-HS

A Hummingbird clearwing moth (*Hemaris thysbe*) visiting a native Wild bergamot (*Monarda fistulosa*) flower.

NJSLS Connections:

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

3-LS4-2: Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

4-LS1-1: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

MS-LS1-4: Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

HS-LS4-4: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Learning Objectives:

- **Identify** types of pollinators found in New Jersey and compare and contrast their physical traits
- **Observe** and **analyze** pollinator behavior to explain the process of pollination
- **Describe** the importance of pollination for the survival of plants
- **Design** a new kind of flower with traits to attract a specific pollinator to demonstrate knowledge of plant-pollinator coevolutionary relationships

A Biocolored striped sweat bee (*Agapostemon virescens*) visiting a native False sunflower (*Heliopsis helianthoides*).

Instructor Background

Pollination is a vital ecosystem service facilitated by insects and other organisms, as well as wind or water for certain plant species. Animal-facilitated pollination represents a mutualistic relationship in which both organisms benefit. Pollinators receive a food source from a plant's flowers in the form of sugary nectar, protein-rich pollen, or even other flower-feeding insects, and plants can complete reproduction as pollen unintentionally carried by insects is exchanged between flowers of the same species. When a pollen grain produced by a flower's male anther reaches the female stigma of a flower of the same species, fertilization occurs and seeds begin to grow as the flower develops into a fruit.

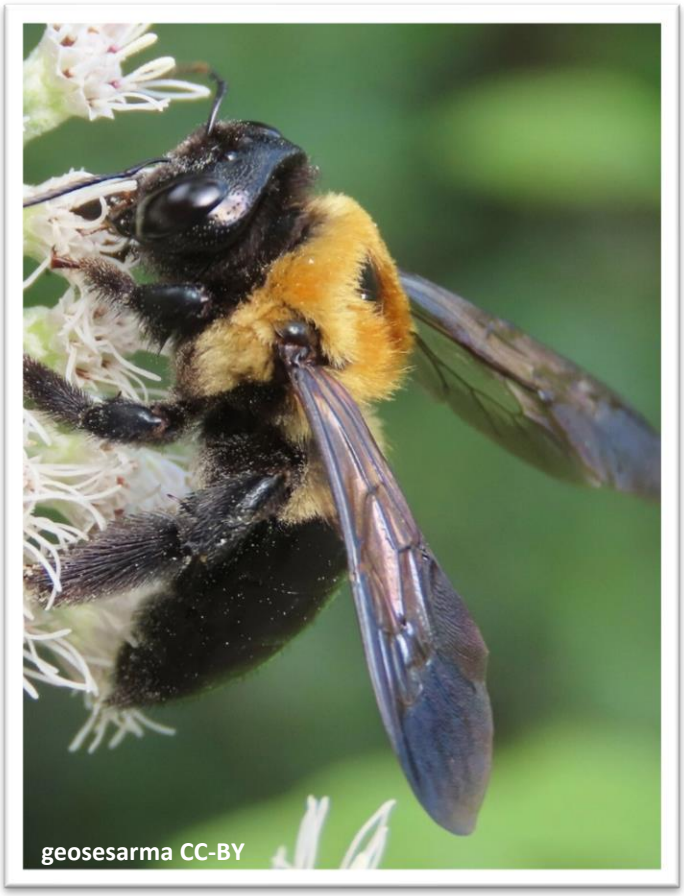
As plants and their pollinators are so closely linked through their relationship of pollination, they have evolved alongside each other for thousands of years. Because of these special coevolutionary relationships, it is often possible to look at a flowering plant and guess which pollinators are the most common visitors to its flowers. In the same way, we can guess what kind of flowers a certain pollinator may visit based on its appearance.

Notably, tongue length is one of the best traits to indicate what type of flower shape a pollinator prefers. Smaller pollinators with shorter tongues, such as most bees, tend to prefer shallower, flatter flowers as the nectar is contained where the pollinator can reach it. Pollinators that have longer tongues or proboscises, like butterflies, hawkmoths, and hummingbirds, most often visit flowers with a longer tube- or trumpet-like shape, as their long tongues can reach deep into the flower to access the nectar held inside. However, many other flower characteristics such as color and fragrance play a part in attracting pollinators.

Pollination Observation

Supplies

- Pollinator observation worksheet
- Field kit for each student with pencil, colored pencils, eraser, and optional magnifying glass
- Clipboards or recycled cardboard to lean on



The Eastern carpenter bee (*Xylocopa virginica*) is identified by its large size and hairless black abdomen.

Preparation

Scout a location with ample opportunities to observe pollinators. This may be a pollinator garden in a school or park, an unmaintained meadow or strip of wildflowers, or even a garden center with the permission of the owner. If an outdoor area to perform this activity is not available, show unnarrated footage of pollinators in a meadow or garden.

Introduction

Hold a discussion to explore students' understanding of pollination:

- What is a pollinator?
- What is pollination?
- Why is pollination important?
- What kinds of pollinators are there?

Introduce flies, beetles, wasps, and birds as pollinators using the Meet the Pollinators slide deck. Review the Insect Pollinator ID guide sheet.

Activity

Head outdoors and guide students to the predetermined for the pollinator observation. Allow students unstructured time to observe and/or record observations and questions about the pollinators and the types of flowers they visit on paper or in a journal. Encourage them to take their time and observe closely.

Pollination Observation

Observation Worksheet

Complete a structured observation using the Pollination Observation worksheet. Students may investigate the number of unique pollinators that visit a single flower over a period of time, the different kinds of pollinators present, and/or whether one type of flower is preferred over another.

Take a closer look! This insect is not a bee but a Transverse-banded flower fly (*Eristalis transversa*).

Share and Discuss

Invite students to share their observations with the class or a partner and invite them to pose questions that came up during their observations. Ask questions to discuss:

- What kinds of animals are visiting the flowers?
- What are they doing? Why?
- What kind of flowers did each pollinator visit? (Note: you may focus on physical characteristics like shape and size rather than taxonomic identification: “We saw a butterfly with a long tongue that drank from the long and narrow red flower”)
- Why does the pollinator want to visit the flowers?
- Why do the flowers need to be pollinated?

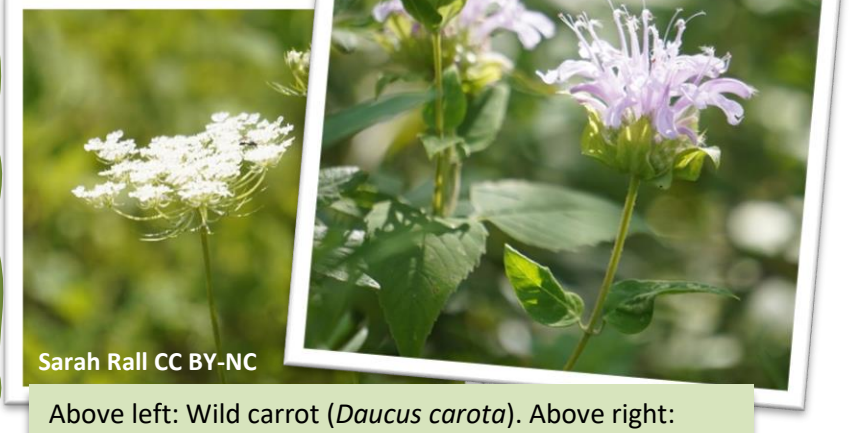
If not addressed over the course of your discussion, review the process of pollination: “A bee (or other pollinator) visits a flower to get a sugary drink of nectar. When the pollinator lands on the flower, some of the sticky pollen made by the flower gets stuck on its fuzzy legs. When the bee visits another flower of the same type, the pollen stuck on the bee's legs is moved to the new flower. When a flower receives pollen from another flower of the same type, the flower begins to grow seeds inside and turn into a fruit,”.

Transition to the create-a-flower activity by reviewing the plant-pollinator partnerships that students observed to instill that different plants have different characteristics to attract specific pollinators, and different pollinators have different characteristics to allow them to visit specific kinds of flowers. Stress the mutually beneficial nature of this relationship.

Create-a-Flower

Supplies

- Create-a-Flower worksheet
- Pencils and colored pencils
- Printable guides for pollinator identification and inspiration
- Field guides of pollinators and wildflowers for inspiration



Above left: Wild carrot (*Daucus carota*). Above right: Wild bergamot (*Monarda fistulosa*). Below: Eastern tiger swallowtail on Purple coneflower (*Echinacea purpurea*).

Preparation

Print guides in the Resources section below and provide photos and field guides of different pollinators and flowers to serve as inspiration.

Introduction

1. Explain: Flowers and their pollinators have a special relationship. Different kinds of flowers have different traits, like shape, color, or fragrance, to attract specific types of pollinators. Examples. Sometimes we can look at a flower and guess what kind of animal may pollinate it, and likewise we can look at an animal pollinator and make a guess about the appearance of the flowers they pollinate.

2. Option to review the Meet the Pollinators slide deck again and have the students guess what kind of flowers each pollinator prefers based on the size of the pollinator and the observed or presumed length of their tongue.

3. Show the videos and/or explore the guides for pollinator identification and predicting plant-pollinator relationships linked below, and supplement with related material from field guides, books, and photos.

Create-a-Flower

Activity

This activity is sourced from the "Survival Quest: A Pollination Game" lesson plan on page 3-113 of Project Botany by the Institute for Applied Ecology. This activity is adapted from the "Reflection" Activity on page 3-118, licensed under CC BY 4.0.

1. Invite students to think creatively to invent a flower for a new or unique pollinator: (black bear, human, etc) using the Create-a-Flower worksheet with the help of the guides for pollinator identification and predicting plant-pollinator relationships linked below.

2. Instruct students to draw and label an illustration of their flower, providing explanations for its particular characteristics. Remind students to consider what the flower looks like and smells like, where it grows, when it blooms, etc. and provide an explanation for each characteristic to provide more details about its relationship with its specialized pollinator. Students may use field guides or other sources to gather more information about their intended pollinator, like its diet, the time of day and year it is most active, and its preferred habitat to better design the flower.

Share and Discuss

Have students share their new flowers with the rest of the class. If any students invented flowers designed for the same pollinator, pair them up or form a group for students to compare and contrast their different flowers designed for the same pollinator. Pair up the remaining students to compare and contrast their invented flower structures with a partner. For older students, also discuss:

- Why do plants evolve flowers with characteristics to increase chances of pollination?
- Why would these characteristics evolve to attract specific types of pollinators?

The native coral honeysuckle (*Lonicera sempervirens*) bears long, narrow, tube-shaped flowers visited by long-tongued pollinators like butterflies, hummingbirds, and hawkmoths.

Materials

- Pollinator Observation worksheet https://www.canva.com/design/DAFm9hztfM4/o4lX2guDyCqrhm9Y69ZYCA/edit?utm_content=DAFm9hztfM4&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton
- Create-a-Flower worksheet https://www.canva.com/design/DAFvlb2PYxg/qcZyiGLMfSGXTpdikRaURQ/edit?utm_content=DAFvlb2PYxg&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton
- Meet the Pollinators slide deck https://docs.google.com/presentation/d/1ATsy1VyLsld2Oebol9b2qSPhp_iRbvftzm2BnwlSJCQ/edit?usp=sharing

Printable Guides

Guides for pollinator identification and predicting plant-pollinator relationships:

- Field guide to New Jersey native bees https://winfreelab.files.wordpress.com/2014/08/newjerseynativebees_foldout.pdf
- Chart of pollinators' preferred flower traits https://www.canva.com/design/DAF_-QU4BdQ/PMlKJl6zJjAAzESNziOaeQ/edit?utm_content=DAF_-QU4BdQ&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton
- Chart of Pollinators preferred flower shapes with photos https://drive.google.com/drive/folders/1cfFqwrcc1W8gADb9vZl14C6lXZaJ_e0J?usp=drive_link
- Insect Pollinator Identification sheet https://www.canva.com/design/DAF_-QM3eO8/pzqDqA07B8F3wx8iqE8DJw/edit?utm_content=DAF_-QM3eO8&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

Articles

Specific examples of plant-pollinator coevolution:

- The Madagascan star orchid and Wallace's sphinx moth
  https://www.nhm.ac.uk/discover/news/2021/september/moth-predicted-to-exist-by-darwin-and-wallace-becomes-a-new-species.html
- Earth's first insect pollinators: beetles and magnolia trees
  https://extension.illinois.edu/blogs/garden-scoop/2018-05-05-magnolia-pollination
- Pollinator shifts and Columbine flowers
  https://www.researchgate.net/publication/6283115_Pollinator_shifts_drive_increasingly_long_nectar_spurs_in_columbine_flowers

Videos for Students

- Overview of pollination and plant-pollinator adaptations
  https://www.youtube.com/watch?v=c9Qokyqhlhc&ab_channel=MADGARDENScience
- Evolution of pollination (middle school and older)
  https://www.youtube.com/watch?v=iyvXZcWUbI0&ab_channel=BeSmart
- Plant-pollinator relationships (early elementary)
  https://www.youtube.com/watch?v=pnBoM4idf1k&ab_channel=SciShowKids
- Native pollinators:
  https://www.youtube.com/watch?v=eDxZojp9yNg&ab_channel=NatureonPBS

Resources

General information on pollination and pollinators:

- https://www.fs.usda.gov/managing-land/wildflowers/pollinators/what-is-pollination#:~:text=Pollination%20is%20the%20act%20of,offspring%20is%20by%20making%20seeds
- https://www.fs.usda.gov/managing-land/wildflowers/pollinators/syndromes
- https://www.fs.usda.gov/managing-land/wildflowers/pollinators/who-are-the-pollinators