MISSOURI BOTANICAL GARDEN
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Grades 3-5

Objective: Understand the eclipse and its impact on the natural world, with a specific focus on insect pollinators and their behavior.

- Preparation
  - Research Insect Pollinators:
    - Research and gather information on common insect pollinators in your region, such as bees, butterflies, and beetles. Understand their typical behaviors and roles in pollination.
      - Honeybees (Apis mellifera):
        - Description: Honeybees are social insects known for their distinctive yellow and black striped appearance. They are approximately half an inch long and have two pairs of wings.
        - Behavior: Honeybees are highly social and live in colonies with a queen, worker bees, and drones. They forage for nectar and pollen from flowers, using their specialized tongue (proboscis) to collect nectar.
        - Role in Pollination: Honeybees are among the most efficient pollinators and play a significant role in pollinating a wide range of crops, including fruits, vegetables, and nuts.
      - Bumblebees (Bombus spp.):
        - Description: Bumblebees are larger and hairier than honeybees, with varying colors such as black, yellow, and orange. They have a robust, fuzzy appearance.
        - Behavior: Bumblebees are social insects that live in smaller colonies than honeybees. They are excellent pollinators due to their ability to vibrate their flight muscles, which helps release pollen from flowers.
        - Role in Pollination: Bumblebees are efficient pollinators for a wide range of plants, including tomatoes, peppers, and blueberries.
      - Butterflies (Various Species):
        - Description: Missouri hosts numerous butterfly species, each with its unique colors and patterns. Common species include the Eastern Tiger Swallowtail and the Monarch Butterfly.
        - Behavior: Butterflies have delicate wings and are known for their graceful flight. They have a specialized feeding structure called a proboscis, which they use to sip nectar from flowers.

            - Role in Pollination: Butterflies are important pollinators for various wildflowers and some garden plants. They are attracted to brightly colored, fragrant flowers.
        - Moths (Various Species):
            - Description: Moths in Missouri vary in size and appearance, with many having drab colors and patterns. Some, like the Hummingbird Moth, resemble hummingbirds.
            - Behavior: Moths are typically nocturnal, and they are attracted to flowers that open at night. They also have a proboscis for feeding on nectar.
            - Role in Pollination: Moths are essential pollinators for night-blooming plants, including some species of orchids and evening primroses.
        - Beetles (Various Species):
            - Description: Beetles that serve as pollinators in Missouri can be diverse in appearance, from small and shiny to large and dull-colored.
            - Behavior: Beetles are often less specialized for pollination compared to other insects. They may feed on both nectar and pollen, with some species being attracted to strong-smelling or foul-smelling flowers.
            - Role in Pollination: Beetles are primarily associated with primitive plant species like magnolias and water lilies. They help pollinate flowers that lack specialized adaptations for other pollinators.
    - Hypothesize Impact on Insect Pollinators:
        - Begin by explaining what a hypothesis is. It's a statement or educated guess that predicts the outcome of an experiment or observation. In this case, students will be predicting how the eclipse will impact insect pollinator behavior.
        - Facilitate a discussion to help students brainstorm factors that might influence insect pollinator behavior. These factors could include:
            - Light levels: Discuss how the eclipse will reduce sunlight during the event.
            - Temperature changes: Explain that temperatures may drop during an eclipse.

- Biological clock: Discuss whether insects have a natural rhythm or internal clock that guides their activities.
- Flower response: Talk about how some flowers might react to changes in light and temperature.
    - Give examples of hypotheses that students can use as a starting point:
        - "I hypothesize that bees may become less active during the eclipse due to reduced light and lower temperatures."
        - "I predict that butterflies will be less affected by the eclipse because they are diurnal (daytime) insects and may not notice the changes as much as nocturnal insects."
    - Encourage students to make specific predictions in their hypotheses. For example:
        - "I predict that bumblebees will visit fewer flowers during the eclipse compared to before and after the event."
        - "I expect that moths, which are nocturnal insects, might become more active and visit flowers during the eclipse."

        - Remind students that their hypotheses are educated guesses based on what they know about insects and the eclipse. The actual observations during the eclipse will provide data to either support or refute their hypotheses.
        - Have students record their hypotheses in their observation journals before the eclipse observation begins. Each student should write down their individual hypotheses.
    - Revisit Hypotheses Post-Eclipse:
        - After the eclipse observation and data collection, gather the students and revisit their hypotheses. Discuss whether their predictions were accurate and if there were any surprising findings.
- Eclipse Observation & Data Collection (Before, During, and After the Eclipse):
    - Observation Equipment:
        - Notebooks and Pencils: Provide each student with a notebook and a pencil for recording their observations. Include separate sections for each phase: Before, During, and After.

        - Thermometers: Distribute thermometers to measure temperature changes during the eclipse.
        - Magnifying Glasses: Offer magnifying glasses to help students examine insects and plants more closely.
    - Environmental Observations:
        - Light and Temperature: Instruct students to regularly record changes in light and temperature during the eclipse. They should note changes during each phase (Before, During, and After).
        - Wind Speed: Measure wind speed changes using an anemometer or by observing leaf and grass movement.
        - Sky Color: Have students describe any changes they notice in the color of the sky before, during, and after the eclipse.
        - Pollinator-Plant Interaction Observation Sheet (Before, During, and After the Eclipse):
    - Structured Observation Sheet: Provide each student with a structured observation sheet designed to track pollinator-plant interactions during each phase.
        - Include the following categories:
            - Before the Eclipse:
                - Date and Time: Record the date and time of observations before the eclipse.
                - Location: Note the specific location where observations are made.
                - Weather Conditions: Document relevant weather conditions.
                - Type of Pollinator: Include images or illustrations of common pollinators and native plants in Missouri.
                - Activity Rating (Before): Use a scale (e.g., 1 to 5) for students to rate the activity level of pollinators and their interactions with plants before the eclipse.
                    - 1 = Completely inactive
                    - 2 = Slow movement or minimal activity
                    - 3 = Moderate activity (e.g., flying around, foraging)
                    - 4 = Active and engaged in pollination
                    - 5 = Extremely active and buzzing with activity
            - During the Eclipse:

  - Date and Time: Record the date and precise times when different eclipse phases occur.
  - Location: Continue to document the specific location.
  - Weather Conditions: Record any changing weather conditions during the eclipse.
  - Type of Pollinator: Maintain the visual reference for pollinators and native plants.
  - Activity Rating (During): Students should rate the activity level of pollinators and their interactions with plants during the eclipse.
    - 1 = Completely inactive
    - 2 = Slow movement or minimal activity
    - 3 = Moderate activity (e.g., flying around, foraging)
    - 4 = Active and engaged in pollination
    - 5 = Extremely active and buzzing with activity
- After the Eclipse:
  - Date and Time: Include sections for recording the date and time of observations after the eclipse.
  - Location: Note the specific location for post-eclipse observations.
  - Weather Conditions: Document any changes in weather conditions after the eclipse.
  - Type of Pollinator: Continue to reference common pollinators and native plants.
  - Activity Rating (After): Students should rate the activity level of pollinators and their interactions with plants after the eclipse
    - 1 = Completely inactive
    - 2 = Slow movement or minimal activity
    - 3 = Moderate activity (e.g., flying around, foraging)
    - 4 = Active and engaged in pollination
    - 5 = Extremely active and buzzing with activity

- Discuss Findings:
  - Hypothesis Evaluation: Encourage students to revisit the hypotheses they created before the eclipse. Discuss whether their predictions aligned with the actual observations and data collected.

    - Encourage them to reflect on which hypotheses were supported and which were not.
  - Comparison of Activity Ratings: Examine the activity ratings (e.g., on a scale from 1 to 5) recorded for each phase. Compare the ratings for pollinators and their interactions with plants across the three phases.
  - Identify Anomalies: Discuss any anomalies or unexpected findings in the data.
    - Ask students to consider why certain behaviors may not have followed their hypotheses and what other factors could have influenced the results.
  - Ecosystem Impact: Engage students in a discussion about the broader implications of their observations.
    - Explore how changes in pollinator-plant interactions during events like eclipses can impact plant pollination and the ecosystem. Discuss potential consequences for food production and native plant populations
  - Facilitate a discussion where students share their findings and observations related to their hypotheses. Ask questions such as:
    - "Did you notice any changes in pollinator behavior during the eclipse that aligned with your hypothesis?"
    - "Were there any unexpected behaviors or findings?"
    - "How did the eclipse impact plant-pollinator interactions, and what does this mean for our understanding of this natural event?"
- Reflect on Hypothesis Testing:
  - Encourage students to reflect on the process of testing their hypotheses. Discuss the importance of collecting data to support scientific claims and how observations during the eclipse helped validate or challenge their predictions.