

My Bee Book
Diversity and Observation of Bees
by
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Beckoning the Bees Lesson Plan Series

Target Audience

Grades 3rd through 8th

Number of Class Periods to Complete Lesson

1 class period (60-90 minutes) to introduce topic and complete *Bee Book*
10-20 minutes per observation (in class or at home)

Overview

Bees are a well-known group of insects, though mostly for the honey bee and bumble bee. Yet Earth is home to approximately 20,000 bee species. Our native bee species are fascinating creatures with unique life histories, behaviors, ecological roles, shapes, colors and sizes. Bees play an extremely important role in nature as its primary pollinators. Bees are one of our most valuable insects; their pollination activities contribute to many fruits, vegetables, seeds and nuts produced in the United States, as well as flowers. Bees have physical traits characteristic of insect as well as structures that improve their ability to pollinate.

Native bee populations have increasingly faced challenges to their survival over the past several years in the United States. Known and unknown environmental factors, such as pesticide use, limited flowering food resources, habitat loss and parasites have caused population declines in several bee species.

This one-period lesson will discuss the importance of making observations, bee classification, anatomy and life cycle. It will introduce several different types of social and solitary bees, their physical appearance, and habitat requirements, the importance of bees to pollination and the significance of bee declines. Students will make their own *Bee Book* and will learn how and where to observe bees. Additionally, students will be introduced to ways in which they can individually participate in and impact the conservation of native bee populations.

Note: This activity will require that students be near live bees. If left alone while foraging, it is highly unlikely that a bee will sting unprovoked. Students should be reminded that they should observe and not touch bees. It is advised to determine whether or not students have any allergies to bee venom in the event that a sting does occur.

Learning Objectives

Each student will construct a *Bee Book*, learn about different types of bees and how to get started with making bee observations. As a result of carrying out this activity, students will develop:

- An understanding of the anatomy and classification of adult bees
- An understanding of the habitat needs of bees

- An understanding of bee diversity, including sweat, leafcutter, mason, carpenter, bumble and honey bees
- An understanding of the role of bees in pollination
- An understanding of metamorphosis and development bees
- An understanding of the significance of making observations and taking notes
- Knowledge, skills and abilities required to work with a group

National Science Education Standards

Unifying Concepts and Processes Standards (Levels K-4, 5-8)

- Unifying concepts and processes in science
- Form and function

Science as Inquiry Standards (Levels K-4, 5-8)

- Understanding of scientific concepts
- An appreciation of “how we know” what we know in science
- Understanding of the nature of science
- Skills necessary to become independent inquirers about the natural world
- The dispositions to use the skills, abilities and attitudes associated with science

Life Science Standards

- Characteristics of organisms (Levels K-4)
- Life cycles of organisms (Levels K-4)
- Organisms and environments (Levels K-4)
- Regulation and behavior (Levels 5-8)
- Structure and function in living systems (Levels 5-8)
- Populations and ecosystems (Levels 5-8)
- Diversity and adaptations of organisms (Levels 5-8)

Science in Personal and Social Perspectives Standards

- Changes in environments (Levels K-4)
- Populations, resources, and environments (Levels 5-8)

Vocabulary

Abdomen: the posterior (hind) body segment of an insect

Antenna: a sensory appendage of the head

Anther: the male part of a flower where pollen is produced

Cell: also called brood cell; the chamber made for an egg to go through its stages of development

Corbicula: a pollen basket located on the hind legs of a bee

Defensive behavior: a behavior that helps protect an animal

Egg: the first stage in the bee life cycle

Exoskeleton: hard, outer covering of insects

Forage: to search for food

Glossa: the tongue of a bee

Habitat: the natural home of a living organism

Larva: the second, worm-like stage of the bee life cycle

Metamorphosis: structural changes that occur through developmental stages. Complete metamorphosis has 4 stages: egg, larva, pupa and adult.

Ocelli: simple eyes which are light-sensitive

Parasite: a living organism that lives on or in another organism, called a host

Pesticide: a chemical or other substance used to kill pests that are unwanted or cause damage to property

Pheromone: a chemical that allows bees to communicate with one another

Pollen basket: the pollen collecting structure (stiff hairs) of bees

Pollination: the transfer of pollen between plants

Predator: an animal that eats other animals

Pupa: the third, non-feeding stage in the bee life cycle

Scopa: a pollen basket located on the underside of a bee's abdomen

Social: refers to bees that live in a colony and share in the task of raising young

Solitary: refers to bees in which a female build her own nest and raises her own young

Stigma: a female part of a flower that is sticky to capture pollen

Thorax: the middle body section of an insect where wings and legs are attached

Background Information

Observation. Observation is the use of one or all of your senses to answer a question. After making an observation, you may actually end up with a question! Why did that happen? What is it doing? In the case of bees, observation lets scientists learn about where bees are found, what they eat, when each stage of their life cycle is carried out, whether the number of bees is decreasing, etc. The observations you make in your Bee Book will tell you much about how and where bees live, what bees are found in your area, etc. Writing down your observations are just as important so that you can compare your notes between years, seasons, locations, etc. or with observations of other students.

Classification. Bees belong to phylum Arthropoda because they are invertebrates (backbone absent) with an exoskeleton, jointed legs and a segmented body. Bees belong to class Insecta because they have 6 jointed legs, a 3-segmented body (head, thorax and abdomen), 2 compound eyes and 2 antennae. Bees belong to the same order as wasps and ants, order Hymenoptera.

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Hymenoptera

Anatomy. The bee has three body regions:

1. Head: aids in sensing the environment and feeding. Has 2 large compound eyes, 3 small simple eyes called ocelli, 2 antennae and a mouth
2. Thorax: aids in movement. Has 6 legs, 4 wings and muscles for movement
3. Abdomen: aids in reproduction and defense. Has a stinger in female bees and reproductive organs

Bee life cycle. Bees exhibit complete metamorphosis. They begin their life cycle as a tiny white egg. This hatches into a white, worm-like larva. After feeding, the larva develops into a pupa within a cocoon. Finally a winged adult emerges. In social bees, eggs are laid by one female and cared for by her workers. Leafcutter and mason bees, the topic of this lesson, are solitary meaning each female makes her own nest and raises her own young.

Social versus solitary bees. Bees may be social, solitary or share traits of both. Social bees are the best known, living in a colony with an egg-laying female. Social bees share the responsibility of raising and feeding the young as well as maintaining the colony's living space. The colony may be annual, as in bumblebees, or perennial as in honey bees. Solitary bees are less known but more common! In the typical life cycle of a solitary bee, a female mates with a male, builds her own nest, and raises her own young. Sometimes solitary bees will share an entrance in the ground, but each female has her own nest cavity branching off a shared tunnel.

Bee diversity. There are more than four thousand types of bee species in North America. Listed below are general descriptions of but a few groups.

- **Sweat bees** can vary in color, from brilliant metallic green with yellow, white and black stripes to dusky black. They are tiny to moderate-sized bees. As their name implies, some are attracted to the salt in human sweat! Sweat bees can be solitary or social with an egg-laying queen and a few workers. Sweat bees are ground-nesters. Females tunnel into loose soils or use abandoned beetle tunnels in rotting wood. Sweat bees visit a wide variety of flowers including crops, such as sunflowers and watermelon.

Note: The *Bee Book* refers to the brighter metallic genera including *Agapostemon*, *Augochlora*, and *Halictus* and does not include genera such as *Dieunomia* and *Lassioglossum* for which more detailed identification is required.

- **Leafcutter bees** are solitary and often build nests in natural or artificial cavities, from abandoned beetle tunnels to hollow plant reeds. Female bees have large mouthparts for cutting circular pieces of leaves or petals, which they use surround each egg in the nest tunnel. Leafcutter bees visit a wide variety of flowers. The alfalfa leafcutter bee has been introduced to pollinate alfalfa, an important livestock food. Leafcutter bees store pollen in a special basket under their abdomen called a scopa.
- **Mason bees** are solitary bees that vary in color from dull black to metallic green, blue, and even purple. They nest in tunnels, using reeds or even holes drilled in wood. Mason bees are named for the walls they build between eggs in their nest tunnel. Females use a variety of materials including mud, pebbles, sand, chewed leaves and flower petals. They hold pollen in a scopa, an area with stiff hairs on their underside. Orchard farmers use them for early spring fruit trees like apples, and crops like blueberries and alfalfa.
- **Bumblebees** are familiar furry bees that range in color from black and yellow to orange and white. Some bumblebees have very long tongues that are better at reaching nectar in very long flowers, like clover. Bumblebees are social, living in a colony with a queen, workers and males. Depending on the species, nests may be built below, at, or above ground level and may contain several hundred individuals. They do not make honey, rather they store nectar in wax pots. Bumblebees use their legs to pack pollen from their fur into baskets on their hind legs. This allows pollen to be transported back to the nest. Bumblebees work long hours and are even seen collecting pollen and nectar on rainy days!

- **Carpenter bees** are large bees named for the nests they burrow into solid wood. Carpenter bees look like large bumblebees but have a shiny, black abdomen. These bees are solitary and each female bores her own nest tunnels as long as 12 inches into solid wood. Eggs are laid with a sticky mass of pollen for food. Males can be territorial and although they appear to be aggressive, male carpenter bees are harmless and cannot sting. Some carpenter bees are much smaller, often metallic blue or green, and make nests in softer plant stems.
- **Honey bees** are social bees that live in a colony, or hive, with a single egg-laying queen, thousands of female worker bees and a few hundred male bees, or drones. The honey bee is the best known of bees because of the honey, wax and pollination services it provides. People who keep honey bees are called apiarists.

Pollination and pollen/nectar collection. Pollination is the transfer of pollen from the male anther of a flower to the female stigma. Many flowers require pollen to be transferred from one flower to another. Pollination is how most of Earth's plants reproduce and make seeds. Bees are great pollinators because they are furry! The hairs covering their body may have an electrostatic charge that attracts pollen and lets it stick to their body. Many bees also tend to collect from the same species of flower, ensuring pollen is passed between the right flower species. Pollen may be stored in a pollen basket on the hind legs in a small orange, white or yellow ball, or it may be stored on stiff hairs covering the underside of the bee's abdomen. Bees are vegetarians, feeding on nectar (carbohydrates) and pollen (protein). We depend on bees to make much of our food. One third of what we eat comes from this pollination!

Bee habitat. Habitat is the natural home of a living organism. Bees need different types of habitat in order to survive. Foraging habitat is where bees search for food and, just as we prefer variety, a variety of flowers is more beneficial to bee populations. Bees also need nesting habitat, such as old rotting wood, sandy soil, twigs and old branches, etc. Some bees may need soil habitat to hibernate through the winter. Foraging habitat is of no use to a bee if has nowhere to build a nest.

Threats to bee populations. Bees are currently facing challenges that are natural and manmade, native and introduced, known and unknown. Bees are considered keystone species, because many living organisms, including humans, rely on them for survival. Sever bee declines or extinction would have a profound effect on all living things. Bees must contend with predators such as wasps, mice, raccoons and spiders. They must also contend with pesticides, which are chemical or other substances used to kill pests that are unwanted or cause damage to property. Many pesticides work on insects that damage food crops. As insects, bees may be easily poisoned and killed when visiting treated crops. Another significant challenge is habitat loss. Bees often need different types of habitat. They need a place to find food, to nest and to hibernate through the winter. Nesting habitat alone is of no use to a bee if it has nowhere to find food. Habitat loss is the destruction of any of these habitats due to construction, agriculture, development, etc.

T-Chart

The T-Chart is a simple pre-assessment method to determine what information students already know about bees, whether it is factual or biased. This method asks two questions to the class and encourages group discussion.

On a black board or white board, draw two columns one for each of the following questions:

Column 1	Column 2
What do you know about bees?	What questions do you have about bees?

If any incorrect ideas are presented while answering “What do you know about bees?” write them down anyway and revisit them at a later time. Let students go back over the Column 1 list and determine if the ‘facts’ are correct.

KWL Strategy

What I **K**now, what I **W**ant to learn and what I did **L**earn

The KWL strategy is a great way of getting students oriented to the lesson, forming individual goals within the group and recapping the lesson.

- The K component questions serve the purpose of brainstorming. Have the students brainstorm as a group (or individually followed by sharing) to drum up what they already know about honey bees and their communication.
- The W component questions give each student a chance to come up with questions they want to find the answer to and to concentrate on something they themselves are curious about. Students can write these questions down and find the answers before, during or after the actual activity.
- The L component questions help the students synthesize the lesson and the information covered. Questions be asked in writing or discussed as a group.

It may be helpful to use a chalkboard or white board to make 3 columns for each step as shown below. This will encourage students to brainstorm about the K and W components and then help gather, organize and share what students learned as a group visually for the L component.

Column 1	Column 2	Column 3
What we K now already about bees	What we W ant to learn about bees	What we did L earn about bees

K Component Questions:

- What comes to mind when you think of bees?
- What is a bee?
 - Insect, head-thorax-abdomen, 6 legs, 4 wings, pollinator, etc.
- Why are bees important?
 - Pollination
- Where do bees live?
 - In many places: in the ground, in old wood, in tree cavities, etc.
- What different kinds of bees can you think of?

- Honey bee, bumblebee and carpenter bee are most commonly known. Mention that other types of bees will be introduced.
- What do bees eat?
 - Nectar and pollen
- Why do flowers need bees?
 - To help produce seeds through pollination
- What attracts bees to flowers?
 - Their color, scent, nectar and patterns on petals
- Can all bees sting?
 - No, only female bees can sting
- What happens to a bee after it stings?
 - Some bees, like the bumblebee, can sting many times because they have a smooth stinger
 - Honey bees have a barbed stinger, lost after stinging. This causes death.
- What are the stages of metamorphosis in bees?
 - Egg, larva, pupa, adult
- How would the disappearance of bees affect us?
 - No pollination, honey, wax, etc. This would mean fewer flowers, fruits, vegetables and even nuts!
- What items should you bring with you when observing bees?
 - Bee book, pens, pencils, sun screen, net, eye glasses, magnifying glass, camera, etc.

W Component Questions:

- How many different kinds of bees are in your area?
- What kinds of flowers do bees like to visit (color, species, etc.)?
- What threats and challenges do bees have to deal with?

L Component Questions:

- How many different kinds of bees did you observe?
- What behaviors did you observe?
 - Flying, crawling, chewing, foraging, nest building, nectar collection, pollen storage, pollination, etc.
- Where did you find bees?
 - On flowers, flying around rotten stumps, flying around twigs and branches, entering holes in the ground, etc.
- When were bees most active?
- What weather brought out the most bees? The fewest?
- How could your observation technique and note taking be improved?
- What challenges and/or threats do bees face?
 - Predators, parasites, diseases, pesticides, habitat loss
- What can you do to help bees?
 - Plant a flower garden, use little to no pesticides on your property, leave some wild areas in your yard, become a beekeeper.

Materials Needed

One Bee Book per student
 Colored pencils, markers or crayons
 Hole puncher

Fasteners or string

Field guides for insects and/or flowers (optional, recommended)

Making the Bee Book

The Bee Book pdf file is 5 pages long, 3 of which have text and images on them. More blank pages can be added for more room.

1. The "My Bee Book" page should be on top with the image facing upwards. It should be followed by "My Field Checklist", next the "Bee ID Guide" and then several blank pages.
2. Fold the stack of papers in half so that "My Bee Book" is on top.
3. Place 2 – 3 holes near the crease of the book.
4. Students should write their name in the rectangle on the cover page.
5. Students may color in images, background, etc. as they please.
6. The "Other" option and the bumblebee image on the second page may be specifically addressed during the lesson.

Introducing the Bee Book

1. Once students have written their name and colored in the cover of the book, ask them what they think they will need to make and record their observations.
2. Have students open up to page 2 and go through items in "My Field Checklist".
3. Ask them to write any extra items they feel would be necessary, ie. Backpack, magnifying glass, camera, water, etc.
4. Have students look at the 3 body regions of the bumblebee diagram on page 2. This may be a good entry to point to go over anatomy such as antennae, location of pollen baskets, wings, etc.
5. Have students color the 3 body regions in different colors to emphasize sections.
6. Have students look at words listed under "Important words to know"
 - a. ask what each means and review if necessary
 - b. discuss how each might be used in the observation journal
7. Have students review "Some questions to answer at each observation" and discuss the following:
 - a. Why each question is important
 - b. What students expect to see during different seasons
 - c. What students expect to see during different types of weather
 - d. What differences in pollen color means
 - e. What color flowers they think bees will prefer (*bees tend to prefer yellows, white, blues and violets*)
 - f. How students can compare between observations (between different types of weather, different seasons, etc.)
8. In their Bee Book, have students write down any additional questions they come up with.

What Bee am I?

This activity will help students review the different bee groups discussed in the lesson. Choose one of the bees and describe it one trait at a time, giving students a chance to guess. Start with traits that are characteristic of all bees, then gradually throw in traits that are unique to the group you chose. This activity can also be done with a student leading the activity. If students shout out the answer to a description such as "I have 4

wings. What bee am I", reiterate that ALL bees have 4 wings. An example is provided below for the leafcutter bee.

"I have 6 legs. What bee am I?"

"I collect nectar from flowers. What bee am I?"

"I can fly. What bee am I?"

"I nest in a tunnel. What bee am I?"

"I use pieces of leaves in my nest. What bee am I?"

Bee Alike

This activity will help students review the different bee groups discussed in the lesson. Have students choose a bee they want to be or assign one to each student. They must keep their identity to themselves and cannot tell anyone. Now they must group themselves together by asking each other questions about their identity **without** using their name **or** the following words: sweat, leafcutter, carpenter, mason, honey or bumble. Remind students that they can use words like solitary, queen, green, leaf pieces, very furry, wax, etc. If you would like to add a competitive edge, assign the bee types to each student so there is a known number of bees per group. The first group to get all of its kind wins!

Diversity of Bees

Several types of bees were introduced in this lesson. However there are many more different types of bees! Have students research bee diversity and as a group come up with a list of additional bees. Students should share their findings with the class. Have students work individually or in small groups, to research one group of. Recommended websites include:

- Discover Life Bee Guides: <http://www.discoverlife.org/mp/20q?search=Apoidea>
- Bug Guide: <http://bugguide.net/node/view/15740>

Student Assessment Techniques

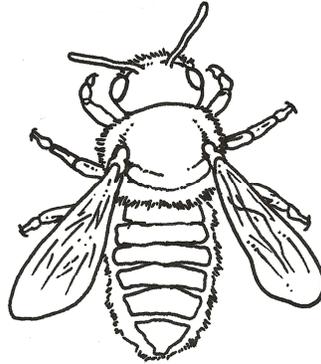
The assessments below are designed to meet the National Science Standards Assessment Standards. It is left to the instructors discretion which of these techniques to use and how to weigh them as part of a total assessment.

Standard Assessment Techniques

The following questions may be used on a quiz or exam to assess student learning of material in a standardized fashion. These questions target key ideas about bee anatomy, habitat requirements and diversity. An answer key is provided.

Name: _____

1. Can you label the head, thorax and abdomen on the bee below?



2. There are many ways you can help bees. Can you circle which thing(s) below doesn't belong?

Plant flowers

Let weeds grow

Leave twigs and wood alone

Spray pesticides

Plant vegetables

Plant fruits

3. Name three different types of bees, other than the honey bee, that you learned about. How are these bees different from one another? How did they get their name?

Answer Key to Quiz

1. From top to bottom, head, thorax, abdomen.
2. 'Spray pesticides' does not belong.
3. Leafcutter, mason, bumble, carpenter, sweat bees.

Essay

Essay topics can vary. This method will help assess student interest in the topic, their listening and recollection skills. It will also help them relate their test subject to themselves. Examples are listed below.

“Compare your food and shelter needs with those of bees. How are they similar? How are they different?”

“What were the three most interesting things you learned about bees? Explain.”

“If you could be a bee discussed in today’s lesson, which one would it be? Why?”

KWL Strategy

Utilize the L-step questions listed above to prompt a discussion with your students and determine what they recall following the lesson. Be sure to wait silently for several seconds after each question is posed. This will encourage students to respond. Allowing students time to answer will make students more comfortable and confident in answering and will encourage a variety of responses and discussion in general.

References

- Center for Science, Mathematics, and Engineering Education. 1996. National Science Education Standards. Washington, D.C.: National Academy Press.
- Giles, Valerie and Ascher, John. 2006. A Survey of the Bees of the Black Rock Forest Preserve, New York (Hymenoptera: Apoidea). *Journal of Hymenopteran Research*. 15(2): 208 – 231.
- Goulson, D. 2010. *Bumblebees: Behaviour, ecology, and conservation*. Oxford: Oxford University Press.
- Hassard, Jack. 2000. *Science as Inquiry: Active Learning, Project-Based, Web-Assisted, and Active Assessment Strategies to Enhance Student Learning*. New Jersey: Good Year Books.
- Loughlin, Jamie-Lee. 2009. Saving the Bumblebee. [BBCT Vimeo video file] Retrieved from http://www.bumblebeeconservation.org.uk/about_bees.htm
- Mader, E., Shepherd, M., Vaughan, M., Black, S. H., and LeBuhn, G. 2011. *Attracting Native Pollinators: Protecting North America's Bees and Butterflies*. Massachusetts: Storey Publishing.
- Michener, C. D. 1974. *The Social Behavior of the Bees: A Comparative Study*. Harvard University Press: Cambridge, Massachusetts.
- Miller, Sara. 2003. *Ants, Bees, and Wasps of North America*. New York: Franklin Watts.