

Entomology

About the 4-H Science Toolkit Series: Entomology

This series of activities is designed to get children outside, learning about their environment by focusing on a subject all kids find fascinating – bugs.

All of these adventures call on students to predict what will happen, test their theories, and share their results. They'll be introduced to entomology vocabulary, gain an understanding of the life cycles of plants and animals and learn how to be good environmental stewards.

The lessons in this unit were developed by and are connected to the Cornell University Department of Entomology.

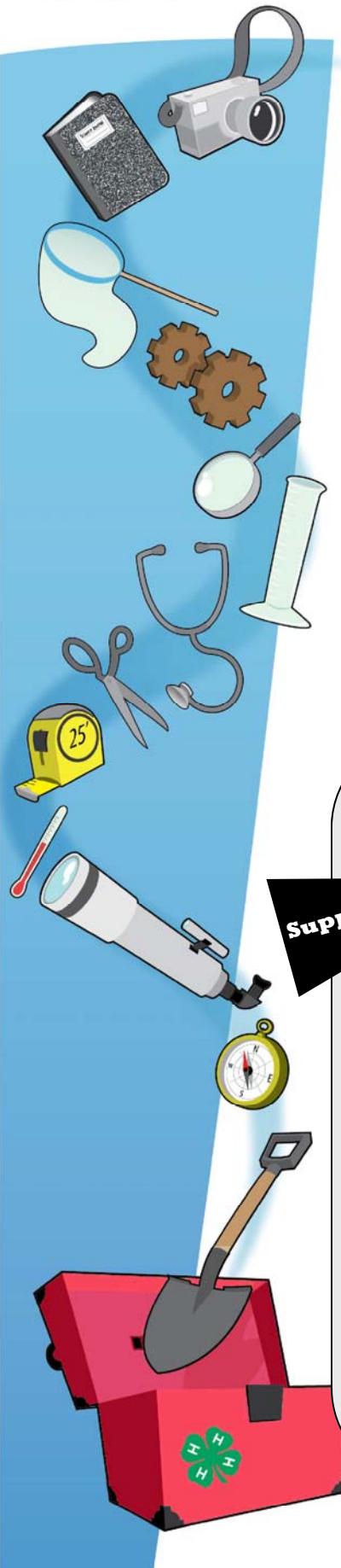
To find out more about entomology activities, visit the Department of Entomology Web site at <http://blogs.cce.cornell.edu/nys4-h-entomology/> and to find numerous resources related to the inserts, outdoor exploration and the environment, check out the NYS 4-H Resource Directory at www.cerp.cornell.edu/4h.

Entomology Table of Contents

- Pollinator Power:** Observe and understand pollination and design flowers to attract pollinators.
- Ballooning Spiders — Aerial Dispersal:** Explore the way spiders leave their nests.
- Beetle Scavenger Hunt:** Learn about some of the 80,000 different species of beetles and how to tell them from other insects.
- The Hornet and Yellow jacket Nest:** Learn how yellow jackets and hornets create their nests full of combs
- Collecting Insects:** Discover three ways to collect insects, then use your new creations to collect and catalog insects to measure the health of an ecosystem.
- Exploring Plant Galls:** Wander into the woods to find unusual growths on plants and learn what caused them and what might live inside.

Entomology: Pollinator Power

Activity Series:
Entomology
Grade: 3-6
Time: 60 min



Main Idea

Pollination is the transfer of pollen from the anther to the stigma of a plant. This is necessary for the production of seeds and the reproduction of the plant species. Insects are the main groups of pollinators. The color, shape and smell of flowers help direct the pollinators to the right place.

Motivators

Did you know that one out of every four mouthfuls of food that we eat requires the assistance of a pollinator? About 80 percent of flowering plants are dependent on animal pollinators and about 130,000 to 300,000 animal species assist with pollination.

Pre-Activity Questions

Before you start the activity, ask the students:

- Name some pollinators that you know?
(bees, honey bees, wasps, flies, butterflies, hummingbirds, beetles, Madagascan Lemur)
- How does a flower attract a pollinator?
(smell, color, shape)
- Some plants do not require insects or other animals for pollination. How do they get pollinated?
(wind, water)

Supplies

Activity: Design and Build a Flower

- Construction paper
- Tissue paper
- Two or three pieces of graph paper
- Scissors
- Glue
- Tape
- Markers
- Pipe cleaners or small dowels
- Reference chart on parts of a flower
- Perfect Pairs worksheet
- My favorite pollinator worksheet
- Reference books on insects
- Magazines with flower/insect pictures to cut up
- Paper egg cartons, cut into cups
- Sugar water (one part sugar, three parts water)
- Eye dropper

1. Read the Perfect Pairs and My Favorite Pollinator worksheets. Using the Internet or recycled nature magazines, find pictures of the listed pollinators and their favorite flowers.

Objectives

- Observe and understand pollination.
- Design a flower to attract a pollinator

Learning Standards

(See Matrix)

Common

SET Abilities

4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Entomology: Pollinator Power

2. Decide which type of insect you would like to work with, and then brainstorm a locally found example of this insect. For example, if you were to choose a bee, you could use the honey bee as your insect. Honey bees are found almost everywhere because they are raised by beekeepers. If you are working in groups, keep the name of your pollinator a secret from the other groups. Read about the specific flowers that attract your pollinator. What shapes are the flowers? What colors?
3. On the graph paper sketch a design for your flower. Keep in mind the materials you have on hand to build the flower, as well as your insect's preferences. Be sure to include the basic parts of a flower: stamens (anthers and filaments), pistil, petals, leaves and sepals. You will use an egg carton cup to hold the nectar, so plan accordingly.
4. Review the design one last time before you start building. Does it meet your insect's requirements? If so, build away! If not, go back to the drawing board.
5. Analyze your flower model. Does it look like your drawing? Do you need to change your plans? Should you try again?
6. If you are working in groups, conduct a flower survey. Ask five people (who are not in your group) what type of insect pollinates your flower? Review your results. Were most of the responses correct? If not, do you need to change your design?
7. Test your model: On a sunny afternoon, choose an outdoor spot that can be observed from a window and is close to pollinator territory.
8. With assistance from an adult, take your flower out to the site and "plant it" in the ground. You may need to attach a stake to help it stand. Once you are sure it's stable, have the adult use the eyedropper to fill the cup with sugar water.
9. Take turns watching your flower from the window. Record any insects that you see land or climb on your flower and how long they stay. If you are working as an individual, you may want to check the flower from time to time and only stay if you see an insect. Or you can videotape your flower.
10. At the end of the afternoon, compare results with other groups. Which flowers were visited the most? What flowers were only visited by one type of insect? (If you are working on your own, you may want to design several different types of flowers and put them out together to compare results).

Science Checkup - Questions to ask to evaluate what was learned

- Which of the following could help pollinate plants?

Bats	Bees	Bumble bee	Flies
Honey bee	Human	Hummingbird	Mouse
Wasp	Water	Wind	Moth
			Slug
- What characteristics might attract a pollinator to a plant?
(smell, shape, color)
- What would happen if honeybees disappeared?
(fewer fruits and vegetables for a while; other pollinators might take over and fill the niche; farmers might have to learn to pollinate by hand; we might have different foods available to eat)

Extensions

- Insects are not only attracted to flowers by their shape and color, but also by smell. Cut five flower shapes from blue cardboard. Place them in your outdoor observation area with milk jug

Entomology: Pollinator Power

caps in the center. Have an adult place a cotton ball dipped in a different scent in each cap. Suggested scents include: peppermint, orange, vanilla, (all extracts), lemon juice, pickle juice, and different kinds of perfume. Observe from the window. What pollinators are attracted to what scents?

- Pollinators help us by supporting the diversity of plant life around us. Experience this diversity by holding a honey tasting. Contact a local beekeeper and obtain samples of different types of honey. The color and flavor of honey vary depending on its source (different kinds of flowers). Clover honey is the most common, but you can also find wildflower and buckwheat honey in your area.
- Plants and pollinating insects have developed a good relationship. The insects help the plants maintain a healthy gene pool and the plants provide the insects with an energy-filled food. A threat to one will hurt the other, and will affect the biodiversity of an area. There are three main factors that are causing the decline of pollinators: loss and fragmentation of habitat, degradation of remaining habitat and pesticide poisoning. Work with an adult or older teen to find out more on these topics.

Vocabulary

Cross-pollination: Transfer of pollen between flowers on separate plants. This is important for genetic biodiversity.

Flower Constancy: A strong preference for one type of flower. Some insects, like bees, visit the same type of flower on each trip. Other insects move around to any source of nectar they can find.

Nectar: A sugar-rich liquid that supplies energy for pollinators. The nectar is located deep inside the flower, and as the insect crawls downward, it gets covered with pollen. The insect moves from flower to flower and spreads pollen along the way.

Pollinators: Anything that carries pollen such as wind, water or animals. Wind and water are not efficient pollinators. Plants that rely on these processes must produce a lot of pollen in order for some of it to get to the correct plant. Animal pollinators are more efficient because they are attracted to the flowers and purposefully move from plant to plant. Animal pollinators range in size from the very tiny fig wasp, all the way up to the 10-pound Madagascan Lemur. The most common insect pollinators are: native bees, honey bees, flies, butterflies, moths and beetles. Bees are the only pollinators that deliberately gather pollen to bring back to their nests for their offspring.

Pollination: The transfer of pollen from the anther to the stigma of a plant. This process is necessary for the production of seed, and the reproduction of the plant species.

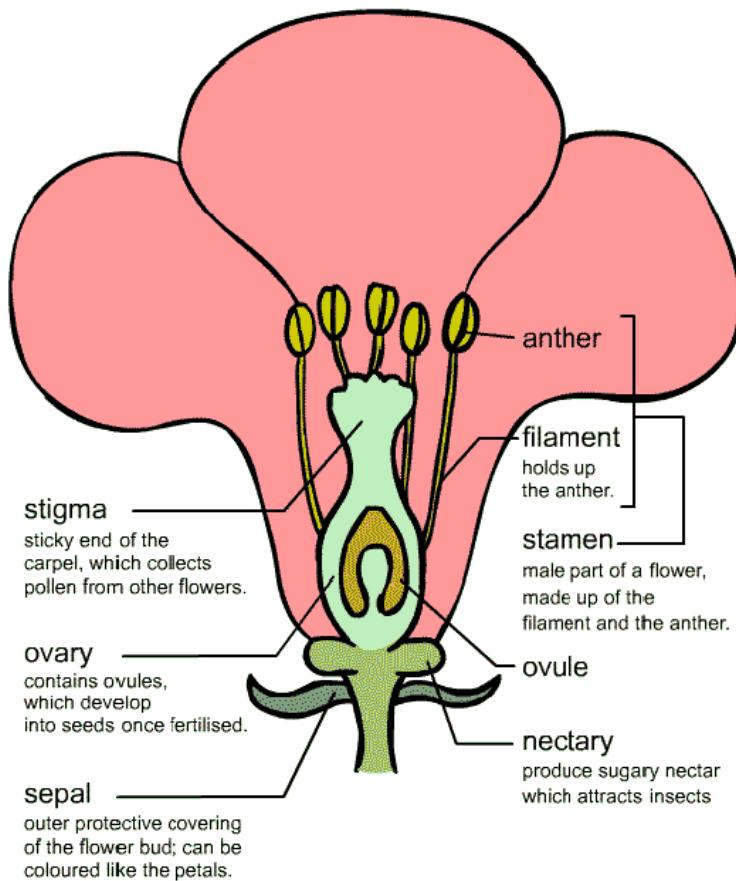
Self-pollination: Transfer of pollen within the same flower or among flowers on the same plant.

Background Information/Resources

- Pollinator Power is adapted from Radzik, Kelly; ed. 2001. The Lower Hudson Valley, An Amazingly Biodiverse Place; 4-H Members Guide. Cornell Cooperative Extension. Chapter 5, pp.1-9. http://cerp.cornell.edu/4h/search_result_details.asp?pid=1815
- Gardner, Suzanne M. & Norby, Monica. 2001. Pollen Detective Activity Book. Nebraska Cooperative Extension 4-H Youth Programs. 28 pp.
- National Gardening Association. 2003. Growing Ideas: Planning a Pollinator garden., www.kidsgardening.com
- Shepherd, Matthew; Buchmann, Stephen; Vaughan, Mace; & Hoffman Black, Scott. 2003 Pollinator Conservation Handbook. The Xerces Society. Portland, OR. 145 pp.

Entomology: Pollinator Power

Design-A-Flower Resources: Parts of a Flower



Design-A-Flower Resources: Perfect Pairs

Flower	Flower shape	Pollinator
Blueberry blossom	Bell Shaped	Bumble bee
Queen Anne's Lace	Upright platform	Silvery Blue Butterfly
Apple Blossom	Flat or bowl shaped	Honey bee
Trumpet Vine	Deep, tube shaped	Hummingbird

Entomology: Pollinator Power

Design-A-Flower Resources: My Favorite Pollinator

The flowers on plants have developed, over time, in ways to attract pollinators. The color, shape and smell of their flowers help direct the pollinators to the right place. For example, flies have short mouth-parts and need open flowers to reach the nectar. Butterflies and moths, on the other hand, have long tongues so they can feed at both simple and complex flowers. Colors are important as well. Most pollinators see a wide range of color but tend to have their favorites. Some flowers have ultraviolet markings that insects can sense, but we cannot see.

POLLINATOR	FLOWER PREFERENCES
Bees	Yellow, blue, or purple flowers. They cannot see red, but sometimes are attracted to flowers with ultraviolet markings. Small bees, which have short tongues, prefer clusters of tiny flowers.
Beetles	They prefer wide-open flowers with lots of landing space, generally in dull colors.
Butterflies	Blue, yellow, red, pink, or orange flowers that they can land on, like flat-topped clusters.
Moth	Light colored flowers (white or green, i.e.) that open at dusk.
Hummingbirds	Red, orange, or purple tubular flowers with lots of nectar. Do not need a landing area, since they can hover.
Flies	White, yellow, green, or cream-colored flowers with simple bowl shapes that their short tongues can reach.

Entomology: Ballooning Spiders- Aerial Dispersal

Activity Series:

Entomology

Grade: 3-6

Time: 45-60 min

Main Idea

Learn how baby spiders weave their own “parachutes” when they’re ready to leave the nest.

Motivator

Let’s design and create a parachute for our baby spider (seed) to fly away with.

Pre-Activity Questions

Before you start the activity, ask the students:

- What would happen if we just put our seeds (spiderlings) into the jug, turned it upside down in the room, then opened the cover?

Test your theory.

- What happens if we take this jug outside and do the same thing?
- What would make a difference? (A: Wind, gravity)
- How can we help our spiderlings travel further? (A: Let them climb up on something and jump off, make a parachute to carry them further)
- What other ways might spiders move away from the egg case as they hatch? (A: Walking, hitchhiking on a seed or leaf)
- Why would spiderlings want to move away from the egg cases once they hatch? (A: Spiders would eat each other, there would not be enough food for all.)
- How can the mother spider help her young even though she will not be there when they hatch? (A: Choose a spot that's protected and gives them space to leave quickly when they hatch.)

Activity

- A spider egg case to examine (someone needs to find one and bring it to the meeting, handle gently)
- Package of seeds to represent baby spiders (carrots work well)
- Bag of craft-store feathers
- Sewing thread
- Scissors to cut thread and trim feathers
- Glue (fast drying) or child-safe nail polish

1. Each person gets a seed and two pieces of string about 10" long.
2. Place a drop of glue on your seed, and lay the two pieces of string so that the middle of the strings cross on the drop of glue on the seed (an “X”). Let the glue dry.
3. Each person chooses a feather, which will be the parachute their seed will use. Attach the other ends of the string to the feather (glue, or tie them on). If you would like to cut your feather into a certain shape, feel free to do so.
4. Go outside. When a breeze blows, have everyone line up on a line, and at the count of “Three,” try out their parachutes.

Objectives

- To learn how spiders leave their nests through aerial dispersal.

Learning Standards

(See Matrix)

**Common SET Abilities
4-H projects address:**

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
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- Question
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- Invent
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- Troubleshoot
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- Collaborate
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Entomology: Ballooning Spiders- Aerial Dispersal

5. Measure the distance from the line that each person's "spiderling" dispersed.
6. Ask these questions: For the people whose spiderling moved the farthest: Why do you think yours ballooned further than others in this experiment? What shapes seem to move the furthest?
7. Have students practice the vocabulary using the word puzzle sheets.

Science Checkup - Questions to ask to evaluate what was learned

- Why might dispersal be important for baby spiders?
- What factors will help spiderlings disperse farther away from the egg sac?
- Is aerial dispersal a good tactic for small things such as insects?
- What other plants or animals use airborne dispersal?

Extensions

- Have people put their names on their creations and fly them on a day when there is a gentle wind, a strong wind or when it is raining lightly, and find out what happens in each instance.
- Ask students to do the experiment again, using the knowledge they gained from the first set of data. Ask them to refine their "ballooning" spider so that it will travel a different distance.
- Students can try cutting their feathers into various shapes. Have some use feathers upside down, some right side up.
- Have a discussion about how other animals and/or plants disperse. Look for some examples and bring some in for the group to view.
- Watch a real spider egg case. If you are lucky enough to see the young hatch, find out how they disperse and how far they go.
- For young children, a pinata might help to illustrate the spiders' egg case. Children can help the spiderlings (treats) burst out of the case with the use of a stick. Do they all come out at once? (Sometimes you need to help them out by hitting the pinata again.)
- Have the students read and learn about other types of spiders. Where do they put their eggs and how do the young disperse? For example, what does a wolf spider do?
- Learn more about spider silk. Explore the Internet for more information.

Vocabulary

Aerial dispersal: Being carried by air currents.

Arachnid: An invertebrate animal that has two main body sections and eight legs, no antennae.

Ballooning: A method of floating away on a warm wind or being carried through the air (for spiders, held up by strands of silk).

Dispersal: Moving away from a center or source.

Egg sack or cocoon: The sack the spider places its eggs in.

Order: A group of related organisms.

Predator: An animal that lives mostly by killing and eating other animals. (For spiders, often insects or other arachnids are their predators.)

Spider: Order Araneida of arachnids. Has two main body sections, four pairs of legs, and two or more pairs of spinnerettes for making silk.

Spiderling: Baby spider.

Spinnerete: A spider's silk spinner organ, usually on the underside of the abdomen.

Spiders I

F N H J R M K Z E E D B G A U
H W T A O I Q V F U N A N Z S
D E G G E L T H G I E L I M Z
B Y S Y A Q B D F S N L H O D
X L B P L L I O P D P O S I F
Y Q A H I N U I L R Y O I C A
J R B C H D D T E A Y N F L N
W T O C K E E D N S X I C E G
A O A A R W A R G A Q N B G S
E R R L D T I B Z K R G V G B
A T I B O U W D U L E A K C C
W N H R S I L K O H G K T A Y
G T Z G S W P R T W A N U S V
R E D I P S F L O W S Z J E S
L U Z S D W L M P L K E F T F

CAN YOU FIND THESE WORDS?

Up, Down, Left, Right, Diagonally, Forwards or Backwords

ARACHNID
BALLOONING
BLACKWIDOW
BOLA
EGGCASE
EIGHTLEGGED
FANGS
FISHING
ORB
PREDATOR
SILK
SPIDER
SPIDERLING
TARANTULA
WOLFSPIDER

Spiders II

N E A B S V R M W B R M T I N
N S R E I G H T L E G G E D C
D A A W L G N A D P S Y Y H T
Z C C S K Q C I E J M N B L N
D G H J M K P V N G G I Z U N
W G N K W S P I B O R B K J C
W E I I F Y Z S W M O O Z R C
T X D L L K T I B T T L N O C
E O O T A R A N T U L A L T B
W W V L F W E C Y G S G N A F
I D A W L C H D V M T O S D B
C D Q T F I S H I N G J O E Y
Q O M U B I G O A P G L J R Q
M X U E S X E J J J S O W P C
U U A K V U V T R C K M I X H

CAN YOU FIND THESE WORDS?

Up, Down, Left, Right, Diagonally, Forwards or Backwords

ARACHNID
BALLOONING
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WOLFSPIDER

Entomology: Ballooning Spiders- Aerial Dispersal

Background Information

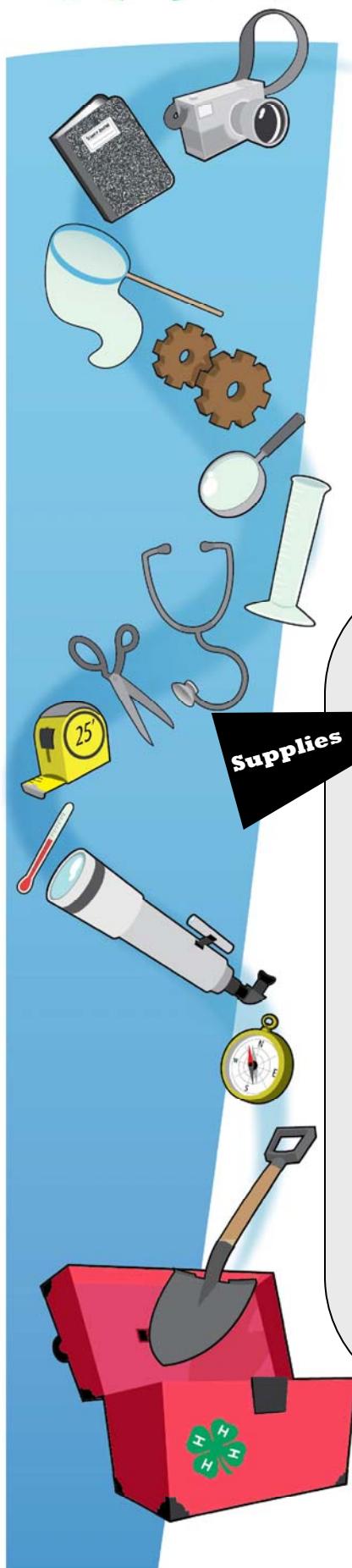
- Dispersal is a very important part of a spider's life cycle. Large numbers of spiderlings hatch from the egg sac at the same time. If they did not move away, they would be overcrowded and would compete for a limited food source. When food is in short supply, many spiders turn to cannibalism.
- Read parts of *Charlotte's Web* by E. B. White to the class, especially the section where eggs hatch and young tumble out. Remind them that they may know about this book and have read it or seen the movie.
- Many spiders produce eggs in the fall, which are wrapped in a silky cocoon, called the egg case. The eggs are first stuck to a silk platform (as many as 200 in some instances), then covered with silk threads. Later, they are wrapped in loose silk, with a final layer of dense, colored silk on the outside. The egg case is suspended in place by lines of silk that hold it safely through the winter.
- In the spring, the eggs hatch and the transparent spiderlings move out from the egg case. If they all stayed with the egg case, the spiderlings would soon get hungry and would start to nibble on each other.
- When the young spiders are ready to disperse they climb up onto stems, twigs or other objects. The spider stands on its toes and releases a stream of silk from its spinnerets. The silk gets picked up by air currents, and when the pull is good enough, the spider lets go and is carried up into the air. This is "ballooning." The spider continues to release silk lines that the wind lifts along with the spider and floats it off to a new area. This is called aerial dispersal. This is somewhat like a kite or a parachute. The spiderlings get carried off in all directions and land when the silk breaks or the breeze stops blowing.
- Sometimes masses of ballooning threads can be seen in the air. Older spiders may use ballooning also. However, because their bodies are heavier, they will require stronger breezes to get them airborne.
- Spider silk is a protein with amazing properties. It can stretch to almost double its length before breaking and when compared to a steel wire of the same diameter, it is stronger. Many spiders recycle silk by eating their old silk before rebuilding a new web.
- For most spiders, silk is important and used on a daily basis. There are at least seven types of spider silk known. Silk is used for lining burrows, protecting the eggs, catching prey and moving about.
- Aerial dispersal is not limited to spiders. A number of insects also use this method of dispersal. The caterpillar of the gypsy moth is one. The tiny caterpillars are lightweight and very hairy, and they spin down on silken threads from a leaf. When a wind comes along, the caterpillar is picked up and transported to a new area some distance away. The hairiness of these small caterpillars helps keep them airborne for a long period of time.

Background Resources

- *Charlotte's Web* by E. B. White, especially Chapters 19, 21 and 22.
- Field guide to spiders, or a field guide to insects and spiders (many choices)
- Golden Nature Guide to Spiders and their Kin

Entomology: Beetle Scavenger Hunt

Activity Series:
Entomology
Grade: 3-6
Time: 45-60 min



Main Idea

Youth will learn that there are more kinds of beetles on earth today than any other kind of insect. Beetles have fascinating life cycle stages and can live in a variety of habitats.

Motivator

There are more than 80,000 species of beetles living on Earth. Let's explore our environment to find some of these critters.

Pre-Activity Questions

Before you start the activity, ask the students:

- What makes a beetle a beetle?
- What Insect Order (group) are beetles classified in?
- How do beetles grow?
- What are the stages in the life cycle?
- List some things that beetles feed upon.
- What kind of mouthparts do beetles have?

Activity

- Plastic jars with lids for collecting insects (peanut butter jars work well)
 - Field, meadow or wooded area
 - Insect net (helpful, but not necessary)
- OR -
- Accurate models of beetles (plastic or rubber toys, 10-20), plus a model of a beetle with its wings spread (or a photograph of the beetle with wings spread) and a model or photograph of life cycle of beetle.

1. After learning a little about beetles, have each participant take a plastic jar outside and find a beetle.
2. Have them note where they found it and what it was doing when it was found.
3. Bring it back to share with the rest of the class. Count how many different types of beetles each group found.
4. If there is time, have students make a quick sketch of their beetle(s).
5. After you have looked at the beetle, it should be returned to the place it was taken from.
6. Have students label the parts of a beetle on the worksheet.
7. Have students practice the vocabulary using the word puzzle sheets.

Objectives

- Distinguish beetles from other insects.
- Know where they live (habitat), what they eat (food), their life cycle and body parts.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
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Entomology: Beetle Scavenger Hunt

Science Checkup - Questions to ask to evaluate what was learned

- What makes an insect a beetle?
- What are some characteristics that make one type of beetle different from another?
- Do you think you would find even more types if you searched in different habitats?
- Would the time of day or night make a difference in what you found?
- What kinds of things do beetles eat?

Extensions

- Try keeping different types of beetles in the proper habitats for a week or two. Try to discover what kind of beetle you have, using books and field guides to help you identify it.
REMEMBER - you must provide food for your beetle(s).
- Can you keep a water beetle? What about a beetle that lives in the bark of dead trees? Or in a bracket fungus that grows on the tree?
- In the fall of the year, collect some acorns or hickory nuts and keep them in a clear container, with a screen top. What happens? Is something chewing the nuts or their shells? If you open one up, what do you find inside? Write a short story about it, or keep a notebook with the "data" in it. What does it eat? Where did you find it?
- When you are done with your observations, the beetle should be returned where you found them.
- Use books or the Internet to find out more about these beetles. Where did they get these names?

Scarab beetle

Hercules beetle

Stag beetle

Rove beetle

Ladybird beetle

Burying beetle

Bark beetles (bark engravers)

Weevils

Tiger beetle

Colorado potato beetle

Diving beetle

Whirligig beetle

Dung beetle

Vocabulary

Coleoptera: The Order (group) of insects to which the beetles belong: "Coleo"(sheath-like) + "ptera" (wing).

Elytra: The leathery or hard forewings or front wings of a beetle, often meeting in a straight line down the back.

Exoskeleton: Skeleton on the exterior of the body.

Segment: A ring or subdivision of the body, made of repeating sections.

Mandibles: The first pair of mouthparts that often form biting organs; the jaws in insects.

Maxillae: The mouthparts behind the mandibles of insects.

Palps: Mouth feelers.

Adult: A mature insect.

Larva: An immature insect, a grub in the case of beetles.

Pupa: An insect in an intermediate inactive stage of its growth, often enclosed in a cocoon or case; the stage between larva and adult, in insects.

Order: A group of related organisms.

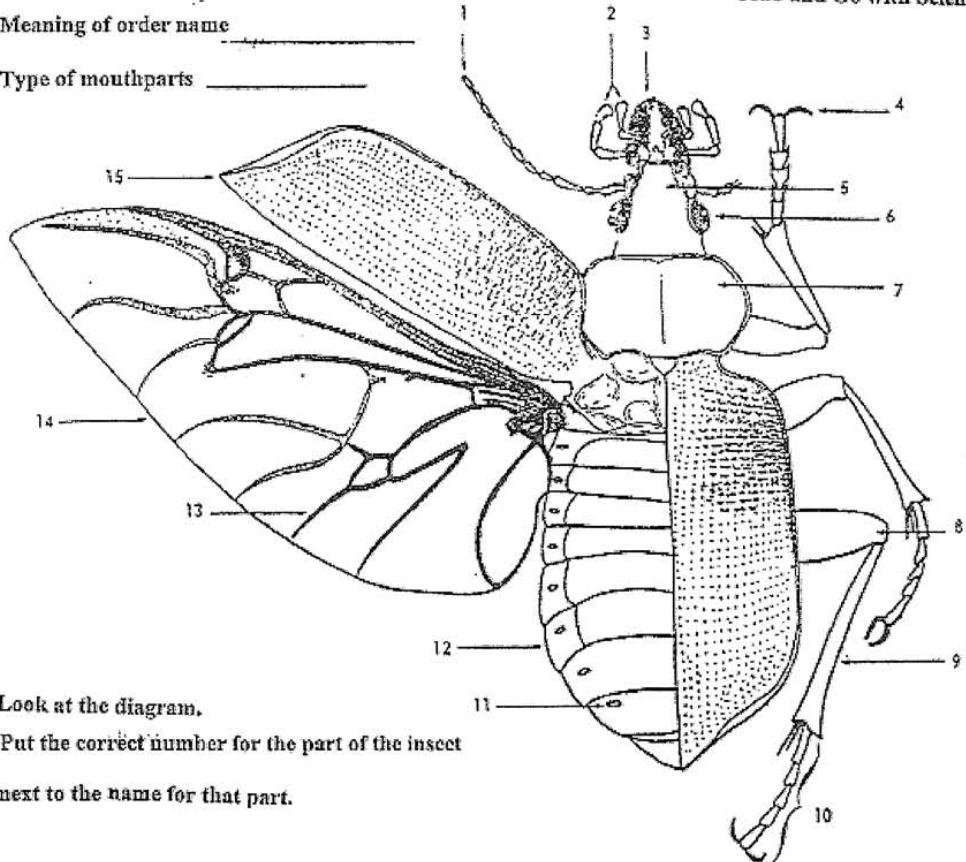
BEETLES

Order _____

Entomology - C. Klass
Grab and Go with Science

Meaning of order name _____

Type of mouthparts _____



Look at the diagram,

Put the correct number for the part of the insect

next to the name for that part.

- | | | | |
|---------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <input type="checkbox"/> abdomen | <input type="checkbox"/> elytra | <input type="checkbox"/> hindwing | <input type="checkbox"/> spiracle |
| <input type="checkbox"/> antenna | <input type="checkbox"/> femur | <input type="checkbox"/> mandible | <input type="checkbox"/> tarsus |
| <input type="checkbox"/> claws | <input type="checkbox"/> forewing | <input type="checkbox"/> palps | <input type="checkbox"/> tibia |
| <input type="checkbox"/> compound eye | <input type="checkbox"/> head | <input type="checkbox"/> pronotum | <input type="checkbox"/> vein |

4-H ENTOMOLOGY WORKSHEET - 5

UNIVERSITY OF CALIFORNIA AGRICULTURAL EXTENSION SERVICE

BEETLES I

O C S L A T I G E R S E L S X
M T O E A R R G S P E X A T T
X A A L L R T O G G L O D A K
G A X T E U V Y V E B S Y G C
P X R I O O C A L E I K B S D
K R A B L P P R F E D E I E D
P A L P S L O T E Z N L R B E
D I V I N G A D E H A E D H T
S C A R A B J E A R M T P H N
S R E V A R G N E R A O U W E
D J A U G R L Q O F O N P O M
R Q P N Y U U F A D A L A G G
G I G I L R I H W O D E O Q E
G N I Y R U B T L U D A L C S
N X X Y T V Q V S L I V E E W

CAN YOU FIND THESE WORDS?

Up, Down, Left, Right, Diagonally, Forwards or Backwords

ADULT	EXOSKELETON	PUPA
BARK	HERCULES	ROVE
BURYING	LADYBIRD	SCARAB
COLEOPTERA	LARVA	SEGMENTED
COLORADOPOTATO	LEAF	STAG
DIVING	MANDIBLES	TIGER
EGG	MAXILLAE	WEEVILS
ELYTRA	PALPS	WHIRLIGIG
ENGRAVERS		

BEETLES II

E C O G M T A H M L D Q D H O
N G O D I V Q A Y R W I C T S
G A D L R G N V I M V X A L E
R T B A E D I B B I A T W U L
A S L A I O Y L N U O H E D U
V A S B R D P G R P R L E A C
E R L M A A G T O I E Y V E R
R E B L G E C D E A H G I G E
S P A L P S A S F R K W L N H
T X R K A R T Y L E A C S L G
E I K L O D E T N E M G E S C
F V G L E X O S K E L E T O N
Q N O E B M A X I L L A E Z Y
D C X R R N Z G F A P U P S G
A F E Y X Z U N G C G X A E A

CAN YOU FIND THESE WORDS?

Up, Down, Left, Right, Diagonally, Forwards or Backwords

ADULT	EXOSKELETON	PUPA
BARK	HERCULES	ROVE
BURYING	LADYBIRD	SCARAB
COLEOPTERA	LARVA	SEGMENTED
COLORADOPOTATO	LEAF	STAG
DIVING	MANDIBLES	TIGER
EGG	MAXILLAE	WEEVILS
ELYTRA	PALPS	WHIRLIGIG
ENGRAVERS		

BEETLES III

L M H T D U Q O D H K J B B O
T P R S I J M N V A L R M T V
D D A E V G U P R E A W A I K
E M S L I V E E W I D T X B R
O V N U N G T R T E O M I A S
E W O C G P J K T P G A L R L
Q W T R O H K N O W S D L A W
Q J E E E W E D X H Z U A C H
W V L H Q M A N D I B L E S E
X O E N G R A V E R S T F P N
C P K E O L R F T L F A E L L
Q N S L V U T D R I B Y D A L
E L O B U R Y I N G D V R P J
I C X M D X L T P I W V R U S
A S E S B T E F O G A T S P Y

CAN YOU FIND THESE WORDS?

Up, Down, Left, Right, Diagonally, Forwards or Backwords

ADULT	EXOSKELETON	PUPA
BARK	HERCULES	ROVE
BURYING	LADYBIRD	SCARAB
COLEOPTERA	LARVA	SEGMENTED
COLORADOPOTATO	LEAF	STAG
DIVING	MANDIBLES	TIGER
EGG	MAXILLAE	WEEVILS
ELYTRA	PALPS	WHIRLIGIG
ENGRAVERS		

Entomology: Beetle Scavenger Hunt

Background Information

- Beetles are insects, therefore their bodies are made up of three body regions: the head, thorax, and abdomen. They have three pairs of legs, and one pair of antennae.
- Beetles also have two pairs of wings. The first pair or forewings are hardened and protect the more delicate hind wings. These forewings are known as "elytra." In fact, the word Coleoptera, the name for the group of insects to which the beetles belong, means "sheath-like wings." The hind wings are larger than the elytra, and when the beetle is at rest, the hind wings are folded neatly over the body. They must be unfolded to fly, then tucked back in when the beetle lands.
- The beetle has chewing mouthparts. The jaws (consisting of large, visible mandibles, and a second pair just below those called the maxillae) work from side to side. There are also one or two pairs of palps, which help to push the food around in the insect's mouth. The mandibles are used to bite and tear bits of food; the maxillae help shred these bits into smaller pieces before they are passed into the digestive tract.
- Insects are cold-blooded. They cannot regulate their own temperature, but depend on the air around them to warm them. When it is warm, they are active, but when it is cool, activity slows down.
- Some beetles have special ways to avoid being eaten by other insects or animals. The Japanese Beetle, a pest of roses and grapes and many other plants, will grow tense, stop feeding, and lift its hind legs when danger approaches. Then it will either fly away or drop to the ground. Some weevils tuck their legs under their bodies, fall to the ground and play dead. Some Water Beetles dive into the water and stay there holding onto a plant or rock, breathing air that they carried with them, until danger has passed (usually about 20 to 30 minutes).

Background Resources

- *Some Beetles of New York*. John A. Wilcox. New York State Conservationist Magazine. February/March, 1960.
- Any field guide to the insects (many choices including: *Peterson Field Guide series*, *Audubon Field Guide series*, *Golden (Nature) Guide series*, *Simon and Schuster's Guide*, *National Wildlife Federation Field Guide*. For younger children: *Peterson First Guide series*.)
- *A Field Guide to the Beetles of North America* by Richard E. White, Roger Tory Peterson and Peterson.



Entomology: The Hornet and Yellowjacket Nest

Activity Series:
Entomology
Grade: 3-6
Time: 45-60 min



Main Idea

Youth will learn how each bee works in the colony and how they build their intricate nest. Yellow jackets and hornets are types of wasps living together in a colony, which starts from a single queen each spring.

Motivator

You are the detective, discovering the secret of a bees' nest and telling others about the colony.

Pre-Activity Questions

Before you start the activity, show students a hive and ask:

- ❑ How many hornets or yellowjackets do you think lived in this hive?
 - ❑ What is the hive made of?
 - ❑ Can you tell us about the life cycle of a hornet or yellowjacket?
 - ❑ What are the steps in the life cycle, starting with the egg?
 - ❑ Is the nest thicker or thinner on top?
 - ❑ Why do you think it was built this way?
 - ❑ How many openings are there for the hornets or yellowjackets to go in or out of the nest?

Activity

- An abandoned aerial hornet or yellowjacket nest (best collected during the winter)
 - A serrated bread knife (for adult use only)
 - Notepaper
 - Pencils
 - Ruler and/or tape for measuring nest size

1. Cut the nest in half vertically with the serrated knife. Examine the overall structure. (Notice that it is thicker on top.) Write down the number of layers of comb (the inside of the hive). The layers closer to the top are larger, and get smaller toward the opening.
 2. Remove the comb, keeping the two halves of each layer in the same place so you can see which ones are larger. While looking at the comb, ask: Do you see different size cells? (Two different width cells should be obvious.) Are some of the cells still capped?
 3. Open one of the cells gently and remove the contents using your pencil point to push it out, or tweezers to pull out. What is it?
 4. Have the group split up and give each group one comb. Have students count and record the number of cells of each size group:

small cells _____
(worker cells) **large cells** _____
(brood cells)

5. If the wasps use each worker cell three times during the growing season, and the queen and drone cells only once, how many wasps might have been in this colony if they all survived?

6. In other words, multiply the number of small cells you counted by 3, then add to that the number of large cells to find the total number of wasps possible if all had lived and were present at the same time.

Objectives

- Learn how hornets and yellow jackets build their nests
 - Explore what they eat , how the nest functions and their life cycle.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate

State a Problem

Research Problem

Test

- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

Contributed By

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Baldfaced hornet. Photo by Johnny Dell, from <http://Bugwood.org>.



Inside a baldfaced hornet nest, showing open cells, capped cells (with pupae), a larva (near center of photo), and an adult worker. Photo by Carolyn Klass, Cornell University.



UGA1482007

Nest made by baldfaced hornets. Photo by Sturgis McKeever, Georgia Southern University, from <http://Bugwood.org>.



UGA1491033

Yellowjacket wasps on a small nest. Photo by Howard Ensign Evans, Colorado State University, from <http://Bugwood.org>.

Entomology: The Hornet and Yellowjacket Nest

Science Checkup - Questions to ask to evaluate what was learned

- What would you do if you saw a wasp or hornet starting to make a nest near your front door under the roof?
- Would you remove the nest now, when there are only a few workers in it, or would you wait longer? Why?
- Since these insects use a sting as a defense, they are often disliked by people. Some people are afraid of them and some may be allergic to the venom in the stings. If you were responsible for the school grounds, you would want to keep the hornets and yellowjackets away from the playgrounds. You would want to control them before the nests got large, and the chances of someone getting stung increased.

Extensions

- Measure and record the size of the nest: length, width and circumference at widest part.
- Make a drawing of the nest.
- Explore how the wasp makes the paper covering of the nest. Make a paper mache nest that is hollow inside and as long and wide as your head. (Use a balloon as the basis for the nest, cover the balloon with strips of newsprint dipped in a flour and water solution. Let dry a few days, then pop the balloon. When dry, cut your "nest" in half with a serrated knife, cut holes in the appropriate places for eyes and a hole to breathe from. Make this into a mask by decorating it any way you wish. (Materials needed: strips of newspaper, balloons, flour and water paste or other paper mache paste, elastic to make a band for the mask to hold it on your head when finished.)

Vocabulary

Annual: Yearly, each year.

Cell: A small enclosed part or division, an individual six-sided structure that together with others makes up the comb.

Colony(Colonial Wasps): A group of living things of one kind living together.

Comb: (honeycomb): A group of six-sided cells built by wasps in their nest to contain brood and food. Honeycomb is made of wax by honeybees.

Hornet: Any of the larger social wasps (colonial living wasps).

Petiole: The stem or first part of a wasp nest that is quite strong and attaches the hive to a branch or other structure.

Pupa: An insect in an intermediate inactive stage of its growth, often enclosed in a cocoon or case. The intermediate stage of growth between a larva and adult in complete metamorphosis. For example, when moth larvae (caterpillars) form cocoons, they enter the pupal stage of their development.

Regurgitate: To throw or pour back out, the casting up of incompletely digested food (as by some birds and insects in feeding the young).

Wasp: A winged insect related to the bees and ants that has a slender body with the abdomen attached by a narrow stalk. The females (queens and workers) are capable of giving a painful sting when alive. Wasps belong to the insect order Hymenoptera.

Yellowjacket: A small, colonial wasp with yellow markings on a black body that commonly nest in the ground or above ground.

Entomology: The Hornet and Yellowjacket Nest

Background Information

- The aerial hornets and yellowjackets that live in the northeastern United States are annual nesters, which means that they start a new nest each year.
- The nest is started by a mated queen that has overwintered successfully. She begins by gathering “wood” and chewing it up into small particles, mixing it with saliva, then placing it in the spot she has chosen for a nest.
- At first she “glues” this material to the structure that will hold the nest, often an overhanging roof or other solid piece of wood in a protected location. This forms the petiole of the nest. Then she begins to draw out the “paper mache” that she makes into a protective envelope and a group of six-sided cells -- usually five or six in the group.
- When these are partially completed, she lays an egg in each one and continues working on the cells and the envelope of the nest. Meanwhile, the eggs incubate, and the larvae hatch in approximately five days. The envelope will protect the nest from weather, and will surround the comb and help the insects to regulate both the temperature and moisture in the nest.
- When the first group of larvae hatch, they are hungry. Being legless creatures they depend on the queen to feed them. The queen goes out in search of insects such as caterpillars or flies, which she captures, chews up, and then regurgitates to her larvae. This is a full-time job when the larvae are actively growing (about two weeks).
- When the larvae are grown, they spin a cap of silk over the cell they are in, and in this location they undergo pupation, a resting stage in which the larva changes greatly, develops legs, wings and antennae and gradually transforms into an adult.
- After about 14 days, the adult is fully formed and ready to emerge from its pupal cocoon. It chews a hole in the cocoon cover and pulls itself out. After a few hours, its body is hardened off, its wings expanded and it is ready to take on the life of a worker.
- The workers from this point on will take over the duties of the upkeep and expansion of the hive, leaving the queen to lay eggs for the rest of the colony. Workers keep building cells and feeding other larvae as they develop. In the life of the colony, the worker cells may be used a maximum of three times for brood during the growing season.
- As fall approaches, the queen continues to lay eggs, some in larger cells the workers have built. These eggs will develop into a brood of new queens and males (drones) which will fly out on warm days, form mating pairs, and then the queens will seek protected places to spend the winter. The larger brood cells are used only once in the life of a colony. Although a few queens may return to the original nest, most find tufts of grass or decaying portions of trees to hibernate in and wait for spring. The old queen, workers and drones die in the fall.

Entomology: Collecting Insects

Activity Series:

Entomology

Grade: 3-6

Time: 20-60 min.

Main Idea

Youth will build simple insect sampling equipment, then explore the fields, bushes, grasses and other vegetation looking for and identifying various species living there. They will also learn about the importance of insect diversity and safe collection and return of insects.

Motivator

Did you know that something as simple as a bed sheet can be used to collect and observe a whole host of different types of insects? Today we'll build some simple gadgets for collecting insects, then go try them out.

Pre-Activity Questions

Before you start the activity, ask the students:

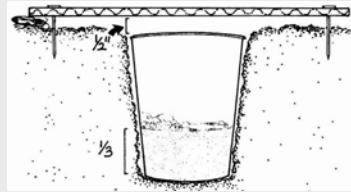
- What is biological diversity?
- Why is it important to have a high level of diversity among insects?
- What might cause the diversity of an area to be higher or lower than a different area?
- How can you minimize your impact on the insect world when collecting?

Supplies

Activity 1: Make a pitfall trap

- A trowel or bulb planter
- Small steep-sided plastic cup or can
- Small piece of plywood or waxed cardboard with a nail in each corner, large enough to cover the cup or can
- Plastic bag or jar with lid
- White sheet of paper
- Tweezers (optional)

1. Dig a hole the size of the 8-ounce cup or can using the trowel or bulb planter.
2. Place the cup or can in the hole so the top is near ground level.
3. Place the plywood or cardboard cover over the cup or can. The four nails should go into the ground to hold the cover in place. The distance between the cup and the cover should be about 1/2 inch. Too large a gap will allow mice or shrews to fall into the trap and too small a gap won't allow insects to crawl in.
4. Choose several different habitats outside. Place one trap in each habitat to get a representative sample of insects.
5. Visit the traps daily, pour out the insects and observe them on your sheet of paper. Use the Insect Diversity Activity Record to write down your findings.



Objectives

- Learn how to build equipment to safely observe and collect insects.
- Sample different habitats to learn about insect diversity.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

Contributed By

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Entomology: Collecting Insects

Supplies

Activity 2: Make a bush beater

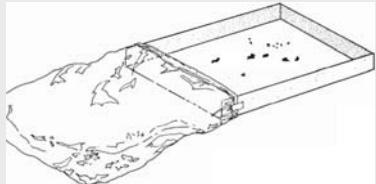
- White bed sheet or large piece of white plastic, about 1 square yard
- Plastic bag
- Bug box or clear jar with a lid

1. Place the sheet or piece of plastic under the bush.
2. Gently beat the bush with a stick and watch the insects fall onto the sheet or plastic.
3. You can observe the insects on the sheet or plastic or you can observe them in the jar or bag by rolling the piece of plastic or sheet into a funnel and pouring the insects into the container.
4. Use the Insect Diversity Activity Record to write down your findings. How many different kinds of insects did you collect?
5. Release the insects when you are finished looking at them.

Supplies

Activity 3: Make a Shake-it Box

- A shallow cardboard box, about 9 inches by 12 inches.
- White paper to line the box if it is not already white
- Tape
- Plastic bag to fit over the end of the box
- Bug box or clear jar with a lid

1. Cut off one edge of the box.
 2. If the inside of the box is not white, line it with white paper, taping the paper in place.
 3. Tape the plastic bag to the bottom and two sides of the box (see illustration).
 4. To use the box, choose a different bush or plant than the one you used in Activity 2. Hold your Shake-it Box under the bush and shake the bush.
 5. You can observe the insects in the box or observe them in a bug box or jar by tipping the box so that the insects slide into the plastic bag. Untape the bag from the box, close it and transfer them to the bug box or jar by holding the plastic bag partly in the box or jar and turning it inside out.
 6. Use the Insect Diversity Activity Record to write down your findings. How many different kinds of insects did you collect?
 7. Release the insects when you are finished looking at them.
 8. Retape the plastic bag to the box so that you can use it again.
- 

Entomology: Collecting Insects

Science Checkup - Questions to ask to evaluate what was learned

- How many different kinds of insects did your group find?
- Did the number of different kinds of insects depend on the habitat in which your sampling took place? Which habitats produced the most different kinds of insects? Why do you think this is the case?
- Were you able to identify any insects?

Extensions

- Youth many want to place insects into groups based on their physical characteristics and make up names for the groups.
- You could help them learn the commonly accepted names of the insects they collect by using field guides to insects, which are available at bookstores and at the library.
- Scientists use Latin names for insects because it allows scientists from different countries to communicate with each other and avoids confusion when one insect has several common names. Explore the origin of the Latin names for insect orders — this can be a helpful way to remember insect names.
- Youth can try other activities in the “Insects All Around Us” curriculum, available at <http://hdl.handle.net/1813/3809>

Vocabulary

Biological Diversity: A measure of the number of different kinds of living things in a habitat. High biological diversity indicates many different kinds of living things. Low biological diversity indicates only a few different kinds of living things.

Background Resources

- An Introduction to the Study of Insects, Donald J. Borror, Dwight M. Delong and Charles A. Triplehorn, 1976.
- Curriculum Guide in Environmental Studies, Grades PreK to 6, Cayuga Nature Center, Ithaca, N.Y., 1988.
- Life Nature Library: The Insects, Peter Farb, 1962.
- Know Your Insects. 4-H member's guide, Carolyn Klass, Cornell Cooperative Extension, 1981.

Entomology: Collecting Insects

Insect Diversity Activity Record

Name: _____

Date: _____

What kind of sampling equipment did you use?

How long did you sample? If you used pitfall traps, how many did you place in each area?

Describe the area(s) you sampled. How many different kinds of plants were in the area?
Can you name or draw any of the plants?

How many different kinds of insects did you collect? Can you name or draw any of the insects?

Entomology: Exploring Plant Galls

Activity Series:
Entomology
Grade: 3-6
Time: 45-60 min

Main Idea

A gall is an abnormal growth on a plant. Many galls on plants are caused by insects. They provide a home where insects can grow and develop. A few plant pathogens (disease-causing organisms) such as bacteria and fungi may also cause galls.

Motivator

When you see a bump on a tree or a funny-looking growth on a plant, do you ever wonder what might be inside? Or why it happened?

Pre-Activity Questions

Before you start the activity, ask the students:

- Where should we go to look for plant galls?
- What do you think we will find inside the galls we collect?

Supplies

(See fact sheet "Some Plant Galls" for illustrations and descriptions of common galls):

- Meadow or wooded area to look for plant galls
- Bag for collecting
- Sturdy garden shears for clipping branches with galls
- Hack-saw for cutting woody galls (adult supervision required)
- Pocket knife (adult use only)
- Magnifying glass, hand lens or microscope
- Notepaper
- Pencils to write/draw with
- Insect guide

1. Take the class out first to show them the collection area and show them a few galls so they know what to look for. Then, go on a gall hunt - see who can collect the most different types of plant galls (abnormal growths on plants) in 10 minutes.
2. Bring collected "galls" back to the meeting site.
3. Carefully cut open one gall of each type to see what is inside, (without destroying whatever is inside). If the plant tissue is soft, a pocket knife or pair of scissors may be best, but if the plant material is hard and woody, you may want to put the gall in a vise to hold it, and gently cut through with a hack-saw.
4. Make a chart of what you found, or draw a picture of a gall or two.

Helpful Hint:

When galls are collected during the winter, it is a good bet that the gall makers will emerge the following spring when the temperatures warm up and plants begin new growth. You may be able to find the adults of insects whose larvae you saw earlier in the season. Add these to your collection even if you do not know the names of the insects causing the galls. A scientist may be very interested to see what you have reared, and may be able to help you with some identifications too.

Objectives

- Be able to recognize plant galls and know what causes them.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Entomology: Exploring Plant Galls

Science Checkup - Questions to ask to evaluate what was learned

- Where could you go to look for plant galls?
- What caused the galls you found?
- If the gall was caused by an insect, why would the insect want to live in there?

Extensions

- There are more than 100 species of gallmakers that attack oaks alone. The galls come in many sizes and shapes and may be found on leaves, stems, flowers and even roots. Have the group explore some oak trees to see how many different galls they can find on this one host.
- Keep a record book. Write down what you find and attach your note to the gall you collect or draw a picture of the gall in your notebook. Ask: What is the host plant? Is there only one insect cell inside or many? Are the insects present? Do you see larvae? Adults?
- Start a collection of plant galls and gall makers. If you are able to collect mature galls when the insects are still inside, you might try keeping them in a jar with a lid with a few holes punched in for air (or a piece of nylon stocking stretched over the top and held in place with a rubber band) and wait to see if anything comes out of the gall.

Vocabulary

Develop: To grow toward maturity

Gall: A swelling or growth on a plant part; an abnormal growth of plant tissue.

Host plant: The plant with the growth on it.

Immature: Not yet fully grown

Larva: A wingless form of an insect that hatches from an egg, such as a grub or caterpillar

Order: A group of related organisms.

Background Information

- A gall is an abnormal development or outgrowth of plant tissue resulting from an irritation. It is often caused by insects, but bacteria or fungi can also cause galls. When insects are the culprit, the immature, or larva stage, is found inside. The larvae cause irritation and the extra growth to occur, and they may also gain their food from the inner walls of the gall, where they are living.
- Galls interfere with the normal function of twigs and other plant parts, causing curling, stunting and tumor-like growths. Some galls are harmful to the plant, while others are not.
- Of the insects, the Hymenoptera (the ants, bees and wasps) and the Diptera (the two-winged flies) are the two orders that cause the majority of plant galls. A number of oak galls are caused by tiny gall-making wasps and the goldenrod ball gall is an example of a fly-caused gall. Aphids and mites also cause a large number of galls.
- Bacteria may cause galls on the stems and crowns of plants such as blackberry or roses. Fungi may cause galls that at various times in the season produce fungal spores. If there is no hollow area inside the gall, it may be caused by bacteria or fungi.
- **A gallmaker's life cycle:** The goldenrod ball gall will serve as our example. A female picture-winged fly lays her shiny white egg in the bud tissue at the top of a young goldenrod plant. She usually lays one egg per plant. She makes a little hole in the stem with her ovipositor (egg laying tube) and then puts the egg in the hole. The young larva (maggot) bores down into the growing part of the stem and begins to hollow out a chamber. A gall begins to form, probably in response to some chemical the larva gives off, and this gall will provide both shelter and food for the gall fly larva. The insect inside the gall remains as a larva until late March or April in the Northeast, when it changes into a pupa. (The pupa is a resting stage of the life cycle, in which the insect transforms from a larva to an adult.) A few weeks later when the goldenrod has just started to grow, the adult fly emerges, mating occurs and the female will begin the cycle again by laying an egg in the young goldenrod plant.

Entomology: Exploring Plant Galls

Some Plant Galls



COOLEY SPRUCE GALL - A 1 to 1½ inch cone-shaped overgrowth that first appears on the tips of the spruce branches in early June. If cut open, one will find numerous tiny gray aphids (adelgids) inside. The galls open in August and September, and the adults emerge to lay eggs. The young adelgids overwinter on the buds and twigs of the host tree.



GOUTY OAK GALL - Caused by a wasp, these galls appear on the stems of black, red, pin and scarlet oaks. They have been known to cause small branches to be killed and break off the tree.

Other common galls include the hickory leaf and petiole gall, first appearing on leaf petioles and small stems in June as hollow green growths, they later turn black. The cause of this gall is a phylloxeran, a small aphid-like insect. The poplar petiole gall is seen as a swelling of the leaf petiole which turns black upon maturity, and it is caused by an aphid.



CROWN GALL is one example of a gall that is harmful and often kills plants. It is caused by a bacterium. Crown gall is usually found at or near the soil level and appears as rough-shaped, hard or soft, spongy swollen tumors. The color of the galls varies from flesh-colored to greenish or dark. Where this gall is discovered it is best to discard the plant altogether.

WILLOW PINE CONE GALL - CAUSED BY A MIDGE
Rhabdophaga strobilooides



SAWFLY GALLS ON A WILLOW LEAF
Pontania proxima



SHOOT GALLS ON WILLOW - CAUSED BY SAWFLY
Tenthredinidae: Euura sp.



HORNED OAK GALL - CAUSED BY A GALL WASP
Callirhytis cornigera