COMPANION FIELD GUIDE FOR INSECT COLLECTION KIT

Who Can Use This Guide?

Anyone interested in learning about familiar insects and arthropods may find interest here. While the primary target audience is teachers of science in grades K-12, the observation-based approach of the guide[1] can be applied to teaching and learning science at any level. The guide is based on the natural history of schoolyards in southwestern Virginia, but many of the arthropods described in this book are also common in other parts of the United States, especially in the east.

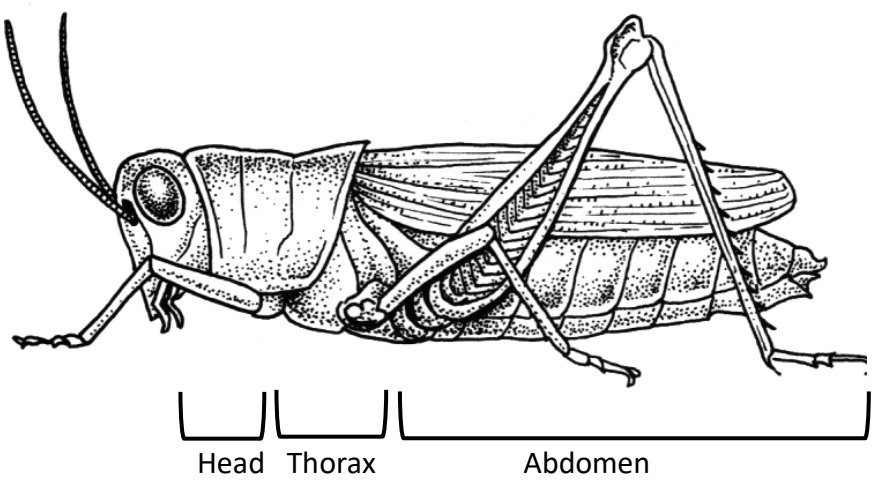
Virginia Science Standards of Learning

This guide follows the teaching of the Virginia Science Standards of Learning, for grades K-12. However, no attempt has been made, however, tailor specific Lines of Inquiry to grade levels. Many activities in the book, as well as the background information, are adaptable to different grade levels.

[1] Adapted from: F. Taylor, Raflo, A., Sharp, L. (1997) *Model Inquiries into Nature in The Schoolyard, The MINTS Book: An Inquiry Field Guide to the Natural History of Southwestern Virginia Schoolyards* (CC-BY-SA)

Chapter 1: Short-horned Grasshoppers
Insect Order: Orthoptera (the grasshoppers, crickets, katydids, etc.)
Family: Acrididae

Grasshoppers are good organisms for observing the key features of insects: an exoskeleton; three main body parts (head, thorax, and abdomen); two antennae[2]; six legs; and (in most insects) wings. Well-developed hind legs enable grasshoppers to jump a great distance in a single bound. Grasshoppers' color varies, but they are commonly gray or brown. Grasshoppers have compound eyes made up of hundreds of individual lenses.



Short-horned grasshopper

Short-horned grasshoppers are most easily found in the fall. They include a whole family of grasshoppers that contains many common species. In contrast to long-horned grasshoppers, whose antennae are often as long as their bodies, short-horned grasshoppers' antennae are usually less than one-fourth as long as their bodies. You

[2] Antennae is the plural of antenna

may find short-horned grasshoppers in the lawn by planting one foot on the ground and sweeping the other foot across the top of the grass in front of you. If grasshoppers are present, you will see them jump and fly away from you. Look near the lawn edges where taller grass and weeds may be growing. You may wish to have a few students attempt to catch a grasshopper with a net or plastic jar. Placing a few grasshoppers in viewing boxes will aid your observations and inquiry. Be careful though: reportedly a common defensive reaction of grasshoppers is to regurgitate a material called “tobacco juice”, which can be an irritant.

While some short-horned grasshopper species do not make conspicuous sounds audible to humans, other kinds do, in two ways. Some species snap their wings in flight, making a crackling sound as they leap into the air. Others rub their hind leg against their wing, making a loud mechanical trill. You might ask your students to compare these sounds with the more melodious sounds of crickets.

Grasshopper History and Uses

Grasshoppers are protein-rich food for many organisms: other insects, spiders, snakes, birds, and even mammals. Their large numbers make them important members of food webs. Almost all grasshoppers feed on plants, with some kinds consuming specific plants and others feeding on almost anything. When grasshoppers occur in large numbers, they can have significant impact on a whole ecosystem. During 1874 to 1877, huge swarms of short-horned grasshoppers, numbering in the billions, darkened the skies as they migrated across many western states in search of food. They devastated crops and consumed virtually all available vegetation.

Short-Horned Grasshoppers Inquiries

The best time to find grasshoppers in and around the schoolyard is when you return to school at the end of summer. The best places to look are in tall grass and overgrown areas on the edges of the schoolyard. Brush your hand or foot gently across the vegetation and watch for grasshoppers as they hop/fly away.

Useful materials: insect-viewing boxes (or plastic containers and hand lenses), insect nets (commercial or homemade).

Grasshopper Structure and Function

Capture a few grasshoppers and put them in separate viewing boxes so that small groups of students can view them closely.

1. How many legs does the grasshopper have? How many antennae?
2. How do the legs compare? Which are similar? Which are different?
3. How do you think the front pair of legs is used by the grasshopper?
4. What is the function of the rear legs?
5. How is the structure of the legs (front and rear) suited to their function?
6. Look at the grasshopper's eyes. Describe what they look like.
    a. Compare the grasshopper's eyes with your eyes. How do they look similar? How do they look different?
    b. How does the position of your eyes in your head differ from the position of the grasshopper's eyes? What might the grasshopper be able to do with eyes in such a position? How does this help the grasshopper survive?

Grasshopper Behavior

Observe the behavior of grasshoppers in the lawn.

1. What are some ways grasshoppers can escape predators?
2. Describe how a grasshopper in the lawn responds if you try to catch it.
3. Does the grasshopper jump once or several times in succession?
    a. Does the grasshopper jump in the same direction each time?
    b. How does the direction of each successive jump change?

    c. Does the grasshopper use its wings to increase the distance of its leap? Does the grasshopper you are observing have wings?
    d. What does the grasshopper do after it lands to make itself less noticeable?
4. What features does the grasshopper have that help it to blend in with its surroundings?
5. How could you find grasshoppers if they did not jump?

Grasshopper History and Uses

1. What animals do you think might eat grasshoppers?
2. How important do you think grasshoppers might be as a food source for other organisms?
3. What do grasshoppers eat?
4. How have grasshoppers been important in the history of the United States?

Chapter 2: Discovering Insects

Important: Remember that many insects can bite, sting, or give off irritating substances. A good general rule is to look instead of touching or grabbing.

As well-prepared as a guide book can be to alert you to particular plants and animals that you can find in your schoolyard, some of the most fascinating discoveries will be those that you and your students make. If you are interested in learning more about insects, you can easily go outside your classroom and make discoveries that would go beyond the scope of this book. There are simply too many kinds of insects to describe all the different ones that you might find.

How can you find these insects? Where do you look? A systematic survey will uncover insects and evidence that they have been at work. Try the following: our suggestions for the "Top 10 Ways to Find Insects". Once you've had some practice, you and your students can create your own "Top 10" list of ways and places to look!

1. Change your focus as you go outside. Look for small things, for things that are moving quickly, and for things that are not moving.
2. Look under logs, rocks, and pieces of bark.
3. Brush your hand or foot across mowed grass, watch for movement, then carefully watch where the escaping insect lands.
4. Look on the sides of school buildings or under eaves, especially around lights.
5. Look at flowers in bloom, particularly on calm, sunny days. Look for pollinators flying from flower to flower, as well as for insects that might be living in or on the flowers. Look inside flowers that have turned to seed.
6. Look carefully at the leaves of trees, shrubs, and herbaceous (non-woody) plants. Look on top of the leaves, underneath the leaves, on the twigs or stem, or in crevices in the bark.
7. Look for damaged leaves as evidence of insects: leaves that have been eaten; leaves with holes in the middle, edges missing, or skeletonization; leaves that

have been folded, rolled up, or stuck together; or evidence of leaf-mining larvae inside leaves.

8. Look for eggs, egg cases, cast skins, or cocoons as evidence of insects.
9. On trees, look for holes or sawdust as evidence of borers. Underneath bark, you may find intricate patterns carved in the surface of the underlying wood by bark beetles.
10. Dig into soil, look at plant roots, and look in decaying leaves or rotting wood.

When observing insects, try to determine what they eat as well as how they eat. Insects have many specialized feeding habits. For example, mosquitoes seek a blood meal, while Mud dauber wasps feed only on spiders. Some insects, like dung beetles, feed on manure, while many others eat plants. Keep in mind that some insects may feed on many different types of plants while others feed only on one type. For example, Japanese Beetles may be found on several different plants around your school, while the Pine Tube Moth is only found on White Pines. Carefully examine different types of plants to locate different insects.

Don't feel that you have to know the name of the insects you find or all about the insect's life history in order to introduce it to your class! There is a great deal you can learn along with your students about a particular insect by watching its behavior, noting the features of its habitat, and perhaps watching it feed or interact with insects of its own kind or other kinds. You can find out more about insects you observe by recording field observations, bring the insect into the classroom for closer observations, or referring to books.

Some of the insects you find in a certain location or on a particular plant may remain at that place only momentarily. Others can be found at that place for days or weeks. A Praying mantis for example, will continue to move from plant to plant in search of prey, while Monarch Butterfly caterpillars will remain on milkweed plants. You may find large numbers of insects on a particular plant. For example, in early summer you may find

aggregations of aphids on the stems of rose bushes. But you may find only one individual caterpillar or beetle on a different plant!

Take time to watch the insects you find in a natural setting. Provide some structured opportunities for students to do this. Provide them with charts and prompts to make some careful observations, then have them discuss their observations within small groups as well as with the whole class. Encourage your students to speculate on their findings and invite alternative explanations or hypotheses for observed phenomena. Discuss and pursue ways to find out more definitive information about these fascinating creatures.

Finding Insects by Habitat

Many sections of this guide discuss various insects and their habitats. The following table identifies a few other places to look for certain insects.

Plant/Habitat	Insect	Comments
Junipers, Yews	Scale insects	Look for small waxy or scale-like flecks on leaves and twigs; examine with a hand lens.
A variety of trees, including White Pine	Bagworm moths	Look for hanging "bags" along underside of branches; you may see a fascinating life cycle!
Deciduous leaves	Miscellaneous leaf miners, leaf rollers, leaf folders, and leaf eaters.	Look at and characterize the damage; do some detective work. Can you find the culprit?
Stems of many plants in tall, weedy areas	Aphids	Look for tiny insects of various sizes, shapes, and colors.
Milkweed	Monarch butterfly (all stages); Milkweed bug	Look for black and orange patterns on the insects.
Boxwood	Boxwood Leaf Miner	Open blisters in leaves to find yellow-orange larvae between leaf layers.

Discovering Insects Inquiries

Refer to the previous section for general instructions on finding and observing insects. See also the next section of this chapter some suggested ways and materials for collecting insects.

Other useful materials: insect-viewing boxes (or plastic containers and hand lenses), plastic zip-loc bags, general diagram of insect parts.

Insects and Habitat

Have your students record the numbers of insects found in different places in the schoolyard. A chart will help them organize the information.

1. Where in your schoolyard did you find the most kinds of insects?
2. Did you also find the greatest number of individuals there?
3. What are the features of the habitat where you found the most insects?
4. How do the surrounding habitats differ?
5. What does this tell you about insects?

Evidence of Plant-Eating Insects

1. What leaf damage can you find that suggests the presence of insects?
2. Why do you think that the damage you observed might have been caused by insects? What else might have caused the observed damage?
3. Does the damage to the leaves follow a pattern? (There may be holes in the leaves, edges missing, only tips of leaves affected, or many other possibilities.)
4. Does there seem to be only one type of damage?
5. Can you find the culprit(s)? If you cannot find the culprit, can you explain why not? What are some possible explanations?

Insect Survival Strategies

1. What are some of the ways that insects you have observed protect themselves from predators?
2. Describe the color patterns of some insects that you find. Do the insects have colors that help them blend into the background or are the insects brightly colored?
3. How might drab colors help certain insects survive? How might bright colors help other insects survive?
4. What behavior patterns might help insects survive?
5. Describe and record how some insects respond when you disturb them. (Do not try this with wasps or bees!)

Insect Structures

Have students study an insect closely, using an insect-viewing box or a hand lens.

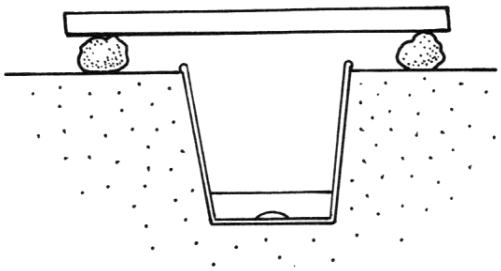
1. What features of the insect can you see using magnification that you cannot see with the naked eye?
2. How is the structure of an insect's body different from yours? How is it similar?
3. What special features does it have? How might these features or adaptations aid the insect in survival?
4. What structures can you observe that are probably used by the insect to "sense" its environment?
5. What "senses" do you have? Does the insect have similar senses? What evidence do you have to support your answer?
6. How many different body parts can you identify? Describe each part.
7. What special structures does the insect have to help it move in its environment? Describe the structure and explain how it might be used.

8. Are all the appendages (the structures sticking out from the body, for example, the legs) the same size, shape, or structure? How do they differ? How does their structure relate to what they might be used for?
9. Do insects breathe? What evidence can you observe that suggests insects do breathe?
10. What mouth parts can you see on the insect you are observing? Describe these structures. What is their function? How are they used? How do they relate to what you know about this organism's feeding habits?

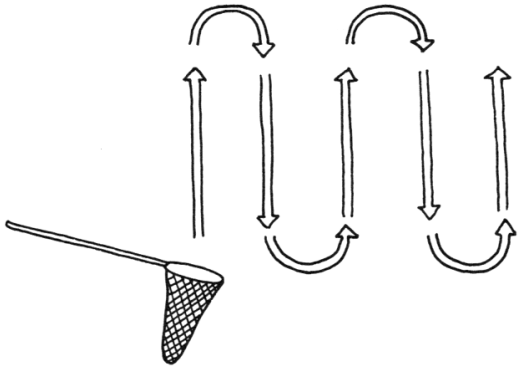
Chapter 3: Collecting Insects

Here are some different ways you can collect insects around your schoolyard. The more ways you use, the more kinds of insects you will find!

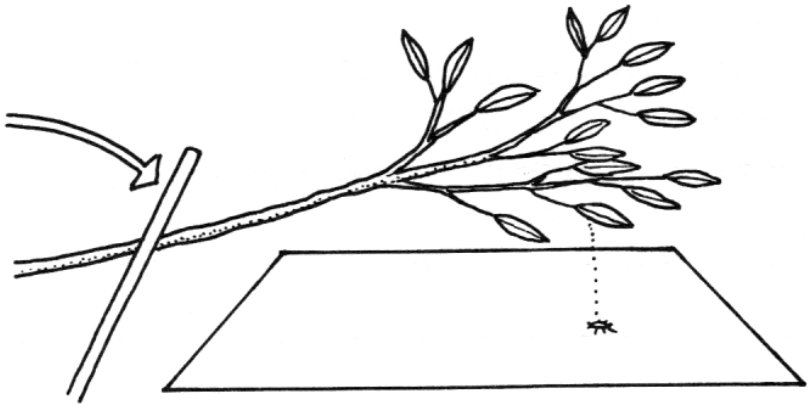
Pit Fall Traps. Use a yogurt cup or a container of similar size, bury the cup so that the rim is even with the surface, and pour about 2 centimeters of a liquid detergent into the bottom of the cup. Cover with a board propped up on stones. Please note – This technique will result in dead insects.



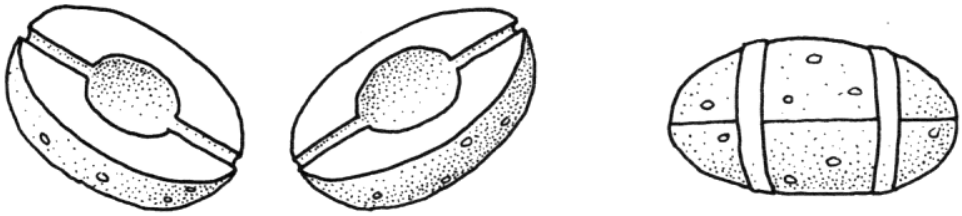
Sweep Nets. See 'em and chase 'em down! Sweep the net repeatedly, back and forth across tall grass or a meadow.



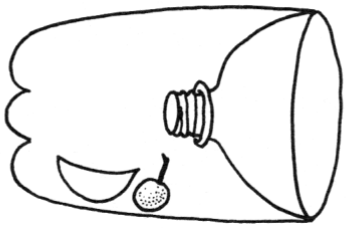
Beating Tray. Hold a piece of white poster board under a branch or bush and shake or tap the vegetation with a stick. Collect insects that fall onto the paper.



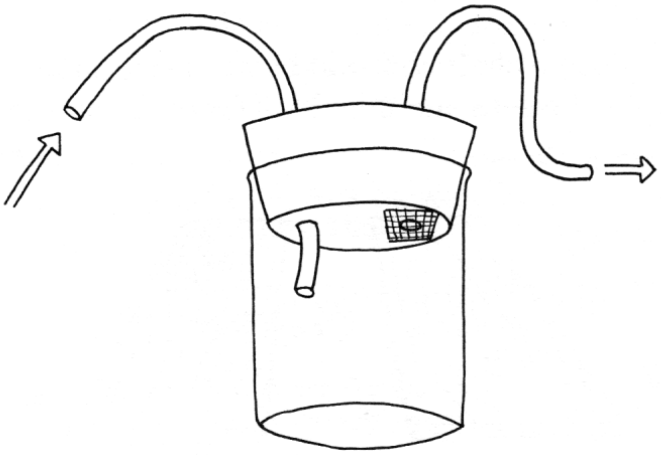
Potato Trap. Cut a potato in half and hollow out the inside with a spoon. Create an opening at each end. Put it back together and fasten with rubber bands. Check periodically for insects that have entered through the openings to feed on the potato.



Bottle Trap. Cut the top off a 2-liter soda bottle and place it back in the bottle in an inverted position. Bait this trap with different foods to capture different kinds of insects.

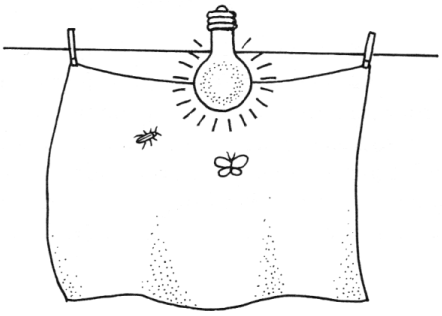


Aspirator. There are many possible variations of this theme. Basically you need a jar with a tight-fitting cork lid and two plastic or rubber tubes protruding from the lid. This works best if you use a short piece of metal tubing (such as plumbing tubing) to go through the cork, then attach the plastic tubing to the metal. Cover the jar-end opening of one tube with a small screen. Put the end of this tube in your mouth and use it to "vacuum-up" small insects from leaves or other places.

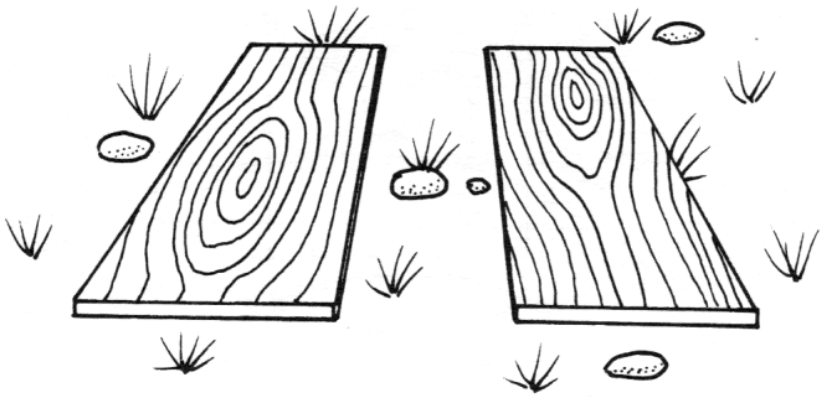


Berlese Funnel. Cut the top off of a 2- or preferably 3-liter soda bottle to create a funnel. Set the funnel in the bottom of the soda bottle. Collect moist leaf litter, soil, or mulch and place it in the funnel. Place a lamp over the funnel. Organisms will migrate away from the drying effect of the light and fall into the jar. As this apparatus will be inside, be prepared for some insects possibly to escape into the classroom.

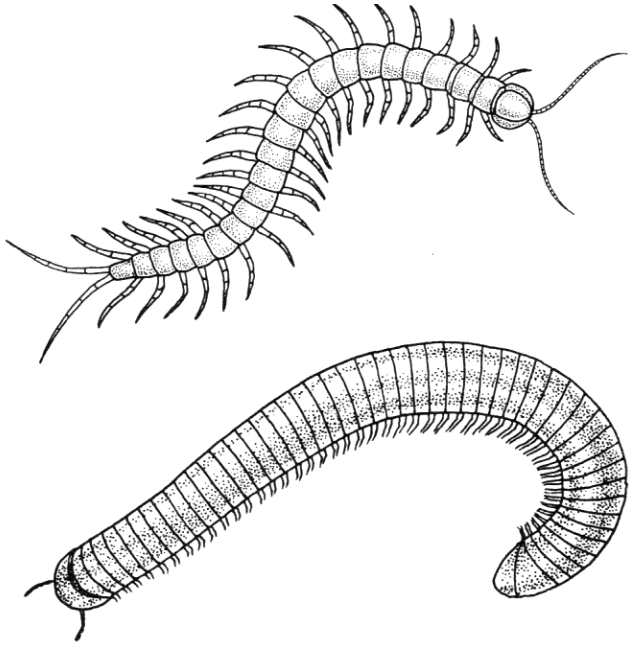
Light Trap. Suspend a white sheet vertically outdoors and shine a strong light on its surface at night. Be ready to try to capture insects that either fly around or land on the sheet. An insect net will help here!



Board Attractors. Lay some old boards out in various locations. Let them sit undisturbed for a couple of weeks and then look for organisms underneath them.



Chapter 4: Centipedes and Millipedes



Classes: Chilopoda (the centipedes[3], top) and Diplopoda (the millipedes, bottom)

Around a school building, centipedes and millipedes can be found under stones, bricks, or boards. These animals can also be found wherever there is a moist layer of decaying leaves. The millipedes will be feeding on the decaying material, while the centipedes will be searching for prey. While centipedes and millipedes are similar in many ways, they have many different features, too. Because these two groups are often confused, comparing and contrasting them can be the basis for student inquiry lessons.

[3] Important: Centipedes can bite, millipedes release a foul-smelling substance that may be an irritant.

General Features

Like insects, spiders, and isopods, these organisms have segmented bodies, an exoskeleton, antennae, and many legs. The names “centipede” and “millipede” come from Latin, where centi- means “one hundred”, milli- means “one thousand”, and –pede means “foot”. Hence the common names – “hundred footers” and “thousand footers”. Neither of these groups of animals, however, actually have the number of legs implied by their names, although millipedes generally do have more legs than centipedes. Millipedes have two pairs of legs per segment, while centipedes have only one pair. The body form of millipedes and centipedes differs in several other ways, as well. While both have long, many-segmented bodies, with legs that move in rhythmic undulating patterns, the legs of millipedes are much shorter than those of centipedes. Millipede bodies are usually rounder, while centipede bodies tend to be flat. Millipedes have shorter antennae, while centipedes’ antennae are often long.

Feeding Habits

The place of each of these organisms in the food web helps explain some other differences between these two groups. Millipedes are vegetarian decomposers, feeding on dead or decaying plant material and the fungus growing on them; centipedes, though, are predators. Millipedes tend to move slowly, while centipedes are fast, enabling them to be more effective at capturing prey. Centipedes may prey upon insects, slugs, worms, and sowbugs. As predators, centipedes are capable of inflicting painful bites. A pair of sharp fangs located behind the head on the first segment are used to seize prey and inject a venom. In contrast, plant-eating millipedes have neither speed, jaws, nor stingers with which to defend themselves. Instead, when threatened, millipedes curl up into a spiral and release a foul-smelling substance. Millipedes are generally dark in color (although some are brightly marked), while centipedes are sometimes bright red.

Centipedes should not be handled directly by students. A centipede can be captured and placed in a plastic container that can be taped shut and then passed around for a closer look. Release the organism unharmed when you are finished studying it. Care should be taken after handling millipedes not to touch eyes or mouth and to wash hands immediately: While the millipedes' protective secretions are released in tiny quantities and are not known to be toxic to humans, the secretions of some millipedes can cause eye irritation.

Centipedes and Millipedes Inquiries

Students should not touch centipedes or millipedes. Use gloves or some instrument to handle centipedes, and wash your hands after handling millipedes.

Useful materials: hand lenses, plastic containers.

Comparing the Features of Centipedes and Millipedes

Collect centipedes and millipedes around your building. Place the animals you collect in separate plastic containers, taped shut, for students to view with a hand lens.

1. Compare and contrast the two organisms.
2. List all the features that you can observe that these organisms have in common, and all the features that are different.
3. Make a chart comparing such features as color, number of body segments, number of legs per segment, length of legs, antennae, body length and shape.
4. If you were a centipede running for Top Centipede, what key features would you use to let voters know that you weren't really a millipede?

Moving Around with Dozens of Legs

1. Describe the problems you might have in walking across the room if you suddenly found that you had 30 or 40 legs.
2. What are some ways your 30 or 40 legs would have to move for you to accomplish this task smoothly without tripping over your legs and falling down?
3. Is there more than one solution to this problem?
4. Watch some millipedes or centipedes as they move in a plastic container. Describe how these animals have solved the problem of using so many legs.

If you are really adventurous, take your class outside and have them stand single file. Then reach forward and place their hands on the waist of the next person. Instruct the line to move forward.

1. How does it work? What happens? Why is this difficult?
2. What happens if you vary the distance from the person in front of you?
3. What are some ways to solve this problem? Try them!
4. Can you (the class) imitate how centipedes and millipedes solve the problem?

Millipede Habitats and Food Preferences

You can attract millipedes and learn more about them by creating habitats. A good type of trap to use is this: a plastic container, with the lid punched full of holes, and with vegetable peelings from potatoes, carrots, or apples. Have your students number the containers, then place these around your school building above the ground in various locations: along the building, under bushes, in sun vs. under shade, in leaf litter, etc. (Other organisms will be attracted too.)

1. Make a chart to record how many millipedes you found in each container.
2. Which sites had more millipedes?
3. What kinds of peelings are most attractive to millipedes?
4. Did you find what appears to be different kinds of millipedes? If so, how are they different?
5. What other organisms do you often find associated with millipedes? How can you explain this?

Chapter 5: Insect Features

Insects are everywhere, so it's good to know one when you see one. This data sheet will help you tell whether a new animal is an insect or not. You can use it with up to three new animals.

Before you start, remember that insects have these key features:

1. 3 body parts (not including legs and wings)
2. 6 legs with joints
3. 2 antennae
4. Often, but not always, wings
5. Usually, but not always, a hard outer exoskeleton.

Data Sheet

Feature	Animal 1	Animal 2
Number of legs		
Number of body parts (*not legs or wings*)		
Size		
Are wings present? How many?		
Color		
Other interesting features?		
Is this an insect? Why or why not?		
Name of this animal (if you know)		

Data Sheet

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