1.4 Feeding Habits Investigations

Action Synopsis

Students design and carry out indoor or outdoor investigations to learn more about animals' feeding interactions.

Session 1		**40–80 minutes**
1. Read and discuss the story of Dr. Mary Price's research.		*linking to real world*
2. Brainstorm research questions and review a list of suggested questions.		*developing research questions*
3. Plan investigations.		*designing experiments*
Session 2		**1–1½ hours IN & OUTDOORS**
1. Discuss habitats.		*introducing new information*
2. Set up investigations.		*investigating*
Sessions 3 & 4		**40 minutes IN or OUTDOORS**
1. Take measurements, collect data, and refine investigation methods.		*investigating*
2. Record observations and ideas in journals.		*observing & recording*

Continued

3. Think about conclusions, and plan how to communicate methods and findings. — *processing findings*

Session 5 — **40 minutes**

1. Share results of investigations. — *communicating*
2. Discuss strengths and weaknesses of completed investigations. — *reflecting*

Desired Outcomes

Throughout the lesson, check that students:

✓ Are familiar with the procedures of scientific research.

✓ Are able to shape a question into a form that can be answered through research.

✓ Are able to make a general plan of action for a research project, and refine it during and after the investigation.

✓ Realize that investigations don't always lead to clear conclusions, and that claims need to be backed by evidence.

What You'll Need

Session 1

For the class:
- ❑ overhead transparency of "Kangaroo Rat and Pocket Mouse" (page 98)

For each group of 3–4 students:
- ❑ copy of handout listing possible research topics (see "Getting Ready")

Session 2

For each group of 3–4 students:

For indoor studies:
- ❑ copy of "Classroom Critter Care Chart" (pages105–106)
- ❑ copy of the *Who Eats What* guide (pages 355–382)
- ❑ habitat chamber (see "Classroom Critter Care Chart," pages105–106)
- ❑ spoon or trowel
- ❑ various animal foods (see "Suggested Investigation Descriptions," pages 99–104)

For outdoor studies:
- ❑ various tools and animal foods (see "Suggested Investigation Descriptions," pages 99–104)

Sessions 3 & 4

For each student:
- ❑ hand lens

Vocabulary

HABITAT - The place where an organism lives that provides all of its needs for survival.

HYPOTHESIS - A statement that can be tested. It often states an action as well as a predicted result (e.g., "If I do such-and-such, then such-and-such will happen").

Getting Ready

Session 1

- Read "Suggested Investigation Descriptions" (pages 99–104). Decide if you'll have students do indoor or outdoor studies. Prepare a handout that lists research topics, research questions, and/or possible methods. As you develop the handout, consider three levels of guidance you can provide, based on how much experience your students have had doing investigations:

Most Guided
Provide a research question and a possible method.

Research Question:
• How do two of the same kind of animal interact over a piece of food?
Possible Method:
• Put two sow bugs in a container with a particle of potato and watch how they interact.

Somewhat Guided
Provide research questions, let students come up with methods.

Possible Research Questions:
• Do earthworms prefer to eat newly fallen or partly decomposed leaves?
• Do different kinds of ants prefer different kinds of food?

Least Guided
Suggest a research topic, let students brainstorm questions and methods.

Possible Research Topics:
• Feeding behaviors
• Food choices
• Foraging abilities
• Amount of food consumed

Try the Least or Somewhat Guided approach to start, using information provided in the Possible Methods sections of the "Suggested Investigation Descriptions" only as a larder for students to raid if they are hungry for ideas. The suggested investigations are observational studies rather than controlled experiments, but each can be adapted to become a "fair test" if students have done lots of simple investigating in the past and are ready to learn this more elaborate form of scientific investigation.

- Familiarize yourself with the "Classroom Critter Care Chart" (pages 105–106). For information about where organisms listed in the chart live, refer to the *Who Eats What* guide (pages 355–382).
- To attract soil organisms and scavengers/decomposers, such as sow bugs and millipedes, to an area, place damp cardboard or newspaper outside several days before students' collection.
- An alternative to collecting organisms for indoor study is to order them from a biological supply catalog. A worm farm with bedding material and redworms is a very convenient, commercially available system for investigating earthworm feeding habits.
- Plan to use either the same student groups as before, or decide on new groupings.

Session 2

- Make logistical arrangements for going outside, either to collect organisms or to set up outdoor studies.

Action Narrative

Session 1

When we were outside you gathered evidence about what different animals eat. This week you'll set up your own studies to find out more about animals and their food. First I have a story to share about a scientist named Dr. Mary Price who also does research on animals and their food.

Read aloud the story on pages 95–97. Summarize by asking students to list the steps of Dr. Price's research.

Dr. Prices's Research Steps

She...

1) saw something that made her curious
2) read what other scientists had already found out about the topic
3) asked a question
4) developed hypotheses
5) did investigations and experiments in the field and laboratory
6) came up with new questions
7) did more experiments
8) wrote up her results and gave them to other scientists to review
9) made changes to her papers and published her findings

Scientists start their research by asking a question about something that interests them. Then they develop a HYPOTHESIS — a statement that can be tested. What animals did you see, or see signs of, whose feeding behaviors you'd like to know more about?

Have students refer to the observations, comments, and questions they recorded while outdoors. Make a list of their suggestions and questions on the board. Most likely their questions will be simple to start with, such as *What do centipedes eat?*

Once you have written a list of questions in students' own words, work through one example of how to make a question specific enough to guide research. Some examples of action-oriented questions are: *Does a centipede eat dead leaves? If I put a millipede in a container with a centipede, would the centipede eat it? How much food does a centipede eat in a day?*

Scientists spend a lot of time coming up with a question because this is the first step towards finding answers. I've made a list of topics and research questions that you can investigate, or you can investigate your own question. You'll have one week to do the investigations from start to finish.

Explain whether students should plan to conduct their investigations outdoors or indoors. Hand out and go over your list of research topics and/or questions with students, then break them into groups to choose one research question, or to refine one of their own questions. Help students who are writing their own questions to put them into a form that is helpful for doing research. Use the questions you've listed on the handout as models.

If you will be doing indoor studies, discourage students from writing questions about small vertebrates such as lizards and salamanders, since it is difficult to assure their comfort and survival in the classroom.

Now that each group has settled on a research question, discuss how you could answer it. Jot down the steps your group will take, and make a list of the materials you'll need.

Show students the materials you have on hand so they know what is readily available. Touch base with groups as they develop their plans.

Students can explain what they are thinking more easily by talking than writing, so help them bridge the gap between what they've said and what they've written if you want them to hand in formal plans. Or you might want to wait until the end of the experiment to have students hand in their methods. The best way for children of this age to figure out what they want to do is by doing it; their planning continues while they are experimenting. Planning doesn't need to be complete before students begin their investigations, but it does need to be a conscious part of their research process.

As students are planning, ask them questions such as:

How will the actions you've outlined help you answer your question?

What will you measure or observe to find your answer?

What will you know if (X) **happens? What will you know if** (Y) **happens?**

How will you keep track of what you are finding out?

It is often more fruitful to wait until students have begun their investigation to help them see weaknesses in their design, and to figure out ways to do things better. Although the planning phase is important, there is no need to prolong it until everyone's plan is perfect.

Review each group's materials list before the next session. Discuss with them which materials you have on hand and which they'll need to bring from home.

Session 2

Today you'll set up your investigations according to the plans you made.

Unless you've ordered organisms from a biological supply company, this phase will begin with a trip outdoors, either to collect organisms for indoor study or to set up outdoor investigations. Continue with the narrative below if you will be collecting organisms for indoor studies.

If you'll be doing outdoor studies, make sure that students have all of the materials they need, and then head outside to spend the rest of the period setting up the investigations.

What are some of the pros and cons of collecting organisms that we should consider?

Help students weigh the benefits of collecting organisms for their scientific knowledge, against the possible risks it could pose to the site and the organisms. They need to understand that, like scientists, they should justify any collecting by stating how it will help them create new knowledge.

How can we minimize our impact on the site as we collect?

Ideas for minimizing impact include collecting only a few organisms that are in abundance, and being careful not to trample or uproot vegetation.

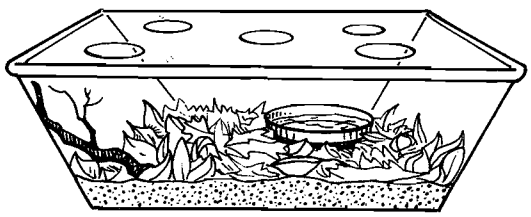
How can we do our best to assure the survival of the animals we collect, so that we can return them outdoors after our studies?

Students might suggest handling the animals gently and making sure they have food, water, and shelter.

Who knows what a HABITAT is?

A habitat is the place where something lives. An animal can meet all of its needs within its habitat — food, water, shelter, mating.

We can make habitat chambers to assure that the organisms we collect will survive once we get them back to the classroom.



Show students an empty habitat chamber and tell them that they should put in it materials from the habitat where they find their organism. Hand out a "Classroom Critter Care Chart" to each group. Encourage them to find the food the animal eats in the chart, or in the *Who Eats What* guide, so that they can include a food source in the chambers as well.

An alternative to having each group make its own habitat chamber is to bring in an entire micro-habitat such as a rotting log. This way you can be assured that everything living in the log has the food it needs. Keep it in a large plastic bag or a large aquarium covered with plastic wrap. Each group can find organisms within the log to observe. They can also observe the entire community within the log, considering what different residents eat, how long it will take them to use up their food, what are the different "housing sites," etc.

Before we go outside, each group needs a habitat chamber and a spoon or trowel for collecting.

Review outdoor study rules and safety guidelines if necessary (see page 69). Once outside, check on each group as they collect organisms, habitat materials, and food. If soil organisms such as sow bugs are plentiful, each group can include two or three of them in its chamber so each group member has an organism of his/her own to observe. Make sure that students don't collect anything that is not necessary, such as whole, living plants.

Back in the classroom, give students time to set up their feeding studies. Encourage them to refer to the "Classroom Critter Care Chart" for information on caring for the organisms.

Sessions 3 & 4

Check on your investigations, take measurements, and record your observations.

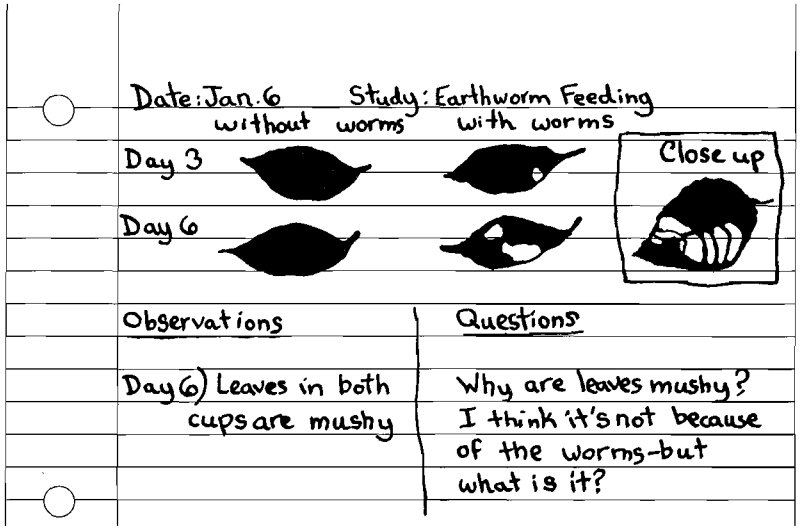
Either take the students outside to check on their investigations, or have them observe habitat chambers if they are doing indoor studies. They can continue to try different manipulations after they record the results of their first trials. Also, they might want to spend time refining the technical aspects of their experiments (e.g., *How can I see sow bugs eat when they scram from the light?*).

Facilitating Students' Investigating

Offering ideas. When students are working productively, it is best to wait to visit them until they have something to tell you, rather than interrupting them to check in. When they are having a problem, find out what ideas they already have about how to deal with it, then offer your suggestions as other possibilities to consider.

Questioning for reflection. You might want to use questions to call students' attention to potential improvements they could make in their methods. For instance, asking *Is there another way besides just looking at the leaf that you could tell how much of it the caterpillar ate since the last time you looked?* will help them consider the benefits of objective measurement over subjective observation.

Supporting notetaking. Encourage students to use their journals to write and draw what they see, measure, and think. Not everyone's notetaking schemes will or need to be the same. Students should think of their notes as information for themselves, rather than something they are producing for a grade from you. When you look over their notes with them, ask what they want to remember and help them find language or a format that expresses their thoughts and observations clearly.



Encouraging sketching. Sketching is a good way to sharpen observation skills and document findings. When you suggest that students make sketches of their organisms and food sources, help them establish a purpose for the sketches — to help them observe details, to make a record for future comparisons, to share with other people when discussing results, etc.

During our next class you'll be sharing your results with one another, so work with your group members to summarize your findings.

Have students wrap up their investigations in time to think about conclusions. Most likely they will not have enough data to answer their research questions, so they could plan to share something new they discovered, rather than conclusions. They should also think about the best way to communicate their research methods and findings. This could involve showing charts of data and drawings, as well as giving a verbal summary. Encourage students to refer to their notes as the source of information for their reports.

Session 5

Scientists often touch base with one another to talk about their latest findings. We'll take some time now for each group to tell the others what you did and found out.

Encourage students to offer positive comments on one another's work and ideas, and to compare their findings to those of their classmates. At this stage in students' development as

scientists, it is most important that they realize that scientists create knowledge by conducting and reflecting on research, just as they are doing. Getting definitive answers about animals' eating habits is of secondary importance.

Ask each group how they could improve their original plan if they were to continue their investigations. You might need to point out specific aspects of an investigation with questions such as *In how many different locations did you put the bait?* to call their attention to things that could be improved.

Thinking Like a Scientist

Some points about research and scientific thinking habits that you might want to stress through discussion are:

Science involves a lot of trial and error. Even if students have no results because "nothing worked" as they planned, they've learned a lot about the "how to" aspect of science. Discussing what methods worked, what didn't, and what could be done differently is an important part of doing science.

A conclusion is strong only to the extent that it is supported by evidence. The stronger the evidence, and the greater the number of people who find it convincing, the stronger the conclusion. A big part of science is convincing other people that your claims are justified by your evidence. When many different scientists finally agree about something, they become more sure that what they are saying is correct.

There can be more than one way to interpret a result. A lot of good ideas can emerge when different people point out other ways to interpret an observation. For instance, if a slug ate lettuce but not spinach, it could mean that: 1) it preferred the lettuce; 2) it had no preference, but just ate what it encountered first; or 3) it preferred spinach, but never found it. Becoming aware of alternative explanations spurs a scientist to refine an experimental design to try to rule out competing explanations.

Be sure to have students return any organisms they collected to the location where they were found.

Ongoing Assessment

Student Reflections

Have students send a C-Mail message or record thoughts in their journals. Optional writing prompts include:

What would be the absolute best way to figure out what an animal eats? What equipment would I need?

What new investigations of animals and their food could I do?

Teacher Reflections

- ❑ Were students able to make their general questions more specific for research purposes?
- ❑ Did they continue to refine their methods as they went along, and could they reflect on the strengths and weaknesses of their completed investigations?
- ❑ Did they keep helpful records of their observations and thoughts?
- ❑ Did they communicate their results clearly to their peers, and give feedback to one another?
- ❑ Did they realize when they did and didn't have enough evidence to draw conclusions?

Extensions

Natural History Stories. Help students prepare to write stories about animals' lifestyles by reading a variety of nature writing (see "Resource List," pages 52–55). Students might enjoy reading animal fables and folk tales, and talking about where, how, and why the truth was stretched. Ask each student to choose an animal and do background research to find out more about its interactions and life cycle. Use a writing workshop method (listing ideas, sharing thoughts, writing drafts, sharing and peer review, editing and revising) to create original stories. These can be modeled after the accurate natural history accounts of nature writers, or in alternative formats such as: an animal's diary entries; a radio news or sportscast; a newspaper article; a chapter from a biography; or cartoon drawings and captions. Share finished products and talk about which parts of each story are fact and which are fiction.

Habitat Resource Maps. Challenge students to depict the study site or habitat chamber from the point of view of one animal. Draw the important places to that animal, such as where it gets food, water, and shelter. Map out where the animal goes and what it does in a day or a week.

Scoping out Seed Eaters: The Work of Ecologist Dr. Mary Price

Dr. Mary Price, an ecologist and professor at the University of California, has been studying the feeding habits of pocket mice and kangaroo rats in the desert of Arizona for the past twenty years. These rodents eat seeds, feeding mainly at night. They have a pouch outside their cheeks where they hold the seeds they collect until they stash them or eat them.

When Dr. Price was in graduate school, she helped some other scientists who were studying desert rodents. They put bait in cages called live traps. These traps have a door that closes behind the animal when it goes in to eat the bait, so it is caught alive and unharmed in the cage. The scientists caught one kind of kangaroo rat called Merriam's kangaroo rat, and three kinds of pocket mice: Arizona pocket mouse, desert pocket mouse and Bailey pocket mouse.

Pause to show "Kangaroo Rat and Pocket Mouse" overhead.

This made Dr. Price very curious. She wondered how four different species of rodents that eat seeds could all survive in the same place, especially since seeds in the desert are in short supply. If more than one species eats the same kind of food, they often have to compete for food. If this happens, one species can win out, and the other species isn't able to live in the same place because it can't get enough food.

Imagine if you moved to a forest with only a few acorns, and had to gather enough of them to eat before the squirrels beat you to it. Who would be better and faster at getting acorns, you or the squirrels? Probably you would have to find something else to eat that another animal isn't already specialized at eating, or leave the forest to look somewhere else for food.

Dr. Price read papers that other scientists had written about animals competing for food, then formed her own research question: Do the kangaroo rat and the three kinds of pocket mice use seeds in a way that avoids having to compete for them?

She had two ideas, called HYPOTHESES, about how these different animals could survive in the same place even though they all eat seeds:

1. Maybe the different animals specialize in eating different kinds of seeds. For example, if some of the trees in the forest where you lived grew pizza-flavored nuts that only humans liked to eat, you could live on pizza nuts while the squirrels ate the acorns.

2. Maybe the animals stay far enough apart so that they don't compete for the same seeds. For instance, if you stayed in one part of the woods and the squirrels stayed in another part, you might be able to get enough acorns to eat without the squirrels getting them before you.

First Dr. Price tested her idea that the four different rodents preferred to eat different kinds of seeds. Can you think of an experiment to test this idea?

Pause for discussion.

Dr. Price put the different rodents in the lab and gave them a buffet of lots of different kinds of seeds — big and little seeds, oily and dry seeds, high and low protein seeds — and let the animals eat what they wanted. She counted how many of each kind of seed each animal ate. What do you think happened?

Pause for discussion.

Dr. Price found that the kangaroo rat and all three kinds of pocket mice preferred the same seeds — those that had the most energy and water in them! So this disproved her first hypothesis that the animals preferred to eat different kinds of seeds.

Next Dr. Price tested her second hypothesis — that the animals ate seeds in different areas of the desert. How do you think she tested this idea?

Pause for discussion.

Dr. Price put over 400 live traps with the same kinds of seeds in them, in two different parts of the desert: in open places and under shrubs. She had lots of assistants help her check the traps in the mornings before the sun got too hot for the animals inside them. What do you think she found when they checked the traps each morning?

Pause for discussion.

Dr. Price found that the kangaroo rats were in the cages out in the open. The pocket mice were all in cages under shrubs, but in different types of shrubby areas: the Arizona pocket mice were under small shrubs; the desert pocket mice were under large shrubs in sandy soil; and the Bailey pocket mice were under large shrubs in pebbly soil.

Now Dr. Price had evidence that the rodents avoided competing for food by eating seeds in different places. So she set up studies in her lab to gather more data.

She timed how long it took each rodent to find and eat seeds covered by sand, by pebbles, and by sticks and leaves. She also measured how much energy they lost and gained. She discovered that the kangaroo rats weren't good at finding seeds under sticks and leaves. But in sandy, open areas, the rats were faster at getting seeds than any of the three kinds of pocket mice. Dr. Price was well on her way to unraveling the mystery of how and why all these rodents could all eat seeds, but still live together in the same region.

Back in the desert, Dr. Price noticed another interesting thing. On nights when the moon was full, she always caught kangaroo rats under shrubs, even though they don't normally feed there. Can you imagine why?

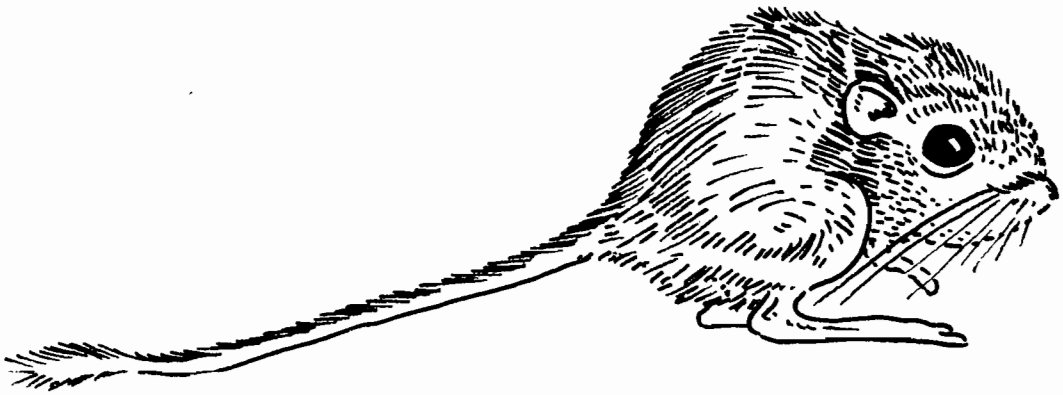
Pause for discussion.

The desert rats and mice don't only have to worry about finding food, they have to make sure they don't *become* food for another animal! Dr. Price is now studying the rodents' risks of getting eaten. She is using techniques such as wearing night vision glasses to watch a Great Horned Owl hunt for the rodents in a huge outdoor cage.

When her experiments are finished, Dr. Price writes up her results. Other scientists review her papers, make suggestions for changes, and decide if they are good enough to be published. After she makes revisions, she publishes the papers so people can learn what she found out.

Dr. Price is still studying desert rodents and their food resources. She has seen how one big question she asked twenty years ago has led to many smaller questions. She hopes that what she is learning will help people understand and protect the natural conditions that allow many species to live in one area, and prevent extinctions. Improving conservation efforts is one long-term goal of Dr. Price's many late nights and early mornings under the desert moon and sun.

Kangaroo Rat and Pocket Mouse



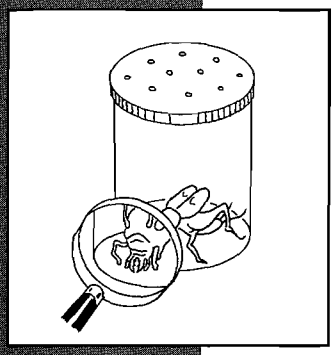
Kangaroo Rat

Pocket Mouse

Suggested Investigation Descriptions

Indoor Studies

Feeding Behaviors



The mouthparts and appendages of small animals are often not readily visible, so close observation is required to figure out how an animal eats its food.

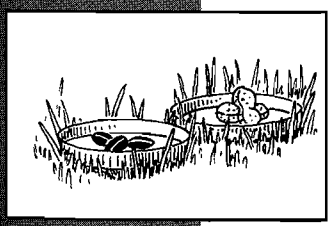
Research Questions:

- Does the animal eat only some parts of its food?
- Does it eat its food in a systematic way (e.g., start at the edges and work in)?
- How does it get its food?
- What body parts and behaviors help it get food?

Possible Methods:

- Design different ways to view animals while they eat (e.g., a magnified feeding chamber, a narrow, double-walled container that keeps the animals near the edge, different kinds of lights or shades to see animals that shy away from light). Make careful observations.

Food Choices



Giving animals an assortment of foods reveals which foods they prefer and whether or not they will eat a variety of foods.

Research Questions:

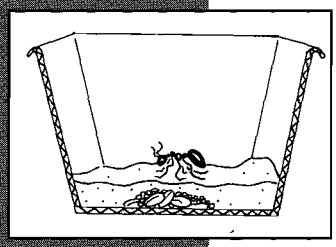
- Does the animal prefer to eat (X) or (Y)?
- Does the animal eat one type of food more quickly or more slowly than another food?
- How many different kinds of food does the animal eat?

Possible Methods:

- Give earthworms (redworms purchased from a biological supply company will survive in classroom conditions better than local earthworms) and other decomposers: 1) a wet and dry sample of one type of leaf; 2) a green leaf, a newly fallen leaf, and a partly decomposed leaf, all of the same species; or 3) different species of newly fallen leaves. Trace leaf edges and interior holes on graph paper before giving them to the animals. Then retrace the leaves at different points after exposing them to the animals.
- Give earthworms identical size squares of fallen leaves from plants in a polluted and a less polluted environment (e.g., plants near and far from a busy road; or plants growing in the city and the country).

Make sure the leaves are from the same kind of plant. Either put the leaf squares on top of the worm's soil to see which disappear, or figure out a way to retrieve the leaves for periodic measurements (e.g., staple them to a pot marker; or put them in a mesh onion bag that can be pulled out of the soil).

Foraging Abilities



Foraging studies relate to Dr. Price's research on how desert rodents specialize in gathering seeds in open areas or under shrubs.

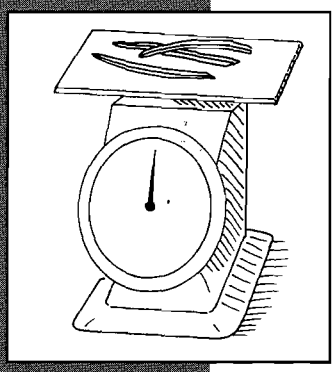
Research Questions:

- Can the animal find its food when the food is:
  - hidden under something?
  - mixed in with sand, pebbles, soil, or vermiculite?
  - artificially scented?
  - made into different sizes?
  - made a different color?

Possible Methods:

- Confirm that an animal eats a certain food by watching it eat or by measuring the food's disappearance. Then take a known amount of the food and vary its location (e.g., put it under something), its substrate (e.g., mix it with various materials), its scent, its size, or its color. See how long it takes the animal to find and eat the food. Compare amounts of altered and unaltered food it eats.

Amount of Food Consumed



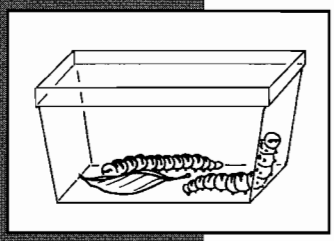
Animals not only have to get the right kind of food where they live, they also need to get enough food to survive. Weighing foods and animals will reveal how much food animals need to stay their same weight or grow bigger.

Research Questions:

- How much does the animal eat in a day or week?
- Does how much an animal eats relate to how big it is?
- Does the animal gain and lose weight as it eats food and releases wastes?

Possible Methods:

- Give a known weight of food to an animal, then weigh the leftover food daily to determine how much the animal eats per day.
- Measure and weigh different individuals of the same species and different species of animals, and compare their body sizes to how much food they consume.
- Weigh the animals on a regular schedule to determine if their body weight fluctuates up and down, steadily increases, or stays the same. Compare changes in body weight to the weight of the food consumed.



Competition for Food

What happens when there is not enough food to go around? Temporarily putting several animals together with limited food will reveal whether they behave differently than they do when they are alone among plenty of food.

Research Questions:

- How do two of the same kind of animal interact over one piece of food?
- How do two different kinds of animals that eat the same food interact?

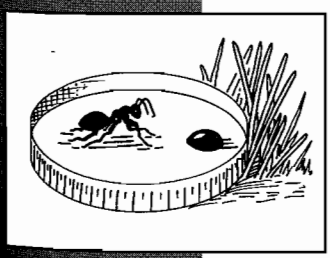
Possible Methods:

- Put several of the same kind of animals (e.g., sow bugs) in a container with a very small amount of food (e.g., a particle of potato) and watch how they interact.
- Put two different animals (e.g., a cricket and a grasshopper) in a container with a small amount of food (e.g., a dead mosquito) and watch how they interact.

Outdoor Studies

Caution!

- Use small quantities of baits so that animals don't become dependent on the food you're providing, and so you don't attract foreign animals into the site.
- Never feed any animal directly by hand.
- Never approach or touch an animal.



Foods for Ants

Ants are just about everywhere. They'll come to food within 15 minutes to an hour in warm weather when they are active. This study will work well even in an urban setting or right outside the school building, if you can't get back to your study site.

Caution!

- Keep your distance from red ants and fire ants to avoid getting stung!

Research Questions:

- Do different kinds of ants prefer different foods?
- Do ants that live in different habitats eat different things?
- Do ants differ in how they handle their food (e.g., suck out liquids vs. carry away chunks)?

Possible Methods:

- Put tiny amounts (1/8 tsp.) of foods such as peanut butter, honey, tiny grains or seeds, tuna fish, lettuce, diluted jelly, or cake crumbs on a laminated index card or jar lid, and note what kinds of ants are attracted to which foods, how quickly different foods disappear, etc. Try covering a set of bait stations (e.g., with an inverted paper cup with small holes cut into its rim and anchored with a rock on top) to exclude anything larger than an ant from the baits.
- Put the ant food buffet in different habitats to see if the types of ants attracted to the foods differ according to the habitat.
- Watch ants at the bait stations (using a hand lens, if possible) to see how different types of ants handle their food. Try to follow them to see where they take any food they carry away.

Plant-Eating Insects

These studies extend the work students did during their previous field trips by requiring more systematic data collection to discover patterns in plant/insect feeding relationships.

Research Questions:

- Do different kinds of plants have different kinds of insects feeding on them?
- Do different insects eat different parts of plants (e.g., fruits, flowers, limbs, leaves, bark, buds, roots)?
- Which insects make which kinds of marks on leaves (e.g., holes, chewed edges, tunnels)?
- Which plants have the greatest number of the same kind of insect?
- Which plants have the most different kinds of insects?
- Are some insects eating the insects that are eating the plants?
- On which parts of plants do camouflaged insects feed?

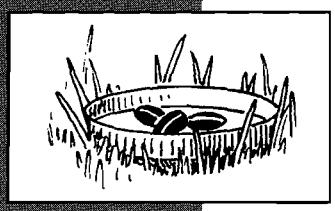
Possible Methods:

- Survey the insect damage to leaves (e.g., holes, tunnels, scrapes). Compare the types of damage on different leaf types. Note whether some leaves have more than one type of damage.
- Look carefully for insects feeding on leaves. In the tips of leaf buds, in curled leaves, and along the veins of leaves are good places to look. Keep track of what insects are found on different parts of leaves on the same plant, on different plants, which insects are camouflaged, etc.

- Spread a white cloth on the ground below tree branches and shrubs. Gently but firmly shake branches to see what insects fall out. Note the types of insects associated with each plant type.
- Put different kinds of fruit collected from plants in the bottom of jars, then put a funnel into the jar. See what insects fly or crawl down the funnel to the fruit. Most will be trapped in the jar until you lift the funnel out.
- Soak strips of cotton in different sweet substances (e.g., plain or scented sugar water, molasses, honey, fruit juice). Hang strips in a variety of locations to see what insects visit them.

Seed Stations

By covering or mixing seeds with different materials, students can find out physical limitations on local animals' abilities or inclinations to get food.

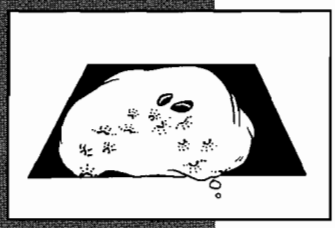


Research Questions:

- Do small or large seeds disappear more quickly in the open and under cover?
- Does the size and position of entry holes into a container with seeds inside determine how quickly the seeds disappear?
- Do seeds mixed with different materials disappear as fast as seeds under a box or out in the open?

Possible Methods:

- Put large and small seeds (e.g., millet, bulgur, shelled and unshelled sunflower seeds, grass seed heads, shelled and unshelled peanuts) in the open, under a shrub, and under a box with an entry hole. Check stations 2–6 days after set-up. Record the numbers and kinds of seeds in each location before and after animals have had time to visit. Look for clues, such as droppings or tracks, to determine whether mammals or birds are taking the seeds.
- Put equal numbers of the same kinds of seed in containers with different entry holes (e.g., big or small; covered by a flap of fabric or open; on the top, bottom, or side of containers) to compare how quickly the seeds disappear.
- Put a known number of seeds in piles of different materials (e.g., leaves, twigs, vermiculite, pebbles) to see how many disappear from each how quickly. Compare this with the disappearance of the same seeds when they're not buried.



Tracking Stations

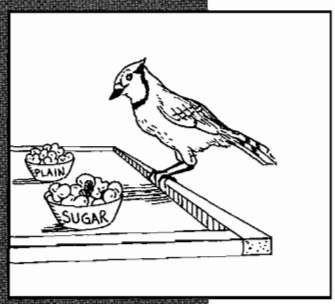
Setting out baits on a surface that will show tracks reveals what animals eat different types and sizes of foods, and how this varies in different habitats.

Research Questions:

- Do different animals eat different baits?
- Do different sizes of the same baits attract different animals?
- Do the same baits in different locations attract different animals?

Possible Methods:

- Make a surface where animal tracks will show by covering a large index card or square of oak tag with aluminum foil. Spread mineral oil on the foil then sprinkle it with talcum powder, or coat the foil with a thin layer of white vegetable shortening. (Alternative tracking substrates for an adult to make: hold a candle under a foil-coated card to get a black coating of carbon on the foil; spread a thin layer of lamp oil on a cookie sheet, then light it and let it burn off to leave a layer of carbon.)
- Put tiny amounts (1/8 tsp.) of baits (e.g., cat food, peanut butter, sugar, lettuce, liver, cheese, hot dogs, raisins, seeds, berries, nuts) in the center of the tracking cards and set them outside. Come back later and try to identify the tracks to see what visited each kind of bait (e.g., ants, roaches, mice).
- Use larger amounts of the baits to see if they are taken by animals that did not visit smaller amounts of the same baits.
- Put tracking cards with the same baits in different habitats to see if visitors vary according to habitat.



Foods for Birds

This investigation will work best at an established bird feeder station, such as on a window ledge or pole outside the classroom, or in a park where pigeons gather.

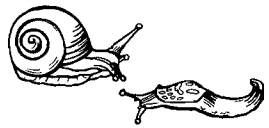
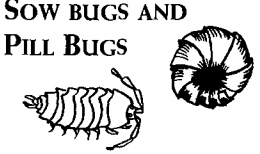
Research Questions:

- Do different seed-eating birds prefer different kinds of seeds?
- Do birds choose among the same kinds of seeds that have been colored differently?
- Do birds react to flavorings (e.g., salt, sugar, vanilla or mint extract, garlic) in seeds, bread, suet, or popcorn?

Possible Methods:

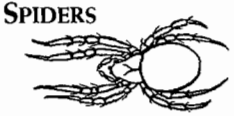
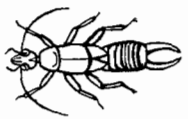
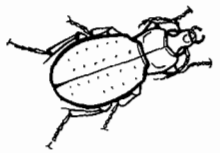
- Feed pigeons in a park or the schoolyard, or other birds at a feeder, different kinds, shapes, artificially colored, or artificially flavored foods to discover their preferences.

Classroom Critter Care Chart — Herbivores and Scavengers *

Organism	Habitat Chamber	Food	Classroom Care
Snails and Slugs 	Large, wide-mouthed glass jar or old aquarium with ventilated cover to maintain humidity and prevent escape. Add 2–3 cm of moist soil for burrowing, plants/branches for climbing, and a damp sponge.	Lettuce, carrots, apple, celery, or oats. Add some crushed chalk to provide calcium for their shells. Replace as needed or as food begins to rot. (Snails may go 2–3 days without eating.) *Wild Food Source: dead leaves*	• Habitat must be kept damp at all times. A sign of dryness is when snails crawl into shells for long periods. • Clean slug habitat often to prevent tiny white mites. • Roll slugs on paper towel to clean off mites.
Millipedes 	Clear terrarium with ventilated lid or plastic salad take-out container with holes punched in lid. Add 2–3 cm of damp, forest, desert, or potting soil. Add plenty of bark and leaf litter from area where millipede was collected.	Plant material from forest or desert floor. Replace as needed. *Wild Food Source: dead leaves, cacti, and pine needles*	• Sprinkle soil with water to make sure it is damp at all times, but not saturated.
Sow bugs and Pill Bugs 	Clear terrarium with ventilated lid or plastic salad take-out container with holes punched in lid. Put 2–3 cm of damp woods soil, or potting soil on the bottom. Add decaying bark and leaf litter. Provide a darkened area by partially covering soil with cardboard placed on a few pebbles.	Slice of raw potato. Alternate with a raw carrot, lettuce, unsweetened cereal, or ripe fruit. Replace as needed or as food rots. *Wild Food Source: dead leaves and wood*	• Sprinkle soil with water to make sure it is damp at all times, but not saturated.
Earthworms 	Styrofoam cooler or bucket with ventilated lid and 10 cm of bedding made of garden soil mixed with leaf litter, peat, sawdust, or cow manure.	Grass, dried leaves, lettuce, apple, potato, cornmeal, oatmeal, or coffee grounds. Chop all plants and fruits into ant-sized pieces. Replace as needed. *Wild Food Source: dead leaves and grass*	• Keep bedding moist (not wet) at all times with spray bottle and cover with a layer of damp newspaper. • Keep container in a cool spot in the classroom. • Replace bedding when it becomes blackish.
Ants 	Clear plastic 2-liter soda bottle cut off at the neck, with a 1-liter soda bottle (cut 5 cm shorter than 2-liter bottle) set inside the larger bottle. Put a small piece of clay on the bottom of 1-liter bottle to keep it in place. Secure a piece of cardboard on top of the 1-liter bottle as a platform for food and a damp sponge. Fill the space in between the bottles with loose, sandy soil.	Bread, cracker crumbs, or bits of fruit and meat. Replace as needed. Remove rotting food. *Wild Food Source: seeds, fungus, and liquid from aphids (Some eat insects.)*	• Do not overfeed. • Cover sides with a dark paper or cloth to provide darkness. • Use artificial light to observe ants. • Dampen sponge when dry.
Crickets 	Large wide-mouthed jar or terrarium with ventilated lid. Put 2–4 cm of sand on the bottom. Place a few layers of water-soaked paper towels in a saucer or place a piece of damp sponge in the jar.	Slices of apple, carrot, potato, celery, or lettuce along with dry dog food. Replace as needed or as food begins to rot. *Wild Food Source: roots, seeds, and berries*	• Keep crickets dry and habitat moist. • Keep at 30–35 degrees Celsius. • Remove accumulated droppings.
Caterpillars 	Large, wide-mouthed glass jar with ventilated lid. Put 5 cm of moist soil on the bottom. Provide habitat with a large piece of bark and a twig leaning against the side of the jar for pupating substrates.	Provide a continuous supply of the plant you found the caterpillar feeding on. Put the plant's roots in a container of water covered with cardboard to keep caterpillar from falling in. *Note: Only keep those caterpillars that you found feeding on a plant.*	• Replace plant at first sign of wilting. • Keep container in a cool spot in the classroom.

** Note: All organisms should be released where captured after classroom study is over.*

Classroom Critter Care Chart — Carnivores *

Organism	Habitat Chamber	Food	Classroom Care
Ladybug beetles 	Clear container with ventilated lid that is large enough for beetles to fly around in comfortably.	Requires live food: aphids. Set a plant stem covered with aphids in a small container of water and place it in the larger container with beetles.	• Replace with similar plant stem every 3 days. • Change the water when you replace the plant that the aphids are eating.
Spiders 	Large, wide-mouthed glass jar with ventilated lid. Put 5 cm of damp soil on the bottom. Prop some twigs up in the jar. *Note: Spiders must be kept separate as they will prey on one another.*	Requires live food: houseflies, fruitflies, sow bugs, mealworms, or crickets. Needs to consume something its own size every 2 weeks.	• When soil begins to appear dry, moisten slightly with a water spray bottle.
Centipedes 	Clear terrarium with ventilated lid or plastic salad take-out container with holes punched in lid. Put 2–3 cm of damp, rich, woods soil or potting soil on the bottom. Add decaying bark and leaf litter. *Note: Centipedes must be kept separate as they will prey on one another.*	Requires live food: sow bugs. Set a slice of potato in the container for the sow bugs. Replace rotting food.	• Sprinkle soil with water to make sure it is damp at all times, but not saturated.
Earwigs 	Large, wide-mouthed glass jar with ventilated lid or plastic salad take-out container with holes punched in lid. Add 5 cm of damp soil, a few stones, plants, and a damp sponge.	Combined diet of bran cereal sweetened with molasses, plant leaves, apples, mealworms, and aphids. Replace rotting food. *Wild Food Source: rotting fruits, aphids, and fleas*	• Keep habitat moist with frequent soil spraying.
Tiger and Ground Beetles 	Clear container with ventilated lid or plastic salad take-out container with holes punched in lid. Put 5 cm of sandy soil on the bottom. Place a jar lid filled with water in a corner of the container. Ground beetles require leaf litter on the soil.	Requires live food: ants, caterpillars, earthworms, and slugs. Replace as needed.	• Refill water as needed.

** Note: All organisms should be released where captured after classroom study is over.*