

exploring

TREES & PONDS



WINTER

Observing Larger Pond Organisms

exploring

TREES & PONDS



WINTER PONDS

Activities

Written by Bernie Zubrowski



Education Development Center, Inc.

Acknowledgments

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Introduction to *Exploring Trees and Ponds*

Exploring Trees and Ponds offers a special opportunity to engage youth in exploring the natural world. The natural changes in nature over time—whether shown in plants and trees, or in pond creatures such as tadpoles and dragonfly larvae—excite middle school youth and make them curious to learn more. The activities in *Exploring Trees and Ponds* are designed to build on this fascination and to give youth, ages 10–14, the opportunity to become more closely connected to the natural world.

Special attention is given to promoting drawing and the use of digital cameras. Research in recent years suggests that the use of visual representations are an essential part of learning. Digital cameras provide an engaging way of recording observations and often provide a starting point for generating and answering research questions.

The activities in *Exploring Trees and Ponds* are meant to be models for carrying out investigations with youth, with the goal of ultimately motivating them to generate their own questions and design their own investigations. When the activities are carried out in an intentional manner with attention to scientific thinking, different scientific process skills can be introduced and fostered throughout the whole project.

The activities can be used as the experiential base for more in-depth investigations of environmental problems or the more formal study of biological principles. For example, some “big ideas” concepts, such as form and function, can be introduced during the fall tree explorations and returned to during the exploration of pond organisms and/or spring trees. More specific science concepts, such as cells and photosynthesis, can also be introduced using these activities.

Preparation

We recommend that you read through all of the activities in this guide before you begin with the youth in your program. There are many steps that can and should be done ahead of the activities to make the experience easier on you and more valuable for the youth, ranging from making sure you have access to the needed materials, especially when those materials need to be gathered from a location outside.

Youth Journals

An integral part of any kind of nature study project should be journal keeping. In their journals, youth can record their discoveries, observations, experiments, and conclusions. This practice is essential if they are going to be systematic in their observations and experiments and allows them to make sense of their experiences in a meaningful manner. It will add depth to the overall project, giving them a sense that they are participating in activities that are significant to their own interests. It can also help them practice skills and habits of mind that will be useful in their school work.

Youth can use inexpensive spiral-bound notebooks as their journals. Paper journals allow youth to save tangible items from their explorations (for instance, flattened leaves) by securing them to the pages of the notebook. There are several methods to do this. The simplest (and least expensive) way is to put a leaf between two pieces of newspaper and press them under (or in) a book. You can add another book over time to increase the weight and make the leaves even flatter. Once the leaves or flowers are dry, youth can use a glue stick to attach them to a notebook page. You may want to research other ways to do this online to share with the youth in your program.

Alternatively, if your program site has computer or tablet access, or if your youth have personal cell phones, you may choose to have them save their journals online to free notebook apps (e.g., Evernote). Some software allow for photos to be uploaded as well.

Alternatives to Field Trips

This program suggests a number of trips to forests, fields, ponds, and even just outside of your program site. We understand that sometimes this number of outings is simply not possible for everyone in every location, so we have included a Photo Resources Gallery at the end of this activity guide and on the *Exploring Trees and Ponds* website (<http://treesandponds.edc.org>) that you can use with your youth should you be unable to complete the outside portions of activities.

Calendar of Activities (extended learning experiences)

The full project (using all three activity guide) can be carried out over a nine-month period, divided into fall, winter, and spring. Although the seasons have been separated into distinct guides, many of the activities contain extended learning experiences that may extend past the end of the formal season. The calendar below provides one example of how you might carry out the entire program from September through May. We hope you enjoy these explorations! We hope you enjoy these explorations!

September – October (Fall)	November – March (Winter)	April – May (Spring)
Investigations		
<ul style="list-style-type: none"> Field trips to forest Local walks Observe leaves (chromatography, composting) Seedlings Seeds 	<ul style="list-style-type: none"> Collect pond organisms Inventory samples Study individual organisms View videos of macro-invertebrates View videos and observe protozoa Experiment with daphnia 	<ul style="list-style-type: none"> Observe bud changes Local walks Grow plants from seeds Observe flowers Observe leaves and substructures Field trips to forest
Long-Term Observations		
<ul style="list-style-type: none"> Adopt a tree → Tree seedlings → 	<ul style="list-style-type: none"> Observe macro-invertebrates → 	
Scientific Process Skills		
<ul style="list-style-type: none"> Observation → Experimentation → Recording data → Communication → 		
Concepts		
<ul style="list-style-type: none"> Form and Function → <p>During the fall (September–October), youth take part in field trips and indoor activities focusing on trees. They can start various kinds of investigations that will carry through the whole project. These might include observing changes in outdoors trees and growing tree seedlings indoors.</p>	<ul style="list-style-type: none"> Cells Energy/flow <p>During the winter (November–March), the focus is on investigating pond organism but can also include some long-term observations of experiments that were set up in the fall related to trees. During the pond activities, youth set up containers with different organisms. They can study the changes in these organisms over several months.</p>	<ul style="list-style-type: none"> Photosynthesis Transpiration <p>During the spring (April–May), youth return to the outdoors to observe the changing trees. They can also continue working with pond organisms they have collected over the winter.</p>

Introduction to Observing Pond Creatures

The pond-investigation activities summarized below were originally developed for implementation in a school context, but they can be adapted for the out-of-school situation. These activities provide a good introduction to pond organisms and will engage youth in a productive way. The activities can be taught in sequence or can stand alone.

Obtaining and Sustaining Samples of Pond Water and Organisms

If youth are carrying out extended observations of pond organisms, visiting a pond and collecting samples can be a very exciting introduction to this endeavor. It is highly recommended that this be a way of introducing the year-long project. A pond visit provides a concrete context by which you can anchor all the succeeding activities. This activity is best done in warm weather. You must carefully prepare to make the visit both productive and safe. You need to check with local authorities as to whether collecting any organisms is permitted.

However, if you do not have access to a pond or other freshwater source OR if the winter weather does not allow you to collect local water, here are some alternatives:

- Plan ahead by collecting pond water in the fall—enough for all the activities you plan to carry out—and sustain it (see below) until it is needed. You can also freeze the water and thaw it before using it in activities.
- Order some organisms from a science supply company (e.g., Carolina Biological Supply, Connecticut Valley, Science Kit Boreal). They have live organisms as well as dry mixtures that will produce a variety of microorganisms when mixed with water. These mixes and materials need to be added to room-temperature pond water or spring water (not tap or distilled). You will need to order these microorganisms a week or so before carrying out the activity, allowing some time for dry mixtures to produce organisms in time for the activity.

NOTE: Tap water and distilled may contain chlorine or chloramines that are harmful and will kill your microorganisms. When using spring water, read the label carefully and make sure that there are no additional additives for taste and that the source is not a municipal water supply. The source should be a natural spring water source.

Store the organisms in containers (e.g., 2-liter soda bottles with their tops cut off, small tanks sold by science supply companies, or other containers at least 1 liter in volume) with some pond or spring water and some plants. Place them in a location where temperatures do not fluctuate greatly—preferably near a window where sunlight comes through for a few hours a day.

To ensure that methane, other gases, and bacteria don't build up, which would kill off some organisms and produce a noxious odor, aerate the water by placing aerator stones with tubing in each container. Connect each piece of tubing to an aquarium pump or use a connector that allows all tubing to be connected to the same pump. Make sure that your containers are constantly being aerated.

Periodically check to make sure that everything in the pond-water container hasn't died because of an introduced chemical or some kind of growth that has choked off key species.

Additional Projects to Augment the *Winter Ponds Activities*:

Observations of Videos of Pond Organisms

There are many available videos of pond organisms. Viewing a video on a computer allows youth to closely study the organisms' behavior. Youth can make comparisons of the behavior on the videos to the living organisms they are keeping in their containers. Discussion can go deeper into such concepts as form and function and habitats.

Making Videos of Pond Organisms

If you have the right kind of equipment (a microscope with video attachment), youth can make their own videos of the pond organisms they have collected. These can be studied as described above.

Experiments with Pond Organisms

Having made a close study of different organisms, youth can generate questions about these organisms and set up different kinds of experiments for further study. *Daphnia* is a good organism to study because it is visible to the eye, is relatively easy to maintain, and has a quickly changing population. Youth can set up containers with different conditions and see what happens over a period of several weeks.

Classifying Pond Organisms

To provide a context for discussing how biologists classify organisms, give the youth illustrations of different kinds of pond organisms and have them group the illustrations in different ways.

Design an Organism

Give youth some simple materials (clay, wire, pipe cleaners) and challenge them to design a pond organism. Have them specify its habitat, its way of obtaining food, and how it reproduces. This project can be a way of assessing what youth have gained from their participation in the previous activities.

Visiting and Exploring a Pond

Rationale

If youth are going to carry out extended observations of pond organisms, it is useful and motivating for them to first visit a pond during early fall or spring when organisms are easily collected. This visit will help provide a mental picture of the home of these organisms. It can also be an exciting adventure for youth, particularly if they have never collected organisms from a pond. Using simple equipment, they can discover where different organisms are found and collect multiple samples to bring back to the program site for a long-term exploration studying organisms in-depth. The goal of this activity is to have youth witness the diversity that can be found in one kind of ecosystem.

NOTE: The visit need not be to a pond but could be to a lake, wetland, or stream, as long as it is a body of fresh water. If you take youth somewhere other than a pond, you need to make sure that the location has a rich supply of organisms. Scout out these environments before the trip to determine where there is dense vegetation in the water and muddy bottoms.

Materials

For each youth:

- Journal and pen/pencil

For the whole group:

At the pond:

- Nets (can be various sizes)
- Strainers (see figure at right)
- Plastic trays (preferably white; at least 12 in. wide x 12 in. long x 2 in. deep)
- White plastic plates (at least 9 inches in diameter)
- White plastic spoons
- Magnifiers
- Buckets (at least 3-gallon)
- Large trash bags with twist ties
- Digital cameras
- Container for holding organisms (e.g., 2-liter soda bottle with top cut off, small tanks sold by science supply companies, or other containers at least 1 liter in volume)
- Disposable gloves



Strainer

CC Image courtesy of arukasa on Flickr

At the program site:

- Chart paper and markers
- Aquarium pumps (1 per bucket being used to store pond samples; alternatively, you can connect 1 aquarium pump to all buckets using a connector and multiple pieces of tubing connected to separate aerators)
- Plastic tubing compatible with outlet of the pumps
- Aerator stones (1 per bucket being used to store pond samples)

NOTE: The buckets will hold the samples that the youth collect at the pond. Use the trash bags to transport the buckets from the pond to your program site, especially if you are driving. Place the buckets of pond water in the trash bags. The bags will contain any splashing that may occur as you take the buckets back to your program site. Youth should use white containers, plates, and spoons to better see the organisms against a white background. Youth should wear disposable gloves when scooping out and handling the pond water.

Preparation

You will need to select a pond or other body of water to visit. You may be fortunate enough to have a freshwater pond near your program site. If so, you can use this as your source for organisms; however, check it out to see that it is in good health and not polluted.

If you do not know of a nearby pond, check with your local environmental agency or park rangers to find out where the nearest ponds are that you can visit and which ones are healthy. Also, ask them which organisms and plants are okay to be removed from the pond for study and whether a permit is required. You may want to combine a field trip to the forest, as suggested in the *Exploring Trees & Ponds* guides, *Fall Trees Activities* and *Spring Trees Activities*, with a visit to a pond. If you do plan to have the youth explore both types of environments, determine ahead of time how much time you will spend exploring each one.

If possible, visit the pond before your trip with the youth. Check how accessible it is from a nearby road and do some scooping out of pond water at different places along the pond's edge to see where the best places are for the youth to explore.

Determine where at your program site you will store the containers of organisms. The location should be quiet, well lit during the day (but out of direct sunlight) and relatively undisturbed by other people.

Invite parents or other adults to accompany and supervise youth on the field trip.

Introducing the Activity

Tell the youth that they will take a trip to a pond. They will explore with nets to see what they can discover in the water at the pond itself, and they will also collect samples to bring back to the program site. They will survey these samples to see what organisms they collected. Containers holding these organisms will then be set up so that the youth can do some long-term observations.

At the program site, before the field trip, ask the youth how familiar they are with living things in a pond. How many animals can they think of that live in a pond? They will probably mention fish and other larger organisms, but they may be unaware of many of the smaller organisms present.

Ask the youth that, when considering the organisms they've come up with, how many are large, how many are small, and how many are very small? On chart paper, write the names of the organisms they mention and their estimated sizes. Keep this paper for later reference.

NOTE: After the youth have spent some time sorting through their collected pond samples and doing some research on pond life, you can bring out the chart paper and have them assess how accurate their earlier estimates were.

Show the youth the materials they will be given when they reach the pond. Tell them that they will work in small groups to collect samples of pond water. Ask them to discuss how they think they should go about their collecting:

- What parts of the pond should they visit to do their collecting?
- Will it make a difference if they collect from the different levels of the pond—top, middle, bottom?

After they have developed a general procedure of how they will go about collecting samples, tell them that one goal is to get a preliminary sense of what is present, but the main goal is to collect numerous samples to bring back to the program site to study.

Explain that the trays and plastic plates will be used for taking a quick look at some of what they have collected. Have the youth form groups of three or four.

During the Activity

When you arrive at the pond, take some time to organize the youth and distribute equipment. Tell them that the best spots for collecting are where there are plants and muddy bottoms. Decide with the youth where each group will go to collect. Demonstrate how to use the nets, strainers, and buckets, and how to look for and at organisms on the plastic plates.

NOTE: For ease of transport, buckets should not be filled more than three-quarters full. Although youth should collect some mud and leaves, too many may be problematic for later portions of the activity.

Have one person in each group take notes (in his or her journal) during the collecting. Have this youth make a bird's-eye-view (in other words, from above) drawing, and then mark on the drawing where in the area the group is collecting its samples. Note-takers should also keep track of which organisms their group sees during the collection.

Check in with groups to see whether they have all found something. If groups are having difficulties, have them move to another spot.

NOTE: Youth may end up finding small fish, tadpoles, and even a turtle in their nets, all of which they will have to return to the pond. Most state and national parks prohibit collecting these larger organisms. Based on what you learned prior to choosing the location for the youth, explain to them what plants and organisms are okay to remove from the pond to bring back to the program site.

After the youth have been gathering pond life for a half hour or more, reconvene the whole group. If time allows, have the youth share their discoveries. If you collected some organisms on your own, show them to the group as well. In their excitement, youth will focus mostly on the *organisms* they have found, but take the time to point out the *plants* that are in the water and where they are located (e.g., near the edge, partially submerged, floating on the surface). If groups have not collected any plants, have a few youth collect some plants and place them in all the buckets.

Make sure that the buckets are no more than three-quarters full. Place the buckets into the large trash bags so that they are totally covered, and close the bags with twist ties. Have some youth collect the rest of the equipment used.

Immediate Follow-Up

When back at your program site, place the buckets in your chosen location. Remember to aerate them right away (see page 1 for more information).

Long-Term Follow-Up

Once the pond samples in the buckets are inventoried, the different organisms can be placed in smaller observation containers and studied closely over a period of weeks. You can also set up experimental conditions with the different containers to observe how these conditions affect the behavior and survival of the organisms (e.g., containers can be placed in locations with more and less sunlight).

NOTE: See the *Finding Out What Is in Pond Water* activity for more ideas on long-term follow-up.

Observing Progress

Youth will likely be quite excited when they are at the pond and will focus on the task at hand. However, some youth may behave inappropriately or unsafely. Keep an eye out for early signs of this kind of behavior and talk to these youth about the importance of being responsible.

Keep track of the youth's comments as they collect the organisms:

- Are they surprised at what they have collected?
- Do they comment on the size and structure of the organisms?
- Do they come up with questions about the organisms?
- Do they comment on where they find the organisms?

Each of these behaviors can be an indicator of their involvement and what they are observing and thinking.

Finding Out What Is in Pond Water

Rationale

Once you have some samples of plants and organisms (whether collected from a local pond or ordered from a science supply company—see Preparation below), conducting a follow-up activity whereby the youth discover what is in their samples will be interesting and exciting for them. If the youth were productive in their collecting, there should be a variety of organisms to study. The youth can place a scoop of water from the bucket on trays or plates for an immediate observation of what is present; they can then transfer the organisms to a transparent container for storage and long-term observation.

The goal of this activity is to give youth a sense of the number and variety of organisms that live in a pond.

Materials

For each youth:

- Journal and pen/pencil

For each group of two or three:

- 2 or 3 strainers (see figure at right)
- 2 or 3 small nets (such as available from pet supply stores)
- Clear plastic cup
- White plastic plate or tray
- White spoons
- Container for holding organisms (e.g., 2-liter soda bottle with top cut off, small tanks sold by science supply companies, or other containers at least 1 liter in volume)



Strainer

CC Image courtesy of arukasa on Flickr

For the whole group:

- Live (or purchased) pond organisms in buckets of pond water
- Newspaper
- Magnifiers
- Disposable gloves
- *Optional:* Field guides

NOTE: At this point, magnifiers are sufficient for youth to view the organisms. For closer observation (such as in the *Close Observation of Pond Organisms* activity), youth should use microscopes. Youth should wear disposable gloves when scooping out and working with the pond water.

Preparation

Check to see that the buckets of pond water contain living organisms and that they are being aerated. (See page 1 for information on how to aerate your samples.) If you were not able to collect pond water, if a lot of the organisms have died, or if there are very few organisms, order some organisms from a science supply company (e.g., Carolina Biological Supply, Connecticut Valley, Science Kit Boreal) to arrive in time to begin this activity.

Move the buckets of pond water to the area where the youth will meet.

In this activity, youth will put the organisms into smaller containers. Determine where at your program site you will store the containers. The location should be quiet, well lit during the day (but out of direct sunlight), and relatively undisturbed by other people.

Introducing the Activity

If you visited a local pond: Review what happened during the visit. Ask the youth to recall what organisms they saw when collecting the pond water. Tell them that there are probably organisms in the collected water that they did not notice while at the pond.

If you did not visit a pond: Point out the buckets of water, and ask youth if they can see any organisms in the water. Tell them that there are probably organisms in the collected water that they can't see.

Tell the group that the goal of this activity is to find out what organisms are present in the water. They will use cups and strainers to scoop out material from the buckets and onto trays or plates to look at it more closely. Once they've examined their organisms, they will transfer them to the containers for long-term observation.

NOTE: Over time, the water in the containers will evaporate, and youth will need to watch the water levels and replace water as needed. Alternatively, they can place some kind of lid (preferably transparent) that fits loosely over the top, allowing air to circulate but lessening evaporation. **Do NOT use tap or distilled water to replenish containers!**

During the Activity

Divide youth into groups of two or three and have them use cups and strainers to scoop material—organisms, plants, leaves, and water—out of the buckets. Have them pour a little at a time into a tray or onto a plate, letting the contents settle for a while so that they can see any movement more clearly.

Move from group to group and check out how they are doing, particularly how they are transferring the pond water to the plates or trays. Have them share with you what they have discovered so far. Encourage them to be patient and wait for the debris in the water to settle on the plate or tray since organisms are more identifiable in calm water.

Tell them to look closely for both large and small organisms. Some larger organisms may be immediately apparent; have them examine the leaves and plants carefully because sometimes organisms hide under these. Some organisms will leave a trail in the debris or mud and can be located in this manner. Encourage them to look very closely and see if they can find any

organisms that are the size of a pin head. Suggest that they take a little time and observe each one with a magnifier, but they should also continue looking for other organisms.

Depending on the length of your session, give sufficient time for the youth to accumulate a number of organisms. After about a half hour or so, have them stop and do some sharing. Groups can take turns showing everyone what they have found.

Show the youth where you have decided they will store their containers of pond organisms for long-term observation. Add pond water to the containers before adding the organisms, and have youth transfer their organisms into the containers you provided. Check to see that all containers have plants in them. If some don't, tell youth to add some plants to their containers.

Follow-Up

The containers can serve several functions:

- Each time you have a session, the youth can take a quick survey of what organisms remain and how they have changed. (With proper aeration, the containers will keep for several weeks or months.)
- You can introduce new organisms and see whether they survive or are eaten by the other organisms. For example, *Daphnia* can be introduced as a food supply since they are eaten by a number of larger organisms.
- In the *Close Observations of Pond Organisms* activity, youth can closely study individual organisms from these containers, making detailed drawings and writing detailed descriptions.

Observing Progress

Some youth may be hesitant at first to dig into the buckets of pond water. However, once they see others finding organisms, they will also become excited and get involved.

Sorting through the detritus that is in the pond water takes a patient and careful eye. When youth dump their small amount of pond water onto a tray or plate, observe what they do:

- Do they spread out the material with a spoon and poke around to find some movement?
- Do they wait for the mud and particles to settle to the bottom of the plate and look carefully for any movement?
- Are they respectful to the organisms as they handle them with the spoon?
- Do they take a little time to examine each organism with a magnifier?

Very small organisms are usually present in pond water. Youth have to look very carefully to see movement from these organisms. Do the youth take time to carefully examine the water to find these organisms?

Close Observations of Pond Organisms

Rationale

Observing organisms in a container over a period of time can reveal some information about their behavior. But because organisms move around and hide in mud or plants, it can be difficult to get a close look at them.

The goal of this activity is to have youth spend some time looking closely at organisms, one at a time, by placing an organism on a tray or plastic plate and then using magnifiers to study its body structure and other features.

NOTE: Depending on how motivated the youth are and the amount of time you have, this activity can be repeated several times over a period of several weeks; youth may closely study one or two organisms during each session. Observations of the living organisms can also be paired with watching a video of the same organisms. In this manner, youth can build up a deeper understanding about what is meant by *form and function* and how organisms survive. Multiple observations also increase the possibility of youth generating their own questions.

Materials

For each youth:

- Journal and pen/pencil

For each group of two or three youth:

- White plastic plate
- Plastic spoon
- 2 or 3 small nets (available from pet supply stores)
- Magnifiers
- Microscope (one for every two groups)

For the whole group:

- Containers holding organisms (see Preparation)
- Digital cameras
- Chart paper and markers
- Disposable gloves
- *Optional:* Field guides

Preparation

If you did not obtain samples from a local pond, see the Obtaining and Sustaining Samples of Pond Water and Organisms section on page 1 of this guide.

Have the youth get acquainted with the macro feature on the digital cameras, which will allow them to take very close-up photos. Take a few photos of the larger organisms to determine the best way to use this feature. Dragonfly larvae are good specimens to take photos of.



Dragonfly larva

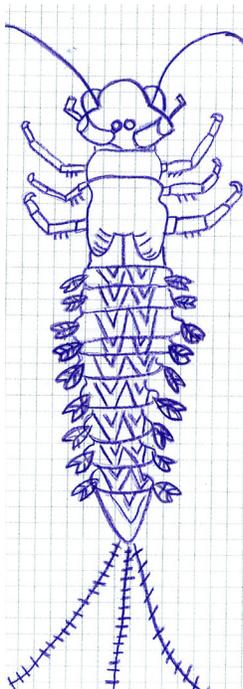
CC Image courtesy of happylittleclouds on Flickr

Introducing the Activity

Ask the youth what they have observed so far about the organisms in the containers:

- Have they looked closely at each of them?
- Do they know if they have eyes?
- How many legs does each have?
- How many body parts does each have?

Most likely, they will not be too confident about answering these questions. Point out that it takes a close study of an organism to begin to fully know it. Biologists spend a lot of time doing this, both in their laboratories and in the field. In this activity, youth can act as scientists and do close studies of their organisms.



Mayfly larva drawing

Ask them how they think they should proceed. What might they look for when observing the organisms?

If the youth have had little or no experience doing this kind of observation, you should spend some time with the whole group discussing how close observation can be helped by recording what they see in words, drawings, and photos.

Ask the whole group what they think would be important to record:

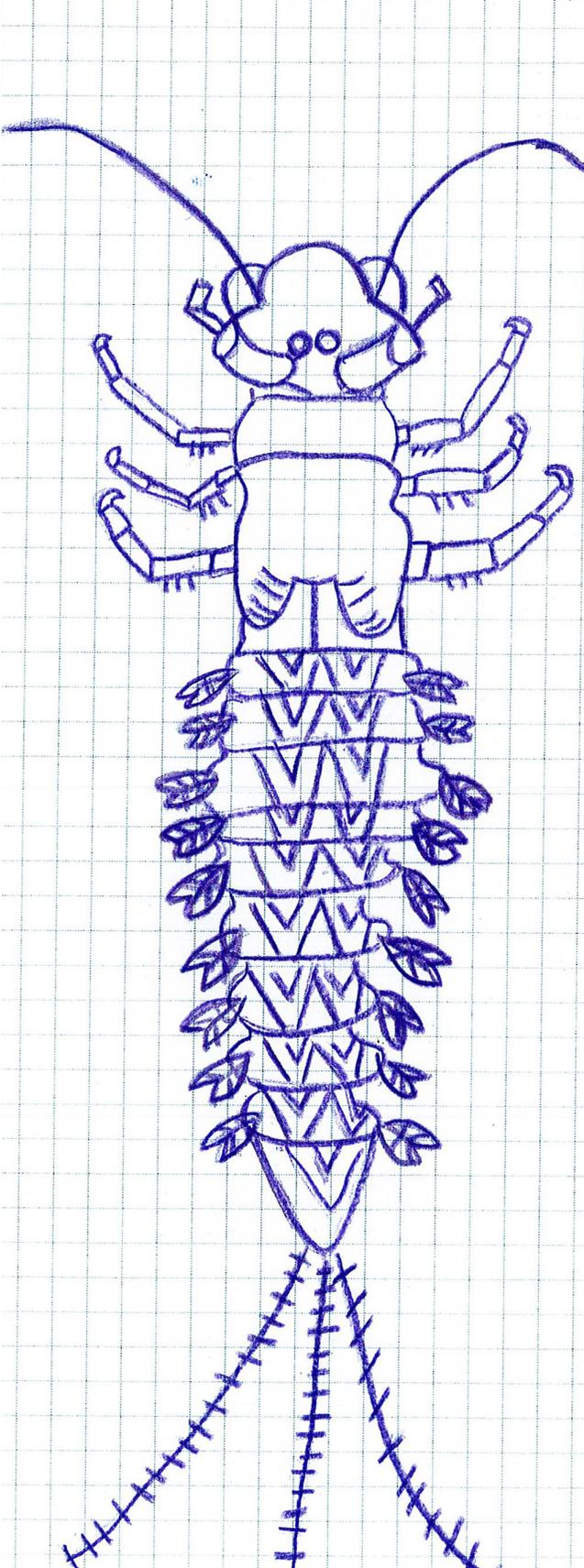
- What might they put in their drawings?
- Besides drawing the whole body and any appendages, what else might they draw? (For instance, some organisms have multiple parts to their bodies, which should be included in the drawing.)
- What about hairs or distinguishing marks on the body? (These should be added to the drawings, as shown in the image of a mayfly larva at left. You can hold the larger mayfly larva image on page 13 up for youth to see.)
- Where are the eyes and legs located? (Eyes and legs are located in various places on different organisms; they are also important to include in the drawing.)

Divide the group into smaller groups of two or three. Make sure that they have their journals handy, and give each group a large piece of paper and some markers.

During the Activity

Suggest that one youth in each group, wearing disposable gloves, scoop out one organism from a container and place it on a white plastic plate. (Make sure that the youth keep the organisms wet on the plate.) Remind the youth to record what they see in their journals. Ask them to write brief descriptions of the organisms and how they move. Additionally, they should make a drawing on the group's large sheet of paper. These large papers will be placed on the wall and shared with the whole group.

Mayfly larva



NOTE: Field tests have shown that some middle school youth are very reluctant to draw and will have a strong resistance to do so. You will need to provide a great deal of encouragement and support to help them make the effort.

One way to help build confidence around youth's drawings and observations is to have the whole group participate in a group drawing and observation. Pick one organism for all youth to observe, and give them several minutes to study it. Place a large sheet of paper on the wall, and tell the whole group that they will now contribute to a group drawing. Start by making a rough outline of the body of the organism. Ask different youth to come up to modify this drawing and to add more to it, such as legs, eyes, and hair. Each time something is added, ask the group to decide if this addition is OK. In this manner, you can model for the youth how to proceed. (See *The Importance of Drawings and Photos* in the How and Why section of the *Trees and Ponds* website [<http://treesandponds.edc.org/>] for more suggestions about supporting youth around drawing.)

Spend some time with each group and observe how they are proceeding. Look for those youth who are not comfortable drawing. Their drawings may be very small and lack any detail. Give them encouragement and show them how to proceed in a systematic manner, starting with the whole body of the organism and then adding the appendages and further details.

Give the groups enough time to complete a large drawing and write down some observations. Have the youth move away from the plates with the organisms and tape their large drawings onto the wall. Have groups present their drawings to the group and report on what they noticed. At this time, you can ask them what else they would like to learn about this organism. Have them write these questions in their journals.

As each group gives its report, ask the youth to speculate about the function of the organism's structure and its different parts. Some questions they might consider:

- If the organism has multiple legs, how could extra legs be helpful for the organism?
- Does it matter where the eyes of the organism are located on its head?
- Some organisms have hairs on their body. Do these hairs have any function?
- How does the organism move through the water? Does it just use its legs or appendages, or does it use its legs and its whole body?
- Does its color have any function for the organism?

NOTE: The purpose of these questions is to start youth thinking about the relationship between the form (structure) of the organisms and their functions, as well as how these are related to the organisms' survival.

Encourage the youth to generate questions that can be followed up on in later activities. You could list all of their questions on chart paper and attach the list to the wall for later reference.

Depending on the time and the number of organisms you have available and the youth's interest, you can follow the same procedure to have the youth study other organisms.

Follow-Up

Save the large drawings that the groups made for later reference. Once you've got drawings of several organisms posted on the wall, you can have the youth compare and contrast the organisms. The drawings can also be shown to parents when you are explaining the activities to them.

Observing Progress

- The amount of detail in the youth's journal drawings can be used as an indicator of how closely they are studying the organisms. Look for smaller details, such as antennae, hairs, and number of segments of the body and legs. Including these details indicates that the youth are paying close attention.
- Written comments about the organisms are another indicator. Do the youth make detailed and extended comments about the organism's body and how it moves?
- If you have youth who are not comfortable with drawing and thus do not produce any, you will have to pay particular attention to their spoken and written comments.
- Do the youth spontaneously come up with questions about the organisms and express a desire to find out more about the organisms?

Surveying Pond Water for Different Kinds of Microorganisms

Rationale

Youth have probably heard about microorganisms through television or other media, but it's likely that their mental images of microorganisms are inaccurate. Seeing the real thing can be exciting when presented in an engaging manner. It will also help the youth gain a better sense of the microorganisms' scale and variety.

While looking at some of the larger organisms with magnifiers or microscopes, youth may have already noticed the movement of "specks of dirt." They can now move on to getting a closer look at these specks.

The goal of this activity is to have youth get a sense that there are very small organisms that are part of pond life and that there is a great diversity of organisms. In this introductory activity, it is not necessary for youth to identify each and every organism they observe. Rather, have them make rough drawings of what they see and make attempts to estimate how many different kinds are present. This kind of experience can add to their understanding of the concept biodiversity.

The guiding questions for this activity are: **Are there smaller organisms than *Daphnia* and copepods? What do they look like and how do they move?**

NOTE: If the youth have not participated in the previous activities involving pond organisms, it is recommended that some time be spent on having them become acquainted with organisms that are visible to the eye. This can give youth a better sense of where microorganisms fit into the ecology of a pond.

Materials

For each youth:

- Journal and pen/pencil

For the whole group:

- Containers of pond water or specially prepared solutions of microorganisms (see Preparation)
- Microscopes
- Microscope slides and cover slips (if slides are made of glass, you will also need tape)

NOTE: Plane microscope slides will work better than those having depressions.

- Thread or thin string
- Stones, about 2 in. wide and 1 in. long
- Eyedroppers
- Polyurethane foam
- Petri dishes or other small glass containers
- Quieting solution (available from science supply companies; this will be added to the water samples on the microscope slides to slow down the movement of the microorganisms)

Preparation

Producing the Microorganisms

If you have not already set up containers of pond water with organisms, either in jars or aquariums, then you will need to do this. If you have already set up containers for long-term observations, these can be continued to be used. However, you will need to check to make sure everything in the pond-water container hasn't died because of an introduced chemical or some kind of growth that has choked off key species. If microorganisms remain plentiful, youth can collect them from these containers.

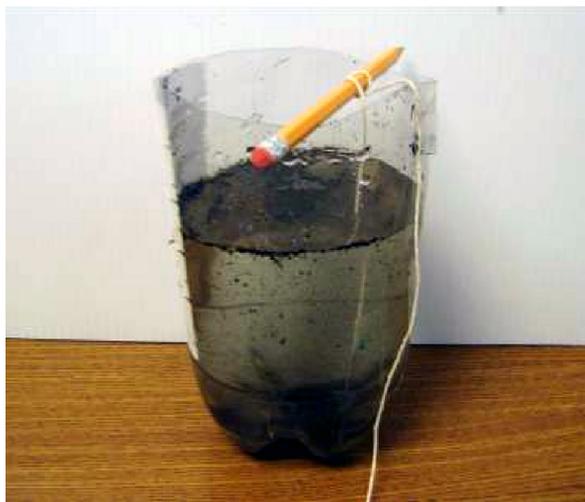
If the microorganisms from the observation containers are not viable, you will need to purchase samples from a science supply company. See Obtaining Samples of Pond Water and Organisms on page 1 for more information.

Collecting the Microorganisms

There are two techniques you can use to collect and concentrate microorganisms: micro-fishing or using porous materials. Once you have the microorganisms, you can set them up in specially prepared containers or in the containers the youth set up in previous activities.

Micro-fishing is a simple technique that gives results directly on a microscope slide:

1. Suspend a microscope slide into the observation water from the end of a thin string or sewing thread. If the slide is plastic, make a hole at one end to tie the thread to the slide. If the slide is glass, use tape to hold the string to the slide.
2. Keep the slide and string from sliding out of the container by holding it in place with a pencil (see figure below).
3. For best results, assemble this micro-fishing set-up several days before youth will use it.



Suspend a microscope slide on a string, using a pencil to keep the string from sliding into the container

Photo courtesy of Bernie Zubrowski

Over a period of several days, microorganisms should collect on the slide. You can pull the slide out of the water and place it under a microscope (be sure to dry one side of the slide with a paper towel before putting it under the microscope). Place a cover slip on the wet side so that water does not touch the lens of the microscope.

The second technique, *using porous material*, such as polyurethane foam (which can be obtained from fabric or craft stores), involves placing the material in pond water or specially prepared solutions to provide a place where microorganisms can congregate:

1. Cut small pieces of the polyurethane foam into 2 cm x 2 cm squares.
2. Using thin string or sewing thread, tie one piece of the polyurethane to a stone heavy enough to allow it to sink into the water.
3. Tie another piece of string or thread to the polyurethane square so it can be retrieved when you are ready to use it.
4. Place the square with string attached in an observation container and leave it undisturbed for at least one week. Let the other end of the string hang outside of the container.
5. When you're ready to start the activity with youth, gently remove the square from the water, and squeeze the water from the foam into a Petri dish or some other small glass container.
6. Using eyedroppers, youth will obtain a small sample from this supply and place it on a microscope slide to observe under a microscope.

Check the microscopes to make sure that they are working properly and that the lenses are clean.

Introducing the Activity

If this activity is a continuation of an extended investigation of pond or river water, have youth recall any prior observations where they may have noticed very small organisms.

To make a connection to previous activities, have them recall any discussions about food chains. For instance, *Daphnia* collect their food by means of passing water through their open shells and collecting any small organisms present. You can ask the youth, "If the *Daphnia* are filtering out something that is possibly food, what might these organisms look like?"

Explain to the youth that there are very small organisms all around us, in pond and river water, in the soil, and in other kinds of natural environments. Show them the containers you set up with the suspended slides or polyurethane squares, and tell them that they will use these containers to observe microorganisms.

Ask the youth to generate their own questions of what they would want to find out about these organisms, and have them write the questions in their journals. Select some youth to share their questions with the group.

If no one mentions these questions, pose them to the group:

- How could they keep track of how many different kinds of organisms they might find?
- How do the smaller organisms move?
- In comparison with the larger pond organisms, how do these smaller organisms move and capture food?
- Do these microorganisms have ways of sensing their environment? For instance, do they have eyes, antennae, or mouths?

If the youth have not used microscopes before, show them the correct procedures for using the particular ones you have.

Establish some procedures for how the youth will obtain their slides and samples. One approach is to form small groups and have one person from each group come to the table with the containers of microorganisms.

During the Activity

Check to see that each group is able to use the microscopes properly, especially in the use of the *diaphragm* (the rotating disk under the stage). Some youth may need help when they move from a lower to a higher magnification. Tell them that they should only use the fine adjustment so that the lens does not touch the cover slip.

While they are observing, encourage them to make quick drawings and try to describe how they think the organisms are moving. Also, have them speculate what they think the organisms are doing. Are they looking for food or just randomly moving around?

Immediate Observations

Have youth place the microscopes and other materials at a central location and then reconvene as a group. Return to the questions suggested by the youth and by you in Introducing the Activity:

- How many different kinds of organisms did you observe? Did others observe similar kinds of organisms?
- Were you able to observe the way the organisms move? (It may not be readily apparent how some of the organisms move. Ask youth to speculate about how the microorganisms moved around.)
- Were you able to observe any appendages?
- How do you think they eat?

Have volunteers share their observations and drawings.

Check the pond water or specially prepared samples to see what varieties of organisms are present. If the youth have discovered and reported on most of what is present, they are ready to move on to another activity.

Observing the Movement of Microorganisms: Ciliates and Flagellates

Rationale

The main way of detecting microorganisms when looking at them through a microscope is looking for any kind of movement. Some move in a jerky movement, while others seem to glide. Movement is a fundamental characteristic of living things and can be a way of categorizing this very large group of organisms.

Scientists have classified some of the microorganisms based on two kinds of movement. Those microorganisms that move using very small hair like arrangement are called *ciliates*. Those that have a single extension resembling a thick hair that whips around are called *flagellates*.

NOTE: If the youth have not participated in the previous activities involving pond organisms, it is recommended that some time be spent on having them become acquainted with organisms that are visible to the eye. This can give youth a better sense of where microorganisms fit into the ecology of a pond.

During their initial observations of different organisms, youth may not have looked that closely at how the organisms moved, so they may not have noticed these two different means. To focus on each mean of locomotion, you may want to introduce these two different groups of organisms one at a time so that youth can see these differences.

The guiding question for this activity is: **How do these very small organisms move?**

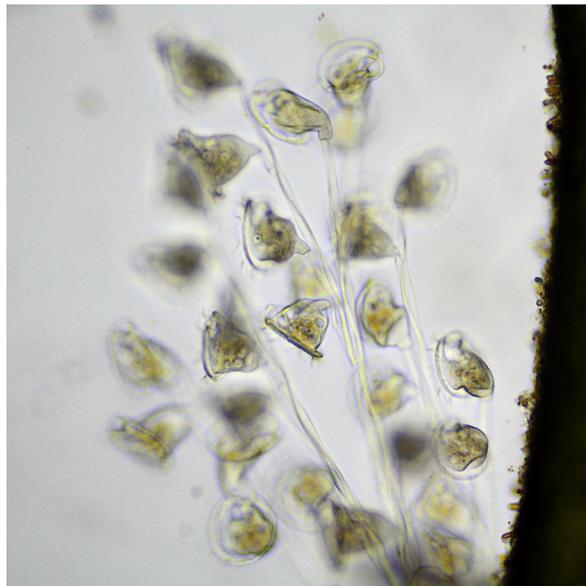
Materials

For each youth:

- Journal and pen/pencil

For the whole group:

- Chart paper and markers
- Set of ciliate culture
- Set of flagellate culture
- Microscopes
- Slides and cover slips
- Eyedroppers
- Masking tape
- Quieting solution



Ciliates

CC Image courtesy of Specious Reasons on Flickr

PART 1: CILIATES

Preparation

Eyedroppers should be used for one type of organism only, so put a tape label on the eyedropper for each type of organism to help youth keep them separate.

Science supply companies have special sets of microorganisms separated into the different categories you will observe. Ordering these sets is the easiest way to ensure that you will have the right kind and a sufficient supply. When you receive the containers, follow the directions for storing them, making sure that they are not placed in direct sunlight or where it may get too hot or too cold.

Decide whether to supplement your lesson with a video. You can purchase videos from a science supply company, downloaded from the Web, or borrowed from the library. Preview any videos ahead of time and decide what parts you will show.

Introducing the Activity

If the youth completed the activity *Surveying Pond Water for Different Kinds of Microorganisms*, ask them to recall some of their observations:

- What do they remember about the way the organisms moved?
- Were they able to get a close look at the parts of the organisms that caused them to move?

There will probably be lots of uncertainty and/or vagueness to their descriptions.

Tell them that you have a collection of microorganisms that all use the same means of locomotion. They will take samples of these organisms and study them closely to see if they can determine what is similar about the way all the organisms move.

If you have samples of different types of ciliates, tell youth that it is very important that they do not mix the eyedroppers used for taking samples from the different containers of the microorganisms. When they take a sample from a container, they should immediately put the eyedropper back in that container.

Have the youth organize themselves into groups to share the number of microscopes that are available.

During the Activity

Check to see that youth are being careful not to mix the eyedroppers.

Check in with each group to help the youth focus clearly on their samples, using the microscope's largest magnification and diaphragm, so that they have a high contrast and clear image of the organism. Remind them to make drawings of the organism they observe. These drawings do not have to be very detailed but should capture the overall form of the organism.

Immediate Observations

Move youth away from the materials and have them report on what they observed.

Draw an outline of one of the organisms that was part of the set of samples on chart paper. Ask volunteers to add to this drawing, in particular showing what they noticed about the any parts on the outside of the organism's body. Did they see similar types of parts on each organism? At this point, you can introduce the term *cilia*, which is used to describe these hair-like projections. Ask the youth what they noticed about how these organisms moved. Did they always move in straight lines, or did they easily change direction?

Have them compare the way people swim underwater to the way these organisms move. If they had multiple arms and feet all over their bodies, what difference would this make in how they could swim underwater? The idea behind this analogy is to get them to realize that having multiple cilia allows the organism to change directions easily and maneuver through small spaces.

You can also point out that some organisms, such as the *Vorticella*, use the cilia to create a current around it, enabling it to gather food.

Observing Videos of Ciliates

It is a real challenge to observe the different behaviors of ciliates and also to see the fine structure of these organisms. To supplement what youth have observed, you can show them videos of these organisms.

One approach is to show just a few minutes of video at a time. To give a more inquiry-like presentation, turn down the audio and challenge the youth to come up with their interpretation of what is being shown. You might show the same segment several times so they can gain a clear sense of what is occurring. After some discussion, you can then show the segment with the narration and discuss what the narration means. This process challenges the youth to make their own interpretations and to become more actively involved in what they are seeing.

PART 2: FLAGELLATES

Introducing the Activity

Follow the instructions under Introducing the Activity for Part 1, except this time you will use flagellates.

During the Activity

During the observation of the samples of flagellates, tell the youth to pay attention to the color of the different organisms. Are some of them green? What would be the significance of this color?

Immediate Observations

Carry out the same sequence suggested in Part 1, but this time also spend time focusing on the green spots of organisms such as *Euglena*.

Observing Videos of Flagellates

Video footage will more clearly show the internal structures of flagellate organisms such as *Euglena*. This can also give you an opportunity to talk about the broad classification of protozoa.

There are the *autotrophic*, which produce their own food through photosynthesis (*Euglena* is an example), and the *heterotrophic*, which obtain their food by eating other organisms or organic matter. Some ciliates and flagellates are examples of heterotrophic microorganisms.

Background Information

For a survey of different kinds of protozoa with drawings and a brief description, see “Pond Water Critters” on the *Microbus* website (<http://www.microscope-microscope.org/applications/pond-critters/pond-critters.htm>).

The *Exploring Trees and Ponds* Series: Activity Descriptions

FALL TREES

Field Trip: Exploring a Forest

An excellent way of starting off the whole project is to take a trip to a local forest. Youth make on-site observations to help gain an overall picture of trees and plants, their habitats, growing conditions, etc. Careful planning for this trip will make it productive and motivating for the youth.

Field Trip: Exploring Your Neighborhood

Youth become acquainted with the trees and plants in their local neighborhood. Since these are readily accessible, they can be the subjects for long-term observations. Youth observe changes during the seasons and thereby gain a sense of how trees survive and grow.

Field Trip: Adopting a Tree

Youth adopt one or several trees in order to narrow their focus. Having been stimulated by several trips to their local neighborhood, they generate questions and then follow through by carrying out systematic observations through the seasons.

Trees: Observation Indoors

Youth compare and contrast changes that happen during the course of the project to small tree seedlings brought indoors. They also compare the environmental conditions that may affect when trees lose their leaves.

Leaves: Extracting Pigments

Youth crush leaves and other natural materials and soak them in different liquids. They then carry out the technique of chromatography to separate out the pigments for observation.

Seeds: Observing and Experimenting

Youth collect and plant seeds to investigate the experimental question of whether seeds will germinate right away or if they need a span of time to germinate.

WINTER PONDS

Observing Pond Creatures

Youth observe creatures as large as fish and tadpoles and as small as beetles and dragonfly larvae. Using an existing curriculum (developed for the traditional school context but easily adapted for out-of-school and for different age groups), we provide suggestions for activities for long-term explorations of larger (fish, tadpoles, snails) and smaller (dragonfly larvae, daphnia) organisms.

Surveying Pond Water for Different Microorganisms

Youth observe samples of pond water using microscopes to see how many different kinds of very small organisms may be present.

Observing the Movement of Microorganisms

Youth use microscopies to isolate a few of the microorganisms and study how they move.

Visiting and Exploring a Pond

Using simple equipment, youth discover where different organisms are found in ponds and collect multiple samples to bring back to the center for a long-term exploration studying organisms in depth. The goal of this activity is to have youth witness the diversity that can be found in one kind of ecosystem.

Finding Out What Is in Pond Water Youth have collected specimens from a pond and have brought them back to their science center. Now they look at them more closely with magnifiers, examining how many different items they've collected and comparing and contrasting them.

Close Observations of Pond Organisms Youth observe their collected organisms very closely by placing one organism on a tray or plastic plate and then studying its body structure and other features using magnifiers. Youth keep notes of what they see and make drawings or take photos that they can share with the whole group during discussions.

SPRING TREES

Trees: Buds and Twigs

Branches from trees and bushes can be collected in the early spring, brought indoors, and placed in water. Youth can then closely observe the emergence of leaves and flowers. They can consider such questions as, Do the leaves on the trees all emerge at the same time or do some trees sprout leaves sooner than others? Do all trees produce spring flowers? What environmental factors may bring about these changes?

Trees: Exploring Their Flowers

On field trips, youth observe the emergence and timing of flowers on different kinds of trees. They also examine different flowers and get a sense of their structure. This provides a context for discussing the reproductive strategies of trees.

Seeds: Emergence and Germination

Youth collect seeds and attempt to germinate them. Youth may not be aware of the dormancy of seeds. Spring is a good time for youth to consider and study this property.

Seeds: Roots and Shoots

The roots of plants are not easily observed. In this activity, youth build a specially designed arrangement that allows them to observe the growth of roots and the correlation between root growth and stem extension.

Leaves: Designing Leaf Arrangements on a Branch

Youth are challenged to design the arrangement of leaves on a branch of a tree using simple materials. This exercise can help them see that there is order to the way leaves grow on trees.

Leaves: Taking a Closer Look at Their Structure

Youth's close examination of the structures of different kind of leaves, especially their cellular arrangements, can be the context for examining the micro-structure of trees and the distribution of water and food in trees.

Leaves: Exploring Estimating Total Surface Area (Optional)

Youth estimate the total number of leaves on a tree and then find the surface area of one leaf. Then they calculate the total surface area of all the leaves on a tree.

Trees: Designing a Tree

Using simple materials, youth are challenged to design their own trees.