A Rottin' Experiment
Post Activity

Program at Nature Station: Wetlands

Grade Level: 7-Adult

Program Length:
Prep time
Activity time: several weeks

Group size: any

Setting:
Classroom

Vocabulary and Concepts:
- decomposition - The separation or breaking down of a substance into its component parts (decay).
- anaerobic - Living, active, or occurring in the absence of oxygen. Oxygen-less.
- compost - A mixture that consists largely of decayed organic matter, used for fertilizing and conditioning land.

Materials:
- slices of bread
- small plastic bags
- clear drinking glass or glass jar
- a small amount of sand
- 9 plastic 2-liter beverage bottles
- marker
- knife or razor blade
- scissors
- hot water, or candle with matches
- pliers
- sewing needles
- clear tape
- netting or mesh fabric
- rubber bands
- shredded newspaper
- measuring cup
- food and lawn scraps
- bucket and shovel or shredded mulch from a garden shop
- 2 small potted plants
- watering can full of water

Background Information:
Composting, recycling, and waste disposal have become prominent conservation issues. Students are probably aware of these topics, but unaware of the processes of decomposition and composting in wetland

conditions. Is the smell of a wetland familiar to them? How or when? The exercise of simulating and observing conditions that make wetlands unique not only demonstrates the process of decomposition, but also the importance of reducing the waste load in landfills.

The process of decomposition requires oxygen. The organic topsoil found near a log is formed by decomposition that took place above the surface of the soil, where oxygen is readily available. Organic wetland soil is not formed by decomposition, but the accumulation of organic material. In anaerobic wetland conditions, organic material does not break down, or does so very slowly. In northern peat bogs, the anaerobic and very acidic peat actually preserves buried plant and animals matter. *National Geographic* magazine has published articles on this subject, including one about the perfectly preserved body of an ancient man found in peat bog- he still even had his hair!

Wetland soil below the first few inches is anaerobic because it is saturated with water all or part of the time. Oxygen is not available to plants or decomposers because the pore spaces in the soil are taken up by water molecules, leaving little or no room for oxygen molecules. Oxygen diffuses more readily across air than across water, so there is little chance of plants extracting oxygen from the water.

Plants that are not adapted to saturated soil conditions will die when the soil below them is flooded, just as houseplants die when they are over-watered. In a pond created by a beaver dam, or at a river with banks constantly inundated by water, trees and other plants soon die from flooded conditions.

Wetland plants, on the other hand, have adapted to life in anaerobic, saturated soils. These plants are able to transport oxygen from their leaves, through their stems, and down to their roots. Many wetland plants also have shallow, spreading roots which can take some oxygen from the more aerobic surface soil.

Procedure:

Ask students if they compost their garbage at home. If any do, ask them to describe what happens to the food items in the compost pile. Discuss factors that make the food decay and decompose. Explain the microscopic bacteria and fungi are two types of decomposers that turn dead plants and animals into compost.

Show students a fresh piece of bread in a plastic bag, and one that is moldy, also stored in a plastic bag. Explain that one was kept in the refrigerator and one was stored on top of it. Which one do they think was stored in the fridge? Why?

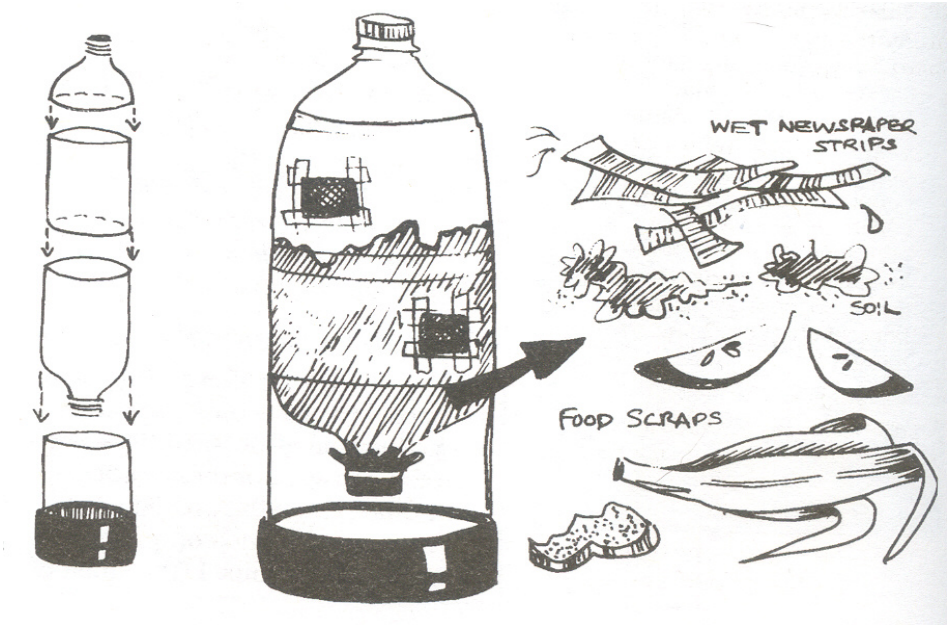
Next ask students to think of conditions that allow mold to grow. List these conditions on the board. Make sure the list includes dampness, presence of oxygen, and heat. Heat made the un-refrigerated bread "sweat" inside the plastic bag. Because the atmosphere inside the bag was both warm and moist, the bread molded quickly. Inside the refrigerator, the temperature was cold enough to keep mold and bacteria at bay.

Explain that moisture, air, light, temperature, bacteria and fungi sources, and the nature of the decomposing material are all important variables in the composting process. Soft food items will decompose faster than twigs and bark. The compost must be warm and moist for the decomposing bacteria to survive. Composting materials produce their own heat, and the added warmth in the compost bin furthers the process of decomposition.

Explain that the class will set up an experiment to see which conditions are the best for composting organic matter. Part of this experiment will illustrate conditions in wetland soil.

Part 1

1. Divide the class into three groups and have each group make one of three composter bins (the control, the "wetland," or the anaerobic environment) as follows: For each composter remove the labels from the three bottles, and black plastic from two of the bottles. Cut the bottle as illustrated. Cover the mouth of the bottle that hangs upside down with mesh, securing it tightly with a rubber band. Assemble the bins. For ventilation poke holes into the plastic with a needle heated with a candle flame or very hot water. (Hold the needle with the pliers during the heating process.) As shown in the diagram cut four ½ inch-square ($1cm^2$) holes with a knife or razor blade; tape mesh over the holes. Do this for each composter.



2. Have students refer to the list they made earlier. What things on the list promote decomposition? Which are characteristic of a wetland?

3. Describe wetland conditions. Do students think saturated soil conditions will speed up or hinder decomposition? If water fills up all space between soil particles, what can't get in? To illustrate this, fill the glass or jar half full of sand and pour water to the top. What do students see bubbling out of the sand? Air bubbles! Explain that saturated soil does not allow room for air (oxygen).

4. Ask students how they could set up an experiment to test whether saturated soil decomposes differently than wet soil that has room for oxygen. What if they put one bottle with wet materials in a sunny spot and kept another bottle with wet soil in a closet, but shook it once in a while to disperse oxygen. If the first bottle got moldy and the second didn't, could they be sure it was only saturated conditions that caused the mold to grow? Since you are studying wetlands, you are interested in the effects of soil saturation. The effects of light and temperature, therefore, are not the most important factors to test at this time. This means that temperature and the amount of light should be kept constant (the same for all three tests bins). Organic materials decompose in the presence of light. You know from the bread discussion that decomposing organisms favor warmer temperatures. You should, then, keep the composters in a warm place (the classroom is probably warm enough; the windowsill may prove a bit warmer if sunlight hits there). The experimental variables, then, are the amount of *moisture* and *oxygen*.

5. Ask students how they could add oxygen to saturated soil. Explain that as water flows over rapids, it gets oxygenated as it is churned up (the air mixes with water). Inform them that shaking and mixing actions add air (oxygen) to water.

6. Give each group equal amounts of shredded newspaper. Have them do the following:
<u>Constants</u>
Sprinkle the same amount of water on each pile of newspaper to wet it well, then put each pile into one of the composters. Dig up a bucket of soil or use purchased shredded mulch. Measure two cups of soil or mulch for each composter. Add the soil to the composter and shake well to mix.

Collect garbage such as pieces of apple, bits of bread, chips, candy-coated nuts, grass clipping, leaves, twigs, etc. Students can make contributions from their lunches. Do not use any meat or bones. Make sure each composter gets exactly the same type and quantities of each of these organic materials. Push each item down into the soil mixture and press it against the plastic for observation. On the outside of each composter, attach small labels next to each item so that identification will be easier when composting progresses. Mark the date on each composter.

Variables

Composter 1, The control: Sprinkle the compost regularly with just enough eater to keep it moist at all times.

Composter 2, The "wetland": Saturate the compost with enough water to fill all spaces between particles. Keep the compost completely saturated at all times.

Composter 3, Oxygen added: Add the same amount of water as in the second composter, but shake vigorously each day to mix in oxygen.

7. Have students predict which composter will work the fastest. Why? Formulate hypotheses (example: too much water, and consequently not enough oxygen, will slow the composting process). Record the predictions and hypotheses for later reference.

8. Set the composter aside. The amount of time it takes for any visible decay will be different for each material. In general, it will take at least a week or two. You should be able to see changes through the plastic. Have students check the composters every day or every other day until changes are visible. Record these changes. Once the process has visibly begun, check every day until the items are no longer recognizable. More advanced students can assign a numerical value to each stage of decay, based on a scale of 0 to 10:
0 = no change
1 = first sign of mold or change

10 = complete decay

Have students graph their data using a different color for each composter. Put the days on the horizontal axis of the graph, and the 0-10 scale on the vertical axis.

Part 2

1. At the time that the composters are set up, present the two potted plants as the second part of the experiment. Is soil condition important to plant growth? Why? (Plants take oxygen and nutrients in through their roots, which grow down through the soil.) Predict what will happen when one of the plants is given too much water.

2. Water one of the plants every other day, or just enough to keep the soil moist. Keep the soil of the other plant completely saturated by giving it a lot of water every day. Record what happens to both plants.

3. Discuss why plants die when over-watered. Explain that roots cannot get oxygen when the spaces in the soil are filled with water.

4. Tell students that certain plants have adapted to survive in saturated wetland soils. Have them suggest how. Through special adaptations these plants transport oxygen from their leaves to their roots.

Assessment or Evaluation:
Have students summarize the results of the composting experiment. Under which condition did the compost decompose the slowest? Why? (The saturated composter had little or no oxygen- it was anaerobic and decomposition was therefore very slow. The oxygen in the control and aerated composters promoted faster decomposition.)

Discuss the factors that "shake up" or mix soil in nature. (Earthworms, sow bugs, moles, and lots of other critters do! These organisms do not live in saturated wetland soil, because they can't breathe in such wet conditions.)

The saturated composter exemplified slow decomposition in saturated wetland soil. If organic material decomposes so slowly in a wetland, what happens over time as more and more material (leaf litter, etc) falls to the ground or washes into the wetland? (the organic material accumulates, forming a thick layer of slowly-decaying organic soil or peat. In a salt marsh, for example, the accumulation of organic matter helps build up and expand the marsh, creating more habitat for animals, more surface area for food production, and so on.

Have students:
- describe conditions that promote decomposition
- assemble an experiment that compares decomposition in saturated and aerated soils
- explain why a regular houseplant may no survive in wetland soils

Two *National Geographic* articles, "Mysteries of the Bog" and "Life-like Man Preserved 2,000 Years in Peat" may be of interest to your students (see resources below).
If you have a beaver pond in your area, take your students to see it. The sight of standing dead trees is quite dramatic.
Use the composters again to compare the rate of breakdown of human-made items to natural materials. Use small pieces of paper products, plastic, aluminum soda can rings, cloth, rubber bands, etc. Do these materials decompose at all, even with oxygen?

Have students apply what they've learned to conditions in a landfill dump. We have shown that saturation in a wetland causes anaerobic conditions in the soil. A landfill can also become anaerobic. It is difficult for oxygen to permeate through a enormous amount of compacted garbage. Without oxygen, the organic materials will not decompose. What happens when the trash and garbage in our landfills does not break down? (It piles up until we have to find yet another place to put it.) Can students suggest some ways to solve this problem? (We can all be more careful about what we throw away. We can recycle and reuse non-biodegradable products and compost garbage for reuse as garden fertilizer.) The class can begin by monitoring trash disposal in your classroom. How much paper, plastic, and food waste are students throwing away? How can they cut down on these quantities? (Try using both sides of the paper and sending it to a recycling center instead of to the landfill. Seal lunch items in reusable containers rather then in disposable products.) Can students think of more ways to reduce trash?

Nature in Your Neighborhood
Can you make soil? Compost kitchen and yard wastes at home! Make a small indoor composter like the one in this activity, or make a larger one for your yard.

With the help of an adult, remove the bottom from an old metal or plastic garbage can. Find a permanent spot for it in your yard. Put damp grass clippings, leaves, shredded newspaper, and soil in the bottom to start the process. Then add food scraps and other organic garbage. Remember, no meat, bones, or other animal products. Leave the lid off or cut lots of quarter-sized holes in the lid so the pile can get oxygen. Use a big stick or a shovel to stir your compost once a week or so to aerate it. With frequent aeration, your compost will have little odor. As the materials decompose, you will see that new soil is forming in the bottom of the compost bin!

Help your neighbors make their own composters or ask them to contribute to yours! This will help cut down on the amount of garbage you send to the landfill. After a few months, you can use the rich soil you have created to plant a beautiful garden for all to enjoy!

Resources:

Levanthes, Louise. March 1987. "Mysteries of the Bog." *National Geographic*.
Glob, P.V. March 1954. "Life-like Man Preserved 2,000 Years in Peat." *National Geographic*.

Source:

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