Mission 9
Mission to Planet Earth- Life in Soil!

SETI INSTITUTE

Can You Recognize Life Up-Close

Overview

In mission 9.1, students examine two soils: an artificial mixture that appears lifeless, and a natural Earth soil, which appears full of life. Both represent samples that might be taken by the extraterrestrial probe. Students describe what they see and then add water to both soils. In mission 9.2, students discover that the apparently lifeless soil is now filled with brine shrimp that have hatched from dormant eggs in the soil. Students realize that simply looking at something may not be the best way to detect life. Adding water to a soil sample is one way of activating any dormant life.

Notes

In mission 8, students characterized "life" If an extraterrestrial civilization sent a robotic spaceship to Earth to collect soil samples, would that spaceship be able to detect life, or would the extraterrestrial scientists conclude that Earth was devoid of life? This concept also applies to the situation of Earth sending an unmanned spaceship to Mars or Venus.

Mission 9.1
Materials

For a Class of 30

- 3 vials (or 6 grams) of brine shrimp eggs
- 1 cup of clean or sterile fine-grained sand
- 112 tablespoon of rock salt
- 2 cups of organic topsoil (with leaf fragments) from an unsprayed garden
- 2 50-ml beakers for the demonstration
- "Incubation Center"-an area kept warm by lightbulbs
- Chemicals to dechlorinate water (see "Dechlorinated Water," in appendix)
- Dechlorinated water in a large container
- Cups
- Stick-on labels or grease pencils
- (optional) 4 dozen tiny colored glass beads

For Each Team

- 2 50-ml beakers
- 2 hand lens
- 2 Petri dishes with samples 1 and 2
- Low-power microscope or stereo microscope (use hand lenses if microscopes are not available)
- 2 dissection needles or probes
- “Dirty Science” directions

For Each Student:

- “Observing Dry Soil Samples” worksheet
- Pencil

Getting Ready

1. Dechlorinate the water, if necessary. (see “Dechlorinated Water,” in appendix)

2. Make two soil sample mixtures as follows:

   Earth Sample # 1.-Gently mix the fine sand, the rock salt, and the tiny colored glass beads (optional) in a clean container.

   Earth Sample # 2-Contains or consists of the organic topsoil (examine the topsoil with a hand lens and a dissection needle or probe to make sure it has easily visible signs of life). Use the soil sample mixtures to prepare a pair of Petri dishes for each student team. Label them “Earth Sample 1” or “Earth Sample 2.”

3. Prepare two demonstration beakers. Label the two 50-ml beakers “Earth Sample # 1” and “Earth Sample # 2.” To each beaker, add one tablespoon of the appropriate mixture. To Earth Sample # 1, add a pinch of brine shrimp eggs.

4. Copy the “Dirty Science” directions for each team and the “Observing Dry Soil Samples” worksheet for each student.

Classroom Action

1. **Discussion.** Divide the class into teams of two students each. Explain that they will play the role of extraterrestrial scientists who are investigating whether there is life on Planet Earth! The scientists have sent a probe to Earth to collect two soil samples.

   Tell students that their objective is to see if they can tell, by looking carefully with a microscope, whether there is something in the soil that is alive, is dead but was once alive, or was never alive. Tell students that they may see objects that they just can't decide about.

Explain that “Don't Know” is a scientifically acceptable answer. In fact, it is a better answer than an unfounded, wild guess. Students should sketch any objects they find so they can determine their attributes later.

Write these categories on the chalkboard: Alive, Once Alive, Never Alive, Don't Know. Ask the class to name things to look for when trying to decide whether or not something is (or was ever) alive. Write students' one- or two-word answers on the chalkboard. Likely things to look for include movement and familiar shapes.

2. **Activity.** Hand out the “Dirty Science” directions to each team and the “Observing Dry Soil Samples” worksheet to each student. Give each team a pair of Petri dishes containing Earth Sample # 1 and Earth Sample # 2, which represent samples scooped up by an extraterrestrial probe visiting Earth. The two samples will appear very different. Explain that the probe took these samples in two different locations: one was in a desert and the other was in a forest. Also hand out two beakers to each team

   Each student should look at Earth Sample # 1, carefully draw the objects seen, and identify each kind of object as either “Alive,” “Once Alive,” “Never Alive,” or “Don't Know.” Students should be encouraged to look at more than one random part of each soil sample.

   Teams should follow the same procedure with Earth Sample # 2.

3. **Demonstration.** Show the class the demonstration beakers. Pour dechlorinated water into the beakers. Cover the “desert” soil (Earth Sample # 1) with a few centimeters of water to allow the shrimp to swim when they hatch. Just moisten the “forest” soil (Earth Sample # 2); too much water will make it mud and may drown some of the life. Explain that this is a life-form detection experiment. If there are dormant life-forms in the soil, water could activate them. Explain that the drier sample requires more water.

4. **Activity.** Each student should gently pour the viewed sample from the Petri dish into the beaker, being careful to label each beaker. Each student should add dechlorinated water to a sample and label it with his or her name.

   Have teams set these submerged samples under a light bulb (the incubation area); this bulb should remain on all night to keep the samples warm enough to have the brine shrimp eggs hatch within 24 hours. (They do not need light, they need heat.) Too much heat will evaporate the water.

   Teacher's Note: *At 82º F (28º*C) *it takes 15 hours for the eggs to hatch; if it is warmer, it will take less time; if colder, more time. Test your setup with a thermometer to determine the distance from your heat source. The eggs will hatch in under 48 hours at room temperature, so they can be viewed on the third day after mission 9.1. The brine shrimp will live at least two days after hatching without food. (Food can be dry yeast.) A good plan is to begin this mission on a Friday and finish it on a Monday.*

Mission 9.2
Materials

For a Class of 30

- Common Soil Organisms

For Each Team

- 1 eyedropper

For Each Student

- “Observing Wet Soil Samples” worksheet
- Soil Sample Analysis” worksheet
- Pencil

Teacher's Note: *Mission 9.2 is the same as mission 9.1 except that students examine their wet soil samples. Make sure that the brine shrimp have actually hatched before you begin this activity. The brine shrimp can be seen with the naked eye as glittering red-brown specks that move around. If the shrimp have not hatched, delay this mission for a day or until they hatch.*

Getting Ready

1. Copy the worksheets “Observing Wet Soil Samples” and “Soil Sample Analysis” for each student.

2. Prepare the “Common Soil Organisms” transparency. Set up the overhead projector.

Classroom Action

Figure 9.1-Baby Brine Shrimp

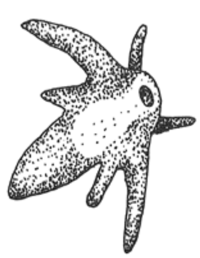
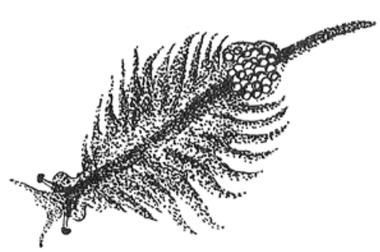


Figure 9.2--Adult Brine Shrimp



1. **Optional Review.** Divide the chalkboard into two sections labeled “Earth Sample # 1” and “Earth Sample # 2.” Ask a few students to start drawing and listing Alive, Once Alive, Never Alive, and Don't Know objects seen in their two Earth Samples. Continue this until each team has listed two or three objects. Use the information on the chalkboard to clear up any obvious misconceptions, or to steer students' thoughts in new directions.

2. **Activity.** Hand out the worksheets “Observing Wet Soil Samples” and “Soil Sample Analysis” to each student. Reassemble the student teams from mission 9.1. Each student should use an eyedropper to take a drop of the water from the top of their Earth Sample # 1 and put it on a Petri dish. Students should label this Petri dish “Earth Sample # 1” and classify any objects seen. Encourage students to look at more than one random part of each soil sample. They may discover, or need to be told, that if they first darken one half of the dish by covering it with paper or their hand, the brine shrimp will swim to the better-lit half. Holding a light to one side of the dish also works. If students take their sample from the well-lit half, they will see more brine shrimp. Students may also discover, or need to be told, that stirring the soil sample a little and then looking at the water again will put a few more objects, including brine shrimp and empty brine shrimp eggs, into view. Teams should follow the same procedure with Earth Sample # 2.

3. **Transparency.** After everyone has looked at the samples, show the “Common Soil Organisms” transparency. This will give you a chance to identify some of the living things that students have seen, and an opportunity to discuss the results of the experiment.

Going Further

Activity: Sea Monkeys!

Brine shrimp are the animals also sold as “sea monkeys.” Have students transfer some brine shrimp into an aerated aquarium, feed them yeast, and watch them grow. They may also be fed to fish!

Activity: Fish out of Water!

Brine shrimp are not the only aquatic animals that have eggs that withstand drying. They are not the only aquatic animals that hatch when exposed to water. There are several species of fish, called annual killifish that live in shallow ponds, mostly along the west coast of Africa. Every year, the ponds dry up, leaving the eggs exposed to the air. When the rains come, the eggs hatch immediately.

An “Instant Fish Kit” using the eggs of the annual killifish *Nothobianchius,* is available from Carolina Biological Supply (see “Ordering Information,” in appendix). The kit contains instructions. You must specify the delivery date for the eggs; the kit comes with a coupon for ordering the eggs. Ask students to add the water to the fish eggs in a Petri dish and watch the hatching, which begins immediately and ends within 90 minutes. Hand lenses or low-power microscopes enhance the experience. Students will see that even complex life can remain dormant until “activated” with water. They will see how life has adapted to a unique environment that is arid for part of the year.

Plan on keeping the fish in a class tropical aquarium. They mature in a few weeks, grow to about two inches, and eat tropical fish food. Perhaps send them home with students, with instructions on their care, or sell them to pet shops that sell fish.

Note: Fish are vertebrates, or animals with backbones. There may be rules that govern the use of vertebrate lab animals at your school.

Discussion: The Lotus

Challenge students with the question: “How long can life remain dormant?” List their ideas and answers on the chalkboard or on butcher paper. Inform students that scientists have taken apparently lifeless lotus seeds from a bone-dry Egyptian tomb and grown one into a regular plant by adding water. These seeds had been entombed for thousands of years. Ask students if this could be the oldest plant on Earth.

Scientists believe that conditions on Mars may have been more favorable to life in the past than they are today. Ask students to suppose that life had flourished on Mars long ago. Could a few dormant seeds remain? What if a probe found such a seed? Could we “activate” it with water?

Activity: Instant Algae

Life (as algae spores) may exist in a water sample, but this is not obvious to the naked eye until there are enough algae cells to turn the water green. Have students seed a mason jar or beaker of dechlorinated water with a few drops of water from an established classroom aquarium (or an algae culture from Carolina Biological Supply-see “Ordering Information,” in appendix). Have students observe the growth of algae by “searching” a drop of the water each day under a microscope. By the time the water turns green, one drop should show many tiny algae cells.

Activity: Soil Search

Life in an organic soil sample may be hard to locate. Have students use Berlese funnels to “sift” through soil samples. This kind of funnel will collect many arthropods from apparently lifeless soil or leaf litter. Have students observe these arthropods under microscopes. (Berlese funnels available from Carolina Biological Supply Company-see
“Ordering Information,” in appendix.)

Activity: The Chia Monster

Chia, cress, or any other tiny seeds that appear to be lifeless can be mixed into sterile potting soil and “activated” with water. Have students spread such seeds onto soil samples in patterns, making a “secret message.” When the seeds sprout, the messages can be read.

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Soil Sample Analysis-Teacher's Key

1. Movement, recognizable shape, growth.

2. Recognizable shape, but it is no longer moving.

3. No movement or recognizable shape; crystalline or geometric form; recognizable as a nonliving thing (*e.g.*, a glass bead!).

4. Adding water to the soil caused eggs to hatch into brine shrimp. The water activated dormant life. It was easier to tell that life was present because it made the presence of life obvious: moving, shrimp-shaped animals instead of round nonmoving balls.

5. A single close-up photograph would pose problems. We would have to rely upon obvious shapes. (A series of still photographs taken at the same spot could reveal movement from frame to frame.) Color might help; green might indicate chlorophyll.

6. Yes! In both samples, recognizable animals were moving around.

7. No! There was no obvious life in Earth Sample # 1 when it was dry. (The brine shrimp eggs were not moving so did not look like life.)

8. Life must be abundant on Earth! Two random samples both contained obvious life. Also, life on Earth must like water.

9. Earth Sample # 1 is probably most like soil on Mars since it was much drier, and we know that Mars has no liquid water. Also, the topsoil looked organic, which is very unlikely for Martian soil.

10. It might be difficult to find life on Mars. A random sample would be small and, by chance, might not have life. It would be a good idea to add water to a sample of Martian soil to see if it would activate any dormant life. We know that Mars once had water maybe some life has survived!