3-5 Decomposition Terrarium Activity

Overview

Focus Question
Are worms important to plants?

Activity Synopsis
Students will conduct an experiment in which they observe:
1. the rate of decomposition of different organic and inorganic materials
2. the effect that worms have on the rate of decomposition of these materials and on soil quality

Time Frame
The initial set-up of the experiment will take approximately three one-hour periods. Less time will be required if worm "recycling centers" are constructed prior to first class session. You may want to consider constructing worm recycling centers outdoors to reduce clean-up. Worm recycling centers should be observed once a week for one month. Observations should be recorded. Each observation recording session will take approximately twenty minutes.

Objectives
The learner will be able to:
- Conduct and keep records of a simple experiment on decomposition.
- Describe how decomposers, like earthworms, cause changes in the environment in which they live.
- Describe the important role that decomposers play in communities.

Student Key Terms
- community
- decomposer
- population

Teacher Key Terms
- carnivore
- consumer
- decomposer
- ecosystem
- food chain
- food web
- herbivore
- niche
- omnivore
- photosynthesis
- population
- producer

Standards

2014 Academic Standards and Performance Indicators for Science

3rd Grade: 3.S.1A.1, **3.S.1A.3**, 3.S.1A.6, 3.S.1B.1, 3.L.5A.1, **3.L.5A.2**
4th Grade: 4.S.1A.1, **4.S.1A.3**, 4.S.1A.6, 4.S.1B.1, 4.L.5B.3
5th Grade: 5.S.1A.1, **5.S.1A.3**, 5.S.1A.6, 5.S.1B.1, 5.L.4A.1, 5.L.4A.2, **5.L.4B.1**, 5.L.4B.3, 5.L.4B.4

*** Bold standards are the main standards addressed in this activity**

Third Grade Performance Indicators

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3.S.1A.1 Ask questions that can be (1) answered using scientific investigations or (2) used to refine models, explanations, or designs.
3.S.1A.3 Plan and conduct scientific investigations to answer questions, test predictions and develop explanations: (1) formulate scientific questions and predict possible outcomes, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.
3.S.1A.6 Construct explanations of phenomena using (1) scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.
3.S.1B.1 Construct devices or design solutions to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the devices or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.
3.L.5A.1 Analyze and interpret data about the characteristics of environments (including salt and fresh water, deserts, grasslands, forests, rain forests, and polar lands) to describe how the environment supports a variety of organisms.
3.L.5A.2 Develop and use a food chain model to classify organisms as producers, consumers, and decomposers and to describe how organisms obtain energy.

Fourth Grade Performance Indicators

4.S.1A.1 Ask questions that can be (1) answered using scientific investigations or (2) used to refine models, explanations, or designs.
4.S.1A.3 Plan and conduct scientific investigations to answer questions, test predictions and develop explanations: (1) formulate scientific questions and predict possible outcomes, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.
4.S.1A.6 Construct explanations of phenomena using (1) scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.
4.S.1B.1 Construct devices or design solutions to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the devices or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.
4.L.5B.3 Construct explanations for how structural adaptations (such as methods for defense, locomotion, obtaining resources, or camouflage) allow animals to survive in the environment.

Fifth Grade Performance Indicators

5.S.1A.1 Ask questions used to (1) generate hypotheses for scientific investigations or (2) refine models, explanations, or designs.
5.S.1A.3 Plan and conduct controlled scientific investigations to answer questions, test hypotheses and predictions, and develop explanations: (1) formulate scientific questions and testable hypotheses, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.
5.S.1A.6 Construct explanations of phenomena using (1) scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.
5.S.1B.1 Construct devices or design solutions to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the devices or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.
5.L.4A.1 Analyze and interpret data to summarize the abiotic factors (including quantity of light and water, range of temperature, salinity, and soil composition) of different terrestrial ecosystems and aquatic ecosystems.
5.L.4A.2 Obtain and communicate information to describe and compare the biotic factors (including individual organisms, populations, and communities) of different terrestrial and aquatic ecosystems.
5.L.4B.1 Analyze and interpret data to explain how organisms obtain their energy and classify an organisms as producers, consumers (including herbivore, carnivore, and omnivore), or decomposers (such as fungi and bacteria).
5.L.4B.3 Construct explanations for how organisms interact with each other in an ecosystem (including predators and prey, and parasites and hosts).
5.L.4B.4 Construct scientific arguments to explain how limiting factors (including food, water, space, and shelter) or a newly introduced organism can affect an ecosystem.

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Cross Curricular Standards

South Carolina College and Career Standards for ELA
Writing (W) – 3-3.1, 4-3.1, 5-3.1

ELA Standards Supported in Decomposition Terrarium Activity
Writing – 3.1, 3.2, 3.4, 4.1, 4.4, 5.1, 5.4

Background

Key Points
Key Points will give you the main information you should know to teach the activity.

- **Decomposers** are organisms that break down non-living organic material by feeding on it. By doing this, decomposers help return nutrients to the **ecosystem**, which can then be used by plants and other living things.
- Earthworms are decomposers that feed on organic material in the soil. They cannot feed on inorganic material. Plants in the **community** depend on earthworms because their feces contain the nutrients they need to survive.

Detailed Information
Detailed Information gives more in-depth background to increase your own knowledge, in case you want to expand upon the activity or you are asked detailed questions by students.

South Carolina is home to many different species of worms. Some are **carnivores**, like the aquatic chaetognaths, with protrusible jaws that are used to capture prey. Many worms that live on land, like earthworms, and many that live in the water, like ice cream cone worms, are **decomposers** and recycle nutrients by ingesting soil or mud and pieces of non-living organic matter (like pieces of leaves, grass clippings, salt marsh grass), and returning those nutrients to their communities through the process of defecation. Worms enrich the soil or mud in the **community** in which they live by recycling nutrients from organic material that would otherwise be unavailable, and returning them to the soil. By creating vast networks of tunnels that help air and water to reach other soil-dwelling decomposers (millipedes, centipedes, bacteria, beetles,…), worms help to speed up the rate of decomposition. Believe it or not, more than 5 billion organisms may be contained in a single cup of soil!

All of the organisms that inhabit a particular area comprise a community. Within a community, decomposers, like earthworms, depend on plants. Non-living pieces of plants (leaves, fallen tree trunks) provide food for decomposers. Likewise, plants depend on decomposers. Plants are **producers** and can harvest energy from the sun to make their food. This is done through the process of **photosynthesis**. However, terrestrial plants also need to uptake minerals from the soil using roots in order to survive. Decomposers provide these essential minerals to plants in a form that the plants can use. Because plants depend on decomposers, decomposers play a key role in **food chains** (and food-webs) in both terrestrial and aquatic systems. Producers depend on decomposers and **consumers** (**herbivores**, **omnivores** and carnivores) depend directly or indirectly on plants.

A **population** of organisms consists of all individuals of a species that occur together at a given place and time. Each worm recycling center will contain its own population of worms. All of the different populations that are living in the same place and the physical factors with which they interact compose an **ecosystem**. Each worm recycling center will be an ecosystem created by soil, water, and non-living organic and inorganic material (the physical factors), a population of worms and possibly an array of other living organisms. A **niche** is the role an organism plays in its community or ecosystem; in the worm recycling centers the worms play the role of decomposer. Students can observe how worms speed the process of decomposition and enrich soil by placing worms in containers that house a variety of organic and inorganic material. The worms, in addition to bacteria and fungi, will begin to decompose the organic and some of the inorganic materials. The rate of decomposition of each material will depend on its molecular make-up. Those materials, like vegetable scraps, coffee grounds, and grass clippings, with a carbon to nitrogen ratio close to 30:1 will be decomposed the fastest. Students should observe how the worms cause change in the environment in which the worms are living. Inorganic materials, like plastic and Styrofoam, take hundreds of years to decompose. Thus, students will observe no change over time in the appearance of inorganics and should be encouraged to think about or discuss the ways in which humans cause change in the environment where they live.

South Carolina Aquarium Spotlight Organism: The Earthworm

Horticulturalists at the South Carolina Aquarium love earthworms! Why would someone who takes care of plants really get into earthworms? Well, here is the scoop.

There are more than 3,000 species of earthworms and earthworms live almost everywhere that there is moist soil. One acre of cultivated land may be home to as many as 500,000 earthworms, each making the soil a better place for plants.

The four-inch long, pale red garden worm is often called nature's plow. The earthworm pushes through soft earth with the point of its head. If the soil is hard, the worm eats its way through, forming interconnected burrows, some several feet deep. Earthworms, like chickens, have a digestive system equipped with a gizzard. A gizzard is a sac with muscular walls. The muscles of the gizzard, combined with mineral particles and very small stones ingested by the earthworm help to grind food thoroughly. Burrows loosen the soil, admitting air and water and helping roots grow.

As an earthworm feeds, organic matter passes through its body and is excreted as granular dark castings (fecal matter). You may see these small casting piles in your garden. An earthworm produces its weight in castings daily. Wormcasts are rich in nutrients otherwise unavailable to plants. When you add nitrogen-rich compost to your soil, you help worms. An earthworm's body is 72% protein, so it requires lots of nitrogen (the building blocks of protein) to maintain itself. However, adding synthetic nitrogen fertilizers may repel earthworms. Worms are sensitive to physical and chemical changes and will flee the salty conditions that result from an application of chemical fertilizer. Earthworms will not burrow into soil with a pH below a certain level, which varies from species to species. Acid-sensitive nerve fibers are present all over the body. Thus, earthworms can be used as bioindicators (1).

The effects of earthworms on the soil are many. Both the castings, which become mixed with the soil, and the open channels created by burrowing ease the down growth of roots and enhance the fertility of the soil by increasing aeration and increasing drainage. The thorough grinding of soil in the gizzard is an effective kind of soil cultivation. When earthworms are present in the soil, agricultural productivity is generally higher, and in some cases greater crop yields have been achieved by introducing earthworms into soils (2).

Earthworms are segmented and their bodies look like a series of attached rings. Each segment of an earthworm contains four pairs of bristles. These bristles aid the worm in locomotion and also can make it very difficult for a bird or a curious human to pull it out of its burrow.

Earthworms, like sea stars, are also capable of regenerating lost body parts. Both the head and the tail of an earthworm can be regenerated, within limits. The extent of regeneration depends on the species, as well as on the position of the "wound" and the size of the worm fragment that remains (2).

Earthworm Life Cycle:

In cold weather, a soil search will turn up mature and young earthworms as well as eggs. By late spring, most worms are mature. As temperatures rise, activity slows; many lay eggs and then die. By midsummer, most worms are very young or protected by egg capsules. As the weather cools, young worms emerge. With wet weather, they grow active, making new burrows and eating extra food, resulting in more worm casts. Egg laying again occurs. Activity continues as long as soil stays damp.
After a heavy rain, earthworms often appear above ground. They haven't drowned. Fresh water doesn't disturb earthworms--they need ongoing skin moisture to breathe--but stagnant or contaminated water forces them from their burrow (1).

Earthworms are hermaphroditic which means that each worm has a complete set of male and female body parts!

Earthworms are eaten by some snakes, centipedes, large beetles and birds (primarily the robin and the woodcock). The niche an earthworm fills in an ecosystem is as a decomposer.

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Horticulturalists at the South Carolina Aquarium have added a species of earthworm, *Lumbricus terrestus,* to the soil in the mountain forest aviary. They know that the earthworms will help to keep the plants in the exhibit healthy.

1. (Year). Bradley, Fern M., and B. Ellis. Rodale's All-New Encyclopedia of Organic Gardening: the Indispensable Resource for Every Gardner. Saint Martin's Press.
2. (1987). Pearse, Vicki and J. Pearse et al. Living Invertebrates. Blackwell Scientific Publications and the Boxwood Press.

Procedures

Materials

- Clear plastic two-liter soda bottles (two per student team) (For consistent gathering of data, make sure all bottles used are clear plastic)
- Scissors
- Two-inch square pieces of cheesecloth, pantyhose, or handiwipes
- Rubber bands (two per student team)
- Tape
- One bag of sand or small-sized gravel
- One bag of garden soil
- Worms (100 total)
- Water
- One-cup measuring cup (one per student team)
- Organic material in separate containers: choose any three items such as grass clippings, coffee grounds, newspaper strips, pine needles, pieces of lettuce, pine needles, leaves; do not use anything that contains meat or fish
- Inorganic material: choose any one item such as plastic, Styrofoam, or fabric
- Ziploc bags (one per student team)
- Newspaper
- Sticks (coffee stirrers or pencils will do)
- Rubber gloves
- Camera or colored pencils/crayons
- Worm Journal (one per student/student group)

Procedure

Each student team will need two worm recycling containers. The following steps can be done prior to the first class session to save time, if needed:

1. Remove the label from the plastic soda bottle.
2. Cut the bottle into two sections; make the cut approximately one-third of the way from the bottom.
3. Cover the mouth of the bottle with a square of pantyhose, cheesecloth, or handiwipe and secure the material to the bottle using a rubber band.
4. Turn the top section of the bottle upside down and place it in the bottom section. Tape the two sections together with clear tape.
5. Place one cup of sand in the worm recycling center.

Students should complete the following tasks once recycling centers are created:

1. Ask student teams to closely observe the organic and inorganic materials to formulate descriptions of how they appear.
2. Students should record these observations in writing or through drawings. If a camera is available, take a picture of each material (pictures and/or descriptions will serve as a control so that one month later students can compare what the materials look like before and after the experiment).

3. Ask student teams to predict which materials will decompose quickly and which will decompose slowly and to record their predictions in journals
4. Ask each student team to choose one material to study in their experiment; ensure that within the entire class at least two different types of organic materials and at least one type of inorganic material are involved in experiments. You can also assign materials to teams to ensure that an array of materials is studied.
5. Ask each student team to take one-half cup of soil and place it in a labeled Ziploc bag for future comparative study (this is a control sample so that students can compare the soil enriched in the worm recycling centers one month later to the soil sample taken at the beginning of the experiment).
6. For each of the two worm recycling centers, student teams should then place two cups of soil on top of the sand, followed by one cup of organic or inorganic material. Repeat this until the soda bottle is three-quarters of the way full. The top layer should be a layer of soil. Students should use only one type of organic or inorganic material per container.
7. Students should then add twenty worms to ONE of the containers. The other container should just contain a mixture of soil and organic or inorganic material. Cover the top of both containers with pantyhose and wrap with a rubber band. The "wormless" recycling center acts as a control to the recycling center with worms; students will be able to compare the contents of each container to determine what effect worms have on decomposition.
   **Students should add one cup of water to each recycling center and place the recycling centers where they will not be disturbed but are accessible for observation.*
8. Students should observe the recycling centers once a week and record their observations in their worm journals.
9. It would also be nice for the students to take pictures as they observe their recycling centers each week. If you don't have access to a camera or a way to print pictures, have them draw their observations in the journal
10. After students have recorded their observations, students should add one-half of a cup of water to their containers (containers need to be watered weekly).
11. At the end of one month, students should pour the contents of each container onto a separate sheet of newspaper and spread out the contents using a stick.
12. Students should walk around the room and observe the contents of each container. They should try to answer the following questions through their observations:
    a. How do the materials from recycling centers that contained worms compare to those that did not contain worms?
    b. How does each material compare to what it looked like at the beginning of the experiment?
    c. Which materials decomposed the most? Are there any materials that did not decompose at all?
    d. Would an earthworm be able to break down most litter if it were left in the woods?
    e. How is the earthworm beneficial to a wildlife community?
13. You can ask students to record observations in their worm journals individually, in student teams or as a whole class.
14. Students should return worms to a compost pile (most commercially bought worms are not capable of surviving in a garden).

Follow-up Questions

- Would a farmer want earthworms in his/her garden? Why?
- What would the world be like without decomposers? Would you want to live there?
- Imagine a person who hates worms, maggots and flies. What could you say to them so they understand the importance of decomposers?

Assessment

Your finished product for this activity will be an earthworm's journal. For each entry, students should record their observations, remind them to:

- Tell what changes they observe and what stays the same.
- Be very detailed about what they observe.
- Tell the whole story. What happens to the organic or inorganic material in your recycling center? Is it disappearing? If so, where is it going?
- Think about the role the earthworm is playing in the wildlife community and how it helps the community.

It would also be nice for the students to take pictures as they observe their recycling centers each week. If you don't have access to a camera or a way to print pictures, have them draw their observations in the journal.

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Conclusion Questions:

1. How do the materials from recycling centers that contained worms compare to those that did not contain worms?
2. How does each material compare to what it looked like at the beginning of the experiment?
3. Which materials decomposed the most? Are there any materials that did not decompose at all?
4. Would an earthworm be able to break down most litter if it were left in the woods?
5. How is the earthworm beneficial to a wildlife community?

Scoring rubric out of 100 points

Complete each journal entry:	10 points each (5 entries, 50 points total)
Correctly answer conclusion questions:	10 points each (5 question, 50 points total)

Cross-Curricular Extensions

STEM Extension

After students research about landfills, have them design on the computer a new type of landfill using what they learned from the activity. Have them build a model from their design and then report to the class why they chose the design they did.

Language Arts Extension

Have students imagine that they are earthworms. They have been placed in a "worm recycling center". Have them use creative writing to complete the following:

1. Use words and pictures to describe what you see as you travel through the recycling center on the first day.
2. Use words and pictures to describe how things have changed after one week.
3. Use words and pictures to describe how things have changed after two weeks.
4. Use words and pictures to describe how things have changed after three weeks.
5. Use words and pictures to describe how things have changed after one month.
6. Use words and picture to describe what it might be like after a whole year.

Art Extension

Have students create posters that show why decomposers are important to communities.

Social Studies

Have students research what happens to wastes in their area. Have them start a composting project in the school to take advantage of decomposers and to reduce the amount of wastes going to local landfills.

Resources

Teacher Reference Books

Appelhof, Mary, *Worms Eat My Garbage,* Flower Press, 1982.
Provides information on setting up and maintaining worm composting systems.

Larson, Gary, *There's A Hair In My Dirt!,* Harper Perennial, New York, 1998.
This book provides a hilarious look at a maiden's view of the surrounding forest and the recycler's role in the habitat through the eyes of Father Worm. The book is not suitable for children but an excellent resource for teachers.

McLaughlin, Molly, *Earthworms, Dirt, and Rotten Leaves,* Macmillian Publishing Co., New York, 1986.
Examines the earthworm and its environment, also includes experiments.

Teacher Reference Websites

The Compost Resource Page
www.oldgrowth.org/compost
Basic information on earthworms and vermicomposting is provided.

The Yuckiest Site on the Internet
http://yucky.kids.discovery.com
This is a wonderful site! It provides kids with background information on earthworms and their job in recycling organic wastes. It also introduces children to five different worm species and their role in the environment.

WormWoman
www.wormwoman.com
This web site provides detailed information on vermicomposting. What is it, how to start, and the benefits of using earthworms for composting are discussed.

Student Reference Books

Glaser, Linda, *Wonderful Worms,* Millbrook Press, Connecticut, 1992.
Describes the physical characteristics, behavior and life cycle of common earthworms.

Henwood, Chris, *Earthworms*, Franklin Watts, New York, 1988.
Provides basic information on earthworms; body descriptions, building a terrarium and worm reproduction.

Lavies, Bianca, *Compost Critters,* Dutton Children's Books, New York, 1993.
Describes what happens in a compost pile and how creatures aid in the process of breaking compost into humus