Teacher's Guide

Action on WASTE

Alberta
ENVIRONMENTAL PROTECTION

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Table of Contents

Introduction 1

Objectives of this Guide 2

Background for Teachers 3

Logistical Stuff to Consider 5

Compost Activities 6

Composting ... Why Bother? 8

Personal Audit 11

Discovering the Compost Cube 13

Building Your Miniature Composter 15

A Cast of Characters ... Discovering Compost Organisms 17

Air Spaces and Water ... What's the Connection? 21

Aerobic or Anaerobic Composting ... What's the Difference? 24

Big Chunks or Little Chunks ... How Does Size Affect Composting Rates? 27

How Does Temperature Affect Decomposition Rates? 29

How Hot Can It Get? Finding Out the Temperature of Your Compost 31

Living Things in Your Compost ... Are They Necessary? 33

Growing Plants With Compost 35

Comparing Compost to Commercial Fertilizers 38

Introducing the Red Wiggler 40

Hatching Cocoons 45

Changing Populations 47

Compost Consultants ... Teaching Others About Composting 50

HELP! A Guide to Common Problems and Solutions to Composting 51

Glossary for Teachers 56

Appendix I: Compost Pile Food Web 58

Appendix II: Additional Resources 59

NOTES

Introduction

Composting projects at home or at school provide excellent opportunities for exploration and investigation. Many science inquiry skills can be learned and practised while students focus their attentions on the variables and problem solving skills necessary to maintain a working compost bin. Students can determine the effectiveness of various composting variables, problem solve, and apply their newly acquired knowledge towards more effective and efficient composting techniques. These skills can then be shared with others.

This guide contains a series of activities that will promote a positive attitude towards composting, an awareness of why composting is important, an understanding of how to resolve problems associated with composting and the recognition that composting is an important waste minimization process that has far reaching economic and environmental benefits.

For various reasons, schools may not always be the ideal situation for setting up a composting program. Several activities included in this guide address this problem and suggest alternatives that will still realize the goals of this guide.

The Objectives of this Guide are:

- to help students recognize the importance of composting as one part of the larger issue of waste management
- to empower students to play a role in minimizing waste through composting
- to provide students with the knowledge and skills required to effectively set up and manage an active compost bin
- to provide a working knowledge of the principles behind composting, enabling students to solve potential problems associated with composting
- to encourage a positive attitude towards an activity that has far reaching environmental and economic benefits
- to encourage the students to share this knowledge with other individuals at home, in school and in their community

Background for Teachers

The materials

There are two booklets that accompany this teacher's guide. Both of these booklets *Taking Action Through Backyard Composting* and *Taking Action Through Vermicomposting* offer complete instructions on how to get started with these projects. A glossary and suggestions for additional reference materials completes this package.

The audience

The activities in this booklet are primarily written for students in division three, but they can be used by any class having an interest in learning about composting.

The goal

Alberta's Action On Waste initiative has set a goal for the year 2000 to reduce the amount of solid waste going into landfills by 50% of 1988 levels. Composting will help to reach this objective. Organic garbage from kitchens and yards make up approximately one third of all the waste currently being brought to landfills. Individuals who combine composting with reducing reusing and recycling, can reduce the amount of garbage they send to the landfill by over fifty percent. The information and activities in this booklet provide suggestions and encourage students to help reach this goal.

What is composting?

Composting is a process where organic materials such as yard and kitchen wastes are broken down through the action of microorganisms into humus, a soil enhancing material. The nutrients released from the compost can be reused by plants. Composting reduces the volume of waste going to landfills.

Environmental factors

These include all the factors necessary for maintaining a healthy and active microorganism population. The health of the microorganism population will determine the rate and extent of the composting process. Essentially, there must be a proper balance of food, air, water and temperature. Environmental factors include:

- Carbon : Nitrogen ratio
- oxygen availability
- temperature
- particle size
- moisture content
- pH

Oxygen availability

There are two kinds of composting; aerobic and anaerobic. Aerobic composting requires oxygen. The other type, anaerobic composting, does not. Both processes break down organic waste into a material that can be used as a soil conditioner. There are significant differences between these two processes in terms of how much effort is involved, the time it takes to finish composting, the type of end products produced and the quality of the finished compost. The composting method that individuals choose depends on their preference and situation.

The two types of composting processes can be described in an equation form:

aerobic composting:

organic materials + oxygen + water = carbon dioxide + water + energy

anaerobic composting:

organic materials + water = carbon dioxide + methane + hydrogen sulfide* + energy

**Hydrogen sulfide is a gas that has a very unpleasant "rotting egg" odour*

Aerobic composting is a more efficient process. This means that the energy stored in the organic material is converted and used more readily by the microorganisms. In the process of breaking down this material, the organisms also release carbon dioxide, water and energy in the form of heat.

Anaerobic composting is a slower process that does not produce as much heat. The methane and hydrogen sulfide produced by this process are responsible for the bad smell of rotten eggs. For this reason, anaerobic composting requires air-tight containers. Occasionally, aerobic compost piles run out of available oxygen and become anaerobic. Because these piles are not sealed in containers, the odours escape freely. It is this situation that often gives backyard composting a bad reputation. This situation can be easily remedied with a small amount of maintenance.

Temperature

Heat is a by-product of the normal metabolic activity of the microorganisms. In aerobic composting, temperatures can reach up to 66 degrees Celsius. After four days at this temperature, many harmful microorganisms and unwanted weed seeds will die. This means that the finished compost can be safely used as a soil conditioner. The temperature of the compost pile is determined by the amount of metabolic activity and the size of the pile. Heat does not escape as quickly from larger piles and so they can reach higher temperatures for longer periods of time. The types of bacteria present in the compost pile changes with the temperature. Some bacteria are more suited to lower temperatures and other bacteria thrive at warmer temperatures.

The biological activity and consequently, the temperature of a compost pile is controlled through aeration and by controlling the moisture level in the pile. Aerating the pile causes a brief drop in temperature followed by a return to higher temperatures as biological activity picks up with the increase in oxygen availability.

Not aerating the pile will cause the temperature to drop because the activity of the microorganisms will slow down. If oxygen levels continue to decrease, the pile will turn anaerobic.

Moisture content

If the compost pile is too dry (below 8-12% moisture), the microorganisms will not be able to function. Adding moisture to a dry pile increases activity and will cause an increase in temperature. The moisture level in the compost pile should meet the needs of the microorganisms. This depends on the volumes of materials present in the compost and how resistant they are to being compressed. Materials that are easily compressed will mat together and need to be mixed with bulking agents (branches, twigs etc.) to prevent this. If the compost pile becomes too moist, the tiny air spaces fill with water. This replaces the necessary air pockets that help maintain an aerobic state. Moisture content can easily be adjusted by adding more water or by aerating(turning) the pile.

Carbon Nitrogen Ratio

The types of nutrients being added to the compost pile can affect the rate at which the composting process occurs and the quality of the finished compost. Green organic waste is rich in nitrogen and is important for the growth and reproduction of the microorganisms. Brown organic waste such as old leaves, twigs, branches, sawdust and wood chips are rich in carbon and is an essential energy source to the organisms in the compost pile. A ratio of 25 parts carbon to 1 part nitrogen is the recommended amounts to feed your compost. If too much green material is added to the compost, the bin will start to release methane gas because there is not enough carbon present to complete the breakdown process. In this case, adding more brown material and turning the compost pile will help to remedy the situation.

Particle size

The greater the surface area, the more rapid the microbial action. This is because more microorganisms can get to work at breaking down the organic material. If the particle sizes are too small however, oxygen molecules are prevented from moving through the compost and anaerobic conditions will result.

Logistical Stuff to Consider

Support

School composting projects will go along more smoothly If you can get a little help and assistance from others. Before starting a project, you might want to consider getting the support and approval from these important people:

- Custodian
- Administrators
- Industrial Arts Teacher
- Other teachers

Location

- Needs to be accessible, but not in the way
- Can be in direct light or in a shaded area. These will have different maintenance requirements.

Collecting Compostable materials

- Include yard waste from school as well as lunch waste.
- Don't collect more than your bin will handle.

Maintenance

- Keep the compost bin and the surrounding area tidy. Have a crew of students responsible for insuring this. Set up a schedule with your class or environment club.
- Keep all shovels, pitchforks and other implements inside and take them out only when they are to be used.
- This is your project, don't delegate the primary responsibility to someone else.

Seasonal breaks

Starting or finishing a compost project is often influenced by the season and by holidays. Composting projects can be started early in the school year, or in Spring. Summer holidays leave you with several alternatives:

- Do you shut down the project? Or,
- Is there a neighbour or someone who is willing to continue giving the compost bin some attention during these school breaks?

Getting More Information

- Alberta Environmental Protection Composting Brochures
- Appendix II

Compost Activities

"What! ...
You can't compost at your school?"

Well, that's no reason to get discouraged. Sometimes there are too many obstacles in the way to get a compost pile up and running in a school yard (but there are lots who do!). This doesn't mean that composting can't be taught in the classroom. Options range from setting up a miniature composter in the classroom, vermicomposting, visiting neighbours who are willing to share their compost pile with a class of curious students, or, starting a neighbourhood / community compost project with the cooperation of community groups or parents. Be creative! you are limited only by your imagination. At the very least, bring some of your own compost from home along with a few pictures.

Some of the activities in this guide don't require a compost pile set up in the school yard. But, see if you can, those obstacles you envision might not be so imposing after all!

George Millar, a teacher in Edmonton has tried composting at his school. Excerpts from an interview with George will give you some ideas (and some motivation!) to try composting at your school.

Question: When did you start building your compost box?

George: Four students helped me build Glendale's first compost box in April 1990. We made it from fence boards and waste lumber from a construction site. (Yes, we did get permission first!")

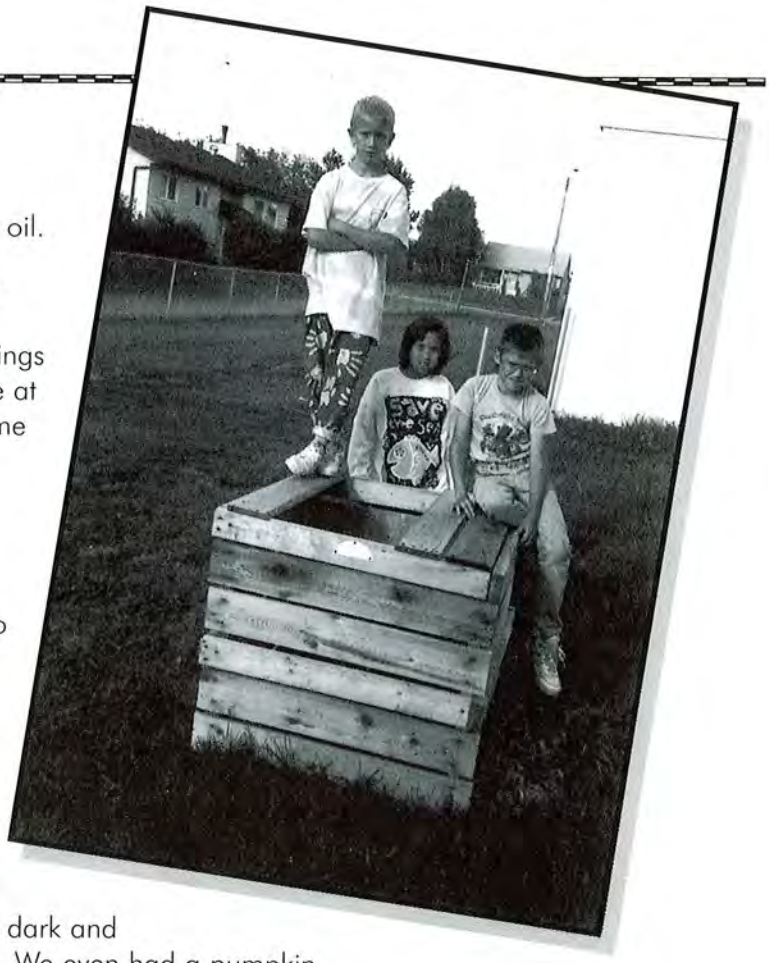
Question: Was it hard to build?

George: No sweat, it was a breeze.

Question: What went into the box?

George: Vegetable scraps, coffee grounds and tea bags from the staff room, hamster litter, wilted flowers, aquarium water, burned toast and non-meat lunch scraps.

Question: What didn't you put into the compost bin?



George: Dairy products, fats, meat or oil.

Question: Did things start composting?

George: Oh yes, very well indeed. Things started to compost in no time at all after we turned it a few time with a pitchfork.

Question: Did it ever stink?

George: Well, a few times. The pumpkins we added were too much. They turned pretty gross!

Question: How did you know when your compost was ready?

George: There were earthworms in the bottom of the bin, the stuff we put in the bin looked dark and crumbly and smelled like soil. We even had a pumpkin growing on the top!

Question: Did you keep adding things through the winter?

George: Yes, we added things and covered them with some soil every week. The soil had been saved in a garbage can in the boiler room. We turned it in the spring.

Question: Where did you use the compost?

George: We dug a trench along the east wall of the school and put in the compost. We planted tulips and they were blooming for Mother's Day!

Question: Would you do this again?

George: Yes, absolutely! In fact ...

*we've started a **second** bin.*

Composting ... Why Bother?

To keep a landfill open as long as possible we need to reduce the amount of unnecessary waste that goes there each day. Yard waste and other organic garbage can be composted rather than being hauled away to the landfill site. By composting these huge volumes of organic waste, the lifespan of the landfill site can be extended. This can save the municipality money because they do not have to pay for collecting, transporting and landfilling compostable garbage. They also save money on the cost of finding and developing new landfill facilities. These savings can be passed on to the taxpayers, or the money can be used for other necessary projects.

Purpose

To demonstrate that the volumes of organic, compostable materials generated by our society can significantly reduce the lifespan of a landfill if they are not composted.

Materials

- graph paper
- landfill volume chart
- pens (2 colours)

Procedure

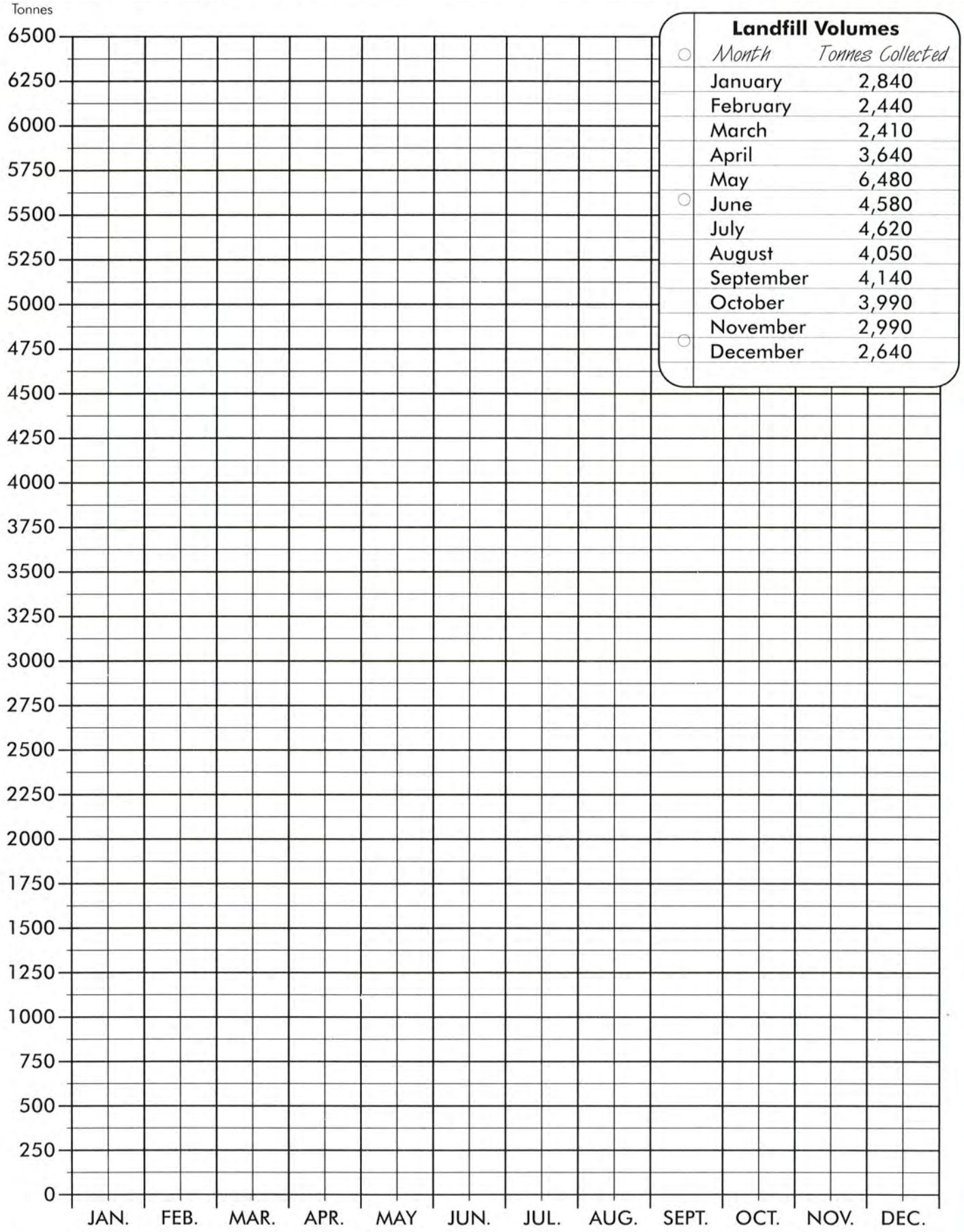
1. Use the information from the landfill volume chart to plot points on the graph.
2. Draw a line connecting the points on the graph.
3. Calculate the average volume of garbage that is landfilled each month. Draw a horizontal line that corresponds to this average volume. Colour the area of the graph that is below this line.
4. Using a different pen, shade in the region on the graph that is above the average volume of garbage that is landfilled each month. This extra volume occurs during the growing season and is caused by the increased amount of organic garbage going to the landfill.
5. Use your completed graph to answer the following questions.

QUESTIONS

1. Which month has the highest volume of garbage going to the landfill?
2. What kinds of garbage would be most likely responsible for this extra volume?
3. Which month has the lowest volume of waste? Can you provide an explanation for this?
4. Suppose the peak monthly volumes for the months of May through September could be reduced by 20%, how would this affect the yearly average?
5. Do garbage truck drivers in your community get paid by volume or by hours of work? Could this affect a communities decision to start a composting program? Why?
6. Would your community benefit from a compost program? Find the average monthly volumes that are landfilled in your community and determine how much of this is organic material that could be composted. What is your community doing?
7. Edmonton's Clover Bar landfill has a methane recovery station. How do you think this methane is produced? How much methane is recovered, and how is it used?

1993 Average Monthly Residential Tonnes Collected

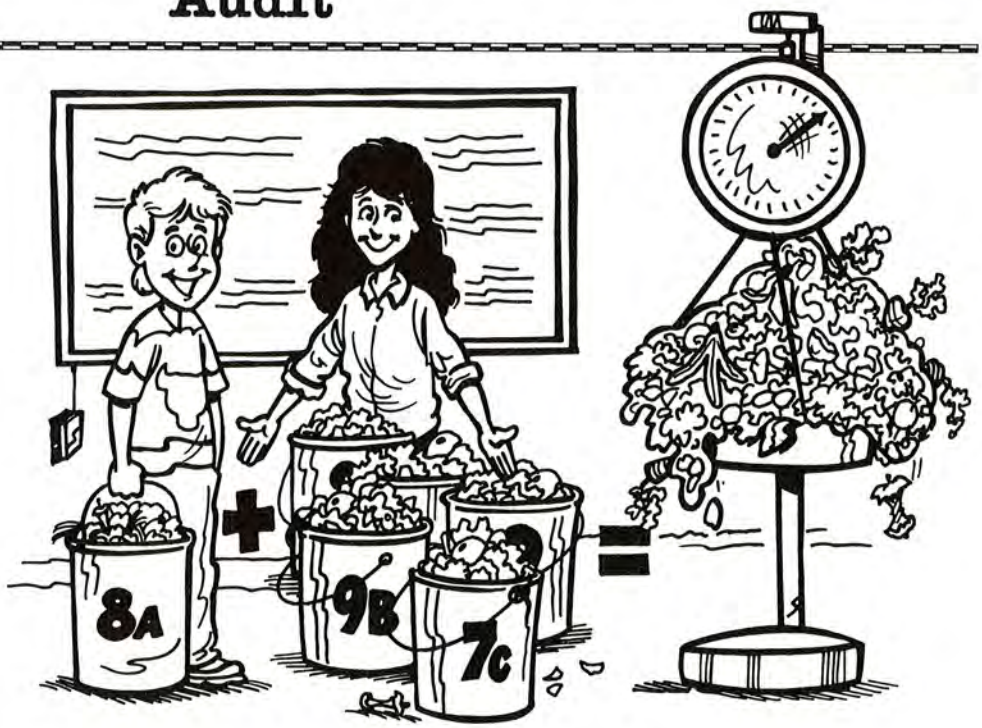
(Calgary 1993 Statistics)



Landfill Volumes

Month	Tonnes Collected
January	2,840
February	2,440
March	2,410
April	3,640
May	6,480
June	4,580
July	4,620
August	4,050
September	4,140
October	3,990
November	2,990
December	2,640

Personal Audit



Many people don't want to start a compost project because they think their actions won't make a difference. An audit is one way of finding out how much of a problem actually exists and gives us a focus to help find ways to solve the problem. Compostable garbage is vegetative waste that will decay into more simple nutrients that can be used as a soil conditioner. Yard and kitchen waste is commonly thrown out with other garbage to the local landfill area. Instead, this waste can be diverted by composting it and returning valuable nutrients to the soil.

Purpose

To find out how much compostable garbage we produce on a daily, weekly and monthly basis as individuals and as a class. By taking the time to complete this audit, we can see how much of a difference we can make towards reducing the volume of garbage going to the landfill.

Materials

- waste audit sheet
- weigh scale

Procedure

1. For one week, weigh the organic compostable waste that is left over from your lunch. Record this information in your waste audit sheet.
2. Use this information to calculate how much compostable lunch waste you generate in one month, in one year.
3. Compare your weekly, monthly and yearly totals with the other people in your class. Discuss why there might be any differences in the values you have calculated.
4. Calculate the average volume of compostable lunch waste generated by your entire class for one week, month, and year.

EXTENSIONS

1. Use the information you have calculated to make a convincing argument about why composting at school is a worthwhile activity.
2. Can you design and conduct a similar audit activity in your home? What waste materials would you include for composting at home?
3. Use the information you have gathered to calculate the volume of compostable lunch waste that is produced by your entire school.
4. What ideas and suggestions can you come up with to successfully collect and compost organic lunch waste for your classroom. What problems might be encountered, and how would you resolve them. Could this same system work for an entire school? Why or why not?

PERSONAL AUDIT

Day	Grams (g) of compostables
MON.	
TUES.	
WED.	
THURS.	
FRI.	
TOTAL	

Try these calculations:

School estimate per year.

Personal estimate for 12 years of school.

Kilograms of compostable garbage from 5 days of lunch

Daily average = Total ÷ 5

Monthly estimate = Total x 4

Yearly estimate = Total x 40*
*(*based on a 40 week school year)*

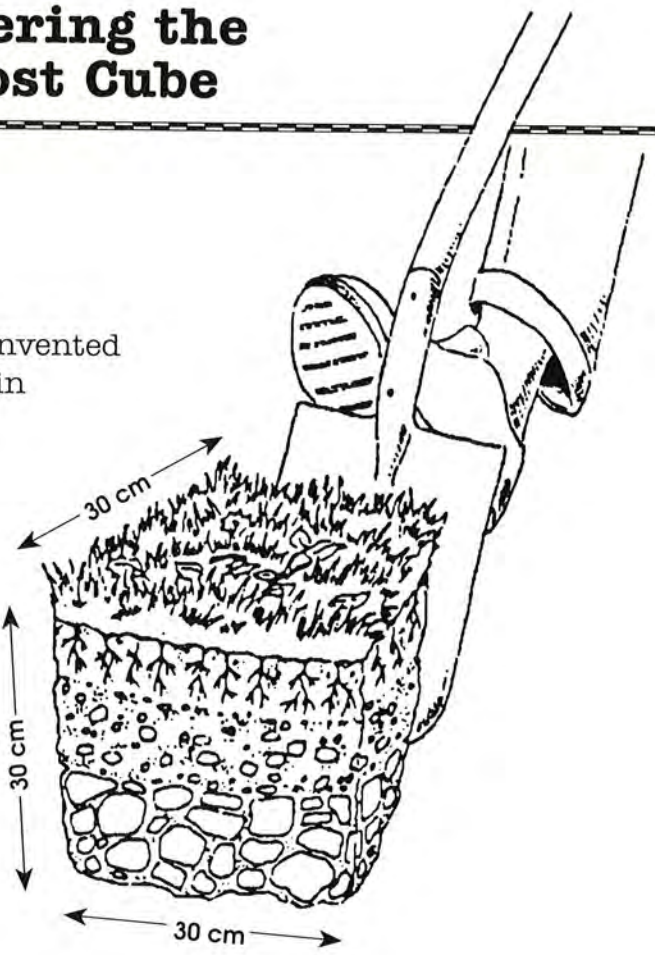
Class total per week = Sum of all individual audits

Class average per week = Class Total ÷ number of students

Class total per year = Sum of all yearly individual estimates

Discovering the Compost Cube

Composting is not a new process invented by humans but has been going on in nature for millions of years. The dead organic material that falls to the ground is broken down by the millions of tiny organisms living in the air and soil. The nutrients from this decayed organic matter is reused by other plants and animals that are part of the same ecosystem.



Purpose

To look at the composting process as it occurs in nature.

Materials

- 30 cm^3 patch of soil (one cube per group) from different areas e.g. undisturbed area under a tree, grassy area, vacant lot, along a roadway etc.
- ruler
- pen/paper

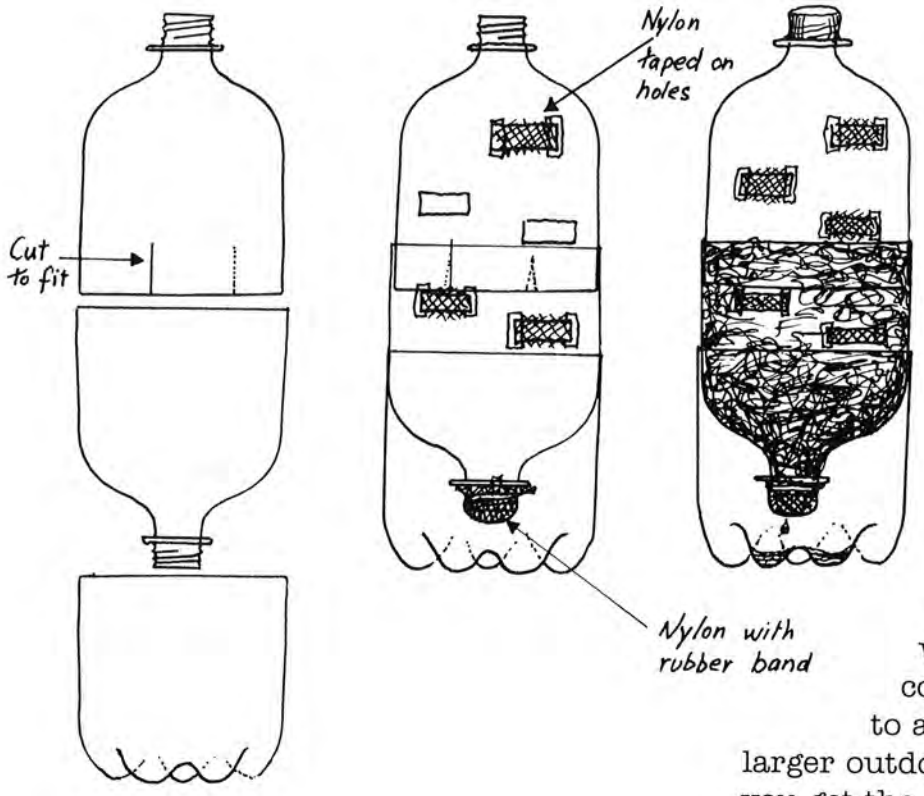
Procedure

1. Place one of the cubes on a piece of plastic. Look for different layers and discuss with your group how these layers are different.
2. Look for evidence of organic material that is in the process of decomposing. Can you recognize what these decomposing items were originally?
3. Look for small animals that make their home in the soil. Discuss with your group how these animals might be involved in the composting process.
4. Record your observations by illustrating the cube you are examining. Include the different layers, the vegetation and the animals.
5. When you are finished observing your cube, trade with another group. Look for any evidence of naturally occurring composting. Illustrate your observations. Compare this cube with the first cube you observed and discuss any similarities or differences.

EXTENSIONS

1. As a class, go outside to find areas where composting is taking place naturally. Discuss how composting in nature is different than the type of composting that people do in their back yards.

Building Your Miniature Composter



A mini-composter is one way of finding out many of the things you need to know about how and what to compost. By building a small composter, you can quickly test different variables such as temperature, the type of organic material being composted, soil types, moisture and the effect of particle size. By experimenting with different conditions, you will learn more about how composting works and be able to apply this information to a larger outdoor composting bin whenever you get the opportunity.

Purpose

To build a miniature composter and use it to become aware of the factors affecting the composting process.

Materials

- two-litre plastic pop bottles (2)
- nylon stocking or fine screen
- tape
- rubber band
- garden soil

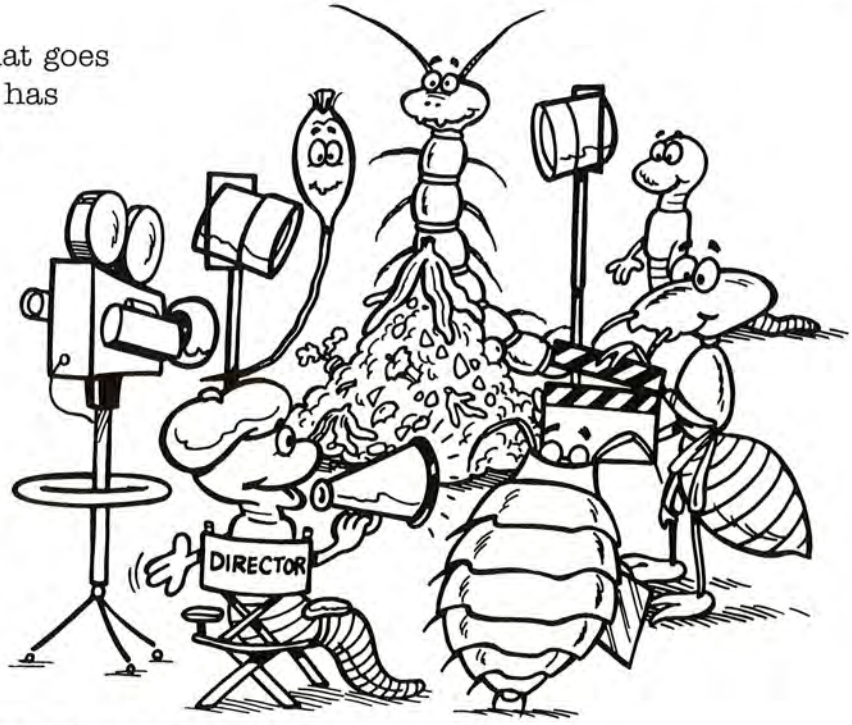
Procedure

1. Cut and arrange the plastic bottles using the illustrations as a guide.
2. Cut three or four air holes in the top two bottles approximately the diameter of your thumb. Cover these holes with pieces of nylon stocking and tape them in place. Stretch another piece of nylon stocking over the opening of the middle bottle and hold it in place with a rubber band.
3. Place soil in the middle bottle and bury small pieces of vegetable, fruit scraps or grass clippings. Add just enough water to keep the soil as moist as a wrung out sponge while allowing a few drops to drain into the bottom of the column.
4. Replace the top bottle making sure the holes remain uncovered so air can flow in and out of the compost column. Put the cap on the top bottle.
5. As you watch your composter, keep the soil moist by recycling the compost water from the bottom container back to the top bottle. Give your compost extra air by occasionally mixing it with a spoon.
6. Observe what happens in your composter. Is there any change in the organic debris or the soil? Is there any odour? Can you see any evidence of organisms? Use a magnifying glass to get a better look.
7. Find out what factors could be affecting the composting process. Many of the other activities in this guide can be done using the mini-composter.

EXTENSIONS

1. You can use the finished compost to grow your own flowers. Put some finished compost mixed with potting soil into some flower pots. Plant quick growing flower seeds and keep the pots in a sunny place. If you time it right, you can have some bedding plants ready to bring home in the spring!

A Cast of Characters ... Discovering Compost Organisms



What happens to all the waste that goes into a compost pile? The answer has a lot to do with the many living things that make a compost pile their home. These organisms are part of a complex web of life that uses the organic material inside the compost pile as a food source. Some organisms get to work eating the organic material directly. Other organisms see the compost pile as an ideal hunting ground and they scurry about catching and eating other living things. The compost pile is an amazing world in miniature. We provide the right conditions, and the organisms do the rest. These organisms break down the compost, loosen it up, move it around, digest it, and when they die add to the changing characteristics of the compost.

Purpose

To investigate and discover the many different types of organisms that make a compost bin their home.

Materials

- student readings on compost organisms
- partially finished compost
- specimen dish
- binocular microscope or magnifying glass (for getting a good look)
- spoon or tweezers
- white plastic container(s)
- appendix I (Compost Organisms)

Procedure

CAUTION

Students with allergies to compost should wear rubber gloves or work with a team in a role that does not require any direct contact with the soil or organic material.

1. Place a small handful of compost material into a white plastic container and carefully turn over the compost for signs of life. You may have to look at several samples.
2. Remove the captured organisms into separate small containers. Use a magnifying glass to get a better look at each organism you find. Note how the organism moves, how it eats, its outer covering and anything else that distinguishes it from other organisms.
3. Take a small amount of the compost and place it on a specimen dish. Use the binocular microscope to see some of the smaller organisms.
4. Draw illustrations of the organisms you have seen.
5. Match the organisms in your compost sample to the *Cast of Characters* descriptions. Use the illustrations in Appendix I to help identify the organisms and to see what their role is in the composting process.
6. Give your cast of compost characters the recognition they deserve! In groups, choose your favorite character (but make sure they all get chosen) and illustrate them in cartoon form. Write out their role in the community, their hobbies, favorite foods, ambitions and anything else that should be known about them. Feel free to use your creativity. Use library books to get more information on the organism you are illustrating. Display this cast of characters on one of the classroom walls or in school hallways.

EXTENSIONS

1. Produce a play or a puppet show that can go "on the road" to other classrooms. Use your show to introduce younger students to composting and to meet the composting organisms.

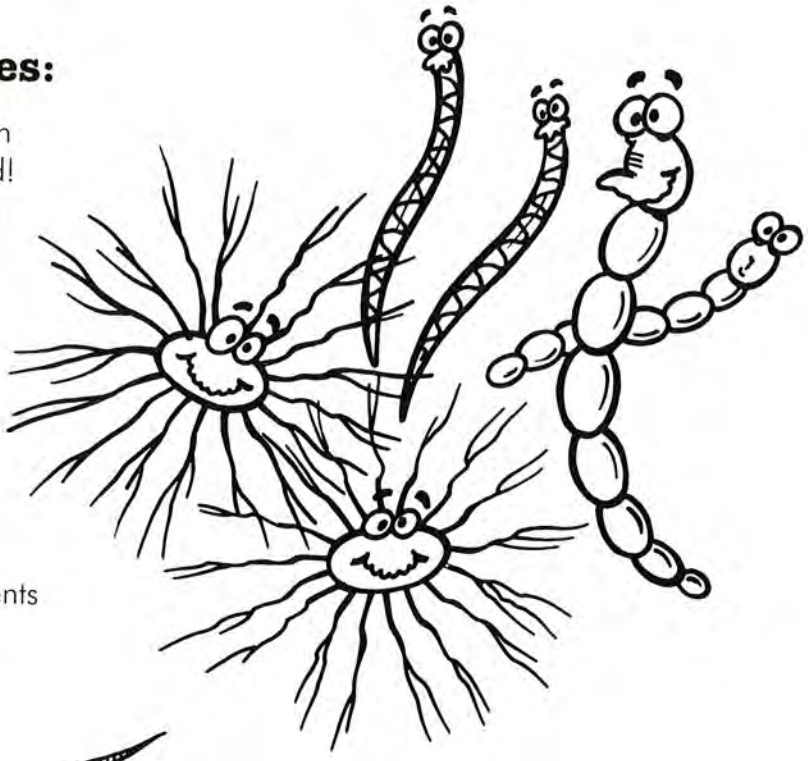
Student Readings:

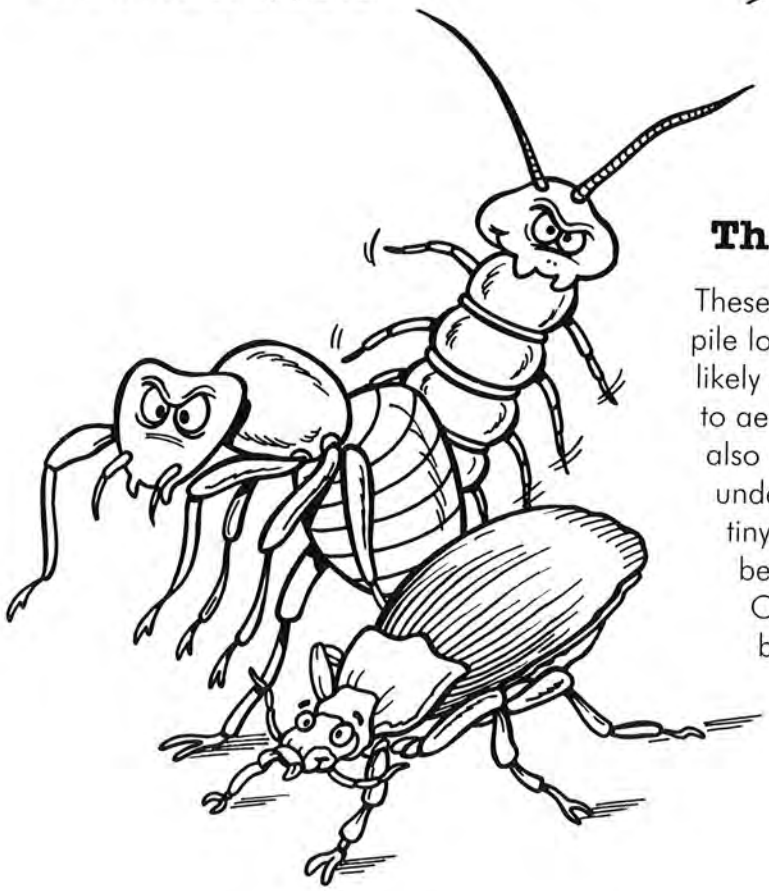
Discovering Compost Organisms... Getting to Know the Cast of Characters

THE CAST

The Invisibles:

You probably won't see these, but you can be sure that there are lots of them around! They are called microorganisms because you can only see them if you use a microscope. There are over 10 million microorganisms in each gram of compost. Microorganisms include bacteria and fungi. There are also millions of microscopic worms called Nematodes in every scoop of compost! Most of these organisms are directly involved in decomposing the organic material. They help to free up many nutrients that are needed by plants.



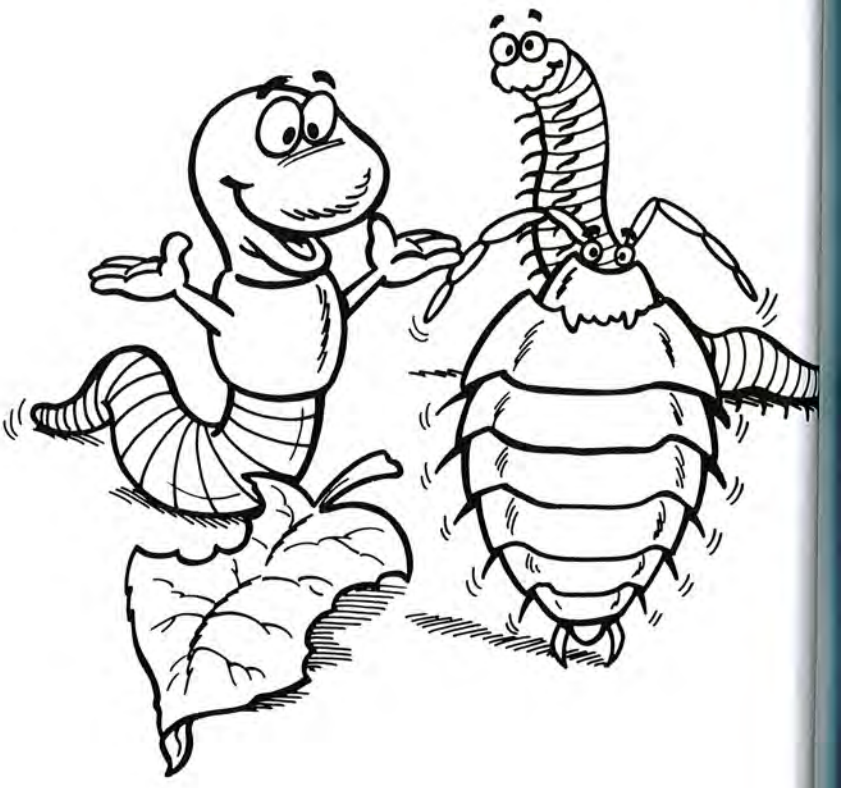


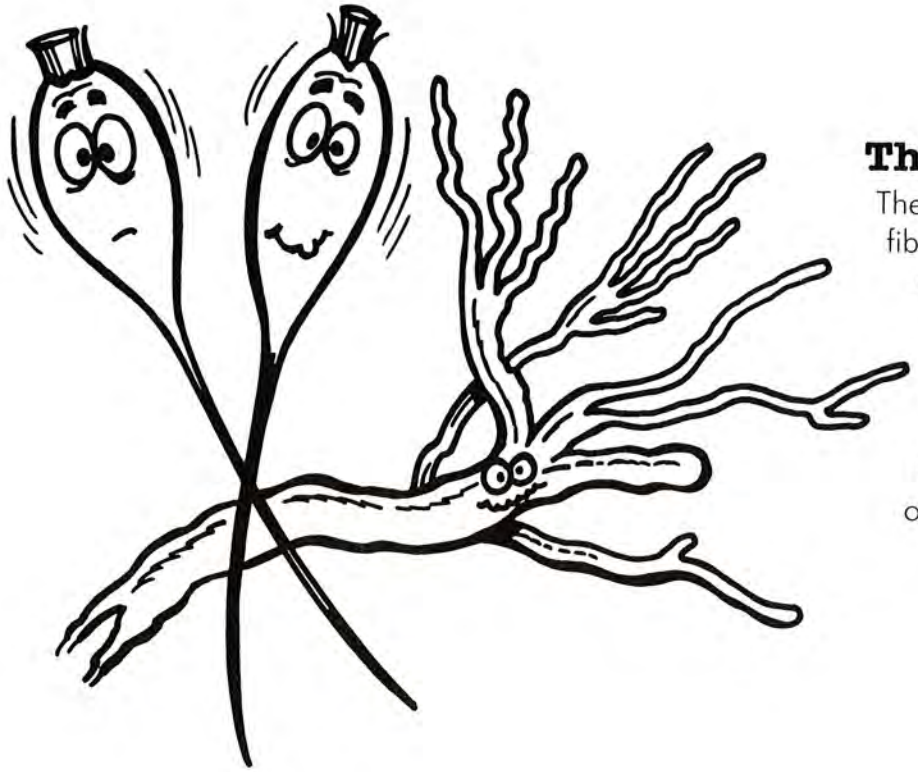
The Hunters:

These organisms move throughout the compost pile looking for other organisms to eat. They are likely to be faster than other organisms. They help to aerate the compost and keep it loose. They also keep the population of other organisms under control. some of these hunters look like tiny scorpions, others are called springtails because of their ability to leap into the air. Other hunters include mites, centipedes, beetles and earwigs.

The Decomposers:

There are many organisms that can be seen without using a microscope. Some of the decomposers are the larger, visible organisms that feed on the organic material in the compost and help to break it down. This group includes worms, sow bugs, and millipedes.



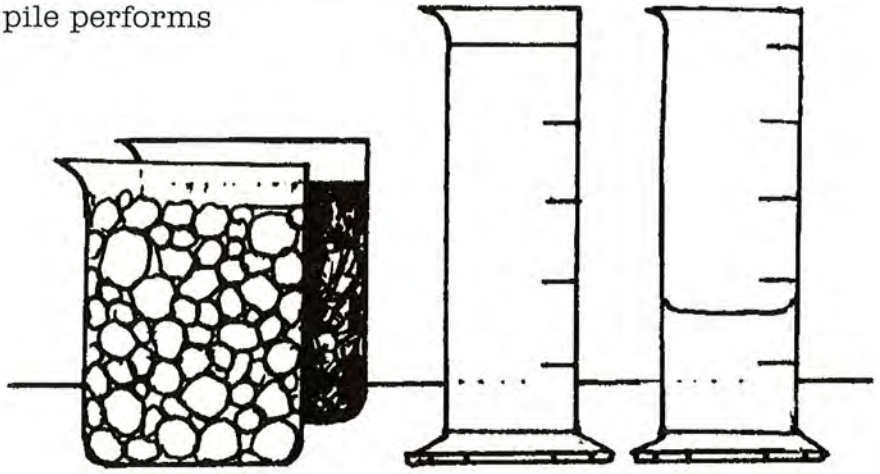


The Fungi:

These organisms spread their fibrous strands throughout the compost. You can often see them as a collection of white/grey fibrous strands that are located in older areas of the compost pile. Fungi also help to decompose organic material.

Air Spaces and Water ... What's the Connection?

Between the particles that make up the compost pile are tiny little air spaces. These miniature pockets of air supply a world of little organisms with the oxygen they need to survive. If conditions get too wet, these air pockets fill with water, the microorganisms suffocate, and the compost pile performs poorly.



Purpose

1 – To investigate the volume of air available in different samples and to determine what will happen to this volume as water is added.

2 – To investigate what happens when too much water is added to the composting process.

Materials

Part 1

- 500 Ml beaker
- gravel
- sand
- dried leaves
- green leaves
- water
- observation chart

Part 2

- 2 wide mouth jars
- garden soil
- apple or other organic lunch waste
- observation chart

Procedure

Part 1: Find out the volume of air that is present in different samples.

1. Fill a 500 Ml beaker with gravel up to the 500 Ml Line.
2. Use a graduated cylinder to pour water into the same beaker. Continue to add water until the water level reaches the 500 Ml line. The water will displace the air pockets between the gravel.
3. Record the amount of water used to fill the beaker. This is equal to the total volume of air that was between the pieces of gravel.
4. Follow the same procedure for different samples of sand, garden soil, wet and dry leaves and grass. Record your observations.

Part 2: Find out how the composting process is affected when air is replaced by water

1. Fill two wide mouth jars half full with compost or garden soil. Place equal amounts of organic kitchen scraps into each jar. Cover these scraps with more soil until the jars are almost full.
2. Fill the first jar with water right up to the soil level and cover it with a lid. Record the amount of water that was used to fill the jar. This is equal to the amount of air removed from the soil.
3. Add just enough water to the second jar so that the contents are moist but not wet. Keep the lid off of this jar and every few days add enough water to keep the contents moist. Do not over water!
4. After two weeks, examine the contents of each of the jars. Is there any difference? Record your observations.

QUESTIONS

1. Describe any differences between the two samples.
2. Did you notice any of the smells coming from any of the jars. Describe the smell and suggest what might be causing it
3. What could you do to provide even more air to the jar that was not over watered?
4. Why do you think that over watering a compost pile is not a good idea?
5. In landfills, the garbage is buried and compacted so that very little air surrounds the garbage. What do you think happens to organic waste that is buried in a landfill?
6. Write a sentence that describes the relationship between oxygen availability and moisture in a compost bin.
7. In a compost pile, air can also be squeezed out because things are packed to tightly. How can this situation be avoided?
8. Earthworms go to the surface after a heavy rainfall. Use the information you have learned from this activity to explain why worms would do this. Use an illustration to assist your explanation.

PART I:

Observations

Sample	Air Volume
Gravel	ml
Sand	ml
Dry Leaves	ml
Green Leaves	ml
Grass	ml

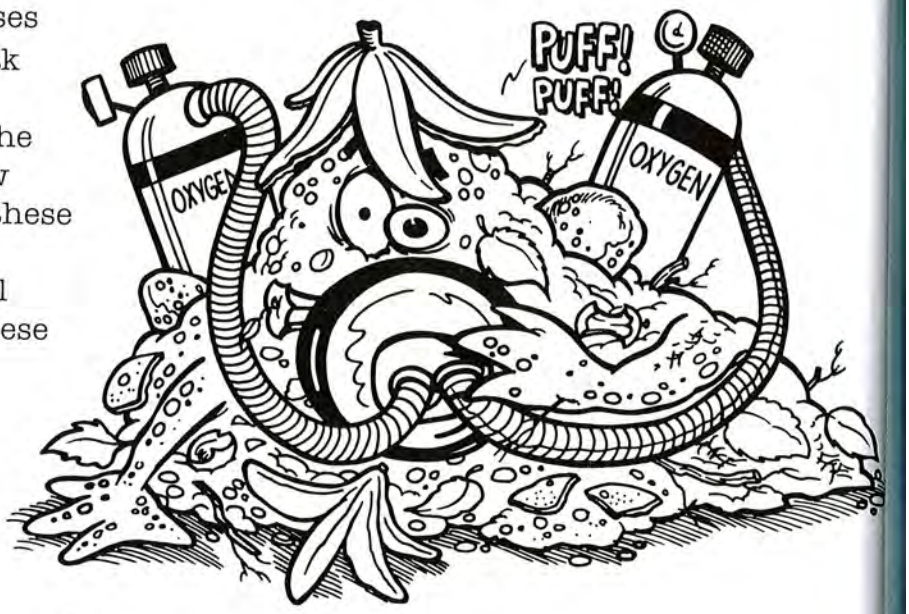
PART II:

Compost Observations

	JAR #1	JAR #2
	day / month / year	day / month / year ← starting date
	day / month / year	day / month / year ← after 2 weeks

Aerobic or Anaerobic Composting ... What's the Difference?

Organic material decomposes when microorganisms break down the dead plant and animal material to obtain the nutrients they need to grow and to get energy. Some of these microorganisms can only decompose organic material when oxygen is present. These **aerobic** (oxygen using) organisms are able to decompose material much more quickly than the **anaerobic** (do not require oxygen) microorganisms. If the compost pile does not get turned, gets compacted, or becomes too wet, the oxygen levels go down and the anaerobic microorganisms take over. When this happens, the compost pile starts to smell. This is because anaerobic bacteria release methane gas and hydrogen sulfide, a gas that smells like rotting eggs.



Purpose

To try composting some organic material aerobically and anaerobically to investigate the differences.

Materials

- background student reading paper
- Zip-Lok bag
- wide mouth jar (2)
- apple, celery or other organic material
- garden soil
- water

Procedure

1. Read the background information sheet comparing aerobic to anaerobic composting.
2. Prepare two identical amounts (about 25 grams each) of organic material to be composted. the pieces should be cut up into small cubes.
3. Place one of these piles into a zip-lok bag. This will become the anaerobic sample so before sealing the bag, carefully squeeze out the as much air as possible.
4. Label two wide mouth jars "Aerobic" and "Anaerobic". Fill the two jars with garden soil until they are about half full. Place the organic material contained in the zip-log bag into the jar labeled "anaerobic". Place the other pile of loose organic material In the jar labeled "aerobic".
5. Fill both jars with garden soil. Add enough water to the aerobic jar so that the soil is damp but not wet. Do not over water!
6. Place both jars into an area that is warm and dark. Every third day, use a spoon to turn and mix the organic material in the jar labeled aerobic. Also, check to make sure that the soil in this jar remains slightly moist. There is no need to do anything else with the anaerobic jar.
7. In two weeks, take the plastic bag out of the anaerobic jar. Do not open the bag. Remove any evidence of organic material from the aerobic jar. Place the pieces if any, on a tray.
8. Compare the two methods of decomposition. Is there any difference in the way the organic material has composted. Describe these differences. There is no need to open the bag to make these comparisons.

EXTENSIONS

1. Find out if plants grow differently in compost that has been produced aerobically or anaerobically. Use regular potting soil and mix it with one type of compost in a 1 to 1 mixture. Do the same with the other type of compost. Place several seeds in each pot and provide them with identical care. Make note of any differences in germination, growth and overall health.

Is Oxygen Necessary for composting?

There are many ways to compost. All of them involve the breaking down or decomposing organic material by microorganisms to produce a material that can be used as a soil conditioner. All of these methods can be divided into two broad categories; one requires oxygen during the composting process, the other does not. Each type has its own advantages and disadvantages associated with them. People usually choose which type of composting they would like to participate in on the basis of their own preference, the amount of time they wish to spend, the volumes of organic material they are dealing with, and the types of material they are composting.

Aerobic Composting

This type of composting relies on microorganisms that need oxygen to survive. Under the right conditions, aerobic bacteria can munch their way through organic material at a fairly rapid pace. As they do this, they release water vapour, carbon dioxide and heat. When thi are going well, an aerobic compost pile does not have any strong offensive odors.

One of the most common reasons for aerobic composting to fail is that for some reason, there is not enough oxygen getting to these microorganisms. This is usually because of overwatering or compacting the material in the bin so that the tiny air spaces located throughout the pile no longer exist. Without oxygen, the microorganisms suffocate and oth types of bacteria that do not require oxygen take over.

Maintenance is a necessary ingredient in keeping an aerobic compost pile healthy and happy. More care must be taken to insure that the material being put into the composter is in the right proportions, that there is sufficient but not excessive moisture and that the pile i turned occasionally in order to aerate and mix the composting material. A great deal of he is produced by the microorganisms as they work their way through the organic material. Th heat is able to kill unwanted weed seeds and other organisms that could cause diseases. When finished, aerobic composting produces a crumbly, earthy smelling, soil-like substanc called humus that is ready to be used in gardens or flowerbeds.

Anaerobic Composting

For those individuals who do not want to put a great deal of effort into the composting process and would prefer to sit back and let things happen on their own, anaerobic composting is the right choice for them. In this process, the bacteria involved in decomposing the organic material do not need oxygen and takes a longer time to finish. Anaerobic composting requires a tightly sealed environment so that the odours produced during this method don't escape. There are many types of anaerobic "digesting" bins that are designed to keep these unpleasant odours locked in.

As the organic material breaks down, methane and hydrogen sulfide gas is released. Unlik aerobic composting, the temperature does not increase. This means that some unwanted weed seeds or disease carrying organisms might not be destroyed in this process. The finished product has a sludge-like appearance and, until it dries out, also has an unpleasa odour. This material, although not as visually appealing as compost produced using the aerobic method, can also be used in gardens as a soil supplement.

Sometimes, a compost pile that initially starts out as an aerobic process begins to turn anaerobic. This is a situation that **must** be avoided because open compost bins are not designed to contain the unpleasant odours that are characteristic of anaerobic composting

Big Chunks or Little Chunks... How Does Size Affect Composting Rates?

A block of ice broken into smaller pieces and left out in the sun will take less time to melt than if it was kept as one large piece. Likewise, large pieces of organic waste will not decompose as quickly as smaller pieces. This is because the organisms involved in decomposing the larger pieces

are only able to work on the outer surface and can't get to the inside. If the same piece is chopped into smaller bits, more surface area is exposed and more organisms can get to work eating at the same time.

Purpose

To investigate how the size of the material being composted can make a difference to the rate and effectiveness of the composting process.

Materials

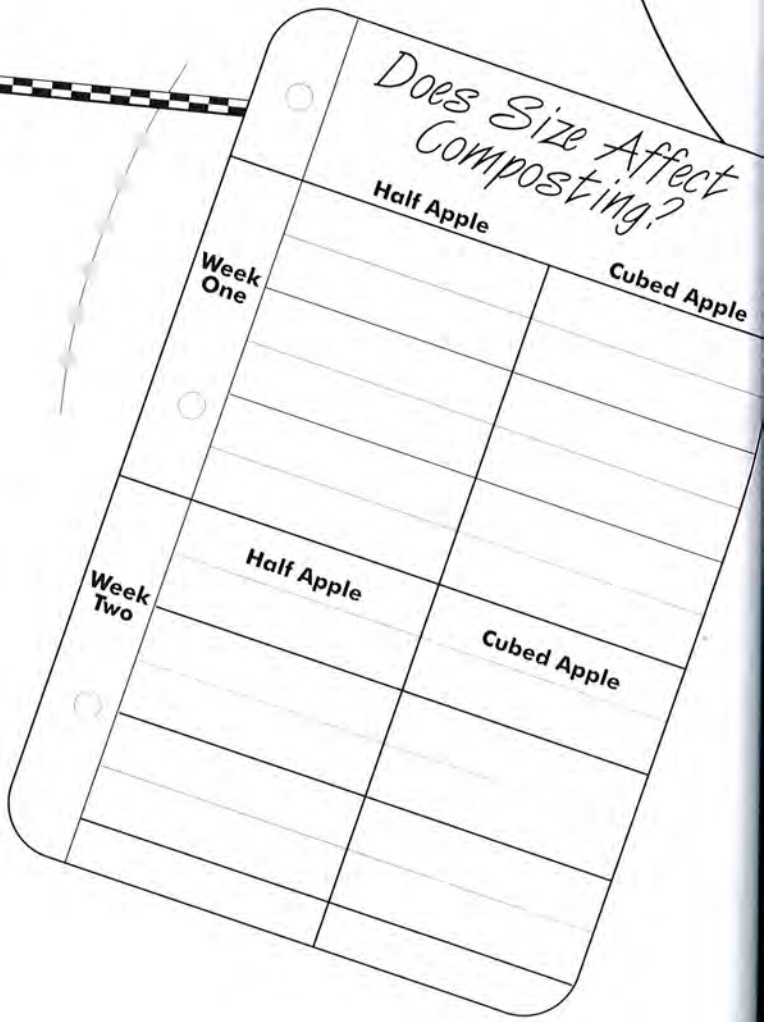
- background student reading paper
- Zip-Lok bag
- wide mouth jar (2)
- apple, celery or other organic material
- garden soil
- water

Procedure

1. Prepare the apple for composting by peeling it and cutting it in half.
2. Using a knife, cut one of the halves into smaller (3cm) cubes.
3. Fill two wide mouth jars (or mini composters) half full with garden soil or compost.
4. Place the cubed apple in one container and the uncubed apple in the other. Fill the containers to the top. Label one container "cubed" and the other "not cubed".
5. Add enough water to keep the soil in both containers moist but not wet. Do not overwater!
6. Set the containers aside for one week. Continue to make sure that the soil remains moist.
7. At the end of a week, unearth the apple from both containers and look for any difference in the rate of decomposition. Record your observations.
8. Replace the apples into their containers, cover them with soil and allow them to continue composting for another week. At the end of the second week, observe the progress in each of the containers. record any observations.

EXTENSIONS

1. Try a similar activity but change the difference in size to very small pieces. Predict the rate these pieces will compost compared to the other sizes.
2. Try a similar activity with other types of organic material.



How Does Temperature Affect Decomposition Rates?

Can composting continue in the dead of winter? How about spring summer or fall? Which season would be the best time to compost? The microorganisms responsible for decomposing the organic material in a compost bin are sensitive to temperature. The populations of the many types of different organisms rise and fall depending upon what the temperature of the pile is. Although composting can occur under a wide range of temperatures, there is an optimum temperature that really gets the composting process going.

Purpose

To find out how different temperatures can affect the rate of decomposition.

Materials

- 2 mini-composters or wide mouth jars
- apple, celery or other organic material
- garden soil or compost
- thermometer

Procedure

1. Prepare three identical amounts (about 25 grams each) of organic material to be composted.
2. Fill three wide mouth jars or mini composters half full with compost. Place the waste into each of the containers and then bury the waste with more compost until the containers are full. Add enough water to the compost so that it is moist but not wet.
3. Label the jars "cold", "room temperature", and "warm". Find locations around your school or home that fit these descriptions. Place the jars in the appropriate locations.
4. Allow the jars to stay where they are for two weeks. During that time, make sure that the contents of the jars are mixed and kept moist. You might have to check the jar in the warm location more often.
5. At the end of two weeks, collect the three jars, unearth the samples and observe the condition of the organic material.
6. Discuss the following questions in class:
   i) After looking at the contents of the three jars, did you notice any difference in the rate of decomposition?
   ii) What would you say the relationship is between temperature and rates of decomposition?
   iii) Why is it important to make sure that the three containers were all kept moist?
   iv) Using the information from this activity, how do you think the composting process would be affected at different times of the year?

How Hot Can It Get?
Finding Out the Temperature of Your Compost

During the decomposition of organic wastes, the microorganisms generate heat through metabolic activity. The combined heat produced by the millions of organisms in the compost bin can actually raise the temperature to a whopping 66 degrees Celsius! That's enough to kill a lot of unwanted weeds and seeds that might be present in the compost bin. If the compost organisms have enough air, food and moisture, they will continue to keep active. A warm compost pile is a sure sign that things are working well and that the decomposition process is going along nicely.

Purpose

In this activity, you will take the temperature of a compost pile during different stages of its development and to determine what effect turning the pile will have on its temperature.

Materials

- large compost pile (1 cubic meter)*
- candy or meat thermometer
- temperature observation chart

**Smaller compost piles are unable to contain the heat as well as larger ones.*

Procedure

1. Start by getting an initial temperature of the compost pile. Use a glove, and place a thermometer deep into the centre of the pile. Take a second temperature reading halfway between the middle and the outside of the pile. A third temperature reading should also be taken of the air surrounding the bin. Record these temperatures in the observation chart.

2. Add some yard and garden waste to the compost. Aerate the pile by turning it with a pitchfork. If required, add enough water so that the pile is moist.

3. Continue to take temperature readings for one week at approximately the same time of the day. Observe any changes that occur during this one week period.

QUESTIONS

1. What was the highest and lowest temperatures taken from inside the compost?
2. Where did you find the highest temperatures?
3. Where is the best place to measure the maximum temperature of the compost?
4. What was the biggest temperature difference between the center of the compost and the air temperature? How many days after turning did this occur?
5. What do you think causes the changes in temperature?
6. What would you be able to say about a compost pile that has an internal temperature that is the same as the outside air temperature?

Compost Temperatures

DAY	Centre °C	Halfway °C	Air °C
1			
2			
3			
4			
5			
6			
7			

Living Things in Your Compost ... Are They Necessary?

When organic waste goes into a compost bin, a horde of tiny little organisms and other animals living in the soil go to work to break it down bit by bit. How important are these tiny organisms to the composting process? The best way to find out is to try to decompose organic waste in sterilized soil that does not have any microorganisms present. To compare, we can place an identical amount of organic waste into a jar containing compost or soil that will have millions of microorganisms per gram. Which waste do you think will decompose the fastest?

Purpose

To observe the difference in decomposition between sterilized soil and soil that contains microorganisms.

Materials

- sterilized potting soil
- garden soil or compost
- 2 wide mouth jars or mini composters
- dechlorinated water*
- apple, celery or other organic lunch waste

**You can dechlorinate water by simply leaving tap water overnight in an open container or by boiling and cooling the water.*

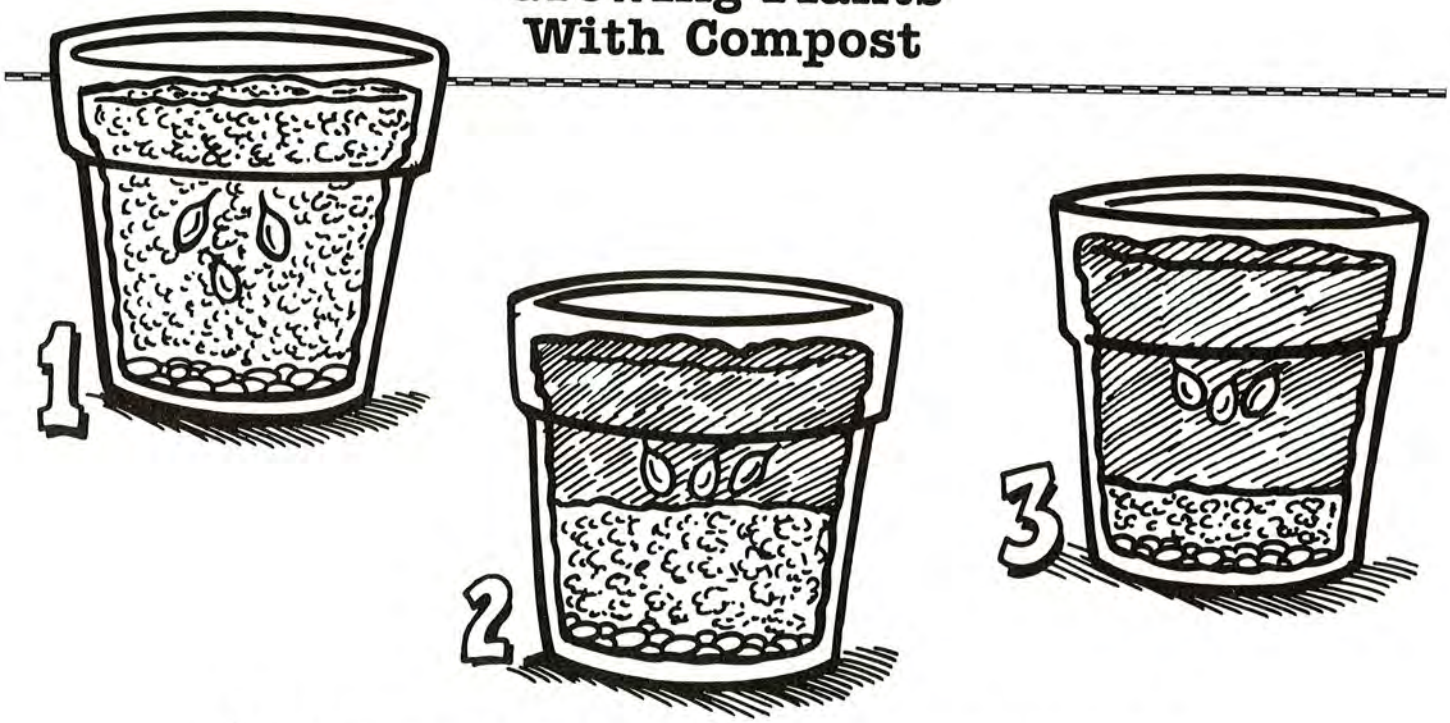
Procedure

1. Prepare two identical amounts (about 25 grams each) of organic material to be composted.
2. Fill one of the jars or mini composters half full with sterilized potting soil. Place one of the prepared samples of organic material into the container. fill the container with more soil and add enough water to moisten the soil. Do not over water!
3. Use an unsterilized garden soil or compost to fill the second container half way. Place the second prepared sample of organic material into the container. Fill the sample with the same type of soil and add enough water to moisten the soil. Again, do not over water. Set both containers aside.
4. At the end of one week, examine the waste samples from each container. Which waste sample appears to be decomposing the fastest?

QUESTIONS

1. What is the main difference between sterilized and unsterilized soil?
2. Based on your observations, which soil is best for composting?

Growing Plants With Compost



Adding compost to the soil provides additional nutrients that can be used by plants. Compost also helps to contain moisture and to keep the soil loose so that plant roots can grow better. Compost is not a substitute for soil but helps to enhance the soil and make it a better place for plants to grow.

Purpose

This activity will help you to see how adding compost can affect the germination of seeds and the growth of plants.

Materials

- growth observation chart
- flower pots or cups with drainage holes (3 per group)
- gravel for drainage
- compost
- perlite (vermiculite)
- bean seeds (9)
- observation sheet

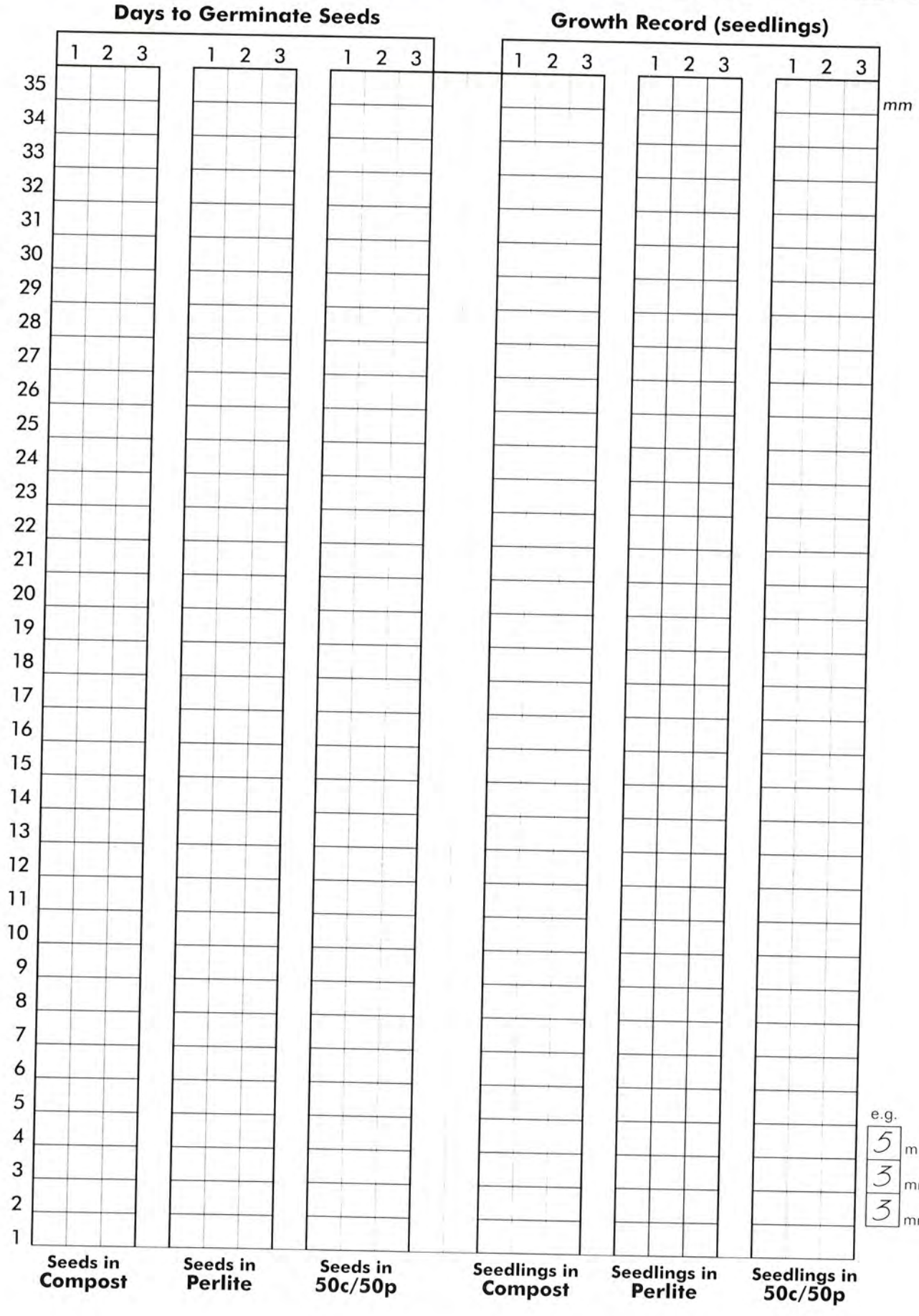
Procedure

1. Put 2.5 cm of gravel in the bottom of each of the flower pots.
2. Add compost to the first pot and label it "100 % compost".
3. Put a mixture of half compost and half perlite into the second pot. Label it "50C/50P".
4. Fill the third pot with 100% perlite. Label it "100% perlite"
5. Plant three seeds of the same species in all three pots. Water your seeds following the instructions on the package. Make sure you add the same amount of water to each pot. Watch for evidence of germination and record your observations.
6. Once your seeds have germinated, continue to record your growth observations on the growth chart. Once a day, measure the height of the plants in each pot and record this value on your Growing Plants with Compost observation sheet. Look for other evidence of health such as colour, strength of stem, and number of leaves. Keep a record of these general observations also.
7. Continue recording your observations for four to five weeks.

QUESTIONS

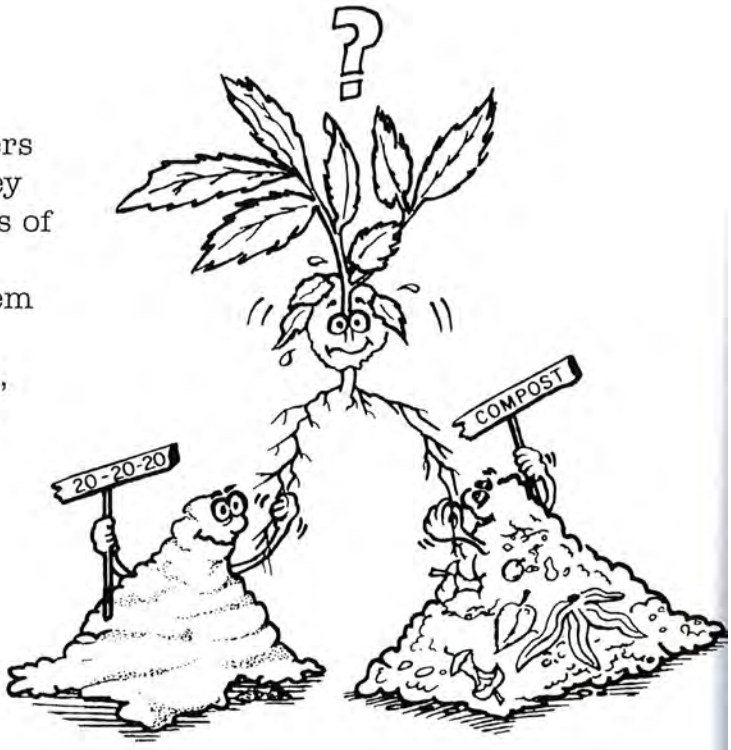
1. What effect did the compost have on the sprouting of seeds? Why?
2. What effect did the compost have on the growth of plants? Why?
3. How do your results compare with the observations from other groups in your class?
4. Would different types of seeds give different results? Can you design an experiment that would help answer this question?

Growth Record



Comparing Compost to Commercial Fertilizers

There are numerous types of fertilizers that consumers can choose from. They all are designed to affect specific parts of plant growth. Some help with root development, others with leaf and stem development, while others help to promote flowering. For the most part, commercial fertilizers have different concentrations of potassium, phosphorus and nitrogen. Finished compost also provides extra nutrients, but usually not in the concentrations provided in commercial fertilizers.



Purpose

To observe any differences in plants growing in soil that has commercial fertilizer compared to plants growing in soil enhanced with compost.

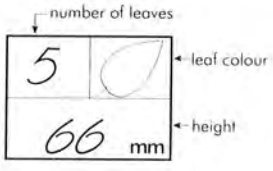
Materials

- compost
- potting soil
- commercial fertilizer
- bean seedlings ready for transplanting
- small plant pots 3 per group
- growth observation chart

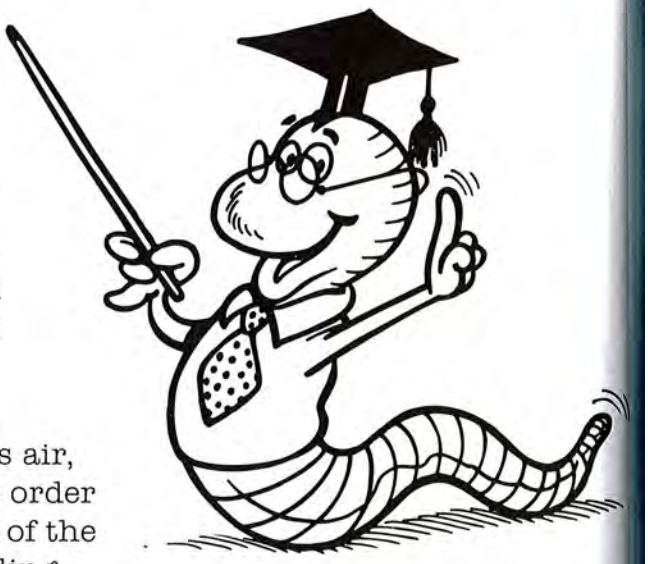
Procedure

1. Label the three pots "commercial fertilizer", "unfertilized" and "compost".
2. Prepare a 50:50 mixture of finished compost and potting soil. Place this mixture in the pot labeled compost.
3. Fill the other two pots with potting soil only.
4. Plant two germinated bean seedlings in each of the three pots.
5. Prepare the commercial fertilizer using the directions on the package. Use this to water the pot marked "commercial fertilizer". Use the same volume of unfertilized water for the other two pots.
6. Keep all pots together in the same location. Continue to water the pots at the same time using the prepared commercial fertilizer or water in equal volumes.
7. Record your observations in the growth chart once every 3 days for 3 weeks. Thing to look for include the rate of growth, number and colour of leaves, height
8. Combine all of your data with the observations from the rest of your class to get results that are more accurate. Use this information to draw your own conclusions about how these different treatments affect plant growth.

Day	Compost	Potting Soil	+ Fertilizer
3			
	mm	mm	mm
6			
	mm	mm	mm
9			
	mm	mm	mm
12			
	mm	mm	mm
15			
	mm	mm	mm
18			
	mm	mm	mm
21			
	mm	mm	mm



Introducing the Red Wiggler



Vermicomposting is making its way into homes and classrooms throughout Alberta. It's no longer unusual to hear someone tell you that they have a box of worms in their kitchen helping them out with their kitchen scraps. In schools, the Red Wiggler worm can be found eating the apple cores, banana peels and other compostable food waste from the lunches of waste conscious students.

Like most living things, the Red Wiggler needs air, moisture, food and a suitable environment in order to survive. These little creatures can't get out of the box to get their own food, water or clean bedding material so someone has to do this for them. **You** are responsible for their well being once you have decided to set up a vermicomposting project. The more you know about these fascinating little creatures, the better you will be able to look after them.

Purpose

To learn more about the Red Wiggler worm. Many people still feel uncomfortable about having worms in their homes or classroom. Sometimes, this uneasiness goes away after they learn more about them.

Materials

- student background information sheet
- magnifying glass
- tray paper towels
- blunt probe

Procedure

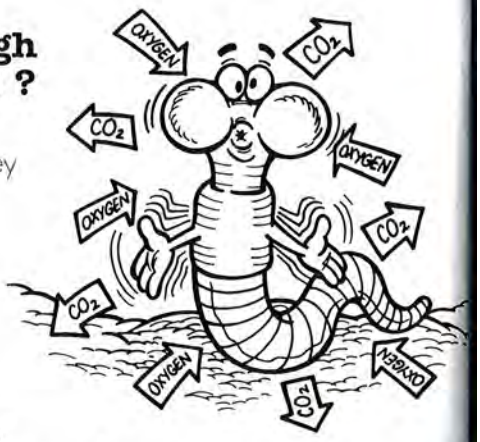
1. Read the worm facts information sheet to get some basic knowledge about the Red Wiggler Worm.
2. In groups of three or four, take a closer look at your Red Wiggler worm. Use the guide "Taking a Closer Look" to help you focus your attention on certain characteristics.

EXTENSIONS

1. Use information sources such as your library or other publications to get more information. Draw your own cartoons to illustrate important worm facts.
2. As a class, set up a "Know Your Worm" section next to the vermicomposting bin.
3. Design a worm information centre that can travel to other classes. Give the rest of your school the opportunity to learn a little bit more about the Red Wiggler and what it can do about waste.

WORM FACTS

They Breathe Through Their What!!! ?



Red Wigglers and other worms need oxygen just as much as we do. But, they don't own a pair of lungs so the only way they can get the oxygen they need to survive is through their skin. Oxygen moves into their bodies through their skin and carbon dioxide moves out. Take a look at a Red Wiggler using a magnifying glass (or even better, a binocular microscope). Can you see a barely noticeable slimy layer covering it? This helps to keep its skin moist so that it can "breathe" more easily.

Whoa now ... That's a Myth!

Please don't cut the little creatures in half to see if they grow into two worms. They don't. You'll just kill it. Worms are delicate animals and need to be treated with care. If a tiny part of a worm is cut off (like the tail end), it can heal and eventually grow back. This is called regeneration. The best way to get more worms is to give them a little bit of TLC (Tender Loving Care). Before you know it, you will have more than enough worms.

Huge Appetite!

Red Wiggler worms can consume their weight in organic material every two days. A bin that has half a kilogram of worms needs to be supplied with half a Kilogram of compost every 2 days!

Aaaaaagh ... Not the Sun!

Our skin is sensitive to the sun and you probably know what it feels like to get a sunburn. Worms are even more sensitive to the sun and can be easily harmed or killed by exposure to its rays or to sun lamps. Their best defense is to keep covered under a layer of soil. If you use a sun lamp to help harvest them, keep this in mind.

Making Babies!

Baby worms come from cocoons that are the result of sexual reproduction. A mature worm (one that is eight weeks old) can produce two to three cocoons per week. Three weeks after a cocoon is produced, an average of four or five baby worms emerge.

Taking a Closer Look

Where are you looking?

Scientists use certain words to describe what part of an animal they are looking at. Try using these words when you are looking at your worm.

Dorsal - back
Ventral - stomach side
Anterior - head end
Posterior - tail (rear) end

Many people still feel uncomfortable about having worms in their homes. Sometimes, this uneasy feeling goes away after they learn a little more about them.

Getting to know a worm takes a bit of investigation on your part. By taking a closer look, you will be able to describe how the worm moves, how to measure them, how they react to light and many other interesting features. Always remember that worms are very fragile creatures and they must be treated carefully. When you are finished looking at your worm, remember to place it back into the worm bin. The following activities will help you to learn more about the Red Wiggler:

(When making your observations, keep your worm from drying out by placing it on a moist paper towel.)

Can worms see?

Worms do not have any eyes, but they are still very sensitive to light. Most of the worms life is spent underground burrowing and tunneling in complete darkness. They don't really need to see and they become uncomfortable when exposed to light. You can find out how your worm reacts to light by aiming a beam of light at its body. What does the worm do? How would you design an experiment to prove that a worm really does prefer darkness over light? Test your idea.

How do worms move?

Red Wigglers have very tiny bristles on their ventral side that help them hold on to the surface they are moving on. If you use a magnifying glass, you might be able to see them. Watch carefully as your worm moves from one spot to another. Describe its motion in your observations. Does a worm move in any direction or does it always go head first? Can worms move better on different surfaces? Come up with a way to test your predictions.

Heads or Tails?

Can you tell the difference between the head (anterior) of the worm and the tail (posterior)? One way of telling is to look for it's mouth. The mouth has a protective flap covering it that looks different than the other segments. Another way is to look for the clitellum, a slight swelling of the segments closer to the head end of the worm.

Measuring a Worm

Trying to accurately measure the length of a worm is not as easy as it might first seem. A worm can stretch out to become long and thin or contract to become short and stubby.

The trick is to get the average size of the worm by measuring it when it is at its shortest and longest. By adding the two measurements and dividing by two you get an average length of the worm.

This can be done by using a pencil to guide the worm into a straight line on a moist paper towel. Use the pencil to place a mark at the front and rear end of the worm when it is stretched out and when it has shortened. Measure the distance between the dots, and you can then calculate the average length of your worm.

Hatching Cocoons

Cocoons are recognizable as tiny oval shaped objects that are present in the soil of mature compost. A mature Red Wiggler can produce 2 - 3 cocoons per week and it takes about three weeks for a cocoon to hatch. Two to five baby worms can emerge from each cocoon. You can collect these fragile cocoons and observe them until they hatch.

Purpose

To identify Red Wiggler cocoons, hatch them and observe the young worms.

Materials

- mature compost from a Red Wiggler worm bin
- magnifying glass
- shallow tray
- paper towels

Procedure

1. Carefully look through compost that has a population of mature Red Wigglers. When you find a cocoon, carefully select it with a spoon or tweezers.
2. Place the cocoons onto a petri dish that has been lined with a moistened paper towel.
3. Place a few grains of oatmeal next to the cocoons so that the hatchlings will have something to feed on.
4. Cover the cocoons with a moist paper towel to keep them from drying out and place a lid over the top of the petri dish. It is important that the cocoons don't get too dry.
5. Each day, look at your cocoons and record the number of cocoons that have hatched each day.
6. Carefully examine the baby worms. How are they different from the adults?
7. When you have finished with your observations, place the worms back into the compost bin.

Changing Populations

With the right conditions, the population of Red Wiggler worms in your worm bin can rapidly increase. If the conditions deteriorate, the population can also decrease quite rapidly. In this activity, you will keep tabs on the worm population in bins that have different types of bedding material. The changes in population will be observed over a six week period.

Purpose

To observe how different bedding conditions can affect the population of worms in a compost bin. This information can be used to help keep a healthier environment for your worms.

Materials

- observation table
- shredded paper
- potting soil
- shredded paper and potting soil mixture (50:50)
- garden soil
- 5 litre ice cream pails (4 per group)
- worm food mixture
- water

Procedure

1. Prepare a mixture of worm food that can be used in all the bins. This can include pieces of apple, celery, bananas and any other compostable lunch waste. Store this mixture in sealed baggies in a fridge.
2. Label and prepare the worm bins using the different types of bedding. Each of the bins should have the same number of small holes punched into the bottom and be covered with a layer of gravel or crushed limestone.
3. Place a starting population of twenty adult red Wigglers in each of the bins. Keep the bins moist but not wet, cover them with a lid (that has air holes) and store them in the same location.
4. Each day, place a similar volume of the prepared worm food mixture into the bins. Remove any of the food that has gone moldy or that looks excessive.
5. At the end of each week, remove the worms and bedding from each of the bins and count the number of adults worms, immature worms, and cocoons. The immature worms will have a whitish colour. Record this data in your observation chart.
6. Continue this investigation for six weeks. At the end of this time, combine your data with other groups so that you can draw conclusion as to the type of bedding.

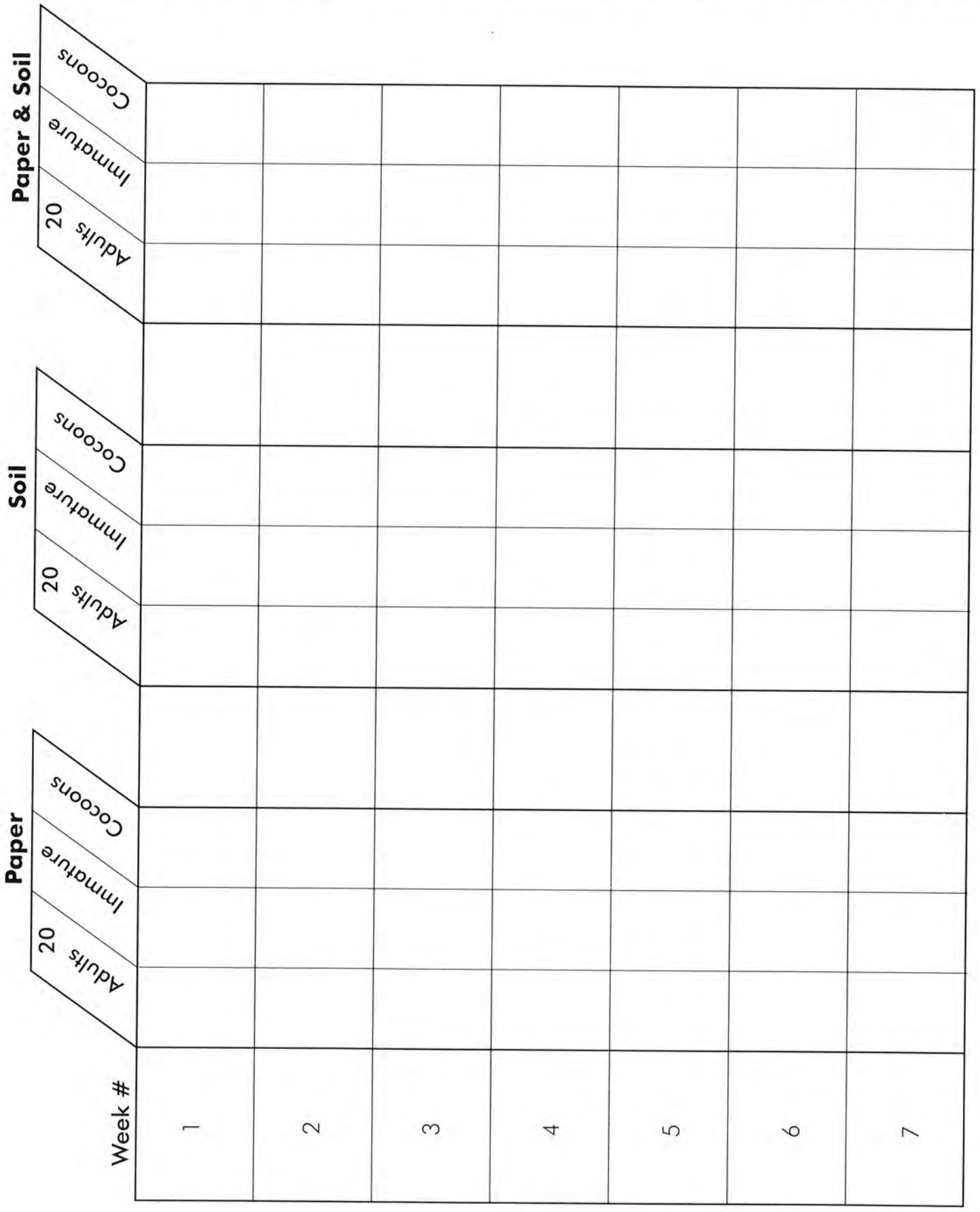
EXTENSIONS

1. Design an activity to investigate other environmental conditions such as food type, moisture, bin size and temperature. Can these factors all be measured with one investigation? Why? Why not?

QUESTIONS

1. Describe any changes to the population of worms in your bins.
2. Provide some explanations that would account for any of the population changes.
3. What factors would keep your worm population from constantly increasing?
4. Did any of your individual data conflict with the combined data from the entire class? What might have caused these differences?

Changing Populations Observation Table



Compost Consultants... Teaching Others about Composting

Your class has been asked by the community council to help develop a strategy for composting organic waste. The community managers have decided that the best way to reduce the huge amount of yard waste (grass, leaves, branches), kitchen waste and other organic material going to the landfill is to promote a backyard composting program. The only problem is that they are not sure what advice they should be giving to homeowners. Your class has been asked to help come up with ways that will motivate people to compost and to design experiments that can be used to show people why certain variables are important to the composting process. The school will be used as a demonstration site. Your class will be involved in producing the brochure that will go out to all the homes in the community. It's an important task, but one that your class can handle!

Now that you are familiar with composting and understand why composting is an important way of managing wastes, you can help others to also learn about composting. Here are some ideas that you can try to help spread the word about composting:

- Create posters to promote backyard or school composting. Display these posters in different locations throughout the school.
- As a group, develop an advertising campaign to convince other classes to compost. The campaign can be based on making brochures, radio spots or even coming up with TV commercials. Use your creativity to motivate others.
- Share your knowledge and expertise with other classes. See if there are opportunities for you to share what you have learned with younger grades.
- Write a brochure on how to compost that can be given to parents, teachers and neighbours.
- Write, produce and direct a "How to Compost" video that can be loaned to people who are interested in starting up a composting project.

HELP!
A Guide to Common Problems and Solutions to Composting

Composting problems do occur, but most of them are easily remedied. Solutions to these problems can be determined by finding out what the circumstances are and knowing what symptoms to look for.

Purpose

To gather information on potential composting problems and solutions. Also, to construct an easy to use compost trouble shooting wheel.

Materials

- Template for compost trouble shooting wheel
- scissors
- old file folders
- contact cement

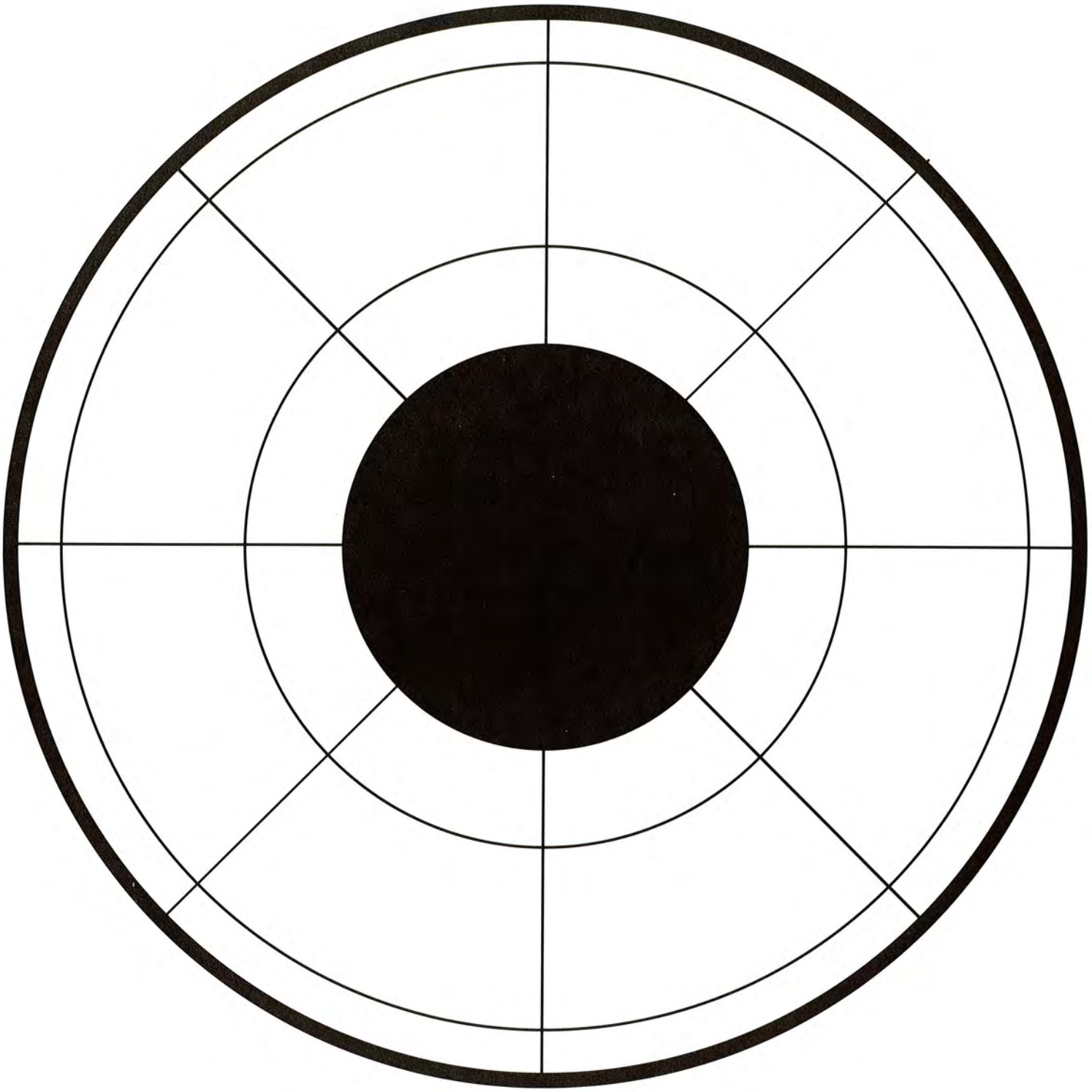
Procedure

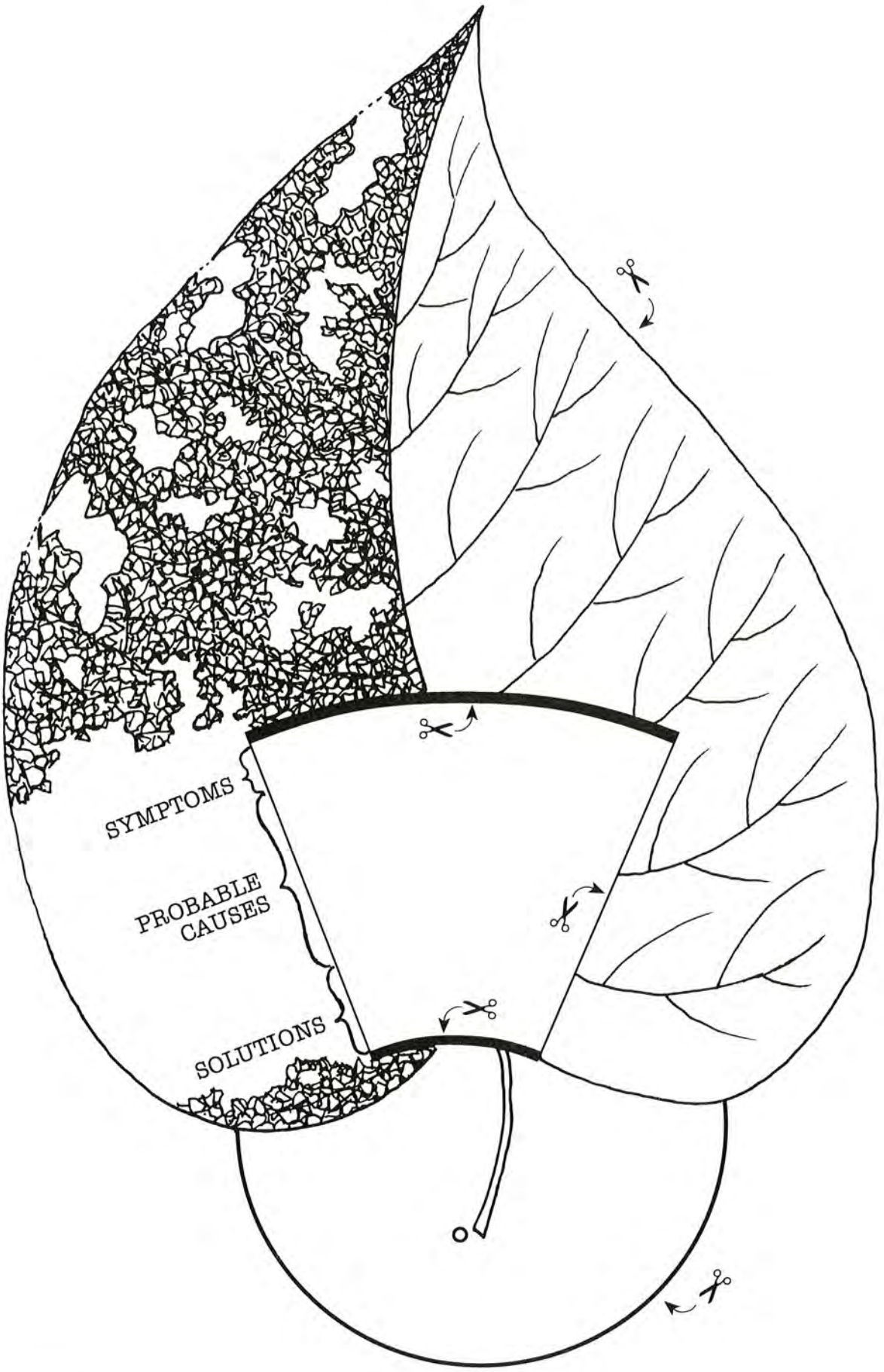
1. Use contact cement to glue the front and back faces of the compost trouble shooting wheel templates to old file folders

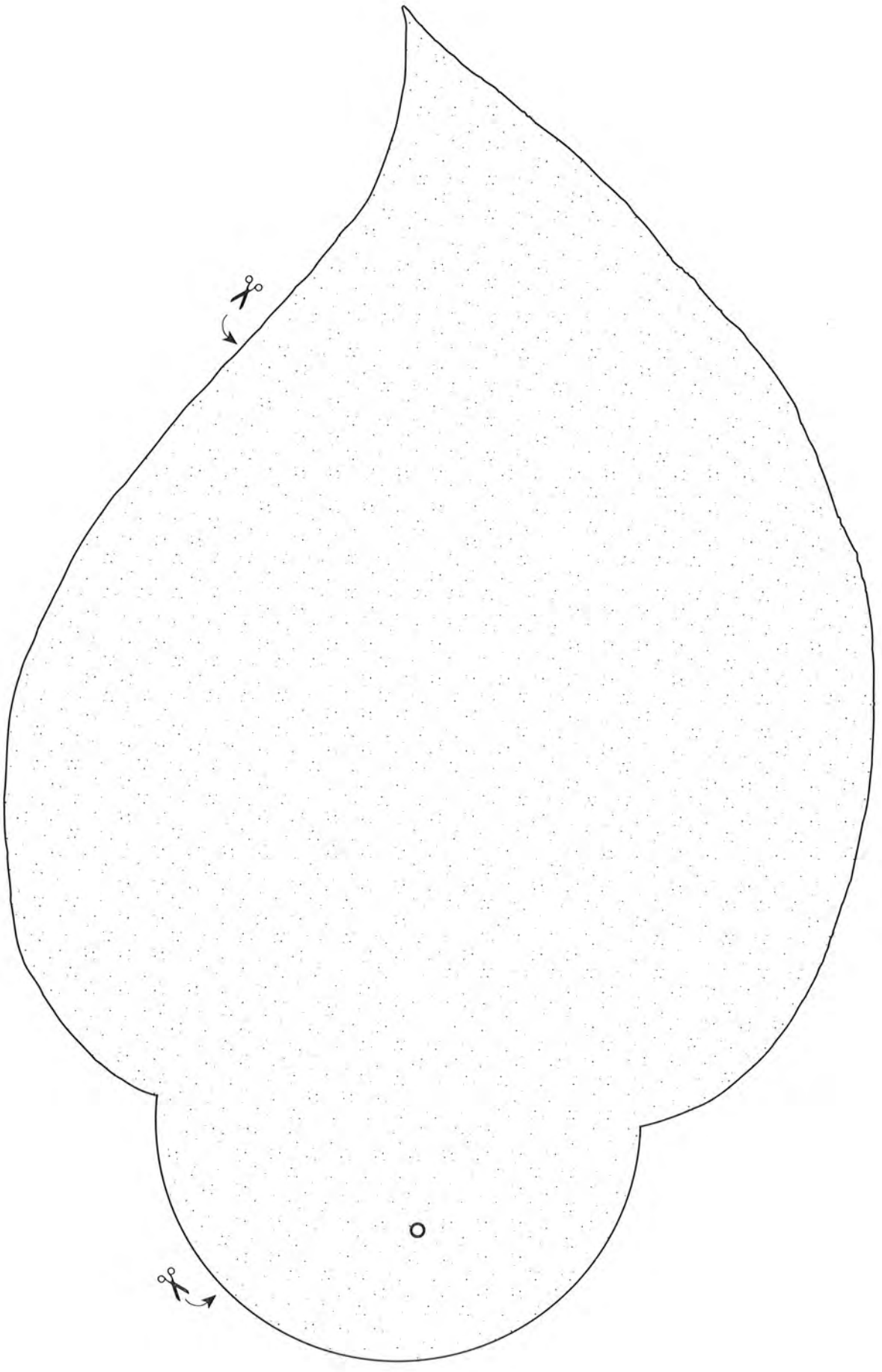
2. Cut along the template according to the illustrations.

3. Add the information to the inner wheel. The outer edge of the wheel identifies the problem, the middle describes the symptoms and the inner part of the wheel suggests possible cures. Use your library or other references sources to find the information you will need.

4. Assemble the wheel. Use a round head paper fastener in the center of the wheel to allow the wheel to spin freely.




SYMPTOMS
PROBABLE CAUSES
SOLUTIONS



Glossary
for Teachers

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Aeration
getting oxygen into the compost by mixing or turning.

Aerobic
requires oxygen. Aerobic conditions in a compost bin are desirable. Aerobic organisms use oxygen to carry out their life functions.
Because oxygen is present, the bin will not smell.

Anaerobic
an oxygen deprived environment or a system that does not require oxygen. Under anaerobic conditions, a compost bin will smell. Anaerobic organisms can grow without the presence of oxygen.

Bedding
materials like newspaper and leaves used as an organic medium for worm composting.

Browns
carbon rich compostable materials. Usually dry as well.

Cocoon
worm eggs or egg cases. They can carry from 2 to 20 worms.

Compost
the end result of the composting process or the process itself. Compost is a dark, rich soil conditioner known as humus which has been created through the biological reduction of organic material.

Compost Critters
micro and macroorganisms that live in the soil and help break down organic matter.

Compost Tea
water in which finished compost has been 'steeped' to concoct a liquid fertilizer for plants.

Compostable Materials
organic materials that will break down in a compost bin.

Composter
container, usually a bin or a box used for composting.

Composting
the biochemical process which occurs when organic matter is broken down by decomposer organisms into a nutrient rich soil conditioner called humus.

Decay
to rot, break down or decompose.

Decomposition
the process of breaking down organic matter into its basic elements including nutrients needed for plant growth. Decomposition occurs in nature and in controlled environments like compost bins.

Ecosystem
a mutually dependent system consisting of plant, animal life and inorganic matter.

Fertilizer
a substance (natural or man-made) used to enrich the soil and to provide food for plants.

Food Scraps
food scraps generally refer to fruit and vegetable scraps or any compostable food materials.

Greens
nitrogen rich compost materials (usually wet).

Heap
an unenclosed compost pile.

Humus
finished compost, formed through the break down of plants and animal matter. Humus retains and slowly releases nutrients to plants.

Leachate
liquid that has been generated by solid waste decomposition and which has extracted, dissolved or suspended materials in it.
The leachate from a compost bin or worm bin is full of nutrients and is an excellent liquid fertilizer.

Leaf Mold
decomposed or mostly decomposed leaves.

Macroorganisms
organisms that are visible to the eye.

Microorganisms
organisms that cannot be seen without magnification.

Mulch
a layer of partially decomposed plant materials placed on top of garden beds and around plants and shrubs.

Organic Matter
any material that is or once was living or was produced by a living organism.

Overload
to put too much food in a worm bin than can be processed aerobically.

Red Worm
a variety of earthworm suitable for vermicomposting. The Red Wiggler is a red worm.

Rodent Resistant
compost bins designed or modified in such a way as to deter pests from making a home in the bin.

Screening
to sift out uncomposted matter from humus to create a fine compost.

Soil
tiny rocks, sand, silt, clay plus decomposers plus organic matter.

Soil Conditioner
something that enriches the physical condition of soil and increases its organic content.

Vermicompost
to carry out composting with worms or the end product from composting with worms. Vermicompost contains worm castings, broken down organic matter, bedding, worm cocoons, worms and other organisms.

Vermicomposter
a worm bin or person who composts with worms.

Vermicomposting
composting with worms.

Vermiculture
worm farming or raising earthworms.

Worm Bin
a container especially prepared for worms to live in and eat organic garbage. A vermicomposting system.

Worm Castings
worm manure or worm 'poop'.

Wet Garbage
usually refers to food scraps, grass clippings and garden waste; compostable, organic materials.

Compost Pile Food Web

1. Primary Consumers
- a. Actinomycetes
- b. bacteria
- c. Molds
- d. Roundworms
- e. Fly larva
- f. Fly
- g. Sowbug
- h. Roundworms
- i. Beetle Mite
- j. Earthworms
- k. Millipedes
- l. Snails and Slugs
- m. Whiteworm

2. Secondary Consumers
- a. Roundworms
- b. Protozoa
- c. Rotifera
- d. Flatworms
- e. Mold Mite
- f. Springtail
- g. Feather Winged Beetle

3. Predators
- a. Rove Beetle
- b. Ground Beetle
- c. Ant
- d. Centipede
- e. Pseudoscorpion
- f. Predatory Mite

(Adapted with permission from Dr. Daniel Dindal.)

Additional Resources

Books For Students

The Amazing Earthworm
Lilo Hess. New York: Scribner's Sons, 1979

Annelida The Wonder Worm
Katie Diepenbrock. Berkeley: Sagittarian Press, 1991

Discovering Worms
Jennifer Coldrey. New York: Bookwright Press, 1986

Lots of Rot
Vicki Cobb. New York: J.B. Lippincott Junior Books, 1981

Books For Teachers

Backyard Composting
Harmonious Technologies. Harmonious Press, Ojai Calif. 1992

Let it Rot
The Home Gardener's Guide to Composting. Stu Campbell. Pownal, VT: Storey Communications, 1990

Squirmy Wormy Composters
Bobbie Kalman & Janine Schaub, Ontario. Crabtree Publishing, 1992

The Rodale Guide to Composting (revised)
Deborah Martin and Grace Gershuny, Pennsylvania: Rodale Press, 1992

The Real Dirt; The Complete Guide To Backyard, Balcony, and Apartment Composting
Mark Cullen & Lorraine Johnson, Toronto: Penguin Books, 1992

Trash Goes to School
Cornell University Waste Management Institute. Ithaca, NY, 1991

Worms Eat Our Garbage: Classroom Activities For A Better Environment
Mary Appelhof, Kalamazoo: Flower Press, 1993

Videos

The Rotten Truth
Children's Television Workshop. New York, 1990

Home Composting: Turning Your Spoils to Soils
Connecticut Dept. of Environmental Protection, 1991

For further information on composting education as well as other environmental education resources contact:

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