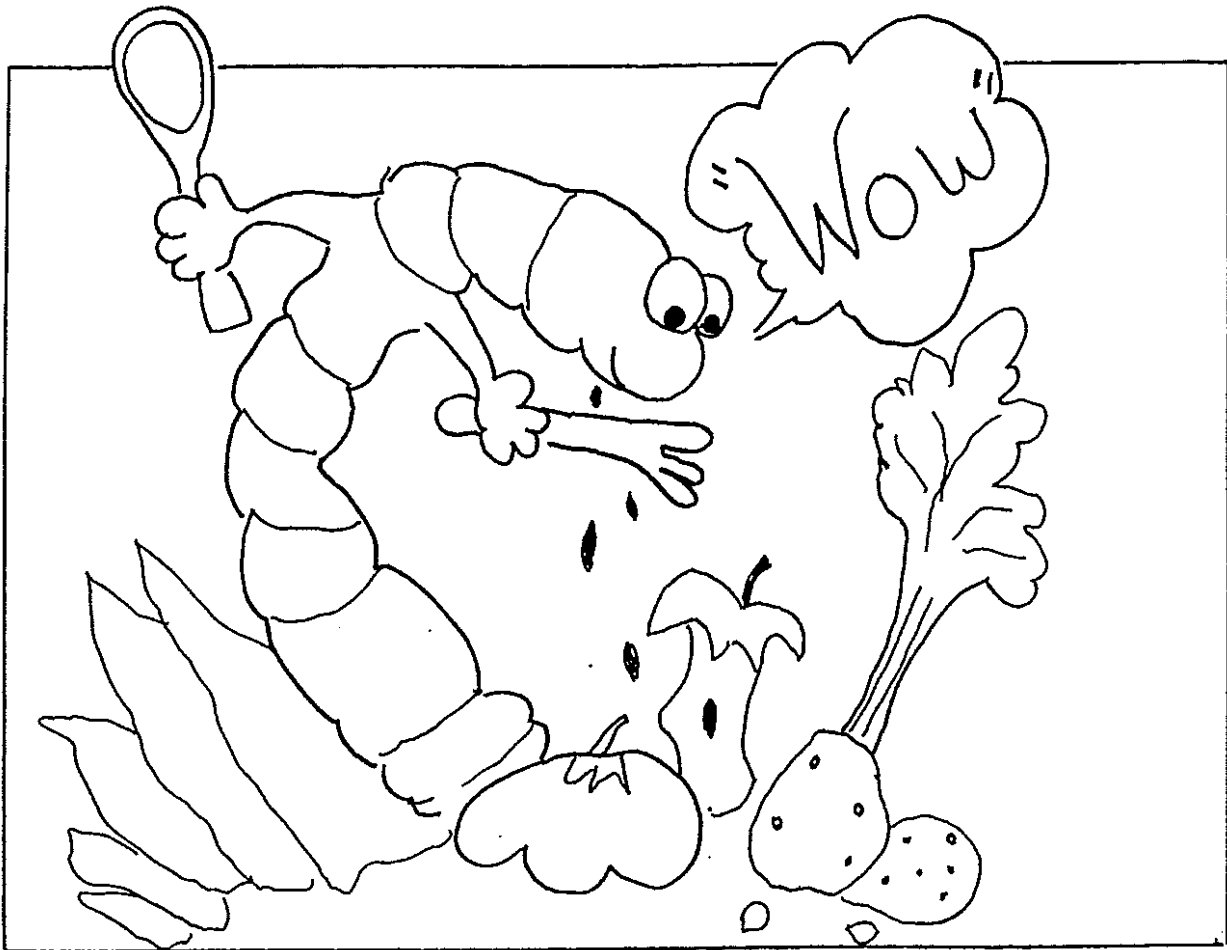


Wonderful Worms

Prepared by Cynthia LeBrun

British Columbia Agriculture in the
Classroom Foundation
Summer Institute 1998 Unit Plan
for grades Two to Three



Summer Institute 1998 was sponsored by:



Summer Institute for Educators

This document is the result of the author's participation in the BC Agriculture in the Classroom Foundations' Summer Institute for Educators. This third year level course in curriculum design is offered through the University of British Columbia's Office of Continuing Professional Education.

Participants (20 educators from Kindergarten to Grade 12) spend one week at the Montfort House Rural Resource Centre situated on UBC's Farm on Vancouver Island. Here they develop a number of practical teaching strategies for their classrooms using examples drawn from the agricultural, environmental, economic and nutritional concepts featured in the Bc Integrated Resource Packages for their particular grade or subject area.

The agricultural community sponsors participants for the costs of learning resources, tuition, meals and accommodation.

Participants taking the course for credit create teaching modules such as this to share with other educators from around the province.

Applications can be made on the BC AITC web site at www.aitc.ca/bc or directly at the AITC office. Contact Lindsay Babineau at 604-556-3088 for an application form.

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Wonderful Worms Unit

Grade 2/3 Science IRP's

Plants and Animals

- students are to compare and contrast different types of plant and animal life cycles in the environment

Direct Experiences

- students should have direct experiences with both natural and human build systems
- students should be provided with opportunities to develop an aesthetic appreciation of the environment

The Environment and Sustainability

- students should learn that human decisions and actions have environmental consequences
- students should become aware that human survival depends upon complex natural and human built systems

Science, Technology and Careers in Agriculture

- students should look for ways that science and technology is used in agriculture
- students should be aware of career opportunities associated with agriculture

Recording Data

- students should construct models, measure and record
- collect information from a variety of sources, including oral discussions
- sort, organize and represent specific information

Background Information for Teachers

The Red Wiggler or Redworms or Eisenia foetida (pronounced i see' nee a fet' id a).

These worms are striped with alternate patterns of buff and red stripes. In Australia they are known as tiger worms. It is the best kind of worm to use. They are incredible garbage eaters. They expend a lot of energy in maintaining their amorous lifestyle so they eat, eat, eat. They eat and expel their own weight every day (bedding and garbage). Think of it, if you had 500 pounds of worms, they could eat 500 pounds of garbage a day!

Nightcrawlers, or dew worms will not survive in a bin.

Red Wiggler Reproduction

Each worm has both ovaries and testes. Two worms join by mucus from their clitella. Sperm then passes from each worm into the other worm. Later, an egg case forms on a belt of slime around the outside of each worm's body. The worm backs out of the hardened case and slips it off its body. As it does this, it squeezes eggs and sperm into the egg case. The egg case is lemon colored and the size of a match head or grain of rice. (The egg case of a giant earthworm in South America is as large as a potato!) After being released from the worm, the egg case closes at both ends. Egg fertilization takes place in the egg case. One egg case may contain 20 fertilized eggs, but usually only two to three baby worms hatch from one end of the egg case. The egg case changes color as the babies inside develop. The egg case starts out pearly white, then become yellow, then light brown and when the worms are just ready to hatch, reddish. By using a good hand lens, it is sometimes possible to see the worms inside the egg case and the pumping of their bright red blood vessels.

It takes at least 3 weeks for the egg case to mature and baby worms to hatch. Newly hatched worms are almost transparent, but you can see a red tinge at one end. At this size, it would take 150,000 hatchlings to make a pound.

Depending upon conditions in the bin, it takes only 4 to 6 weeks for the hatchling to become sexually mature! Once it breeds and begins laying cases, it can deposit 2 to 3 cases per week for six months to one year. It has been calculated that 8 worms could produce 1500 offspring in six months.

The Compost

Finished compost can be harvested in 2 months.

It is rich and odorless and very fine in size. It looks and smells similar to peat moss.

The Bedding

The shredded newspaper should be 6-8 inches deep and kept moist but not wet. The ink does not hurt worms. Colored sections is fine, as well. Shredded computer paper or cardboard boxes also works well. Keeping the lid on will help keep it moist and the area dark, conditions the worms prefer.

Food

Red wigglers will eat just about any type of kitchen waste such as pizza, spaghetti, corn flakes, bread, pastries, coffee grounds, coffee filters, tea bags, fruit peelings, egg shells. Spoiled and moldy food is fine for worms, too.

Feed them only in small quantities at first until you learn what they prefer. Provide a good balance of different types of food.

Egg shells are needed to maintain bedding at correct ph level. Have the children crush egg shells down with a rolling pin, to the size of table salt and feed about 1 tablespoon per pound of worms per week. Sprinkle it over the bedding. If you add more egg shells than this, you do not need to bother adding lime to the bedding. Some egg shells are fine left in halves. Worms love curling up in empty egg shells.

CAUTION! Do not add slaked or hydrated lime, as this will kill the worms. Add only powdered limestone, also known as calcium carbonate.

Meats, dairy products, fats, salt and vinegar should not be included.

Feed the worms only once or twice a week, not every day. Store scraps in a small, sealed pail. Keep at room temperature. Feed in a different spot in bin each time. **DO NOT OVER FEED**

They can be left on their own for two weeks if adequately fed and watered. They actually prefer to be left to themselves most of the time.

The Bin

Rubbermaid plastic bin about 16" x 19" x 12"

Holes punched in the lid. Pointed tip screwdriver works well to make holes.

Press bit into the lid up to the handle so that the holes are large enough for air circulation.

Keep it at room temperature. They will survive in temperatures from 40 to 90 F.

Other types of containers can be used as long as it is shallow, no deeper than 12". In deeper containers the bedding tends to pack down. You want the bedding to be moist, yet loose and fluffy. The secret to an odor free bin is to have oxygen available throughout the bedding so that both the worms and the microorganisms can break down the waste aerobically.

The Odor

The feed waste is buried to avoid odor and attracting fruit flies. The bin should be odorless. Mold or strong odors result from over feeding or excessive moisture.

Harvesting Compost

After 2 or 3 months you will notice the original bedding is no longer recognizable. It is now vericompostor worm castings. Working in bright light (100 watt bulb), mound the bedding into a pyramid or dump the bin and make several small piles. disliking the light, the worms will head to the bottom of the pile(s). Start removing the castings a little at a time until you reach the worms at the bottom. You may want to use a screen type devise of just have the students sort through with their hands. Gather the worms, place them in a small container, like an empty ice cream pail and shade from light. Now add new bedding to the bin, add the worms and feed. Keep a bright light shining on top of the covered bin for 24 -48 hours to make sure the worms do not migrate

through air holes. After rebedding, worms tend to panic and seek escape. A new population of redworms can be started if you pick out the baby worms and egg cases from the vericompost, and place it in a new bin. In a few weeks there will be a lot of visible worms.

Using Finished Compost

Vermicompost is organic, non burning, and rich in nutrients. It builds the soil and helps retain moisture. Use the compost as a cure for sickly house plants or in the soil mixture when repotting or as part of a soil mixture in the garden when seeding.

Hand Washing

Teach children to always wash their hands with soap after handling worms of the compost. Many primary children have a different concept of what this means and so a 10 minute demonstration with a basin of water and soap is strongly recommended. Model correct hand washing technique, then have some of the children model it in front of the class. Make sure there is a supply of soap (pump bottle is a must) by the sink in the classroom.

Moisture

All worms need moisture. They breathe through their skin, which must be moist for exchange of air to take place. If you flood their bedding, the worms will drown.

Sunlight

Direct sunlight will kill worms. They like to be in deep shade.

Air

Worms take in oxygen and release carbon dioxide, just as we do. Make sure that you have air vents on their bin. If you do not, they will smother.

What is Soil Made Up Of ?

Soil is an important natural resource that covers much of the earth's land surface. All life on earth depends on the soil as a direct or indirect source of food. Plants get nutrients from the soil. Animals get nutrients from plants.

Soil contains: 1) mineral 2) organic particles, 3) air and 4) water.

Minerals: sand, silt and clay make up most of the mineral part of soil

Organic matter: plants and animals and animal droppings in various stages of decay

Worm Questions

What is the worm's mouth like?

At the very front part of the worm is the mouth. It is really more like a big upper lip. The worm will stretch out its body to make the upper lip stick out. The lip is sensitive and can find food particles. When the worm finds food it will suck it into the mouth cavity.

Do worms have teeth?

Worms do not have teeth. They have a strong part of their digestive system called the gizzard. The gizzard is able to make very strong contractions that can grind up the food. The gizzard, also found in birds, contains bits of sand that help with the grinding process.

From the gizzard the food moves to the small intestine. Here the food is mixed with strong digestive juices that help with digestion. The nutrients contained in the food are then absorbed into the blood through the intestinal wall. Once in the blood the nutrients are taken to all parts of the body.

The digestive system of the worm is not very efficient. Plant material, soil particles and even bacteria from the soil will pass out of the worm and back into the soil. This "manure" (worm castings) is a very rich natural fertilizer to plants growing in the soil.

Do worms have eyes?

Worms have no eyes. They cannot see. They do have cells on their skin that are sensitive to light. Most of these are on the front end of the worm.

How long does a worm live?

Most worms will live for one year. In that time they will produce many new worms.

How do you know if a worm is a male worm or a female worm?

Worms are both male and female. There is no differentiation. This type of creature is called a hermaphrodite.

On all big worms you can see a wide band that goes around the body.

What is this and what is it for?

This large band is only found on adult worms. It is the part of the body that is able to form the egg case. The band is called the clitellum.

Is it true that if you cut a worm in half you will be able to get two new worms?

The half that contains the head will be able to grow a new tail. The tail part is not able to grow a head part.

The Importance of Worms for Soil Sustainability

The worm is often called "nature's plow". Their burrowing brings air down into the soil to the roots of plants. Worms also loosen the soil and make it crumbly so that rainwater can soak in and get to the roots of plants. Everything the worm eats while plowing gets changed into rich manure. In these three ways, worms are always creating better soil which in turn helps to produce sustainability in agriculture.

In this activity, children can observe how worms plow the soil. Fill two large glass jars 3/4's full with soil. Compact the soil down firmly. Add a thin layer of sand to the top of each, to about 1 inch in depth. Moisten each jar with water. Add just a small amount of decomposing vegetable scraps and finely crumbled egg shells to each. (Too much will attract fruit flies and create an odor. Continue to add partly decomposed scraps as the worms need it.) Add two or three worms to one jar and put no worms in the other. Put a lid on each jar with air holes punched in the top. Cover the whole jar with black paper so no light gets in. Observe each jar each day and note how the soil in the jar with worms is always being plowed up and how the vegetable matter on top is being consumed and turned into soil. Note how stagnant the jar without worms is. After two weeks, slowly sprinkle in 1/2 to 1 cup of water to each jar. Predict which jar will soak up the water in the most efficient way both in rate of soaking in and in distribution of water throughout the jar.

Career Opportunities Associated With Agriculture

Arrange to take the class to see a vermiculture operation (worm farm). Prepare interview questions to find out:

- career opportunities in vericulture
- who purchases worms
- why are worms essential for the sustainability of agriculture
- what students can do at school and at home to protect worms
- how protecting worms will help sustain agriculture and the environment

Worms as a Source of Food in Other Cultures Around the World

A discussion can be held about the importance of tolerance and understanding for other people's food choices. During the lunch time meal at school, children will often see other children's food which they may not want or that they may think is unusual. Children need to be taught that they should never make a rude face or rude comment about what another child has in their lunch. A way to open this discussion might be to ask the children what they would think if they saw another child eating an apple that had been cored and stuffed with peanut butter. The immediate reaction of some children will be to make a grimace and say yuck, while other children might think it sounded good. Establish the point that it does not matter whether they think it is good or not, obviously, that child's mother thought it was good and nutritious for her child, the child probably was looking forward to eating it, but as soon as someone made fun of their food, they would feel embarrassed and likely not want to eat it. Another point is to really think about may be:

Is the food we think as edible, escargot, for example, so different from food other people around the world eat? The children may want to list food that people in their area may eat that people in other countries may think strange.

How does a worm move and is a worm really strong?

A worm has no legs. It needs to move around by contracting the strong muscles in its body. A worm is capable of lifting or moving objects that can be up to 50 times heavier than the worm itself. It is one of the strongest creatures on earth.

When I lift up a rock or an old piece of wood I can find lots of worms.

How do they stick to the rock when they seem so slippery?

Worms have very small bristles that are located on the sides of their bodies. These bristles are called setae. A worm can draw them into its body when it wants to slide along or it can stick them out and attach to something when it wants to stay.

Have you seen a robin trying to pull a worm out of the ground? It looks like it has to tug at the worm and stretch it and it does! The setae attach to the soil in an effort to protect the worm. Worms can also feel vibrations on their skin to warn them of predators.

Why can you not see a heart in a worm?

Worms do not have hearts but they do have enlarged blood vessels that act like hearts to pump the blood throughout the body of the worm.

What happens to all of the worms in the winter?

Worms find it too cold in the winter (their bodies are made mostly of water and this can freeze) and too dry in the summer. Worms will dig very deep cavities in the ground to keep from freezing or from drying out. Here they will rest until conditions are right again. They can rest without food for up to two months. Worms cannot survive in regions like the North Pole or the Sahara Desert.

How big can worms get?

The largest worm on record was 7 meters long.

What does the term nocturnal mean when speaking of worms.

Nocturnal is a term given to creatures that are active in the nighttime and resting during the day. The phrase "the early bird gets the worm" comes from the birds (usually robins) that are up so early in the morning trying to get the worms before the worms bury themselves deeper into the soil.

Why do gardeners get so excited about the value of worms?

Worms are able to digest decaying plant material and animal waste and convert these materials into valuable food for plants. They also loosen the soil and provide air passages to the roots of plants. They are also the number one food source for birds, snakes, moles, shrews and fish.

We can help worms by not spraying lawns with herbicides and by having compost boxes in our back yards.

Setting Up a Classroom Worm Composter Bin

Materials:

Rubbermaid plastic bin about 16" x 19" x 12"

Holes punched in the lid. Pointed tip screwdriver works well to make holes.

Press bit into the lid up to the handle so that the holes are large enough for air circulation.

worms: only use Red Wigglers (*Eisenia foetida*). They cost \$32.00 per pound. You will need 1/2 to 1 lb.

lime

sand

newspaper

water

blender and a apple and a carrot

Information for teacher:

Encourage the children's questions and try to extend their thinking about why the bin is set up the way it is, and how soil is formed.

Vocabulary:

Sand: worms need it for their gizzard to help digest the food

Lime: it is their calcium and aids digestion

Newspaper: the worms chew up the paper completely. In two or three months, the paper will no longer be recognizable

Blender for food: worms have small mouths

Vermicomposting: composting food waste in a bin using worms

Red Wigglers: the best worm for composting because they eat their weight in food per day and reproduce rapidly

Compost: It can be harvested in two months. Compost as the children will eventually see, looks and smells like fine peat moss or fine soil. Soil is made up of compost and rock particles such as sand and clay.

Student Activities:

1. Pass out newspaper and have the children shred the paper into long strips about 1/2 inches wide. Put the shredded paper into the bin. The paper should be 6 to 8 inches deep.

2. Sprinkle a some lime (calcium carbonate, the type used for liming school fields) on the newspaper. Use about 2 tablespoons. Sprinkle a fistful or two of sand on the paper. Add water, a little at a time as you mix. Keep mixing and adding water until the newspaper is like a damp, well wrung sponge. The paper should be moist and fluffy not soggy nor dry. Do not squeeze the paper into a compacted pulp.

3. Add the worms to the bottom of the bin in the center.

4. Since the box is new for the worms and food hasn't had time to decompose, it is best to blend up some food for them in a blender, for this first feeding. One whole apple and a carrot blended with a tablespoon or two of water, should do it. It should be thick as applesauce.

5. Bury the sauce food in one corner and cover deeply with newspaper. The worms will migrate over to it.

6. Keep the bin uncovered, with a bright light shining on it for a complete 24 to 48 hour period. If you do not do this, the worms will all migrate out of your box into secret corners of your classroom! The reason for this is that they have been disturbed and fear disaster so instinctively migrate on mass. Worms will not travel in bright light. After 24 to 48 hours, you should be able to keep the lid on and not have a problem of them sneaking out of air holes.

7. Keep the paper moist. Feed the worms every second day. Do not over feed. Keep rotating spots around the bin to deposit food. Always keep food covered so as not to attract fruit flies.

Wigglers Unit of Activities for the Classroom

Kindness to Worms

Taking worms out of their natural environment and placing them in containers creates a human responsibility. They are living creatures with their own unique needs, so it is important to create and maintain a healthy habitat for them to do their work. If you supply the right ingredients and care, your worms will thrive and make compost for you.

Before working with worms, the class could create a 'caretakers oath' by brainstorming a list of qualities of good worm caretakers. Then each student could sign the document.

Student Lead Scientific Inquiries

After several weeks of free exploration, the teacher could ask each student to list 5 observations and 3 questions, such as: What colors do worms prefer? What are our worms favourite foods? Flip a worm over and see what happens. Using a magnifying glass, find the worm's bristles and sketch them. Small groups of children could invent their own experiments to try and test their theories. (Students will discover that worms prefer darker colors.)

Seeing Right Through a Worm

Put a worm on a glass plate. Hold the plate above a 60 watt bulb. Children will be able to see somewhat through the worm's body. Notice the passage of food through the body. Notice the wavelike motions in the worm. This carries the food along the digestive tract. Notice the blood vessels.

Soil Investigations

Have children dig down through all the soil layers. There are usually 3 major layers. The first is top soil. This is the worm layer. This soil is rich in organic matter and minerals. The second is the subsoil which has less organic matter and minerals, and the third is the gravel layer. Have the children take samples from all 3 layers and experiment with growing plants in each type. Note and record observations.

Books on Worms

Gather all the books that can be found on worms and soil for children to conduct their own investigations

Make a Worm Observation Tank

Find a large glass jar, or narrow glass sided tank, like an ant farm tank. Fill the tank or jar with layers of different colored soils, and sands. Add water to moisten. Add a few worms. Put food on top. Cover the top with black paper with a few air holes punched in it. Later children will see how the worms mix up the soil as they tunnel through it. Keep in a cool, dark place. Water now and again.

Growing With Worm Compost

The students might wonder how good worm compost is for plants. Let small groups of children conduct their own investigations by planting seeds in various types of soil. I have heard, that if you plant seeds in soil from the playground in one pot, soil from pure worm compost in a second pot and in a third pot put a mixture of playground soil and worm compost; the plants that do the best will be from the third pot. Plants need a mixture.

Earn Money for the Classroom Field trips

These worms rapidly reproduce. Sell your surplus worms to parents to set up their own kitchen waste recycling bins. The going rate is \$32.00 per pound. The pure compost, excellent for house plants, sells for \$4.00 a litre. Although it is not necessary, you may wish to kill off any unwanted living larva, if the compost is used for house plants. Do this by spreading a layer of plastic sheeting on the ground on a hot, sunny day. Spread the compost on top of the plastic. Cover the compost with a second sheet of plastic. Secure the corners with rocks, so the wind can't blow the sheet off. The sun will bake the compost and kill any living organisms. Collect the compost in a few hours.

Plant a School Yard Garden or Enrich Existing Beds

Use the compost to plant vegetables or flowers or enrich beds as a school service project.

Sketch the Life cycle of the Worm

It takes about 3 weeks for the fertilized eggs to develop in a case, from which 2 to 10 tiny worms hatch. Hatchlings are white. In a few days they get a red streak. They grow rapidly in size. It takes them one month to become an adult and produce their own eggs.

Sketch the Inside of a Worm's Body

Sketch and label the following parts: the mouth, throat, gizzard, intestine, and anus

Observation and Sketching

Use a hand held magnifying glass. Find and sketch the following: an egg case, a hatchling, a young worm without a clitellum, an adult with a clitellum.

Observation Outside

Go outside with a hand held lens and a shovel. Dig around and look for worms of various ages, egg cases and worm casts.

Record Keeping and Graphing

Keep a record of how much waste you are feeding your worms. Have the children estimate first. Record feeding on graphing paper.

Seek and Record Evolving Thinking

In small groups, children should brainstorm how they think worms help us. They should record their thoughts in a notebook. Periodically, the children should update their thoughts on how worms help us, as they become more knowledgeable with time spent around worms.

Make a Worm Dictionary

record new vocabulary and definitions as they arise

Botswana

Mopane worms are considered a food item.

Mexico

Several types of worms are eaten, including the red agave worm and the meal worm.

Australia

The aboriginal people have traditionally supplemented their bush diet with grubs and worms for a valuable source of protein.

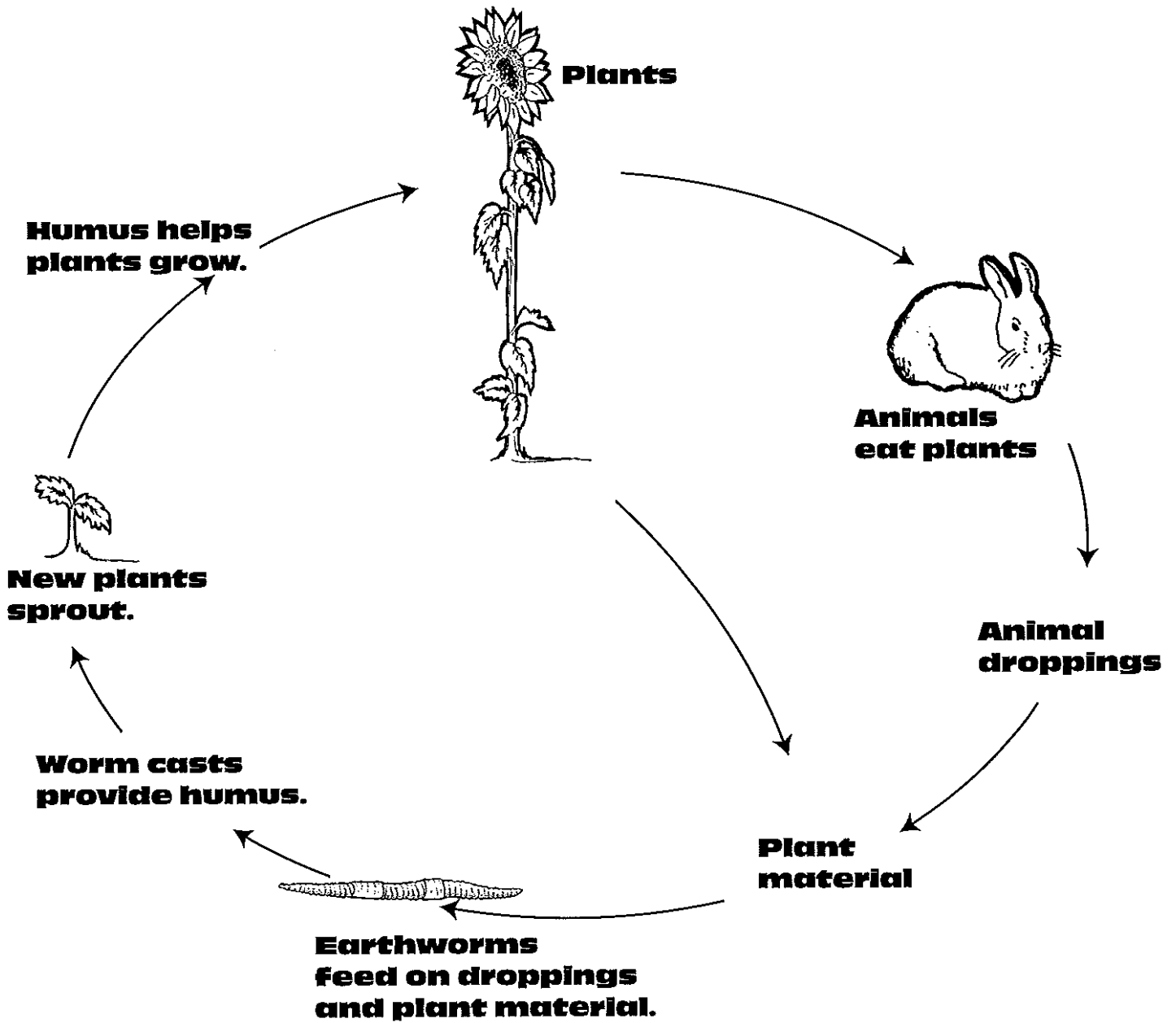
Indonesia

The sago palm worm is enjoyed barbecued.

China

Silk worms are enjoyed stir-fried.

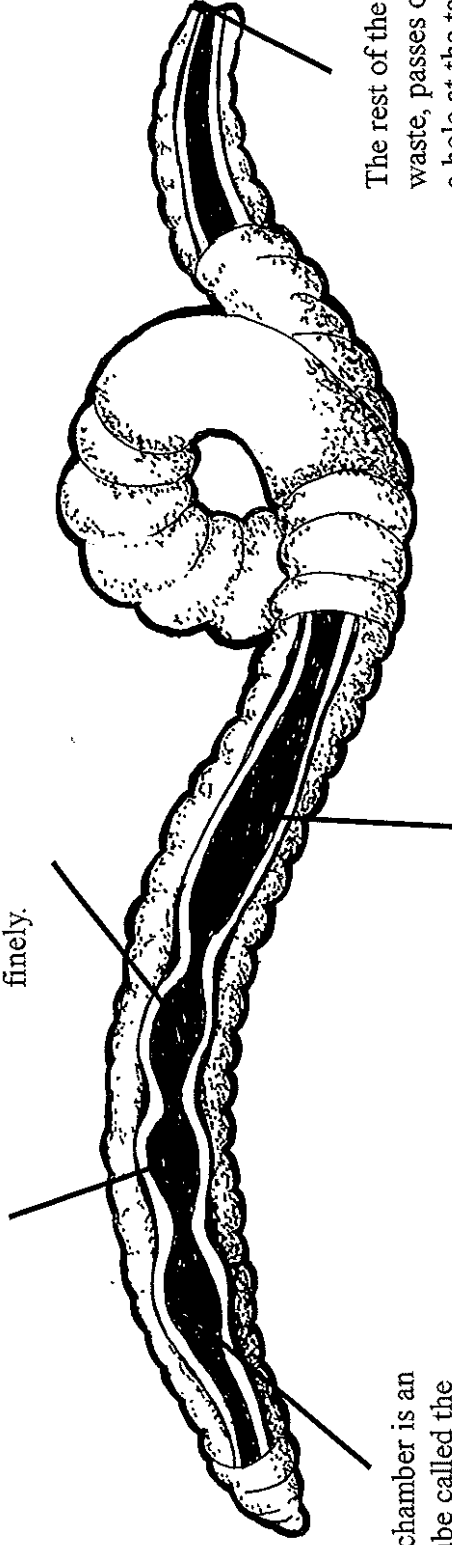
Earthworms in the Food Chain



The earthworm uses its strong muscles to push its food through three chambers within its body.

The second chamber is called the crop. The crop is bottle shaped and has thin walls. Here the food is stored for a short time.

From the crop, the food is pushed into the gizzard. Inside the gizzard, there are tiny grains of rock. These are used by the gizzard to grind the food finely.



The first chamber is an narrow tube called the esophagus.

The food travels to the longest part of the worm's digestive system—the intestine. Digestive juices in the intestine set to work on the food, extracting its goodness, or nourishment.

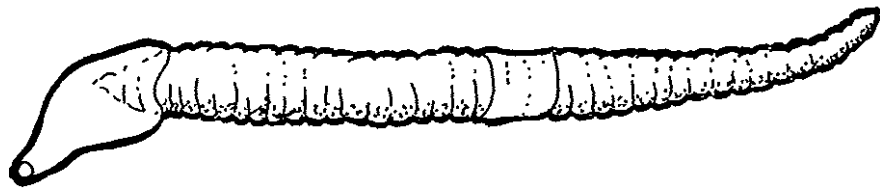
The rest of the food, or waste, passes out through a hole at the tail end of the worm.

First the earthworm makes an egg case. The egg case begins as a belt of slime around the worm's body. The earthworm squeezes some female and male cells into the egg case. Then the worm slips the egg case over its body and drops it into the soil. Both ends of the egg case close up and the slime hardens.

Belts of slime around an earthworm's body.



The belt of slime slips down the body and into the soil.



The egg case in the soil.



Observation Sheet

Name	Name
Name	Name
Name	Name

Name _____ Date _____

Unit: _____

Activity or Project _____

Purpose of Observation _____

Names/Groups	Oservation

Resources for Vermicomposting

Dennis Renaud

for advice and Red Wigglers
(250) 336 - 2738
Home Address:
2787 Primrose Rd.,
Cumberland, B.C.

Worms At Work,
P.O. Box 468,
Cumberland, VOR
1S0

There are about 1000 red wigglers in a pound and it sells for \$32.00

Appelhof, Mary. (1982). Worms Eat My Garbage. Kalamazoo, Mi: Flower Press

Appelhof, Mary. (1982). Worms Eat Our Garbage: Classroom Activities for a Better Environment. 232 pages (gr. 4-8)

Plater, Inge. (1995). How Earthworms Live. Sunshine Science Books. Publisher: Applecross Ltd., Distributed in Canada by Ginn Publishing, Scarborough, Ont.

Plater, Inge. (1995). How Earthworms Grow. Sunshine Science Books. Publisher: Applecross Ltd., Distributed in Canada by Ginn Publishing, Scarborough, Ont.

Plater, Inge. (1995). Earthworms and Their Food. Sunshine Science Books. Publisher: Applecross Ltd., Distributed in Canada by Ginn Publishing, Scarborough, Ont.

Internet Sites:

This is a good educational site for teachers.

<http://www2.garden.org/nga/Edu/coolsite.htm>

On this site, your class can find penpals with other classes around the world who are into composting with worms. You can link to a class in Saudi Arabia that is composting and making a school garden, for example.

<http://www2.garden.org/nga/Edu/penpals.htm>

Brain Paley's home page has 45 pages of information. He has many interesting facts for the vermicomposter, including scientific information and basic worm information.

<http://gnv.fdt.net/~windle/>

Mary Appelhof is the author of the two great books mentioned above. Her website of WORM WOMAN, MARY APPELHOF can be found at:

<http://www.wormwoman.com>