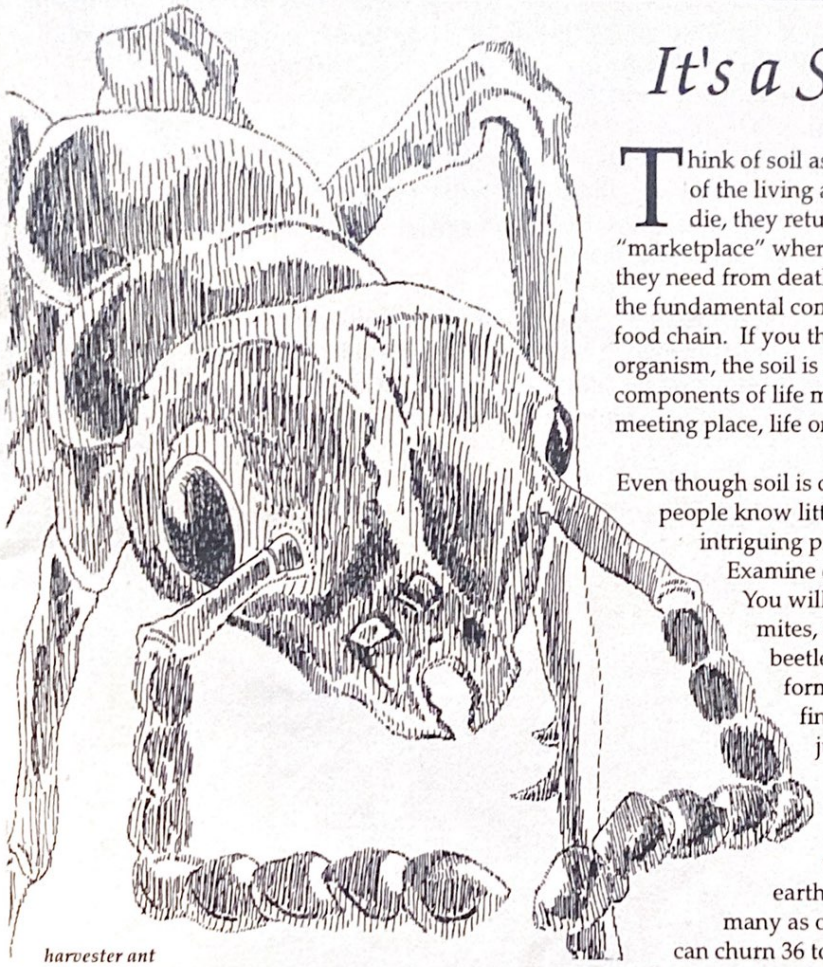
Growing WILD

Winter 1997

Utah's Project WILD Newsletter



harvester ant

It's a Small World!

Think of soil as a place where two worlds meet, that of the living and the dead. When living organisms die, they return to the soil, a thriving and complex living "marketplace" where countless plants and animals take what they need from death. These plants and animals, in turn, pass the fundamental components of life on to the next group in the food chain. If you think of the earth as a huge, single-celled organism, the soil is much like a membrane through which the components of life must pass. Without this thin, precious meeting place, life on earth's landmasses would be unlikely.

Even though soil is critical to all terrestrial ecosystems, most people know little about it. The world of soil is an intriguing place occupied by unbelievable creatures. Examine one square foot of forest soil, one inch deep. You will find 1,356 living organisms, including 865 mites, 265 springtails, 22 millipedes, 19 adult beetles, and various numbers of 12 other life-forms. If you include microscopic life, you will find billions of bacteria, fungi, and protozoa in just *one teaspoon* full of that same soil!

Many of the wild creatures that make up soil provide important services to humans without our awareness. Consider the earthworm. In one acre of soil there may be as many as one million earthworms. That acre of worms can churn 36 tons of organic matter through their intestines in one year! Through this process, worms aerate the soil and produce nutrients critical for plant growth.

"You must love the crust of the earth on which you dwell more than the sweet crust of any bread or cake."
-Henry David Thoreau-

Soil and its inhabitants beg to be investigated. With a few hand lenses and some healthy soil, students of all ages can become explorers of an unknown world. They can watch soil form in homemade compost columns built out of soft drink bottles. Or, if your students are looking for an interesting action project, they can create compost bins at school or home to recycle food waste and enrich soil in their own backyards.

This issue of Growing WILD *explores the world of soil and suggests activities and themes for use by educators. Take the opportunity to reconnect young people to soil, one of our fragile connections to life.*

A World Beneath our Feet

There are more organisms in a gram of soil than there are humans on earth. It has been estimated that one gram of soil harbors, 100,000,000 bacteria, 1,000,000 fungi, 100,000 micro-algae, 10,000 protozoa, 1,000 nematodes, 10,000,000 other invertebrates and innumerable viruses! Totals like this are mind boggling, but even more amazing is the soil's biodiversity. It is estimated that in one gram of soil there are over 10,000 different species of microorganisms. That is more than all the different species of mammals found on earth!

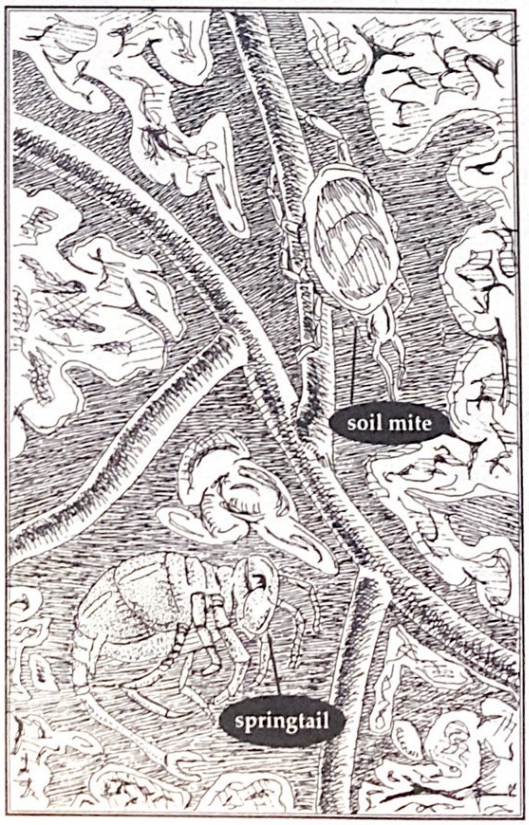
"There is a world under this world of which we have no suspicion."
-Jules Michelet-

And as you can imagine, the relationships between soil organisms are complex and depend upon highly changeable conditions. Temperature and moisture can change suddenly, and nutrients are not constantly available, but come in bursts. As a result, many organisms lie dormant, waiting for good conditions. Azotobacters are a good example. They are free-living bacteria that can take atmospheric nitrogen and change it into a form that plants can use. During harsh conditions, Azotobacters produce cysts which serve as a resting stage of the organism. Only when conditions improve do the bacteria become active again.

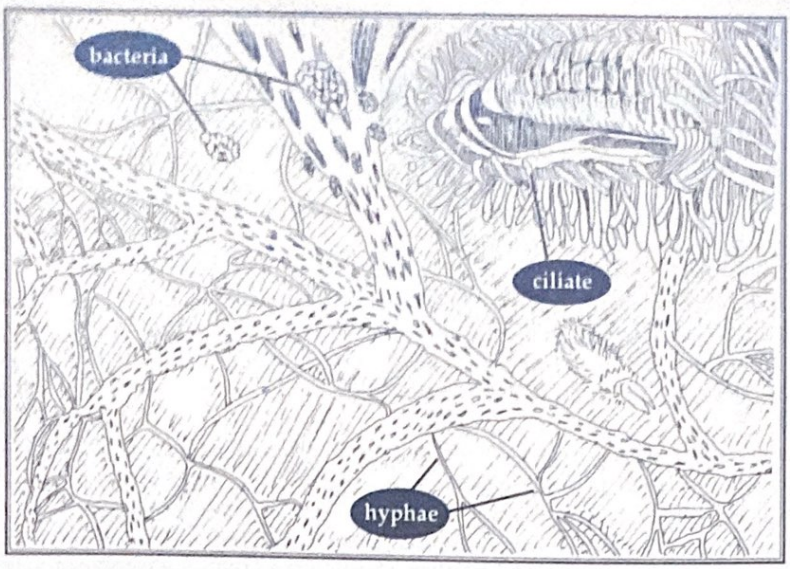
Insects, earthworms, gophers, ants, and other burrowing animals create conduits for the passage of water and roots through soil. Through their burrowing activities they also enhance the exchange of nutrients throughout the soil column by blending soil from the surface with that from below. Earthworms alone are capable of moving tons of soil annually, enriching it as it passes through their bodies.

The breakdown of leaves and woody material on the soil's surface enlists a different cast of players. Decomposition of cellulose is a difficult task which requires an interesting partnership. Unlike most animals, termites can digest cellulose because they have the help of a protozoan which lives in their digestive system. The protozoan is able to change cellulose to a usable form of food for the termite. The protozoa, in return, gets a nice comfortable home in the gut of the termite!

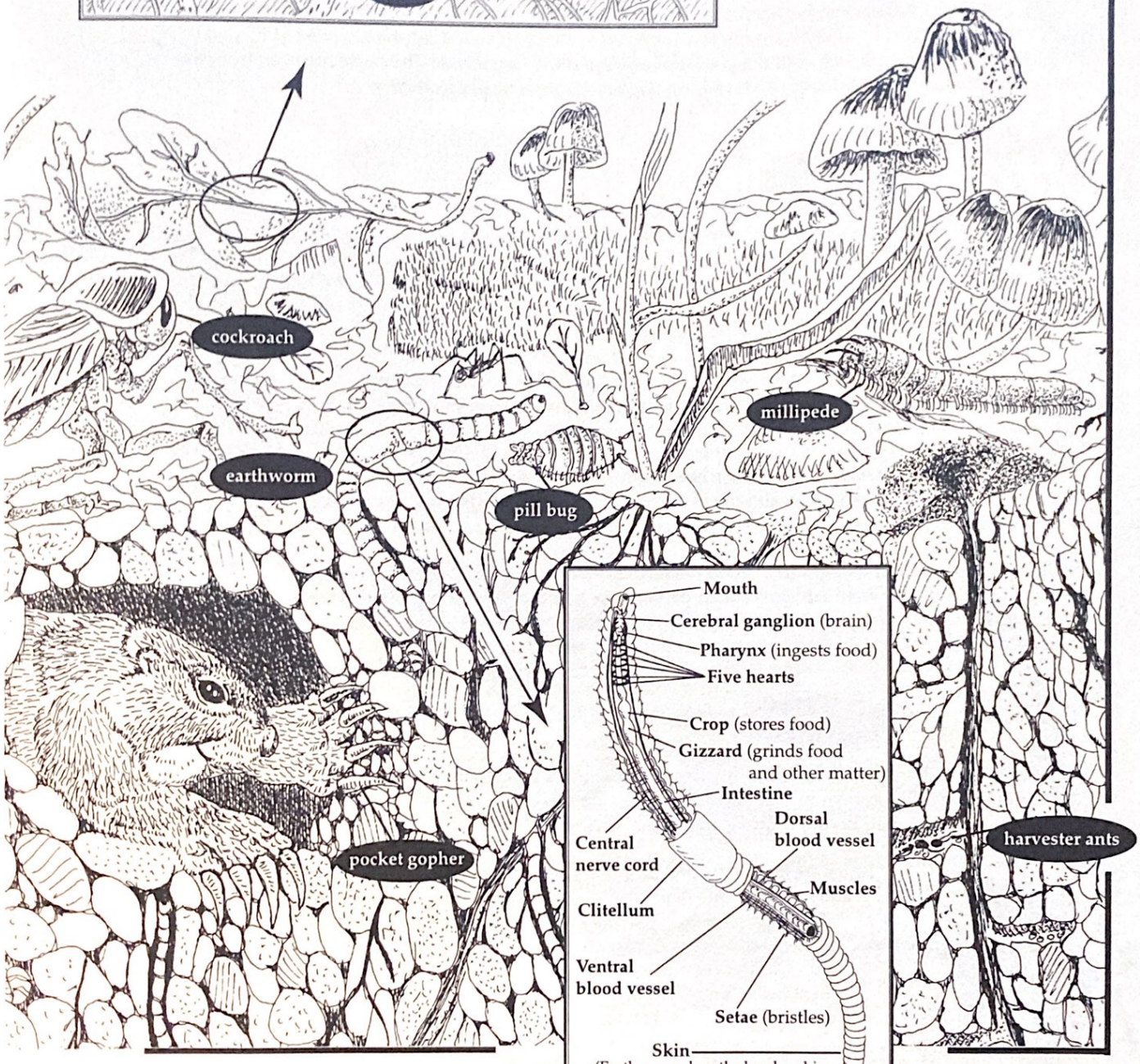
After insects begin to decompose a tree, then fungi and microbes move in. Fungi produce long thin filaments called hyphae which grow through decaying plants, decomposing the woody fibers. After the fungi breakdown the woody fibers, microbes move in and further decompose the tree. Decomposition of a tree to soil takes a long time. A ten-inch log can take 20 years to decompose. Imagine our world without soil organisms!



Springtails and soil mites are some of the many different animals which live in the soil.

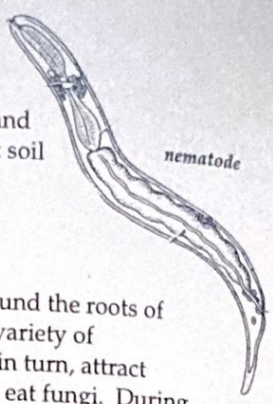


At a microscopic level, bacteria consume the woody fibers of a leaf vein, and ciliates, a type of protozoan, consume the bacteria. Surrounding this microscopic food chain are the hyphae of fungi which also decompose the leaf.

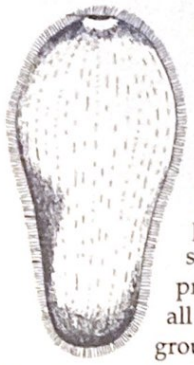


Soil is More Than Dirt!

Soil Microbes



nematode



ciliate

When Thoreau writes in his journal, "Nature is mythical and mystical always, and spends her whole genius on the least work," he could have been writing about soil microbes. Unseen by the naked eye and unbelievably important, soil microorganisms play a vital role in the decomposition of organic matter, the production of humus, the cycling of nutrients, and the fixation of elements.

Much of the microbial activity in the soil occurs in the rhizosphere - the area around the roots of plants. Activity is concentrated in the rhizosphere because plant roots secrete a variety of substances that provide nutrients for microbes such as bacteria and fungi. They, in turn, attract predators - ciliates and other protozoans which eat bacteria and nematodes which eat fungi. During all this activity, biochemical transformations take place that create substances needed by plants. One group of bacteria known as nitrogen fixers are especially important. They take nitrogen from the atmosphere (N_2) and change it into a form that can be used by plants (NH_3).

Pillbugs

Turn over a rock in your backyard and you may find familiar small, grayish-purple pillbugs. Many people mistakenly think pillbugs are insects. Instead, they are classified as a type of crustacean (like crayfish and lobsters) called isopods. Most isopods live in water, but pillbugs live on land. They breathe through gill-like structures, and must live in moist places where they feed on fungi and decaying vegetation.

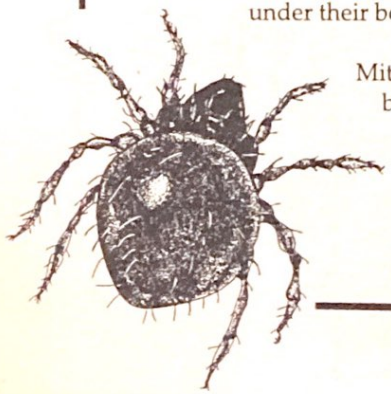
Pillbugs are called pillbugs because they roll up into a tiny ball or pill when disturbed. They are also sometimes called wood lice, potato bugs and roly-polies. Sow bugs, close relatives of pillbugs, run when disturbed instead of rolling up.

Pillbugs are 5 to 15 mm long. They have a head with two antennae and a pair of eyes, a thorax with 7 pairs of legs, and an abdomen. Their exoskeleton is made up of shield-like flexible plates.

Female pillbugs carry their eggs in a brood pouch beneath their thorax. When the young emerge, they look like small replicas of their parents. As in most arthropods, pillbugs shed their exoskeleton as they grow, but pillbugs do it in a unique way. First they crawl out of the back half and then a few days later, they crawl out of the front half.

Soil Mites

A shovel full of soil might reveal a few tiny dark brown or black, shiny, bead-like critters. These are probably soil mites, also known as Oribatid mites. Most are less than 1 mm long and some can tuck their legs under their bodies forming a little ball. Oribatid mites are also known as beetle mites.



Mites are closely related to spiders. Both have eight legs but unlike spiders, a mite's body is fused into one piece, with no separation between head and abdomen. There are many different species of mites, surpassing all other orders of arachnids in diversity. People often think of mites as plant and animal parasites, or transmitters of disease, but many, such as soil mites, are not only harmless, but beneficial. They feed on decaying plant litter and play an important role in the formation of humus, the dark fertile topsoil in which plants take root.

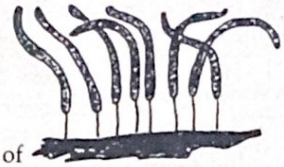
Botta's Pocket Gopher

The Botta's pocket gopher is a common gopher species in Utah, occurring almost anywhere there is soil suitable for digging. The pocket gopher is a rodent superbly adapted for life underground. It has small eyes and ears, large claws on its powerful front feet, and large chisel-like incisors for gnawing the roots, tubers, grasses, and seeds upon which it feeds. It can even close its lips behind its teeth to chew without getting dirt in its mouth. And, its fur lays smooth either forwards or backwards allowing it to crawl through its tunnels without turning around.

Pocket gophers get the first part of their name from their external fur-lined cheek pouches. The term "gopher" is derived from the French word *gaufre* which means "honeycomb" and refers to their extensive tunnel systems that can cover an acre of ground. The tunnels are 2-4" in diameter and run parallel to the surface, about 6-18" deep. Soil from the tunnels is pushed to the surface creating crescent-shaped, flat mounds.

Gophers do not hibernate. In winter they make tunnels in the snow that they fill with dirt excavated from their burrows. When the snow melts, long dirt piles known as "eskers" remain on the surface of the ground.

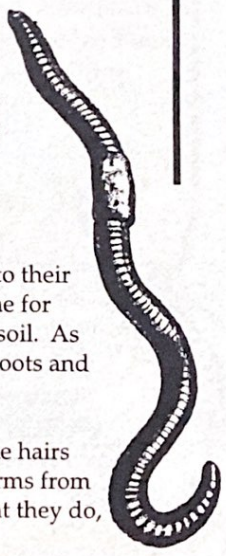
Slime Molds



Slime molds are scientifically known as myxomycetes, a word which comes from the Greek words *myxa* (slime) and *myketes* (fungi). Slime molds, are some of nature's most bizarre organisms. They exhibit characteristics of both animals and fungi during different stages of their lives. In the feeding stage, slime molds slide along like a mass of protoplasm (the plasmodium), engulfing bacteria, spores, and decaying organic matter. In this stage, they are most often found under the bark of decaying logs, between layers of leaf litter, in rich loose soil and, in dung. They look like bright red, orange or yellow, jelly-like, flattened globs of slime that move very slowly.

When their food supply is exhausted or other unfavorable conditions occur, the plasmodium contracts and takes on the appearance of a fungus, by producing fruiting body structures (sporangia) that contain reproductive spores. Sporangia appear on rotting wood or among decaying leaves. Each species' sporangia has its own characteristic design. Some are on long stalks and others are covered with hard limy cases. Most are too small to be seen in detail without a hand lens. Spores are released into the wind and germinate into new plasmodial bodies when conditions are again favorable.

Earthworms



Earthworms can be found almost everywhere on earth except in deserts, which are too dry, or in polar regions, which are too cold. Although about 2000 kinds of earthworms have been identified, the species most familiar to us is the red worm, *Lumbricus rubellus*.

Earthworms live within the top 6" of the soil, where they literally eat their way through their surroundings. Soil, decaying organic matter, bacteria, and other soil organisms are sucked into their mouths by a muscular pharynx, passed to a gizzard for grinding, and pushed into the intestine for digestion. Castings, which come out the other end, are nutrient-rich clumps that fertilize the soil. As earthworms plow through the soil, they also create channels for air and water to reach plant roots and help bring minerals up from below. All of this helps to keep the earth green with plants.

An earthworm moves by first extending the front-half of its body, anchoring it with bristle-like hairs called setae, and then pulling its back-half forward. These bristles also help prevent earthworms from being pulled from their burrows by robins, shrews and other predators. With all the good that they do, earthworms are easy to love.

Microcosmos Thematic Unit...
Unseen Essentials

In the following Project WILD activities students focus on the small but important organisms of the microcosmos - creatures like bacteria, protozoans, arthropods, snails and worms!

springtail

Grade 6

Wildlife is Everywhere! - evidence that microorganisms exist everywhere (Science)

Micro Odyssey - observe and collect data about microorganisms (Science, Math)

Interview A Spider - classification, comparison of shapes and structures of microorganisms (Science), using references and conducting research (Social Studies)

Eco-Enrichers - describe interactions of microorganisms in an ecosystem (Science)

First Impressions - identify helpful aspects and significance of microorganisms in the environment (Science)

Adaptation Artistry - examine roles of microorganisms in environments (Science, Art)

Animal Poetry - compose descriptive selections (Language Arts)

Deadly Links (use microbes, earthworms and robins) - draw inferences about roles of microorganisms in a food web (Science)

Something's Fishy Here! (younger student version) - list possible outcomes and alternative solutions to a given problem (Social Studies)

scarab beetle larva

scarab beetle

Grades 9-12

Microtrek Treasure Hunt - understand concepts of biological diversity and its importance, examine relationships of organisms in a system (Science)

Ants on a Twig - compare and contrast characteristics of organisms, analyze methods for meeting biological needs (Science)

Grasshopper Gravity - relate functions and structures of organisms, analyze adaptive advantages of organisms (Science)

Interview a Spider - classification of organisms, biological diversity (Science)

Spider Web Geometry - analyze geometric shapes, mathematical connections (Math)

Eco-Enrichers - investigate ecosystem using the tools of an ecologist, identify the role of producers, consumers and decomposers in carbon and nitrogen cycles, (Science), evaluate importance of a natural resource (soil) (Social Studies)

Which Niche - food chains, cycle of matter (Science), career exploration (Language Arts)

The Glass Menagerie - measure abiotic factors and identify, quantify and graph biotic factors in an ecosystem, carbon, nitrogen and phosphorus cycles (Science)

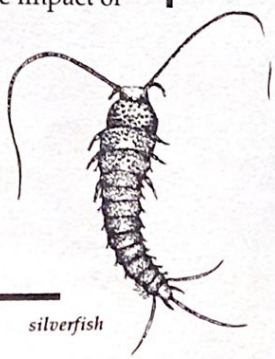
Good Buddies - describe symbiotic relationships within an ecosystem (Science)

Deadly Waters - analyze the effects of humans in an ecosystem, evaluate impact of organic compounds on society and the environment (Science)

Something's Fishy Here! (older student version) - evaluate how technology can create and mitigate damage to the environment (Science)

Wildlife Issues: Community Attitude Survey - discuss recent environmental problems created by ecological imbalances (e.g. topsoil depletion) (Social Studies) examine topic of global concern (Language Arts)

termite



silverfish

Resources

Check-out the following from Project WILD; call (801) 538-4719.

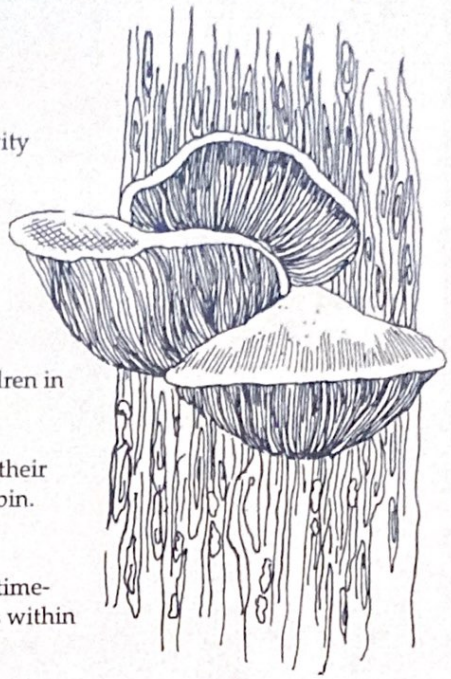
The Microcosmos Curriculum Guide to Exploring Microbial Space - Activity manual includes chapters titled, *Magnifying Without Money, Microbial City, Root Beer Making* and much more!

Soil, We Can't Live Without It - National Wildlife Federation slide-tape program emphasizing the value of soil and the importance of conserving it. Educator's guide included.

Bugs Don't Bug Us - an award-winning video that captures preschool children in a field investigation of invertebrates.

Wormania - video featuring footage and information on how worms move, their role in soil ecology, how they breed, and how to set up a worm composting bin. Includes an activity guide.

The Secret Life of 118 Green St. - video of electron microscope images and time-lapse photography bring to life the teeming multitudes of unseen organisms within our homes and on our bodies.



oyster mushroom

Spiders; Insects; Invertebrates; Rocks and Soil - four new video titles available in the Bill Nye the Science Guy series.

Spiders and Insects Resource File - full of materials including activity guides, magazine articles, and books.

Request a free copy: (801) 538-4719

Worm Worlds - an OBIS activity guide that engages students in a study of worms living in schoolyards and backyards. Other OBIS titles available as well: *Bugs, Worms and Others; Super Soil; Isopods; Ants; Web It; Mystery Marauders; Bean Bugs.*

A Soil Ecosystem - colorful transparency depicting soil organisms in their environment.

Invent an Insect - an adaptation of the Project WILD activity "Adaptation Artistry" for insects.

Bug Briefs - bug activities/handouts from the Entomological Society of America.

Bug Fun Facts - more good bug stuff.

Eco-Enrichers - one title in the excellent North Carolina WILD Notebook series focusing on classroom composting and the role of soil organisms.

Internet Sites

Creeping and Crawling through the Web

Visit **http://sln.fi.edu/tfi/hotlists/insects.html** for links to information about a variety of insects.

A comprehensive list of entomology-related sites can be reached at **www.ent.iastate.edu/list/complete.html.** Look at Dr. Frog's Recipe Page for frog approved bug recipes. The link is found under "Miscellaneous".

Don't forget our worm friends and visit Worm World at **www.nj.com/yucky/worm/index.html**, billed to be the yuckiest page on the internet. Students can interact and ask questions at this fun site.

Take a tour of the Microbe Zoo at **http://commtechlab.msu.edu/CTLProjects/dlc-me/zoo/**. Visit Dirtland, the Animal Pavilion, Water World or several other places to learn about microorganism ecology.

pseudoscorpion

BOTTLE BIOLOGY

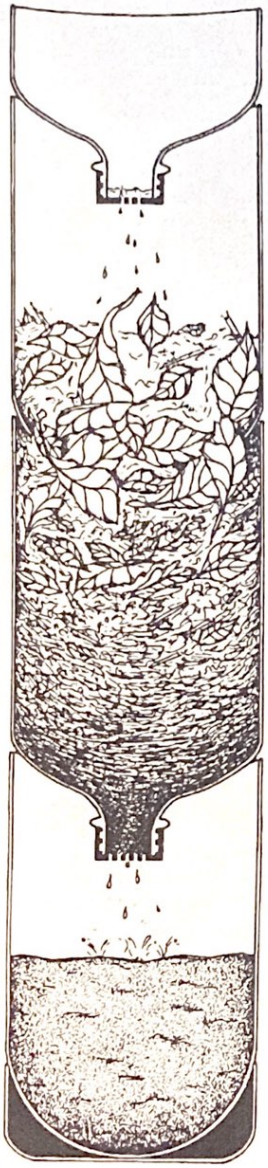
WISCONSIN

Compost Columns

Where do things go when they die?
Explore the process of decomposition.

Composting is based on the biological process of decomposition. What turns plants and animals into compost? Microscopic bacteria and fungi, which feed on dead tissue, are the chief agents.

What affects the composting process? The amount of moisture and air, temperature, light, sources of bacteria and fungi, and the nature of the decomposing material are all critical. The presence or absence of air (oxygen) is one of the most important factors in composting. The practice of composting allows air and moisture to speed the natural process of biodegradation. Making a compost column lets you see and experiment with this process, and witness nature's world of recycling.



Materials Needed:

- Three 2-liter plastic beverage bottles
- Hot tap water, knife or razor blade, scissors, marking pen, sharp needles for poking holes, clear tape, netting or mesh fabric, rubber bands.
- Organic materials for composting, such as kitchen scraps, leaves, newspapers, animal manure, and grass clippings.

Procedure:

Remove the bases from two bottles, and the labels from all three, by pouring about two cups of hot tap water into the bottles. (Columns can also be made from bottles that don't have removable bases.) Replace the cap, tilt the bottle so the water softens the heat-sensitive glue, peel off the label and twist off the base. Pour out the water, draw cutting lines around the bottle, make incisions with the knife and cut with scissors and assemble as illustrated.

Most columns will require air holes for ventilation, and these can be poked into the plastic with a sharp cold needle or with a needle or paper clip heated in a candle flame. Alternatively, larger holes can be cut into the sides with the knife and covered with fine mesh fabric held in place with tape. A piece of mesh fabric over the lower end allows for drainage. Refer to the illustrations. Add ingredients for composting through the top of the column.

Explorations:

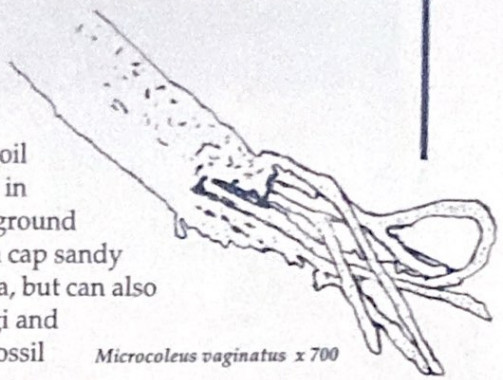
The possibilities for compost column explorations and discoveries are endless. There is no limit to what can be put inside, or the conditions under which the column can be kept. In addition to simply observing changes, you can design experiments which explore the effects of variables on you column.

For a free set of *Bottle Biology* activities, write:

Bottle Biology Project, Dept. of Plant Pathology, University of Wisconsin,
1630 Linden Drive, Madison, Wisconsin 53706

Microbiotic Soils...

The Desert's Delicate Skin



Microcoleus vaginatus x 700

Thousands of square miles of the Colorado Plateau, including millions of acres in Utah, are covered by a soil called microbiotic or cryptobiotic soil. In some places in Southern Utah, microbiotic soils represent 80% of the living ground cover. The soil is a crust of small, dark brittle mounds which cap sandy subsoil. Most of this crusty soil is composed of cyanobacteria, but can also be composed of lichens, mosses, blue-green algae, microfungi and bacteria. Cyanobacteria are the oldest form of life known. Fossil cyanobacteria, called stromatolites, date back 3.5 million years.

One common species of cyanobacteria found in Utah's microbiotic soils, *Microcoleus vaginatus*, is composed of tiny, sticky mucilaginous sheaths filled with filaments. When moistened, this cyanobacteria becomes active and moves through the soil, partially extracting the filaments from the sheath. Each new filament then grows a new sheath, leaving a heavy trail of thick mucilage behind, much like the trail that a slug or snail leaves. The result is a thick intricate webbing of fibers which joins soil particles like beads on a string.

The ecological role of microbiotic crusts is critical in cold desert ecosystems. Many species of cyanobacteria are capable of fixing atmospheric nitrogen. This means they can capture inert atmospheric nitrogen and change it to an essential nutrient that all plants need. In this way, microbiotic crusts produce plant nutrients in ecosystems which are typically nutrient deficient. In addition, cyanobacteria sheaths are extremely hydrophilic (water loving) and will absorb water, swelling up to 10 times their original size. This adaptation provides plants and animals with water during dry times and extends the active period of cyanobacteri which are active only when wet.

"In this pipeline of life, the highest achievement anything can reach is the soil itself."
-Rick Bass-

It has been demonstrated that microbiotic soils are critical in protecting dry desert landscapes from the erosional forces of wind and water. The complex of cyanobacteria sheaths, algae and fungi serve as a protective cap and provide a place where larger plants might germinate, thereby forming a later stage of succession. Cyanobacteria are world famous as pioneer species. In fact, they are often one of the first life forms to colonize lava flows and cinder cones!

Unfortunately, human activities can have a detrimental and lasting effect on microbiotic soils. Actions such as cycling, hiking, overgrazing, ORV riding and construction have exposed many acres of Utah to erosion. Once the microbiotic soils are disturbed to the point of breaking the brittle, dry sheaths of the cyanobacteria, erosional forces can go to work. The loose soil particles that are blown or washed on top of the microbiotic crusts, block out the sunlight that cyanobacteria need for growth. When this process begins, the sandy subsoil is exposed to a greater extent and the microbiotic soil is slowly covered by sand dunes. The rate at which these soils can regenerate and stabilize is slow. In the best situation, cyanobacteria can recolonize an impacted area to a depth of 2-4 mm thick with one or two species after seven years! Undisturbed crust can be over 100 mm thick and consist of 14-15 species.

Protection of microbiotic soils is a priority for people who care about the land. When you are visiting places with microbiotic soils, honor the phrase, "Don't Bust the Crust!"

Advanced Wildlife Workshop

Neotropical Migratory Bird Weekend

yellow-billed cuckoo

Tired of the cold? Ready for some excitement? Do you want to meet some famous world travelers? Join Project WILD at Lytle Ranch on **April 4-6,** to study Neotropical migratory birds. Frank Howe, Utah Division of Wildlife Resources's Avian Program Coordinator, Merrill Webb, birding expert and Provo High biology teacher, and Rick Fridell, conservation biologist, will guide us in learning about some of Utah's most fascinating creatures in one of the nation's premiere birding hot spots.

The objectives of the workshop are:

- learn how to collect and interpret data about migratory birds
- learn to identify some of Utah's Neotropical migratory birds
- learn about Utah's Mojave ecosystem

Lytle Ranch is in one of Utah's most biologically diverse areas. Everything from the common black hawk to desert tortoises can be found in a small area. We will be camping and there will be moderately difficult hiking.

Project WILD will run a shuttle from the Wasatch Front. Substitute pay for Friday is also available. Registration is limited to 15 people. Workshop fee is $30. Send registration to: **Project WILD, UDWR, PO Box 146301, West North Temple, Salt Lake City, UT 84114**

Return form with $30 check payable to UDWR.

Name _____ Phone _____

Address _____

Grade level _____ School _____

_____ I need substitute pay.

_____ I need transportation from Salt Lake City.

Resources

swallowtail

Free! Call Project WILD at: (801) 538-4719

The High Plains Ecosystem - an informative poster and article from "Science and Children" magazine highlighting the prairie region's web of life.

Again the Eagle Soars Poster - produced by the U.S. Fish and Wildlife Service, touts the success of the Endangered Species Act.

California Condor Reintroduction Information Packet - information for teachers reviewing the effort to recover the endangered California Condor.

Vegetative Types and Land Resource Areas Poster - a detailed color representation of Utah's vegetation zones. Produced by the Natural Resources Conservation Service.

Geography: Exploring a World of Habitats, Seeing a World of Difference - National Geographic Society's Geography Awareness Week teacher's packet that features ecosystems, biodiversity and endangered species. Includes three full-color posters!

Not Free, But Worth the Cost:

Spanish Translations of Project WILD Activity Guides - all of the Aquatic guide and many of the activities from the original Project WILD guide are now available in Spanish. $3.50 per guide.

Mountain Plants of Northeastern Utah and Desert Plants of Utah - two comprehensive Utah State University Extension publications (out of print) with excellent illustrations and information about Utah's plant species. $6.00 each or both for $11.00.

Wildlife of Utah: A Photo Essay - 68 pages of color photographs, including descriptions of Utah's ecosystems and a map of habitat zones. $5.00.

New Resource Files Available for Check-out:

Rivers and Streams

Urban Environments

Mountains and Forests

Wildlife Internet Sites

Endangered Species - information and fact sheet - **http://nceet.snre.umich.edu/EndSpp/end2.html**

US Fish and Wildlife Service, Endangered Species Home Page - new address - **http://fws.gov/~r9endspp/endspp.html**

Yellowstone Journal - up to date information about wolves, grizzlies and other Yellowstone wildlife - **http://www.wyoming.com/~yellowstonejournal/**

Coral Forest - information about protection of coral reef ecosystems and available teaching resources - **http://www.blacktop.com/coralforest/**

Bird Monitoring Programs - informative site to accompany Project WILD activity "Bird Song Survey" - **http://www.im.nbs.gov/birds/html**

project WILD

Utah Division of Wildlife Resources
1594 West North Temple, Suite 2110
Salt Lake City, Utah 84114-6301

Growing WILD is written by Bob Ellis and Diana Vos. Robert Hibberd drew the harvester ant, underground scene and yellow-billed cuckoo. Jill Rensel drew the pocket gopher. Josh Ketchum drew the spider mite and pill bug.

STATE OF UTAH
NATURAL RESOURCES
Division of Wildlife Resources

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