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ABSTRACT

This environmental unit is one of a series designed for integration within an existing curriculum. The unit is self-contained and requires minimal teacher preparation. The philosophy of the series is based on an experience-oriented process that encourages self-paced independent student work. This particular unit investigates soil in relation to acidity, moisture, minerals, and organisms. Students in grades 2-9 can discover how these factors are interrelated and what effects they have on the soil through the activities included in the unit. Techniques for determining soil pH with litmus paper and the presence of soil nitrates with test kits are included. Also, students make a sample of organisms in the soil with the help of a Berlese funnel. Each activity includes a list of the materials needed and where they can be found, background information, directions, and questions for discussion. (MA)

THE ENVIRONMENTAL UNITS

This is one of a group of Environmental Units written by the Environmental Science Center and published by the National Wildlife Federation.

In both theory and practice education is the essential base for long-range local, regional and national programs to improve and maintain the quality of environment necessary for man's welfare and survival. Citizens must be aware of ecological relationships in order to recognize, appreciate and fulfill constructive roles in society. This awareness should be launched through the existing educational process—in classroom and related school activities. No special courses on ecology can replace the need to integrate ecological learning throughout the existing curricula of our school systems. Furthermore, the life-styles and value-systems necessary for rational environmental decisions can best be acquired through repeated exposure to ecological learning which pervades the total educational experience.

It was with these thoughts that we developed these curriculum materials. They were designed for the classroom teacher to use with a minimal amount of preparation. They are meant to be part of the existing curriculum—to complement and enhance what students are already experiencing. Each unit is complete in itself, containing easy-to-follow descriptions of objectives and methods, as well as lists of simple materials.

The underlying philosophy throughout these units is that learning about the environment is not a memorization process, but rather an experience-oriented, experiment-observation-conclusion sort of learning. We are confident that students at all levels will arrive at intelligent ecological conclusions if given the proper opportunities to do so, and if not forced into "right" answers and precisely "accurate" names for their observations. If followed in principle by the teacher, these units will result in meaningful environmental education.

In the process of development, these units have been used and tested by classroom teachers, after which they have undergone evaluations, revisions and adaptations. Further constructive comments from classroom teachers are encouraged in the hope that we may make even more improvements.

A list of units in this group appears on the inside back cover.

About the National Wildlife Federation—1412 Sixteenth Street, N.W., Washington, D.C. 20036

Founded in 1936, the National Wildlife Federation has the largest membership of any conservation organization in the world and has affiliated groups in each of the 50 states, Guam, and the Virgin Islands. It is a non-profit, non-governmental organization devoted to the improvement of the environment and proper use of all natural resources. NWF distributes almost one million copies of free and inexpensive educational materials each year to youngsters, educators and concerned citizens. Educational activities are financed through contributions for Wildlife Conservation Stamps.

About the Environmental Science Center—5400 Glenwood Avenue, Minneapolis, Minnesota 55422

The Environmental Science Center, established in 1967 under Title III of the Elementary and Secondary Education Act is now the environmental education unit of the Minnesota Environmental Sciences Foundation, Inc. The Center works toward the establishment of environmental equilibrium through education—education in a fashion that will develop a conscience which guides man in making rational judgments regarding the environmental consequences of his actions. To this end the Environmental Science Center is continuing to develop and test a wide variety of instructional materials and programs for adults who work with youngsters.

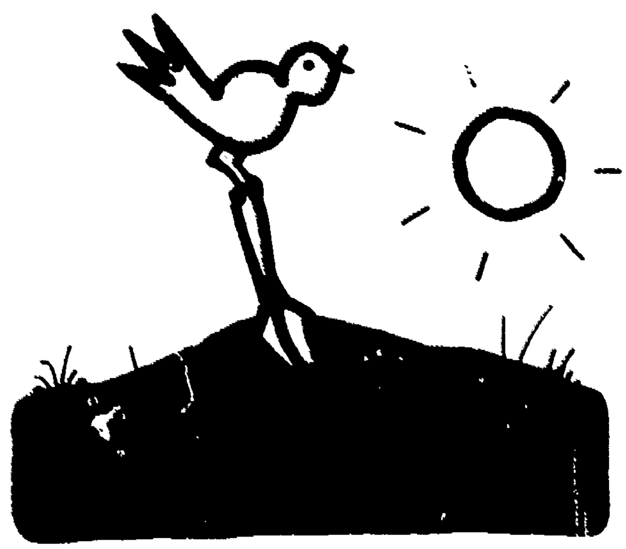
Soil

An Environmental Investigation

BY

NATIONAL WILDLIFE FEDERATION

MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.



Design and Illustrations by

JAN BLYLER

Youngsters should all be exposed, as early as possible, to their environment and its parts. The *way* that they first confront these surroundings can be critical in terms of their future interest and learning.

There are abundant opportunities to use the environmental sciences as a content background for investigations and discoveries in and around your school grounds. Several such activities are described in this unit.

Our hope is that through these activities your students will gain a general feel for how various elements of the environment work together. We hope that these activities will help children to look differently at everyday things such as soil, and help them realize that there is much to learn from everyday items. If they become aware and interested in the natural things around them, then maybe they will want to do more to protect these elements.

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INTRODUCTION

Both density and appearance of plants are controlled largely by the soil in which the plants are growing. This means that one reason certain plants are found in certain places is because the soil contains some of those things necessary for the plants to grow.

Not all plants have the same requirements for growth. This becomes apparent when correlations are made between certain plants and certain areas. For example, you would only expect to find cattails around moist areas or ponds where the soil can hold relatively large amounts of water. On the other hand, cacti are adapted to dry soil and are structured to conserve water. Cottonwood trees grow best in moist soil, oaks in dry. These are examples of the *plant-water relationship* which is influenced by soil type. This relationship is the most essential determinant of plant distribution, but by no means the only one.

Clover grows well in soil which is alkaline but grows poorly in acid soil. Bog plants or blueberry bushes will grow well in acid soil but not in soil which is alkaline. But then again, crabgrass seems to do just as well in either type of soil as long as there is enough light.

Certain plant nutrients, sunlight, and temperature variation are other factors which determine plant distribution. No single factor accounts for distribution patterns. Instead, several factors acting at once upon the plant determine whether or not it can survive in a given area.

Since it is not easy for students to investigate all of the contributing environmental factors, this unit will concentrate on developing one technique at a time for studying the soil. The acid content of soil will be checked with litmus paper; water content by touch; water holding capacity by volume measurement; nitrogen with chemical test kits; and organisms by sampling. We hope that your imagination and the enthusiasm of your students will take it from there.

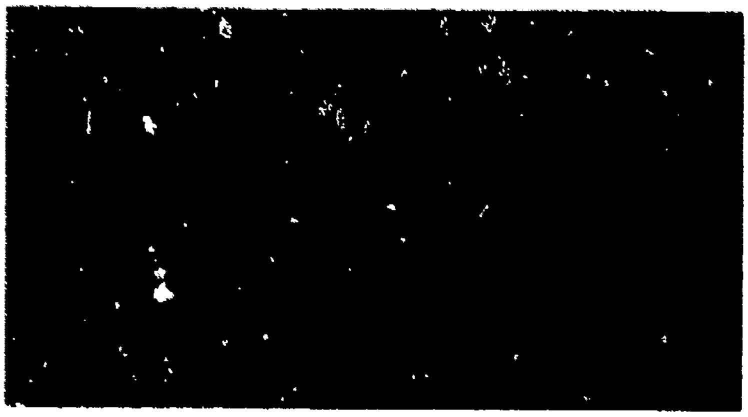
MATERIALS

- paper cups
- plastic spoons
- tongue depressors
- litmus paper
- glass slides
- distilled water
- 1" ruled graph paper
- tin cans
- filter paper
- rubber bands
- plastic trays or other shallow containers
- ring stands
- balances
- baggies or plastic bags
- commercial plant food
- 8" pots
- bean seeds
- plastic gallon jugs
- small jars
- light bulbs in portable extension sockets or desk lamps
- string
- alcohol
- paste

Model El Soil Test Kit Code #5679 (optional). Available from:
LaMotte Chemical Co., Chestertown, Maryland 21620
Also available from:
Hacht Chemical Co., P.O. Box 907
Ames, Iowa 50010

Soil

Acidity—Alkalinity



I. Background

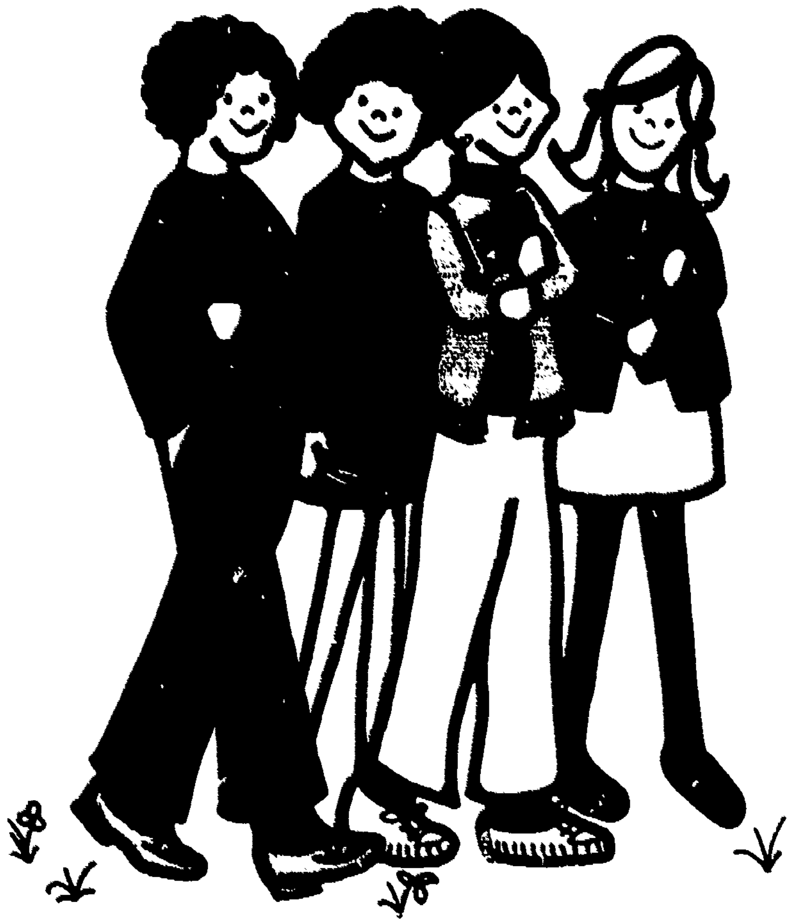
The acid content of soil can be checked with litmus paper, which is available in red and blue strips. Red strips turn blue if the material being tested is neutral or alkaline, while blue strips turn pink if exposed to acidic material. The children need only know that these strips are being used to detect a certain *property* of the soil. The important idea is whether or not this property is uniform throughout a sample area.

In this unit, the children will learn an easy way to sample a plot of ground systematically. They will collect and record data from soil tests and observations. Finally, they will construct maps of their plots and draw some conclusions from the tests and observations of their soil samples. To as great an extent as possible, permit the children the freedom to make their own discoveries, arrive at their own conclusions, and determine for themselves the next phase of their investigations. While some structure must necessarily be imposed by you, freely and actively involving the children in the procedure of the activities may make the unit more rewarding for both you and your students.

II. Activities

These activities can be done year-round, but they work best in the fall or spring. Begin by organizing the children for a field trip around the school yard. They should be equipped with pencils and paper or small notebooks. Gather together the spoons, paper cups and tongue depressors plus some ordinary crayons for marking purposes. Bring these materials with you.

The trip should be directed toward an area of lawn somewhere near or on the school grounds. Before the trip, it would be a good idea to find an area of lawn where the grass is not uniform in color or texture and where it might be possible to stake semi-permanent markers (the tongue depressors). The lawn area should be about the size of a classroom.



When the site has been located, ask members of the class to observe different areas on the lawn and describe what they see in their *particular* areas. Most of them will not perceive much challenge in describing an ordinary lawn. Actually, the challenge lies in their ability to make accurate, perceptive observations about the lawn. When you determine that they have made fairly complete descriptions, bring them together on the lawn to share their observations and discuss what they see. They may see short grass, long grass, brown lawn, green lawn, weeds, bare soil, bumps, litter, wet soil, trees, paths, insects, birds, shade, and many other things.

Ask if they can think of any reasons for differences among some of their observations. For example, why might one student observe weeds in his section of the lawn while another does not, or why might one see green grass while another student describes the lawn as being brown. They might give a variety of reasons for why these differences exist. Variation in rainfall (if for instance, part of the lawn is sheltered), the presence of "bugs," different kinds of grass, weeds, poor soil, and lack of fertilizer are all possible explanations for variations in the lawn. After a number of ideas have been presented, ask if the class could investigate in detail any of the possible reasons for variation. When this question has been discussed adequately, suggest that one place to begin the investigation might be with the soil itself. How could the students find out more about the soil? During this discussion you should try to make the students aware of the importance of **testing.** Help them see that the results of certain tests can help them answer the question "Why is there variation?"

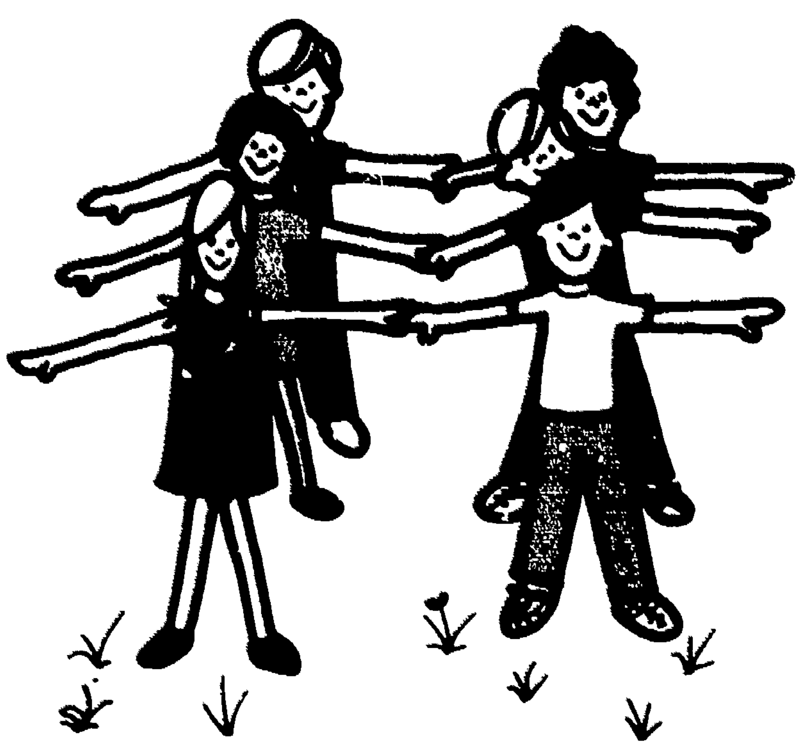
In order to test the soil, samples will have to be taken.

FOR DISCUSSION:

Does it matter *how* we collect samples of the soil? Would the method make any difference in the results of our tests? Is it possible that we might all collect one type of soil even though there are several different types in this area? How can we avoid this?

One way to systematize the collecting of soil samples would be to arrange the students in equal-length rows—say, six rows of five students each. Then you could have the students space themselves over the site by extending their arms so that only finger tips touch in any direction they turn. (You might want them arranged in the same order as their seats in the classroom. This would make locating their relative positions more convenient.)

The patch of ground directly under each child's feet will be his sample area. The students will make and record observations of the grass in their area. Make sure the children note their position in relation to the rest of the students around them so that they can make accurate maps of the study area when they return to class.



When the students understand this spacing technique, provide each with a paper cup, a spoon, and a tongue depressor. Have each student scoop up several spoonsful of soil and place them in the cups. Depressors should also be labeled (preferably with wax crayons) and pushed into the ground so that each patch is identified.

Return to the classroom with the materials. Have the students sprinkle the samples onto some paper on their desks. Each child should observe his sample and record his observations. Things to list might be color, texture, odor or anything else of interest. You might then ask if there is anything about the soil which the students might not be able to check with their senses. If they think so, have the class suggest what these qualities might be.

This is the time to introduce the litmus paper. Distribute four pieces of moistened litmus paper (two red, two blue) to each student. If possible, distilled water should be used for the moistening, since tap water may contain some minerals which will cause the paper to change color. Provide each child with a microscope slide and direct them to place one blue and one red strip of paper on the slide about two inches apart. Next, have them put a sample of soil—about one half teaspoon—on each paper strip. If the soil is very dry, it should also be moistened with several drops of distilled water.

Questions may arise as to what kind of paper they have been given. You could describe it as paper containing certain chemicals which change when they come into contact with other chemicals, and will therefore indicate something about the chemical properties of the students' soil. You don't have to pursue your explanation in any great detail. Gauge this by the class' interest.

After several minutes, ask the children to lift their slides and observe the color of the paper through the underside of the glass. Ask what they see. Are the colors still the same? What do they have to use for purposes of comparison?

Before further discussion, give each student a piece of large graph paper or plain paper ruled into one inch square units. Have each student envision the graph as a representation of the plot of ground which the class surveyed. Have him write his name in the square which represents his position in the field. Go around the room and have each student identify which square is his, as well as the results of his litmus test. The class should color in all squares accordingly, with red or blue crayons, to indicate the color of the litmus at the end of the test.

For younger children, you might draw the grid on the board and number each square consecutively. Have the children copy the numbers onto their own small grids. Then have each child come to the board, one at a time, and write his name in the appropriate box. With blue or red chalk he should then color in the square, making it match the color of his litmus paper at the *end* of the test. Have each student copy his classmates' names and colors onto the appropriate square of his own small grid. (The numbers will help the students keep track of the grid sections.) The squares should be colored in with blue or red crayons.

When the charts have been completed the children will have derived a pattern for the site in terms of the chemical condition of the soil. Ask the students if the pattern matches or compares with other observations or descriptions which they made of the lawn. Is the lawn uniform? Were the test results uniform? If the lawn is **not** uniform (that is, if it has bare spots or if the grass is brown in one place and green in another) does there appear to be any correlation between the acidity-alkalinity grids and the pattern of the lawn?

FOR DISCUSSION:

How much ought to be concluded on the basis of these tests alone? Should more tests be made to verify these results or should other factors now be investigated? What might the next step be? In this activity we added water to the paper and, in some cases, to the soil. Was there any variation in the soil's moisture before we began?

Moisture Content of Soil

Water may enter soil as rain, or surface run-off, or it may seep up from ground water below. The *amount* of water in the soil will depend on many factors including the *amount* and *frequency* of rain, the *nearness* of ground water to the surface, the *porosity* of the soil, the *humidity* and the *temperature* of the air, the *amount* of wind, the *exposure* to sun, the *types* of surface vegetation. In this section, students will sample and record the change in soil moisture for one week following a soil-soaking rain. To make the investigation, select a variety of locations around your school grounds. Assign small groups or individual students to sample the same location each day for a week or longer.

Each student should record his observations of the sampling location and then test the soil's moisture content according to the following criteria:

a. **Dry**—falls apart and sifts between fingers.
b. **Slightly moist**—appears moist but does not stick together when squeezed.
c. **Moist**—sticks in a clump when squeezed.
d. **Very moist**—squeeze and the water is obvious.
e. **Wet**—water drips.

Each student can use a data sheet similar to the following. This sample has been filled in with information similar to what a student might find. (See the back of the book for the full-scale duplication of the data sheet).

[illegible]	very moist	rain
[illegible]	very moist	overcast
[illegible]	moist	clear + cool
[illegible]	moist	clear + warm
[illegible]	moist	clear + warm
[illegible]	slightly moist	clear + warm
[illegible]	slightly moist	clear + warmer
[illegible]	slightly moist	clear + hot
[illegible]	dry	clear + hot
[illegible]	wet	rain
[illegible]	moist	overcast
[illegible]		

FOR DISCUSSION:

Discuss the effect of weather on soil moisture. Does soil type have any effect on the change of soil moisture? Do the observations of different students agree or conflict? Might other environmental factors besides rainfall be affecting the soil's moisture?

Water-holding Capacity

I. Background

Soil-water relationships are the most significant determinants of plant distribution. The fact is that soils differ in their capacity to hold water. It takes a great deal of water to soak heavy or clay soils, but light or sandy soils are saturated by relatively little moisture.

These ideas are of extreme importance to the soil conservationist who is interested in controlling the movement of water and the washing away of soil, and to the farmer who knows that some plants grow best in wet soil and some in dry. But, these relationships should also be investigated and understood by students since they as future citizens will need to make many decisions about our changing environment.

The activity presented in this section describes a procedure for measuring the water-holding capacity of soil. During a field trip children will again obtain soil samples from various sites on or around their school grounds. As part of their collecting experiences they will again examine and describe their soil samples. After they investigate the water-holding properties of the various soils collected, they will relate their measurements to new descriptions of soil types.

II. Activities

Before organizing the field trip with your class, examine the soil around the school grounds. Look for areas where fallen leaves have formed a layer ½ to 1 inch above the soil. Find a nearby field where weeds have overgrown the area. Select a spot where the soil has been mixed with sand, and one which appears to be primarily clay in type. (Most of these soil differences may be recognized by variation in color.) You won't need *all* the types for this activity. It would be of value, however, to identify some contrasting types so that the students can see some differences.

In the fall or spring, ask the children to begin saving frozen juice cans. Have them remove the usually unopened end at home and then bring them to school when you are about to begin this activity.

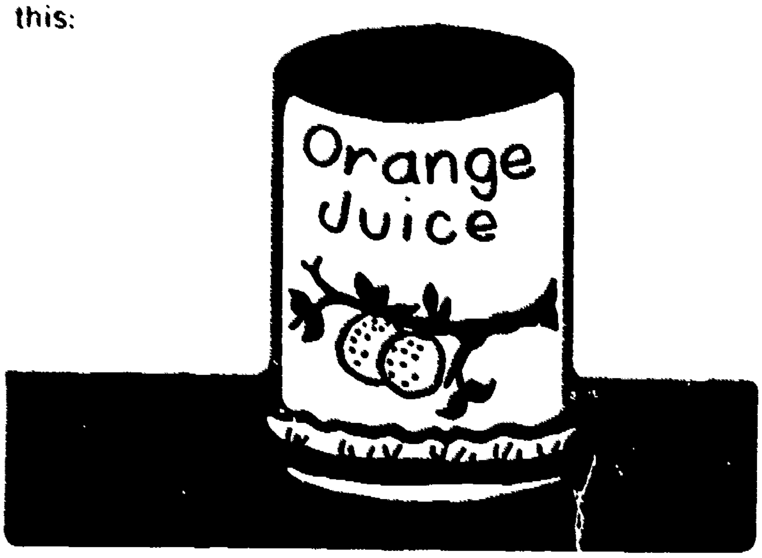
Launch the field trip by providing each child with a plastic spoon and bag. Once outdoors, take them to the collecting areas you have chosen and have them examine the soil. Again they should observe color, texture, odor, particle size, and anything else of significance.

If the class is divided into teams of two students, each team may observe a different patch of soil and then share its observations with the other teams. If you have four locations, you will probably have three or four teams at each one. See if the students remember to space themselves evenly. Do not stress that they must do so if they do not feel the need. Try to avoid stating that differences in the soil do exist; let this conclusion arise from student observation and discussion.

After comparisons have been made, you will want the students to speculate about the significance of their observations. Various soils differ in many properties. Particles may be large or small; the soil may be black, tan, reddish, sandy, sticky, full of plant particles; the soil might be wet or dry, hard or soft. Of what importance, then, are these differences? Some possible answers might relate to the kinds of plants capable of growing in a particular soil, to the notion that the soils are made of different things, or that one kind of soil is "rich" in quality and one is "poor" in quality. Perhaps someone will suggest that different soils are capable of holding differing amounts of water. (It is not essential for them to arrive at this conclusion because it will be investigated when they return to class.)

When the discussion is concluded, direct the teams or individuals to collect about a half a bag of soil each and take it back to class. Have them use the spoons and plastic bags for collecting. When back in the classroom, have the students empty the soil from the bags onto paper toweling or several sheets of writing paper. Students should place their names on the paper and record their descriptions of their samples. Then they should set the soil aside for several days. Make sure the samples do not get mixed up.

When all samples appear to be dry (this can be rushed by oven drying), hand out filter paper, rubber bands and fruit juice cans to each student. Students should secure the piece of filter paper over one end of the can with a rubber band so that it looks like this:



Then make several "weighing stations" by arranging scale balances around the room.

Each of the cans should be weighed and each weight should be recorded. Then have each student fill about ½ of his container with his dried soil sample. The soil and can should be weighed again, and recorded.

Have the students place water in the shallow trays and immerse only the lower half of the soil samples in the water. Let them stand overnight. On the following day, the students should remove the cans from the tray and allow them to drain for about one half hour. Draining may be accomplished by emptying the remaining water in the tray, placing sticks about the size of rulers across the tray, and standing the dripping cans on the sticks.

Before proceeding with draining you may want the students to make observations of the soaked cans of soil. Did the water enter the soil? Did its level rise above that of the soil? Can they account for this? In addition to draining the soil, you must remove all excess moisture on the can before weighing it. When this is done, ask the students to make predictions about the new weight of the can. Next, have them weigh the entire unit and compare the new weight with the old weight. How do they explain the difference in weight?

They will now need a means for determining the percent of moisture-holding capacity. "Raw" weights cannot be used because the amount of soil in each can may vary. Also, the comparison is being made between soil and water, and should have nothing to do with the cans. The formula for calculating the percent is relatively simple as shown below:

weight of dried soil = weight of can and soil, minus weight of can

Gain in weight due to immersion = weight of can, soil, and water minus weight of can and soil

$$\textbf{percent moisture-holding capacity} = \frac{\textbf{Gain in weight due to immersion}}{\textbf{weight of dried soil}} \times 100$$

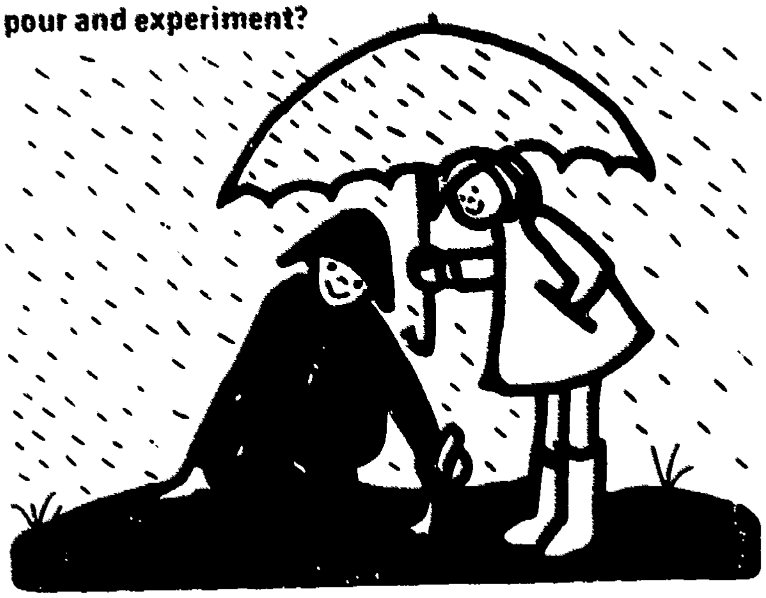
When students have completed their calculations, collect their data and place it on the board for the class to discuss. You may make a simple chart based on the descriptions of the samples which the students give: (The headings are only suggestions)

Students	Pat	Becky	John	Jan	Lee	Nick	Wendy	Dick	Jim
Dark Soil	60%		62%				58%		
Sandy Soil		5%			7%			5%	
[illegible]				18%		20%			23%

Each student should determine which description best fits his soil. His data should then be entered in the appropriate column. After all of the results are reported, observations may be discussed.

FOR DISCUSSION:

Did students with similar soil obtain similar results? Which type absorbed the most water? Did any sample hold more than its *initial* dry weight? That is, is any soil capable of holding more than its own weight in water? How might water-holding capacity, in turn, be related to the kinds of vegetation that a soil supports? Would soil that could hold a relatively large amount of water tend to be a wet, a moist, or a dry soil in a rainy climate? Did vegetation have anything to do with the water-holding character of your soil? Which type might most easily erode? During a downpour, on which type of soil might water most easily run-off? What are some ways of preventing this run-off? Could students go outside in a downpour and experiment?



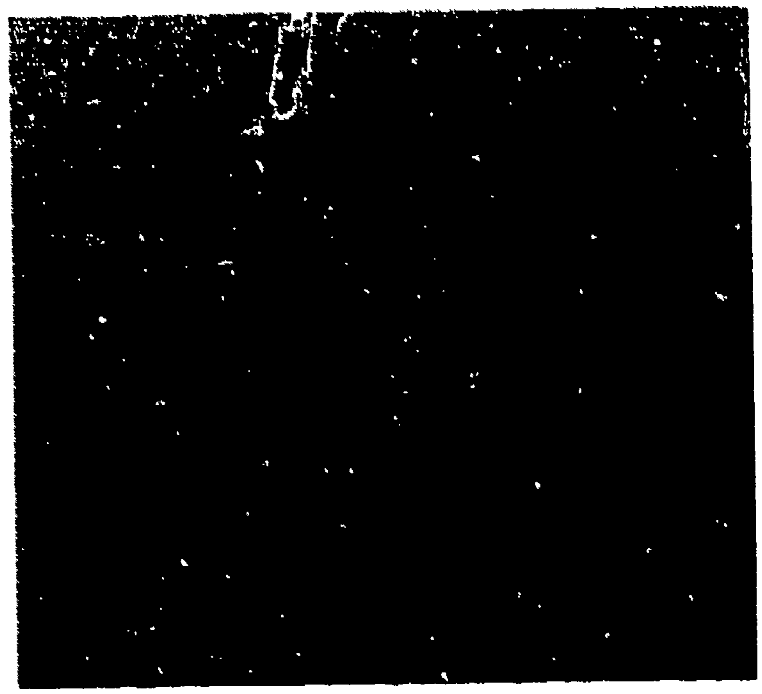
The student's chart can be used as a **model** for moisture-holding capacity. This means that, given adequate soil type descriptions and the data in the chart, unknown samples of soil can be compared with the chart descriptions and their water-holding capacity can be predicted on the basis of their similarity to the **known** types. Suggest that the students collect a variety of soils from around their homes or elsewhere, bring them to class, compare them with those previously tested, predict a water-holding capacity, and then verify their predictions by performing the previous procedures.

FOR DISCUSSION:

How useful is the data for making predictions about unknown samples? Can the model data be improved and refined by collecting additional data? What are some of the shortcomings of the original data if it is viewed as a model system? Have we exhausted the testable qualities of soil?

The class has tested soil for acidity, water content, and water-holding capacity. If no one has brought up the fact that soils contain minerals, now would be a good time to do so.

Testing for Soil Minerals



I. Background

Nitrogen is an element which has a profound effect on plants. Organic matter in soil contains almost all of the natural soil nitrogen. In this form, the nitrogen is not available for use by plants and must first be transformed by soil bacteria to water-soluble nitrates or ammonia. Plants can then absorb the nitrates through their root systems. When nitrogen is in the form of nitrates, it stimulates above-ground growth and produces the rich green color which is characteristic of a healthy plant. The plant's utilization of potash, phosphorus, and other nutrients is also stimulated by the presence of nitrogen. An *excess* of nitrates, however, can produce harmful effects such as delayed maturity or ripening, and decreased resistance to disease.

Some investigators indicate that the presence of excess nitrates in foods may be detrimental to health. This harmful effect is caused by the reduction of nitrates to nitrites by bacteria in animal intestines. Nitrites in the bloodstream are poisonous and may cause abortions in cattle, hay poisoning, grass tetany, or reduction of hemoglobin content in blood. They cause illness and anemia in human children.

Soils ordinarily contain about 0.1% nitrogen and a smaller percentage of available nitrates. Unavoidable loss of nitrogen is hastened by the leaching action of water. Sandy soils, particularly, are low in nitrogen because of the rapid rate at which water moves through these soils.

Nitrates can be added to the soil in the form of inorganic fertilizers. Great care is necessary to add just the right amount to stimulate plant growth but not to do it harm. The back of the book, page 16, contains a diagram which illustra.'s the various limiting factors which affect plant productivity. You might want to consult that diagram at this time, for further background information.

The ammonia form of nitrogen, HH3, is quickly changed to nitrate in the soil by bacteria and chemical reactions with other minerals. Ammonia is, therefore, very difficult to detect in most soils unless there has been a recent application of ammonia fertilizer, fresh animal manure, or rotting plants. However, in forest soils, especially in the humus layers, ammonia is often the most abundant available form of nitrogen.

Nitrites are formed as an intermediate step in the production of nitrates in soils. In adequately drained and aerated soils they are found only in very small amounts. A high count for nitrite nitrogen will indicate a soil condition which may be unfavorable to the formation of nitrates and toxic to plants.

A test whose results indicate the presence of nitrates in soil will reveal a soil which is probably suitable to plant growth—if there are other required minerals and if the nitrate concentration is not too high.

Phosphorus and potassium are two other soil minerals which can be studied.

II. Activities

Teams of students should select soil samples from a variety of places such as a rich lawn, a sparse lawn, a playground, a vacant lot, a roadside ditch, etc. They should write down descriptions of the location, the soil, and the plant growth of the area from which they take the samples.

In class, each team should test the soil sample for nitrates, (and phosphorus and potassium if desired) following the instructions on a Model EL Soil Test Kit (see Materials list).

Have the class discuss any possible relationships existing between the presence or absence of soil nitrogen and the observed characteristics of the sample areas. If nitrogen was present but plant growth poor, can any suggestions be given regarding other limiting factors? (see page 16.)

Have the class select a soil which has tested poor in nitrates (probably a sandy soil) and obtain enough of it to fill at least two wide flower pots (8 inch). Have the students set each pot in a shallow bowl or pan. They should then water one pot with tap water until the soil is moist. The other pot should also be watered until the soil is moist, but this pot's water should be mixed with commercial "plant food" fertilizer (accordng to the directions on the oottle.)

Have students take nitrogen soil tests of each pot of soil. Does the label on the bottle indicate that soil nitrogen or nitrates are in the "plant food"? Are there nitrates in the tap water?

Consider, also, the presence of phosphorus and potassium.

Now poke at least a dozen bean seeds which have been soaking overnight, into the soil in each pot. Place the pots side by side in a sunny but cool window, and keep them watered so that the soil is moist but not soaked.

It may take one or two weeks before the plants begin to indicate the presence of limiting factors, because much food and minerals were stored in the seed and these will be used by the plant until they are exhausted. When the plant becomes completely dependent on the soil, a lack of nitrogen will be indicated by a paler green and scrawnier look to the plant.

Have students note any differences between plants in the two pots. They should also note any differences between plants in the same pot. Ask: Between which plants are the differences greatest?

Help the students become aware of other limiting factors such as insufficient light, too much heat, too little heat, insufficient moisture, etc.

FOR DISCUSSION:

What did this activity demonstrate? What are some things plants need in order to remain healthy? How does the soil get its nitrogen? Is it possible that there are *living* things in soil?

Conclusive or definitive answers to these discussion questions may not be possible, even with much more data available. Posing the questions, however, may at least stimulate discussion and speculation and serve to demonstrate the complexity of some of the plant growth.

A Survey of Soil Organisms

I. Background

One's first impression of the soil is that it is composed of dead material and there is no activity in it. To the contrary, many organisms are closely associated with the soil. Animals may build their homes on or under the ground; plants find support and nutrients in the soil. Soil microbes are found in large numbers, and these organisms are important in the continued cycling of nutrients.

Plants and animals in the soil are necessarily influenced by the soil type and its components. In addition, climate, land use by man and competition with other organisms combine to dictate rather well-defined limitations for any one kind of life. The delicate set of of circumstances might be imagined as a standing row of dominoes—to tip one down results in a position change as the others interact with the falling domino. It is also true that the soil type is influenced and changed by the kinds of organisms which will live in it. Plants are influenced mostly by soil itself but are also affected by the animals in the soil. Animals depend upon certain plants for food and protection and will be found in soils where plant food and protection exist.

In this section, students will investigate the kinds of organisms living in different soils.

II. Conducting the Survey

A survey of this type may be conducted on virtually any type of soil habitat—grassland, woodlot, marsh area, vacant lot, or lawn. The types of plants, animals, and soil will vary in each case. You might want to divide the class into teams of a convenient size and have each team investigate a different type of soil. It is *not* necessary to identify organisms in order to demonstrate the concept of interrelationship. A listing of the *variety* of life forms is what's important in preliminary activities. For contrasting studies between one or more types of soil habitats, the class might want to construct a picture chart of the different life forms in the individual samples as well as the abundance of each form.

It is suggested that the students sketch a map of the area they are studying and designate their sample sites on their maps with numbers. A more elaborate wall chart can also be constructed for the classroom.

A. Sample the Plants and Make a Chart

The plant types found growing in different numbered locations of the sample area can be sorted according to different kinds of plants. Each student or team can take one sample and then count or estimate the numbers of each of the kinds of plants in his immediate area. Big plants (trees and bushes) should be counted as well as small plants (grass, mushrooms, moss, mold, etc.). Sample plants (or leaves) of each type can be pasted along with their count on a sheet of paper. Identify these counts and samples with the number of the sample's location, as taken from the map. These estimates, of course, will be very general, but they will give the students a rough idea of plant distribution in their survey area. In Part B, the students will be asked if they can find any correlation between this plant distribution and the distribution of animals in the soil.

Team# 1 Area- 10'x10'
Team Members: Becky, Lee, Jim, Tom, Jon
Location under big tree, behind school
Soil Type Sandy, dark, dry

Survey of Plants	Comments	Survey of Insects	No.
	many scattered clumps of grass		20
	2 small sprouts on a bush		4
	3 clumps of dandelions		8
	leaf from a big tree		2

B. Sample the Animals and Make a Count

To take a sample of the microscopic animals in any soil, students can use a simple device called a Berlese funnel. The construction and use are illustrated in Figures 1 and 2. Samples should consist of soil taken down to a depth of about 7 inches. In principle, as the light source heats and dries the soil, the inhabitants are driven progressively deeper until they fall into the collecting jar which contains the alcohol. Placing a small bit of loose grass in the neck of the bottle helps prevent loose dirt from falling into the jar. But the grass must be loose enough to allow animals to crawl through. The alcohol will bleach the natural colors of the animals and most will appear white to tan in color.

Have the students sort the preserved animals and count them. They should dry the specimens or samples of them and paste them up as was done with the plants.

Have them save a sample of soil type in a plastic bag and attach it to the plant and animal charts.

Help students to compare the samples taken from different locations.

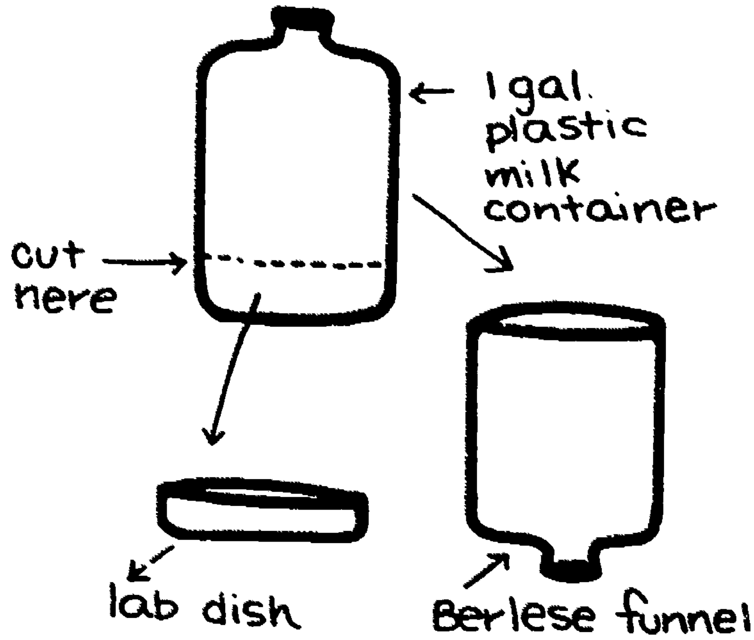


Figure 1. **Use of plastic containers to improvise a Berlese funnel and lab specimen dish.**

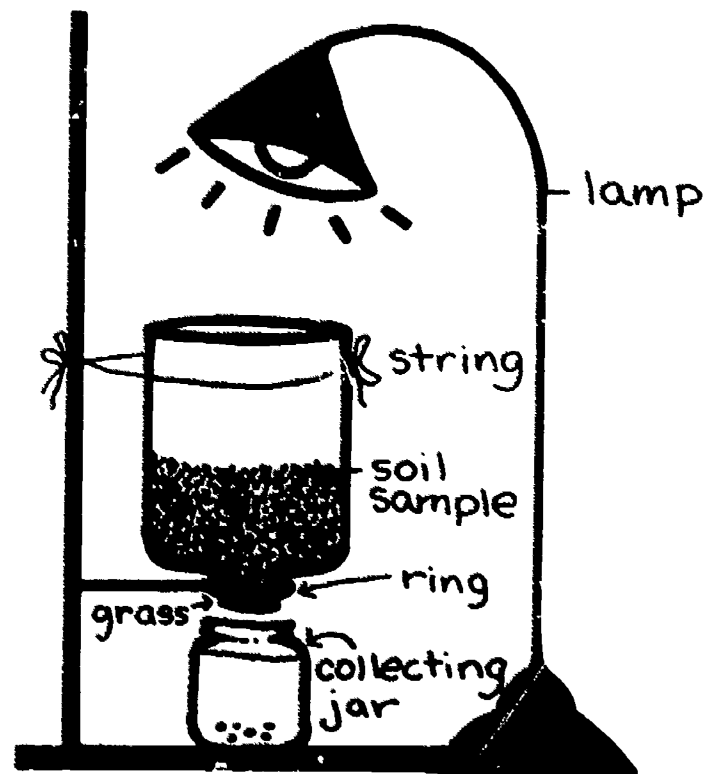


Figure 2. **Suggested set-up for improvised Berlese funnel.** With string, tie the container (the upside down jug) to the vertical part of a laboratory ring stand. Make sure that the mouth of the jug is directly above a collecting jar with alcohol in it. Secure the light source above the apparatus, as illustrated.

FOR DISCUSSION:

Do animal types vary with plant types? Does soil type influence the plant and animal types found? Are there any other factors which influence soil organisms that might be noted at the sampling locations —sunlight or shade, moisture, human use, exposure to wind or cold?

The Back of the Book

SOIL MOISTURE SURVEY

LOCATION NO. ____________________

NAME ____

PHYSICAL CHARACTERISTICS OF LOCATION ____________________

____

____

DESCRIBE SOIL ____

	SOIL MOISTURE	WEATHER
DAY 0		
DAY 1		
DAY 2		
DAY 3		
DAY 4		
DAY 5		
DAY 6		
DAY 7		
DAY 8		
DAY 9		
DAY 10		
ETC.		

PLANT AND ANIMAL SURVEY

TEAM# ____________________

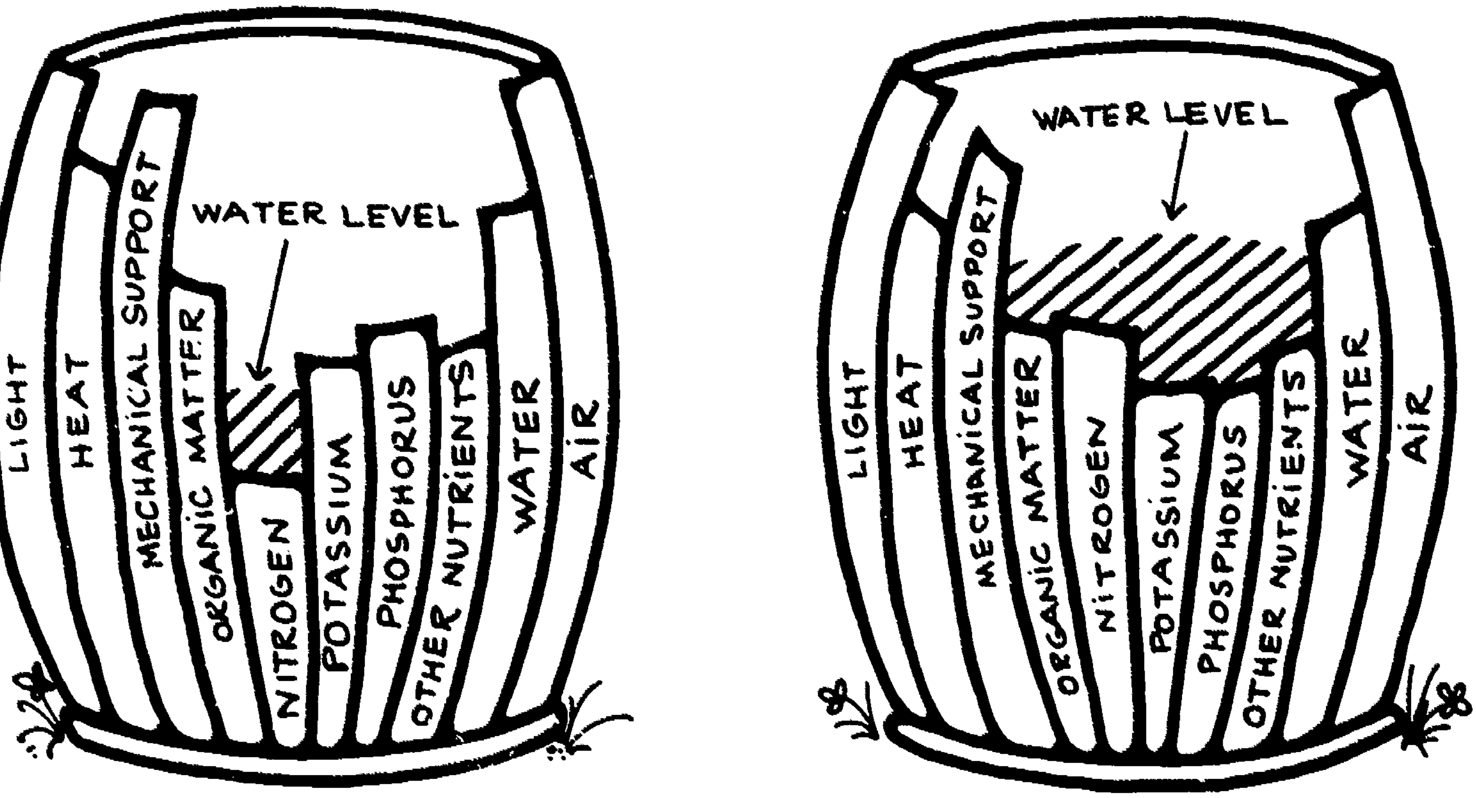
TEAM MEMBERS ____

LOCATION ____

SOIL TYPE ____

SURVEY OF PLANTS	COMMENTS	SURVEY OF INSECTS	NO.

INTERPRETATION OF LIMITING FACTORS



This diagram illustrates how limiting factors in a plant's environment affect the productivity or "success" of that plant. The slats in the barrels each represent one factor which limits a plant's growth. For any given plant in a certain environment at a certain period of time, some factors will be more limiting than others. This concept is depicted by the height of the slats.

The water level represents the plant growth or productivity. As in a real barrel of water, the water level can go no higher than the shortest slat of the barrel. Therefore, the factor which exerts the most ***immediate*** influence over plant productivity at a given time would be represented by the shortest slat.

In the first barrel, nitrogen is represented as the factor that is most limiting. This means that even though the other factors are more than adequate, productivity can not exceed that allowed by the nitrogen available. In this analogy, the water level cannot rise above the height of that slat.

The addition of more nitrogen via plant food or some other source (this is represented in the second barrel) will increase plant productivity until another factor becomes the most limiting influence. Until that time the plant will prosper and grow. But when the water level in the diagram rises to the height of that next shortest slat, the plant will have symbolically reached its ***optimum*** level of productivity for that given quantity of that factor.

THE ENVIRONMENTAL UNITS

Below is a list of the first titles in the Environmental Discovery Series. The ones with order numbers next to them are available as of January, 1972. The others are in preparation and will be available in the coming weeks. Also, ten additional units will be announced soon.

Next to the titles, we have suggested the grades for which each is most appropriate. We emphasize that these are suggested grade levels. The teacher is encouraged to adapt the activities to a wide range of grade levels, and subject areas depending upon the interests and abilities of the students.

Order No.	Title	Grade Level	Price	Order No.	Title	Grade Level	Price
79007	Plants in the Classroom	3-6	$1.50	79132	Soil	2-9	$1.50
79016	Vacant Lot Studies	5-9	1.50		Tile Patterns and Graphs	1-2	
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79043	Wind	3-6	1.50		Nature's Part in Art	3-6	
79052	Snow and Ice	1-6	1.50		Change in a Small Ecosystem	5-9	
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If you would like a free brochure describing activities in the individual units, write:

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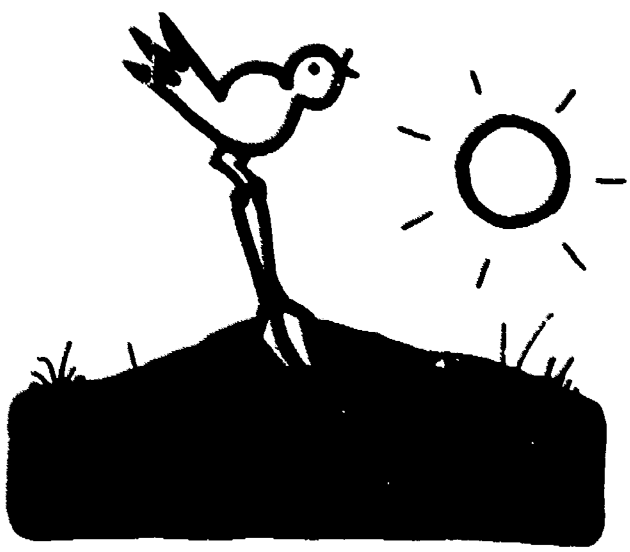

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