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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 this series is based on an experience-oriented process that encourages self-paced independent student work. The purpose of this particular unit is to prove that variation does exist within populations. Skills employed in the unit's activities include collection techniques, quantitative measurement methods, record-keeping, and the use of graphs. Materials for study can be collected at a preliminary field trip or from classroom potted plants. Activities are geared for students in grades 4-8. Teacher information such as materials, background information, and additional, more sophisticated topics is given. (MA)

Differences in Living Things

An Environmental Investigation

edited and published by

NATIONAL WILDLIFE FEDERATION

written by

MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.

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.

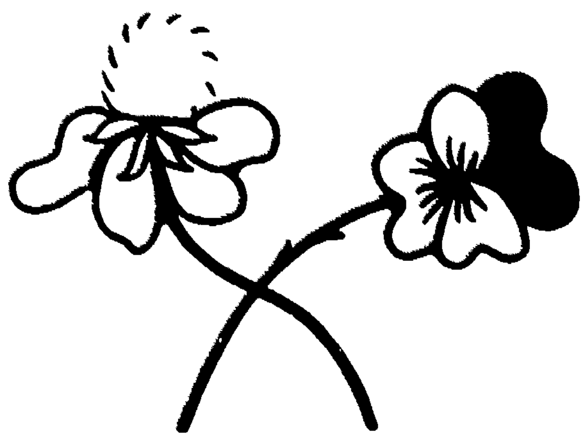
Differences in Living Things

An Environmental Investigation

BY

NATIONAL WILDLIFE FEDERATION

MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.



Design and Illustrations by

JAN BLYLER

The variations studied in this unit will be those that the children can identify in their own plants. They may find variables in leaf number, leaf length and breadth, leaf area, and plant weight. In attempting to understand how variations occur, two areas could be studied: 1) environmental conditions, and 2) heredity. The purpose of this unit, however, is to prove that variation does exist, rather than explaining why it does so. Therefore, the thrust of this unit will be aimed at variations which arise from conditions in the environment.

During the course of this unit children will become familiar with collection techniques, quantitative methods of measuring the variations studied, record-keeping, and the use of graphs as a means of showing and comparing variations. The concepts stressed will be: 1) that life exhibits variety even within a species, and 2) that the range of this variety is predictable and limited to a normal curve.

This unit would be used most appropriately as an outdoor activity in the spring or fall. But if potted plants can be obtained in the quantities required, the activities could be conducted in the classroom during the winter.

Table of Contents

INTRODUCTION*

The study of ecology begins with an observation of plants and animals in their own habitats. Since many environmental factors can be measured at once, it's possible to correlate the behavior and structure of plants and animals with the forces of the environment. It seems, for instance, that plant behavior may vary according to the amounts of available water, heat, light, soil, wind, etc. Over **long** periods of time, certain adaptations may become inheritable and may account in part for the variety in plant and animal types. (See **Population Variation,** a unit on heredity in this series.)

Within a relatively **short** time, some changes in plant and animal types may occur as a result of immediate pressures from the environment. These changes are not hereditary. This is why the behavior or structure of a given plant or animal species is not always uniform in all the areas where it is found.

This unit illustrates some of the variations that exist within a species. Our investigations will be limited to a member of the plant kingdom, but the conclusions drawn and the concepts developed can be extended to the animal kingdom as well.

MATERIALS

sheet	string tags	milk cartons
scissors (round point)	pins	Cheerios
scale or balance (opt.)	small paper plates	colored chalk, pencils, crayons
plastic bags	string	tape
rulers (centimeter)	long nails	
graph paper		

*This unit can be used in association with **Transect Studies** and **Contour Mapping** of this series.

Differences in Living Things

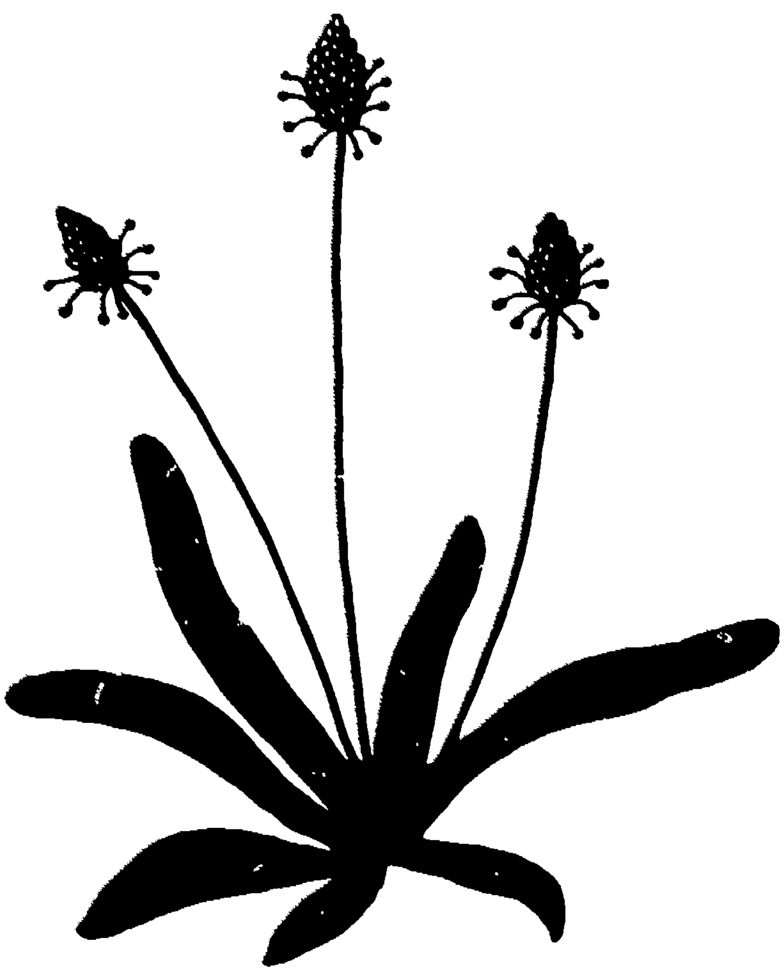
ACTIVITIES

I. Pre-Field Trip

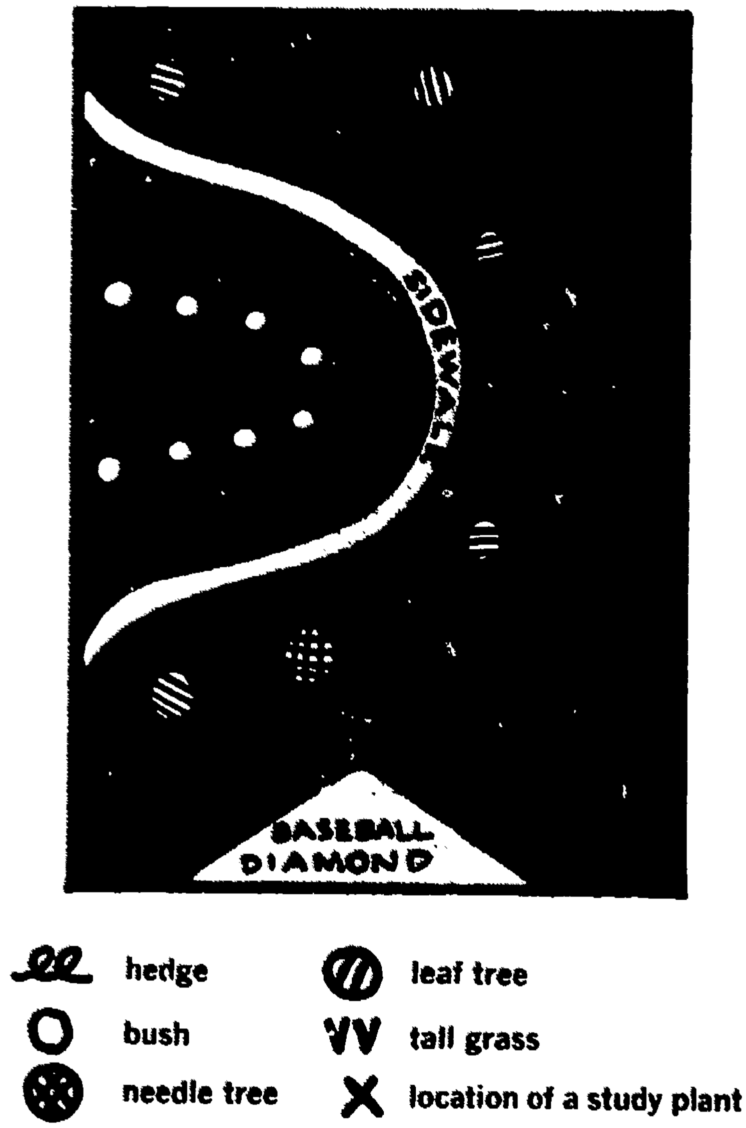
This activity begins with a general survey of several plant types and then proceeds to a specific study of a single plant type. The general survey will introduce the children to the idea that variation exists among all species. The specific study will measure these variations as they exist in one selected plant species.

The site you select for the study can be any grassy area which is easily accessible to your class. Since it will be necessary to remove plant specimens from this area, you may have to get permission to use it.

The plant chosen for the second phase of this unit will be collected most extensively. **Plantain** is suggested for three reasons: plantain grows profusely under a variety of conditions, so it is usually available; its large broad leaves are easily handled and studied; and the removal of these plants probably won't be regretted by the caretaker of the grounds. However, any species (bush, tree, or smaller plant) is usable, provided a number of different plants of the species can be studied. Also, the leaves should be accessible to the children and easily handled. They should be large and smooth-edged.



A map of the study site should be made if you are planning to do the "Additional Studies" listed at the conclusion of this unit. The class will use the map to record the location of the study plant, so it should be drawn in large scale. Include on this map all the prominent objects, structures and plants which project above the grass level. A free-hand sketch will suffice; however, you may want the class to prepare a more accurate map as an exercise for the unit entitled **Contour Mapping** in this series.



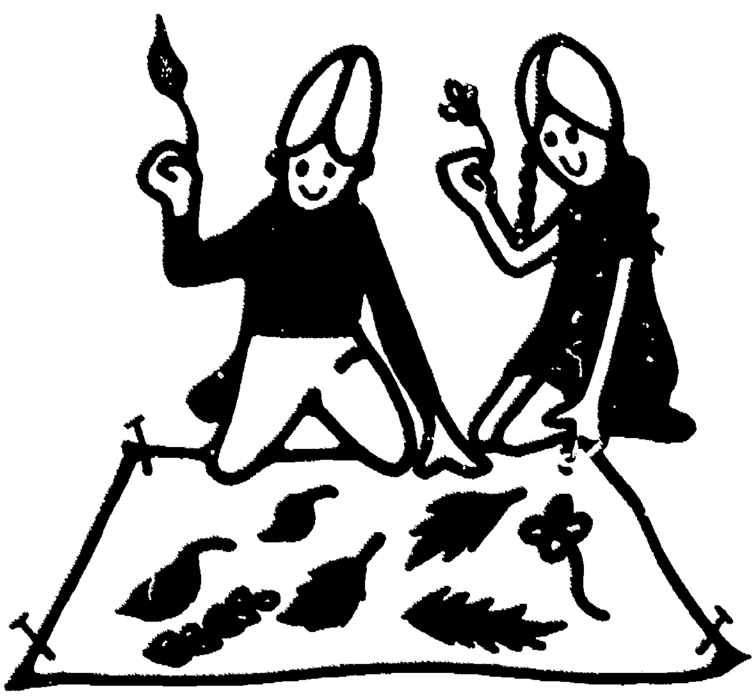
II. Field Trip

Part 1. Surveying the Area

The initial activity will be a general survey of the plant types in the study site. Have the children comb the area and collect as many different leaf types as possible. A good background for examining these leaves can be provided by staking down an old sheet in a central location. Provide straight pins or scotch tape so that each child can attach his leaves to the sheet as he collects them.

When the children have finished collecting leaves, gather the class around the sheet and play a "matching game." To demonstrate the game, have one child pick a leaf near him and see if he can find another leaf of the same kind on the sheet to match it. Ask what reasoning he used to decide the second le[illegible]s the same type as the first. Did he use color, [illegible]e, size? Ask for volunteers to match the remaining leaves, expressing the criteria they use to do so. This will result in several groups of distinct leaf types. These distinct leaf types belong to plants of the same species.

Now that the children have noted some characteristics which differentiate species, shift the game to that of pointing out those characteristics which vary **within** a species. Choose one of the leaf groups, and ask a child to pick one leaf from the group. Remove all the pins or tape, put the chosen leaf back into the group, and shuffle all the leaves of the group together. Ask him again to select the leaf from the group. Inquire how he determined which was the correct leaf. (Does this leaf have a slightly different size? shape? color?)

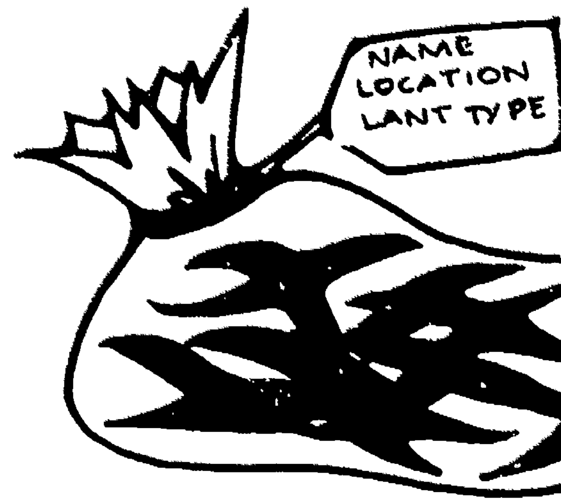


Now ask the class to pair off and select leaf groups from the sheet. If an insufficient number of species has been collected, the class should pick more leaves from the surrounding area. Have them examine their leaves, noting differences among members of the group. As the teams finish observing their leaves, they may exchange leaf groups. After each team has observed several leaf groups, ask them what characteristics they found which varied within their species. Characteristics which might appear on such a list include size, shape, color, leaf edge, vein pattern. You may need to point out that these are the same characteristics they used to differentiate **between** species. The important fact is that within a leaf type there is some variation in characteristics, but these characteristics are still basically similar enough to differentiate the leaf from another leaf of another species.

Part 2. Studying a Plant Type

Now proceed to a more specific study of your area by concentrating on the collection of one plant species (e.g., plantain). Examine a group of leaves of the selected plant, beginning with the samples from the sheet collection. The children may list the variations they see in these leaves. Ask if they can look at this small group of leaves and determine what characteristics (size, shape, etc.) the most common leaf for this plant would have. Do they think that all possible variations of any given characteristic are represented within this group? Ask if they are certain, and how they might find out. Try and wait until one of the children suggests that they examine a greater number of leaves, in order to be more sure of what the most common leaf would look like.

To take a more complete sampling, provide the children with [illegible] scissors, string tags and plastic bags. Ask them to survey the area again, this time searching specifically for the selected study plant. One plant or ten leaves per child should suffice. When collecting a plant the students should remove it as a whole, with the leaves intact. This will require that they cut the plant close to the ground. When collecting leaves from a bush or tree, they should all collect from the same area on the bush. For example, they might all collect from the tip of the branch back towards the stem. Why each child should collect and cut in much the same way may be an impossible question for them to answer at this point. Later, when they compare variations, the importance of having used the same technique should become more apparent.



The child's name should be on a tag along with the date of his collection. A tag may then be attached to each plant or inserted into the bag of leaves. At this point, the plant's location may be marked on the site map if one has been prepared. Place the plants or leaves in plastic bags to prevent drying out while transporting them to the classroom. Leaf freshness can be further insured by sprinkling them with water.

III. Classroom Activities

Part 1. Observation and Measurement

After the children have examined their leaves ask them to state some of the variations they observe. List these on the board and ask them to find who has the extremes of these variations. For example, "Who has the longest leaf?" In order to find an answer to this question, they will be required to compare leaves.

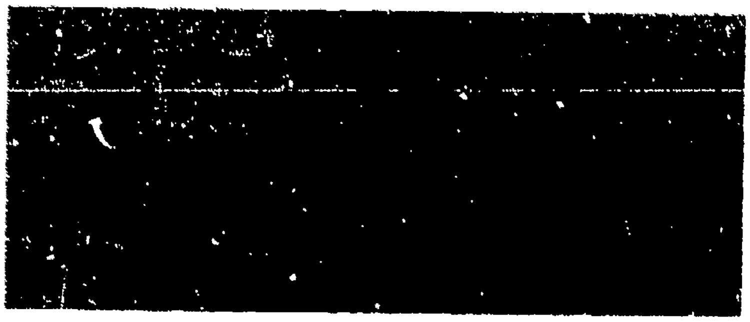
Comparisons are best made by measurement, though you might want them to decide upon measuring on their own. Perhaps if equipment such as balances, graph paper, and rulers are arrayed on a table, some ideas for measurement will occur to them. Some variations (e.g., color, leaf thickness, etc.) require rather sophisticated apparatus. These may have to be examined on a descriptive basis (e.g., darker, thicker).

In order to make comparisons, it will be necessary to choose one method of measuring a certain variation and make sure that everyone uses it. Otherwise the measurements will not be uniform and comparisons will be fruitless. Allow the children to devise their own methods at first. Eventually, the children must establish, through class discussion, one best method for the measurement of each variation. These variations can then be compared on graphs.

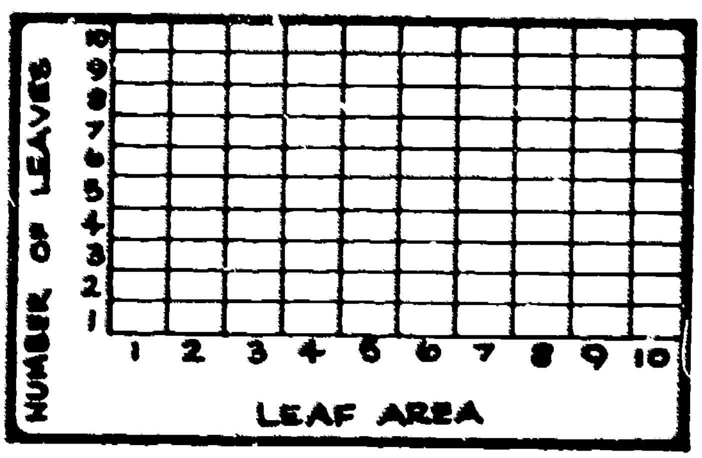
All measurements should be recorded. Explain that record-keeping is a natural requirement for science, and that the children will find it advisable to record their measurements and other information in notebooks. Do not set forth a specific format for the notebooks. The children should not be restricted to keeping notes in only one way or about only certain things.

They may see importance in recording information seemingly unrelated to the point of the activity, but this should not be discouraged. After the class has made its measurements, each child will construct his own graph from the data recorded in his notebook.

Part 2. Constructing the Individual Graphs



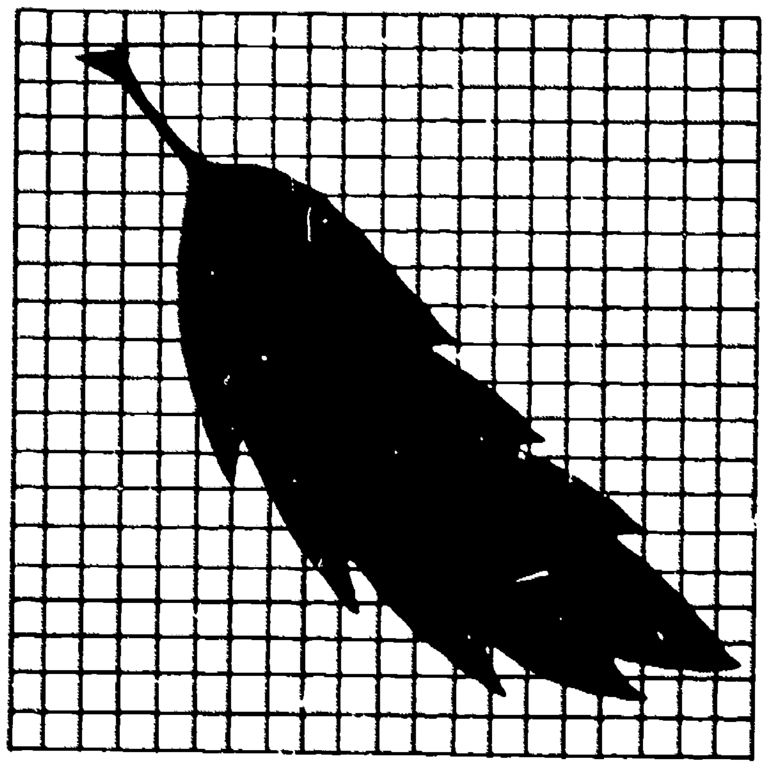
The variations selected for study by graphs should be those which have been measured in the same way by the entire class. Provide the children with graph paper and ask that they make one square equal to one unit of the variation measured. Individual graphs such as the following can be made.



Here are some methods which could be used for the determination of leaf area and weight. Your class may devise others.

Leaf area can be approximated in two ways. The children could outline a leaf on graph paper. They could then count all the whole squares inside the outline, and count every square which is only partly inside the outline. Of course, if the students are familiar with fractions they can use these. The second method requires making an outline of the leaf on drawing paper. The children fill in this outline with peas and count the number of peas used.

Leaf weight can be approximated even if a balance scale is not available. Make a string harness for two small paper plates by punching three equidistant holes in each plate's circumference. Take three pieces of equal length string, and knot each one to a separate hole. Tie all three strings together at the top.

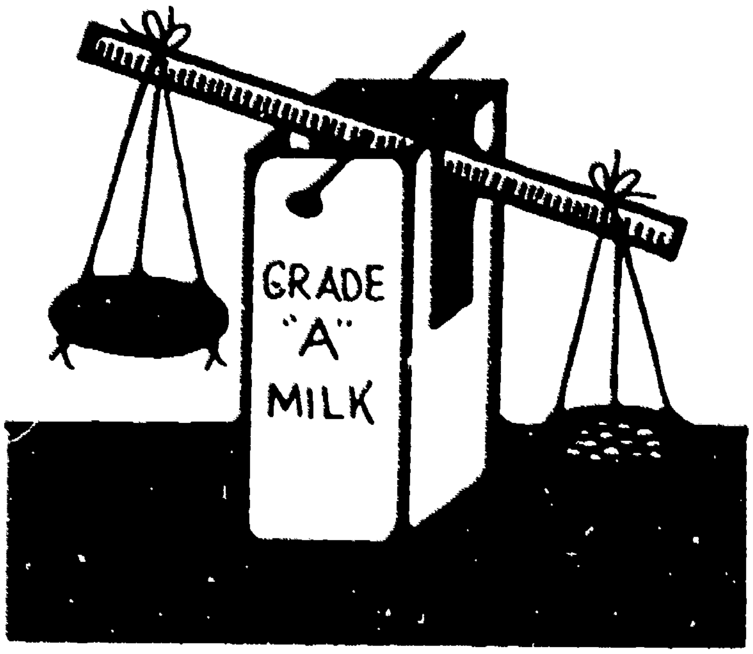


You may want the children to think up their own methods for making a string harness.

When the harnesses are made, hang them from the ends of a 30 cm. wooden ruler by attaching them with tacks. Support this ruler at some point between the two plates so that it balances. (Note: the mid-point of the ruler, i.e., the 15 cm. point, may not be the point of balance.) Mark this point and drive a long nail through the ruler to support the ruler and plates. Work the nail so that the ruler swings on it freely.

This device can be supported across the top of a sand-filled milk carton whose top has been cut off, and whose two opposite sides have been cut away near the top to allow room for the balance arm to swing. The leaf is put onto one of the paper plates.

Cheerios are placed one at a time onto the other plate. The weight of the leaf is determined as being the number of Cheerios required to once again balance the plates. The children might cut a Cheerio in half if an even smaller unit of weight is required.



After each child has completed his graph of each of the variables chosen for study, have the class look at all the data. Separate the graphs into groups according to the type of variation measured, and post these where they can be examined by the class. Again question who had certain extremes of a variation. Ask, for example, who really had the longest leaf.

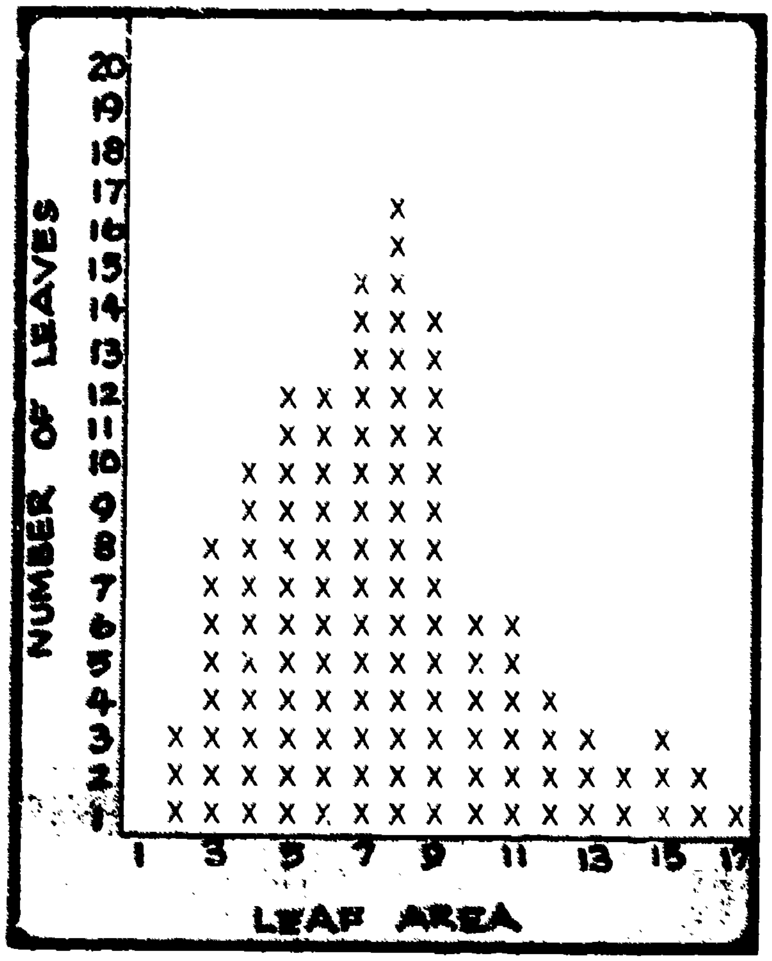
Part 3. Graphing Composite Histograms

Do the children find some difficulty in searching each graph for data? If so, the graphs might all be reordered to make answering questions about the variation of a particular characteristic easier. It would be helpful to make one large graph for the entire class. This would eliminate examining each graph independently when a question is posed. (Remember, though, that only data for the same characteristic may be combined to make a composite graph.)

Prepare large graph outlines for each variation (e.g., area, length, weight, etc.) either on the board or on sheets of paper. For a class of thirty students, collecting one plant each, a graph with 50 units on the vertical axis and 25 units on the horizontal should be sufficient for any variation measured. These graphs will not contain any information initially. The data will be registered on these graphs by individual children.

Colored chalk, crayons, colored pencils, or a combination of all three, could be used by the children when transferring information from their individual graphs to the class composite graph. Line up the colored chalk or pencils. The first piece of chalk or crayon is used by the first child and replaced in its position, the second piece by the next child and so on. In this way, each child can keep track of his contribution to the composite graph.

Below is a graph showing data collected by a group of ten teachers for leaf area. Each teacher measured the area of twelve lilac leaves by outlining the leaves on $\frac{3}{4}$-inch grid graph paper. They counted the number of whole squares enclosed by the outline, and estimated the number of whole squares which might be made from the fractions of squares enclosed in the outline. Similar composite graphs may be constructed for leaf width, length and weight. The class as a whole might measure the variation in the number of leaves per plant. Of course, this is only practical if they have collected entire plants such as plantain.



If there is sufficient data for each variation measured, perhaps the students will see a pattern developing among the several graphs. A line following the shape of the graph, connecting the top-most point in each column, will make this pattern more evident. Ask the students how they would describe the general shape formed by the line that's been drawn.

The measurement of many of the variations in characteristics within a species are found to be distributed normally. That means, of course, that they tend to cluster around a central point. An ideal curve would be bell-shaped and symmetrical. However, any plant collection may be biased because of collecting techniques and environmental influences and thus the curve may be skewed.

It is important for the children to recognize the tendency for most things which are measured in the biological world to fall into the middle of a continuous range regardless of what is measured. Ask the class what conclusions might be drawn from this about the differences and similarities of individuals of the same species. Let the students figure out that the characteristics of a species cluster because the specimens of a plant type are, by definition, basically similar.

Some questions follow which could be asked about the previous composite graph. Similar ones may be asked of your students in relation to their graphs:

"What appears to be the most common area for the leaves according to our sampling? What are the second, third and fourth most common areas?"

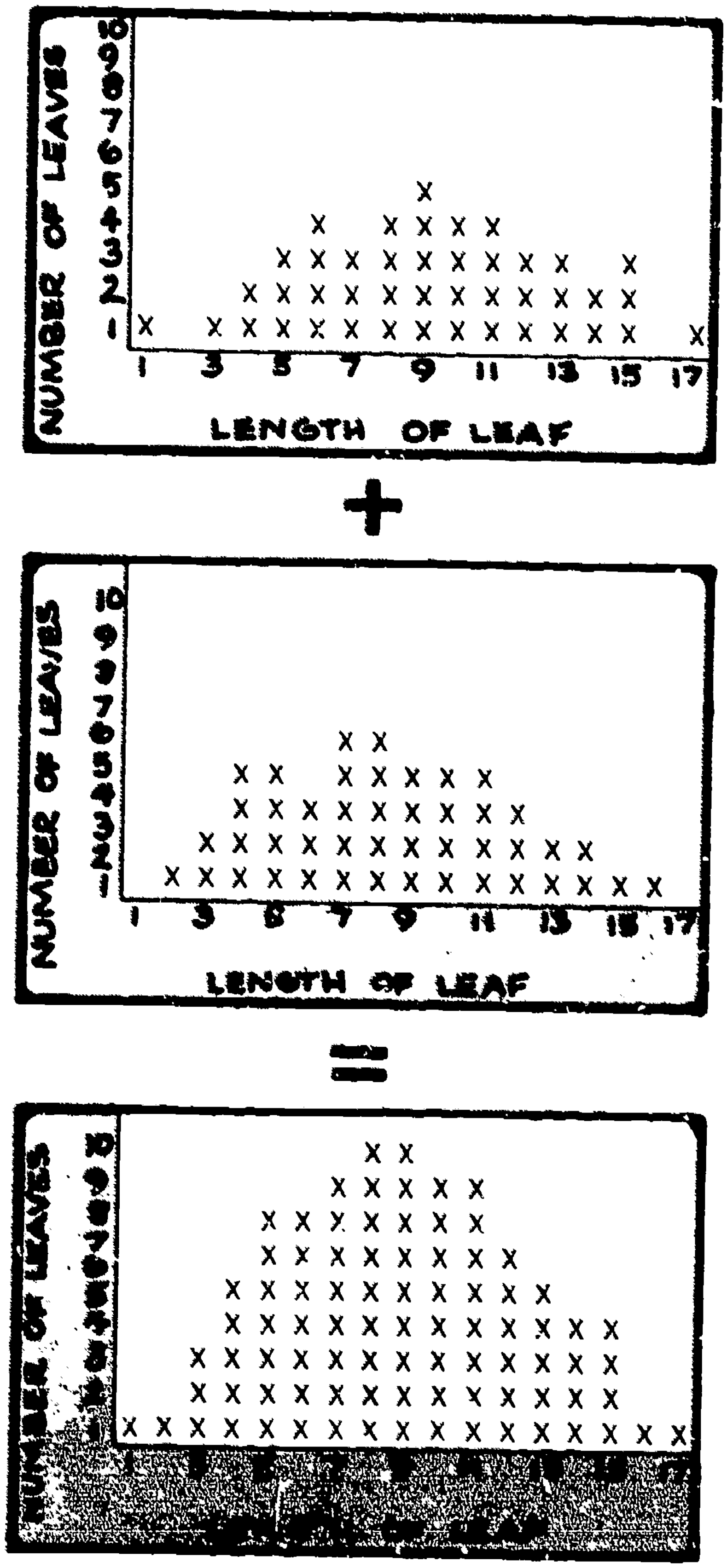
"Can we say our composite graph tells us there are positively no plants with leaves of an area less than 2 squares or more than 17 squares?" (Such an assumption cannot be made no matter how large a sampling was taken. They can only assume that it would be unlikely to find a leaf of either of these areas in the location where their sample was taken.)

"Can we assume we would get the same graph if the same size sampling were taken from another area?" Environmental factors and hereditary factors must be considered before answering such a question. If the area has the same environmental factors of soil, light, temperature, etc., and if the plants of this area evolved under the same conditions as the study plants, the resulting graph might well be the same but complete similarities of conditions are very unlikely.

"If we measured these variations in another plant species, would we get the same results?" The class should now understand that the general shape of the curve (bell-shaped) should be the same but the curve might occupy a different position on the graph.

To firmly establish the idea of sample size as it influences the results, have the children look at their individual graphs. Ask if they see any bell-shaped curves on these individual graphs. They probably won't. Can they explain why? Organize the children into groups of six and ask them to try to combine two or three graphs within their groups to see if a symmetrical or bell-shaped curve results. Possible small graph combinations follow. Here are sample questions which could be asked about them:

What is the smallest number of leaves in these several composites which resulted in a bell-shaped curve? If the questions asked about the class composite graph were asked of the small composite graphs, would the answers be the same? If not, which results are the most valid, those of the class composite or those of the small composites? If the results are the same, could we say why a sampling of this smaller size could replace the larger class sampling? Could it be this result was "lucky?" Do the children think it is repeatable?



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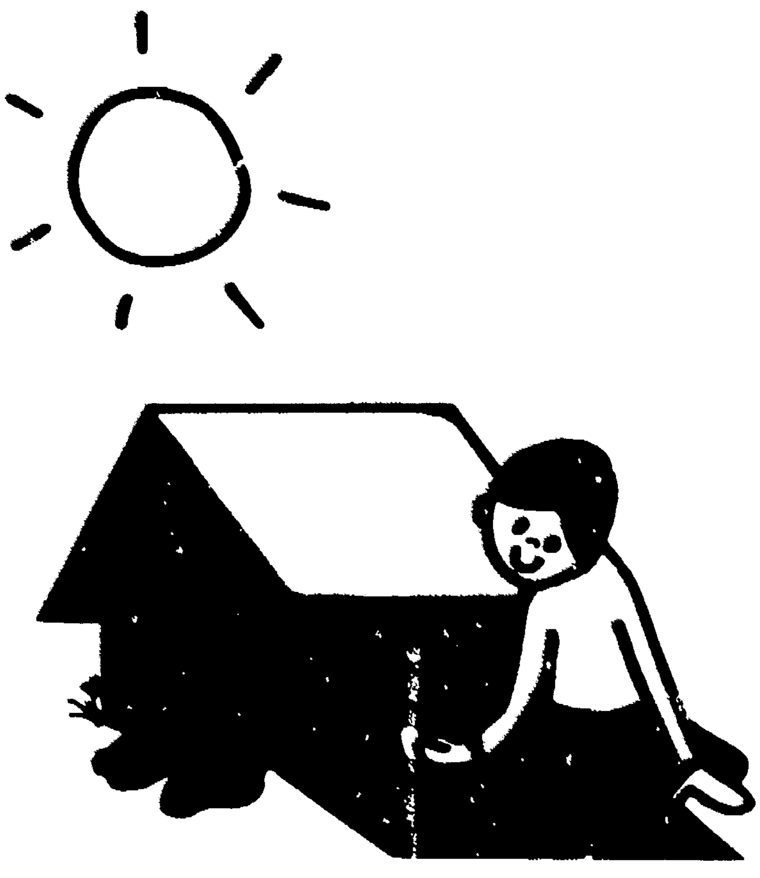
ADDITIONAL STUDIES

Environmental influence on plant growth may be further studied using the following methods.

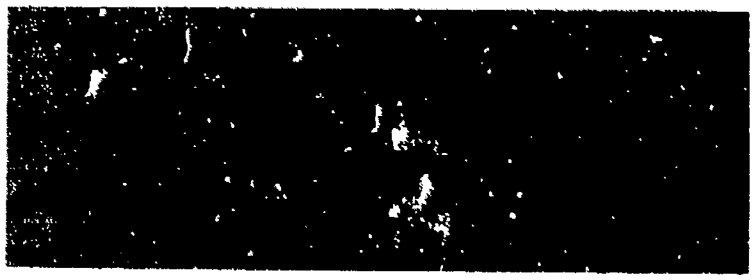
I. Comparing Two Graphs

Select a plant for study which seems to grow under a variety of conditions. Plantain, for example, can be found growing in many types of soils, under wet and dry conditions, in both shady and sunny areas. However, it is reasonable to assume that plantain has a specific set of conditions which will result in its optimum growth and health. It is a less healthy and a less successful plant under anything other than these conditions.

The children might take a sampling (ten leaves or one plant per child) of all the plantain found in spots which are shaded for much of the day. They could measure and graph variation in area, leaf length, number of leaves per plant, etc. They might then take a sampling of all the plantain they found in areas which received sunlight all day. The same variations can be measured and graphed for this sampling. Have the children compare the two graphs. Ask if they are essentially the same. If not, ask how they differ. Do the children think that plantain prefers shade to light or light to shade? Can they answer this question without investigating other possible environmental variables such as soil type? Extensive procedures for testing two environmental factors are found in the units on **Soil Acidity and Alkalinity** and **Soil Water Holding Capacity** in this series.



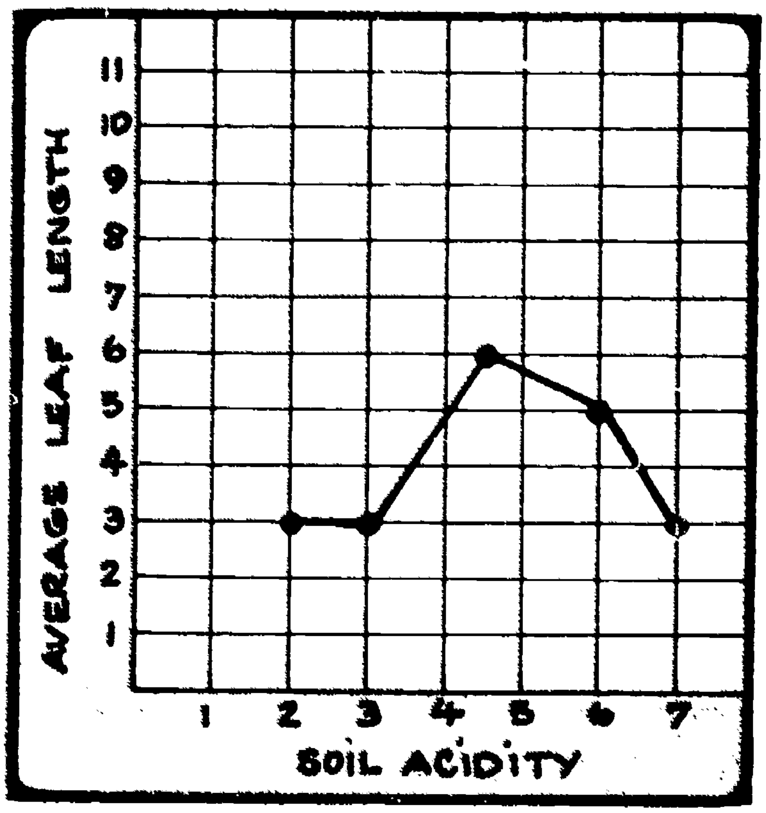
II. Graphing Using Two Variables



It is possible to graph two variables, such as average leaf length and soil acidity, so that each one is seen in relation to the other. Taking this a step further, one of the variables may be seen as a **function** of the other because it varies as a result of a change in the other factor.

Suppose, as shown in the graph which follows, we have five plants of the same species. To each of the five, we add the same amount of water, at the same intervals. We expose each to the same amount of sunlight and we keep the temperature the same for all five. In fact, all environmental elements are kept the same for all five plants, with the exception of one element — which varies for each — in this case, soil acidity. (Soil acidity can be measured with a soil test kit.) By maintaining this environmental control over a period of time, we can then assume, as the graph indicates, that any difference in average leaf length is dependent upon soil acidity.

Thus, from the data, we see that a soil acidity of 4.5 makes for optimum leaf length in those plants tested. Also, leaf length tends to decrease as the soil becomes more or less acid than 4.5.

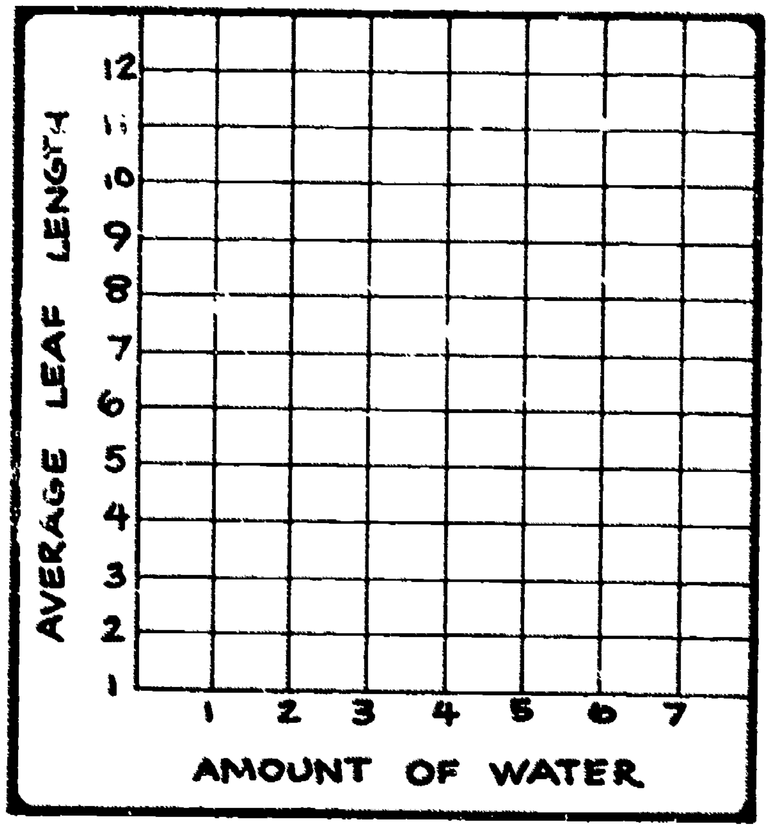


Suppose, as a class project, we want to investigate what effects water supply could have on leaf length. We might approach the problem in the following way:

First, in a single large container, we mix enough potting soil to fill five pots. Next, we put one plant in each pot, taking care to place each into the soil in the same way (i.e., same depth, same degree of packing around roots, etc.). The plants should all be as close to the same size initially, as possible. This could probably be assured by planting a large number of seeds in a single cold frame at the same time. When the seeds have sprouted and grown to a couple of inches or so in height, it should be easy to choose five that look of equal size. (Beans might be good plants to use.)

Once the plants are potted, they should be put in a place where the environmental factors (sunlight, temperature, etc.) will be the same for all five. Then at regular intervals, we add varying amounts of water to each plant. To the first, the class could add, say, one eighth cup, to the second, one fourth cup; and so on, increasing by an eighth of a cup each time. Choose any convenient quantity of water, but be sure to increase the amount proportionally in each of the five plants. Add the water every other day, or at some other interval, if experience suggests another pattern is better.

After three or four weeks, or whenever there is noticeable growth, measure the leaves of each plant, take an average leaf length for each plant, and then plot the data in a way similar to that for soil acidity. What conclusions, if any, can the class draw about the relationship of available water to leaf length?



III. Heredity

As was mentioned in the introduction to this unit, heredity is the second large category which affects plant variation. For studying this unit in greater depth, see **Population Variation,** another unit of this series.

You might want to delve into this area further from an environmental standpoint. Darwin's concept of "the survival of the fittest," for example, implies that the species or specimen which is **fittest for his environment** is the one which will prevail. The students could relate this to the two previous graphs which involve the correlation of two variables. For each variation which was recorded there was an **optimum** condition: leaf length was longest when certain other variables were existing in a certain quantity. How would the students explain the link between this information and the fact that traits ultimately get transmitted through genes?

It's important for the children to understand that heredity is a separate phenomenon from environmental adaptation. Several traits, such as that of having blue eyes, are transmitted by hereditary means, but provide no apparent aid in adaptation. For studying this area in greater detail, see **Population Variation,** another unit in this series.

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 August, 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	79123	Genetic Variation	4-9	1.50
79016	Vacant Lot Studies	5-9	1.50	79132	Soil	2-9	$1.50
79025	Differences in Living Things	4-8	1.00	79141	Tile Patterns and Graphs	1-2	1.00
79034	Shadows	1-8	1.00	79150	Plant Puzzles	1-6	1.50
79043	Wind	3-6	1.50	79169	Brine Shrimp and Their Habitat	1-5	1.50
79052	Snow and Ice	1-6	1.50	79178	Nature's Part in Art	3-6	1.50
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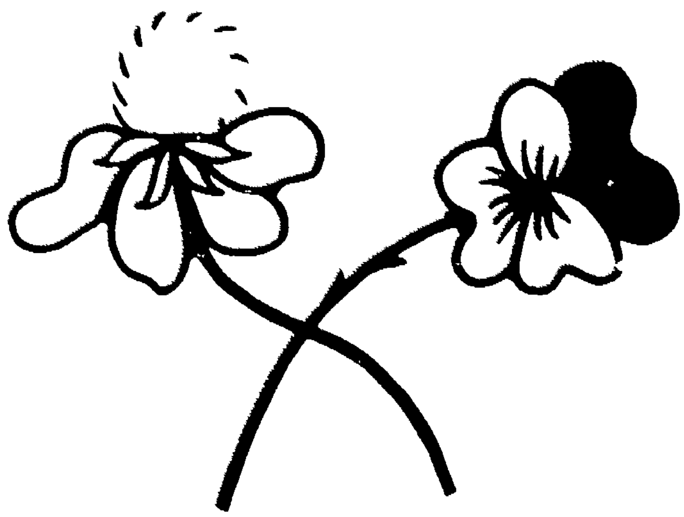

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