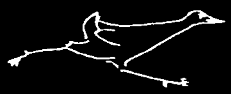
Life On Guam
Schoolyard Ecology



by Jeffrey E. Shafer

art Lita Payne

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...a project to produce locally applicable class, lab, and field materials in ecology and social studies for Guam junior and senior high schools. This project is funded by a grant under ESEA Title III, U. S. Office of Education - Department of Health, Education and Welfare — whose position, policy, or endorsement is not necessarily reflected by the content herein.

> ".....to ultimately graduate citizens who are knowledgeable and conscientious about environmental concerns of Guam and the rest of the World."

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Junior-Senior Edition - 1976

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Introduction

The great variety of life found in a schoolyard is not always appreciated. One explanation could be that the school and its surroundings are so familiar that students and teachers hardly ever think about them. Whatever the reason, people just do not take the time to look at their surroundings.

When contractors scrape away too much vegetation on a construction site it provides a chance for 'pioneer' plants to start coming in. This situation provides plenty of material for a week's study. Even a simple on-campus field trip would provide a wealth of information and could form the basis for studying almost every ecosystem you might find.

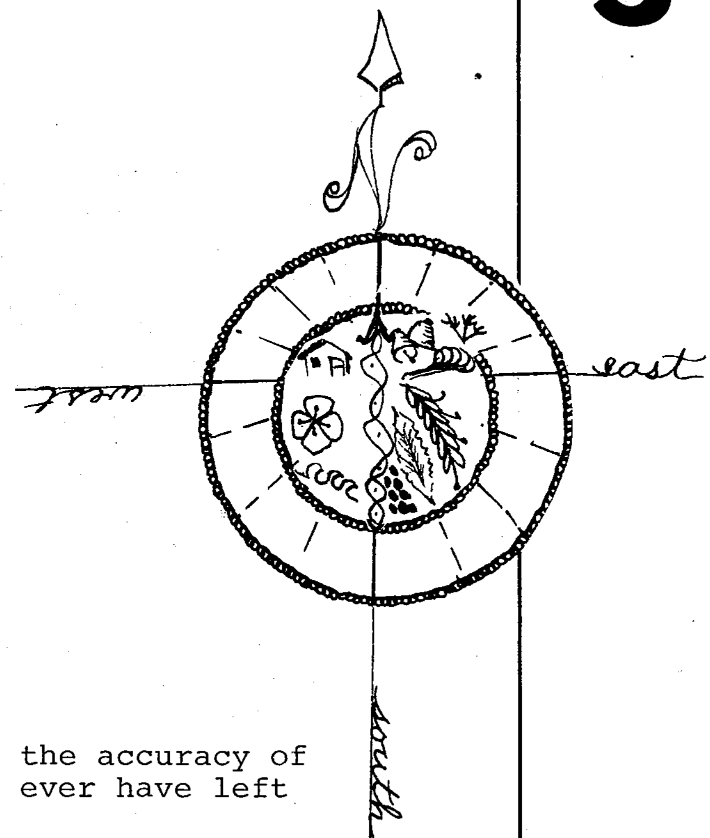
The activities in this unit are designed to be interesting and student-centered. That means they've been written to make use of your natural curiosity and inventiveness.

In addition, please recognize that the unit is not intended to be exhaustive in its treatment of the subject; life communities in each schoolyard will vary with the location, even on our somewhat small Island.

Schoolyard Ecology will introduce basic techniques for studying a schoolyard, or neighborhood, or backyard, or any other area. All schools and other buildings have at least one thing in common——a disturbed environment. True, some schoolyards may be further along in replacing what man has altered than others. This replacement around buildings is almost always man-controlled. It might be interesting to compare two schoolyards. A class visit to almost any other schoolyard would provide plenty of materials for comparing and contrasting.

As you gain more confidence in your abilities to observe, make theories, gather data, state objectives and results, and draw conclusions, you should be able to express your own ideas and feelings about your schoolyard and the environment in general.

Any new approaches to solving environmental problems ought to be encouraged and welcomed. Perhaps you may "invent" a solution to such a problem; if so you should also design an investigation to test the solution. Your teacher may be able to provide materials necessary for the test and to act as a "consultant" as you do your investigations.



ACTIVITY ONE:

KNOW WHERE YOU ARE

AND YOUR

RELATIONSHIP

TO OTHERS.

If Columbus had not questioned the accuracy of maps during his time, would he ever have left Spain for the Indies?

In this activity you are going to be challenged —when you study anything in detail you should become as familiar with that subject as you possibly can. You are now in the schoolyard unit, so let's get familiar with the schoolyard.

OBJECTIVES - By the end of this activity you should be able to:

1. Identify prominent biological and physical features of your schoolyard.

2. Draw an accurate map of your schoolyard showing these features. Try to make the best map you know how, and maybe next year the school will use your map instead of the one being used now!

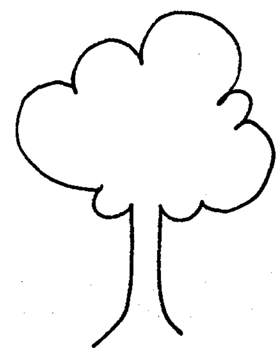
MATERIALS:

Notebook and pencil.
Large piece of paper, say 0.75 m x 1.0 m.
Magnetic compass.
Colored pencils, pens, or magic markers.

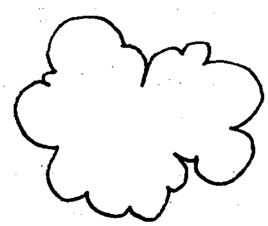
ACTION:

A hint: Work in groups of three or four. This is a good way for organizing and dividing up the work.

1. Assemble your group.
2. Decide how you are going to go about mapping your school. You will need to decide how elaborate you want to make your map. For example: Do you want to show a tree like this



or like this (from above)?



What about bushes, shrubs, grass, cars, flagpole, fences, parking lot? What about hills, valleys, trash containers, mudpuddles, steps, walks, courtyards? Whatever you decide, just remember to always use the same symbol for the same object or feature. Make a key to refer to. Don't forget to show direction (North) on the map.

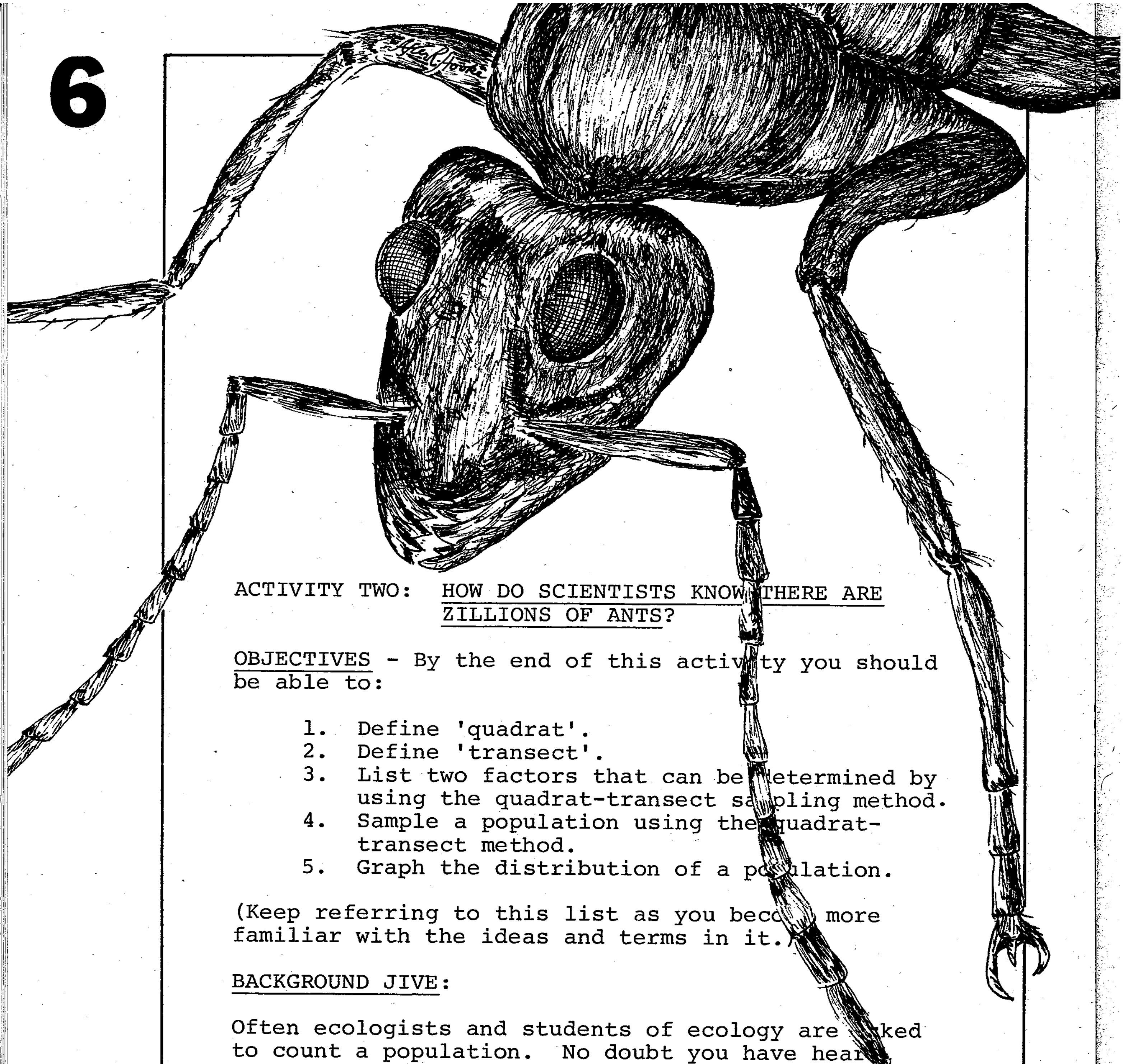
Before you start, list in your notebook any problems you think you might encounter—like, "Who is going to sign my hall pass?"

When you have finished your map, you will be able to answer (based on your group's opinion) the following questions:

1. What special problems did you encounter?
2. How did you solve these problems?
3. What was the most prominent feature of the site?
4. What evidence of man's influence did you find?
5. What do you think this site looked like fifty years ago?
6. What do you think this site will look like fifty years from now?

So get a head start on everyone else and be thinking about the answers as you construct your map.

FOLLOW-UP: Suggest to your teacher that the class select the best map and give it to the principal —maybe it will be used next year.



ACTIVITY TWO: <u>HOW DO SCIENTISTS KNOW THERE ARE ZILLIONS OF ANTS?</u>

<u>OBJECTIVES</u> - By the end of this activity you should be able to:

1. Define 'quadrat'.
2. Define 'transect'.
3. List two factors that can be determined by using the quadrat-transect sampling method.
4. Sample a population using the quadrat-transect method.
5. Graph the distribution of a population.

(Keep referring to this list as you become more familiar with the ideas and terms in it.)

<u>BACKGROUND JIVE</u>:

Often ecologists and students of ecology are asked to count a population. No doubt you have heard that certain species are now so few in number they are in danger of <u>becoming extinct</u> (dying out). How do scientists know this? That they do know it is shown, among other things, by the fact that every year the National Wildlife Federation publishes an "Endangered Species List". Does your school have one? (NWF, 1412 6th St., NW, Washington, D.C. 20036.)

In this activity you have a chance to learn and work with a standard sampling technique. This technique is used by ecologists and other scientists:

1. To find out the size of plant and animal populations.
2. To determine whether a particular population is evenly distributed or is concentrated in certain places.
3. To find out and record any change in population numbers after the environment has changed.

We will use a form of random sampling to check our populations. Random sampling means choosing by chance! It avoids selecting certain areas on purpose and thus making the results invalid. Suppose you were asked, "How much grass grows on your schoolground?"....Would it be valid for you to look on the basketball court and parking lot and say "Almost none"? Of course not. You would not have made a random sample. You would have biased the results by choosing places which provided misleading data.

One way to sample a population is to draw a line through the area to be sampled. Then, at random places along the line, count individuals. This line is called a transect. The areas where individuals are counted are quadrats. A quadrat is an appropriately-sized square (usually) for sampling a given area. If you're counting trees, the quadrat would be large; if you're counting blades of grass, small.

The quadrat-transect method is a form of random sampling. The method itself, however, is not random, or "chance". It is very carefully designed.

In applying this random sampling method, you will use several quadrats along a transect line to gather several sample population counts. If the population is evenly distributed you can make a pretty good estimate of the numbers of organisms in a whole area.

Organisms vary in abundance from place to place according to the biotic (biological) and abiotic (non-biological) characteristics of those places. For this reason you may want to keep your counts separate as expressions of different community types, for instance——a flat grassy area and a hilly, rocky area.

The sampling exercise in this activity will let you practice the quadrat-transect method. You will also find out the makeup and "organism" population of several model populations. (They're 'model' populations because they aren't real animals. Later you will design and carry out an investigation that will randomly sample the plant and animal populations of a given area of your schoolyard.)

The model populations consist of three sheets of printed shapes representing marine animals:

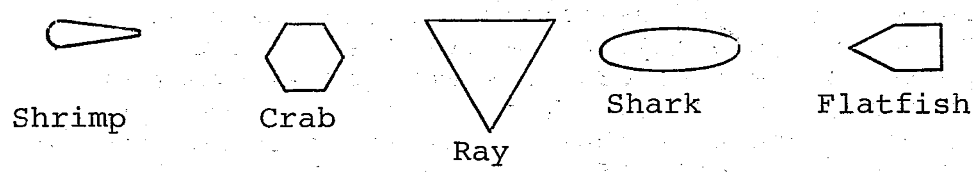


Figure 2-1.

Each sheet shows a different distribution of the five model populations.

For these model population counts, you will use a "quadrat" consisting of a regular paper clip opened into a shape something like

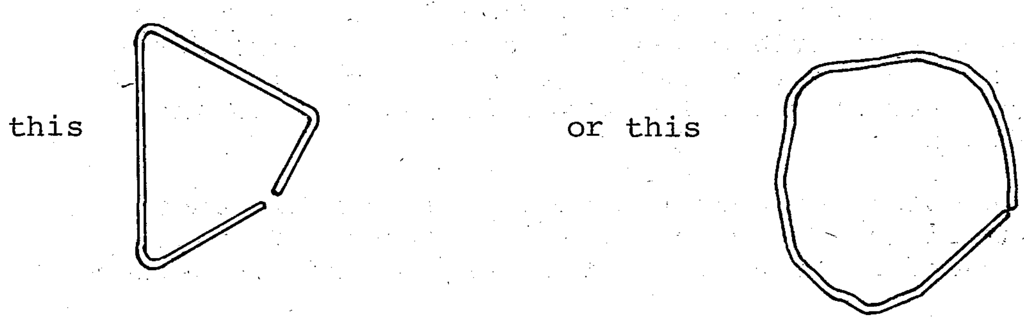


Figure 2-2.

Or you may use any clear "circular" object no larger than 3-4 cm in diameter.

The transect lines will consist of imaginary lines from the top of a population sheet to the bottom. You will sample quadrats at selected intervals along the transect lines. The correct arrangement of transect lines and quadrats is shown in the following figure.

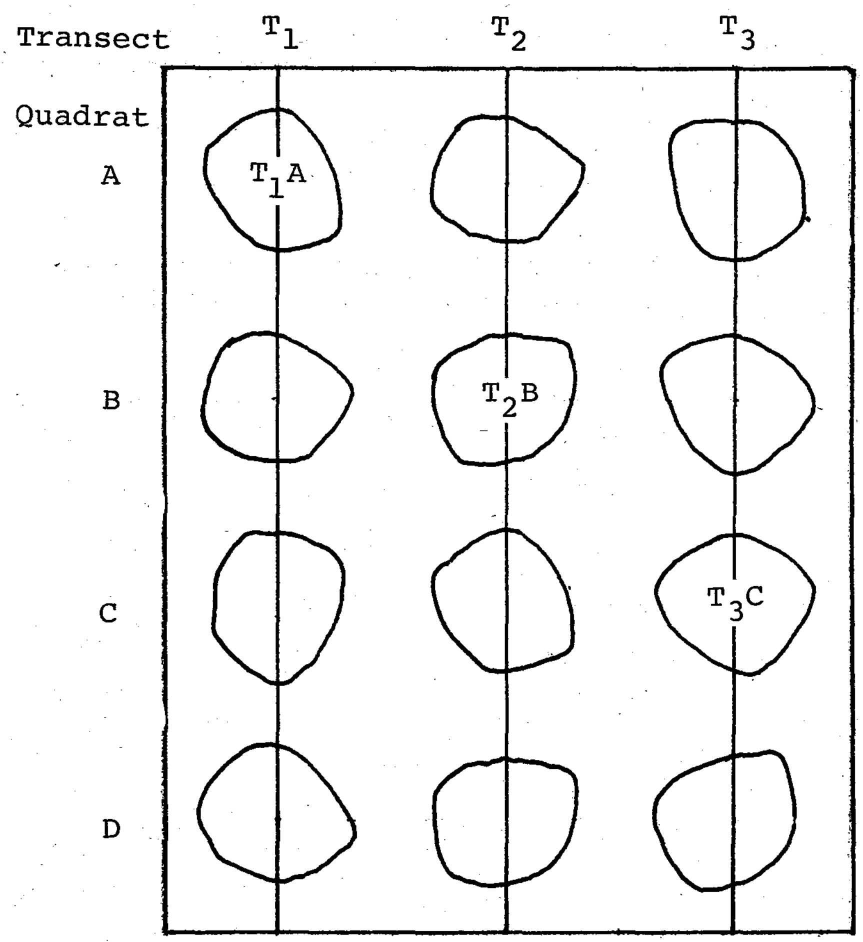


Figure 2-3.

Model population sheet showing 3 transects, 12 quadrats.

MATERIALS:

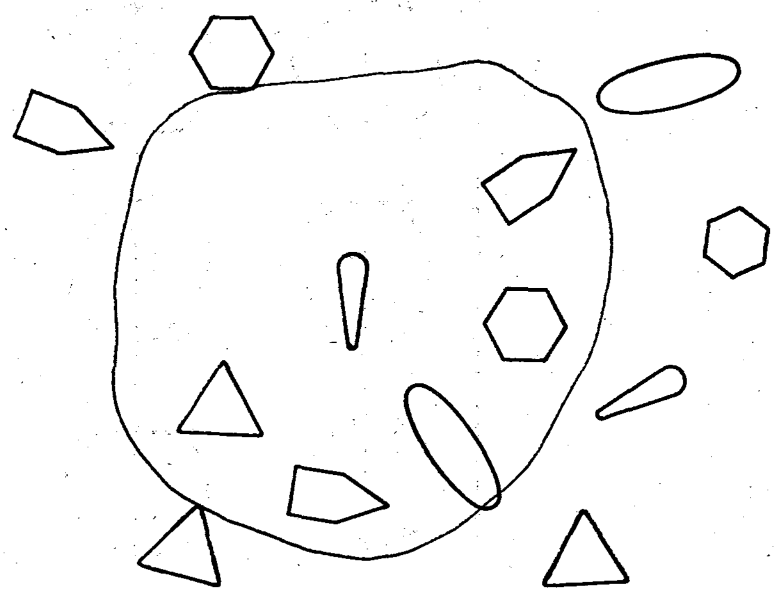
Notebook and pencil.
Model Population sheets I, II, and III.
Quadrat, 3-4 cm diameter (bent paper clip, beaker, or whatever). The diameter of the quadrat should not exceed 3-4 cm. Anything larger would be impractical, considering the size of our model.
3 Data sheets and graph paper.

ACTION:

Part A. Sampling.

1. Start with "Model Population I".
2. Draw an imaginary transect line (T_1) vertically down the left side of the page. Place the quadrat marker near the top of this line. This will be Quadrat A of Transect 1, or Quadrat T_1A. Each transect should contain the same number of quadrats——in this activity, four. The quadrats should not overlap. (No animal should be counted more than once.)

3. Count any animal touching or within the quadrat. (See Figure 2-4.)



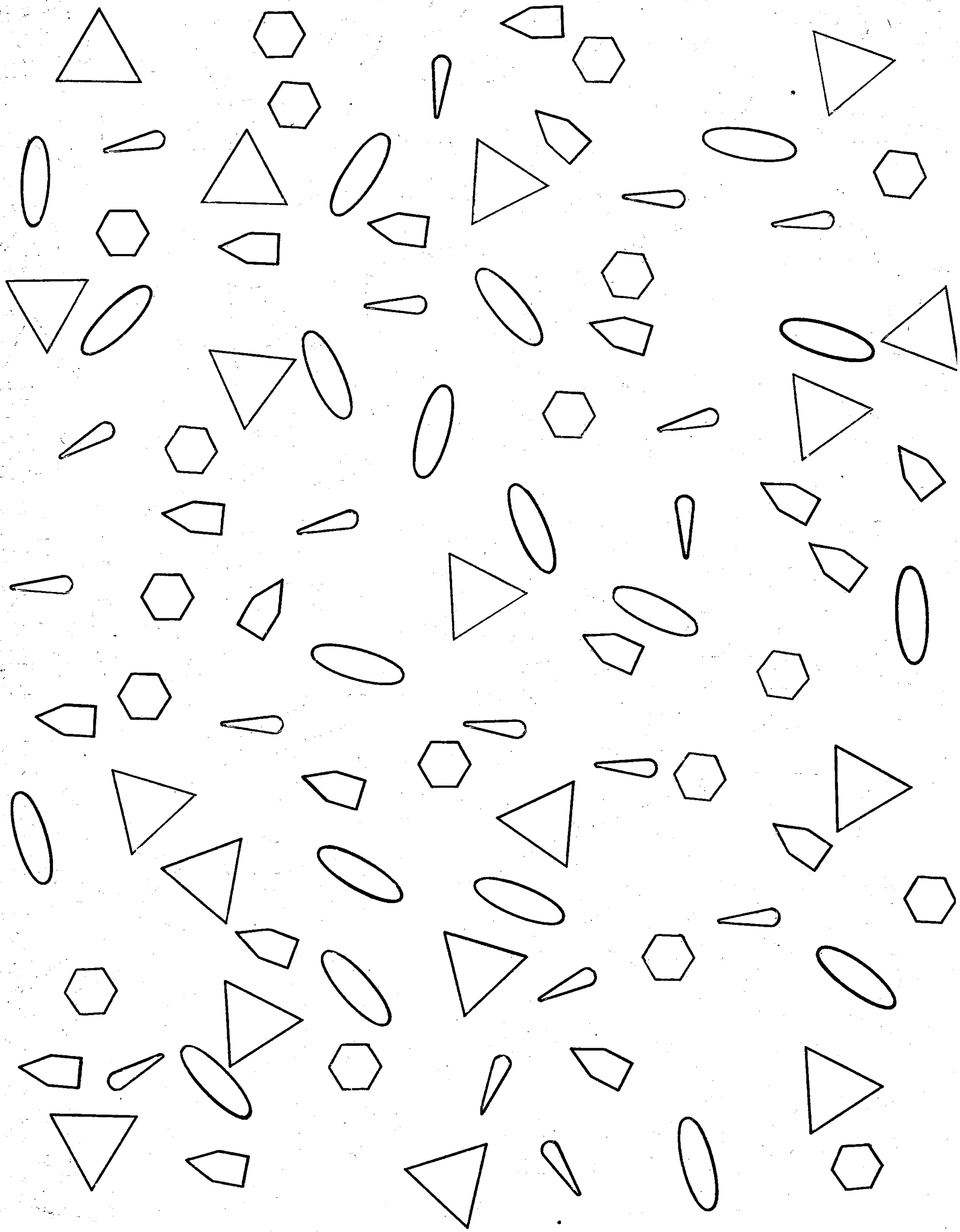
Totals:

Crab	2	Ray	2
Flatfish	2	Shark	1
		Shrimp	1

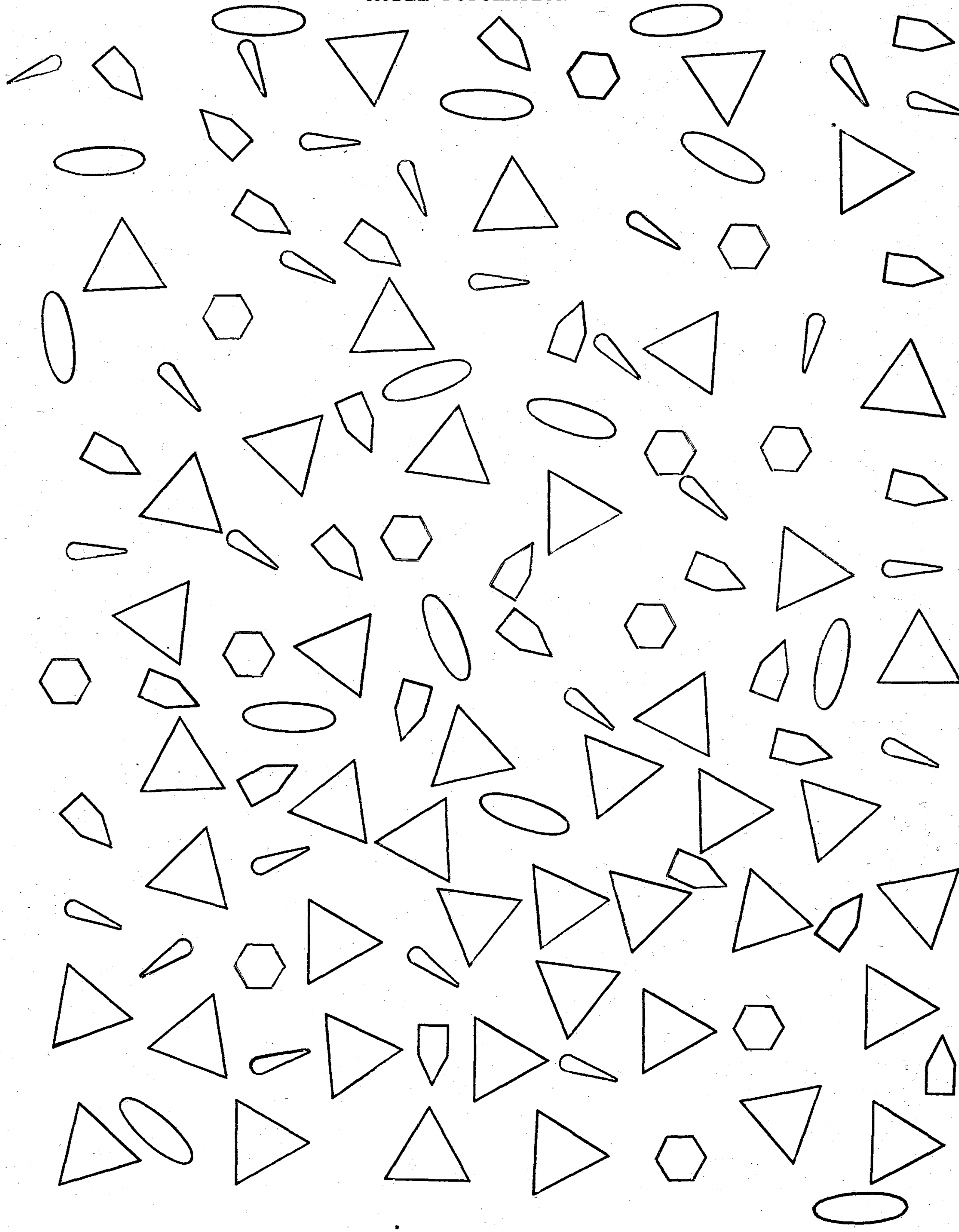
Figure 2-4. Quadrat with 8 animals.

4. Record in the appropriate T_1A boxes on the Data Sheet <u>all</u> the animals of Quadrat T_1A.
5. Move the quadrat to position T_1B. Count and record all the animals of this quadrat.
6. Continue the procedure until you have completed 12 quadrats as shown in Figure 2-3.
7. Once you have finished the first model population, do the same for Model Populations II and III making a new Data Sheet for each.

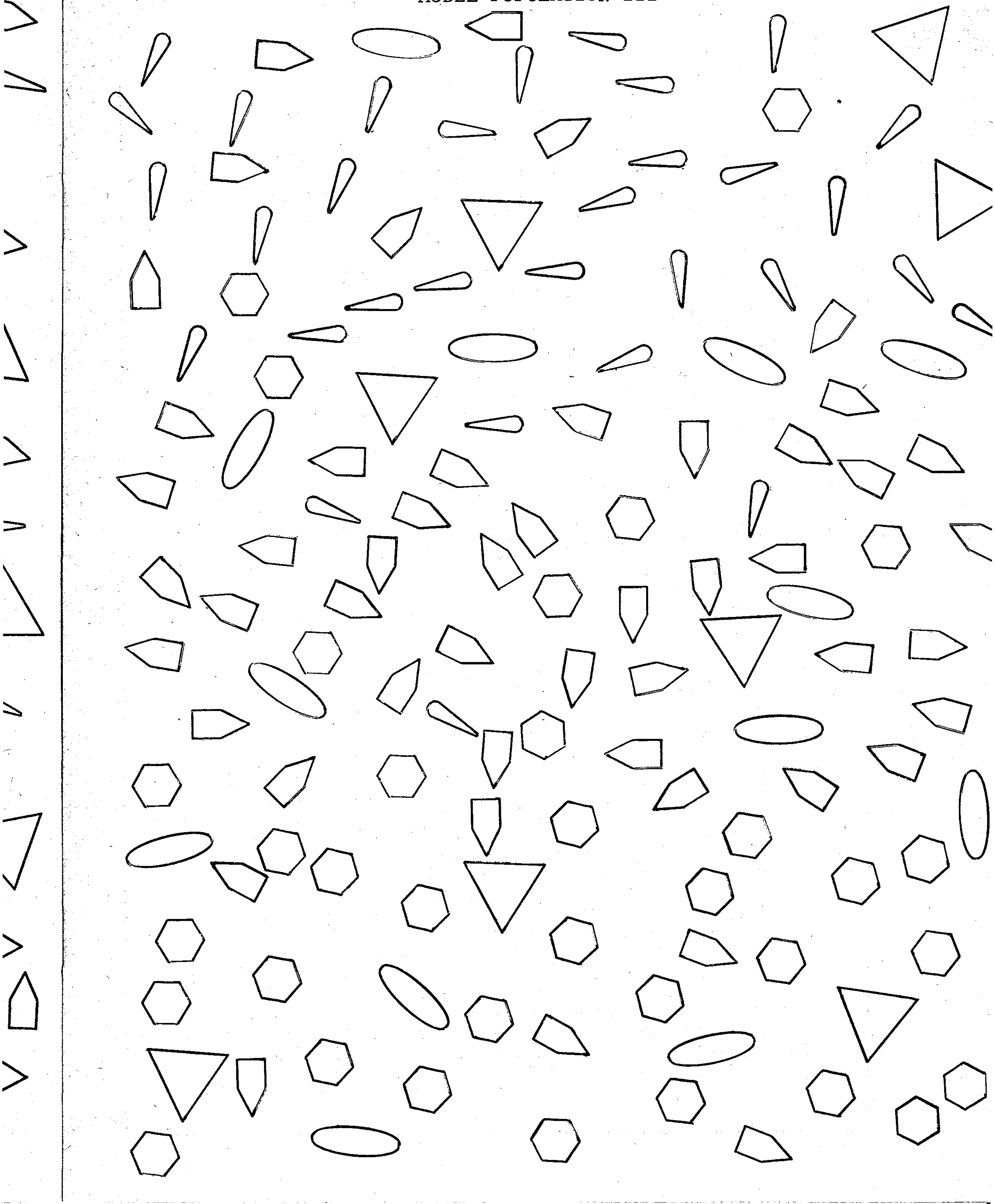
MODEL POPULATION I



MODEL POPULATION II



MODEL POPULATION III



ACTION:

Part B. Analysis of Data.

Now that the raw data has been gathered you can begin to think about what it means. Let's compare quadrats and see if the distributions of the populations are the same from top to bottom of the sheets.

Add the figures horizontally, so you get the total of each kind of animal for A, B, C, and D quadrats respectively. Divide each of the totals by 3 and record these numbers in the column headed "Average per Quadrat".

You now have a numerical basis for comparing quadrats, but it will be much easier to do if you make a graph.

Part C. Graphing the Data.

A graph will show at a glance how the populations are distributed. Plot one animal population at a time and connect the four points with a line. Make the lines different for different kinds of animal. (Here are examples you could use if you wish: crab ——————, fish -------, ray ——— — ——— —, shark oooooooo, shrimp.........) Be sure to include your key on the upper right corner of the graph.

On a graph one point gives two pieces of information—it shows the "amounts" of two different items. The first item is independent of the other and is called the independent variable. The second item is dependent on the first and is called the dependent variable. The independent variable is always plotted horizontally and the dependent variable is plotted vertically. Your graphs will show the quadrats sampled and the number of animals in each. (Which variable is independent of the other and therefore goes on the horizontal axis?)

The ability to read graphs is a valuable tool for a person to have. Compare the complete graph with all the numbers in the boxes above it on the Data Sheet. See how much easier it is to 'get the picture' from the graph? Right on!

SCHOOLYARDS - DATA SHEET - ACTIVITY TWO - B & C
MODEL POPULATION ___

Crab

	T1	T2	T3	Tot.	Avg/ Quad.
A	1	3	1	5	1.7
B	0	1	2	3	1
C	2	2	2	6	2
D	1	4	1	6	2

Fish

	T1	T2	T3	Tot.	Avg/ Quad.
A	0	1	2	3	1
B	1	0	1	2	0.7
C	2	1	1	4	1.3
D	2	2	3	7	2.3

Ray

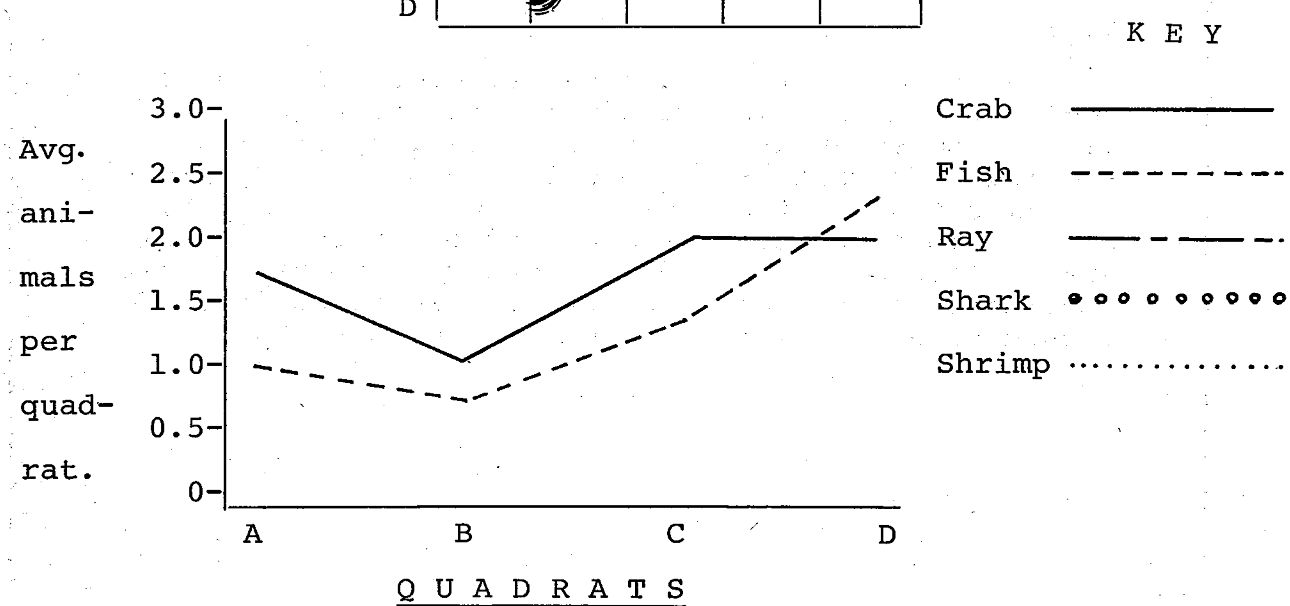
	T1	T2	T3	Tot.	Avg/ Quad.
A					
B					
C					
D					

Shark

	T1	T2	T3	Tot.	Avg/ Quad.
A					
B					
C					
D					

Shrimp

	T1	T2	T3	Tot.	Avg/ Quad.
A					
B					
C					
D					



ACTIVITY THREE: HOW DO YOU CHOOSE?

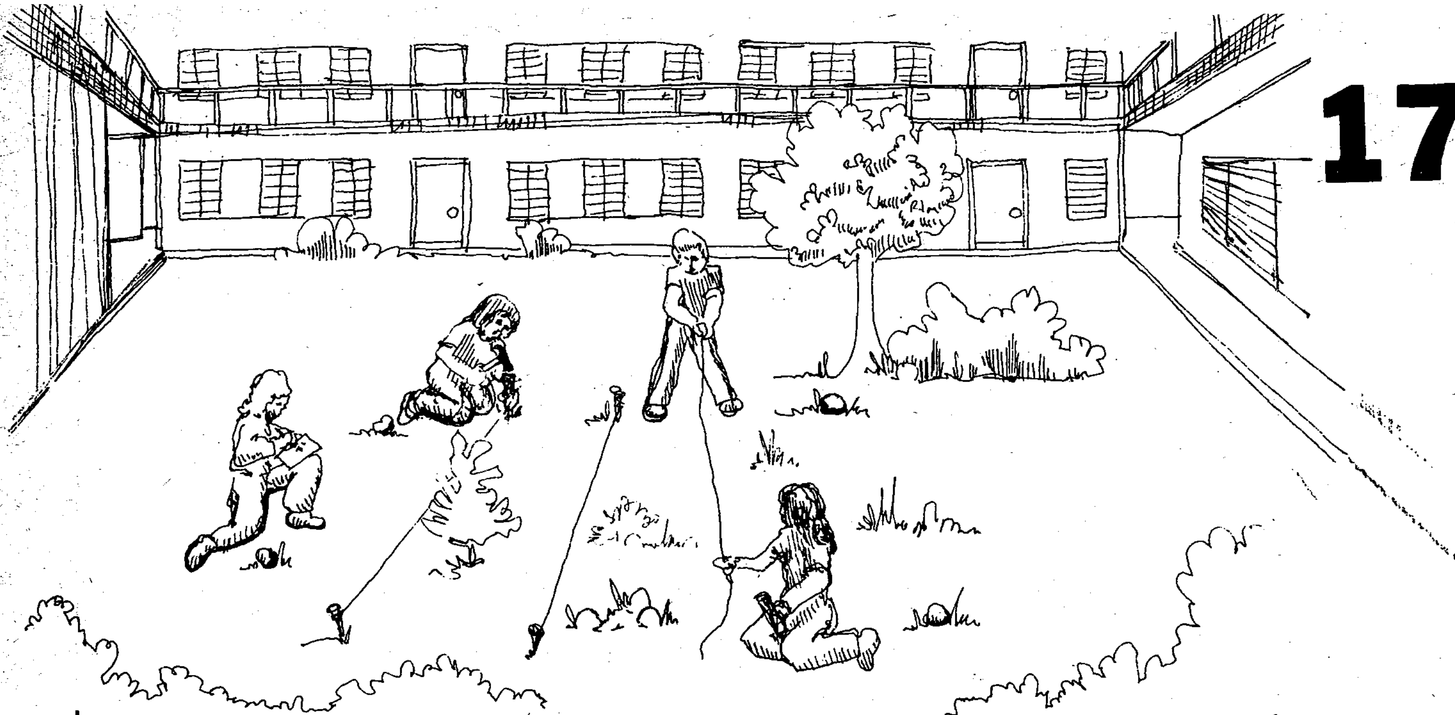
Use the quadrat-transect method on your group map to identify preliminary areas you would like to study in greater detail in the next activity. Select at least three areas and outline them on your map in colored pencil.

MATERIALS:

Group map of schoolyard
Colored pencil

ACTION:

Go to each area you have selected. As a group decide which area you would like to study in detail. Try to choose an area that has a variety of plants growing. The method you use to choose a study plot is not important. It may be by consensus (vote) or by drawing lots (number the plot and place the numbers on small slips of paper and draw one from a hat). Most important in the selection process is curiosity. You should select a plot that you are curious about.



ACTIVITY FOUR: LOOK DOWN AMERICA——SEE WHAT YOU'VE GOT!

By now you have selected an area from your map to investigate in detail. Let's look at what you've done so far:

/x/ Made Schoolyard Map

/x/ Plotted and interpreted a graph

/x/ Learned Quadrat/Transect Technique

/x/ Identified Area of Schoolyard to be studied.

/ / Laid out 4 m x 4 m Study Plot.

In the above figure the last box is not checked off. Why not? Right——you haven't done it yet! Now that you have identified the general area you are going to study it is time to narrow that area down into a more manageable "Study Plot".

OBJECTIVES: By the end of this activity you should be able to:

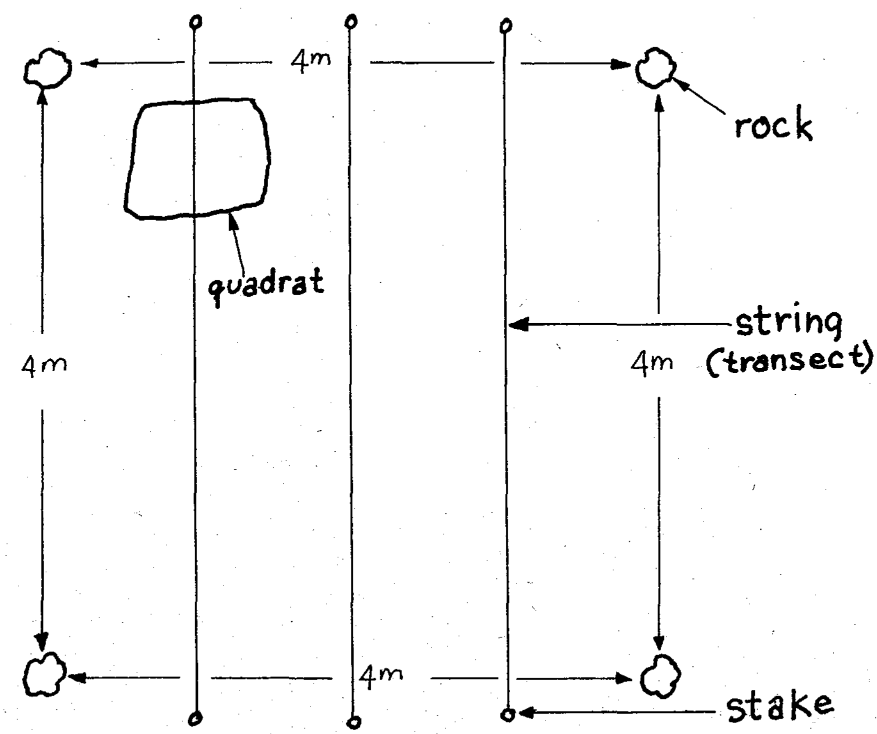
1. List the types of plants that are found in your study plot (i.e. trees, shrubs, grasses, etc.).
2. State the number of these plant types in your study plot using the quadrat-transect technique.
3. Graph the distribution per quadrat of plant types in your study plot.

MATERIALS:

Notebook and pencil.
1 quadrat marker per group (30 cm x 30 cm square).
6 wooden stakes.
1 rock or hammer for driving the stakes.
1 meter stick.
3 strings 4.5 m each.

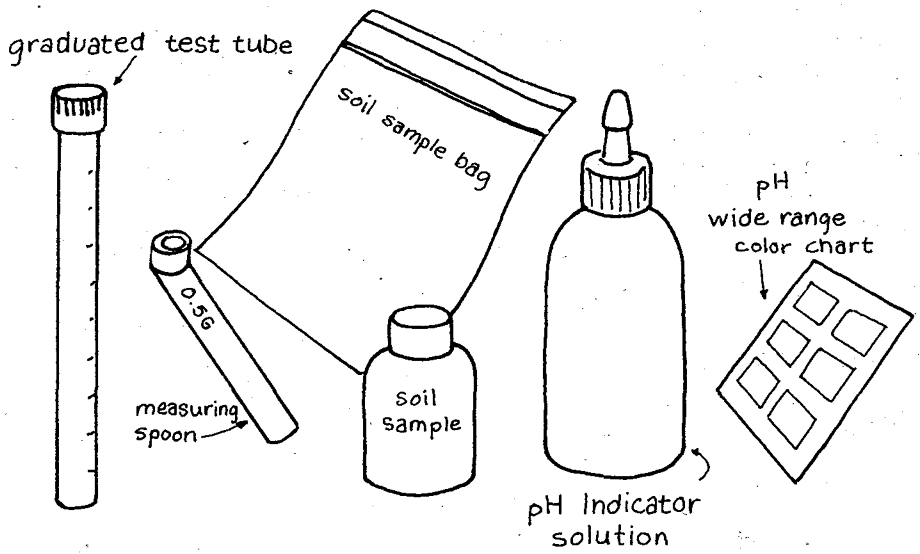
ACTION:

Obtain all the materials required and go to your study plot. Be sure to take a notebook and pencil along to record your data.



Using small rocks, mark off your study plot. Drive the stakes at intervals of 1 m and connect the stakes with the strings. You now have constructed transects and are ready to sample along them. Take samples along each transect at least 3 times. You may do more, but it is not necessary.

Make a data sheet that will later enable you to organize your data in the manner of Activity Two.



ACTIVITY FIVE: BENEATH THE PLANTS

OBJECTIVES: After you complete this activity you should be able to:

1. Write about and discuss the characteristics of the soil in your study plot.
2. List two factors which are controlled by soil characteristics.
3. List two factors that determine plant distribution.
4. Describe the reaction of blue and red litmus paper to acid and alkaline conditions.

BACKGROUND JIVE:

Both the density and appearance of plants are controlled largely by the kind of soil in which the plants grow. One reason that certain plants grow in certain places is that the soils there contain things necessary for these plants to grow.

Not all plants have the same growth requirements. For example, you would expect to find water lilies only in water. On the other hand, sword grass readily adapts to dry soil and is built to save water. These are examples of the plant-water relationship, an important determinant in plant distribution. Acidity and alkalinity of soils affect plant growth. Sword grass grows well in acid soil; tangantangan flourishes in alkaline soil. Plant nutrients (foods), sunlight, and temperature also influence plant distribution.

It is not easy to investigate all of the contributing environmental factors at once. This unit will therefore concentrate on developing one technique at a time for studying soil. Soil acidity will be checked with litmus paper in Part I; water content by touch in Part II; nitrogen with chemical tests in Part III.

MATERIALS (per group):

Notebook and pencil

3 paper cups

Litmus paper

Distilled water

Map of schoolyard

Part I - Acid-Neutral-Alkaline

BACKGROUND JIVE:

Acidity and alkalinity are usually expressed in "pH". The pH scale runs from 1 to 14. A substance with a pH of 7 is neutral. Anything below 7 is acidic and anything above 7 is alkaline. Lemons are acidic, distilled water is neutral, and soap is alkaline.

The acidity of soil can be checked with litmus paper, available in red and blue strips. Red litmus turns blue if the material being tested is alkaline, and blue litmus turns pink if exposed to acid material.

ACTION:

1. Using the quadrat-transect method, select 3 sample areas in your 4 m x 4 m study plot.

2. Label 3 paper cups Q1, Q2, and Q3. Into each cup put about a teaspoon of soil from the corresponding quadrat in your study plot.

3. Go back to the classroom and mix the soil in each cup with 1 tablespoon of water. (Note: Distilled water may be required. Tap water may not be neutral and will interfere with results. Test it to check.)

4. In your notebook make a table like the one below.

5. Place a piece of litmus paper in each cup. Note any color change. Record it on the Data Sheet.

DATA SHEET:

Quadrat	Acid	Neutral	Alkaline	Comments
1				
2				
3				

QUESTIONS:

1. Is the soil in your study plot acid or alkaline?
2. Compare the soil in your study plot with the soil of other groups.
3. What types of plants seem to live in acid soil? Alkaline?
4. What do you think could account for any variations in soil acidity-alkalinity?

FOLLOWUP:

1. Using litmus paper, test five soil areas around your schoolyard for acid-alkaline content. Mark these areas on the schoolyard map and indicate which are acid and which are alkaline. Be sure to pick areas that have obvious differences in the kinds of plants growing there. Also try to pick some areas that are dry and some that are moist.

2. Make a catalog of plants on your school campus and find out which type of soil each plant grows best in. Consult other groups to make your catalog complete.
3. Check your home/ranch soil the same way.

Part II - Moisture Content of Soil.

<u>BACKGROUND JIVE</u>:

Water may enter soil as rain and surface runoff. It may seep up from ground water below, or someone may water the ground. The amount of water in the soil will depend on many factors including the frequency and amount of rain, nearness of ground water to the surface, <u>porosity</u> (what does this mean?) of soil, humidity and temperature of the air, amount and direction of wind, exposure to sun, and the types of surface plants.

Here is a sample Data Sheet. Draw one like it in your notebook.

Soil Moisture Survey

Group Name ________________________

Physical characteristic of study plot

____

____

Describe soil (color, sandy, clay, etc.)

____

____

Day	Time	Soil Type	Moisture	Weather - General Description
(today) 0				
1				
2				
(etc.)				

SAMPLE

Moisture Key:

This will enable you to determine the general moisture content in your soil sample.

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

ACTION:

Go to your plot each day for ten days and check moisture content of the soil. This should take no more than ten minutes a day. Record your observations and conclusions in your notebook.

Look over the questions below and be sure that your group can answer them. Be ready to explain your answers.

QUESTIONS:

1. What effect does weather have on soil moisture?
2. What effect does soil type have on changes in soil moisture?
3. How do your observations compare with those of other students?
4. How do you account for any differences?
5. List four environmental factors besides rainfall which could affect the soil's moisture content.

Part III - Soil Minerals

OBJECTIVES: By the end of this part you should be able to:

1. List some things plants need in order to grow and remain healthy.
2. Show how the soil obtains nitrogen, by sketching the nitrogen cycle.
3. Be able to write the equation for nitrogen fixation.

BACKGROUND JIVE:

Nitrogen (N_2) is an element which has a very great effect on plants. It stimulates above-ground growth and produces that rich green color characteristic of a healthy plant. The plant's use of potassium, phosphorus, and other nutrients is stimulated by the presence of nitrogen. Too much nitrate, however, can produce harmful effects such as slowdown in maturity or ripening, and decreased resistance to disease.

Organic matter in soil contains almost all of the natural soil nitrogen. In this form, nitrogen is not available for use by plants but must be transformed by soil bacteria first into ammonia, NH_3, and then into nitrates. These dissolve in water and so can be absorbed by plant root systems.

Some investigators also think that too much nitrate in plants we eat can cause illness in humans and other animals. This is triggered by the reduction of the nitrate to nitrite ($NO_3^- \longrightarrow NO_2^-$) 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 also cause anemia and other illness in children.

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

Nitrates can be added to the soil in inorganic fertilizers. Great care is necessary to add just the right amount to stimulate plant growth.

The ammonia form of nitrogen, NH_3, is very quickly changed to nitrate in the soil by bacteria and chemical reactions with other minerals. Unless nutrients containing ammonia, such as fresh animal manure and rotting plants have recently been added, ammonia is very difficult to detect in most soils.

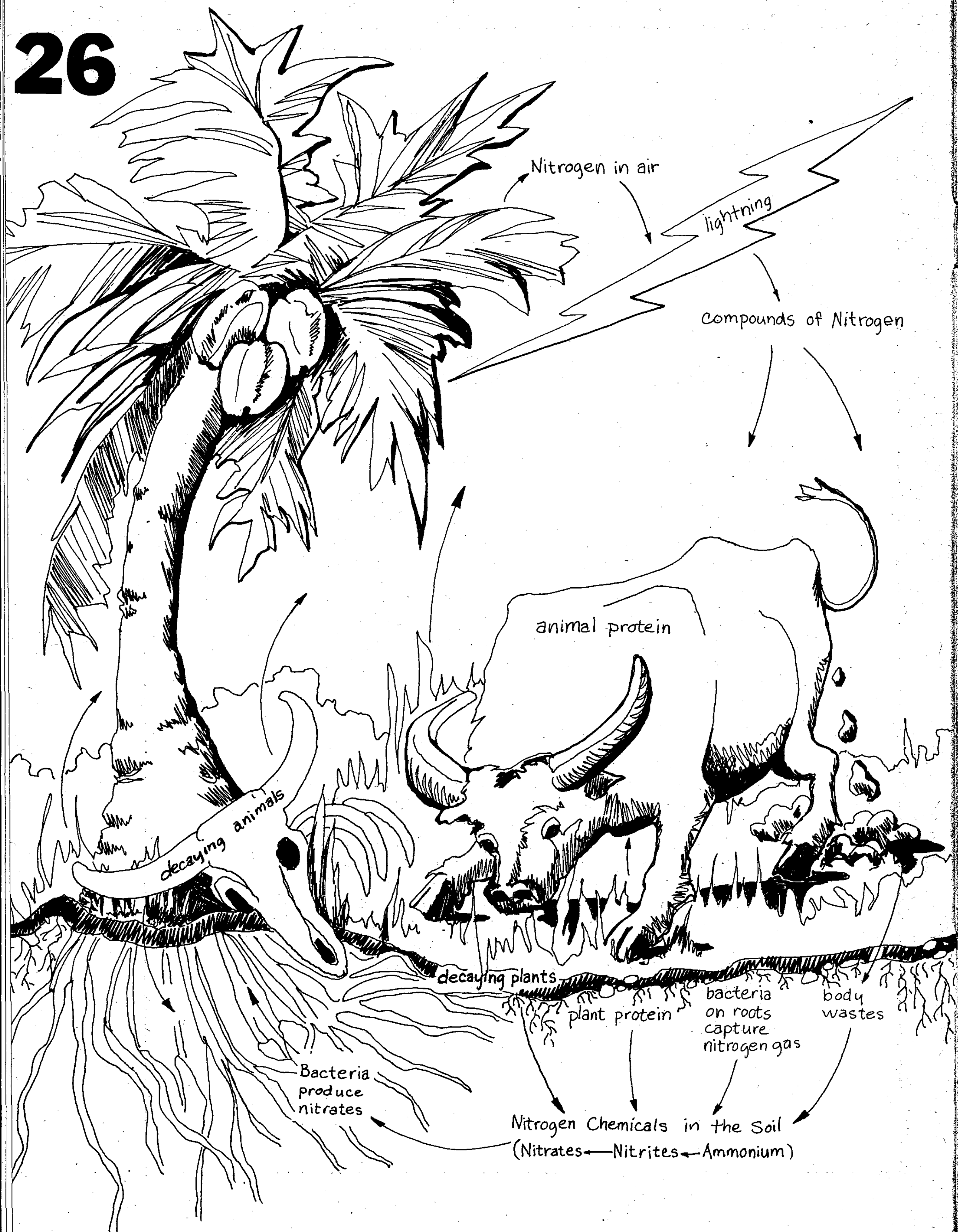
In forest soil, especially in the top humus layers containing decaying inorganic matter, ammonia is often the most abundant available form of nitrogen.

In soils (see Nitrogen Cycle below), nitrites are formed as an intermediate step in the production of nitrates. In adequately drained and aerated soils nitrites are found in very small amounts. A high count of nitrite would reveal a soil condition unfavorable to the formation of nitrates, and toxic (poisonous) to many plants.

On the other hand, soil test results showing the presence of nitrates indicate soil which is likely to be suitable to plant growth—if there are other required minerals and if the nitrate concentration is not too high.

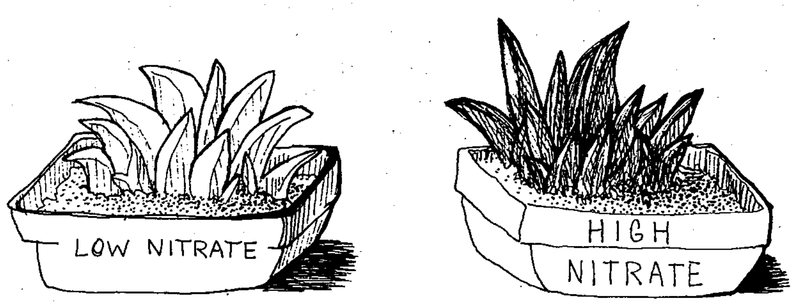
MATERIALS:

Notebook and pencil.
Soil test kits (for example, Model EL Soil Test Kit, Code No. 5679, available from LaMotte Chemical Co., Chestertown, MD 21620, or Hach Chemical Co., P. O. Box 907, Ames, IA 50010), 8 per classroom.
Flower pots (2 or more) or milk cartons.
Shallow bowls or pans for pots (2 or more).
Bean seeds—garden seeds are best, but dry, uncooked beans from the grocery store produce about 50% live seedlings.
Plastic bags for soil samples.
Fertilizer.
Schoolyard map.


Nitrogen in air
lightning
Compounds of Nitrogen
animal protein
decaying animals
decaying plants
plant protein
bacteria on roots capture nitrogen gas
body wastes
Bacteria produce nitrates
Nitrogen Chemicals in the Soil
(Nitrates←Nitrites←Ammonium)

ACTION:

1. Obtain samples of soil from a variety of places, such as the open playground, under a tree, under a water spout, around a garbage can, and others.
2. Be sure to label all the soil samples you get.
3. On your school map, number the location of each spot you sampled. Be sure also to sample soil from your Study Plot.
4. Note down the types of plants growing in the areas sampled. Try to select a variety of soil types — sand, clay, etc.
5. Test the soil for nitrate. Discuss with your group the relationships you see between soil nitrate and the other things you notice about your sample areas.
6. Select an area whose soil is poor in nitrate and an area whose soil is rich in nitrate, according to your tests. Get enough soil from each test area to fill two pint-size milk cartons.



If none of your soil tests low in nitrate obtain some sand from your teacher and use the sand as a low nitrate soil. If on the other hand your soil does test low in nitrate, add a small amount of fertilizer (¼ teaspoon) to one of your soil samples.

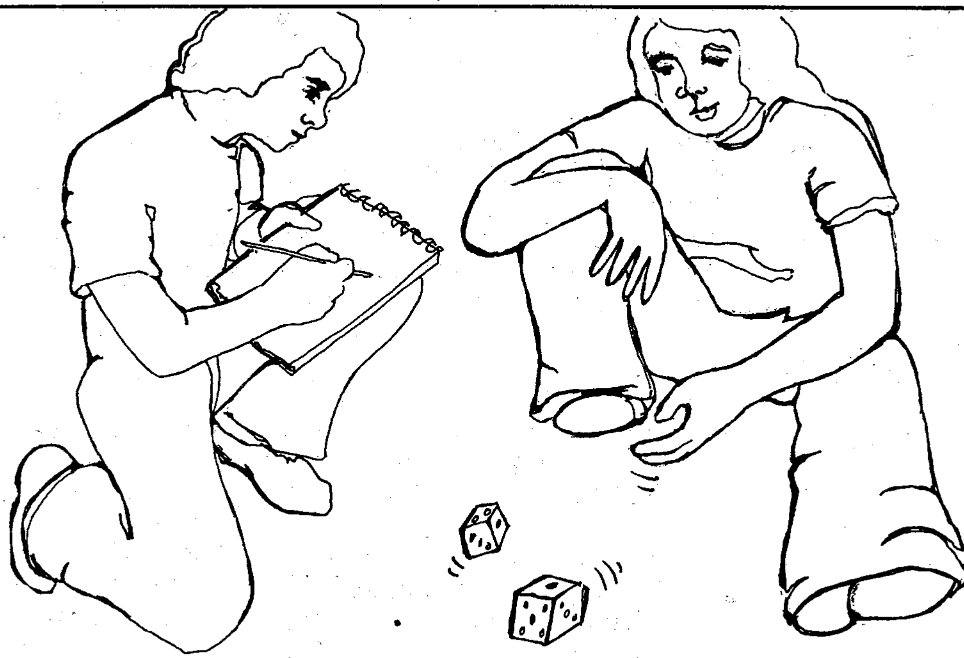
Plant the bean seeds (3 to each carton); add water twice a week. Once the seeds have sprouted measure the seedlings daily and record the data on a chart like the one below. Be sure to record any color changes in your plants — look closely! After 3 or 4 days remove the weaker seedlings so that only one remains in each container. Carry out the rest of the experiment using these two plants.

Plants and Soil Nitrates

Day	Low Nitrate Soil		High Nitrate Soil	
	Color	Height (cm)	Color	Height (cm)
1				
2				
3				
(etc.)				

FOLLOW-UP AND QUESTIONS:

1. In your notebook make a graph of your data. Label the horizontal axis 'Number of Days' and the vertical axis 'Height in cm'.
2. What conclusions can you reach from the data in your graph?
3. If you were a farmer and noticed a field where your plants were not growing well, what would you do?



ACTIVITY SIX: EENY, MEENY, MINY, MOE....

BACKGROUND JIVE:

Random sampling, done by random selection, is used to count populations which seem to be scattered haphazardly with no particular pattern or arrangement. (Do trees planted on your schoolyard appear to be randomly scattered?) Samples are taken from locations chosen by random selection. In Activity Two you learned how to use one form of random sampling, the quadrat-transect method.

In random selection, every spot in an area has the same chance of being selected as every other spot. This random selection prevents the data collector (researcher) from choosing sites which might favor the results he hopes to obtain. Random selection can be done in any way which prevents human bias from entering into the choice of sampling areas.

OBJECTIVES: By the end of this activity you should be able to:

1. List three randomly distributed populations in your schoolyard (if there are any).
2. List three non-randomly distributed populations in your schoolyard.

3. Make up at least one method of your own to randomly sample one of these populations.
4. Make a definite statement to your class and teacher regarding the distribution of the population you chose.

ACTION:

1. Here are two ways to make random selections for sampling a randomly distributed population:

   a. Stand in a field with your eyes closed. Turn around some, and while turning throw a colored object (rubber ball, pencil, etc.) in any direction. Whereever it lands becomes the center of a quadrat.
   b. Place a grid over a map of the schoolyard and number each square. Throw dice or pick numbers out of a bag to decide which grid squares will be sampled.

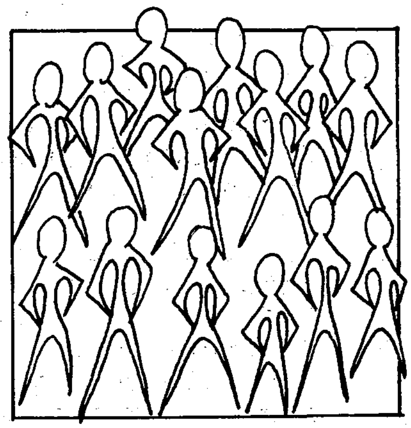
2. Devise at least one sampling method of your own.

3. Choose a population from the total area of the schoolyard to study.

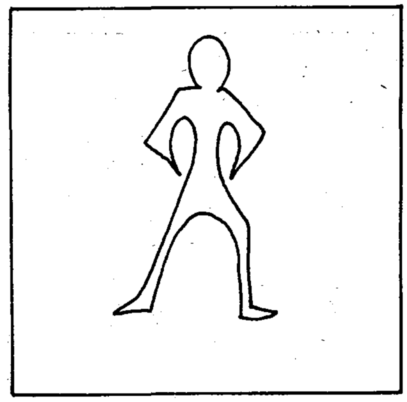
4. Count the numbers of organisms at each of the sampling sites chosen using the method you invented.

5. What is the distribution of your chosen population? How can you be sure you are correct?

NOTE: Be sure to record the data you collect. It will be used in the next activity.



Density = 14
Frequency = 100%



Density = 1
Frequency = 100%

ACTIVITY SEVEN: DENSITY AND FREQUENCY OF ORGANISMS.

BACKGROUND JIVE:

We introduced the term 'density', referring to number of organisms present, in Activity Five. Now we'll use another ecology term, 'frequency', indicating the percentage of sample plots containing a given organism.

Using sampling techniques, the density of a population can be estimated by dividing the total number of organisms found by the number of plots sampled. This results in a kind of average:

Total organisms in all plots sampled	÷	Number of plots sampled	=	Density

For example, the following diagram represents a field of castor bean plants. Notice that the population seems to be scattered randomly throughout the field. To sample the population, the field was marked off into quadrats of 1 m^2. Each quadrat was assigned a number for identification.

Quadrats to be counted were selected at random by drawing numbers out of a hat. In this case, quadrats 2, 4, 7, 10, 13, 16, 17, 20, 23 and 25 were selected.

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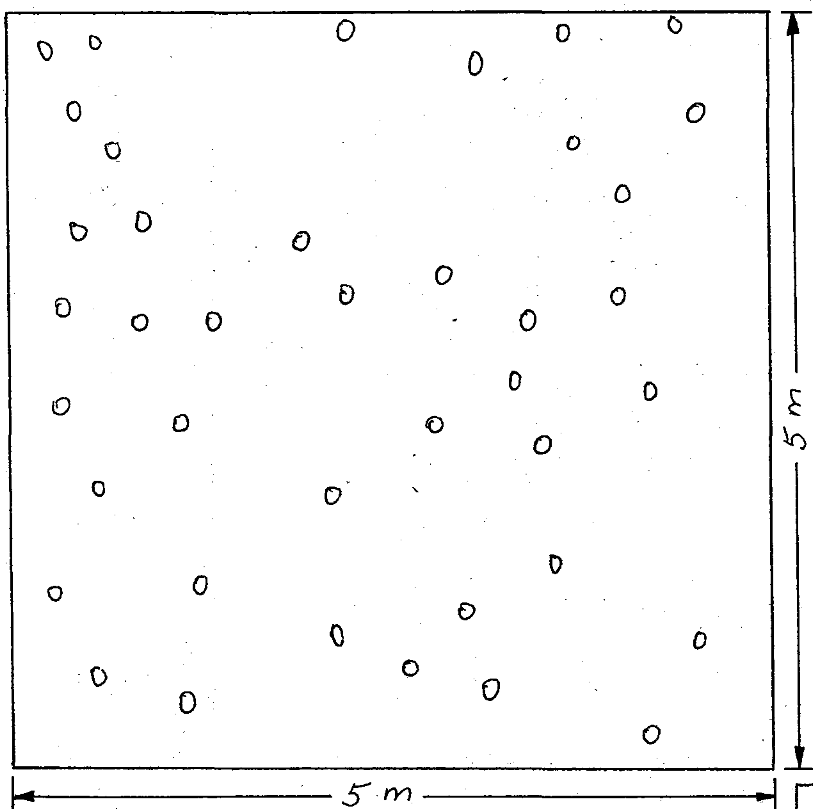
CASTOR BEAN PLANTS IN A FIELD OF 25 SQUARE METERS



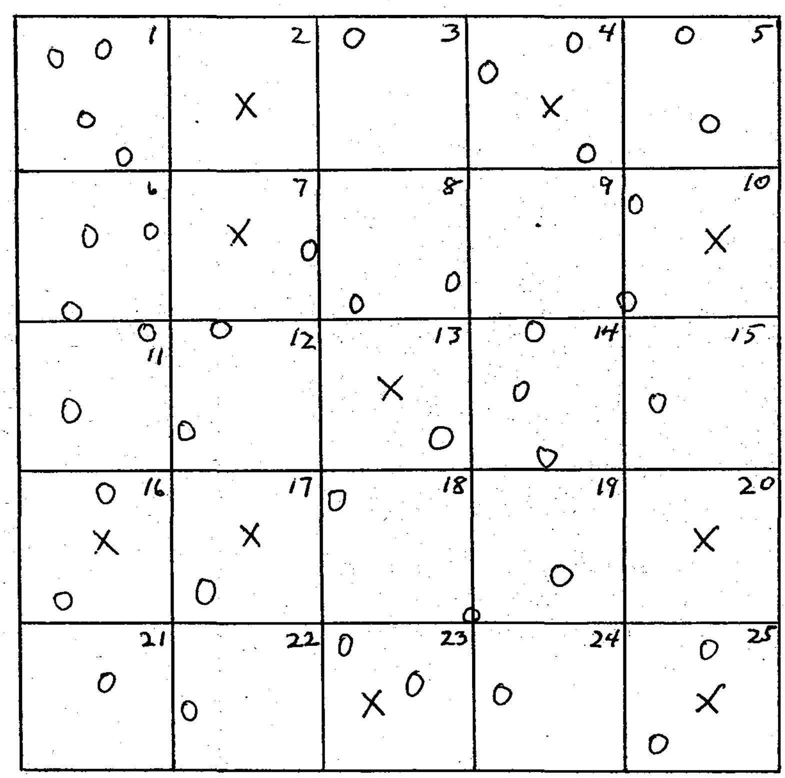
1. The castor bean plants are randomly distributed in the field.

2. The field is marked off into quadrats of 1 m^2.

3. Quadrats to be sampled are selected by drawing numbers from a hat.

4. Density and frequency are determined as shown in the table.

(Count any plant within a quadrat or touching its lower or right-hand boundary line, e.g., for quadrat 7, 2 plants.)



Quadrat Number	Number of Plants Counted	Present (+) Absent (–)
2	0	–
4	3	+
7	2	+
10	1	+
13	1	+
16	2	+
17	1	+
20	0	–
23	2	+
25	2	+

Total castor bean plants counted (14)	÷	Number of plots (10) sampled	=	Density 1.4 (castor bean plants per m^2)

OBJECTIVES: By the end of this activity you should be able to:

1. Determine the density of your chosen population.
2. If given the necessary data, calculate the density of any population.
3. Calculate the frequency of various organisms in your study plot.

ACTION A:

1. Using the method you "invented" to sample a population in the previous activity, calculate the density of the organisms you counted. Hint - humans are also organisms. See if you can do a study of the types of students that "hang out" in certain areas of school. Think in terms of age, sex, ethnic background, religion and any other categories you can.

2. Prepare a report on your results and present it to the class.

Frequency

Frequency refers to the distribution of organisms in an area, and is expressed as a percent:

Number of plots with organisms	÷	Total number of plots sampled	x	100	=	__% Frequency

In determining the frequency of organisms in an area, we are not concerned with how many organisms there are in each sample plot. The only data taken for frequency measurement is whether the kind of organism is present or absent in the sample plot.

For example, in the field of castor beans just examined, the same quadrat system can be used to determine frequency.

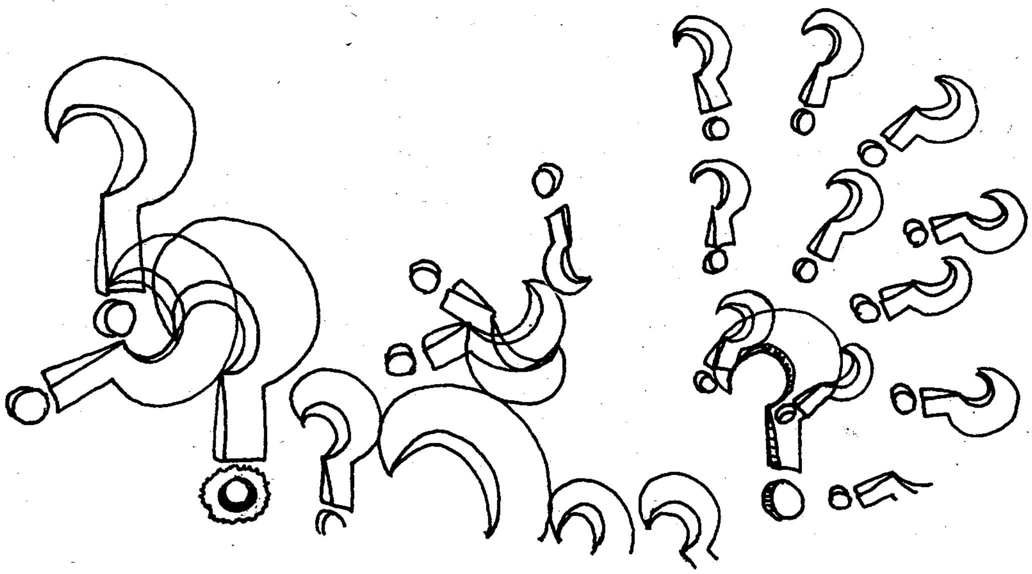
We sampled 10 of the 25 quadrats. Castor bean plants were present in 8 of the 10 sample plots.

Number of quadrats with castor bean plants		Number of quadrats sampled				Frequency of castor bean plants
8	÷	10	x	100	=	80%

In order to validly compare frequency, all quadrats must be the same size.

ACTION B:

1. Calculate the frequency of organisms for the previous activity and incorporate the data into your report to the class.
2. Can you make any conclusions regarding the frequency of the variables investigated?



ACTIVITY EIGHT: IT'S YOUR TURN TO BAT!

Throughout this unit we have been concerned with sampling your study area and investigating various factors within it. You are now ready to conduct a study of your own involving your group's Study Plot. Below you will find a list of materials— some with instructions for use, and some without.

OBJECTIVES: By the end of this activity you should be able to:

1. Use the available materials and the concepts you have learned from Activities 1-7 to design and carry out an investigation of your own. You may make mistakes and we hope you will have a thousand questions. Good! That is the whole idea behind scientific research— the more questions you ask the more answers you will get and the more you will learn about yourself and your environment.

2. To start, ask yourself, "What is it that I want to find out about my own study plot?" Make a list of the questions you want to find answers to. When you have conducted your study your group will write a final report. Use the following format.

S A M P L E

Report Format

1.0 Statement of the Problem:

How can the distribution of very very small animals in a study plot be determined?

2.0 Methods and Procedures:

Describe how you intended to gather the data to answer the questions you asked yourself and how it actually was done.

3.0 Materials:

Notebook and pencil
Graph paper
Berlese funnel (see next page)
Magnifying glass
Alcohol
String
Lamp w/100 watt bulb
Small glass or jar
Ring stand
Plastic bottle (clorox or other)
Small plastic bag
Index cards
Paste
Anything else
you think you
will need.

4.0 Collecting the Data:

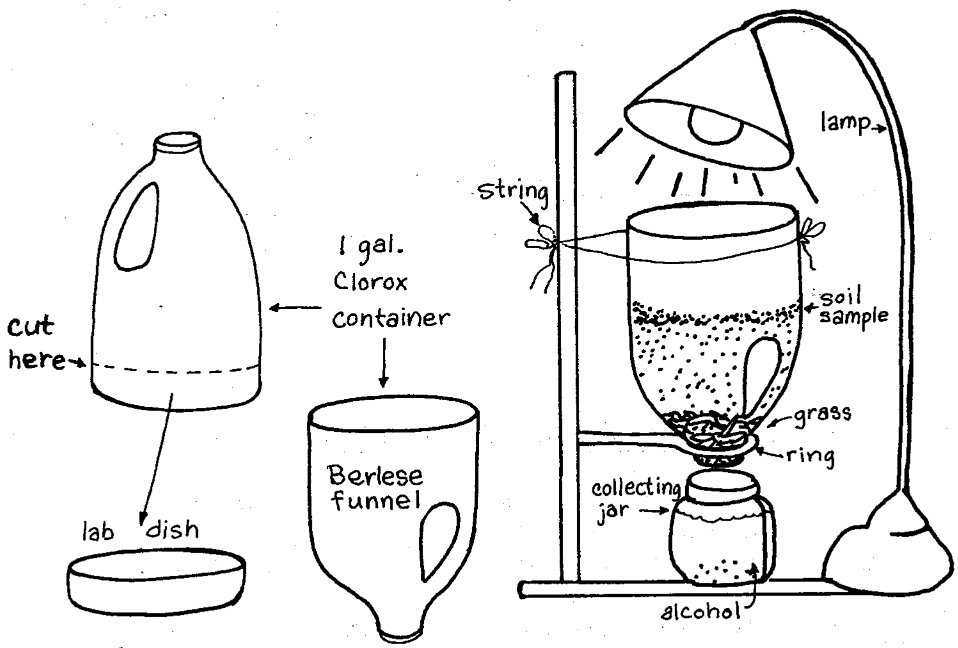
Data - This should be a summary of the information collected and should include summary data sheets, charts, graphs, etc.

5.0 Results and Conclusions

What can you say about answering the problem (1.0) in relation to the data collected?

Directions for Using the Berlese Funnel:

To take a sample of the tiny animals in any soil, use the simple Berlese funnel shown.



Samples should consist of soil taken down to a depth of about 20 cm. In principle, as the light source heats and dries the soil, the inhabitants are driven progressively deeper until they fall into the collecting jar of alcohol. Placing a small bit of 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.

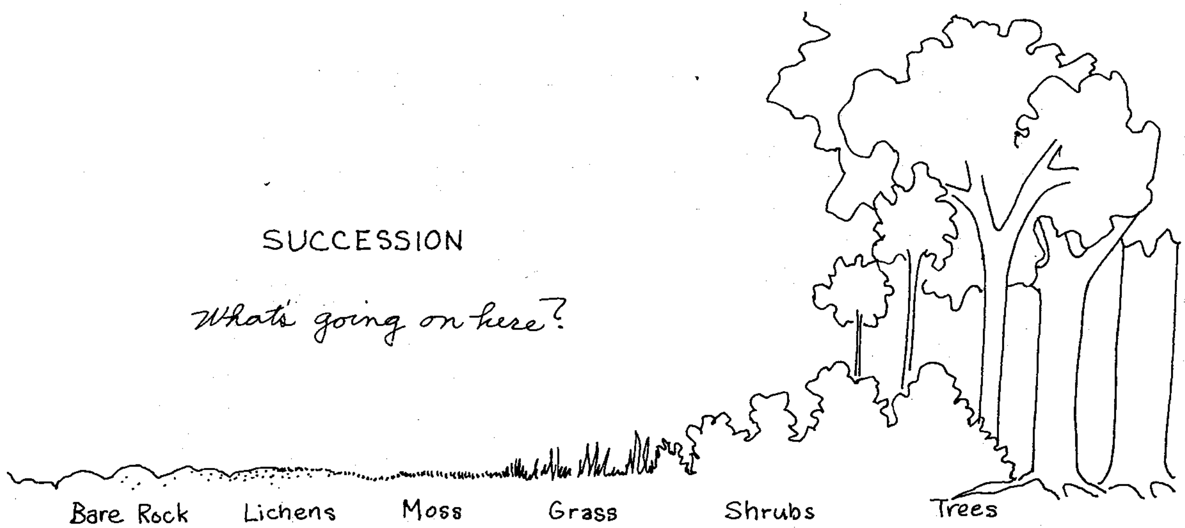
Sort the preserved animals and count them. Dry the specimens or samples of them and paste them on the index card.

Save a sample of soil type in a plastic bag and attach it to the animal charts.

Compare the samples taken from different locations with those of the other groups.

SUCCESSION

What's going on here?



ACTIVITY NINE: SUCCESSION IN A STUDY PLOT

This activity will take several weeks. For the next two months observe your study plot every week and record any changes that take place.

OBJECTIVES: By the end of this activity you should be able to:

1. Define 'biological succession'.
2. Describe the changes that take place over a period of time in a sample disturbed environment.

BACKGROUND JIVE:

Events that clear an area of existing organisms provide the conditions from which succession starts. For instance, about 10,000 years ago in the mountains of Colorado, the glaciers melted away leaving the area ready for new plants and animals to come.

Floods, fire, typhoons and volcanic eruptions may also denude large areas, starting new chains of succession.

Usually the first plants to grow in disturbed areas on Guam are those having windblown seeds. Next, plants such as grasses, sedges, and the "Guam daisy" (beggar's tick, *Bidens pilosa*) come along. Not far behind these are papaya and tangantangan.

Probably papaya "trees" are brought in by pigs which eat the fruit and scatter the seeds with their droppings. Man, dogs and other animals also play an important role in succession. The diagram below is one possible type of plant succession on Guam, in areas recently denuded.

GUAM SUCCESSION MODEL:

Windblown seed plants ⟶ succeeded by ⟶ grasses, sedges, beggar's ticks

followed by ⟶ papaya, tangan-tangan and finally ⟶ pandanus, breadfruit, ifil (the climax community)

MATERIALS:

- Notebook and pencil
- Data chart
- Study Plot map
- Spade, shovel, or trowel

ACTION:

Using the shovel "plow" up ¼ of your study plot. Make sure no plants are left growing in this section of the plot.

On a Data Chart like the one below, record the date the plot was "plowed". On a bi-weekly basis (twice a week, preferably Monday and Friday) record your observations. Make sure you also indicate on some type of map the location of any new growth that occurs. Continue your observations for at least two months. Be sure to indicate prominent environmental factors of your study plot, i.e. north-south indicator, whether your plot is shaded for part of the day or in open sunlight, location of buildings, trash cans, etc.

Beginning Date ____________
Environmental Factors:

Observation No.	Date	Rain	Growth Observations

ACTIVITY TEN: HOW COULD YOU IMPROVE YOUR SCHOOLYARD?

BACKGROUND JIVE:

In the introduction it was mentioned that all buildings, regardless of their size, have at least one thing in common, a recently disturbed environment. Of course, some buildings are older than others and the natural process of succession as well as man-designed planting schemes of landscaping tend to replace what man removed while constructing the building. The same applies to schools and schoolyards.

Usually when a new school is begun the contractor prepares the site for construction with scant regard for the environment. Centuries' worth of rich topsoil and trees are scraped away, and shrubs and other vegetation are knocked down. If this practice was confined only to the space to be occupied by the building it would be all right. More likely than not, however, an area considerably larger than the school building is also stripped bare of topsoil and vegetation. Soil and gravel are purchased to backfill the site. Afterwards, when the building is completed, landscape artists are called in to plant trees, flowers and shrubs with little thought given to natural growth patterns of the plants.

Why don't contractors preserve the natural environment when building a new school, or new hotel? Part of the answer lies in economics.

It is quicker, therefore cheaper, to level a site, backfill, and then let someone else worry about landscaping.

One outstanding example of construction on Guam in which the contractor gave consideration to the environment is the Continental Hotel. When completed, it provided very little work for a landscape artist, because only those trees growing where buildings were planned had been removed. The rest were left nearly in their natural state.

OBJECTIVES: By the end of this activity you should be able to:

1. Make a list of environmentally planned construction on Guam.
2. Produce a landscaping master plan for your school or other public building on Guam and present your plan to the Government for consideration.

ACTION:

On your own or with your group prepare a list of buildings on Guam that use the natural environment as a part of the landscaping scheme. Compare your list with other groups. As a class discuss the lists and prepare a final class list of environmentally planned construction.

Your schoolyard may already be landscaped. If not, prepare a master plan for landscaping it using as many local plants as possible. If your school is landscaped, look for ways in which the planting can be changed or added to, to improve the surroundings.

QUESTIONS:

1. How can you tell if a building has used the natural environment to advantage?
2. Is your school's landscaping man-made or natural? How do you know?
3. Find out what steps are being taken by the Government of Guam to beautify the Island.

Appendix

SUGGESTED EQUIPMENT LIST IN ORDER OF APPEARANCE

Notebook and pencil
Large piece of paper (about 0.75 m x 1.0 m)
Magnetic compass
Colored pencils, pens or magic markers
Model Population Sheets I, II, and III, (in Text)
Paper clips
Data sheets
Graph paper
Quadrat markers (30 cm x 30 cm square)
Wooden stakes
Hammer or rocks for driving the stakes
Meter stick
String
Paper cups
Litmus paper
Distilled water
Baggies or other plastic bags
Soil test kits
Bean seeds
Flower pots (Milk cartons)
Plastic trays or other shallow containers
Fertilizer
Berlese-type funnel (plastic bottle)
Ring stands
Alcohol
Small jars
Lamp
Hand lens (magnifier)
Index cards
Paste
Shovel or trowel