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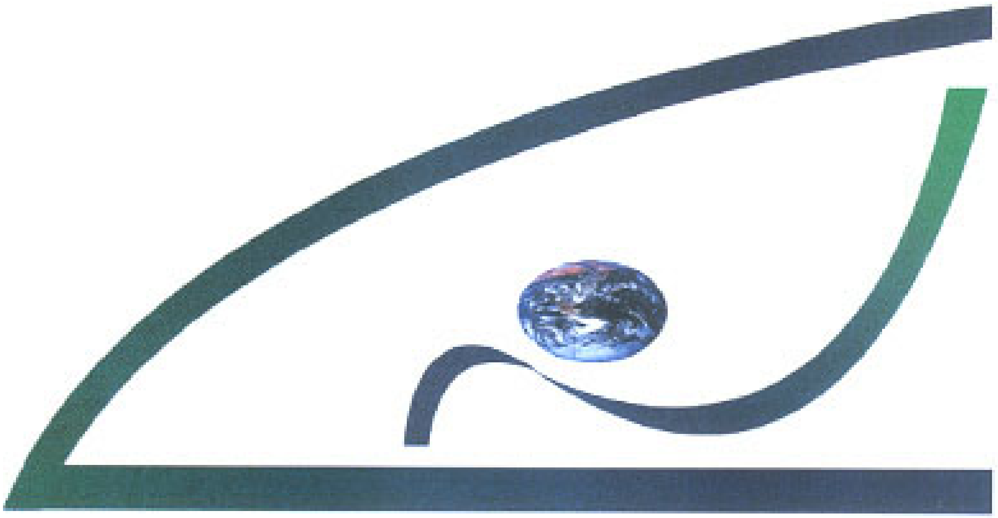

COMMUNITY BASED BIOLOGY

By
Anthony J.F. Griffiths

UNESCO IUBS BIOLITERACY SERIES N° 1

IUBS
Commission for Biological Education (CBE)

UNESCO
Programme on Science and Technology Education

Community-Based Biology

UNESCO-IUBS Bioliteracy Series N°-1

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PREFACE

This publication on "Community Based Biology" represents the first issue of the Bioliteracy Module Series developed in collaboration between the IUBS Commission for Biological Education and the UNESCO Programme on Science and Technology Education.

The rationale for bioliteracy stems from the social, cultural and economic changes occurring as a consequence of scientific discoveries and technological inventions in the domain of biological sciences. Bioliteracy, by emphasizing personal development, aims to promote biology education as an important contributor to the welfare and sustainable development of human society. The personal development aspect recognises the possibilities within biology curriculum to enhance students' personal skills in logical thinking, expression, personal management, self-directed learning, co-operation and responsible action. This demands more attention to teaching children how to learn, manage their own learning, analyse problems, as well as design and implement solutions.

Despite the fact that our planet's essential goods and services depend on the variety and variability of genes, species, populations and ecosystems, and that biological resources feed and clothe us and provide housing, medicines and spiritual nourishment, the development and consumption patterns of people in urban and rural areas are severely stressing the global ecosystem. There is a need thus, to provide people, young and adult, with the capacity (basic knowledge, attitudes and skills) to change behaviour in favour of a more sustainable manner of living.

Following the present issue on "Community Based Biology," future modules of the Bioliteracy Series will address the important topics related to development, environment, society and citizenship. Such topics will include bioliteracy for health, new therapies and emerging diseases (Gene Therapy, Prion diseases, etc.); Bioliteracy for Sustainable Development, Biodiversity, and Carrying Capacity; Bioliteracy on Genetically Modified Organisms and Genetically Modified Food; Bioliteracy and Creative Learning and Memory for Life, Biology of Emotion, etc.

The authors of the Module Series are prominent biologists and biology educators, members of the IUBS Commission for Biological Education (CBE), from a large number of countries in both the industrialised and developing countries. A variety of approaches and methods were used in the development of the modules, reflecting the authors broad range of expertise, and natural and cultural environments.

Learning to understand basic concepts and principles of Biology through participating in Biology-related activities with special emphasis on the community's environment will undoubtedly help provide people with basic ecological knowledge and a wider understanding of the environment as a whole. In this connection, the overall intention of the module is to provide opportunities and encourage activities aiming at achieving basic biological knowledge and skills in the young and adult population.

The module is meant to be used cooperatively by teachers, parents and pupils, teacher-trainers, science clubs, and leaders of youth organisations. It is intended to be a sample model adaptable to different systems, settings and environments and we hope that the users will provide useful feed back for improving its utility. We see this endeavour as a splendid opportunity to make a real and ongoing contribution to promote bioliteracy for the betterment of human life.

Orlando Hall-Rose
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OBJECTIVES

This module links biology to the community. It is designed to counter the fact that biology is often presented to a child as "book science," something that other people have thought about and done. Although many children find this interesting, they often cannot see the connections to their own lives. They see science as a specialised, "difficult" activity done by the mysterious "they," and as a result do not see biology as a worthwhile activity for themselves, or the possible career connections.

The module presents a set of interesting hands-on activities related to the biology going on in the child's neighbourhood. Most activities are designed to be cooperative ventures between parent/teacher and child. As in any type of education, children need the encouragement, advice and prompting of an adult, but it is important that children do as much of the activity as possible. These activities are mostly relatively long-term projects, which by their length promote good scientific habits involving patience, persistence, careful observation, recording and interpretation of results.

INTRODUCTION FOR EDUCATORS

Biology is for everyone

Biology is something everyone can do. It is not restricted to professional scientists, who earn their money that way. The science of biology is simply trying to understand the living world around us through the application of logical thought and investigation.

All science stems from curiosity about the world we live in. Curiosity raises questions, and the questions lead to actions to gather the information we need to try to answer these questions. These actions can be experiments, or simply careful observation and recording. There is no requirement for being "smart." All that is needed is a desire to find out.

There is no such thing as being right or wrong in biology or in any part of science. In science any idea is acceptable until it is knocked down by some new observation or experiment. Hence an important part of science is to let your mind wander and come up with an idea based on your observations, and then go on to explore and test that idea. Equally important is the acceptance of the fact that your idea might get disproved tomorrow.

Science is interesting in itself, but the thought processes used in science are transferable to other walks of life. People who are used to thinking scientifically about the world they live in will also ask questions about philosophy, politics, art, business and ethics. These are skills important to any thinking member of society.

The scientific approach to life can lead also to imagination and inventiveness, qualities in high demand in the job market. Therefore these types of generic aptitudes and attitudes are just as important as job-specific skills.

Science needs a context

This module links biology to the community. Biology is often presented to a child as "book learning", something that other people have thought about and experimented on. Although some children find this interesting, others cannot see the connections to their own lives. They see science as a specialized "hard" activity done by the mysterious "they," and as a result do not see biology as a worthwhile activity for themselves, or the possible career connections.

Our module is based on the belief (for which there is good educational basis) that children start questioning the world around them from an early age, and that their initial interest is in their immediate environment, which we collectively call the community. The community consists of concentric circles centred on themselves, and includes their own family, their home, their pets, their friends, their garden, their street, their neighbourhood and their town.

The community provides an ample supply of fundamental questions that form the context for a sound footing in biology. Questions like "What tree is that?" "How do these animals find their food?" and "Why are there weeds here and not over there?" are key parts of a child finding out how they relate to the rest of the world they live in.

Being a biologist is not necessarily a career, but a life-long learning experience

We believe that science is not an activity that can be turned on and off. The questioning and exploring attitude of science is always part of our day-to-day existence. Through inquiry, we are always learning. Some people have tried to characterize our present global society and its economy as information-based, but we believe that in reality it is learning-based. Those who are lifelong learners will always be able to adapt their personal lives and their careers to the conditions at hand.

Science, and biology in particular, is often presented to young people as short capsules of "magic tricks" that can be done in a brief period of time. These activities are fun to do, but rarely do they make a strong connection with the scientific disciplines involved in the activity. Hence the child sees them as a series of untethered and unconnected experiences with little or no context.

Because most of biology is not "golly-gee" or "whizz-bang", many of the activities in this book are relatively long term, requiring hours, days, weeks or months to complete. This is all part of the idea that science is an ongoing learning activity. Rewarding insights do not always come easy. The key is to develop good learning habits, which require careful observation, reflection and patience over the long run. Only in this way is it possible to develop an awareness of our common environment, its wonders and its problems.

ACTIVITIES

1. Most activities are designed to be cooperative ventures between parent/teacher and child. As in any type of education, children need the encouragement, advice and prompting of an adult. Having said that, it is important that the child do as much of the activity as possible. The doing part is just as important as the results.

2. The child must never be criticized in this; only positive feedback is allowed. Suggestions must be couched in a positive way such as "Do you think so-and-so might work?" Never, never take the specimen, pencil, or anything away from the child and do it yourself. The child must be allowed her/his own successes and failures.

3. Many of the activities are low key, and this is intentional. Things like drawing, collecting, describing, and comparing plants and animals are basic things that biologists actually do. These low key activities focus the mind and from them come the ideas or the inspirations. Don't get hung up on identifying plants and animals with their proper names. This will come in time; the main thing is to get to know them - call them whatever you want. Too often people are put off science by its "official" side. This is important for professionals, but not for kids.

4. The activities involve a mix of the life forms that are most relevant in the child's exploration of the living environment.

5. Most of the activities can be done anywhere in the world. People living in urban settings can do many community-based biological activities, and there are many examples of these in the list.

Basic requirements

As far as possible we have stayed away from specialized equipment. Most of the projects can be carried out with materials easily accessible around the home. One possible exception is a hand lens or magnifying glass, which can provide an inspiring new view of the miniature world of life.

You can spend a fortune on reference books - so don't! Most are handy at your local library. The Internet is also a useful source of reference materials.

This module is based on the belief that few experiences in life are as rewarding as sharing the discovery of the natural world of plants, animals, and microbes with a child. We hope our activities will help you along this road. Our activities are only suggestions; in time you and your child will surely come up with better ones of your own.

List of activities

All of these activities are meant as suggestions; they can be modified or extended as appropriate to the local setting.

1. Observing birds
2. Ecosystem in a jar
3. Pigeon diversity
4. Weed watching.
5. Tree charting
6. Measuring plant growth
7. Making a plant collection
8. How the human body grows
9. Mushroom spore prints and beyond
10. Observing and recording animal behaviour
11. Snail population biology
12. Fungal succession on manure
13. Tree girths - a population study
14. Colonization of rock surfaces under water.

1. OBSERVING BIRDS

What it's all about

For most children, birds are the most easily accessible wild animals. They provide a wonderful opportunity for children to be inspired by watching nature. Observing birds allows children to engage in studying and recording animal activities in a scientific manner. Bird watching provides children with opportunities to study bird behaviour patterns, classification, adaptation and ecology. For many children, birdwatching becomes a lifelong enriching experience.

What you will need

1. Some basic household materials for building a bird feeding station; perhaps some wood, if you like to try some simple carpentry.
2. If possible (but not essential), a pair of binoculars, a recording journal, and a bird book.

Getting started

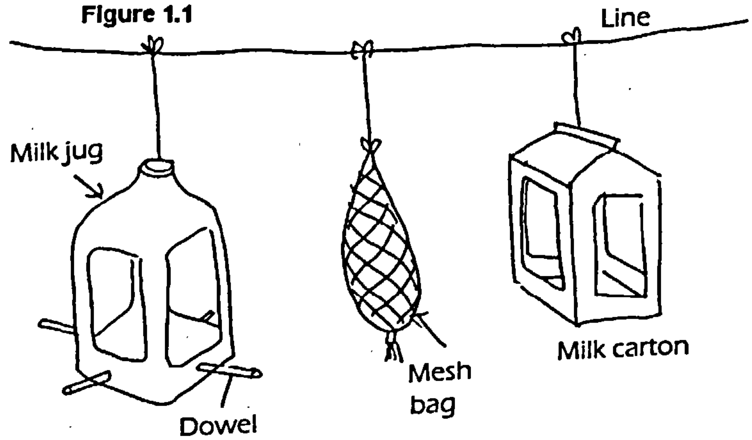
A good time to start this project is in the autumn when food gets scarce for the birds. If you feed the birds regularly, they will make your home part of their daily circuit throughout the winter and summer.

Begin by helping your child make a birdfeeder for your garden or veranda. You can make a feeder from a milk carton/jug, scraps of wood, or other simple materials (see the Figure 1-1 and 1-2 for some simple design ideas). Try to let your child do most of the work in making the feeder. You can assist with the difficult parts, or intervene if the child asks for help. It is much better for your child to make a feeder than for you to go out and buy one. By involving your child in the design and building of the feeder, s/he will have a greater interest in carrying out the project.

Hang the feeder from a line in a place where it can easily be seen from the house/apartment. Be careful to put it in a place where cats or other predators cannot get at it. Have your child suggest ideas where to place the feeder so that it is out of the reach of predators. Squirrels are sometimes a problem, too, and you might need to put up squirrel barriers (once again, ask the child for suggestions).

Commercial birdseed and blocks of suet can be purchased from a pet or hardware store. Alternatively, you can use kitchen scraps or stale bread crumbs. Try to get the child into the habit of putting food out each day.

Figure 1.1



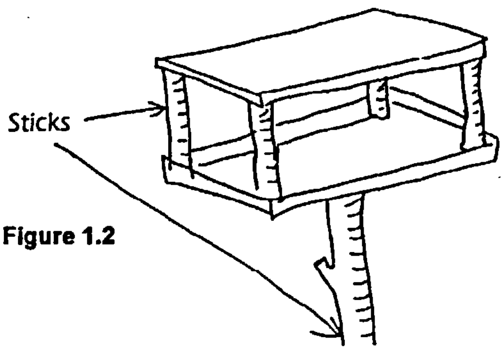


Figure 1.2

Starter activities

1. Give the child a notebook to record observations. (Or make a notebook together.) This should be stored safely and used like a diary, with each observation dated.

2. Observe the activities at the feeder. Start with simple questions like "How many different types of birds visit our feeder?" "How many of each type are there?". Record these numbers each day. Using a bird guidebook, try to identify the birds. You can also get your child to do simple drawings of the birds that visit. Point out that this is one way that scientists record data, and that when recording scientific data, artwork need not be perfect. (A bird diary with drawings can become a magical possession.)

3. Invite your child to make observations at different times of the day. Review the daily entries with your child and ask him/her and if there are differences in the numbers of birds that visit on different days, or at different times of the day. Encourage him/her to make educated guesses on the possible reasons for any differences observed.

4. Note the weather at the time of each observation, and invite your child to see whether s/he can see any relationships between the types of birds that visit and the weather.

5. If you have friends or relatives in different parts of the region, try to make this a shared study. Compare notes on the types of birds that visit in different geographic areas.

6. Have your child look for specific bird behaviours such as bird squabbling. Do birds of the same type squabble or fight? What are the outcomes of squabbles? Do birds of different types squabble? Is the outcome always the same? Do birds ever hurt each other during their squabbles? Is there different behaviour between adults and young birds? Can you identify mating behaviour? Appeasement rather than hurting or killing is often the outcome of animal conflicts: can you identify appeasement behaviour?

Taking it further

1. Start experimenting:

a) Have your child place different types of foods in piles or dishes to see which are preferred by each type of bird. Invite your child to compare food preferences with the different types of beak and/or body size.

b) Make several feeders and put them at different heights . Observe which feeder is the most popular with each type of bird. Compare this preference with the type of feet the birds have to see if there is any relationship between the type of feet and the height of the feeders.

c) Record where the birds fly from to reach the feeder (fence, bush etc.) Make a map showing these sites in the notebook and measure distances. Then provide some new perches closer to the feeder (branches, posts etc.) and see which are preferred.

d) Provide different types of feeders (different sizes, openings, with or without perches, etc.) and observe which works best for each type of bird.

2. Help your child to photograph the different birds that visit. Compare the photographs to the pictures in the birdbook. Look for similarities and differences.

3. Try recording bird calls on an audiocassette. Invite your child to match the bird calls with the various birds. Ask the child to try imitating them to "call" birds. (Some stores stock *inexpensive bird-calling devices. You might want to consider purchasing one.)* Have your child experiment with these calls in the yard or when you are going for a walk in the neighbourhood or in the park. See if the calls make the birds pop up out of the bush to take a look at you.

4. Take a birdwatching walk or hike. Early morning or late afternoon is usually best for birdwatching. Also try looking at water birds on the ocean or on a lake. All towns have birdwatching groups who welcome newcomers and novices (especially children). You might want to consider joining one.

5. Try making a bird nesting box before the nesting season (generally the springtime). Birds like a small (20x15x15cm) waterproof box placed up high where there is little likelihood of disturbance by predators. Different sizes of entry hole are favoured by different types of birds; try holes of 3, 4 and 5cm in diameter in different boxes. Record which birds investigate the box, which make nests, and the dates of these activities. If baby birds appear, count them and record their relative successes in learning to fly, weight gain etc.

6. Try making a bird bath. This is just a flat tray of any diameter containing less than 3cm of water to avoid drowning. As with the other items, it should be place where cats and other predators cannot get to it. Activities involve observing behaviours in the water bath (drinking, bathing, grooming and so on.)

7. There are various national scientific networks that actively solicit bird feeder data from amateurs. Check out this internet website: http://birdsource.cornell.edu/pwf/index.html

8. Buy your child bird books or binoculars at gift-giving times.

2. Ecosystem in a Jar

What It's All About:

Most people pass by ponds and ditches unaware that they are teeming with miniature life. The animals and plants that live in these small bodies of fresh water can easily be brought indoors. A whole new world will be revealed to your family - a world of interdependent creatures. Children are fascinated by these small pond creatures and will happily learn to identify and study small freshwater animals and plants for months.

An important biological idea is revealed in an aquatic ecosystem that you can set up at home. Below, you will find instructions on how to build such an ecosystem. This ecosystem is a miniature model of the Earth in that it has only one source of energy - the Sun. On Earth, all the energy that plants use to grow, reproduce and produce oxygen is supplied by the Sun. All life depends on plant growth and the oxygen that plants produce. In a similar way, the plant life in an aquatic ecosystem (both visible and microscopic) provides the energy and oxygen needed by the rest of the living organisms in the ecosystem.

Many communities contain small but rich pond ecosystems. Sadly, ponds are not valued much and are often seen as muddy nuisances. Ponds are being drained and lost all around the world. The reduction in the number of ponds is thought to be contributing to the world-wide decrease in frogs, newts and salamanders (animals known as amphibians.)

What you will need

• A large clean, clear jar such as a pickle jar, with a tightly-fitting lid. An extra large plastic soda or water bottle is also suitable, although a bit harder to fill.
• Water, bottom mud, and aquatic plants from a freshwater pond habitat. You can collect the materials in ice cream buckets and plastic bags. Scoop nets are useful for catching some of the larger aquatic beetles.
• Magnifying glass, magnifying sheet or hand lens.
• Journal or notebook for recording observations.

Getting started

Look for a pond or ditch the next time you and your child go for a walk. Forests and parks are good places to start. Get close to the surface of the water to see if you can see any organisms swimming around. You might want to dip a plastic bag in the water and look at what you bring up. A waterscope can be a useful tool for looking a pond life (see Figure 2-1). If you look closely, you should see small transparent creatures zooming around that you and your child can bring home to create your "pond." Most children will be thrilled at the idea. Some will express distaste, but if you persist with the idea, most children become fascinated by pond studies.

Figure 2.1

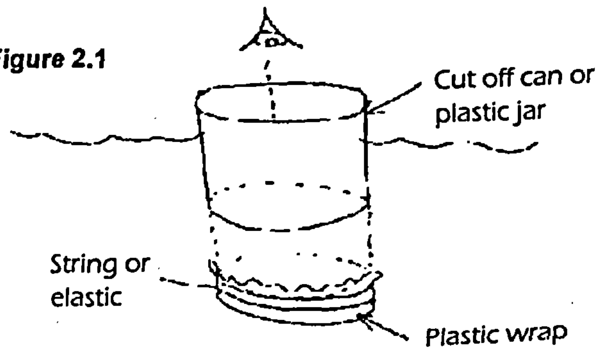
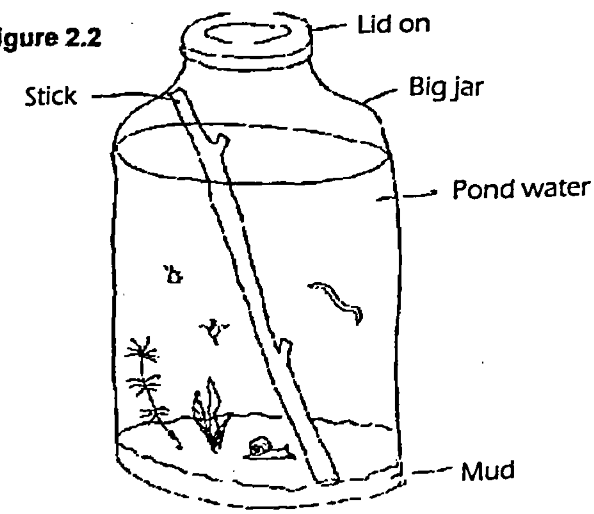


Figure 2.2



1. Look closely at the water before you begin to build your ecosystem. The water from the pond will be full of tiny creatures without backbones (called invertebrates), tiny plants (called phytoplankton), and bacteria. The bottom mud will be full of interesting larger animals, such as worms, leeches, snails, flatworms, an assortment of insect larvae and eggs that are hidden in the mud. If you use a magnifying glass or magnifying sheet to look at the plants and animals, you will be able to see greater detail. Encourage your child to identify as many organisms as possible and to draw pictures in a pond notebook.

2. Place 2 cm of bottom mud on the bottom of the jar. Then carefully pour the pond water down the side of the jar, taking care to disturb the bottom mud as little as possible. Fill the container about 3/4 full. You can add tap water if you don't have enough pond water. Get your child to plant a small quantity of the aquatic plants in the mud bottom. (They will grow rapidly.) Add a stick that is long enough to protrude out of the water when it is leaning against the side (see Figure 2.2). Ask your child to guess why you are putting this in. (It's to allow certain pond animals to crawl out of the water.) You can either invite your child to write down their guesses in their pond

notebook or explain to them the purpose of the stick. Don't be surprised if the water takes several days to clear after you have created your miniature ecosystem.

3. Seal the jar. This will prevent evaporation and ensure that this is a closed ecosystem in which the plants and animals are in balance.

4. Place the jar or aquarium in the shade; in the northern hemisphere an unshaded north-facing window is ideal. Do not put it in direct sunlight, as the heat from the sun will kill the animals. You will need to monitor the light conditions carefully to ensure that the ecosystem doesn't overheat and that it is getting enough light. Try not to disturb your ecosystem.

5. Look at the ecosystem every day or every other day so that you can see the changes in the populations of small invertebrates. Look at it at night too. Try shining a flashlight in the side. Some animals get more active at night.

6. Use the magnifying glass to examine the organisms in the water. Leave the pond notebook by the aquarium and make regular notes about the activities of the organisms. You and your child may choose to watch together, or you may want to take turns observing and recording. Each week, measure and record how much the plants are growing. Encourage your child to think about what is happening in the ecosystem by asking questions such as:
   Where are the animals found at different times of the day?
   Where do they go at night?
   Who eats whom?
   How much do the animals eat?
   Do any new organisms appear?
   Do the numbers of certain types of organisms appear to be increasing or decreasing?

7. Here are some of the organisms you may see (see Figure 2-3):
   - water fleas (*Daphnia*) bobbing up and down as they move. These aren't really fleas and they don't bite. Look for increases and decreases in their number.
   - copepods (*Cyclops*) zooming around or floating. The females will have egg cases that look like baggy shorts.
   - tiny black dots (seed shrimps) zooming around.
   - leeches swimming or looping along the glass (They may only come out at night).
   - white or red worms (*Tubifex*) in the mud waving their tails.
   - transparent or green hydra attached to the sides of the jars catching water fleas.
   - snails gliding along the glass (Look for tracks made by the teeth on their tongues as they eat the algae on the glass).
   - eggs laid on the glass or on the plants (Watch for them to hatch)
   - insect larvae chasing and capturing other species.

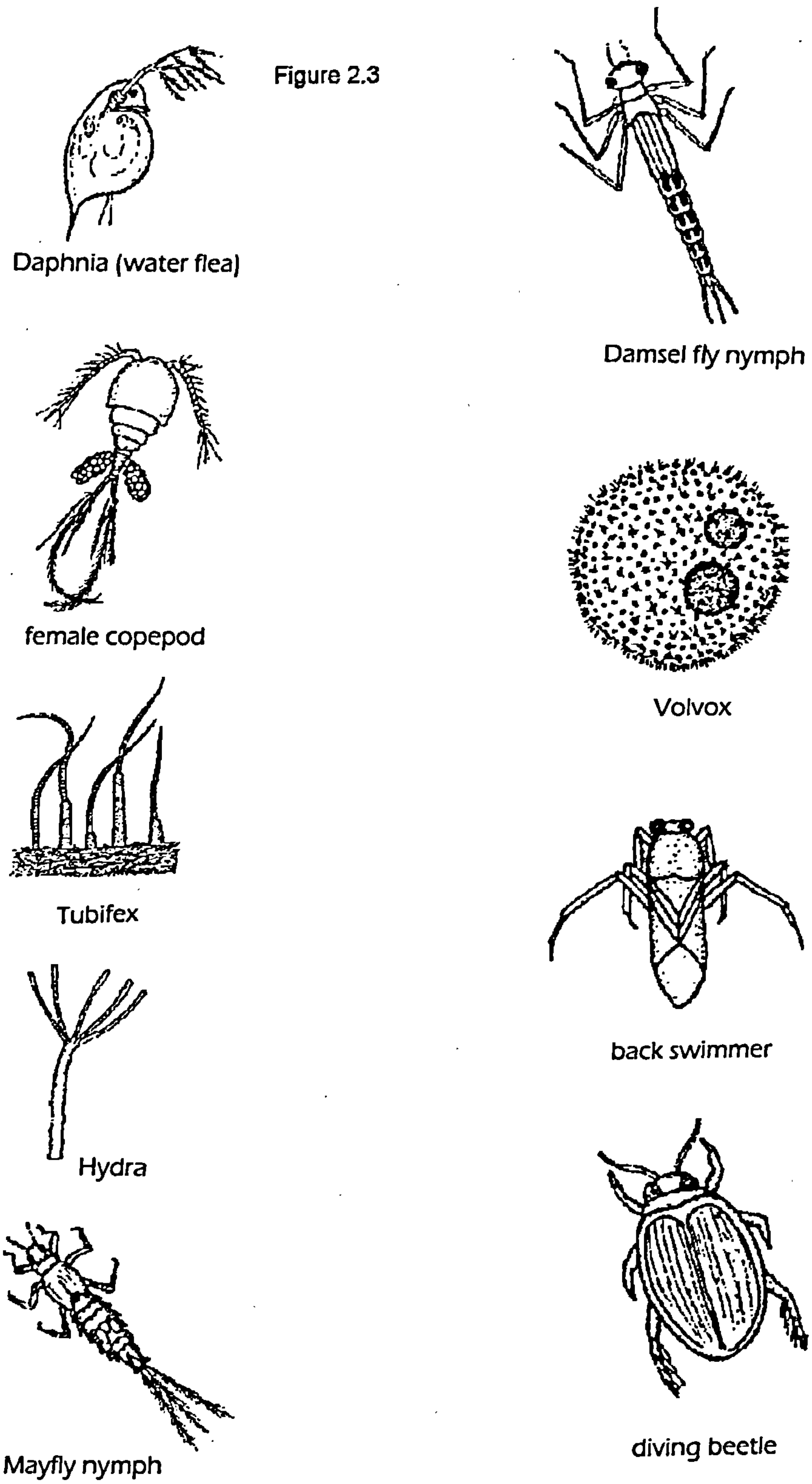

Daphnia (water flea)
Damsel fly nymph
female copepod
Volvox
Tubifex
back swimmer
Hydra
Mayfly nymph
diving beetle

Figure 2.3

8. Watch for animals that change form. For example, insect larvae will turn into adults (metamorphosis). If this happens, be sure to release them outside, preferably near a pond.

9. Look at the bottom mud as it develops an orange layer. This is a natural phenomenon that occurs when bacteria that live in mud reproduce and increase in numbers.

10. If things go well, your ecosystem may survive for several years. You may wish to add new pond water from time to time to boost the numbers of organisms. If you wish to dispose of your ecosystem, return the components to the original pond or to a local watery ditch.

11. Things to watch out for:
   - overheating, which will cause everything to die and turn black and stinky;
   - takeover by anaerobic bacteria (those that can live in low or no oxygen environments). This is unpredictable and happens occasionally despite all your care and attention. All the components of the ecosystem will gradually turn orange (and sometimes black) as the system becomes anaerobic (no oxygen) and the other organisms die;
   - walls of the jar become covered in black or brown "stains." These stains are actually colonies of tiny one-celled plants called diatoms that tend to stick together on flat surfaces. You'll need to scrape them off, or light will no longer be able to get in and the other plants and animals will die, causing the jar to go black.

Taking it further

1. You may wish to check your local library for books that examine the life cycles of the organisms.
2. Challenge your child to see if she or he can figure out who eats whom and draw a diagram that illustrates the feeding relationships (called the food web) for his/her ecosystem.
3. Investigate or map the distribution of ponds and streams in your neighbourhood or nearby community.
   Do they contain the same organisms as the pond you used?
   Do the ponds look healthy or polluted?
4. Go on a guided tour or take a weekend workshop at a local nature reserve that features freshwater habitats.
5. Consider joining a volunteer community group that is working on the health of local streams or ponds.

3. PIGEON DIVERSITY

What's it all about?

Pigeons are fairly common birds in cities and towns around the world. A careful look at these birds shows that pigeons have interesting plumage variations. This activity encourages children to observe pigeons more carefully, to record the variations they see and try to deduce the genetic makeup of the different birds. This is also an introduction to the study of biological variation and genetic diversity.

Pigeons are native to Europe, where they were originally cliff-dwellers. This explains why they like roosting in high spots on houses and skyscrapers. They have been extensively bred by pigeon fanciers and pigeon racing hobbyists. Many of the variants you will see are derived from birds that were escapees from captivity.

Background information

The characteristics of all living things are determined by hereditary units called genes. Genes are parts of chromosomes, long worm-like structures found in our cells. These long structures are made of a threadlike substance called DNA. Genes are the functional regions along the DNA. In most big organisms (like ourselves), every cell in the body contains two complete sets of chromosomes, hence all genes are in pairs.

Most of the variation in plumage we see in city pigeons has occurred because of spontaneous changes in the genes. These spontaneous changes are referred to as mutations. Some of the new appearances which originated as a result of mutations were considered by pigeon fanciers to be particularly attractive. These pigeons were bred so that there would be more pigeons with the same variations in plumage. At some point, some of these pigeons escaped into the wild, where they began to breed with other pigeons.

The original pigeon was probably "blue" in colour (actually a steely-blue-grey), and had two prominent "bars" on its wings.

Mutations from this original type have resulted in a variety of types that now exist in populations. Some of the common mutant types found in cities are (see Figure 3): checkered wings, red colour (actually a pinkish-beige), grizzled pattern, and solid black. However, careful observation will reveal many other, rarer types.

To keep track of normal and mutant genes, scientists use an alphabetical naming system. Genes are labelled with letters of the alphabet. The same letter is used for each of the two genes in the pair.

Let's use the pigeon gene for blue colour as an example. The normal gene that determines blue colour is represented by the capital letter "E". The mutated gene that causes red is represented by the small letter "e".

Because the genes are always in pairs, there are three possible gene combinations: EE, Ee and ee. In the Ee case, the gene represented by the capital letter (E) "dominates" the other gene (e), so pigeons of type Ee look blue exactly like those of type EE. Pigeons that have the ee combination are red in colour.

What's needed

Journal for recording observations. Binoculars are useful but not essential.

Getting started

If you see pigeons near your house or in the park, pique the curiosity of your child by asking why these birds always seem to hang around buildings. Ask them to imagine where pigeons might have lived before there were buildings - or cities.

Invite your child to notice the similarities and the differences between pigeons and to record these differences by making notes or drawings in a notebook.

Help your child to analyse the genetic makeup of two or more different-looking pigeons they have observed. The information in the "What's it all about" section above, and the coding system below should enable them to begin to describe the genetic features they are observing:

Original	Mutation
c = dark bars on wings	C = dark checker marks on wings
E = bluish colour	e = reddish pink colour
g = not grizzled	G = grizzled (mottled with white spots)
s = not solid black	S = solid black

Note that in one case the original gene is dominant and represented by a capital letter (that for blue), but in all other cases shown the mutations are dominant.

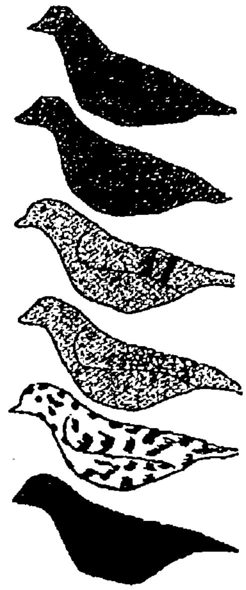
The complete genetic makeup of any one pigeon type can be deduced as follows (a dash means the gene can be either type):

Type	Relevant Genes
original type (blue barred)	cc EE gg ss
blue checkered	C- EE gg ss
red barred	cc ee gg ss
red checkered	C- ee gg ss
grizzled	cc EE G- ss
solid black	cc EE gg S-

With your child, visit a park over a number of days and count the numbers of each type of pigeon in a flock. Each day, list the different types of pigeons in order of commonness. Invite your child to explore whether the percentages are always the same. You might want to consider repeating this activity in another park or region. Are the same types of birds present and are the proportions always the same?

Figure 3

Type	Relevant genes	Plumage
original type (blue barred)	cc E- gg ss	
blue checkered	C- E- gg ss	
red barred	cc ee gg ss	
red checkered	C- ee gg ss	
grizzled	cc E- G- ss	
solid black	cc E- gg S-	



<u>Taking it further</u>

Connect pigeon variation with courting behaviour. Often male pigeons puff up their neck feathers and strut around in front of the female as part of their courtship behaviour. Suggest to your child that s/he follow one male bird that is doing this. Is he making his advances to one female only or to any female? Invite your child to investigate whether males tend to make advances towards females of similar genetic type (eg blue with blue), or opposite genetic type (perhaps blue with red). Alternatively, are pairings are more or less random?

4. Weed Watching

What's it all about?

Weeds are viewed by gardeners and farmers as a nuisance, but they are simply highly successful plants that do very well in areas in which the soil has been disturbed. Most weeds are plants introduced from another country; they succeed in competition with native plant species. Many weeds have had an extremely negative impact on natural ecosystems.

This activity will get you and your child thinking about what weeds are about in your community, and what factors enable these weeds to succeed. You will be exploring the annual cycle of plants, how plants germinate and grow, and how they compete with one another. The activity requires careful observation and recording over a period of time. However it is an activity that can be carried out by looking at weeds in your garden or on any vacant plot.

What's needed

Notebook, pencil, ruler, string, wooden or plastic strips to act as stakes. Possibly a plant identification book and a garden sieve.

Getting started

Early in the spring when the ground can be dug, invite your child to select a piece of ground for a weed observation garden. Prepare a 1 meter x 1 meter piece of ground by clearing it of all visible plant material. It is important to get out all the roots, stumps, bulbs, dead leaves that you can. Dig up the earth to a depth of about 15 cm. If you happen to have a garden sieve, pass the soil through the sieve to remove any remaining organic material. When you have finished, pat the soil down gently so that it is flat.

Have your child divide the square into smaller squares, using sticks, string, pieces of wood, etc. (see Figure 4-1). Then, have him/her draw a diagram of their garden plot in their journal

Now, sit back and wait for things to grow. Have your child record the position of the various plants that appear in his/her notebook. In order to facilitate record keeping, suggest to the child that s/he give each plant that appears a number. Every two weeks s/he can draw a sketch of each of the plants so as to have a record the changes that appear over time. Figure 4-2 shows one way of counting and recording the number of plants using a colourful bar chart.

Encourage the child to record the height of each plant when sketched, and to arrange the results to show which plants grow fastest. One way to show these results is to draw a chart of the changes in height over time. Discuss the best ways of designing such a chart.

Figure 4.1

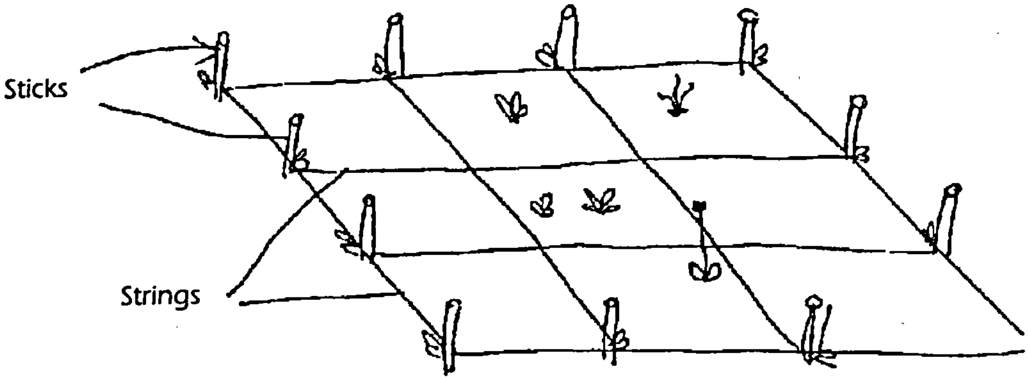
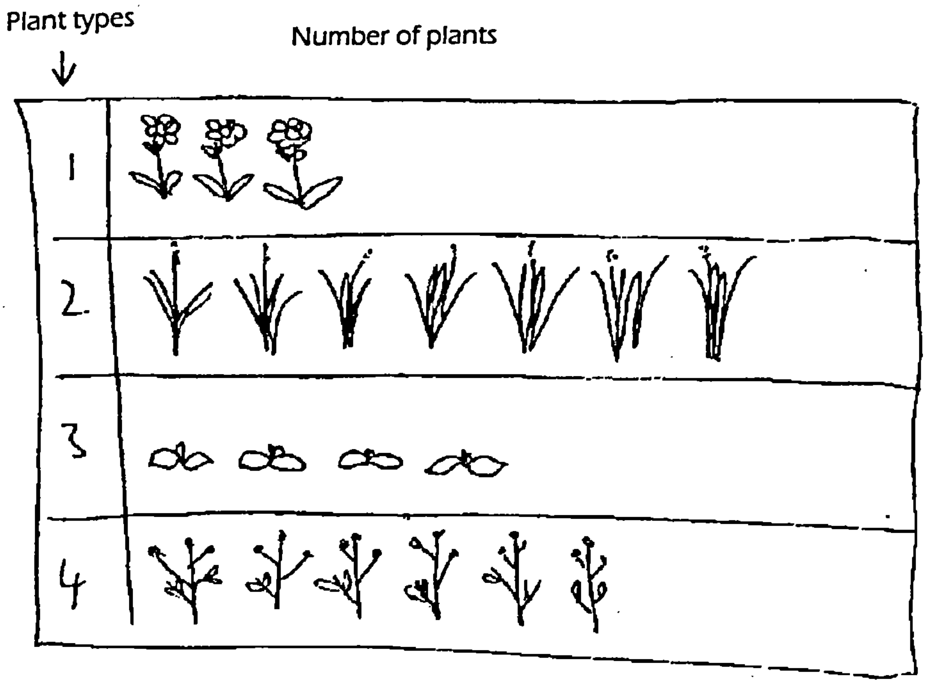


Figure 4.2



Taking it further

1. Encourage your child to identify the plants as they mature and as new features appear. How long did it take before your child was able to identify each of the plants? What features were particularly helpful in the identification process?

2. Using a plant identification book, try to determine which plants are native to your country and which were introduced from another country.

3. Visit other yards, gardens or parks to observe the types of weeds that are present. Engage your child in a discussion of which types of environments particular plants appear to thrive in. As you and your child examine the plants which seem to favour particular environments, invite the child to identify which of each plant's features might be key to its ability to thrive in such an environment. Do these plants grow only in areas disturbed by human activity or natural disturbances such as landslides?

4. Has your child found areas where weeds seem to be competing with native plants? If so, is it possible to tell which type is winning?

5. When the plants begin to flower and produce seeds, estimate how many seeds each plant will produce. Discuss the possible relationships between the number of seeds produced and the success with which the weeds are able to grow in a particular environment. Try to relate this to the origin of the weeds that grew in your plot. Encourage your child to identify other features of the plants that might account for their success as weeds.

5. TREE CHARTING

What's it all about?

Trees not only beautify a neighbourhood, but they produce the oxygen for us to breathe, reduce atmospheric carbon dioxide produced from pollution, and provide homes for many species of organisms, animals, plants and fungi. In this activity your child will learn to identify different types of trees and recognize which ones are native and which were introduced to your area from elsewhere. He/she will also learn different methods of mapping trees and gain some basic knowledge of tree biology.

What's needed

Note book, a tree identification book (available from most libraries), tape measure, newspaper, knife, hand lens or magnifying glass, possibly a protractor.

Getting started

It is sometimes difficult to decide whether a plant should be classified as a bush or shrub, or whether it should be called a tree. This is something that can cause difficulties for biologists, since young trees often look shrubby. For the purposes of this activity, tell your child that a plant a will be called a tree if it has one main woody trunk with relatively few branches near the bottom of the plant and many branches with leaves higher up.

1. Begin by having your child look closely at trees in a particular area. Your own neighbourhood or a small park or naturally treed area will work well. Try to choose an area that is not too big and daunting. Invite your child to go for a walk around the neighbourhood or in the park to examine the various types of trees there are.

2. Trees are beautiful and while most trees have some feature in common, each species has its own special features. Engage your child in a discussion of what appears to make one type (or species) of tree different from another. Encourage your child to record in his/her your notebook a list of all the tree features they notice. Gently lead him/her to examine the colour and texture of the bark, height, amount of branching, angle of branching, leaf shape, leaf arrangement, leaf colour, flowers and fruits. A chart like the one below may help to organize the observations:

bark colour	bark texture	leaf shape	leaf arrangement	leaf colour
1				
2				
3				

You can also look at branch pattern, shape of the crown of the tree (the mass of leafy branches), the type of flowers, fruits, cones and anything else that enables a tree to be distinguished from others.

Figure 5.1 (a)

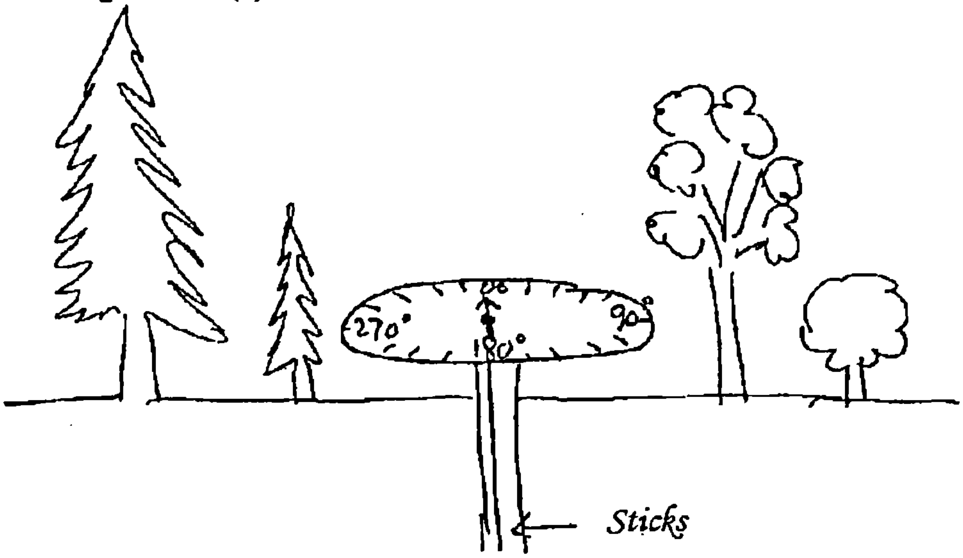
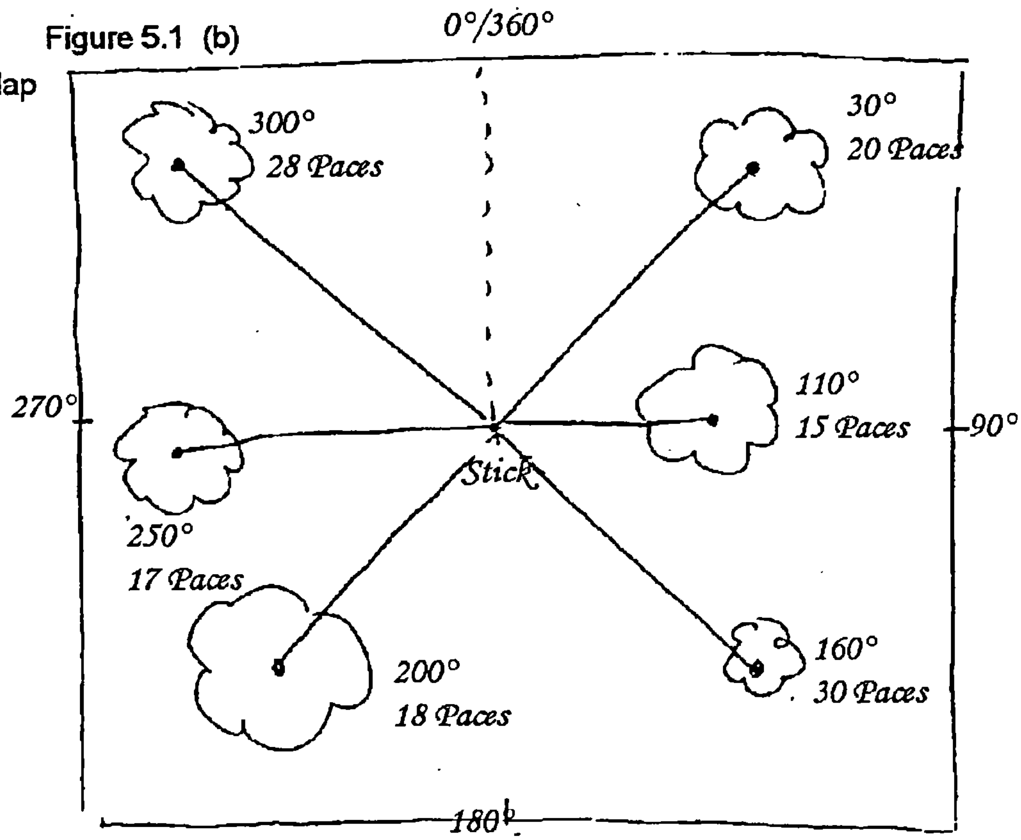
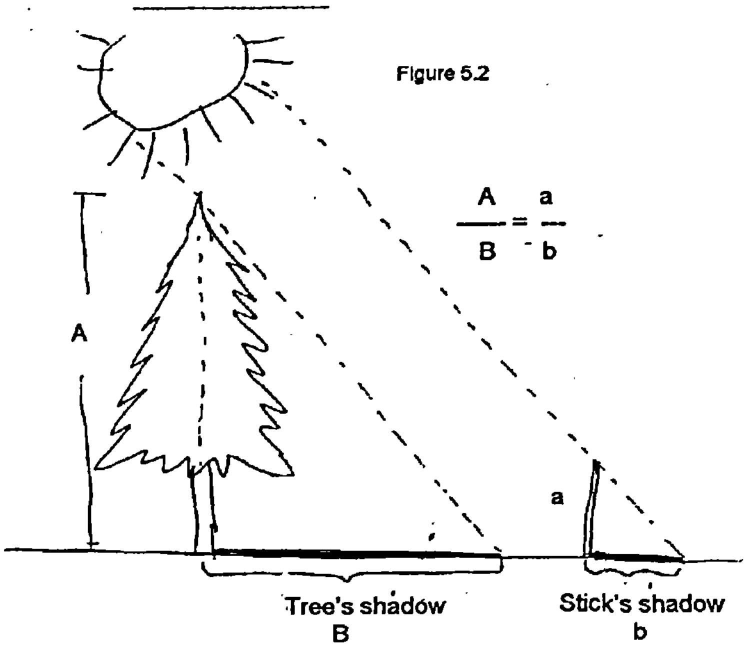


Figure 5.1 (b)

Map





3. Ask your child to identify what he/she thinks are general categories into which we can classify trees. It is not important that the categories be botanically correct. The main idea is for your child to start thinking about the process of classification.

Encourage your child to draw rough sketches to illustrate the different types of trees they have seen. These sketches need not be detailed or finished works of art. They are merely a means of recording data.

Point out to your child how important trees are, and suggest a further project to examine them more closely.

4. Have your child draw a map of the area and record where the various trees are found. If there are lots of one type of tree in a particular area, encourage your child to show them as a group of trees on the map. If there are lots of different kinds, you child might want to consider developing a key or guide to indicate which type of tree is located where. Suggest to your child that he/she try out the map with a friend or family member. Can he/she find the trees indicated on the map?

If you are mapping an open area such as a park, try a surveyor's approach. Have the child make a round disc of cardboard and mark it into 360 degrees (mark positions of 0, 10, 20, 30....360 degrees). Make a cardboard arrow the same length as diameter as the disc. Use a thumbtack to attach the arrow and the disc onto the end of a stick (at right angles to it) and drive the stick into the ground (Figure 5-1). For each tree to be mapped, look across the now horizontal disc and record the position of the tree in degrees. Now walk to the tree and record how far it is in paces. Hence, for each tree, you have the angle it is seen at and its distance. These measurements can easily be converted into a map on paper.

5. Have your child begin to look more closely at a tree that s/he finds particularly interesting or beautiful. Encourage him/her to focus on the general shape of the tree and how the branches are distributed. Have him/her note the shape and size of the leaves and fruits. Are the leaves are in pairs opposite each other, or do they alternate up the stem? Have your child record his/her observations by drawing a leaf in the recording notebook. If drawing the leaf is too difficult, encourage him/her to do a leaf rubbing by placing a piece of paper over the leaf and rubbing a soft pencil across the paper to bring out the leaf shape.

6. Encourage your child to observe how the tree changes over time. Do the leaves change colour? change size? Do the leaves fall off? Do any remain behind? Some types of trees keep their leaves all year long (evergreen trees) and others drop their leaves in the fall (deciduous trees). Conifers (cone-bearing trees) are mostly evergreen (for example Christmas trees). Most deciduous trees have broad leaves, whereas conifers have narrow needle-like or scale-like leaves.

Taking it further

1. Buy or check out of the library a tree identification book with lots of pictures. Look at the pictures and try to decide if any of the illustrations resemble the trees in your community. There is no need to learn botanical names for all the trees in your study area. Identifying even a few will be good practice in careful observation and comparison.

2. Compare the trees in your area with another area - perhaps an area far away (your summer holiday site?). What are some reasons for the differences between the trees in different locations?

3. Try to find out what trees were growing on your town block before buildings were built. Think about and discuss how you might be able to figure this out. (Try a comparison with nearby natural areas for clues).

4. Trees have their very own animal communities. Begin to look for the organisms that live on trees. Try to go beyond birds and squirrels. Scrape the surface of the bark and collect the scrapings on a piece of newspaper and examine them closely for tiny plants and animals. Record any plants or animals you see. A hand lens or magnifying glass is useful for this. Ask your child to speculate how these organisms obtain their nutrition. Look carefully at the undersides of leaves and branches to find insects. Try "beating" the branches over a sheet of newspaper or plastic and see what insects fall out. (This is the time-honoured method used by all professionals and amateurs who study insects). Encourage your child to draw some of the insects in the recording journal.

5. Tree reproduction is interesting. Trees grow from seeds. Questions that you might want to investigate with your child include: What do the seeds of a particular type of tree look like? Where are they found on the tree? Are the seeds present all year round or only at certain times? How are they dispersed (by animals? by wind?) Big seeds such as nuts, acorns etc. are easy for a child to handle and grow.

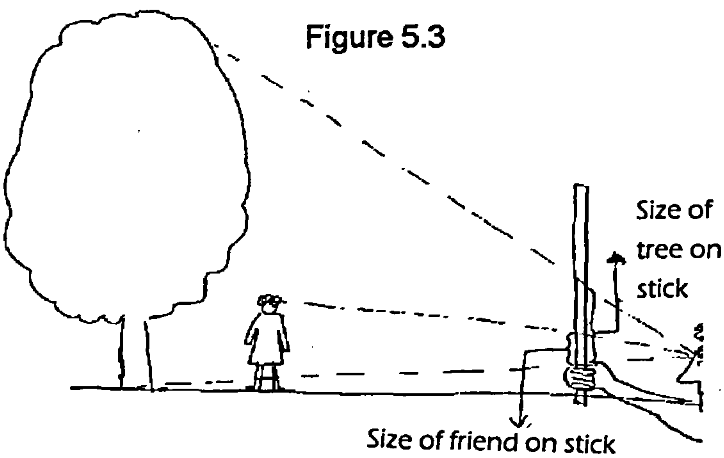
6. Try measuring the heights of some trees. It's not necessary to have an extra tall ladder or mechanical device to do this. On a sunny day place a stick in the ground and measure its height and the length of its shadow. Now measure the length of the shadow of a tree. The height of the tree can be calculated as follows:

Height of tree = height of stick multiplied by length of the tree shadow, all divided by the length of the stick's shadow.

Mathematically, this is true because in triangles with the same angles (similar triangles), the ratio of any two sides is always constant - see Figure 5-2.

Another easy way to measure a tree is to stand 50-100 meters away from the tree and have a friend or parent of known height stand under the tree. Hold up the stick at arm's length and line up the friend with the stick and make a mark on the stick (see Figure 5-3). Next do a sighting on the height of the tree and mark this on the stick, then the width, trunk and any other measurement needed. Then simply do the following type of calculation, which basically asks how many "friend lengths" the tree is, and multiplies by the friend's height.

Figure 5.3



size of tree on the stick divided by size of friend on stick, all multiplied by size of friend.
Example:

Height of friend	= 2 metres.
Size of tree on stick	= 24 cm
Size of friend on stick	= 3 cm
Therefore height of tree	= (24/3) x 2 metres = 8 x 2 = 16 metres

7. Spot the "top ten" trees of your area (measured in terms of most numerous or most ground cover).

6. Measuring Plant Growth

What's it all about?

Plant growth is important in farming, horticulture and forestry, all key elements of the economy. This activity invites you to examine the miracle of plant growth in a new way that can stimulate interest in plant biology.

What's needed

A growing plant. In the home, a bulb is good material to study (Amaryllis is the most spectacular, but any will do). Broad beans (or any beans) are also good and fast-growing. However any fast-growing house plant will do. If you are starting your own plant, you need seeds, a pot, some potting soil, and a location near a window where the plant can get sunlight. India ink, a thin pen nib or brush, (or a thin permanent magic marker), a ruler.

Getting started

The following steps deal with Amaryllis and broad beans, but the same approach can be applied to any plant.

1. Amaryllis: Plant the bulb in soil, keep the soil moist, and place it in a warm place with light. Begin the project once the flower bud has emerged and the stalk is about 5 cm long (see Figure 6-1).

2. Bean: Roll up some paper towels or other absorbent paper and place inside a jar containing an inch or two of water. Place the bean down the side, wedged between the wet paper and the glass, but not submerged (see Figure 6-2). Top up water as it evaporates and never let it run dry. Once the bean has put out its stalk and leaf, allow the stalk to grow about 3 cm and begin the project. Keep the paper wet and keep turning the plant to avoid it leaning over into the light too far. (Alternatively, you might want to monitor the movement of the shoot throughout the day, which makes an interesting study in itself.)

HINT: Plant an extra bulb or bean or two if you can. When doing any activity where you study living things it is always a good idea to study more than one.

3. Keep track of how your plant grows. To do this you will need to mark various parts of the plant (stem, leaves, even roots in the beans) with lines spaced evenly apart, say 1mm apart (see Figure 6-3). This takes a steady hand, but is not too hard to do.

4. Observe carefully and record the growth changes in a notebook or journal. As the plant grows, watch what happens to the lines, and record the results with sketches and measurements of the distances between the lines.

5. Explain your observations.

What parts of the plant show no growth? Which part shows the fastest growth? Is growth occurring along the long axis (length) of the plant or across the width of the plant, or both? Calculate the rate of growth in the various marked off regions (that is, how many millimetres does a part grow per day?). Are your answers to these questions the same for each of your plants (assuming you planted more than one). If not, why not?

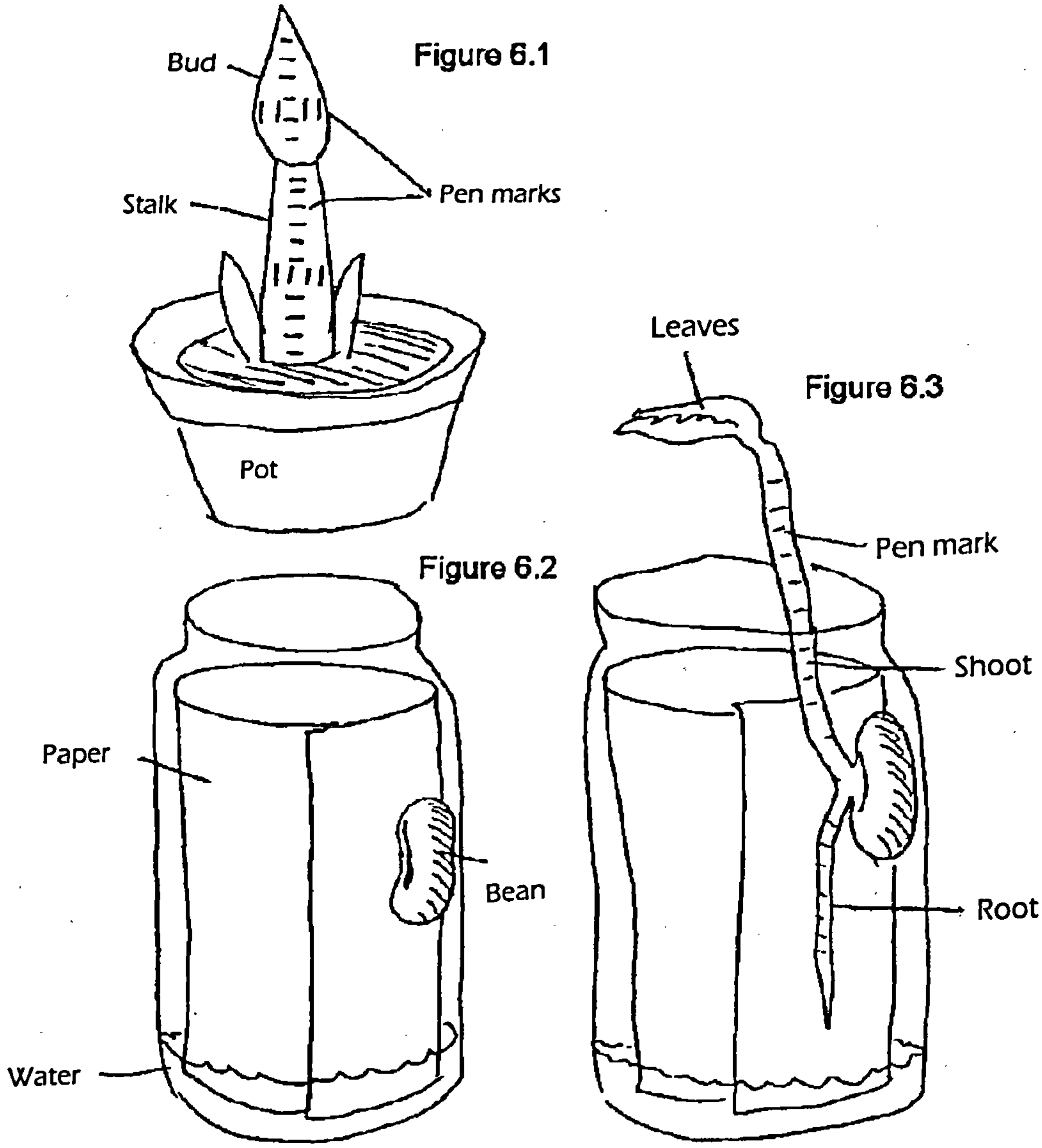


Figure 6.1

Figure 6.2

Figure 6.3

Taking it further

The same approach can be used in garden plants, although because rain might wash off the ink, you might need to use paint or nail varnish to mark the lines on your plants. Experiment with different types of plants. The quickest and most interesting results will be obtained in spring and early summer when the plants are showing their fastest growth. Compare the growth speed of different plants. Which are the fastest? What types of plants are the fastest?

7. Making a Plant Collection

What's it all about?

Botany (the study of plants) is a fascinating hobby for children, and if their interest is piqued when young, studying plants can provide a lifetime of pleasure. In this activity the child constructs a plant press and uses it to prepare a collection of local plants. This activity is an introduction to plant biodiversity in the community, a key element in awareness of the environment and in conservation issues. The activity also gives practice in recording botanical information and plant identification and provides an opportunity to gain skill in plant illustration.

What's needed

- two sheets of plywood either 6 mm or 9 mm in thickness and about 30 cm square
- up to ten sheets of corrugated cardboard the same size as the boards (old grocery boxes are fine for this)
- up to twenty sheets of newspaper the same size as the boards (this is an excellent opportunity to recycle newspaper)
- four 4 or 6" stovebolts with wingnuts on them, eight washers, a drill and bit of diameter slightly larger than the stovebolts, (a couple of old large belts work fine for securing the boards if you don't have bolts and wingnuts)
- white paper
- transparent tape
- possibly a plant identification book.

Getting started

1. Make the press - see Figure 7-1.

2. Take a walk, bike ride or drive to the nearest natural area and collect up to 10 healthy specimens of plants, with flowers if it is the flowering season, and roots if they are not too big. Remember the specimen has to fit in the press you have made. Wash any dirt from the plants and blot dry. Create a collector's notebook and record the date and the site where the plant was found, as well as a brief description about what the plant was like.
Two environmental and legal cautions:
- it is illegal to pick plants in parks or conservation areas
- use common sense and do not pick any plant that seems to be rare.

3. Set up your plant press. Place the plants between two sheets of newspaper and stack as follows:

wood / cardboard / newspaper / plant / newspaper / cardboard - and so on.

Don't forget to create a system for recognizing your plants later -- jot a number on a bit of paper or on the newsprint and record this number next to your notes in your notebook. This will make identification much easier when you open your press later on.
Put the bolts on and tighten the wingnuts so that the plants are firmly pressed between the sheets. Don't overtighten - this will bend or break the boards. If you are using straps or belts, pull them tight around the entire sandwich of boards and plants.

Figure 7.1

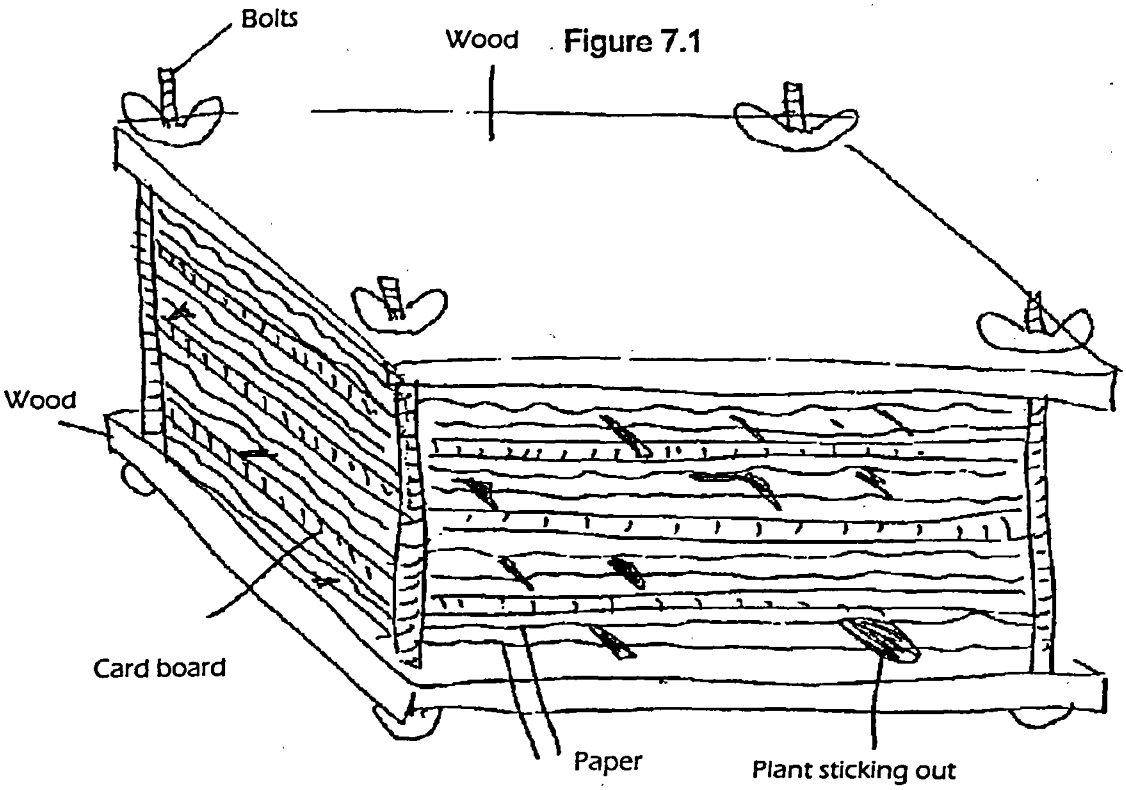
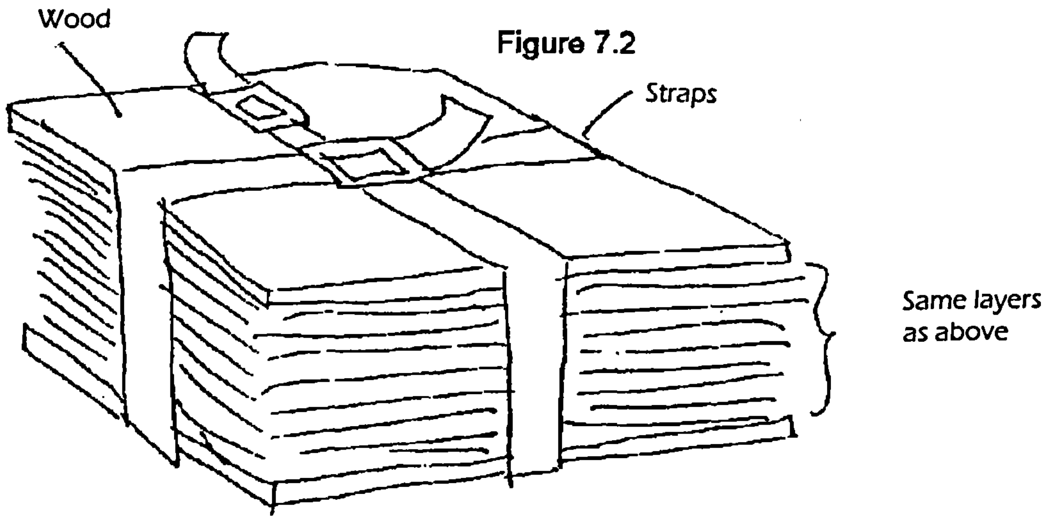


Figure 7.2



4. Allow the press to dry for a few weeks in a dry place. Have a look to see how the drying and flattening is progressing. When the plants are dry, remove them and begin the cycle again with new plants, if desired.

5. Mount the dried, pressed plants on the sheets of white paper, sticking them down with small pieces of scotch tape. Don't forget to write down the number of your plant on the corner of the paper.

6. Identify your plants. Now is when your system of recording comes in handy. Refer to your number and the notes in your collectors notebook and try to identify your plant (if you haven't already done so). Write the names of the plants on the paper alongside the pressed plant. Also write the date and collection site.

7. The plants can be stored in between two large sheets of cardboard tied up with string. Or they can be made into a scrapbook.

Taking it further

1. Take your plant press on holiday and make a collection of holiday plants. In most countries, if you go abroad it is legal to bring back dry plant material if there is no dirt on it. Dirt may contain insects or other creatures that may harm local plants so make sure your plants are completely dry, pressed, and clear of any soil. Compare the holiday plants with the local plants.

2. Join a club and find out more about plants. Local natural history or nature clubs often hold plant hikes; this is a natural extension if your child shows some interest in finding out more about plants.

3. Make greeting cards using dried flowers arranged in pleasing patterns. The plant names could be written on the back of the card.

4. Go to the seashore at low tide and sample the marine plants, (seaweeds). Look for small specimens, as large ones are difficult to dry and store. (Hint: the tiniest ones are very beautiful and delicate and live on the rocks in tidepools.) The drying process is the same as described above, but you will need to change your newspapers more often to help in the drying process (seaweed starts wetter, and takes longer to dry).

8. How the Human Body Grows

What's it all about?

Growth is a key element in the maturation of any organism, and human growth is an easily studied and interesting type of growth for children to explore. This activity involves measuring family members and correlating the measurements with their age and gender. A program of measurement carried over a long time period can show how sizes and proportions change with time.

What's needed

Tape measure, pencil, notebook, perhaps some graph paper (or any paper marked with squares).

Getting started

Many body measurements can be heavily dependent on dietary quality and quantity. In doing a growth study it is best to measure body parts that aren't directly influenced by what you eat. The measurements below are chosen to be relatively independent of diet.

1. Create a data table in your notebook or journal. For each family member measure record the following information:
   - height
   - length of torso from shoulder to groin
   - circumference of head just above the ears
   - length of hand
   - width of hand
   - length of middle finger
   - length of arm from armpit to wrist
   - length of upper arm
   - length of lower arm
   - length of inner side of leg (measure standing)
   - length of thigh (knee to groin)
   - length of calf
   - length of foot
   - width of foot at ball of foot.

2. Look for relationships between each measurement and the age and gender of different family members. To do this, first graph each measurement in relation to age (see Figure 8-1 for an example). Do the points in your graph all lie on a single, straight line? If the answer is yes, then growth is a constant value over time. If not, then the speed of growth must be different at different ages. Repeat this activity, this time graphing measurements in relation to gender (Figure 8-2).

Figure 8.1 : Males & Females

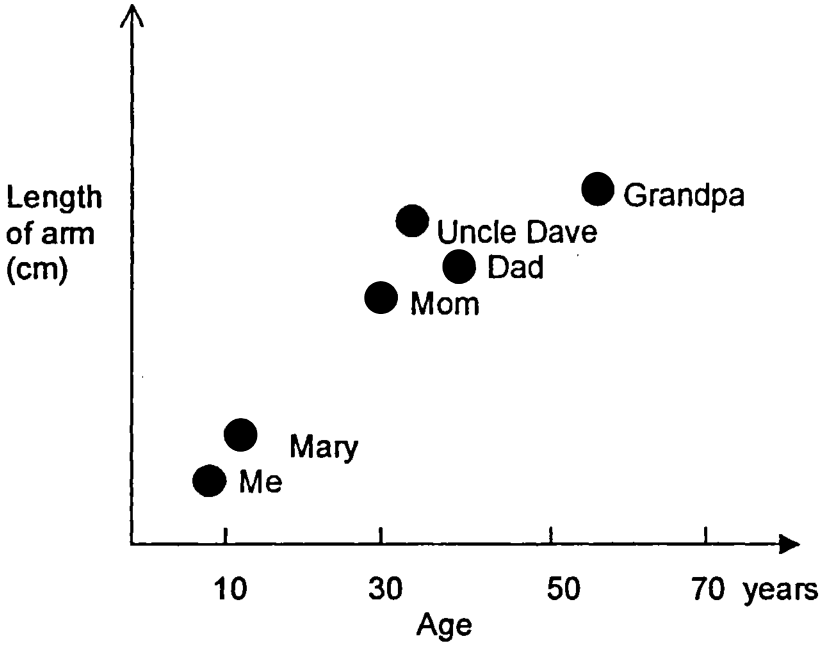
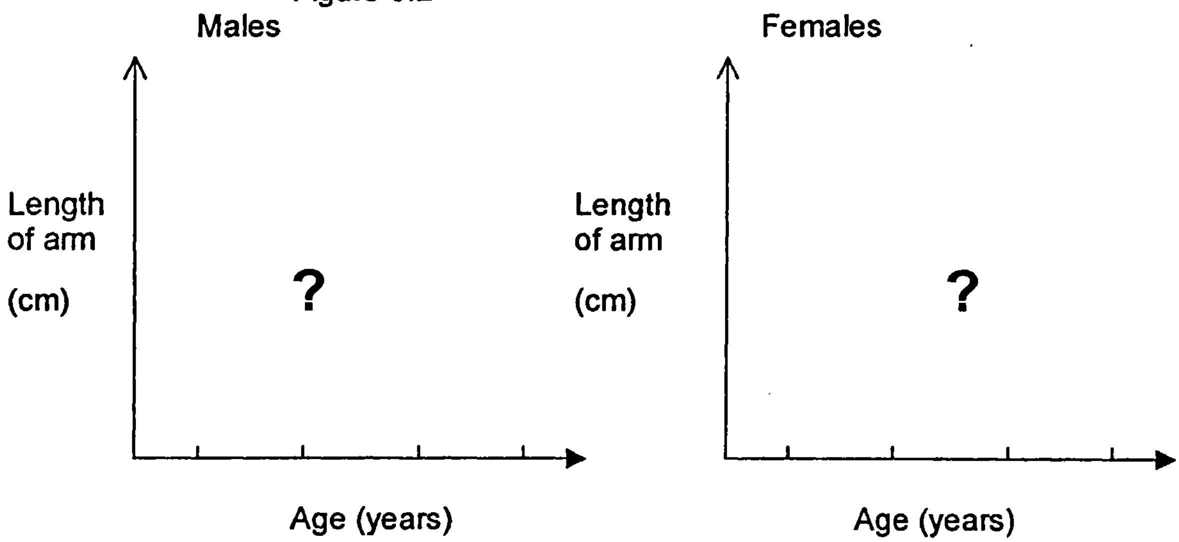


Figure 8.2



3. Calculate some ratios of measurements and see how these vary with age. For example, hand length might be 20cm and hand width 5cm, so the ratio of the two would be 20 divided by 5 which equals 4. Choose two measurements and calculate the ratio for the various family members. Then graph these ratios against age in the same way as you did in procedure 2 above. Do you notice any patterns?

4. Make measurements of children at 3 monthly intervals. Graph these against age. At which age is growth most rapid? Which ratios change the most?

9. MUSHROOM SPORE PRINTS AND BEYOND

What's it about?

Fungi are crucial components of the environment, as they are nature's recyclers. In the ecosystem, they promote the decay and rot of dead organisms, thereby returning the nutrients to the environment so that they can be reused by other organisms. (Imagine what would happen if this didn't occur - all the dead plants and animals would accumulate!) The type of fungus that most of us are familiar with is the mushroom. Mushrooms appear either on the surface of the ground or as plate-like protrusions or "brackets" growing on the bark of trees. Fearing that they are dangerous, poisonous or slimy, children are sometimes frightened by fungi. A few fungi are poisonous, however handling these is not dangerous if the hands are washed afterwards. (Never eat any type of wild mushrooms – even those people tell you are edible. Even "experts" are sometimes fooled by them.)

Mushrooms (and other types of fungi) reproduce by means of spores; they don't produce seeds like flowering plants. Spores are reproductive cells that can grow if they fall on the right surface, and become a new fungus.

This activity begins by making a collection of spore prints from mushrooms. Spore prints are used by experts to help identify the species of a mushroom. The prints can also be kept as a permanent record in your notebook or scrapbook.

What's needed

White and black construction paper. Notebook and pencil. Perhaps a fungus identification book. Kitchen dishes or plastic tubs. Possibly some hair spray or art spray.

Getting started

1. Find some mushrooms. Mushrooms generally appear in spring and fall, when the weather is damp. So it is best to go mushroom hunting during these two seasons. Take a hike to an empty lot, in a forest or wood near your home. Collect about 20 mushrooms in a paper bag or box.
2. Collect some data about your mushrooms. Assign each specimen a number and make a quick sketch showing its size, shape and colour. Then record the date and place where you collected each specimen.

3. At home prepare your spore prints. Cut off the caps (Figure 9-1). Note that underneath the caps are radial membranes called the gills. The spores are produced on the gills. Pull away any tissue to expose the gills fully, and then place the cap gills-down on the white or the black paper. Place a dish, cup or plastic tub upside down over the cap to prevent air currents from disturbing the spore drop. Leave the caps on the paper overnight and inspect the next day. If there is no spore print, leave them longer, as necessary. If you have no success the first day on one colour paper, repeat the next day with the other

colour - they might show up better. If you have success, remove the dish immediately, label the spore prints and leave them for another day to dry off.

Figure 9.1

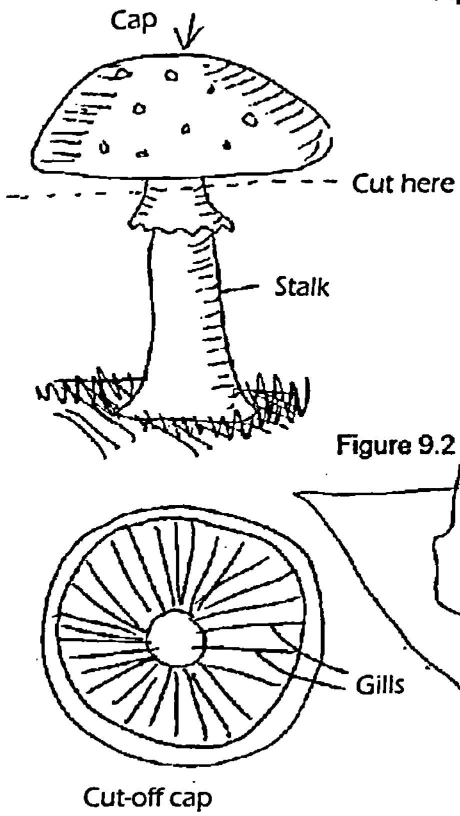
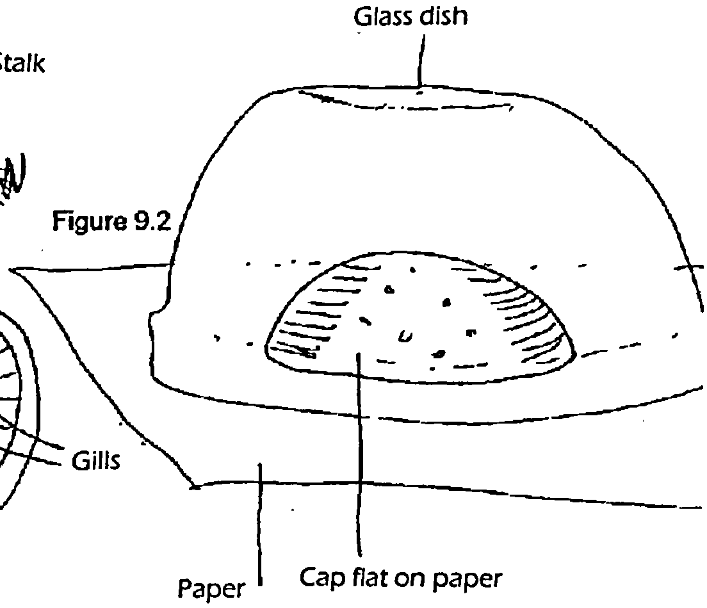


Figure 9.2



4. Preserve your spore prints. Apply hair spray or art spray carefully (if available) to attach your spores to the paper. To avoid changing the arrangement of spores, apply spray from about 30 cm away, letting it fall gently on the prints. Label the spore prints with the specimen number. In the notebook, next to the specimen number and sketch, stick in the spore print. Cover with wax paper if spray is not used.

<u>Taking it further</u>

1. Make collections at different times of year, and from different places. Compare with your first collection.

2. Try to identify some of the mushrooms using a mushroom book specific for your area.

3. Look for evidence in the soil that will show you more about how mushrooms grow. Mushrooms don't have roots like green plants. Explore the soil around the base of

mushrooms and try to locate the whitish threads that are the underground part of the fungi and which absorb nutrients from the soil.

4. Try recording fungal diversity in different places in your neighbourhood:

• Compare fields with forest. Do you notice any difference in the diversity? In the forest, many of the mushrooms are living in symbiosis with the roots of trees - these are called mycorrhyzal fungi - so they tend to be bigger and more numerous than the mushrooms in fields, which are mostly saprophytic, breaking down dead plant and animal material to obtain nutrients.

• Compare mushrooms growing near or under broadleaf trees with those under evergreen trees (you will probably see more under the former).

• Bracket fungi grow on tree trunks, looking like protruding shelves. Compare bracket fungi with others. Some bracket fungi decay the non-living heartwood, some are parasitic on the living sapwood. Are they bigger or smaller than soil fungi? Do they have stems? Speculate why or why not? What are some other differences?

• Try poking around close to the ground for small or unusual fungi. Remove the leaf litter - you might see small "cup fungi," small mushrooms, and possibly the whitish threads that fungi are made from.

• Look for jelly fungi, which grow on dead tree stumps, logs or fences (they look like pieces of yellow or whitish jelly), and coral fungi, which grow on the ground.

Make an assessment of fungal diversity in your area studied.

10. OBSERVING AND RECORDING ANIMAL BEHAVIOUR

What's it all about?

Someone once said "Science is seeing what everyone else has seen, but thinking what nobody else has thought." In this activity, we try out this notion on the behaviour of animals. Everyone has seen animals behave, but here we try to record scientifically exactly what this behaviour is and how much time they spend on various activities. Some of these activities are innate whereas others are learned. Behaviour is just as important a component of an animal's characteristics as its appearance. Hence, understanding behaviour is a key to understanding the needs of various animals to survive in their natural and human-made habitats.

The activity involves careful observation, making choices about categorizing the activities the animal is engaged in, and recording the activities for future analysis.

What's needed

Pencil, notebook, timer (watch, stop watch, clock - whatever timing device is available; if you have no timing device you can count seconds by saying "one crocodile, two crocodile three crocodile", etc.)

Getting started

1 First choose what animal in your community you would like to study. Household pets are a good place to start. Common animals like squirrels, birds and insects also make interesting subjects.

2. Have a preliminary look at what your chosen animal does and decide what categories of behaviour would make up the daytime activities of the animal in question. (For examples see the list below] This doesn't have to be an exhaustive list; you can always expand on it later if necessary.

3. Draw up a chart in your notebook showing the categories of behaviour.

4. Spend some time observing the animal closely and recording the amount of time it spends on each activity. Try to stay at a distance from the animal so as not to disturb its natural behaviours - in other words, spy on it unobserved if possible. An example of your observations might be:

"activity A, 10 seconds, then activity B, 30 seconds, then activity A, 15 seconds, then activity C, 20 seconds........" and so on.

5. Enter these on the chart and at the end of the observation period, calculate total time spent on each activity.

6. Repeat at different times of day and different seasons for the same animal, and compare different animals.

7. Do some further analysis and thinking about of the behaviours you see to learn more about the particular individual and/or species.

Some activity categories to guide your analysis for specific animals:

<u>Squirrel Activities</u>

- Resting
- Obtaining food
- Grooming
- Territorial behaviour (chasing, threatening, fighting)
- Mating
- Communication (calling, tail waving etc.)

<u>Bird Activities</u> (see Activity 1)

- Resting
- Obtaining food
- Grooming
- Nest building
- Territorial behaviour (chasing, threatening, fighting)
- Mating
- Food preferences
- Communication (calling, displaying, posturing)

<u>Cat/dog Activities</u>

- Grooming
- Obtaining food
- Resting
- Aggression
- Territorial behaviour (barking, chasing, etc.)
- Mating
- Playing
- Communication (calling, tail wagging, sniffing)

<u>Bee Activities</u>

- Obtaining food (from flowers)
- Travel
- Resting
- Communication
- Time on flowers of plant species A, species B, etc.
- Time on flower 1
- Time on flower 2, etc.
- Time on plant 1, plant 2 of species A

- Time spent within 1 meter radius of a particular plant or object
- General direction of journey
- How were the times of a second bee influenced by the times of the first?

Additional Bee/Wasp Study Activities

Make artificial flowers from different coloured paper. In the middle of one put a soda bottle cap (or other small container) full of sugar water or honey. Wait for one bee to find it, then *time* how long it takes for the number of bees on the sugar to rise to 2, 3, 4 etc. Once the sugar has been well and truly found, move the sugar cap and mix up the positions of the coloured flowers. See which one the bees will go to.

Fish Activities

- Obtaining food
- Resting
- Communication
- Aggression
- Just swimming

- How many times does the fish pass a piece of tape stuck on the side of the tank?
- How long does it spend at the bottom, middle, top of the tank? (Use tape to divide the tank).
- Is behaviour affected by time of day? For example, how do these times change at different time of day?
- Is behaviour affected by the weather? For example, how do these times change in different weather conditions?
- How do activities change in different degrees of lightness/darkness?
- Can the fish anticipate feeding time (can you prove this with your records?) Can you train a fish into a feeding response using a bell or other signal?

Taking it further

1. Try doing your animal behaviour study in varied locations. The same types of observations and measurements are fun and interesting to do at the zoo or aquarium.
2. Human beings are animals too. Try the same kind of observations on people, at the beach, in the park, in the shopping centre etc. If you decide to study people, remember it is important to be sensitive and polite; staring directly at people will make them uncomfortable – be unobtrusive and discreet.
3. Try Activity 1, also about animal behaviour.

11. SNAIL POPULATION BIOLOGY

What's it all about?

Snails are commonly encountered animals in most parts of the world. This activity asks children to take a new look at snails, examine their unique structure and habits, and perform some simple analyses in basic population biology and general biology. In some snail populations there might be genetic variation between the snails. This can be assessed as a type of biological diversity.

What's needed

Several collection vessels such as plastic tubs and lids with small holes for air; one litre plastic soda bottle; sticky tape; marking pen; several small pots of hobby paint (enamel or acrylic), coloured nail varnish or other waterproof paint; notebook and pencil.

Getting started

1. Determining distribution.

Look for snails in your garden or any other site in your neighbourhood. Snails come out mainly at night, so this would be a good time to look for snails on the move. (Use a flashlight). In the daytime, they often come out after a rain storm. Look on the branches of bushes, trees and other plants. Snails often hide down in long grass or rest high in the branches of shrubs.

Try to be systematic in your collecting. Record the number and types of snails you find in each place (e.g. each bush). Draw a map of the collection site and use it to record where you found the snails. All the snails you find will be called collectively "sample 1".

2. Estimating population size

Mark all the snails you have collected in the following way (see Figure 11-1). Dry the shells with a cloth or paper towel and put one or more small dots of coloured paint on the snail shell, well away from the shell opening. Alternatively, you could paint numbers. Let the paint dry (the paint types suggested above are fast drying). Release the snails and record where they were released. They should be released randomly over the area.

After one week collect the same number of snails you collected previously – call this sample 2. If you find marked snails, record their location and compare this location with that of the previous week. The aim is to see if the snails return home to a specific site.

Add up the total number of marked snails in sample 2. You can estimate the total population size of snails in a area by looking at the proportion of marked snails in the second collection. If the second time you found that 1/3 of the snails are marked, then the total population is

collection sample size (say 100) x 3 = 300

You might be surprised by the answer you obtain!
(This is called a mark and recapture experiment, a procedure used extensively in population biology.)

Figure 11. 1

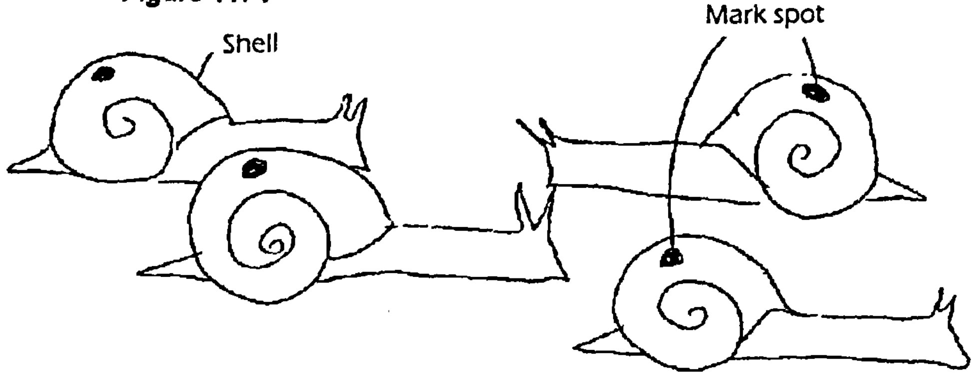
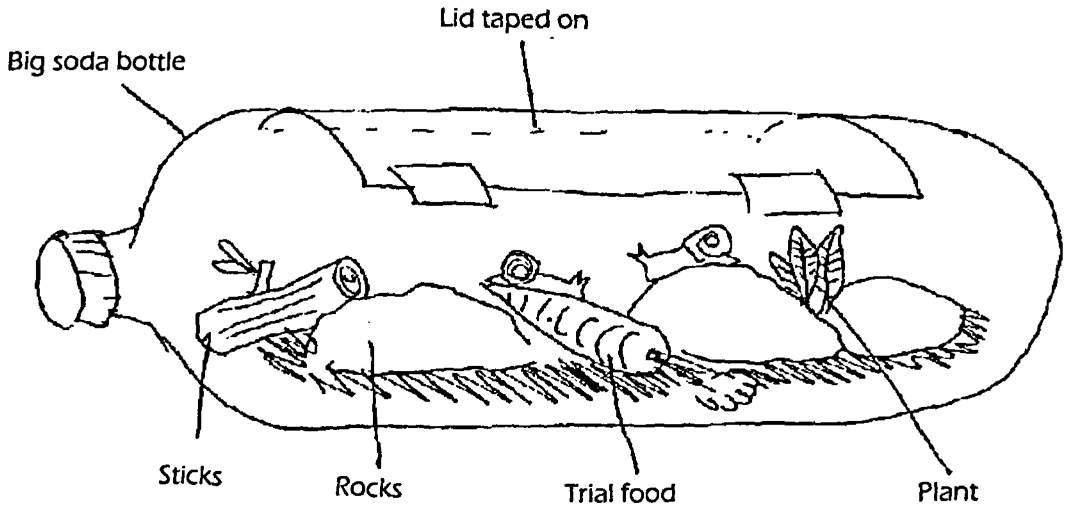


Figure 11. 2



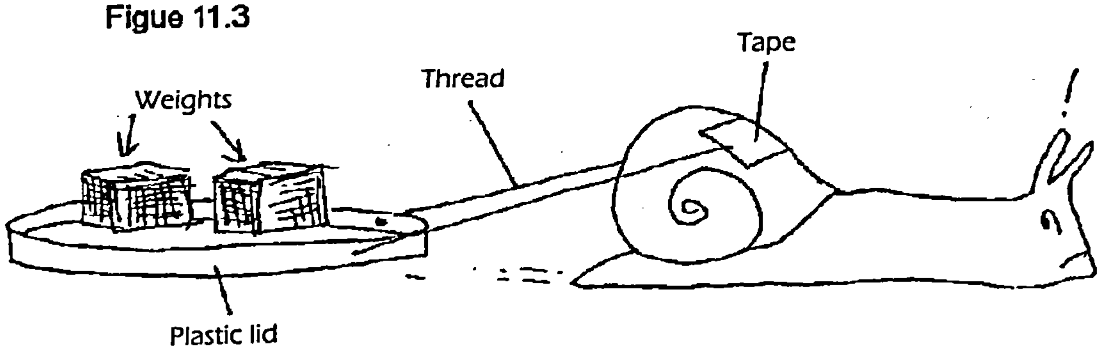
Finally, write a short summary of your studies on the total population size, site preferences, and mobility of snails. Ask your neighbours if they have seen any marked snails. How far do the snails move?

Taking it further

1. Make a snail habitat in a plastic bottle (see Figure 11-2). Put about five snails in the bottle. Place the bottle in a shady place in the garden or in a garage or shed (not indoors). Record the snails' activities during the day and night. Place pieces of vegetable in the bottle (carrots, lettuce, potato etc.) Observe and describe how snails eat. Record which vegetables they eat. Assess feeding preferences.

2. Did you see different shell patterns and/or colours in different snails? You might be looking at the snail *Cepaea* ("see-pay-a"). These patterns are genetically determined. In their original territory (Europe), there is evidence that these patterns confer a type of camouflage against predators (birds mainly) and specific patterns give protection in specific habitats. Test this idea by measuring the proportion of specific patterns collected in different habitats. This would be best done in several natural settings, eg. reeds, grass, shrubs, etc., or wherever you can find the snails.

Figue 11.3



3. Watch a snail in action to learn about how it moves. Measure the speeds at which snails move. Mark where a snail starts moving, time two minutes and measure distance covered. Calculate average speed in mm per minute. Do this on different days when the air temperature is different and look for correlation of speed with temperature. Find the snail individual speed record holder. Have snail races. (They love to crawl upwards, so position them at the bottom of a sheet of plastic or wood and tilt it vertically.) Put snails on their backs and record how long it takes for them to flip over. Are the fastest flippers also the fastest crawlers?

4. Can snails crawl over sharp objects? Try broken egg shells and razor edges. (Get a small wooden block. Ask your parents to tack razor blades around the edge to make an enclosure. Place snails in middle and watch what they do: can they crawl over the sharp edges of the razors?)

5. How strong are snails? Devise a sled out of a plastic lid. Attach it to the snail's shell with tape (Figure 11-3). Add small stones one at a time to the sled and see what the maximum weight is that snails can move. Weigh the stones to get a precise measure. Find the strongest snail.

6. Snail territoriality. Put out an upside-down flower pot and prop it up a bit with a stone so that snails can get in. Snails go out and eat mainly at night, and will find a hiding place before daytime. Check to see if snails have used your hiding place. Mark them with numbers and put them back in the pot. Check again the next morning to see if you have the same or different snails. Explain the results.

12. Fungal Succession on Manure

What's it all about?

Fungi are the decomposers of nature. They break down dead plants and animals and various kinds of solid and liquid animal wastes, returning the nutrients into the ecosystem. This activity focuses on manure fungi, and shows how they break down horse manure.

A number of different fungi will be observed on the manure, in a precise order. This precise sequence is caused by two things: first, different fungi grow at different speeds, and second, one fungus can prepare the way for another. When one organism, merely by living in one place, prepares the conditions that make it possible for another organism to live there later, and the second organism prepares the way for a third, and so on, the process is called *ecological succession.* Succession is a well established general ecological phenomenon observable in many settings.

In this activity, the organisms are fungi living on horse manure. Fungal spores on the grass eaten by a horse survive the journey through its body, and then germinate and grow on the manure.

The activity is an introduction to the ecological principle of succession, and to the subject of mycology (the scientific study of fungi).

What's needed

An extra-large clear disposable plastic bottle such as a 1 or 2 litre soda or water bottle. A large pickle jar is also suitable. A manure collection bag (supermarket bags are fine for this). Horse manure from a horse feeding in pasture (a field) or from hay. Some clear tape. Notebook and pencil.

Getting started

1. Collect some fresh manure - enough to fill the bottom third of your clear bottle.

2. Cut the top off the bottle so that the manure can be put inside. Then use the tape to connect the top back on (it doesn't have to be a perfect seal). Poke a few 1mm holes in the upper part of the bottle.

3. Place the bottle in the shade to allow the fungi time to grow. In the summer, put it outside the house, and in the winter put it inside - a window sill on the north side is about right. The bottle must be in the light for the daylight hours. After putting the manure in the bottle there will not be any appreciable odour from it, however make sure no pets or other animals can knock it over.

4. Watch what happens to the manure. Fungi will start appearing after a few days. Record and describe any and all fungal growth. Record the date at which growth of one fungal type begins and ends. Draw the fungi that grow.

5. Summarize the entire succession of fungi from beginning to end.

Taking it further

1. Was the fungal succession in your first experiment just a chance thing? Or was it a biologically inevitable sequence? Explore these questions by repeating the experiment with another sample of manure from the same horse, a different horse, the same field, a different field.

2. Try dung from rabbits, sheep or deer, and compare the fungi that grow.

3. Compare the results in all your trials. If you find the same sequence in all cases, make a record of this sequence.

4. You can experiment further by changing the conditions in your bottle.
- Try adding water so that the manure is partially (not fully) submerged.
- Try adding a table spoonful of vinegar mixed with water, or a spoonful of baking soda in water.
- Try putting the manure in the dark.
- Try higher and lower temperatures.

5. From the library, obtain some books on fungi and see if you can find the scientific names of fungi similar to the ones you observed on the manure. If you are unsure of a specific case, a statement such as "Looks like species X" is quite acceptable.

13. TREE GIRTHS - A POPULATION STUDY

What's it all about?

This activity asks your child to document the sizes of trees in a particular area of his/her choice. Through an analysis of tree size, your child will begin to investigate the ecology and structure of tree populations, and will get an introduction to statistics. There is also a game element that can be used if desired.

What's needed

Notebook, pencil, long tape measure (preferably more than 10 metres long), sheets of graph paper or plain paper. Optional: a tree identification book and a saw.

Getting started

1. Together with your child, select a natural wooded area in your community in which there are a fair number of trees.

2. Ask your child to begin by making a rough estimate of the number of different types of trees in the area.

3. Suggest that your child focus on one particular type or species of tree. A good starting point is to examine the type of trees that have the thickest trunks. Have your child measure the distance around the trunk of the largest trees (the circumference). In order to have a point of comparison, encourage your child to take the measurement at same height for each tree (that is, choose a standard height above the ground - breast height is convenient). Move on to the smaller trees of this same type. Record the measurements of lots of trees, big and small; one hundred if possible. Don't be selective.

4. At this stage, when your child has found the approximate range of tree sizes for a particular tree species, it might be fun to have a contest to see who can find the fattest tree. This works well if there are several children or family members involved.

5. Chart the results using a bar graph (also called a histogram - see Figure 13-1). The horizontal axis represents circumference and the vertical axis, the number of trees. For easier plotting of the circumference, choose intervals that are appropriate for the data collected, (e.g. 0-50 cm, 51-100 cm, 101 - 150 cm etc). The length of the bars on the vertical axis should reflect the number of trees you found in each category.

Questions:

1. What is the average (or mean) tree circumference? The average is calculated by adding up all the circumferences and dividing by the total number of trees measured.

2. What is the most common circumference? Is it the same as the average (or mean)? If not, why not?

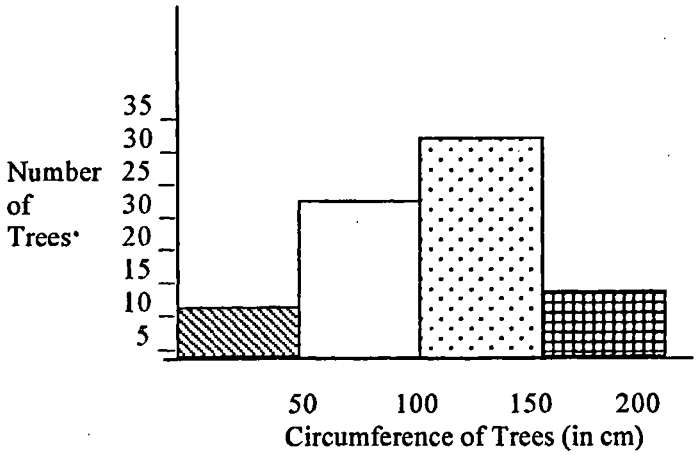


Figure 13-1

3. What is the smallest and the largest recorded circumferences?

4. Make an assessment of what stage your tree population is in. Look at the data you have collected. Is there a more or less continuous range of sizes from very large to very small? If a population is actively regenerating itself, it should contain small seedlings, and all sizes of trees from there on up. If the range of tree sizes does not extend down to seedling size, the population might not be actively regenerating. Look for clearings caused by windfalls, or look at the edge of the population; are there seedlings in these locations? If so this might show that regeneration is occurring. No seedlings, or the presence of seedlings of another species of tree might indicate imminent replacement (ecological succession – see also Activity 12). When the present trees reach a certain size, they will die from disease or windfall and may be replaced by another species. Broadleaf trees often precede coniferous (evergreen) species in this way.

Taking it further

1. Repeat for another tree species in the same wood, perhaps the second most common. Compare numbers and the histograms - are there differences? If so, suggest a reason.

2. Find a fallen tree, preferably one with a cut end. If not, cut off the end of a fallen tree with a saw. The aim is to see the growth rings, which are laid down one per year. Counting the number of rings will give a measure of the age of the tree.

3. It is possible to use the information provided by the fallen tree above to discover the approximate age of any of the other trees measured. Begin by measuring the radius of the tree, that is, the distance from the centre of the tree to the outer edge. Use this information to calculate the number of rings per cm of radius (e.g. 2 rings per cm). This tells you that it took 2 years for the tree to add one cm to its radius.

The original data you collected measured the circumference of the trees, not the radius. However, it is possible to find out the radius of any of the trees as the relationship between the radius and the circumference is always the same:

circumference = 2 x π x radius (π is a mathematical constant, approximately 3.14).

Rearranging this formula,

radius = circumference / 2 x 3.14

so, radius = circumference /6.28.

A tree that has a circumference of 73 cm, for example, must have a radius of 11.64 cm (73 / 6.28 = 11.64). Since we know that the trees in this area added 1 cm to their radius every two years, a tree with a radius of 11.64 cm would be approximately 23 years old (11.64 x 2).

You can easily make an age distribution for the trees in your sample by converting all their circumferences to ages!

14. Colonization of Rock Surfaces in Water

What's it all about?

Plants and animals are constantly competing for space in which to live. A new generation of any species has to find its own space in a process called colonization ("making new colonies"). In the present exercise, the child provides a vacant space under water, and documents the process of colonization by various aquatic plants and animals over time.

What's needed?

Some flat bare unpolished rocks, the larger the better; around 30 cm is perfect. Notebook.

Getting started

This exercise requires a body of water, either a stream/river, a lake/pond or the ocean.

1. Obtain some flat rocks with bare surfaces, i.e., with no encrusting plant or animal life. Rougher surfaces will probably encourage more colonization. Even bricks or cement slabs would be fine. These will provide surfaces for the attachment of plants and animals to start colonies. Many aquatic plants disperse by cells (spores) that float around and settle on a new surface. Likewise, animals often disperse by small, motile larvae that swim around and settle down in a new location.

2. Place the rocks in various positions under water. Exercise great caution near deep or rough water. Try:
   - different distances from the shore
   - different depths (very deep locations could be tested by tying a line around the rock and lowering it from a boat and tying the line to a float for future retrieval).
   - different degrees of turbulence (fast running or still water; surf or quiet pools).

3. Re-examine the rock surfaces over time. Record the changes you see. Remember that although some colonies are easy to see (such as attached animals like snails) some colonies, especially in the early stages, look just like crusts or paint on the surface (some algae are like this). Make sketches of the encrusting forms that appear. Be sure to compare the upper and lower surfaces and record differences. Place the rocks back in the same orientation they were before. It might be useful to scrape some material off the rocks to examine it under a lens or microscope, if available.

Taking it further

1. Try different locations.
2. Try different types of surfaces, such as wood (weighed down), metal or plastic.
4. Investigate how the presence of animals and plants change the surfaces they reside on. Do they make the surface rougher? Smoother? A different colour?

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