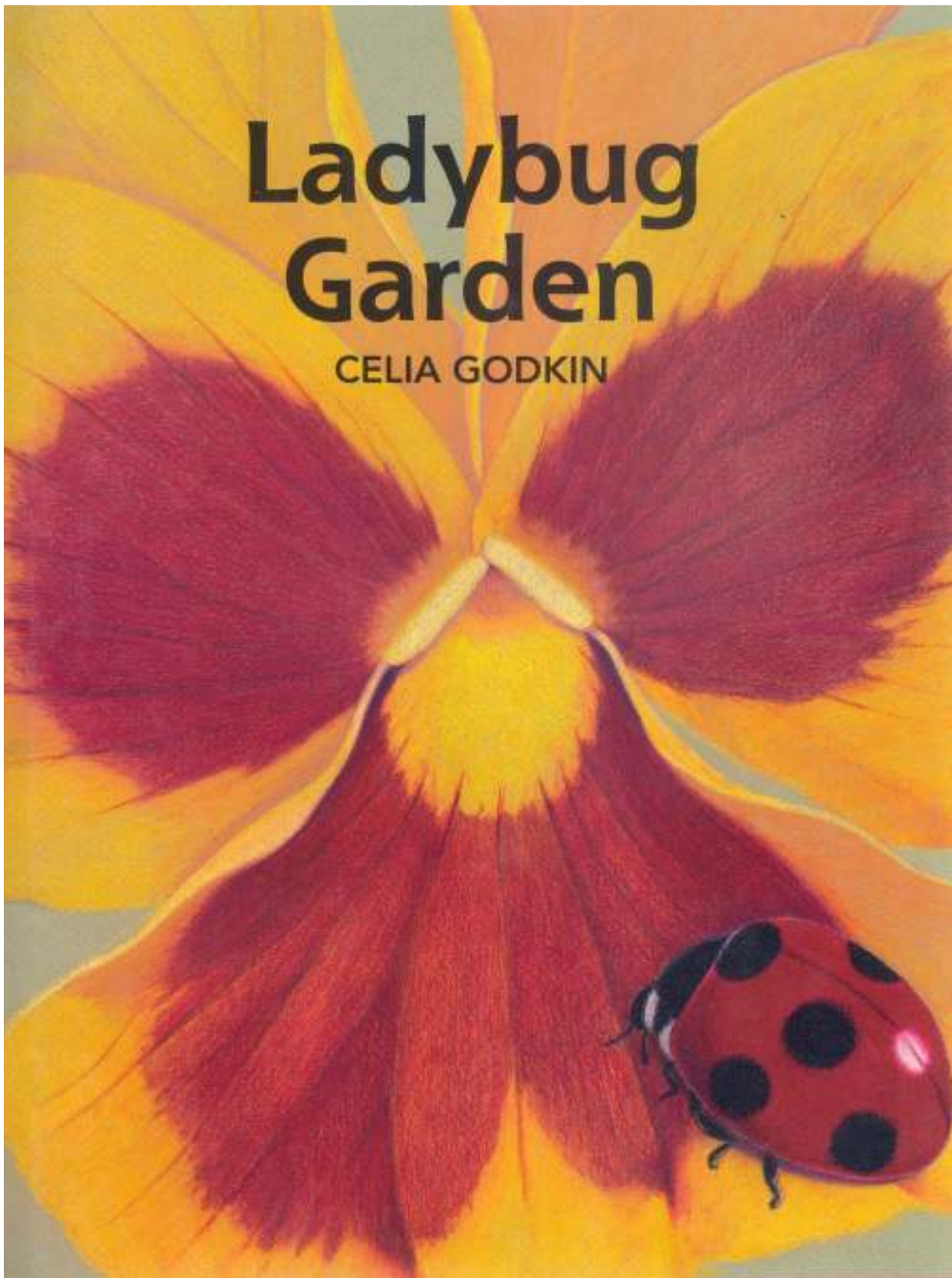





Ladybug Garden

CELIA GODKIN



INFORMATION GUIDE

PAGE BY PAGE NOTES:

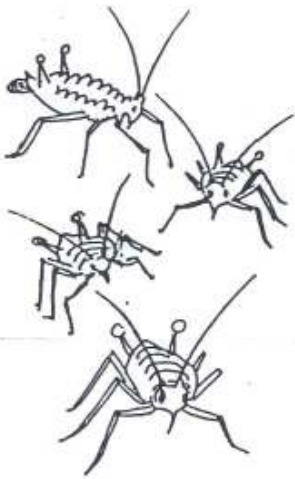
	<p>Title page</p> <p>The gardener is digging his garden in spring. The white boxes are beehives.</p>
	<p>Pages 2 – 3 <i>The gardener looked...</i></p> <p>Have the children look at the picture and identify the plants and animals mentioned in the text. They may have difficulty telling the difference between the bee (flying away on the far left) and the wasp (right foreground). This is not surprising, as these closely related insects do look very similar. For a closer look at bees - which are much hairier than wasps - see the next page.</p>
	<p>Pages 4 – 5 <i>The gardener thought ...</i></p> <p>You can explain pollination briefly by saying that, from the insect's point of view, flowers are a kind of snack bar or grocery store, supplying them with nectar to drink and pollen to eat. Note the yellow pollen sacs on the bees back legs. The pollen sacs are specialized hairs, to which the pollen sticks. They can be thought of as the bee's shopping bags.</p> <p>From the flower's point of view, the insects are couriers picking up pollen from where it is produced and delivering it to where it is needed. When an insect arrives at a new flower, some of the pollen it has collected sticks to a sticky green stalk in the flower (the stigma). The pollen grows down the stalk to a swelling at its base (the ovary) in which lie eggs (ova). The pollen unites with the egg and a seed is produced.</p> <p>Ask the children to tell you: what is a seed? What happens when you put a seed in the ground? From their answers draw out the fact that a seed is a baby plant. (technically speaking a seed is a dormant period in the earliest stage of development of a young plant. It will remain dormant until conditions are right for it to grow into a plant.)</p> <p>To learn more about pollination see: LEARN MORE ABOUT PLANTS below.</p>



Page 6 - 7 *Though the butterflies ...*

What are the insects in the picture doing?

Insects have received much bad press as pests. In fact, the vast majority of insects are either beneficial or harmless or, like the butterflies, ants and wasps in our story, they play a mixed role. More often than not, when insects do become seriously destructive it is because nature's natural controls have been disrupted by human interference.

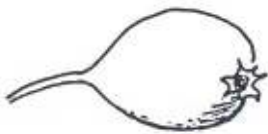


Pages 8 - 9 *There was no question ...*

Aphids, also known as plant lice or greenflies, are common garden insects that often go unnoticed because of their small size. They have mouthparts much like a hypodermic needle, which they use to pierce plant tissues, and suck out the sap or juice from the plants. This is very much like a mosquito sucking blood from a person. And, like mosquitoes, which may carry malaria or the West Nile virus, aphids sometimes carry diseases in the form of plant viruses.

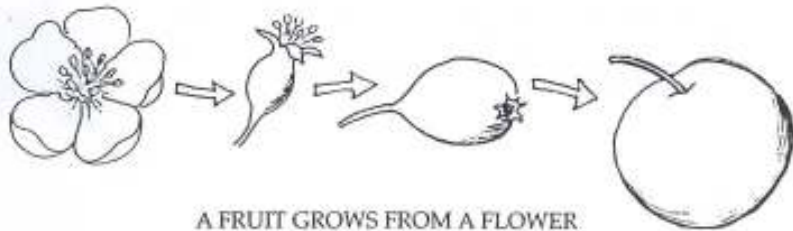
Ask the children to imagine they are a plant covered with little juice-sucking bugs. How does it feel?

Ladybugs eat aphids. But the gardener doesn't know this yet, and we are getting ahead of ourselves...



Pages 10 - 11 *One day ...*

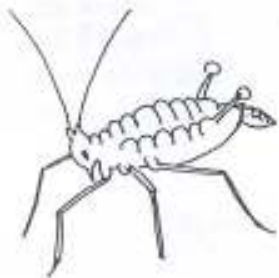
Notice that the gardener is not spraying fruit tree blossom. He has waited until the blossoms are over and the fruit is starting to form. The instructions on the pesticide can would have advised him to do this because spraying fruit tree blossom would poison the pollinating insects visiting the flowers.





Pages 12 – 15 *As the gardener ...*
When the gardener ...

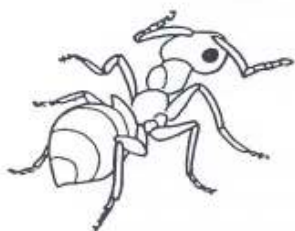
Spraying with pesticide does have the effect of eliminating ladybugs, but the mechanism is more complicated than the story suggests. What actually happens is that carnivorous insects, such as ladybugs, are more susceptible to the effects of pesticide than are herbivorous insects such as aphids. Thus ladybugs die in greater numbers than the harmful pests at which the spray is aimed. For details of how this works, see: PESTICIDES AND THE FOOD CHAIN below.



Pages 16 -17 *The aphids ...*

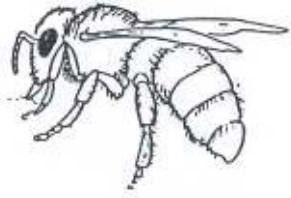
In the picture, the yellow balls on the ends of the aphids “tails” are droplets of honeydew, or aphid excrement. During a heavy aphid infestation often the first thing people will notice is that the plants are sticky. This is caused by the coating of honeydew.

Aphids are unusual in that they can, under favorable conditions, skip the larval stage and give birth to young which are small replicas of the adults. This allows them to reproduce at a phenomenal rate, and is in contrast to the majority of insects which must go through metamorphosis, a complex process in which insects pass through different body forms between egg and adult. For more on metamorphosis, see: LEARN MORE ABOUT INSECTS below.



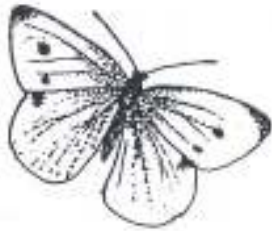
Pages 18 -19 *The ants ...*

Honeydew is one of the major food items of ants. Some species actually take aphids home with them and set up aphid “farms” in their underground nests. They bring leaves in to feed the captured aphids and then “milk” the aphids for their honeydew. In return, the aphids benefit from this arrangement by receiving protection from their natural enemies.



Pages 20 -21 *The bees ...*

Bees are not particular about where they get their sugar, and usually obtain it from the most readily available source. They have not learned to “milk” aphids, as the ants do, and so they just suck up the drops of honeydew left by the aphids on the plants. (Like other nectar-feeders, bees have tubular mouth-parts which work very much like a drinking straw.) In some parts of the world, for example the Black Forest in Germany, the entire honey crop comes from honeydew. Some people think honey made from honeydew tastes inferior to that made from nectar.



Pages 22 - 23 *With fewer flowers ...*

Can the children identify the butterflies in the picture? The white butterfly and green caterpillar are cabbage whites, a major pest of the cabbage family. Despite the fact this is one of our commonest butterflies, most children do not know it by name. They are much more likely to recognize the more spectacular monarch butterfly with its striped caterpillar.



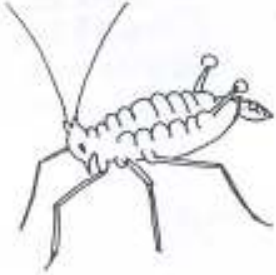
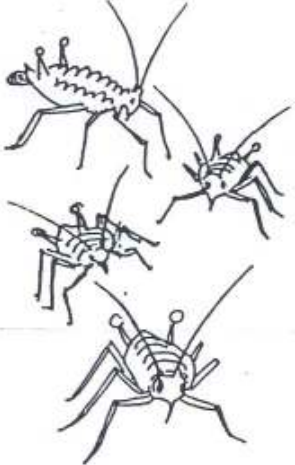

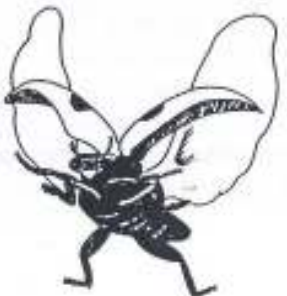
Monarchs are one of our most beautiful and interesting butterflies, remarkable for having the longest migration of any insect, traveling thousands of miles from their wintering grounds in Mexico up through the US to Canada, where they spend the summer. How they find their way is one of the great mysteries of science, for no butterfly making the journey has traveled the route before. Unfortunately, monarch butterfly populations are currently being decimated by habitat destruction in their over-wintering grounds in Mexico.




NOTE: Monarch caterpillars feed exclusively on milkweed. Despite every effort to maintain accuracy, monarch caterpillars are erroneously shown on pea plants. My apologies!



Pages 24 - 25 *Not only ...*

In the spring and early summer wasps feed their larvae with grubs (other insect larvae). The wasp larvae excrete a sugary substance, much like honeydew, which the adult wasps feed on. In late summer, wasp colonies stop producing larvae, and instead the wasps seek sugar from ripening fruit.

	<p>Pages 26 - 27 <i>And all the while ...</i></p> <p>Because aphids are able to skip the larval stage (see notes for pages 16 - 17) they can reproduce themselves more quickly than other insects. Under normal circumstances, aphids numbers are kept under control by the many insect species which prey on them. However, when aphid predators are destroyed by pesticides, aphids multiply at a phenomenal rate and the result is an infestation such as the one we see here.</p>
	<p>Pages 28 - 29 <i>The gardener knew ...</i></p> <p>Just as the amount of blood taken by a single mosquito does very little damage to the host animal, the amount of sap taken by a single aphid would not harm the host plant. However, when a massive infestation occurs, it is more akin to a slow hemorrhage, and the results are curled, withered leaves and deformed or stunted flowers, from which fruit is unable to develop. Aphid infestations not only cause physical deformities, they also weaken plants and make them vulnerable to disease. The honeydew that aphids leave on the plants encourages the growth of fungus and, as noted above (pages 8 - 9) aphids may also spread plant diseases.</p>
	<p>Pages 30 - 31 <i>The gardener didn't ...</i></p> <p>Some species of ladybugs hibernate in large colonies over the winter, and these are collected and sold to suppliers. Ladybugs may be purchased at garden centers and some supermarkets. They can also be ordered by mail.</p>
	<p>Pages 32 - 33 <i>When the box ...</i></p> <p>Note how ladybugs fly. They lift their colorful hard wing cases and unfold the large transparent flying wings, which are tucked up underneath when not in use. The main function of the hard wing cases is to protect the delicate flying wings.</p> <p>These hard wing cases, called elytra, are the distinguishing characteristic of the Order Coleoptera, or beetles. Ladybugs are beetles, not bugs (Order Hemiptera). Beetles are <i>the</i> most successful group of animals, in terms of numbers of species. Over 350,000 species of beetles have been described – that's approximately one third of all the animals named by science.</p>

	<p>Pages 34 - 35 <i>The ladybugs ...</i></p> <p>Ladybugs have a voracious appetite for aphids, and can eat as many as fifty in a day. Both larval and adult ladybugs feed on aphids and other pest species.</p> <p>In 1888, an infestation of the cottony cushion scale insect threatened to wipe out the entire citrus industry of California. In the first documented case of an insect being used for biological control of a pest species, a mere 514 ladybugs were imported, and in less than two years the pests were brought under control. Since then, ladybugs have been used extensively to control aphids, scale insects and mealy bugs all over the world.</p>
	<p>Pages 36 - 37 <i>When the ...</i></p> <p>A garden in late summer suffering from a massive aphid infestation would take time to recover, even with the introduction of ladybugs. The improved health of the garden would not be apparent until the following year.</p>
	<p>Page 38 <i>The gardener smiled.</i></p> <p>He seems to have learnt his lesson!</p>

FOLLOW UP ACTIVITIES:

1) LEARN MORE ABOUT INSECTS

Insects are by far the most numerous animals on earth, in terms of numbers of species: approximately three-quarters of all animals are insects. Insects belong to the joint legged animals, or arthropods, which also include the spiders and their allies - ticks, mites and scorpions - as well as aquatic crustaceans such as shrimps, crabs and lobsters.

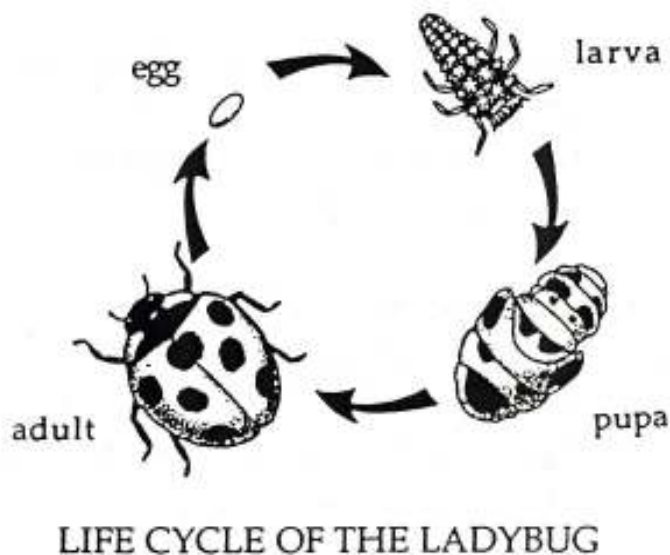


ARTHROPODS: SPIDER, ANT, CRAB

All the joint legged animals have an exoskeleton, which is to say their skeleton or bones are on the outside of the body, not the inside as with us. It's a bit like living in a suit of armor, and it offers the same advantage, for it protects the soft body inside. However, there is one big disadvantage, which is that the exoskeleton can't grow as the rest of the insect does. So the insect grows as much as it can inside this confining armor, and then it literally "bursts at the seams": the exoskeleton splits open and the insect wriggles out. Underneath is a new exoskeleton, which is flexible to allow for expansion, but it's also soft, so it doesn't protect the insect. After a short time the new exoskeleton hardens, but in the meantime the insect is very vulnerable to predators.

Every insect grows through a series of molts, shedding its skin every time it gets too tight. This in itself is amazing enough, but even more astonishing is the way in which insects change their shape. By a process known as metamorphosis, insects change from one body form to another.

Ask yourself if you know what a ladybug looks like when it hatches out of the egg. Very few people would recognize a larval ladybug, because it looks nothing at all like the adult. See the picture opposite for your answer.






Most insects hatch from eggs as a grub-like larva which eats and grows, eats and grows. Some insects, like the grasshopper, gradually become more and more like the adult with each successive molt. Others, like beetles and butterflies, grow to a certain size, then enter a resting phase called a pupa. On the outside the pupa doesn't appear to be doing much, but on the inside it is undergoing a miraculous transformation from the larva into the adult insect. One day the pupal skin splits open, and out comes the adult insect.

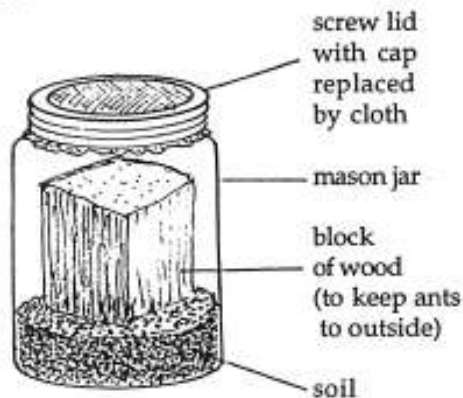
There are many good books on insects, with detailed suggestions for activities. Here are some ideas:

Look for aphids on indoor and outdoor plants. A magnifying lens will help. Notice if there are any other insects associated with them, such as ants or ladybugs, and try to see what they are doing.



<p>In the garden, watch bees visiting flowers. Do the bees seem to have favorite flowers? In other words, do they visit the same kind of flowers or a variety of different ones? Do they visit different flowers on different days? Why do you think they behave the way they do? Record what you see and discuss the results of your observations.</p>	
<p>Buy ladybugs at your local nursery and release them outdoors in a park or garden. Watch what happens and record how many ladybugs you can find over the next few days.</p>	
<p>Look for butterfly and moth pupa. If you find some, keep each one in its own glass jar, with holes punched in the lid for air. (Or a piece of cloth tied over the opening.) Watch it every day for signs of an emerging butterfly or moth. Once the butterfly or moth has emerged, release it where you found it. Note: make sure the jar is plenty big enough to accommodate a large moth or butterfly, or you may injure it. Learn more about butterflies by making a field trip to a butterfly farm.</p>	

• Build your own ant farm:



First, prepare a container as illustrated above, to hold your ants. Put just enough soil in the bottom to hold the wooden block in place, leaving lots of room to add soil with ants in it. Put your container in the refrigerator for a few hours to chill it: this will slow the ants down and make them easier to handle. Locate an ant nest out in the garden. Then, take your container out to the nest and very carefully, dig into it with a hand trowel. Scoop up the soil and the ants together and gently transfer them into the container. (If it's a hot day, you may want to wrap the container in newspaper to stop it warming up too quickly.) Don't forget to collect the ant's eggs as well as the ants. And, if you can find the queen ant (bigger) collect her as well. But be careful not to mix up different kinds of ants (different species).



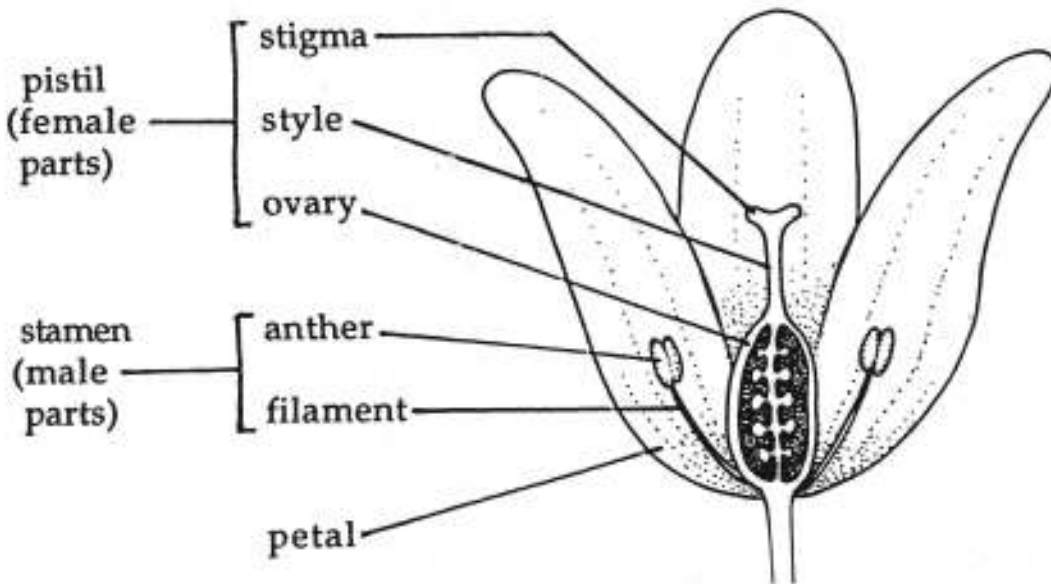
Put the lid on your container, and bring it indoors. Feed your ants with very small quantities of leaves, grass seed, sugar, fruit, vegetables or bread. Watch them build tunnels. After a few weeks release them where you found them.

2) LEARN MORE ABOUT PLANTS

a) FLOWERS AND POLLINATION

Ladybug Garden touches briefly on the topic of pollination. To understand pollination more fully, it is necessary to examine flowers in some detail.

Bring in some large simple flowers such as tulips or lilies, and identify the different flower parts by comparison with the picture below. You may cut open the ovary with a razor blade (careful!) to reveal the eggs inside. A magnifying glass will help you to see them.



A FLOWER CUT IN HALF TO SHOW ITS STRUCTURE

The most conspicuous part of the flower are the brightly colored petals. The petals are visual advertisements designed to attract pollinating insects, which include moths, wasps and flies as well as the more familiar bees and butterflies. Flower fragrance also serves to advertise the presence of flowers, particularly for night flying insects like moths, which are usually attracted to fragrant white flowers. In addition to insects, birds such as hummingbirds and some species of bats also pollinate flowers.

Pollen is produced by the anthers. These are small pads of yellow, orange or brown, borne on top of delicate stalks called filaments. Anthers and filaments together compose the stamens or male parts of the flower. The female parts or pistils, are made up of a hollow structure - an ovary - containing eggs, on top of which is a stalk (the style) with a sticky pad at its tip (the stigma).

In order for a plant to produce seeds (plant embryos), the male pollen (equivalent to sperm) must unite with the female ovum or egg. Because plants are fixed in one place, they must rely on an outside agency, such as wind or insects, to carry the pollen from one flower to another.

Though plants may fertilize themselves, it is usually preferable to ensure genetic diversity by transferring pollen from one plant to another. Most plants have some mechanism to ensure that cross-fertilization takes place. Pollen blown by wind or transported by insects will adhere to the sticky stigma, grow down the tube of the style and enter the ovary, where it unites with an egg.

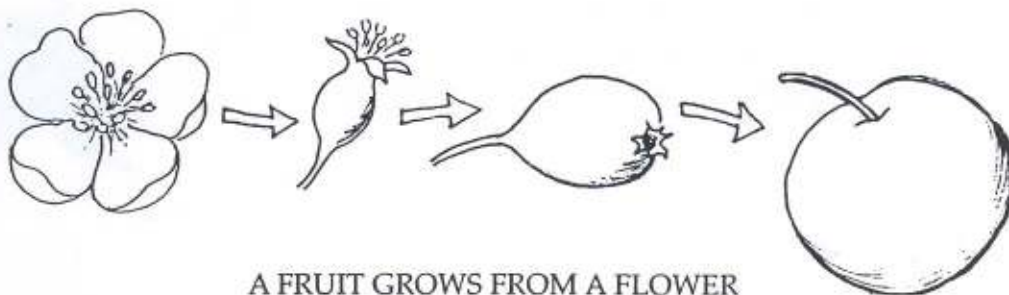
b) VEGETABLES, FRUITS AND SEEDS

The fertilized egg develops into a seed. Seeds must also be dispersed, or the plants would all grow one on top of another. Once again, plants use wind or animals to help them disperse their seeds. Seeds dispersed by wind often have some kind of parachute mechanism to catch the wind. Dandelions are a good example.

Seeds dispersed by animals include burrs, which have little hooks to catch on fur or clothing, and fruits. A fruit is a plant structure which is composed of seeds surrounded by fleshy tissue which is attractive to animals. Fruit may be carried away by animals or eaten on the spot. If the seeds are small, they are usually swallowed whole and pass through the gut unharmed. Later on, at some distance from the parent plant, they will be deposited in a nice pile of ready-made manure!



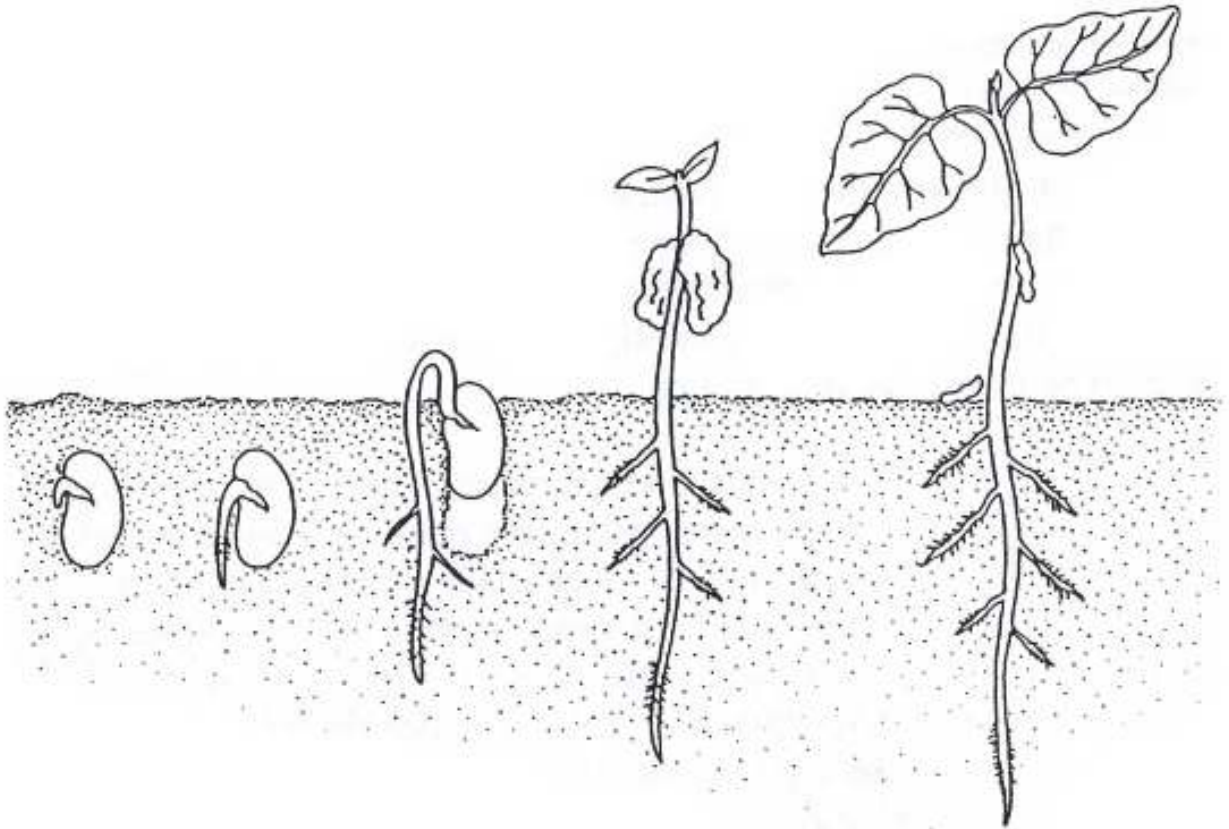
WIND-DISPERSED SEEDS



A FRUIT GROWS FROM A FLOWER

Bring in fruit and vegetables to study. Many of the vegetables we eat are actually fruit. How can you tell? If it's fleshy and contains seeds, then, technically speaking, it's a fruit. Think of all the vegetables we eat that have seeds inside them. Make a list. These are fruit masquerading as vegetables. Now make a list of other vegetables and decide which part of the plant we eat. Is it the leaf, stem, root, flower or seed? Or some other part?


Plant seeds and watch them grow. Quick growing seeds like cress or "sprouts" grow well indoors. Peas, beans and zucchini seeds take longer to sprout, but they are hardy and will grow well outdoors.



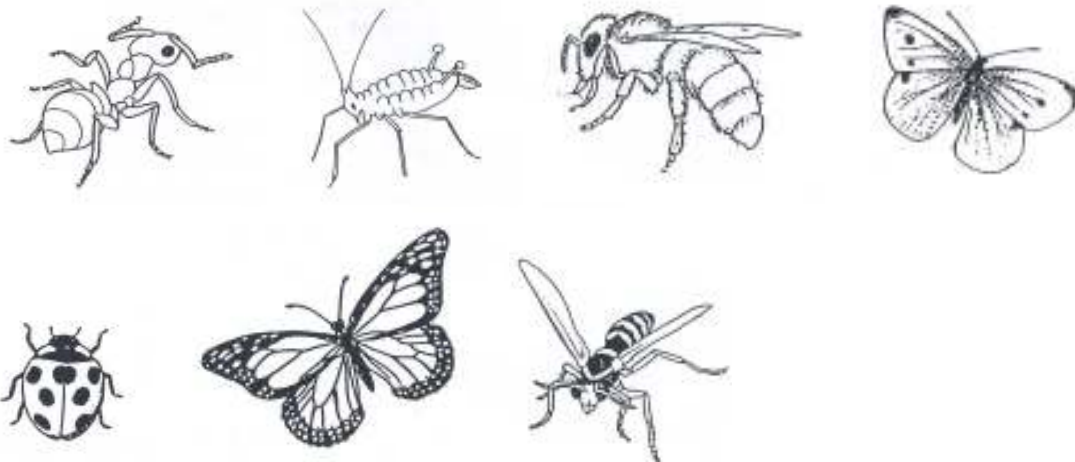
If you are able to carry this activity through several months, you will be able to watch the shoot develop leaves and flowers, and the flowers grow into seed pods (peas and beans) or fruit containing seeds (zucchini). In other words, you can watch these plants complete their life cycles in a single growing season.

In areas with a short growing season, plant frost-hardy snow peas as soon as the ground can be worked outside. Or start plants early inside and transplant when the danger of frost is over.

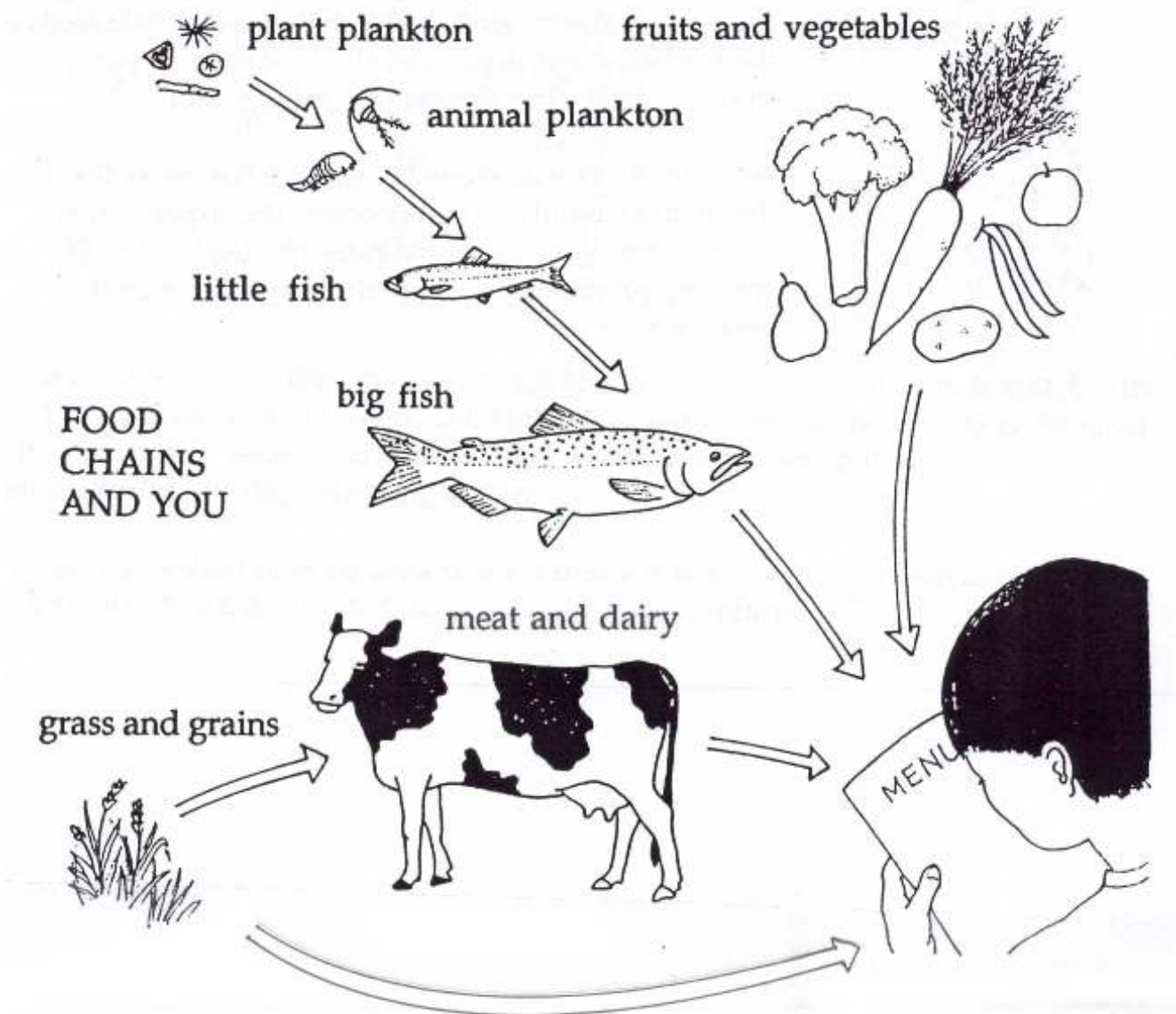
3) PESTICIDES AND THE FOOD CHAIN

 <p>A FOOD CHAIN</p>	<p>The reason pesticide sprays are more harmful to ladybugs than they are to aphids has to do with diet. Many plants contain natural toxins as a deterrent to being eaten. Animals that eat plants (herbivores) have acquired, over evolutionary time, resistance to toxins. Animals that eat animals (carnivores) lack this built-in resistance.</p> <p>Not only do ladybugs lack resistance to toxins, but, as they eat more and more aphids contaminated with pesticides, so the toxins accumulate in their bodies until they kill them. The higher up a food chain an animal is, the more the toxins will accumulate. (A food chain is a succession of organisms living in a natural community such that each link in the chain feeds on the one below and is eaten by the one above. To put it simply: a food chain is who eats whom.)</p> <p>In the food chain illustrated (left), each successive link in the chain accumulated more poison. This explains why birds of prey were more adversely affected by the DDT spraying programs than were the insects at which the poison was aimed.</p>
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Have the children write down what each of the insects in the story eats. Based on their diets, which ones are going to be most affected by the pesticide? Which ones will be least affected?



Have the children make a list of the things they eat in a normal day, and construct food chains from them. They will have to look up the ingredients for some items, such as baked goods. Plants are at the bottom of the food chain, so all the plants they eat (fruits and vegetables) have only one link in the chain. The meat and animal products they eat (dairy and eggs) are fed on plants (grass and grain), and these will have two links in the chain. Do they eat any animals that eat other animals, like fish perhaps? These will have three or more links in the chain.



4) VALUE JUDGEMENTS - GOOD GUYS AND BAD GUYS

In the story of *Ladybug Garden* it's easy to think of the ladybugs as the good guys and the aphids as the bad guys. We use the term "pest" to describe any insect that eats our food or otherwise inconveniences us by, for example, sucking our blood. The good guy insects are those that eat the pests. We call them beneficial insects, meaning they benefit us. In other words, we humans tend to view other creatures with varying degrees of regard, depending on how their activities affect us.

We make similar judgments about plants. “Good” plants are the ones we grow for food or decoration. “Bad” plants are those that are growing where we don’t want them. We call them weeds.

What many people don’t realize is how subjective these categories can be. We’ve already seen how the insects such as the ants and wasps in our story don’t fit neatly into good guy/bad guy categories. Even the bees, who pollinate flowers and provide us with honey, are liable to be viewed as pests when they sting us.

Not only do the good guy/bad guy categories not always fit a given species, but they will often change with the same species from one part of the world to another. For example, in North America we think of cats and dogs as our friends and companions (pets). But in some parts of the world they are seen the way we see rats, as vermin (pests). Similarly, we think of dandelions as undesirable weeds, but in some parts of the world they are harvested for food.



PET OR PEST?

If the children in your class are from different parts of the world, ask them for a list of adjectives to describe a variety of animals commonly associated with humans. Such as cat, dog, rat, mouse, cockroach, spider, moth, fly, mosquito, goldfish, hamster, canary. Discuss the results.