

4 Natural enemies

4.1 Introduction

One of nature's laws is that large animals have long generation times and few offspring, while small ones have short lifecycles and many offspring. Insects produce a huge number of offspring. Sweetpotato stemborer for instance, on average produces 150-300 eggs per female. Suppose that a pair of stemborers has 100 offspring, all of which would survive to become adults. If in a month each female produces 100 surviving and productive offspring again, the growth of the insect population month by month would be as follows:

Generation	Number of pairs	Number of insects
0	1	2
1	50	100
2	2,500	5,000
3	125,000	250,000
4	6,250,000	12,500,000
5	312,500,000	625,000,000
6	15,625,000,000	31,250,000,000

Half a year later the number of insects descended from a single pair is more than 31 billion! Suppose that each insect weighs 0.5 g, then the total weight of the insects descended from the first pair and alive after six months will be 15,625 t. Compare this weight to a good crop of sweetpotato yielding 30 t/ha. It would take more than 500 ha to produce the quantity of sweetpotato equivalent to the weight of the descendents of a single pair of insects six months later.

Many insects, like aphids and planthoppers, can produce far more than 100 offspring per female and their generation times can be far shorter than one month. The question is, then, why are we not drowning in insects? The answer is because there are many mortality factors that reduce the growth of insects and all living things. In addition to unfavorable environmental conditions, population growth of all living organisms is regulated by natural enemies.

4.2 What is a natural enemy?

A natural enemy is a living organism that kills, injures or causes disease in other living organisms. There are three kinds of natural enemies:

- Predators.
- Parasites.
- Pathogens.

4.2.1 Predators

Predators are animals that hunt and eat other animals. Examples include: tigers, snakes, spiders, and ladybird beetles. Predators have to consume many prey individuals in order to fulfil their daily dietary requirements. The bodies of predators are designed to hunt, catch, kill and eat prey. Predators generally have strong teeth or mouth parts, sharp vision and strong legs.

4.2.2 Parasites

Parasites also consume other organisms but by entering the body of their victims and obtaining nourishment from their fluids and tissues, which weakens or even kills them. We call the victim a "host." The parasites that attack insects are usually species of wasps or flies. The winged adult is able to search for a host and then lays eggs in or on the host's body. Insect parasites can be classified as follows:

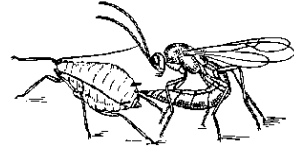
- Egg parasites lay their eggs in the eggs of other insects.
- Larval parasites lay their eggs in or on the larval stage of other insects.
- Pupal parasites develop in the pupal stage of other insects.
- Some parasites develop in the nymphal or adult stage of their hosts.



egg parasite



pupal parasite



parasite of aphid nymph

The developing larva of the parasitic insect lives in or on the egg or body of the host, slowly weakening the host insect which, thus, cannot complete its development. The parasite larva, however, is able to enter the pupal stage before killing the host completely. Some pupae are formed within the body of the host, while other parasites pupate on or near the body of the host. The adult parasite emerging from the pupa usually lives on nectar or pollen. Weed flowers are a main source of food for adult parasites.

4.2.3 Pathogens

Pathogens are microorganisms that cause disease. They enter the body of their host, living and multiplying within, and hence weakening and finally killing the host. Some pathogens require more than one kind of host in order to complete their life cycle. Bacteria, fungi and viruses are kinds of pathogens. Insects attacked by pathogens are usually swollen, exhibit color changes, move slowly, often stop eating and may be covered with a powdery substance. There is a bacterium called Bt that is produced and used as a biological pesticide (Dipel WP is an example of brand of Bt). Bt kills several kinds of pests but does not affect most natural enemies.

4.3 Common natural enemies in sweetpotato fields

The pictures below show some predators commonly found in sweetpotato fields:



Earwig



Rove beetle



Big-headed ant
(Pheidole)



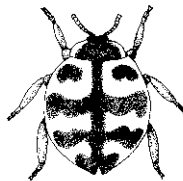
Long-legged ant
(Anoplolepis)



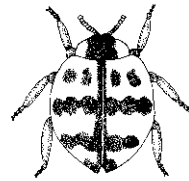
Ground beetle



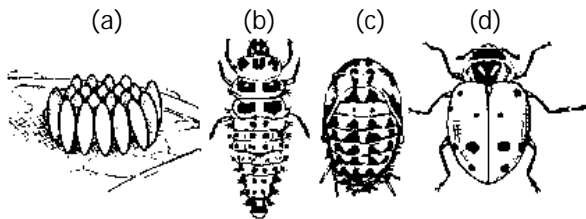
Spider



Two common types of ladybird beetles



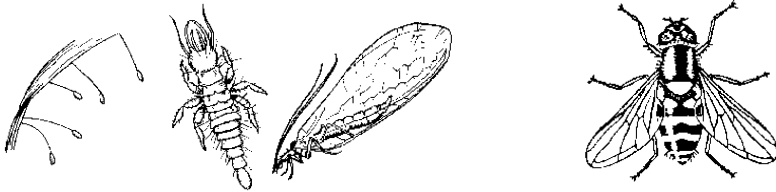
The life cycle of the ladybird beetle: (a) egg, (b) larva, (c) pupa, (d) adult:



Both the larva and adult of the ladybird beetle are predacious. The ladybird beetle is an important predator of aphids. Generally the wings of the adult beetle are red, but some species have yellow wings. Black markings are usually present on the wing. The eggs are easily distinguished by their upright, oblong, grouped arrangement. They are usually yellow or orange.

Other important predators of aphids are the lacewing and the flower fly (syrphid). The lacewing has only three stages in its life cycle: egg, nymph and adult. Adult lacewings are light green. The wings have a netlike appearance. The egg is on the edge of a long stalk. The nymph is the predacious stage.

The flower fly is often found hovering around flowers. Both the larva and the adult are predacious. The larva moves slowly, but eats a great deal. During its development, a single larva can consume 420 aphids. Lacewing and flower fly are drawn below. Some more examples of predators are shown in the color pictures below.



lacewing egg

nymph

adult

flower fly

(BK)

(BK)



(HB)



(ARB)

(ARB)

Predatory ants attacking weevils



A predatory ant of sweetpotato weevil eggs



The larva of the ladybird beetle is an aggressive predator

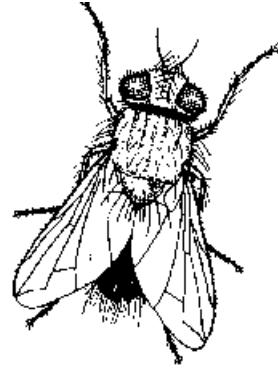


Flower fly (predator)

AR



Common parasites of sweetpotato pests include several kinds of wasps and flies that attack foliage and stemborer eggs and larvae. The parasitic wasps are normally very small and difficult to identify. The picture on the left shows the pupae of a parasitic wasp on the surface of a larval host. The picture on the right shows a parasitic fly.



Common pathogens of sweetpotato pests include the fungus *Beauveria bassiana*, which is commercially available in some countries, and various viruses, such as the one shown in the picture below.

A sweetpotato weevil killed by Beauveria bassiana, a fungus



(ARB)

A hornworm killed by a virus. The way the worm is hanging indicates that the death was caused by a virus infection.



(ARB)

Photographs:

Ann R. Braun (ARB), Bayu Kusuma (BK), Henk van den Berg (HB)

4.4 Natural enemies and pesticides

4.4.1 What are pesticides?

In many local languages words that mean “remedy” or “medicine” to refer to pesticides are often used. Nevertheless, pesticides are not remedies or medicines, but rather poisons that kill. This becomes clear when we look at the formal names and the actual meaning of different kinds of pesticides:

- Insecticide = kills insects.
- Rodenticide = kills rats.
- Fungicide = kills fungi.
- Bactericide = kills bacteria.
- Herbicide = kills weeds.
- Nematicide = kills nematodes (microscopic worms that cause cracking of sweetpotato roots).

Some pesticides interfere with breathing or digestion. Others kill indirectly by interfering with development or reproduction. Whatever the mechanism, the result is the same: the pest is killed. But not only the pest! Other insects, including natural enemies, and even animals and humans can become sick or be killed from exposure to pesticides.

We should avoid referring to pesticides as medicines or remedies and call them what they are: poisons. When we do this we are reminding ourselves and others that pesticides are dangerous and should be avoided whenever possible. If it is absolutely necessary to use pesticides, they should be used very carefully, because they present dangers to environmental and human health.

Insecticides are divided into two main groups based on the way they act. One type is absorbed directly by the insect when it comes in contact with the pesticide; this is called a contact insecticide. The other type must be taken into the body of the insect through food and will poison the insect when it passes through its gut. This is called as a systemic insecticide. Systemic insecticides

are usually applied in granular form to the soil and are absorbed by the plants. They are taken in by insects as they feed on leaves. Generally, contact insecticides are sprayed onto plants. Insects come in contact with them as they move around on the plant. Both types of insecticides are toxic to natural enemies.

4.4.2 Pesticides, natural enemies and pests

Generally natural enemies are more susceptible to pesticides than their prey or hosts. Many pests and diseases have become resistant to chemical pesticides. In the case of insect pests, this occurs because insecticides never kill all the insects in the crop. Those that survive pass on their resistance to their offspring. Insecticide use acts to select the most resistant insects, since only these survive each time an application is made. Natural enemies can be killed directly by pesticides. Alternatively they may die because they have eaten prey or have developed in hosts that have absorbed or consumed pesticides. Natural enemies usually have longer life cycles and produce fewer offspring than plant-eating insects, which makes them more vulnerable to the effects of pesticides. Because they are fewer in number they take longer to recover from exposure to pesticides. In the absence of natural enemies, the expansion in the number of pests proceeds very rapidly, what is known as a population outbreak.

Most farmers have observed that the problem with pests such as aphids, and others of small size, have begun to occur since they began to use insecticides. There are two reasons for this:

- A. Insecticides never kill all of the pest individuals in the field. The insects that survive are more resistant to the pesticide than those that died. The surviving insects are the ones that reproduce and they pass on their resistant characteristics to the next generation. If the insecticide is applied frequently and at high concentrations, the selection of resistant insects will occur rapidly. Insects like aphids that have short life cycles can develop resistance to insecticides very quickly.
- B. Pesticides kill natural enemies. Natural enemies are more susceptible to pesticides than pests are. The life cycle of most natural enemies is longer

than that of pests. This means that it will take a long time for natural enemies to recover their numbers after a pesticide application. Without natural enemies to limit their numbers, pest insects can multiply very fast.

4.4.3 Pesticides and human health

The effect of pesticides on human health can be acute or chronic. When acute poisoning has occurred there are symptoms such as dizziness, nausea, vomiting, blurry vision and trembling. When there is repeated use of pesticides over a long period of time, chronic illnesses can occur. The symptoms include blood pressure changes, heart disease, skin problems, nerve problems and cancer. Pesticides can kill human beings. The World Health Organization of the United Nations has reported that about a million people are poisoned by pesticides every year, 20,000 of which die.

