

## DDT and Malaria

*Contents:* Reading, questions and discussion on the benefits and drawbacks of DDT.

*Time:* 1 to 2 periods, depending on amount of discussion.

*Intended use:* GCSE Biology and Integrated Science. Links with work on malaria, parasites, disease control, insects, food chains and balance in ecosystems. Assumes familiarity with the concept of food chains.

*Aims:*

- To complement and revise work on parasites and disease, and food chains and ecology
- To show the impact of malaria in tropical countries
- To develop awareness of the benefits and drawbacks of pesticides, and a more general awareness that scientific and technological developments may have both positive and negative aspects
- To provide opportunities to practise skills in reading and comprehension, and to encourage students to enter discussion.

*Requirements:* Students' worksheets No. 402. If possible, some packs of insecticides.

The discussion points at the end are best tackled in small groups, although they could also be opened up for class discussion. There may not be time to cover all the points.

### Notes on some of the questions

*Qs 1 and 2* There are a number of points to be made here. Organisms at risk from DDT include those which feed specifically on insects, or on crops treated with insecticides. Organisms at the end of food chains are also vulnerable because of the tendency of DDT to become concentrated along the chain. Birds of prey are particularly affected by DDT, which appears to cause their eggs to have exceptionally thin shells, thus lowering their rate of breeding success.

*Q.3* The resurgence of malaria in the late 1960s has been blamed on a number of factors. In particular, over-confidence following the successful WHO campaign, high pesticide prices, shortages of pesticides, and the establishment of new mosquito breeding sites may all have played a part, though many experts also blame the DDT ban.

### Notes on the discussion points

The quotation by Professor Kenneth Mellanby, of Monks Wood Experimental Station, is from an article in *The Times Literary Supplement*, 21 August 1981.

The accumulation of DDT in the fatty tissue of humans has been a major cause for concern. Humans are often secondary consumers, and as such are subject to the effect of insecticide concentration along food chains. Insecticides can also enter the body from residues on food crops.

Pyrethrum is produced from *Chrysanthemum cinerariaefolium*. It is widely harvested in Rwanda, Kenya, and other parts of Africa. It has no toxic effects on plants and its toxicity to animals other than insects is relatively low. It is effective against insects in very low doses. In terms of environmental acceptability it is a nearly ideal insecticide: the main obstacle to its wider use is cost.

It might be helpful to have one or two samples of insecticide packs for the students to look at when discussing the last point. Alternatively, they could look at some at home.

---

**Other resources**

*Man and the Environment* (2nd edn) by Arthur Boughey (Macmillan) contains a good deal of information on the environmental problems of DDT use. The story of 'Operation Cat Drop' is adapted from this book.

The British Agrochemicals Association, Alembic House, 93 Albert Embankment, London SE1 7TU, has a useful booklet called *The Fight for Food*, putting the case for pesticides. Available free to teachers.

*Acknowledgements* Figure 1 supplied by Shell; Figure 3 is reproduced by permission from *Science* by Graham Hill and John Holman (Nelson); Figures 4 and 5 supplied by United Nations Information Centre.

## DDT AND MALARIA

Every year about 200 million people get malaria in tropical countries, and about two million die of it. Malaria is spread by mosquitoes. The disease can be controlled by using insecticides to kill the mosquitoes. An insecticide called DDT has been very successful in doing this, but it has also brought problems, as you will see in this unit.



Figure 1 A magnified malaria mosquito on a human forearm

### What is malaria?

Malaria is caused by single celled organisms called *Plasmodium*. These parasites are injected into the blood by the bite of a tropical mosquito, called *Anopheles*. Once in the body, the parasites head for the liver, where they feed and multiply. Later they invade the bloodstream. The parasites bore their way into the red blood cells. Inside the red cells, they multiply for a few days, then break out. This causes very serious fever, with high temperature, sweating and delirium. Eventually the fever passes, but it keeps coming back as long as the parasite is present in the body.

The malarial parasite reproduces very rapidly in the liver and the blood. Next time the person is bitten by a mosquito, some of the parasites are sucked into the mosquito's stomach along with the person's blood. The parasites continue to multiply in the mosquito's stomach. They are passed on to the next person the mosquito bites.

The whole *life cycle* of the parasite is shown in Figure 2 on the next page.

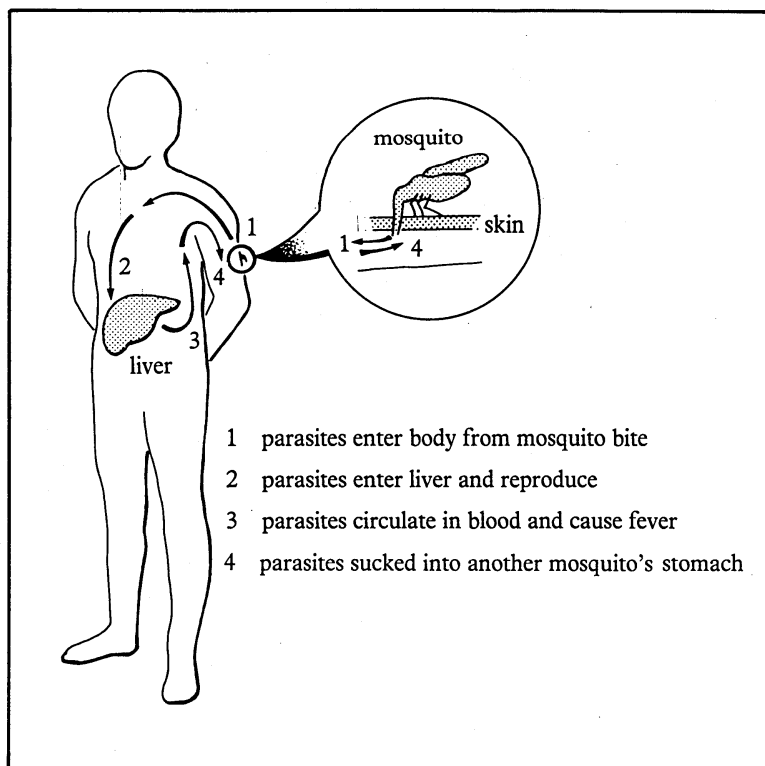


Figure 2 Life cycle of the malaria parasite

Malaria can be cured with medicines, but it is best to prevent it in the first place. This means avoiding being bitten by the malaria mosquito — perhaps by sleeping under a net at night. But the most effective way of preventing malaria is to control the mosquitoes, using insecticide.

## What is DDT?

DDT stands for *dichlorodiphenyltrichloroethane*. It is quite a complicated chemical compound whose formula is  $C_{14}H_9Cl_5$ . DDT is very poisonous to insects. DDT is not as poisonous to birds, animals and humans as to insects, though it is still harmful.

DDT is a very stable chemical. This means it is slow to break down in the environment. So it stays around a long time. DDT stays in the insect's body long after the insect has eaten it. The DDT gets concentrated along food chains, building up in the body from one organism to the next. In this way, organisms at the end of the food chain may get a lethal dose of DDT. Figure 3 on the next page illustrates this problem.

In the 1960s many species of animals, particularly birds and frogs, were found to be affected by DDT. DDT was even found to be present in human milk.

### Questions

- 1 Why are birds and frogs particularly affected by DDT?
- 2 What type of birds do you think are likely to be worst affected by DDT?

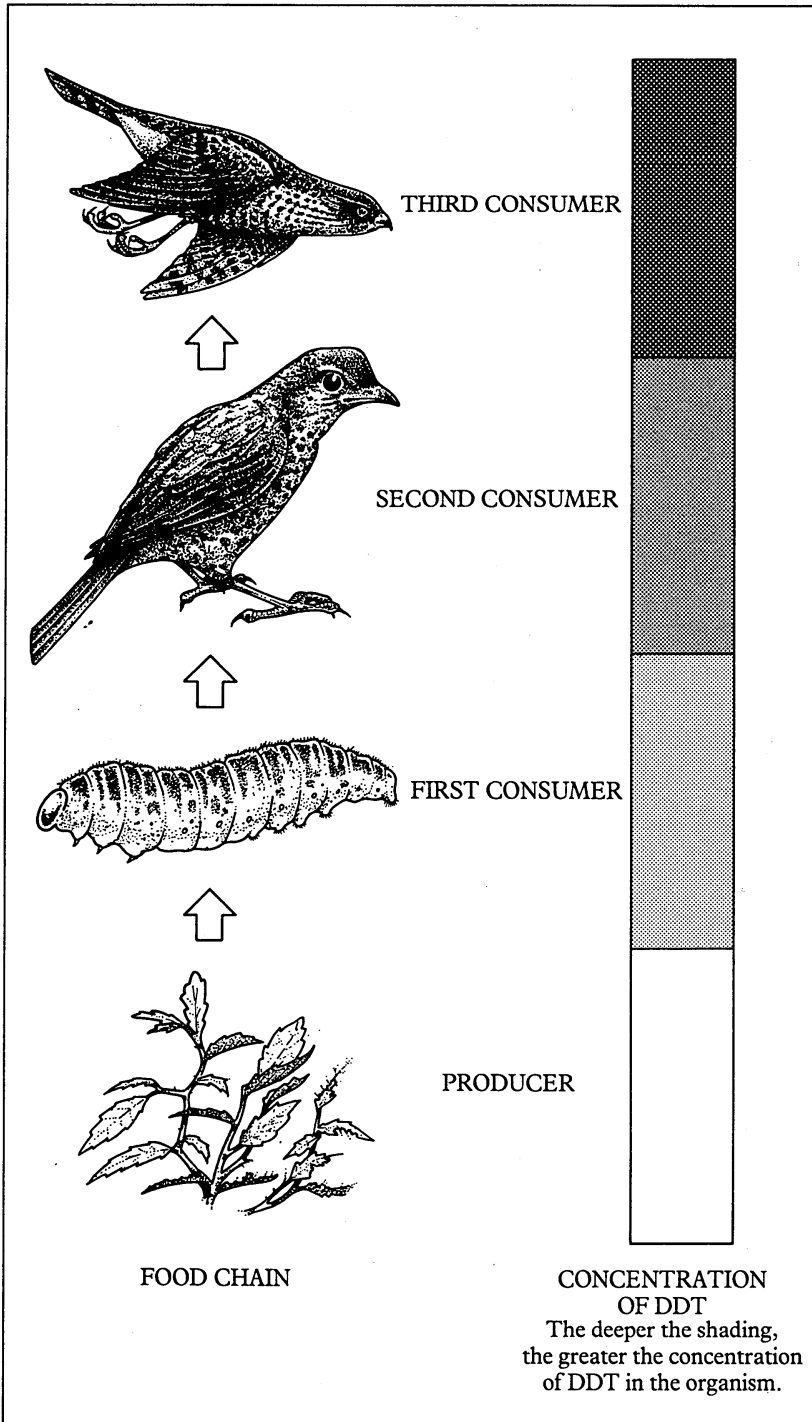


Figure 3 The concentration of DDT along a food chain

**DDT and malaria control**

In 1955 the World Health Organization (WHO) began a programme to try to wipe out malaria using insecticides. DDT was the major insecticide used. The mosquitoes' breeding sites were sprayed with DDT. This greatly reduced their number. The programme was very successful. It has been estimated that in fifteen years, 2000 million malaria cases were prevented, and fifteen million lives were saved.

However, in the early 1960s, people began to be concerned about the effects of DDT on the environment. DDT was banned in the USA, and later in other countries. In 1964 the WHO stopped using it in the anti-malaria programme.

In the late 1960s, malaria began to increase again. For example, in India the number of malaria cases rose from 49 000 in 1961 to 6.5 million by 1976. There were several reasons for this, but one reason was the fact that DDT was no longer being used. Other insecticides were used, but these were less effective than DDT.

### Question

- 3 *Apart from the DDT ban, what other causes could have been responsible for the increase in malaria in the late 1960s?*



Figure 4 A health worker making a 'count' of the larvae of malaria-carrying mosquitoes



Figure 5 A drop of blood is taken to test for signs of the malaria parasite — a routine check among schoolchildren in Comoros.

## Operation Cat Drop: a cautionary tale from Borneo

Read this story carefully, then answer questions 4 to 7.

The Dayak people of Borneo live in large thatched huts called longhouses. At the time of this true story they suffered seriously from malaria. The World Health Organization decided to try controlling the mosquitoes which were causing the disease.

Every longhouse was sprayed with DDT. Sure enough, the numbers of mosquitoes dropped dramatically. This greatly reduced the number of cases of malaria.

Unfortunately, spraying with DDT interfered with other parts of the ecosystem within the Dayak longhouses. Cockroaches lived in the longhouses in large numbers, and were eaten by lizards. The cockroaches absorbed DDT, which became concentrated in the bodies of the lizards which ate them. The lizards were eaten in turn by domestic cats. By the time the food chain reached the cats, the DDT had become concentrated enough to kill them.

With the death of many of the cats, the rat population of the longhouses began to increase. These rats carried parasites, such as fleas and lice, that spread a disease known as *sylvatic plague*. The Dayak people no longer suffered from malaria, but sylvatic plague became common. Eventually a new population of cats was brought into the Dayak community by parachute, dropped from helicopters. These helped to bring the rat population under control.

But this is not the end of the sad story. Caterpillars lived in the thatched roofs of the huts, eating the thatch. If their numbers became too great they seriously damaged the roofs. Spraying with DDT killed the caterpillars, but also killed the predators and parasites which kept the caterpillars under control. Some time after the spraying, the caterpillar population began to grow again. But the populations of predators and parasites were much slower to recover. The result was a caterpillar population explosion. By the time the rainy season came, the thatched roofs of the longhouses had been so badly damaged by caterpillars that they collapsed.

### General points for discussion

You might prefer to discuss these in small groups.

- Professor Kenneth Mellanby, one of the world's leading experts on insects, has said:  
On a world scale, the effects of the American ban on DDT have been disastrous, as it has probably led to more deaths than the 1939-45 war.  
What do you think he meant? Why did he only say the ban had *probably* led to these deaths?
- Consider the benefits and drawbacks of DDT.

<i>Benefits</i>	<i>Drawbacks</i>
Valuable for controlling insect-spread diseases like malaria and typhus	Kills animals other than insects
Valuable for controlling insects which eat food crops	Disturbs the balance of the ecosystem

How do you think these benefits and drawbacks weigh up against each other? Was it right to ban DDT?

- Research in 1964-66 showed that English people had an average of 3 parts-per million of DDT in their body tissues. How did it get there?
- Nowadays many different kinds of insecticides are available. Many of them are designed to break down quickly after spraying. Why is this important?
- Do you or your family use insecticides? If so, what for?
- Some plants produce their own, natural insecticide. This can be collected from the plant and used by humans. An example is pyrethrum, which is produced by one type of chrysanthemum. Pyrethrum is widely used in parts of Africa.  
Why might natural insecticides like pyrethrum be preferable to synthetic insecticides like DDT?
- Have a look at the labels on some insecticide packs. What is the active chemical in the insecticide? Read the safety warning on the pack. What does the warning tell you about the insecticide?

### Questions

- 4 Explain why DDT spraying led to the death of domestic cats in the longhouses.
- 5 Explain why there was an outbreak of sylvatic plague following the DDT spraying.
- 6 Why did the DDT spraying lead to the collapse of the thatched roofs?
- 7 An ecologist has said 'When we use insecticides, we must think of their effects on the whole ecosystem, not just on insects.' Why is this important?