

Box 3.7

The warnings of the DDT story

DDT (Dichlorodiphenyltrichloroethane) is the best known of a number of chlorine-containing pesticides. It was used extensively in the 1940s and 1950s to kill malarial mosquitoes and the lice that spread typhus. As such, it saved millions of lives. Unfortunately, experience proved that DDT had a number of unfortunate and unpredicted ecological consequences, so much so that its use was banned in the USA in 1972 and by 1980 its export from the USA ceased. However, its manufacture and use in less developed countries continues. The main lessons learnt from experience with DDT are:

- DDT is *persistent*, being broken down only very slowly by decomposers. It has a *half-life*, the time taken for half of a substance to degrade, of about three years. This results in environmental accumulation and distribution of the substance. DDT is now found everywhere in the world from the Antarctic ice to the bodies of humans.

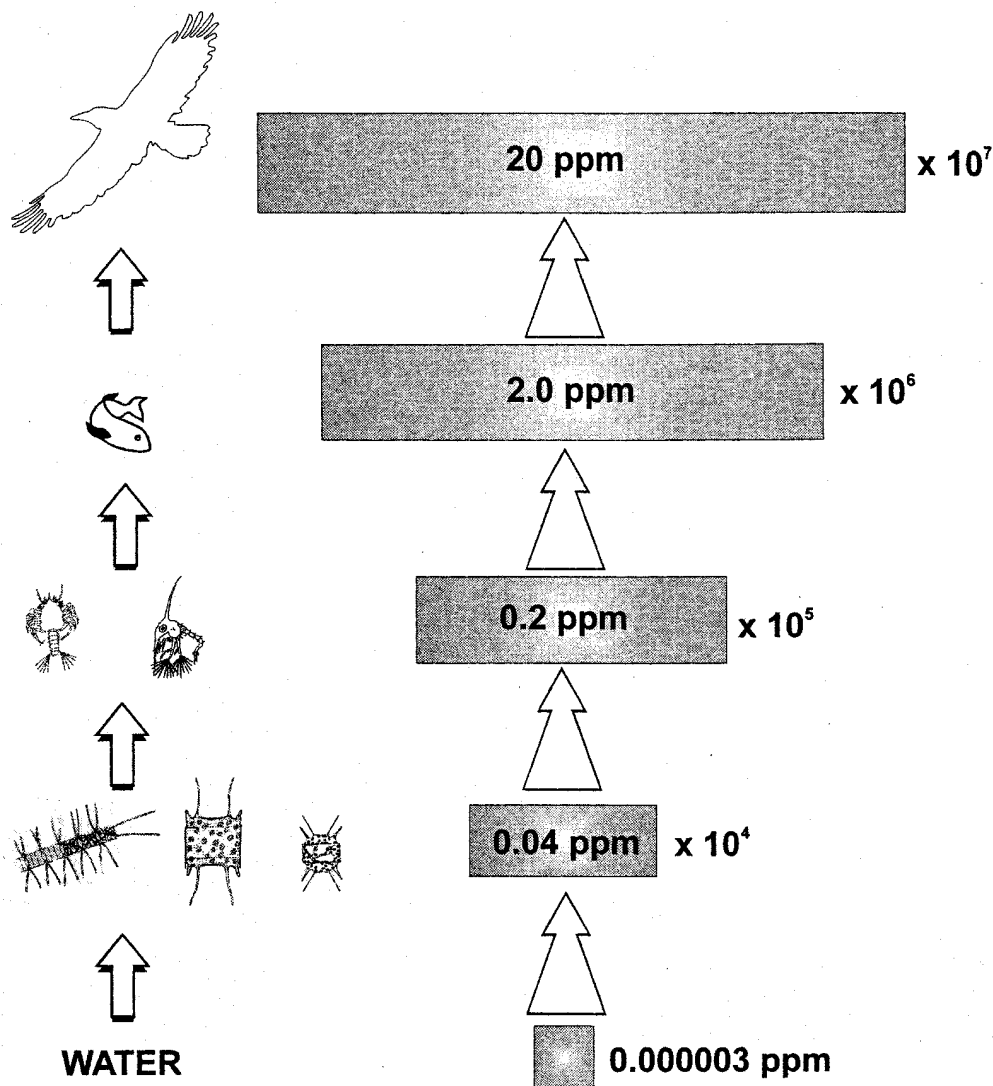


Figure B3.4 Biomagnification of DDT along an aquatic food chain. The concentration factors (relative to that in the water) are shown alongside the boxes. The levels in the top predator may be 7 million times greater

- DDT was the first pesticide to which diverse insect pests developed a *resistance* by evolutionary selection for resistant genotypes in exposed populations. Thirty-four species of the malaria-carrying *Anopheles* mosquito are known to be DDT-resistant.
- The primary breakdown product is DDE (Dichlorodiphenyldichloroethane), produced by dechlorination reactions that occur in alkaline environments or enzymatically in organisms. Unfortunately, DDE is almost as persistent as DDT and is responsible for shell-thinning in predatory birds. Breakdown products must always be considered when the risks associated with chemical releases are being evaluated.
- Bioaccumulation, the retention or building up of non-biodegradable or slowly biodegradable chemicals in the body to produce what is termed a body-burden of a substance, is an important process, especially for persistent materials. DDT is particularly soluble in lipids but not very soluble in water (less than 0.1 ppm) and both it and its metabolite DDE readily accumulate in the fatty body reserves of organisms.

The problem of bioaccumulation is compounded in aquatically based food chains by *biomagnification* (biological amplification), whereby the concentration of a chemical increases at each trophic transfer. This process can result in concentration factors between trophic levels of one or two orders of magnitude and for heavy metals such as mercury, factors of a thousand times have been reported. (Figure B3.4). Concentration factors along the entire food chain may result in the top predator containing several million times the concentrations in the water column.

Although it was clear that high concentrations of DDT would be lethal, other *sub-lethal* mechanisms of ecological and public health impact have become evident. These include a reduction in resistance to diseases, parasites and predators, and a reduction in reproductive capability. Populations of top predator birds such as fish-eating ospreys and bald eagles and rabbit-eating birds of prey declined dramatically in the 1960s. This was not only a consequence of deaths resulting from lethal concentrations of DDT/DDE being accumulated but also because of loss of eggs due to eggshell thinning and shells breaking. This was because DDE reduces the amount of calcium in the shell.

Name _____ Date _____ Period _____

THE WARNINGS OF THE DDT STORY

1. How much DDT is found in the top predator?
 - a. 20 ppm
 - b. 2.0 ppm
 - c. 0.04 ppm
 - d. 0.000003 ppm

2. Which of the following is NOT an effect of DDT or DDE?
 - a. decreased resistance to disease
 - b. increased thickness of eggshells
 - c. decreased reproductive capability
 - d. increased deaths of bald eagles

3. The primary purpose of this article is to...
 - a. suggest ways to lower the amount of DDT in the environment
 - b. warn the reader about the effects of DDE on eggshells
 - c. explain how DDT was used extensively in the 1940s and 1950s
 - d. discuss the problems caused by biomagnification of DDT

4. What event took place most recently?
 - a. DDT was used to kill mosquitos.
 - b. DDT was banned in the USA.
 - c. Populations of rabbit-eating birds of prey declined dramatically.
 - d. DDT was no longer exported from the USA.

5. Explain why DDT and DDE accumulate in many animals in the food chain.

6. Describe the main difference between DDT and DDE.
