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Halogenated biphenyls, terphenyls, naphthalenes, dibenzodioxins and related products

Editor

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CHAPTER 3

Environmental pollution of air, water and soil

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3.1. Introduction

Most of the chapters in this book touch upon environmental contamination by one or more of the compounds discussed. Pollution may be heavy in localized areas where industries have discharged materials into waterways (Environmental Defense Fund, 1977; Mowrer et al., 1977) or have deposited them in dumps that are leaking. If dumps, in addition to the PCBs and other persistent chemicals, also contain solvents, their spread becomes more likely. From such point sources, contamination of the surrounding areas may be extensive and far reaching. In addition, illicit or improper disposal of such chemicals (Dunphy and Hall, 1978a, 1978b) also greatly contributes to the contamination of the environment. Open-ended uses (Chapter 1) as pesticides, flame retardants, additives in paints, to give a few examples, are another source. A number of reviews are available on this subject (IARC, 1978; WHO, 1976; NRC, 1979) for polychlorinated biphenyls, whilst much less information is available on the other compounds. All of these compounds are only very slightly soluble in water, but soluble in lipids and some organic solvents, have a low vapor pressure, and are stable and persistent. Once they have been released into the environment, they will reach the food chain where they are concentrated. Fish and wildlife are the most consistent targets for such contamination, but livestock may also become contaminated and people gradually acquire body burdens of these materials. These chemicals are not very readily taken up by plants, and because they dissolve very poorly in water, they are primarily found in sediments of polluted lakes and rivers. They are also concentrated in municipal sewer sludge if they enter waste treatment plants. If such sewer sludge is used as fertilizer, it contributes fur-

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ther to environmental contamination (Chapter 9A). They may be released into the atmosphere from municipal incinerators (Chapter 2). Their presence as contaminants in commercial products (Chapter 2) is an additional source.

3.2. Polychlorinated biphenyls

3.2.1. Air

Monitoring data is primarily only available for PCBs. Urban areas of large cities in Japan, such as Tokyo, contained 0.02 $\mu g \cdot m^3$ PCBs, while medium-sized cities, such as Matsuyama, had 0.002–0.005 $\mu g \cdot m^3$. The air around electrical appliance factories and paper recycling mills had much higher PCB levels (up to 12 $\mu g \cdot m^3$) (Tatsukawa, 1976; Tatsukawa and Watanabe, 1972).

In the United States, Kutz and Yang (1976) found that the average concentration of PCBs in samples of ambient air from suburban locations was 0.1 $\mu g \cdot m^3$.

3.2.2. Water and sediments

A national survey conducted in the U.S. showed that the PCB levels in unfiltered water samples during 1971–1974 ranged between 0.1 and 3.0 $\mu g \cdot l$ (Dennis, 1976). Kleinert (1976) estimated that the waters of Lake Michigan contain as much as 10 ng/l PCBs.

In Japan, in a survey of the surface water of Suruga Bay, near Fuji, where there are a large number of paper mills which use recycled paper, the levels of PCBs varied from 0.9 to 1.6 $\mu g/l$. Surface water in Tokyo Bay in 1973 contained as much as 0.3 $\mu g/l$ (Fukushima, 1974).

Eichner (1976) found that the PCB levels in the Rhine River and Lake Constance had increased slightly during the period 1973–75, from 0.01 to 0.075 $\mu g \cdot l$.

The average concentration of PCBs in samples of seawater taken from 11 stations off the northwestern Mediterranean coast in 1975 was 0.013 $\mu g \cdot l$ (Elder, 1976).

Nadeau and Davis (1976) found up to 2.8 mg/l PCBs in the water and up to 6700 mg/kg in the sediments of the Hudson River in the vicinity of a factory using PCBs. Dennis (1976) reported that bottom sediments from major drainage basins throughout the U.S. and Puerto Rico contained from 1.2 to 160 $\mu g \cdot kg$.

Sediments from 1445 sites in Japan contained less than 1 mg/kg PCBs, while sediments in the rivers entering Tokyo Bay, where many factories using PCBs are located, contained up to 2.7 mg/kg (Tatsukawa, 1976; Tatsukawa and Watanabe, 1972).

Biodegradation has been a minor factor in PCB destruction for those isomers of tetra- through decachlorobiphenyl.

3.2.3. Soil

In 1972, in the United States, only 0.1% of samples contained detectable levels of PCBs. In urban areas, 12 of 19 soil samples from metropolitan areas (63%) showed detectable levels. A PCB pattern corresponding to 54% chlorine was identified in

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40% of the positive samples, and a pattern corresponding to 60% was recorded in 20% of the samples (Carey and Gowen, 1976). However, the actual number of samples analyzed was small in comparison to the size of the United States.

In Japan, a nationwide survey of soil samples from 88 sites showed that 40% of samples had less than 0.01 μg g PCB, 24% had 0.01–0.10 μg g, 21% had 0.11–1.0 μg g, 7% had 1.1–10 μg g, 3% had 10.1–100 μg/g and 5% had more than 100.1 μg g. As a result of contamination of soil and the atmosphere with PCBs, detectable levels have been recorded in vegetation: an analysis of PCBs in unhulled rice from 33 sites in Japan in 1972 showed that 79% had less than 0.01 μg g, 15% had 0.01–0.10 μg g, 3% had 0.11–1.0 μg/g and 3% had 1.1–10.0 μg g (Tatsukawa, 1976).

3.3. Other halogenated compounds

Extensive background monitoring data for halogenated terphenyls, naphthalenes, dioxins and furans are not available. The isolated instances where environmental monitoring has been done have been in relation to special environmental contamination problems and have been discussed in the other chapters.

One open-ended use of polychlorinated terphenyls and biphenyls is in the investment casting industry. In the vicinity of one such factory in urban Chicago, Illinois, soil levels of 0.17–0.23 mg/kg were found 1000–1900 m away from the plant. The highest concentration was 13 mg/kg at a distance of 20 m from the plant. The chlorinated terphenyls most closely resembled Aroclor 5460. Most likely, contamination of the surroundings of the plant was from airborn particles (Stratton and Sonebee, 1976). Similarly, the polychlorinated terphenyls were also found in sewage sludge from a waste treatment plant which served an investment casting facility in Troy, Michigan.

Jan et al. (1978) have found 0.05–0.90 mg. kg PCT in fat and 0.005–0.80 mg/kg PCT in flesh of fish from Slovenia rivers flowing through industrial areas.

Trace amounts of PCT in the environment have also been reported from Japan (Doguchi, 1977), in a gull egg from the Rhone delta in Europe (Mestres and Illes, 1973) and in eggs and fat from herring gulls from the Bay of Fundy–Gulf of Maine area. Overall, however, the contamination of the environment with chlorinated terphenyls is not nearly as extensive at the moment as with chlorinated biphenyls.

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