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PCB's: Coping With The Indestructible Pollutant

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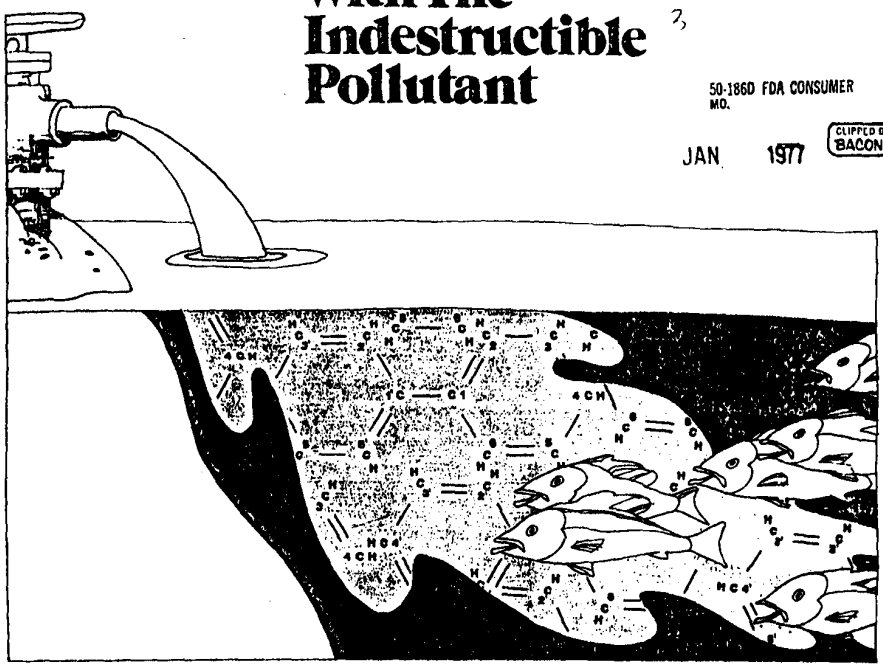
JAN 1977



Although polychlorinated biphenyls have been used for almost half a century, it wasn't suspected until a decade ago that they may be endangering the public health. Use of PCB's is declining now, and a new law will end their production and distribution in the United States in about two years. But FDA will continue keeping a close watch on PCB levels in food, because once this chemical gets into the environment it stays there for a long time.

by Annabel Hecht

It is, as one scientist has put it, an example of toxicology being unable to keep pace with technology. For nearly 50 years, a toxic chemical has been imposed on our environment, yet it is only in the last decade that anyone realized the public health implications of the widespread use of this ubiquitous pollutant with the polysyllabic name—polychlorinated biphenyls, or more simply, PCB's.

PCB's, a distant relative of the pesticide DDT, are a class of industrial chemicals derived from benzene, a highly flammable colorless liquid used in motor fuels, detergents, nylon, pesticides, and other products. First synthesized in Germany in 1881, PCB's were not commercially available until about 1930. Since then, they have been manufactured in the United States by one firm, Monsanto Company, as well as by companies in Europe and Japan. By 1970, U.S. production accounted for about half the world output of PCB's.

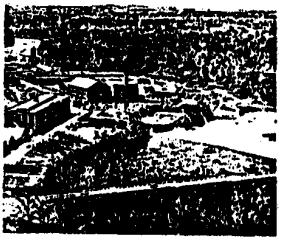
The recently enacted Toxic Substances Control Act calls for an end to PCB production and distribution in the United States over a two and one-half-year period. A few days before the law was signed, the Monsanto Company announced that it would stop producing PCB's by October 1977. While this will reduce direct contamination from PCB's in the United States it will not bring an instant or total solution to the problem. Some PCB's from products already in use in the United States undoubtedly will find their way into the environment. PCB's from products used in other countries also will get into the environment and over a period of time may "migrate" to the United States in the atmosphere or ocean currents.

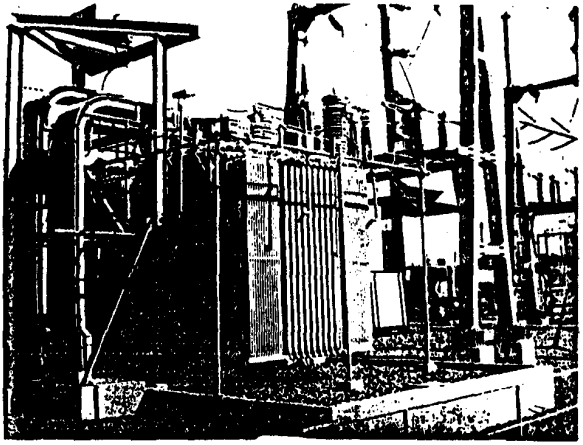
Another reason that halting production will not end the problem is that PCB's are virtually indestructable.

Lake Ontario fishermen who reel in coho salmon like these can mount them as trophies but have been warned not to eat their catch because of high PCB levels.

Employees of the New York State Department of Environmental Conservation (center) trap fish in the Hudson River for analysis and measurement of PCB levels. Although now halted, discharge of PCB's from industrial plants into the Hudson has created a major environmental problem for New York State.

Domestic sales of PCB's now are limited to use in "closed" electrical systems such as this station transformer (bottom) used by a large power-generating company.





They do not decompose in water, acid, or alkalis, and require temperatures up to 650° C. (1,200° F. for complete destruction).

Because they are chemically stable, fire resistant, and do not conduct electricity, PCB's have been widely used as insulating fluids in electrical transformers and capacitors, in heat transfer systems, and in hydraulic fluids where the ability to resist high temperatures is required.

PCB's also have been used in consumer goods. They have been used to make plastic more workable and flexible. They have been put into adhesives, sealants, caulking, paints and varnishes, insulating tape and protective lacquers, lubricants, materials used for waterproofing and fireproofing, fluorescent light starters, printing inks, carbonless (pressure-sensitive) copy paper, and cutting oil. Outdoors they have turned up in substances used to retard the erosion of soil and to dissolve pesticides.

The stability of PCB's may have been a boon to industry, but their persistence has proved to be anything but that to the environment. Each year, millions of pounds of the chemical have been escaping into the environment—dumped into rivers and waterways through industrial waste and accidental spills, leaked into the soil from trash in dumps and landfills, and carried into the air from burning of waste and from vapor escaping from paints and coatings. It is estimated that over the past 45 years 1.25 billion pounds of PCB's have been produced and used in this country. Of this, about 50 million pounds have degraded and 750 million pounds are still in use. That leaves about 450 million pounds of PCB's in the environment.

Although there had been reports in the 1930's of skin eruptions, called chloracne, and other symptoms as a result of occupational exposure to PCB's, not much thought was given to the possibility that the chemical presented a threat to the public health until 1966 when a Swedish scientist found PCB's in fish. The fish were first thought to contain the pesticide DDT, which is chemically similar to PCB's. Subsequent findings of PCB's in birds and other wildlife in remote parts of the world showed that contamination of the environment had become global.

Then, in 1968, an incident in Japan confirmed that the health of man could be affected by the commercial product. A substantial number of people ate rice oil contaminated with PCB's that had leaked from a heat exchange unit during processing of the oil. Many of those who ate the rice oil developed some adverse reactions, among them severe symptoms of weakness, numbness of the limbs, dark pigmentation of the skin, swelling of the eyelids, and disturbances in liver function. Babies born to mothers who had eaten the oil had skin discoloration which disappeared in time.

Fortunately for U.S. citizens, the Food and Drug Administration had started the wheels moving to protect the Nation's food supply from PCB contamination even before the Japanese misfortune. In 1967, FDA began a project to devise a means of separating PCB's from chlorinated pesticides encountered in the analysis of food. In July 1969, FDA laboratories throughout the country were provided instructions for the new analytical method, and by November 1970, analysis for PCB's was routinely included in both FDA's pesticide surveillance program and total diet studies. Under these programs, samples of fresh fruits and vegetables, dairy products, shell eggs, grains, fish, animal feeds, and processed foods were analyzed for a variety of chemical contaminants.

In 1971, the U.S. Department of Agriculture began sample testing of meat and poultry for PCB's and both that department and FDA have kept a close watch for PCB contamination in food during their regular inspection activities.

West Virginia was the site of one of the first documented cases of PCB contamination of food in the United States. In July 1969 FDA scientists found PCB's in milk from several dairy farms near Martinsburg. The source of contamination was traced to used transformer fluid that had been used as a base for an herbicide which had been sprayed near the cattle grazing areas. Advised that FDA would not permit interstate shipment of the contaminated milk, State officials halted marketing from the affected farms.

Within the next 2 years, seven more incidents of avoidable PCB contamination of food were investigated by FDA, the Agriculture Department, and State officials. In one case, chickens had been fed rations containing ground bread cartons and wrappers which may have contained PCB's. In another case, heat transfer fluid leaked into fishmeal which, in turn, was fed to poultry and catfish. This was probably the most serious incident of PCB contamination of the food supply and led to recall or seizures of poultry, eggs, fish, and feeds in a 10-State area by FDA and the Agriculture Department.

In several other cases, PCB's in paint and sealant used inside silos migrated into cattle feed and ultimately were detected in milk. This situation occurred again in 1976 when PCB's in two samples of milk were traced to silos coated with PCB-contaminated sealant.

FDA analysis of food samples during 1969-1971 indicated that PCB levels were relatively low in all foods except fish, milk, cheese, eggs, and by-products used in animal feeds. No PCB's were found in cereal grains and fresh fruits and vegetables. For the most part, PCB's in animal feeds were traceable to isolated industrial accidents and were not a widespread problem. PCB's in milk, however, were caused by their presence in paint or other coatings used in silos and this was a problem of wider magnitude.

PCB's were found in fish samples collected throughout the country, however, with the highest levels found in fish caught in waters near industrial and metropolitan centers. Early in 1970, FDA established an interim regulation—called an "action level"—forbidding the interstate shipment of any fish that contained more than 5 parts of PCB's per million parts in the edible flesh of fish.

The complexity of the PCB problem was only beginning to be realized. In July 1971 a new source of PCB contamination was revealed when low level residues of the chemical, found in breakfast cereal samples, were traced to the package the product came in. The manufacturer of the packaging material had used about 95 percent recycled paper, including carbonless copy paper which contained PCB's. A nationwide survey undertaken by FDA later that year showed that 36 percent of food packages sampled had PCB residues ranging up to 338 parts per million and that there was a definite correlation between the presence of

The use in silos of paints or sealants containing PCB's has been identified as one of the causes of PCB contamination of milk. The chemical can migrate into the feed and then turn up in the milk of cows that eat the contaminated food. FDA now prohibits the use of paints or other materials containing PCB's in animal feed storage areas.

In a number of instances chickens have become contaminated with PCB's by eating feed that contained the chemical. Most of the occurrences of PCB's in animal feeds have been caused by isolated industrial accidents.

PCB's in the packaging and the use of recycled paper in the packaging material.

To strengthen the Government's efforts to protect the public from actual or potential harm, a task force was established in September 1971 composed of representatives of the Federal agencies most concerned, including FDA. The report of the task force, published in May 1972, recommended restrictions on the use of PCB's, rather than an outright ban, based on the belief that such restrictions and better housekeeping during manufacture, use, and disposal of PCB's and products containing them would gradually eliminate these chemicals from the environment.

Even as the task force worked, FDA was preparing regulations to set temporary tolerances for indirect PCB contamination of food, animal feed, and packaging. Taking into account the average daily intake of food that might contain PCB's and the levels of PCB's found in surveillance programs, the Agency set tolerances which would provide an adequate margin of safety for the public and at the same time minimize the economic impact on the food and feed industries. Published in 1973, the temporary tolerances were as follows:

- 5 ppm (parts per million) in the edible portion of fish and shellfish.
- 5 ppm in the fat of poultry.
- 2.5 ppm in the fat of milk and manufactured dairy products.
- 0.5 ppm in eggs.
- 0.2 ppm in finished animal feed.
- 2 ppm in animal feed components of animal origin.
- 0.2 ppm in infant and junior foods.

The regulations also prohibited the use of PCB's in new equipment or machinery used by the food, food packaging, or animal feed industries and in coatings or paints for use in animal feed storage areas. To preclude accidental PCB contamination, manufacturers of food-packaging materials, human food, and animal feed were required to replace heat exchange fluids containing PCB's with fluids that did not contain this chemical. They also were required to eliminate, wherever possible, equipment, machinery, and materials containing PCB's that could contaminate packages, food, or feed.

An action level of 10 parts per million was set for PCB's in paper food-packaging material except where there is a barrier through which PCB's cannot pass between the package and the food. This action level was established pending a public hearing on the issue.

Because of FDA's efforts and com-

pliance by the affected industries, there have been no "PCB accidents" involving food or feed in interstate commerce since 1972, other than the two silo incidents. Except for fish, the rate of occurrence of PCB's in samples of various types of food analyzed by FDA had dropped to less than 1 percent by 1975. Samples of meat and poultry checked by the Agriculture Department also showed a significant decline in PCB occurrence.

Fresh water fish remain a problem, though not a major one in terms of the Nation's total diet. In 1971, Monsanto Company, sole U.S. producer of PCB's, limited its domestic sales of the product to use in "closed" electrical systems such as hermetically sealed electrical transformers and capacitors.

Monsanto's restrictions helped reduce, to some extent, the amount of PCB's entering rivers, lakes, and streams, but it did not eliminate the PCB's already there. PCB's have a nasty way of accumulating in the flesh of fish (and other animals and humans) that eat them. In some instances the PCB levels in fish have been found to be hundreds of thousands of times higher than the PCB levels of the water in which they were caught. Thus, even a low level of PCB contamination in water can lead to high levels of the chemical in fish and other aquatic life. This is particularly true of older, larger, oily fish.

While the overall percentage of fish containing PCB's has declined, the percent with more than the permissible 5 parts per million has remained about the same. Areas where these high level fish have been found include the Hudson, Mississippi, and St. Lawrence Rivers, and Lakes Michigan, Ontario, and Onandaga. Coho and chinook salmon, steelhead trout, striped and smallmouth bass, carp, eel, rock bass, and catfish are among the species most affected. It should be stressed that these are fresh water fish which represent a very small part of the national fish diet, although in some areas fresh water sport fish are a significant part of the local diet.

The problem is not just a local one, however. Lake Michigan carp have been used to stock private fishing lakes in Illinois, Ohio, Indiana, and Missouri. Migratory fish, such as striped bass and shad, spawn in the Hudson, then go out to sea, and Great Lakes salmon, loaded with PCB's, have been seized by FDA inspectors on the West Coast where they had been shipped for processing.

In February 1976, FDA endorsed a decision by New York State to ban commercial fishing—except for shad—in the Hudson River and to advise the public not to eat Hudson River fish or salmon from Lake Ontario. Michigan also has warned the public against eating sports fish caught in Lake Michigan. A two-year study, funded by FDA, revealed that people who eat Lake Michigan fish have more PCB's in their blood than people who do not. But no adverse health effect could be identified in the study population.

Laboratory studies have shown that commercial PCB mixtures can cause damage to test animals. PCB's affect the reproductive ability of mink and monkeys. Liver damage has been produced in chickens, rabbits, quail, and rats. Monkeys fed PCB's developed reproductive problems, liver disease, acne, eye inflammations, weight loss, and loss of hair. Of particular concern is the finding that PCB's produced liver tumors in mice and rats.

Except for people who have been exposed to high concentrations of PCB's on the job or who have consumed large quantities of PCB-contaminated fish, the population at large has had minimal exposure to these chemicals. Still, PCB residues have been found in human fat tissue.

It has been estimated that 51 percent of the population has detectable levels of the chemical in their bodies. Preliminary findings from a national study of insecticides in human milk revealed that 65 of 67 women were found to have measurable amounts of PCB's in their milk. A group of experts in pediatrics and toxicology who studied the findings to date agreed that women should not be advised against nursing their babies. No illness has been reported in the United States, other than from occupational exposure, that can be directly connected with PCB's, although what long range effect they will have on human health is yet to be determined.

While Congress debated the merits of the Toxic Substances Control Act, efforts were being made on a number of fronts to prevent future pollution from the diehard chemical. The American National Standards Institute issued guidelines for industry on the use, disposal, and labeling of PCB's. The Department of the Interior now prohibits the use of PCB's in offshore oil drilling equipment.

The Environmental Protection Agency (EPA), which is charged with protecting the Nation's waterways from pollution, has issued regulations to prevent spills of hazardous substances, including PCB's, and has proposed regulations that would prohibit practically any discharge into waterways of industrial wastes containing PCB's. These regulations would apply to manufacturers of PCB's and manufacturers of transformers and capacitors that use PCB's.

Earlier this year, EPA recommended carefully controlled incineration as the best method for the disposal of industrial wastes containing PCB's.

A number of States have enacted or are considering legislation limiting use of PCB's to closed electrical systems, including Michigan, Minnesota, Indiana, Wisconsin, Illinois, and New York.

An assessment of the effects of PCB's on health has been made by a task force of the U.S. Department of Health, Education, and Welfare made up of representatives from FDA, the National Cancer Institute, Center for Disease Control, National Institute for Occupational Safety and Health, and National Institute for Environmental Health Sciences. In its report, issued in July 1976, the group called for more research on the chemical components of PCB residues and on the effects of these chemicals on man and animals. Specifically recommended were long-range health studies of people who consume substantial amounts of fresh water fish which have high levels of PCB's.

FDA will conduct an expanded surveillance program for PCB's in fish and other foods and continues to encourage other Federal and State agencies to step up their efforts to control the entry of PCB's into the environment. And although the use of PCB's is declining, their tenacity in clinging to the environment means that all responsible agencies will have to devote considerable resources to the control of PCB's for years to come.

Annabel Hecht is a staff writer with FDA's Office of Public Affairs.