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Science

Controversy continues over PCB's

Scientists search for definite cause-effect relationship between PCB's in environment and birth defects found in wildlife

Widespread headlines were generated earlier this year when 50,000 turkeys in Minnesota, as many as 88,000 chickens in North Carolina, and tens of thousands of eggs at various locations were destroyed after they were found to be contaminated with polychlorinated biphenyls (PCB's). Similar headlines have accompanied other findings that indicate that PCB's are extensively distributed in the environment. PCB's have been found in U.S. and foreign waters, in zooplankton in the ocean, in many species of fish, and in a variety of wild fowl. But even though high concentrations of PCB have been associated with various birth defects in birds and in animals, a definite cause-effect relationship has never been established.

Biological cause-effect relationships are, of course, inherently difficult to establish. The most obvious example involves cigarettes and cancer: That a link exists between smoking and cancer has been recognized for some time, but that smoking causes cancer has never been conclusively proved. Other such links that are the subject of continuing investigation include those between hormones and homosexuality, viruses and cancer, and PCB's and birth defects.

Persistent. PCB's have been known for nearly a century, and have been used extensively since the 1930's. Chemically, PCB is a generic term covering a family of partially or wholly chlorinated isomers of biphenyl; commercial PCB's (42 to 60% chlorine) may contain as many as 50 different detectable isomers. Furthermore, PCB is a colorless, highly viscous fluid that can withstand temperatures up to 650° F. without degradation, does not conduct electricity, and is resistant to fire. Such properties make PCB an ideal fluid for heat exchangers and electrical equipment such as transformers. These properties also make the more highly chlorinated PCB's very resistant to degradation in the environment, so that their persistence is similar to that of DDT.

Monsanto Co. is the only U.S. producer of PCB, although PCB's are also made in Japan, Europe, and the U.S.S.R. Monsanto, however, is the only company that has released production figures: Since 1960, the firm has made some 353,000 tons of PCB, with output reaching a maximum of 42,500 tons in 1970 (C&EN, Dec. 6, page 15). About 60% of that output has been for closed-system uses and much of the remainder has been either recycled or safely destroyed. Nonetheless, a certain amount has apparently been allowed to enter the environment, where contamination continues to be detected.

Contamination. Last month, for example, Dr. George R. Harvey of Woods Hole Oceanographic Institution revealed that PCB at levels ranging from 1 to 100 p.p.b. have been found in nearly all animal and plant species from the Atlantic Ocean. Levels as high as 1.5 p.p.m. were found in zooplankton, Dr. Harvey says, but corresponding PCB levels were not found in fish that feed on the zooplankton.

Also last month, Rep. Gilbert Gude (R.-Md.) disclosed that the Maryland Department of Natural Resources has found PCB at levels as high as 0.2 p.p.m. in soft-shelled clams taken from the Chesapeake Bay. This level is well below the Food and Drug Administration's guideline of 5 p.p.m. PCB in fish and poultry. Rep. Gude points out, however, that the clams were contaminated with other chemicals, mostly pesticides, and it is not known whether combinatorial or synergistic effects can occur. Maryland is currently beginning a study to determine if other species in the bay contain PCB.

The November issue of *Natural History* magazine described a three-year study of birth defects among terns on Great Gull Island in Long Island Sound. One specimen found on the island, a four-legged chick that lived for three days after hatching, is shown in the accompanying photo. The authors, Helen Hays of the American Museum of Natural History, New York City, and Dr. Robert W. Risebrough of the University of California's Bodega Marine Laboratory, Bodega Bay, say they also found birds with no flight feathers, with twisted mandibles, and with stunted extremities. The two workers attribute the high incidence of deformities to pollution in the sound.

Dr. Risebrough says the median concentration of the pesticide DDE in the flesh of all terns was 2.1 p.p.m.—about the same level found in other wild birds, and sufficient to account for the observed thinning of eggshells. The concentration of PCB in the flesh



Four-legged tern on island in Long Island Sound lived only three days after hatching

of the birds, however, ranged from 5 p.p.m. to 175 p.p.m. Despite these high levels, he points out, no cause-effect relationship between PCB levels and birth defects has been established for the terns.

Laboratory tests in the Netherlands, Dr. Risebrough notes, have shown that fertile chicken eggs injected with chlorinated dibenzofurans, a PCB contaminant, produce similarly deformed chicks. Monsanto, however, says that U.S.-made PCB's do not contain that contaminant.

Ospreys. Dr. Risebrough has also collaborated with Paul R. Spitzer of Cornell University to examine ospreys inhabiting the Long Island Sound area. Their results, disclosed last month, indicate that the ospreys may be more contaminated than any other wildlife in North America. They found that lipids of both viable and overdue osprey eggs obtained from the shore of the sound have PCB levels varying from 545 to 2270 p.p.m.

Another Cornell worker, Dr. David B. Peakall, has found strong evidence of chromosomal damage in ring doves fed food containing 10 p.p.m. PCB. His preliminary results, sent to the Environmental Protection Agency in September, indicate that all hatchings from the first generation of birds were normal. When the hatched doves were mated, however, only 20% of the embryos survived. Dr. Peakall is continuing his work in an effort to find why the damage is manifested only in the third generation.

Firm. Monsanto, meanwhile, continues to stand firm behind its contention that there is no "scientific data that indicate polychlorinated biphenyls may cause birth defects." A company spokesman indicates that Monsanto has sponsored several feeding tests and a teratogenicity study, all of which indicate only minimal effects from PCB's. Rats fed food containing 100 p.p.m. PCB, for example, showed only slightly increased liver weights after 18 months. Dogs fed a similar diet exhibited a tendency not to gain weight as well as expected. Chickens, however, were observed to exhibit loss of weight, thinning of eggshells, and decreased hatchability of eggs, although no embryonic deformities were observed.

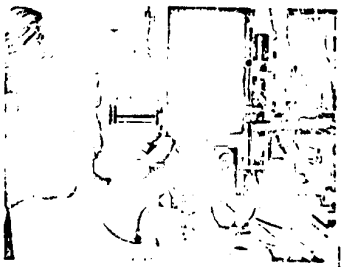
Clearly the PCB file isn't closed. Monsanto's withdrawal of PCB from the market for uses where end products can't be controlled will reduce the amount of PCB entering the environment. But until a cause-effect relationship between PCB's and birth defects can definitely be proved or disproved, controversy will surround any use of PCB at all.

Stanford system separates living cells

A system devised by a Stanford University team for sorting living cells will have immediate application in the study of the body's immunochemical system, its developers say. The system enables investigators to separate specific cells capable of producing antibodies from a general population of cells. The key to the sorting process is selective tagging of cells with fluorescent substances followed by excitation with a laser beam and photoelectric detection of the fluorescing species.

The development team, which includes geneticists Leonard A. Herzenberg and H. Russell Hulett, pathologist Paul L. Wolf, and engineers William A. Bonner and Richard G. Sweet, says that important clinical applications of the cell sorter will include rapid differential counting of immature red blood cells, malaria organisms, fetal cells in maternal blood, and possibly a complete white blood cell count. Future uses may also include the separation of cancer cells from the blood stream.

The sorting technique makes use of an antigen—a substance, usually protein, polysaccharide, or lipid, which, when introduced into the body, stimulates the production of antibodies. In the separation process, an antigen tagged with a fluorescent material such as fluorescein is added to living cells in suspension in a test tube. The added reagent attaches to cells having particular immunochemical characteristics and only those cells become "stained." Greater sensitivity is possible with a "sandwich" technique, Dr. Herzenberg says, in which cells with surface sites that bind particular antigens are made fluorescent by addition of the antigen first, followed by addition of a fluorescent-tagged antibody specific to that antigen.



Engineer Bonner adjusts cell separator

Air pressure then forces the cells through a nozzle in a fine stream 0.002 inch in diameter. The cells pass through a laser beam, and fluorescent light emitted by the stained cells is converted into electric signals by a photomultiplier tube. A signal pulse is thus generated whenever a fluorescent cell crosses the laser beam.

The stream is broken into a series of uniform droplets downstream of the laser by vibration of the nozzle. The signals from the photomultiplier cause a voltage to be generated and applied to the stream. The delay between each signal and charge corresponds to the time it takes the cell to move from the laser beam to the point where the drops break off. Thus, a charge is given to the drops containing fluorescent cells as they break off. The drops then pass between two electrostatically charged deflection plates and are deflected to containers.

