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PCBs Revisited

"PCB in Eggs Dooms 300,000 Chickens"
"PCB Warning on Mississippi"
"Stricter PCBs Rule Delayed"
"Equipment Is Dismantled at Plant with PCB Leak"

Recent weeks have seen an increase of news stories across the country about PCBs. This month *Environment Midwest* takes another look at this group of toxic chemicals: what EPA is doing about them and what remains to be done. We also bring you up to date on the work of Dr. James Allen, a leading researcher on the health effects of PCBs on primates, and of Dr. Douglas Hallett, whose work is with herring gulls on the Great Lakes.

By Susan Nelson

As *Environment Midwest* went to press, blood tests and breast-milk samples were being considered in the West for residents of nine States who had possibly been exposed to PCBs in their food. Health officials had found PCB contamination in food or animal feed in Idaho, Utah, Montana, Washington, Oregon, Iowa, North and South Dakota, and Minnesota. And the list of States seems sure to grow.

PCBs—polychlorinated biphenyls—have been called one of the most persistent toxic pollutants in the environment. Members of a broad family of organic chemicals known as chlorinated hydrocarbons, PCBs were discovered in the late 1800s but were not used industrially in the United States until 1929.

Between 1929 and 1971, however, PCBs came into wide usage in industry. Their chemical and thermal stability, fire resistance, and good conductivity were properties that suited them for electrical transformers and capacitors. Other properties of PCBs were well-matched to the manufacture of such various products as plasticizers, adhesives, paints, carbonless carbon paper, inks, and lubricants.

In 1966 Swedish scientists began to speak and write of the toxicity of PCBs. In 1968 some 1,200 people in Japan were accidentally poisoned after they used cooking oil that had been contaminated with PCBs. Health symptoms—skin lesions, constant abdominal pain, numbness and pain at the limbs, menstrual disturbances, babies born with abnormally dark skin, forms of cancer, changes in the blood—have been and continue to be documented by scientists who have followed up on what is now called the "Yusho" incident.

Manufacturers of PCBs and those who transported and used the chemicals began to reduce and restrict PCBs in the early 1970s. In 1976 EPA banned the manufacture of PCBs. On July 2, 1979, EPA announced the total ban on use and transport of PCBs, except by EPA-approved permit.

EPA's Region V Toxic Substances Office sent registered letters to the Region's 2,837 known users of PCBs before the ban. (The largest users are transformer repair or service companies; heavy industries, including steel producers, that use transformers, capacitors, and hydraulic systems; and utility companies.) The Toxic Substances staff has responded to more than 2,000 PCB-related telephone inquiries. And, as part of a nationwide program EPA began in January of this year, the staff has been making compliance inspections of known PCB users. Results of these inspections are being evaluated for potential EPA enforcement actions.

Why all the attention paid to something the eye can't even see?

PCBs are harmful. Once they are released into the environment—as they were before regulations and the ban, as they continue to be when improperly disposed of—they do not break apart into new, less harmful chemical arrangements. Instead they remain bonded together (chlorine molecules and biphenyl molecules) and bioaccumulate in organisms throughout the environment.

In other words, PCBs that have been discharged into waterways, for instance, will remain there, or in the bottom sediments, where organisms that inhabit those waterways feed on PCB-contaminated matter. These organisms—from microscopic plankton to small fish to large fish and gulls to man—retain PCBs in varying levels in their bodies, particularly in the fatty tissues and the organs. As PCBs move up the food chain, from lesser organisms toward man, their concentration increases.

The same pattern is followed if PCBs are accidentally mixed with poultry feed, for instance, or if PCBs are mixed with oil used in cattle back-scratchers in feedlots, as happened this last summer in Kansas.

Since the ban on PCBs was announced, the U.S. Food and Drug Administration, which sets allowable standards on PCBs in foods that humans eat, announced it was lowering PCB levels for the four food categories in which PCBs are known to be found. As reported in *Environment Midwest* in August, these levels were as follows, with

MAJOR PCB DISCHARGERS AND PROBLEM AREAS IN REGION V, BY STATE

(Noncontaminated Great Lakes rivers and harbors typically register PCB levels of 1 part per million (ppm).)

STATE	LOCATION OF PROBLEM	MAXIMUM PCB CONCENTRATION	YEAR DISCOVERED
ILLINOIS	Waukegan Harbor	10,000 ppm in sediments	1976
	North Ditch tributary to Lake Michigan	245,000 ppm in sediments	1976
INDIANA	Bedford	30,000 ppm in sediments and sludge; 300 ppbillion in outfall water	1976
	Bloomington	Above 50 ppm in sludge	1976
	Indiana Harbor	26 ppm* in sediments	1977
MICHIGAN	Saginaw River	23 ppm* in sediments	1976
MINNESOTA	no known significant discharge areas		
OHIO	Ashtabula River	63 ppm in sediments	1979
	Fields Brook tributary to Ashtabula River	72 ppm in sediments	1979
WISCONSIN	Fox River	61 ppm* in sediments	1977
	Sheboygan River	190 ppm in sediments	1978
	Soil adjacent to Sheboygan River	120,000 ppm	1978

*Based on currently available data. Further investigations may yield significantly higher concentrations of PCBs.

lowered levels to become effective on August 28, 1979:

Eggs...from .5 to .3 parts per million (ppm)
Milk and Dairy Products...from 2.5 to 1.5 ppm
Poultry...from 5 to 3 ppm
Fish and Shellfish...from 5 to 2 ppm

Lower levels for the first three groups went into effect, as planned, on August 28. But the National Fisheries Institute, a trade association, filed objections to lowering the standards for fish and shellfish and requested a hearing.

Therefore, allowable standards for PCBs in edible portions of fish and shellfish remain at 5 ppm. The hearing has yet to be announced. (If you want to make your opinion known, either supporting or opposing the new, lower level, send your comments to Hearing Clerk, FDA, Room 4-65, 5600 Fishers Lane, Rockville, MD 20857.)

The increased attention being paid to PCBs no doubt comes from a better-informed public—as well as the much tighter regulations that pertain to PCBs. (For a copy of *EPA's Final PCB Ban Rule: Over 100 Questions & Answers To Help You Meet These Requirements*, write to EPA's Office of Toxic Substances, TS-799, Washington, DC 20460.)

Unfortunately, there is much more to controlling PCBs than banning their manufacture, use, and transport, especially in the Midwest.

Region V is number one in the Nation for heavy industries that require the use of PCBs, says Dr. Sheldon Simon, director of Region V's PCB program in the Toxic Substances Office. "People are becoming aware of the ban and the new regulations now," he says. "And industries should have had in-house programs since 1978" for the proper marking, use, storage, and disposal of PCBs.

Indeed, it is the disposal of PCBs that poses the greatest threat to the environment: The growing awareness of PCBs has not yet brought about a similar growth in finding and gaining acceptance for properly managed and approved disposal sites for products containing PCBs.

Only seven such sites currently exist in this country for land disposal of PCBs: in Niagara Falls and Model City, New York; Livingston, Alabama; Santa Barbara County, California; Beatty, Nevada; Arlington, Oregon; and Grand View, Idaho. An application has just been approved that establishes Region V's first PCB land disposal site in Clermont County, Ohio, near Williamsburg.

Properly managed landfills and high-temperature incineration are the only two known means for disposing of PCBs. Only one such incineration facility currently exists, a General Electric Company incinerator in Waterford, New York, that is permitted to accept only on-site PCB wastes.

This situation is also likely to change soon. Region V has received a half-dozen applications for high-temperature incinerators that propose to dispose of PCBs. Among the applicants, according to Charles Grigalauski of Region V's Hazardous Wastes Branch, are firms in Chicago, Chicago Heights, Detroit, and Middletown, Ohio. Applications are pending. When the applications are deemed complete, a public notice will be issued soliciting public comments.

When PCBs are burned at temperatures too low to destroy the molecules, they escape into the air, where they are carried by wind currents to locations hundreds or thousands of miles from their source. It is this type of burning that is said to be introducing PCBs to Lake Superior. Though levels there fall below FDA's standards, scientists say there is no other source for Lake Superior PCB contamination than airborne pollution. EPA is conducting and funding research into the PCB problem in Lake Superior, as well as PCB research throughout the country.

It is to combat improper disposal techniques—and to end the stockpiling of PCB wastes that is inevitable until and unless proper disposal facilities are found and approved—that EPA is applying much of its efforts.

Susan Nelson is a writer/editor with EPA Region V

Monkeys React Drastically to PCBs

Dr. James Allen, an experimental pathologist at the University of Wisconsin Medical School, is a leading researcher in the field of health effects of PCB contamination.

He began PCB studies—"primarily their ability to stimulate the enzymes that control liver function"—in 1967. When the Yusho incident occurred in Japan in 1968, he says, "we expanded our work to include more clinical studies.

"In a relatively short time we found that rats were relatively poor subjects. We switched to rhesus monkeys in 1968-69 and found that they more closely approximate symptoms observed in man."

Dr. Allen presented results of PCB studies — of rhesus monkeys at the Wisconsin Regional Primate Research Center—at EPA's National Conference on PCBs, held in Chicago in November, 1975. His results startled the scientific world.

Female monkeys that had been fed 25 ppm PCBs in their diets "developed facial lesions similar to those observed in the animals receiving higher levels of PCBs," his 1975 presentation stated. "After two months on the PCB diet it was necessary to discontinue the exposure due to the severity of the intoxication. One of the six experimental animals died four months after the initial exposure to PCBs. The surviving adult female monkeys continued to be devoid of eyelashes and displayed facial acneform lesions two years following exposure to the PCBs. Infants born to these females were small and contained PCBs in their tissues at birth."

Female monkeys that had been given 2.5 and 5 ppm PCBs in their diets developed facial swelling, swollen eyelids, loss of hair, inflammation of the skin, and acne within two months. "By the fourth month, irregularities in the menstrual cycle were recorded." Six of the eight females that were bred after six months of PCB exposure conceived; the other two did not. (All of the control-group females conceived.) Of those that did conceive, "four experienced early abortions." All eight of the 2.5 ppm females conceived, but only five carried their infants to term. (All of the control females carried their infants to term.) All PCB-exposed infants were small, "and at birth their skin contained detectable levels of PCBs.

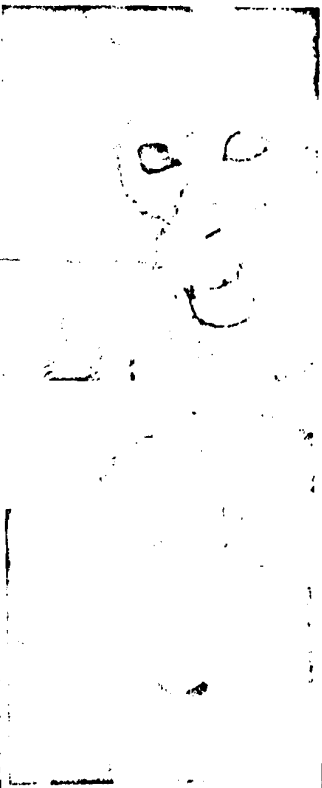
"The infants were permitted to nurse for four months," Dr. Allen reported four years ago. Within two months the infants showed swollen lips and eyelids, loss of eyelashes, lesions, and increased pigmentation of the skin. "Within four months, three of the six infants that had survived died due to PCB intoxication."

Dr. Allen's studies of the effects of PCBs on rhesus monkeys has continued, with the last group of infants born early in 1979. His evaluations of the studies also continue, and he says that results suggest both the toxicity and the tenacity of PCBs upon the more than 100 monkeys that have been involved to date.

"Another group of females fed 1 ppm and .5 ppm PCBs for more than two years were bred after six months," Dr. Allen said recently. "The mothers showed no abnormalities over a period of two years" at those levels. "However, their infants have shown the same changes observed in the previously described experiments." Of 16 females—eight fed the two levels of PCBs and eight controls, which received no PCBs — "eleven animals were born. Seven survived. There were [spontaneous] abortions."

Beyond this, the PCBs apparently bring about "learning disabilities, small infants, altered immune responses—infants that are more susceptible to common bacterial infections—and learning and behavioral deficiencies.

"I think we can look at these data," Dr. Allen told *Environment Midwest*,



This female monkey is shown before receiving 2.5 months and after receiving the PCB diet. The most no loss of hair and acne.

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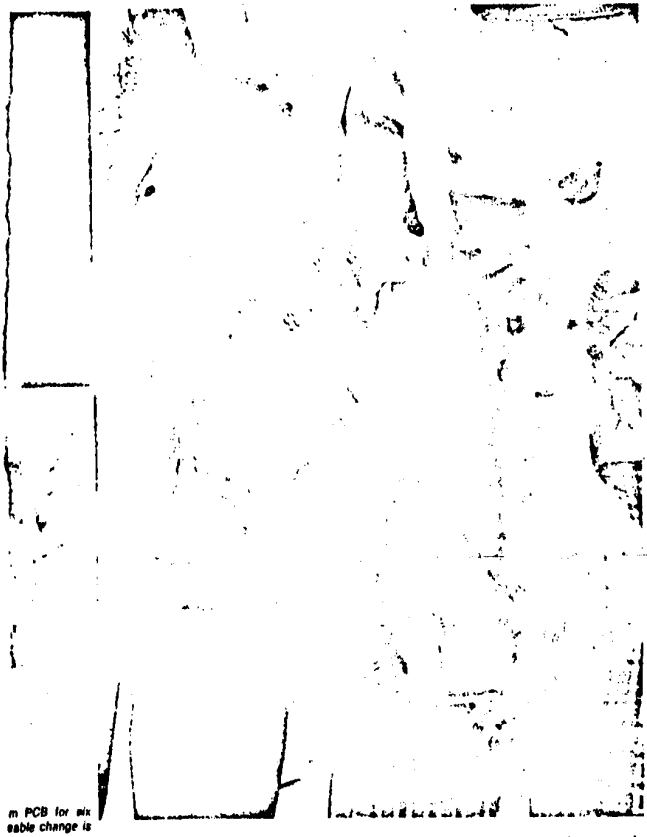

How do PCBs affect rhesus monkeys? The adult females here are evidence. The monkey on the left is a control; the one on the right received 5 ppm PCB in her diet for six months before this picture was taken. Note loss of weight and hair.

"and say that PCBs are extremely toxic. The fetus and the neonate—newborn—are the most susceptible to PCB exposure. The adult may show no signs of intoxication, yet there will be an effect on the infants or the fetuses."

It is his opinion that rhesus monkey data being collected suggest that "we should look closely at the human population...for fetal and neonatal effects that may be occurring. These may be very subtle, but they should be clarified."

(Admittedly, such tests will not be easy. "How are you going to tell if a child has a little lower IQ, or is a little more susceptible to a bad cold, or is a little smaller?")

As for any such PCB-related studies under way, Dr. Allen said that the National Institute of Environmental Health "has a rather large study in North Carolina, and a number of States have smaller studies."

Apparently there is time for such studies. "I am not aware of any incidents of human intoxication by PCBs" beyond the Yusho incident and isolated industrial cases, he said. "There are no documented cases of PCB intoxication in the human population." After a pause, he added: "Maybe we haven't looked closely enough...but the reason we should do epidemiological studies (those that deal with incidence, distribution, and control of disease) is to see if we *do* have a problem.

"If there are injurious effects, one hopes we'll be able to modify these through our own efforts, or through repair mechanisms in our own bodies so that these effects will be less toxic."

Yet, Dr. Allen says, "Even though we have no proof that human babies are affected, I would go along with regulations in many States in the Great Lakes area that pregnant mothers not consume [potentially PCB-contaminated] fish during pregnancy or while nursing."

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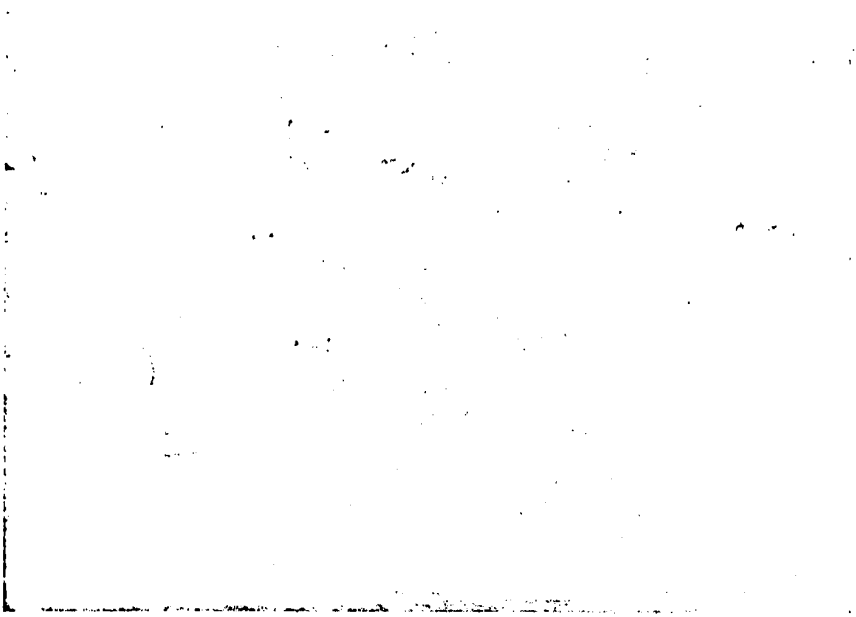

EPA Documerica Photo

Herring Gulls: a New Indicator?

The race to track down PCBs in the environment follows several paths. Sampling fish and other sources of food for mankind is one such path; the reason is obvious. Another, newer method of monitoring for PCBs is the use of a species of gull that, like fish, feeds on smaller fish.

Like fish, these gulls move about in order to find food. Unlike fish, however, the gulls tend to move farther, and they are easily observed in their habitat. And, according to the Canadian scientist who is carrying out extensive research with them on the Great Lakes, these gulls are a much more sensitive barometer to accumulations of PCBs and other contaminants than the fish that are tested by each State and the governments of both the U.S. and Canada.

Findings are so new that they have not been widely published in scientific journals, which provide peer review of new scientific evidence. But information about research on the herring gull was presented in July at the annual Great Lakes Water Quality meeting of the International Joint Commission (IJC) in Detroit. Explaining his work was Douglas Hallett, a research scientist with the Canadian Wildlife Service in Ottawa.

Dr. Hallett has been involved in studies of herring gulls since 1975, when Canada's research that had begun around 1970 became a major Canadian research effort. The gulls — a nonmigratory species found within the entire Northern Hemisphere and particularly throughout the Great Lakes region—were chosen for several reasons. First, they are found throughout the Great Lakes region. Researchers in Sweden and in Japan were conducting studies at that same time on herring gulls in the Baltic Sea and the Sea of Japan, respectively. Dr. Hallett says, and were finding elevated levels of toxic contaminants in the birds. More urgent in 1970, though, was the fact that herring gulls on Lake Ontario were known to be in trouble, and toxic contaminants were the suspected reasons.

"Reproduction success of the birds was virtually zero," Dr. Hallett says. Herring gull populations are relatively stable, he explains. They live in colonies that are well established; adults tend to mate for life when they are four years of age, he adds.

Besides, Dr. Hallett says, "Herring gulls are the only species with which we can visibly monitor the biological effects of contaminants on an annual basis as well as look at trends in residue levels themselves, to see if they're going up or down." The gulls are especially valuable because "they integrate the whole Great Lakes system by eating so many fish," he says.

His research is based on 10 colonies of herring gulls, each well established and consisting of approximately 100 families. The Canadians have chosen two colonies at either end of Lakes Superior, Huron, Erie, and Ontario. Since 1975 the U.S. Fish & Wildlife Service has monitored two colonies of birds on Lake Michigan, which lies entirely within U.S. boundaries.

Three visits are made to each colony each year. On the first visit, scientists first count and then "randomly select 10 eggs from 10 different families." (Each female lays three eggs.) These eggs are taken back to the same laboratory and analyzed for levels of bioaccumulation of toxics. "Levels in the eggs closely reflect levels in the livers of adult birds," Dr. Hallett says. (During intensive studies—conducted in 1975-77 on Lake Ontario and in 1978-79 on Lake Erie—researchers have taken about 10 adults off the whole lake. We have tried to capture breeding pairs so that we can tell levels of bioaccumulation in the mother, father, and the eggs.")

On the second visit researchers count the number of chicks that have hatched, which is a further assessment of the fertility level of the eggs. The third time out, Dr. Hallett says, researchers "count how many actually flew away."

Results of this research are encouraging, Dr. Hallett says. The levels of PCBs between 1974 and 1978 have decreased on all of the Great Lakes, according to analyses of the herring gull eggs. Lake Ontario gulls are "back to normal, and all the lakes are showing normal reproduction" rates, he says. "Herring gulls are on the increase now."

Studying gulls is but one of several ways to monitor the environment for PCBs and other contaminants that accumulate in living organisms for long periods of time. "I think we certainly need to continue to monitor fish, to bear out things we're finding in herring gulls," Dr. Hallett says.

EPA and other agencies that are committed to protecting the environment continue to monitor, and to be receptive to, new methods for assessing toxic contaminants in the water that mankind depends on.

– S.N.