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HEADLINES:

HOW WE GOT HERE--PART 1 THE

HISTORY OF CHLORINATED DIPHENYL (PCBS)

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HOW WE GOT HERE--PART 1 THE HISTORY OF CHLORINATED DIPHENYL (PCBS)

If you had to pick one chemical that best exemplified our modern situation, it might well be PCBs (polychlorinated biphenyls).

PCBs were first manufactured commercially in 1929 by the Swan Corporation, which later became part of Monsanto Chemical Company of St. Louis, Missouri.[1] Monsanto then licensed others to make PCBs and the product took off. PCBs conduct heat very well, but do not conduct electricity, and they do not burn easily. Furthermore, they do not change chemically--they are stable--and they are not soluble in water. Therefore they are ideal insulators in big electrical transformers and capacitors (devices that store electricity). As electricity came into widespread use during the first half of this century, equipment suppliers like GE and Westinghouse became major users of PCBs.

Many of the characteristics that make PCBs ideal in industrial applications create problems in the environment. Like many other chlorinated hydrocarbons, PCBs are soluble in fat, though not in water, so they tend to accumulate in living things and to enter food webs, where they concentrate. Larger, older predators tend to accumulate PCBs in their fatty tissues, including their eggs (in the case of birds and fish) and their milk (in the case of mammals). PCBs were first recognized as an environmental problem in 1966 when a Swedish researcher reported finding them in 200 pike from all over Sweden, in other fish, and in an eagle.[2] For the next decade, scientists accumulated information about PCBs, finding them disrupting food webs all over the planet. By 1976, the destruction wrought by PCBs was so obvious and so well understood that even the U.S. Congress comprehended the danger and took action, outlawing the manufacture, sale, and

distribution of PCBs except in "totally enclosed" systems. Between 1929 and 1989, total world production of PCBs (excluding the Soviet Union) was 3.4 billion pounds, or about 57 million pounds per year. Even after the U.S. banned PCBs in 1976, world production continued at 36 million pounds per year from 1980-1984 and 22 million pounds per year, 1984-1989. The end of PCB production is still not in sight.[3]

The whereabouts of 30 percent of all PCBs (roughly a billion pounds) remains unknown. Another 30 percent reside in landfills, in storage, or in the sediments of lakes, rivers, and estuaries. Some 30 percent to 70 percent remain in use. The characteristics of PCBs (their stability and their solubility in fat) tend to move them into the oceans as time passes. Nevertheless, it is estimated that only one percent of all PCBs have, so far, reached the oceans.[3]

The one percent that HAVE reached the oceans are causing major problems. As noted above, PCBs tend to concentrate in the food chain; the higher you are on the food chain, the greater the concentration of PCBs. Large fish, and creatures that eat large fish, tend to accumulate thousands of parts of million (ppm) in their flesh. Furthermore, by a cruel twist of fate, large birds and large marine mammals (seals, sea lions, whales, and some dolphins) lack enzyme systems to efficiently detoxify PCBs. As a result, PCBs build up in the bodies of oceanic predators and are passed to their offspring through eggs (in the case of fish and

birds) and milk (in the case of mammals). PCBs mimic hormones and are a powerful disruptor of the endocrine system that governs reproduction. Marine mammals are already having trouble reproducing.[4] It is entirely possible that, as more PCBs reach the oceans, all large mammals will disappear.[5]

Humans, too, are contaminated by PCBs and are passing these powerful toxins to their infant children through breast milk. In the U.S. and other industrialized countries, PCBs are present in breast milk at about 1 part per million (ppm) in the milk fat. An infant drinking milk contaminated at this level will take in a quantity of PCBs that is 5 times as high as the recommended "allowable daily intake" for an adult, as established by the World Health Organization.[6]

Children exposed in the womb to PCBs at levels considered "background levels" in the U.S. have been found to experience hypotonia (loss of muscle tone) and hyporeflexia (weakened reflexes) at birth, delays in psychomotor development at ages 6 and 12 months, and diminished visual recognition memory at 7 months.[7]

How did we get here?

In 1937--just eight years after Swan Chemical began manufacturing PCBs in commercial quantities--the Harvard School of Public Health hosted a one-day meeting on the problem of "systemic

effects" of certain chlorinated hydrocarbons including "chlorinated diphenyl" (an early name for PCBs).[8] The meeting was attended by representatives from Monsanto, General Electric, the U.S. Public Health Service, and the Halowax Corporation, among others.

Before World War I, the Halowax Corporation began manufacturing chlorinated naphthelenes as a coating for electric wire and companies like General Electric began using it. The president of Halowax, Sandford Brown, told the meeting that they had observed no problems in their workers until "the past 4 or 5 years... Then we come to the higher stages [greater number of chlorine atoms in the mixture], combined with chlorinated diphenyl and other products, and suddenly this problem is presented to us."[8]

By the mid-1930s, workers at Halowax and at GE, and even some of their customers, were breaking out with chloracne--small pimples with dark pigmentation of the exposed area, followed by blackheads and pustules. In 1936 three workers at the Halowax Company died, and Halowax then hired Harvard University researchers to expose rats to these chlorinated compounds, to see if they could discover the underlying cause. The Harvard researchers made "a number of estimates of chlorinated hydrocarbons in the air of different factories," then designed experiments to expose rats to similar levels. They reported that "the chlorinated diphenyl is certainly capable of doing harm in very low concentrations and is probably the most dangerous [of

the chlorinated hydrocarbons studied]."[8] And, they said, "These experiments leave no doubt as to the possibility of systemic effects from the chlorinated naphthalenes and chlorinated diphenyls."[8]

From a brief report on the one-day conference, we can gather that problems caused by PCB exposures were serious and widely known. Mr. F.R. Kaimer, assistant manager of General Electric's Wireworks at York, Pa., said, "It is only 1 1/2 years ago that we had in the neighborhood of 50 to 60 men afflicted with various degrees of this acne about which you all know. Eight or ten of them were very severely afflicted--horrible specimens as far as their skin conditions was concerned. One man died and the diagnosis may have attributed his death to halowax vapors, but we are not sure of that...."[8]

GE's medical director, Dr. B. L. Vosburgh of Schenectady, N.Y., attended the meeting. He said, "About the time we were having so much trouble at our York factory some of our customers began complaining. We thought we were having a hysteria of halowax mania throughout the country."

Monsanto Chemical Company was represented at the meeting by R. Emmett Kelly. Mr. Kelly told the meeting, "I can't contribute anything to the laboratory studies, but there has been quite a little human experimentation in the last several years, especially at our plants where we have been manufacturing this

chlorinated diphenyl." He went on to describe the results of Monsanto's human experiments: "A more or less extensive series of skin eruptions which we were never able to attribute as to cause, whether it was impurity in the benzene we were using or to the chlorinated diphenyl."[8]

GE's F.R. Kaimer described the HUMAN reaction of GE executives to the disfigurement and pain of GE workers exposed to PCBs: "[W]e had 50 other men in very bad condition as far as the acne was concerned. The first reaction that several of our executives had was to throw it out--get it out of our plant. They didn't want anything like that for treating wire. But that was easily said but not so easily done. We might just as well have thrown our business to the four winds and said, 'We'll close up,' because there was no substitute and there is none today in spite of all the efforts we have made through our own research laboratories to find one."[8] And so GE executives--contrary to their personal ethics--reached a business decision to continue using PCBs.

[To be concluded next week.]

--Peter Montague

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[1] Robert Risebrough and Virginia Brodine, "More Letters in the Wind," in Sheldon Novick and Dorothy Cottrell, editors, OUR WORLD IN PERIL: AN ENVIRONMENT REVIEW (Greenwich, Conn.: Fawcett, 1971), pgs. 243-255.

[2] Soren Jensen, "Report of a New Chemical Hazard," NEW SCIENTIST Vol. 32 (1966), pg. 612.

[3] Kristin Bryan Thomas and Theo Colborn, "Organochlorine Endocrine Disruptors in Human Tissue," in Theo Colborn and Coralie Clement, editors, CHEMICALLY-INDUCED ALTERATIONS IN SEXUAL AND FUNCTIONAL DEVELOPMENT: THE WILDLIFE/HUMAN CONNECTION [Advances in Modern Environmental Toxicology Vol. XXI] (Princeton, N.J.: Princeton Scientific Publishing Co., [1992).] pgs. 342-343.

[4] See, for example, Robert L. DeLong and others, "Premature Births in California Sea Lions: Association With High Organochlorine Pollutant Residue Levels," SCIENCE Vol. 181 (Sept. 21, 1973), pgs. 1168-1170; and Peter J. H. Reijnders, "Reproductive failure in common seals feeding on fish from polluted coastal waters," NATURE Vol. 304 (Dec. 4, 1986), pgs. [456-457.]456-457.

[5] Shinsuke Tanabe, "PCB Problems in the Future: Foresight from Current Knowledge," ENVIRONMENTAL POLLUTION Vol. 50 (1988), pgs. 5-28.

[6] Kristin Bryan Thomas and Theo Colborn, "Organochlorine Endocrine Disruptors in Human Tissue," in Theo Colborn and Coralie Clement, editors, CHEMICALLY-INDUCED ALTERATIONS IN SEXUAL AND FUNCTIONAL DEVELOPMENT: THE WILDLIFE/HUMAN CONNECTION

[Advances in Modern Environmental Toxicology Vol. XXI] (Princeton, N.J.: Princeton Scientific Publishing Co., [1992).] pgs. 365-394. For the comparison of U.S. breast-fed infants' intake vs. World health Organization's standard for adults, see pg. 385.

[7] Hugh A. Tilson and others, "Polychlorinated Biphenyls and the Developing Nervous System: Cross-Species Comparisons," NEUROTOXICOLOGY AND TERATOLOGY Vol. 12 (1990), pgs. 239-248.

[8] Cecil K. Drinker and others, "The Problem of Possible Systemic Effects From Certain Chlorinated Hydrocarbons," THE JOURNAL OF INDUSTRIAL HYGIENE AND TOXICOLOGY Vol. 19 (September, 1937), pgs. 283-311. Thanks to Bridget Barclay of the Hudson River Sloop Clearwater for sending us this revealing article. Ms. Barclay and her colleagues at Hudson Clearwater have worked tirelessly for years to force a sensible cleanup of PCBs that GE dumped, contaminating the length of the Hudson River; Hudson Clearwater can be reached in Poughkeepsie at (914) 454-7673.

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--Peter Montague, Editor

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