

WHAT HAPPENS TO PCBs IN THE ENVIRONMENT?

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Because they can be detected by the same analytical methods, and because some suspect that they may have similar biological effects to DDT, polychlorinated biphenyls in the environment (PCBs) have become a cause of concern. It is, therefore, important to present data to show that PCBs do disappear from the environment.

Probably the most effective way to do this is to compare what has been put into the environment with what is found there now. This can be done in the following way:

The commercial PCB products are mixture of chlorinated biphenyl homologs containing from one to ten atoms of chlorine per biphenyl molecule. If there were no degradation in the environment, or if all homologs degraded at the same rate, the ratio of homologs in "aged environmental samples" (samples taken at a distance from a known source) should be the same as that in the products introduced into the environment. On the other hand, if the homolog ratio in "aged environment samples" differs from that of material produced, some process must be operating in the environment to remove different homologs at different rates. Monsanto, the major U.S. producer, recently released data on its sales of the various commercial grades of PCB for the years 1957-72. Rest-of-world sales by other producers and production before 1957 probably represent a similar product mix. Using the Monsanto data and known homolog analyses of each of the commercial grades, the percentage of each homolog in the total U. S. production can be calculated.

The other required datum is an estimate of the homolog distribution in "environmentally aged samples." Analysts experienced in this field generally agree that material recovered from such samples is similar to Aroclor 1254 or 1260, the Monsanto trade name for mixtures of PCBs with chlorine contents corresponding to an average of five and six chlorine atoms per biphenyl molecule respectively (1-8). In order to present a conservative comparison and because most analysts cite Aroclor 1254, we shall use the homolog content of that material in our comparison.

The homolog contents of the material produced in the U. S. from 1957 to 1971 and that of Aroclor 1254 are tabulated below:

Homolog

0	1	2	3	4	5	6	7	8
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U. S. Sales 1957 - 1971

0.1	1.3	14.8	29.9	21.9	16.1	10.5	4.2	1.1
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Aroclor 1254

2.1	2.1	2.5	1	21	48	23	6	ND
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It is apparent that the homolog ratio of the material sold is quite different from that of Aroclor 1254. There must, therefore, be one or more processes in the environment which remove the lower homologs at much greater rates than the higher ones. The precision of the data is too low to permit accurate calculations of the relative rates of loss. However, it would appear that the homologs containing less than four chlorine atoms may be degraded at rates approximately thirty times those for the five and six chlorine homologs. Laboratory data which we hope to publish later show that the rate of bacterial degradation is an inverse function of the chlorine content for PCBs and might, therefore, be one of the degradative processes responsible for the relative decrease in the lower homologs.

- 1) L. M. Reynolds, Pesticide Residue Analysis in the Presence of Polychlorinated Biphenyls Residue Reviews 34, 27, 32, 41, 42, 44 (1971).
- 2) R. W. Risebrough, P. Reiche and H. S. Scott - Current Progress in the Determination of the Polychlorinated Biphenyls - Bulletin of Environmental Contamination & Toxicology 4, 192, 199 (1971).
- 3) G. E. Bagley, W. L. Reichel and E. Cromartie - Identification of Polychlorinated Biphenyls in Two Bald Eagles by Combined Gas-Liquid Chromatography-Mass Spectrometry - Journal of the AOAC 53, 251, 252, 257 (1970).
- 4) Albert C. Tas and Rudolf H. deVos - Characterization of Four Major Components in a Technical Polychlorinated Biphenyl Mixture - Environmental Science & Technology 5, 1216 (1971).
- 5) Judith A. Armour and Jerry A. Burke - Method for Separating Polychlorinated Biphenyls from DDT and Its Analogs - Journal of the AOAC 53, 763, 765 (1970).
- 6) Ian Prestt, D. J. Jefferies and N. W. Moore - Polychlorinated Biphenyls in Wild Birds in Britain and Their Arian Toxicity - Environmental Pollution 1, 3, 15 (1970).
- 7) V. Zitko - Polychlorinated Biphenyls and Organochlorine Pesticides in Some Freshwater and Marine Fishes - Bulletin of Environmental Contamination & Toxicology 6, 464, 467 (1971).
- 8) PCBs & The Environment - Interdepartmental Task Force on PCBs - Washington May, 1972 - COM-72-10419 - Table 6, P. 93.

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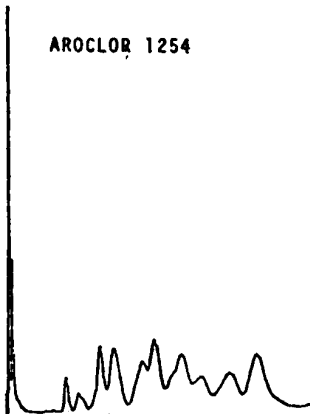
1. WE CANNOT DETERMINE IF PCBs DEGRADE IN THE ENVIRONMENT FROM THE TOTAL CONCENTRATIONS FOUND THERE.
2. THE PCBs ARE MIXTURES OF HOMOLOGS.
3. THEREFORE, COMPARISON OF HOMOLOG RATIOS IN "ENVIRONMENTALLY AGED SAMPLES" WITH HOMOLOG RATIOS IN MATERIAL PRODUCED CAN BE USED TO GAIN INSIGHT AS TO WHAT IS HAPPENING IN THE ENVIRONMENT.

HOW DO WE GET THE DATA NEEDED?

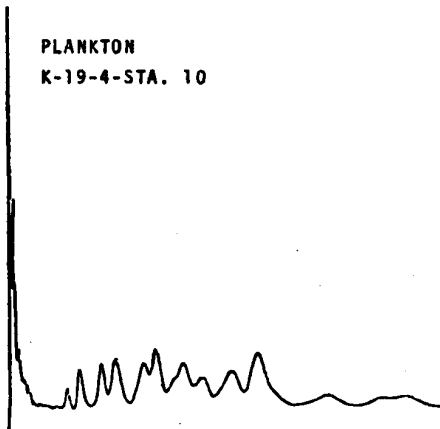
1. PRODUCTION FIGURES FOR ALL MONSANTO PCB PRODUCTS AND HOMOLOG CONTENT OF EACH PRODUCT ARE AVAILABLE FOR 1957-71. WE USE THESE DATA TO CALCULATE HOMOLOG RATIOS FOR 1957-71 PRODUCTION.
2. EUROPEAN PRODUCERS MAKE SIMILAR PRODUCTS IN ABOUT THE SAME RATIOS AS MONSANTO.
3. PRODUCTION BEFORE '57 WOULD NOT AFFECT THE FIGURES GREATLY SINCE PRODUCT RATIOS WERE SIMILAR AND PRODUCTION SMALLER.
4. ANALYSTS GENERALLY AGREE THAT MATERIAL FOUND IN "AGED ENVIRONMENTAL SAMPLES" IS SIMILAR TO AROCLOR 1254 OR IN RARE CASES EVEN TO AROCLOR 1260.

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AROCLO 1254



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A COMPARISON OF THE HOMOLOG RATIOS FOR PCBs SOLD
WITH THOSE FOUND IN AGED ENVIRONMENTAL SAMPLES

	HOMOLOG								
	0	1	2	3	4	5	6	7	8
U.S. SALES '57 - '71	0.1	1.3	14.8	29.9	21.9	16.1	10.5	4.2	1.1%
AROCLO 1254	<.1	<.1	<.5	1	21	48	23	6	ND

CONCLUSIONS

1. THERE ARE MARKED DIFFERENCES BETWEEN THE RATIOS OF HOMOLOGS IN PCBs FOUND IN "AGED ENVIRONMENTAL SAMPLES" AND THE RATIO OF HOMOLOGS FOR MATERIAL PRODUCED.
2. THESE DIFFERENCES CAN BEST BE EXPLAINED BY ASSUMING THAT THE PCBs WITH 3 OR LESS CHLORINE ATOMS PER MOLECULE DEGRADE MUCH MORE RAPIDLY THAN THE HIGHER HOMOLOGS.
3. THE HOMOLOG RATIO DATA DO NOT GIVE INFORMATION ON THE RATE OF DEGRADATION OF HIGHER HOMOLOGS. HOWEVER, SEMI-CONTINUOUS ACTIVATED SLUDGE TEST DATA SHOW THAT THESE TOO DEGRADE BUT AT A SLOWER RATE.