Polychlorinated Biphenyls (PCBs) in the Environment

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 (PCBs) have been much in the news, both scientific and lay, recently. "Chemical Pollution: Polychlorinated Biphenyls," Science, January 14, 1972, p. 155 gives a short review of the subject. An example from the public press is an article which appeared in the December 12, 1971 issue of The Observer, London, England, under the by-line of a science correspondent named Gerald Leach. This article reports analyses of oceanic plankton by Dr. George Harvey of Woods Hole Oceanographic Institute. It states that he "estimates that PCBs last more than one hundred times as long as DDT (itself highly persistent) - in other words, at least 500 years."

Although Dr. Harvey has indicated verbally to the writer that he did not make the statement attributed to him by Leach, it is important to present data that 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 environmental samples "differs from that of material produced, some process must be operating in the environment to remove different homologs at different rates. Monsanto, the sole 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 PCB's with chlorine contents corresponding to an average of five and six chlorine atoms per biphenyl molecule respectively (1-7). 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
U.S. Sales '57 - '71	0.13	1.34	14.75	29.90	21.86	16.14	10.49	4.21	1.14%
Aroclor 1254	0.0	0.06	0.32	0.78	22.99	47.38	19.75	4.62	0.0%

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 fifty 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.

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