Analytical Chemistry
Special Study 71-7
Job No. 1348006

DETERMINATION OF POLYCHLORINATED BIPHENYL RESIDUES IN ALBINO RATS FROM A TWO-YEAR CHRONIC ORAL TOXICITY STUDY

INTRODUCTION

An integral portion of the Aroclor Environmental Project is to obtain a more complete understanding of the environmental behavior and impact of our past and current polychlorinated biphenyls (PCB) products. In order to accomplish this objective, several feeding studies were initiated at Industrial Bio-Test Laboratories (IBT). This report covers the results of the analyses of the tissues from IBT #B7298, "Two-Year Chronic Oral Toxicity Study of Aroclor 1242, Aroclor 1254, and Aroclor 1260 in Albino Rats", for PCB residues.

The specific objectives of this study were to establish the relationship between tissue storage levels and exposure period, exposure level, degree of chlorination, and observed toxic effects as well as determining the homolog distribution of the PCB residues.

SUMMARY

The residues retained in the tissues of the animals fed these products were isolated by solvent extraction and the level and type of PCB's determined by electron capture gas chromatography (Analytical Chemistry Method No. 71-39). Significantly lower residues were found in the animals fed Aroclor 1242 vs those fed the higher chlorinated products Aroclor 1254 and Aroclor 1260.

PCB residues from these Aroclor products were observed in all the tissues (liver, fat, kidney and muscle, at all levels fed (1, 10 and 100 ppm) and at each sacrifice interval (3, 12 and 24 months). The residue levels found in the tissues of the animals fed 1, 10 and 100 ppm of Aroclor 1242 and 1 ppm of Aroclor 1260 did not continuously increase, but instead began to plateau at some point after three months of expoaure.

Alteration of the homolog distribution of all products was also observed. The alteration was greatest for Aroclor 1242 and least for Aroclor 1254 and Aroclor 1260. The dominant PCB homologs found in the residues were in all cases those which have been observed as environmental residues.

Although the observation of gross toxicity effects caused by the ingestion of the PCB products were few, the data indicated that they occurred (enlarged livers) when the PCB lipid storage levels were in the range of 500-1000 ppm.

DETAILS

All tissue samples were analyzed as outlined in Analytical Chemistry Method 71-35, with the exception that the chemical clean-up procedures (saponification and sulfuric acid extraction) were not necessary. The

DETAILS (Cont'd)

procedure employed involved maceration of the weighed tissue sample in the presence of hexane and sodium sulfate followed by an alumina column clean-up of the hexane extracts and detection of the type and level of PCB's retained in the tissue by electron capture gas chromatography.

Standard solutions of the Aroclor fed were used to prepare the calibration curves for quantitation in the cases of Aroclor 1254 and Aroclor 1260. In the case where Aroclor 1242 was fed standard solutions of Aroclor 1254 were used to prepare the calibration curves, since the principal isomers found in the tissue extract were those that are dominant in production Aroclor 1254.

The PCB residue levels found in each of the tissue samples are shown in Tables I and II. The values in Table I were calculated using the original wet weight of the tissue, those in Table II were calculated on a hexane soluble lipid weight basis.

A graphical interpretation of these data demonstrating the observed trends are shown in Figures I - V.

Figures I - III are semi-logarithmic plots of the average PCB residue level found in the tissues (muscle, fat and liver) at each feed level vs the oral exposure period. Examination of these figures indicates that the level of PCB's stored in the tissues for all products generally increases as the exposure level and period increase. Apparent exceptions to this generalization are the residue storage levels for Aroclor 1242 at all feed levels and Aroclor 1260 at the lowest feed level. It appears that the storage levels with these materials, at the feed levels noted, begin to plateau after approximately three months of feeding.

Figure IV is a linear plot of the average PCB residue found vs the exposure period for each Aroclor at the highest feed levels. It simply illustrates the marked difference that exists between Aroclor 1242, the lowest chlorinated biphenyl fed and Aroclor 1254 and Aroclor 1260. After 24 months of exposure the ratio of the residue levels for Aroclor 1254 and Aroclor 1260 to Aroclor 1242 at the 100 mg feed level were 8.4/1 and 24.5/1, respectively.

The relationships between the average tissue storage levels at each fed level, after 24 months of exposure, and the degree of chlorination are shown in Figure V. It clearly demonstrates that as the degree of chlorination of the PCB fed and the exposure level are increased that the tissue storage level increases, especially when the product fed contains dominant amounts of the higher chlorinated isomers (penta, hexa, hepta, etc.).

Chromatograms I, II and III compare a typical tissue extract against the Aroclor fed. Isomeric alterations were observed with each Aroclor at all feed levels. Aroclor 1242 was altered to a greater extent than either Aroclor 1254 or Aroclor 1260. The chromatographic conditions

DETAILS (Cont'd)

employed while ideal for quantitation of the PCB residues in the tissues are not suitable for the identification of the specific isomers which are retained. Nevertheless with these limitations, the chlorine number(s) of the principal isomer(s) have been shown above each peak on the chromatogram. An inspection of the chromatograms reveals that the less chlorinated isomers are degraded while the higher chlorinated isomers are retained. To get an appreciation of this effect, one has to ratio the peak heights of the early eluting isomers to the peak heights of the later eluting isomers and then compare the ratio for the standard vs the ratio for the tissue extract. In most cases, the response of the detector for the tissue extract has been amplified to get sufficient area for good quantitation and this tends to obscure the fact that some isomers are almost completely removed while others are drastically reduced. It should also be noted that the animals were fed the Aroclor containing feeds right up to the point of sacrifice.

REFERENCES

1. "Two Year Chronic Oral Toxicity Study of Aroclor 1242, Aroclor 1254 and Aroclor 1260 In Albino Rats", Industrial Bio-Test Laboratories Report (IBT #7298).

2. "Statistical Analysis of Bio-Test Oral Toxicity Study - Albino Rats", Statistics Special Study 71-14.

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TABLE I

ppm Wet Weight Ex

Two Year Chronic Oral Toxicity Study Of Aroclor In Albino Rats

		1 ppm			10 ppm			100 ppm		
		3 mo.	12 mo	24 mo.	3 mo	12 mo	24 mo	3 mo.	12 mo	24 mo
1) Aroclor 1242	Muscle	0.7	1	18	14	6	14	5	33	73
	Liver	0.1	0.2	05	02	06	1	09	5	5
	Fat	6	7	6	12	30	43	60	144	220
Aroclor 1254	Muscle	2	2	13	8	131	98	46	14	35[illegible]
	Liver	0.1	0.4	12	1	23	6	15	[illegible]4	13[illegible]
	Fat	6	19	45	75	63[illegible]	31[illegible]	1208	794	1533
Aroclor 1260	Muscle	6	8	15	8	50	116	10	41[illegible]	[illegible]5
	Liver	0.2	1	0.8	2	[illegible]	5	18	5[illegible]	107
	Fat	[illegible]8	56	50	417	224	29[illegible]	48[illegible]	[illegible]	[illegible]47

1) Calculated as Aroclor 1254

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TABLE II

ppm Lipid Weight Basis

Two Year Chronic Oral Toxicity Study Of Aroclor In Albino Rats

		1 ppm			10 ppm			100 ppm		
		3 mo.	12 mo	24 mo.	3 mo.	12 mo	24 mo.	3 mo	12 mo.	24 mo.
1) Aroclor 1242	Muscle	8	6	5	16	38	74	76	236	239
	Liver	11	16	18	26	40	52	77	241	234
	Fat	6	8	9	13	32	47	67	151	227
Aroclor 1254	Muscle	10	11	38	96	(721)	389	756	1092	2164
	Liver	18	24	82	115	(914)	307	1137	869	1810
	Fat	6	19	55	76	(608)	348	1121	860	1894
Aroclor 1260	Muscle	16	47	44	60	259	436	146	2247	5154
	Liver	20	50	56	102	189	442	1677	1752	6310
	Fat	32	60	62	138	262	354	866	2143	5060

1) Calculated as Aroclor 1254

FIGURE I

Two Year Chronic Oral Toxicity Study of Aroclor in Albino Rats

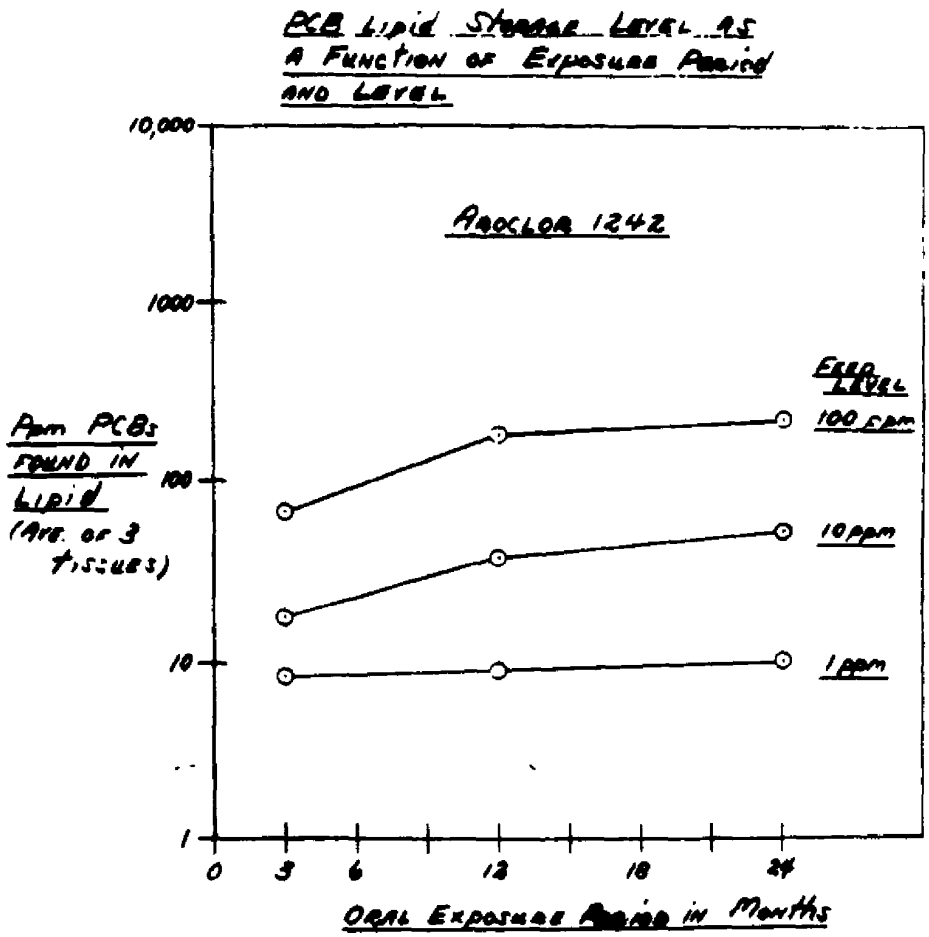

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FIGURE II

Two Year Chronic Oral Toxicity Study of Aroclor in Albino Rats

PCB Lipid Storage Level as a Function of Exposure Period and Level

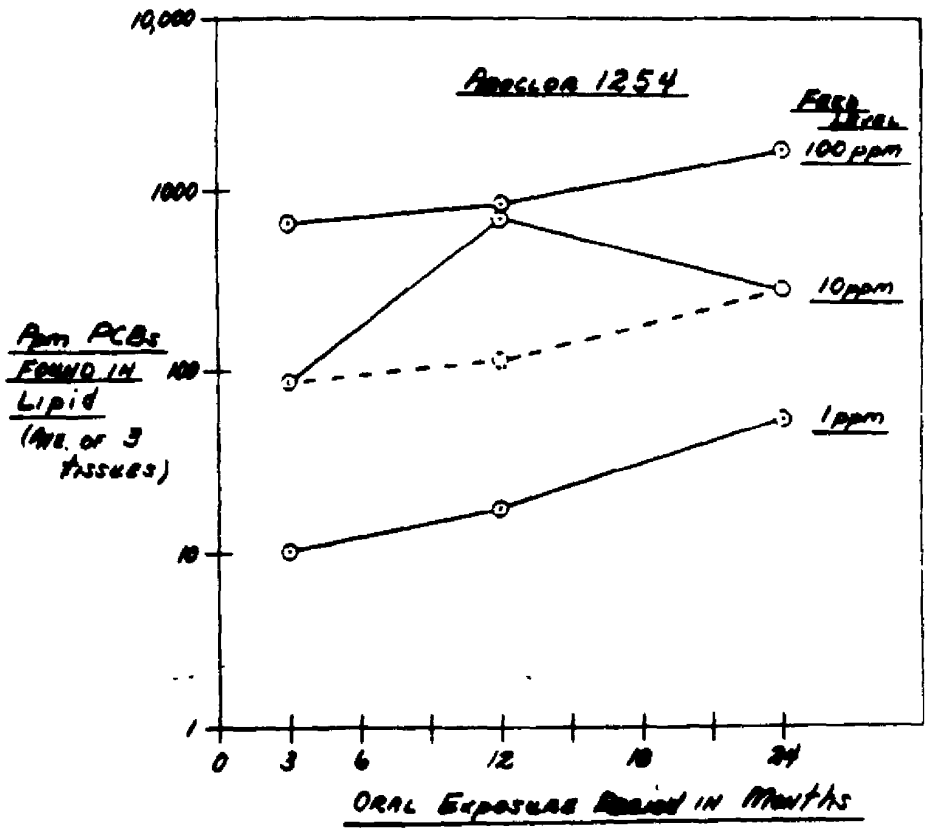

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FIGURE III

Two Year Chronic Oral Toxicity Study of Aroclor in Albino Rats

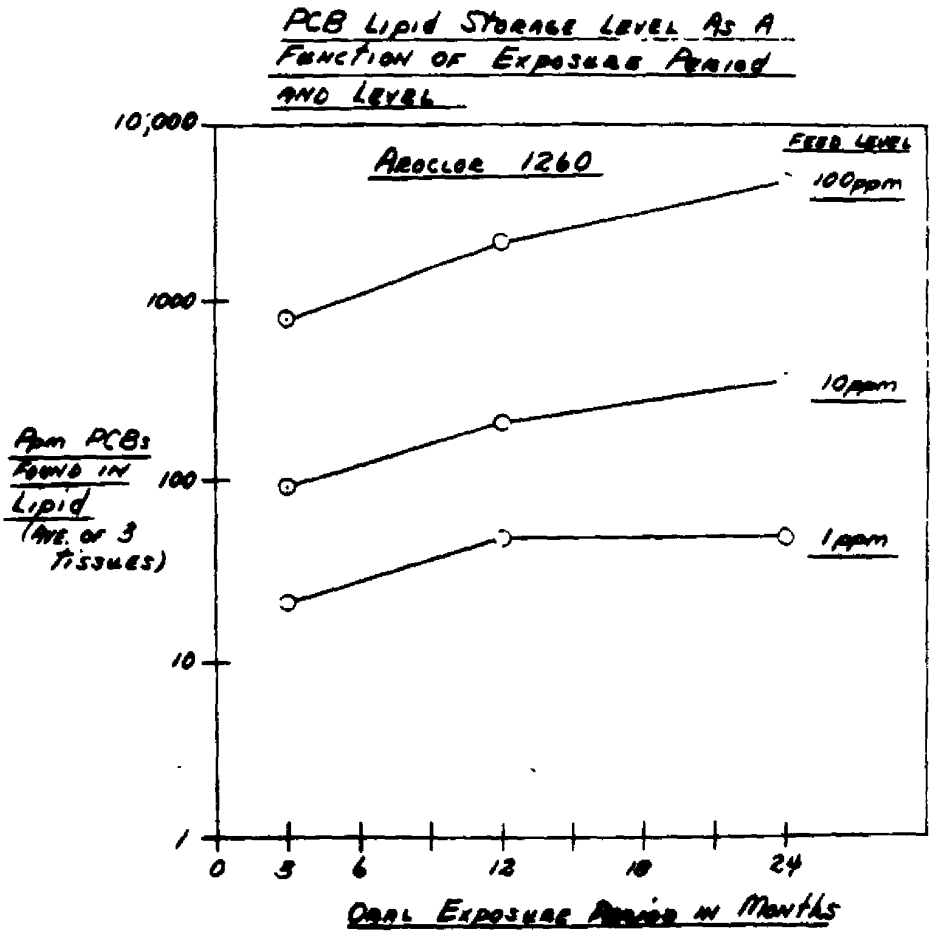

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FIGURE IV

"Two Year Chronic Oral Toxicity Study of Aroclor in Albino Rats"

PCB Lipid Storage Level as a Function of Aroclor and Oral Exposure Level

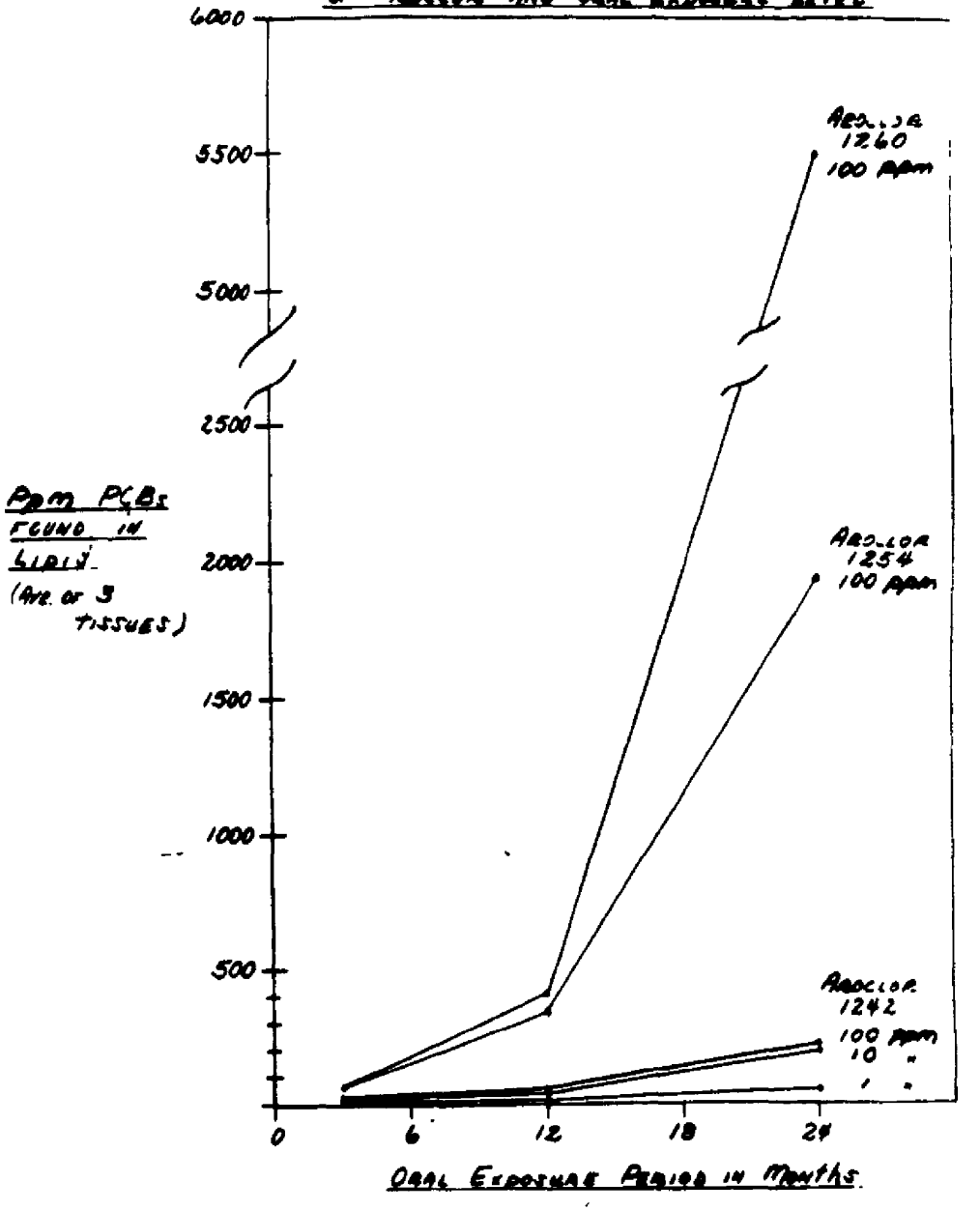

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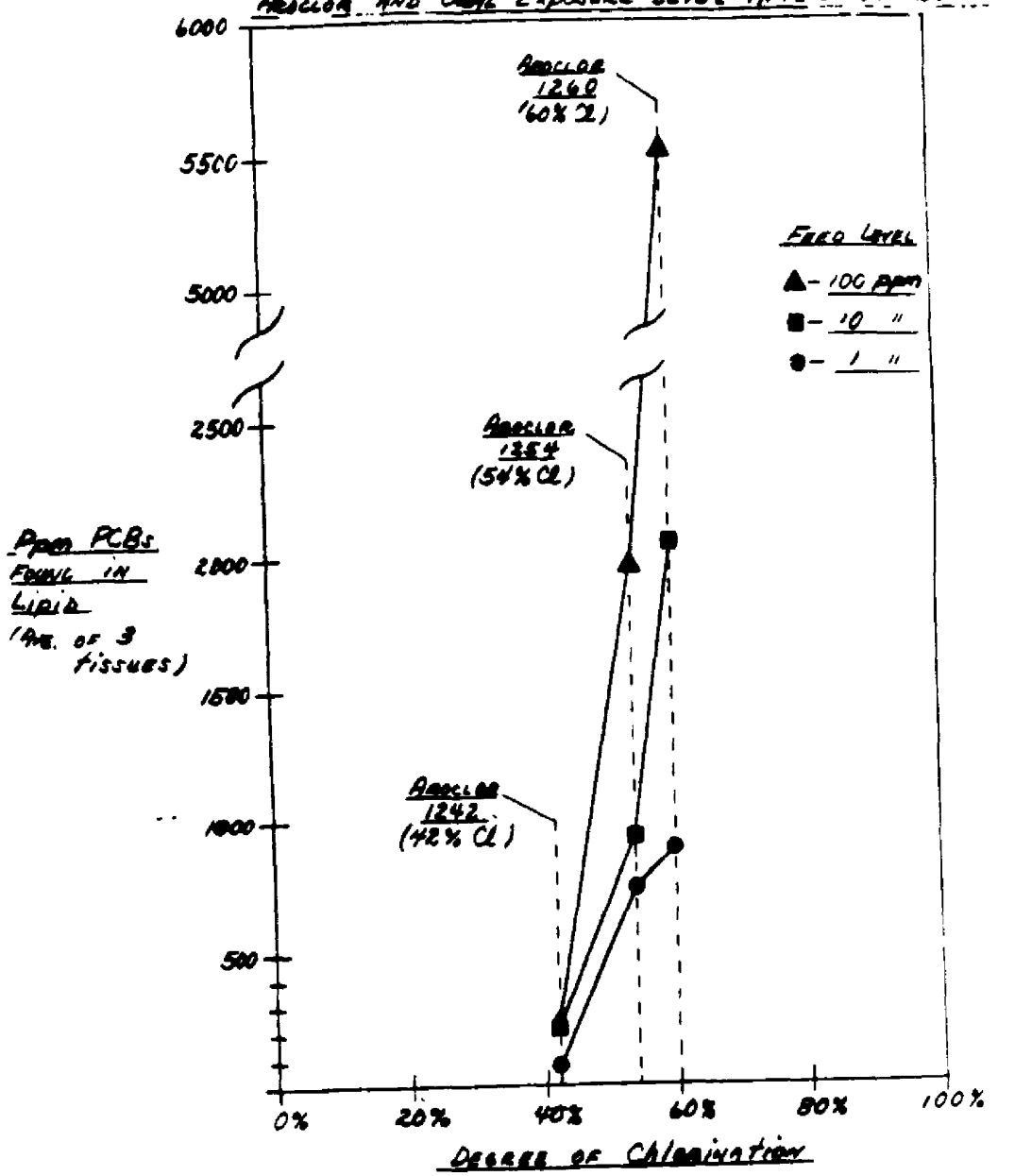
FIGURE V

"Two Year Chronic Oral Toxicity Study of Aroclor in Albino Rats."

PCB Lipid Storage Level as a Function of Aroclor and Oral Exposure Level After 24 Months



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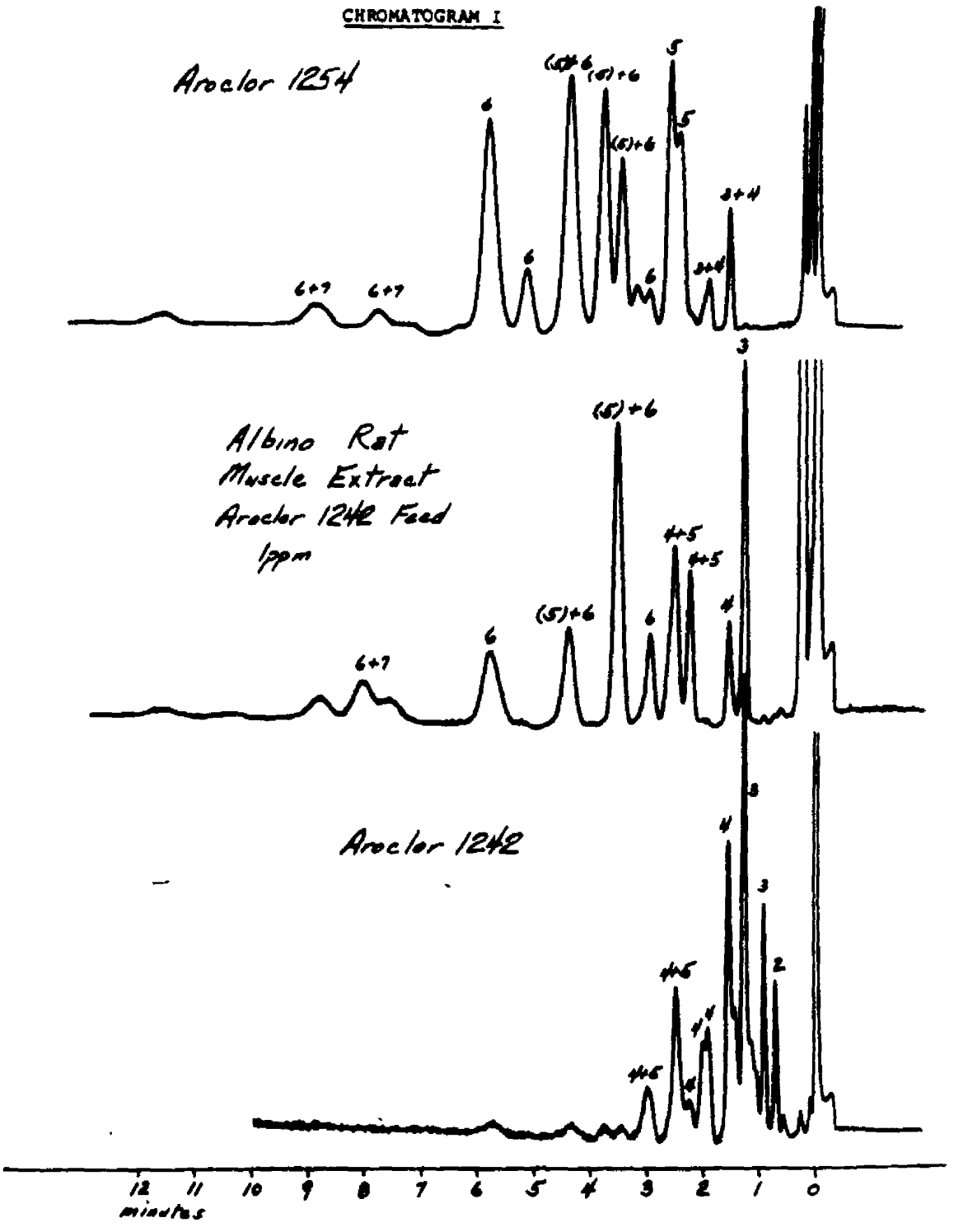
CHROMATOGRAM I



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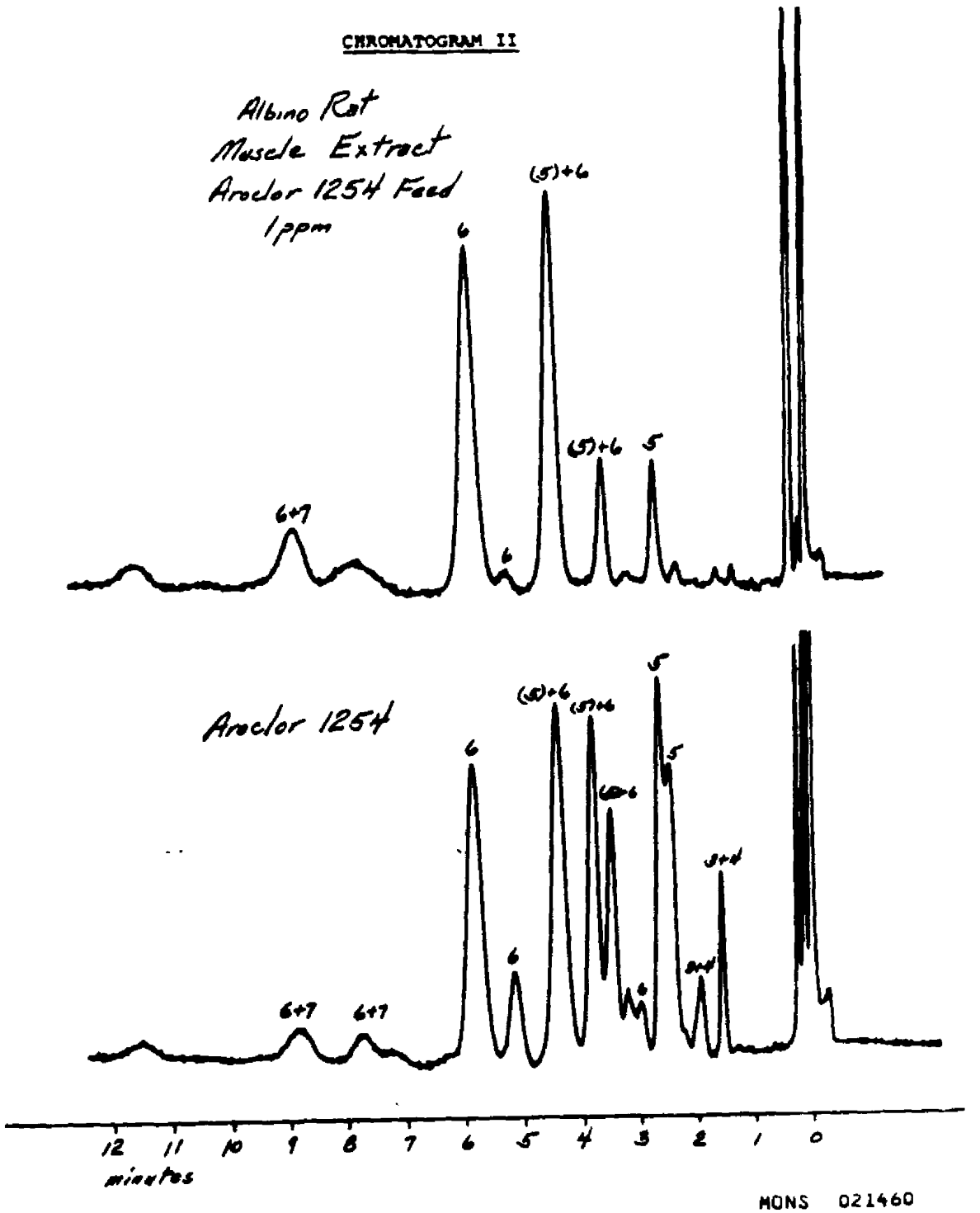

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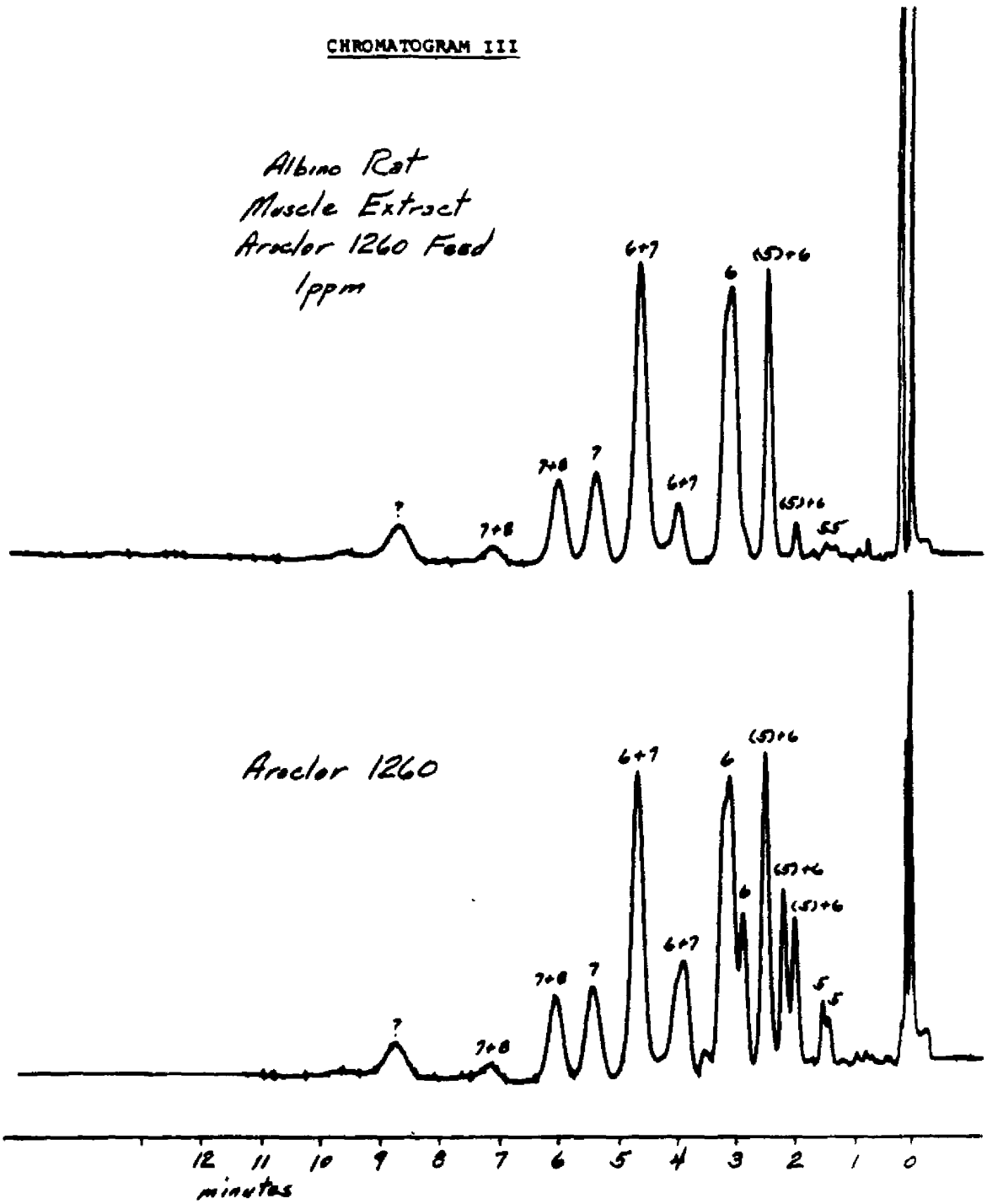
CHROMATOGRAM III



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