Acute Effects of Aroclor® 1254 (PCB) on *Ictalurus punctatus* (Catfish)

by B. J. CAMP, E. HEJTMANCIK, and C. ARMOUR
Department of Veterinary Physiology and Pharmacology
and
D. H. LEWIS
Department of Veterinary Microbiology
Texas A&M University
College Station, Tex.

The ubiquity of polychlorinated biphenyls (PCBs) as environmental contaminants has been widely reported and documented. SANDERS and CHANDLER (1) have reported on the toxicity of PCBs to aquatic invertebrates and WALDISH (2), JEFFERIES and PARSLOW (3) and others have reported on the toxicity of PCBs to vertebrates. However, there is a paucity of information on the biochemical and physiological effects of these compounds on aquatic vertebrates.

The purpose of this study was to measure the uptake and tissue distribution of PCBs and to observe for changes in specific biochemical constituents in catfish (Ictalurus punctatus) exposed to Aroclor^{R} 1254.

Materials and Methods

Fingerling catfish were held in aquaria for a minimum of two weeks prior to the study. Aroclor^{R} 1254 was dissolved in Corexit 7664 (Enjay Chemical Co.) according to the procedure of ZITKO (4), and then added to aquaria containing distilled water (98 l.) to give concentrations of 2, 4, and 8 ppm.

Ten control fish were sacrificed at zero time to establish normal blood and tissue levels. At hourly intervals, 5 control and 5 principal fish were sacrificed for blood and tissue specimens. Fish that died during the sampling interval were not used in the study. Blood was collected into heparinized and plain capillary tubes from the caudal artery. Each fish was placed in an individual plastic bag and stored at -20°C for subsequent PCB analysis.

Pooled sera from control and principal fish were assayed in duplicate. Serum cortisol was assayed by a microfluorometric procedure according to MEHRLE (5) using an Aminco SPF 125 fluorometer. Serum transaminase (SGOT) activity was determined by a SIGMA (6) procedure. Analysis for sodium and potassium was made by flame emission with a Perkin-Elmer 403 atomic absorption spectrophotometer. Total serum protein (TSP) was

Bulletin of Environmental Contamination & Toxicology,
Vol. 12, No. 2 © 1974 by Springer-Verlag New York Inc.

determined with a Goldberg refractometer (American Optical Co.). Individual serum proteins were measured by microzonal electrophoresis (Beckman Instrument Co.).

Aroclor® 1254 content of individual tissue was assayed by macerating the tissue with anhydrous sodium sulfate in a glass homogenizer with pesticide grade hexane. Hexane extracts were concentrated to 1 ml and quantitatively transferred to a micro silica gel column. The column was eluted with 30 ml of benzene: hexane (1:1), and the elute was evaporated to dryness. Quantitation of PCBs was made by electron affinity gas chromatography employing a Ni^{63} detector and pulser. The sample was dissolved in 1 to 3 ml of hexane, and a 1 to 3 µl aliquot sample was injected on a 6 ft. glass column containing 3% OV-17 on 100/120 mesh Gas-Chrone Q, operated at 185°C.

Quantitation of tissue PCBs was based on the detector response of tissue extracts relative to the dectector response in hexane of a comparable quantity of Aroclor® 1254 (1 to 6 µg) with the assumption that each PCB isomer exhibited equivalent detector response. Aldrin (10-50 pg) was injected concomitantly with each hexane sample as an internal standard to correct for variation in detector response.

Results and Discussion

There was a significant increase in the transaminase activity of fish exposed to 8 ppm of Aroclor® 1254 for 4 hours. This increase in SGOT activity would suggest hepatocellular damage. BRUCKER *et al.* (7) fed rats Aroclor® 1242 and observed histopathologic alterations in liver and kidney with a 3 fold increase in SGOT activity. A decrease in total serum protein with an attendant reduction in the albumin-globulin ratio further supports the contention of liver dysfunction.

Cortisol content of the sera of principal fish was lower than cortisol level for control fish. However, the changes are not clinically significant because the sodium to potassium ratio was constant. The results of this study are presented in TABLE 1.

The accumulation of PCBs by brain, liver, and skeletal tissue was rapid and the deposition increased markedly with time. The greatest biological magnification occurred with liver (>300x) as presented in TABLE 2. In view of the rapid absorption and tissue accumulation of the PCBs, an additional study was

TABLE 1

Transaminase, cortisol, total serum protein values and albumin - globulin ratio in pooled sera of catfish exposed to Aroclor^{R} 1254 (8ppm)

Time Hours	SGOT 1/ Sigma Units C 3/	P 4/	Cortisol µg/100 ml C	P	TSP 2/ g/100 ml C	P	Albumin/ Globulin C	P	Sodium/ Potassium C	P
0	68		35		7.0		0.85		29.4	
2	22	64	49	25	8.7	3.6	1.13	0.82	--	--
4	42	206	50	36	6.2	4.0	0.80	0.61	24.1	29.1

1/ Serum glutamic - oxaloacetate transaminase
2/ Total serum protein
3/ Control fish, not exposed to PCBs
4/ Principal fish, exposed to PCBs

TABLE 2 Average PCB content of tissue from fish exposed to 8ppm of Aroclor^{R} 1254

Time (hrs)	Fish wt in g	Tissue		
		Brain	Liver µg/g	Skeletal
2	41.4±9	200.0±124	401.6±169	1.38±1.1
4	33.9±2	348.0±260	668.0±392	5.41±5.5

TABLE 3 Average PCB content of tissue from fish exposed to Aroclor^{R} 1254

Time (hrs)	Fish wt in g	Tissue		
		Brain	Liver µg/g	Skeletal
			2 ppm	
1	9.0±3.4	36.6±7.2	85.0±33.6	1.4±0.7
2	9.6±3.0	62.2±30.8	68.9± 3.8	2.6±0.4
4	9.7±1.7	49.0±12.9	91.5±33.7	2.2±0.6
8	10.6±3.3	86.6±8.2	297.1±39.2	2.4±2.8
			4 ppm	
1	9.5±3.9	58.6±24.9	154.7±41.1	3.5±2.0
2	10.6±1.5	80.8±18.9	145.3±56.6	4.3±1.5
4	11.2±5.2	91.8±63.5	278.6±114.1	3.5±2.2
8	8.3±1.6	115.7±64.6	180.6±80.2	1.5±0.9
			8 ppm	
1	7.1±1.4	33.3±18.7	125.9±78	1.34±0.6
2	8.4±1.5	72.1±24.8	132.1±20.9	3.3±1.3
4	12.8±2.0	124.5±23.7	189.4±36.7	3.5±1.9
8	8.9±2.3	156.6±117.1	269.4±157.2	9.5±8.3

conducted to ascertain the relationship between concentration of the compounds in water and tissue magnification. The results of this study are presented in TABLE 3. There was rapid absorption of PCBs by the fish during the first hour with the greatest deposition in the liver. In most instances, there was a direct relationship between biological magnification and concentration of Aroclor^{R} 1254 in aquaria water. The most consistent relationship between exposure levels and time was observed with brain tissue. In all of the tissue examined by GLC, there was no discernable change in the PCB profile from the profile of the standard Aroclor^{R} 1254.

The rapid deposition of PCBs in nervous tissue would account for some of the clinical signs observed in intoxicated fish. The clinical signs observed in diseased fish were lethargy, petechiae around the mouth dyspnea and disorientation.

References

1. SANDERS, H. O., and J. H. CHANDLER: Bull Environ. Contam. and Toxicol. 7, 257 (1972).

2. WALDISH, D. J.: Bull Environ. Contam. and Toxicol. 5, 202 (1970).

3. JEFFERIES, D. J. and J. L. F. PARSLOW: Bull. Environ. Contam. and Toxicol. 5, 306 (1972).

4. ZITKO, V: Bull. Environ. Contam. and Toxicol. 5, 279 (1970).

5. MEHRLE, P. M.: Personal Communication, Fish-Pesticide Res. Lab., Columbia, Mo.

6. SIGMA, CHEM. CO., St. Louis, Mo.: Tech. Bull. No. 505.

7. BRUCKER, J. V., K. L. KHANNA and H. H. CORNISH: Toxicol. Appl. Pharmacol. 24 434 (1973).