W. B. PAPAGEORGE

October 26, 1970

H. S. Bergen
W. R. Richard
R. E. Keller
E. P. Wheeler

J. R. Savage

Recent data from Dr. J. P. Mieure's work indicates the presence of naphthalene in biphenyl and anthracene or phenanthrene and dibenzofuran in Santowax R used in the manufacture of Aroclors.

The naphthalene, anthracene or phenanthrene could be present in the benzene used in the diphenyl unit or could be co-produced with the biphenyl, terphenyl and quaterphenyl.

The dibenzofuran could result from oxygen containing contaminants in the benzene or, more likely, be formed because of the presence of the promoter, acetone.

The Anniston Plant should design and execute a program for determining the source or sources of these contaminants.

W. B. PAPAGEORGE

ss

027158

C.A. No. B-84-1103-CA

SCM 068509

PLAINTIFF'S DEPOSITION EXHIBIT

[redacted]

TOWOLDMON0055093

Monsanto

FROM (NAME & LOCATION) Medical Department

DATE: November 3, 1970

SUBJECT: Status of Toxicity Studies and Needs--Aroclors and Substitutes

REFERENCE:

cc: H. S. Bergen, HBERG
M. W. Farrar, Queeny
R. E. Keller, S. Second St.
W. R. Richard, WRICH
J. E. Springgate, JSPRI

TO : W. B. Papageorge
WPAPA

Confirming our discussions, I have attached copies of tables showing the information available and what we we may need if the current plan for continued sales for some members of the Aroclor family and substitutes for others is to be implemented. The enclosed may not be a complete listing and will have to be reviewed and updated occasionally. Particularly lacking may be references to non chlorinated plasticizer materials.

Premises on which the "needs" are based include:

1. The determination that the chlorinated terphenyls can and will be found in environmental samples.

2. Biodegradation of the chlorinated terphenyls is virtually impossible.

3. Escape to the environment cannot be prevented in all proposed applications (including disposal of products containing them).

4. The lower chlorinated biphenyls may be biodegradable (metabolized in the mammalian species) with more toxic effects than the higher chlorinated PCB's--or at least at lower levels of insult.

5. Nothing more than acute data would be obtained for mixtures of the lower chlorinated biphenyls and the chlorinated terphenyls.

6. No chronic (two year studies) would be anticipated.

7. No sub-acute or chronic data would be obtained on non-halogenated substitute products such as phosphate esters, glycols, etc.



SCM 044584
C.A. No. B-84-1103-CA





For budgetary purposes fairly definite costs are indicated. The total of the costs are as follows:

I. Those studies I feel we cannot avoid--$191,300

II. Studies to be deferred for the time being--$287,000

In the case of Item I, we can make arrangements to pre-pay Industrial Bio-Test prior to the end of 1970.for any amount you have available. The remainder can be paid whenever you wish in 1971. We can also include next year any portion of the costs for the studies to be deferred as time and circumstances dictate.

Elmer P. Wheeler

EPW:ju

Enclosure

SCM 044585

027160

TOWOLDMON0055095

AROCLOR TOXICITY DATA

Toxicity Data	Cost	AROCLOR 1221 Have	AROCLOR 1221 Need	AROCLOR 1221 Date Begin	AROCLOR 1221 Date End	MCS 1016 Have	MCS 1016 Need	MCS 1016 Date Begin	MCS 1016 Date End	AROCLOR 5432 Have	AROCLOR 5432 Need	AROCLOR 5432 Date Begin	AROCLOR 5432 Date End	AROCLOR 5442 Have	AROCLOR 5442 Need	AROCLOR 5442 Date Begin	AROCLOR 5442 Date End
Acute																	
Rat-LD50	$ 200	X	$ (200)*	11/15 1970	12/31 1970		$ 200	11/15 1970	12/31 '70	X	$	11/15 1970	12/31 '70	X	$ (200)*	11/15 1970	12/31 '70
Rabbits-MLD (dermal)	250	X	(250)*	"	"		250	"	"	X		"	"	X	(250)*	"	"
Skin Irr. (rabbit)	100		100	"	"		100	"	"	X		"	"		100	"	"
Eye Irr. (rabbit)	125		125	"	"		125	"	"	X		"	"		125	"	"
Vapor Inhalation (Rats)	200		200	"	"		200	"	"			"	"			"	"
Fish (2 species)	600		600	"	"		600	"	"		600	"	"		600	"	"
Sub-acute																	
90-day rat **	6,000		6,000	1/2/71	6/1 '71		6,000	1/2/71	6/1 '71		6,000	1/2/71	6/1 '71		6,000	1/2 '71	6/1 '71
90-day dog	10,000		10,000	"	"		10,000	"	"		10,000	"	"		10,000	"	"
Fish (30-90 day)	3,000 (est.)		3,000				3,000				3,000				3,000		
Reproduction																	
Rats	17,000		Defer				Defer				Defer				Defer		
Chickens	8,000		Defer				Defer				Defer				Defer		
Teratology																	
Rabbits	4,500		Defer				Defer				Defer				Defer		
TOTAL:	$49,975																
NEED NOW:			$20,475				$20,475				$19,600				$20,275		
DEFERRED:			$29,500				$29,500				$29,500				$29,500		

* (Repeat)
** Control group cost $2,100

SCM 044586

TOWOLDMON0055096

AROCLOR TOXICITY DATA

Toxicity Data	Cost	AROCLOR 1254 Have	AROCLOR 1254 Need	AROCLOR 1254 Date Begin	AROCLOR 1254 Date End	AROCLOR 5460 Have	AROCLOR 5460 Need	AROCLOR 5460 Date Begin	AROCLOR 5460 Date End	HB-40 Have	HB-40 Need	HB-40 Date Begin	HB-40 Date End	MIPB Have	MIPB Need	MIPB Date Begin	MIPB Date End
Acute																	
Rat-LD50	$ 200	X				X				X				X			
Rabbits-MLD (dermal)	250	X				X				X				X			
Skin Irr. (rabbit)	100	X				X				X				X			
Eye Irr. (rabbit)	125	X				X				X				X			
Vapor Inhalation (Rats)	200	X				X											
Fish (2 species)	600	X					$ 600	12/15 1970	1/31 '71		$ 600#	12/15 1970	1/31 '71		$ 600#	12/15 1970	1/31 '71
Sub-acute																	
90-day rat **	6,000										6,000#	11/2/70	2/15 '71		6,000#	11/2 '70	2/15 '71
90-day dog	10,000																
Fish (30-90 day)	3,000 (est.)		$ 3,000														
Reproduction																	
Rats	17,000	X					Defer										
Chickens	8,000	X				X											
Teratology																	
Rabbits	4,500		4,500	11/15 1970	2/15 '71		Defer										
TOTAL:	$49,975																
NEED NOW:			$ 7,500				$ 600				$ 6,600#				$ 6,600#		
DEFERRED:							21,500										

(Repeat)

* Control group cost $2,100

\# Already paid

SCH 044587

TOWOLDMON0055097

AROCLOR TOXICITY DATA

Toxicity Data	Cost	MCS 1043 Mono-Chloro Mono-Bromo Biphenyl Have	Need	Date Begin	Date End	Have	Need	Date Begin	Date End	Mono-Bromo Dichloro Diphenyl Have	Need	Date Begin	Date End	AROCLOR 6062 Have	Need	Date Begin	Date End
Acute																	
Rat-LD50	$ 200		$ 200	3rd qtr. '71	1st qtr. '72		$ 200	3rd qtr. '71	1st qtr. '72		$ 200	3rd qtr. '71	1st qtr. '72	X			
Rabbits-MLD (dermal)	250		250	"	"		250	"	"		250	"	"	X			
Skin Irr. (rabbit)	100		100	"	"		100	"	"		100	"	"	X			
Eye Irr. (rabbit)	125		125	"	"		125	"	"		125	"	"	X			
Vapor Inhalation (Rats)	200		200	"	"		200	"	"		200	"	"				
Fish (2 species)	600		600	"	"		600	"	"		600	"	"				
Sub-acute																	
90-day rat **	6,000		6,000	"	"		6,000	"	"		6,000	"	"				
90-day dog	10,000		10,000	"	"		10,000	"	"		10,000	"	"				
Fish (30-90 day)	3,000 (est.)		3,000	"	"		3,000	"	"		3,000	"	"				
Reproduction																	
Rats	17,000		Defer				Defer				Defer						
Chickens	8,000		Defer				Defer				Defer						
Teratology																	
Rabbits	4,500		Defer				Defer				Defer						
TOTAL:	$49,975																
NEED NOW:			$20,475				$20,475				$20,475						
DEFERRED:			$29,500				$29,500				$29,500						

(Repeat)

* Control group cost $2,100

SCM 044588

027163

TOWOLDMON0055098

AROCLOR TOXICITY DATA
2,2 Prime Dichloro Diphenyl Ether

Toxicity Data	Cost	Bromo-Chlorobenzene Have	Need	Date Begin	Date End	Have	Need	Date Begin	Date End	Have	Need	Date Begin	Date End	Have	Need	Date Begin	Date End
Acute																	
Rat-LD50	$ 200		$ 200	3rd qtr '71	1st qtr. '72		$ 200	3rd qtr '71	1st qtr. '72								
Rabbits-MLD (dermal)	250		250	"	"		250	"	"								
Skin Irr. (rabbit)	100		100	"	"		100	"	"								
Eye Irr. (rabbit)	125		125	"	"		125	"	"								
Vapor Inhalation (Rats)	200		200	"	"		200	"	"								
Fish (2 species)	600		600	"	"		600	"	"								
Sub-acute																	
90-day rat **	6,000		6,000	"	"		6,000	"	"								
90-day dog	10,000		10,000	"	"		10,000	"	"								
Fish (30-90 day)	3,000 (est)		3,000	"	"		3,000	"	"								
Reproduction																	
Rats	17,000		Defer				Defer										
Chickens	8,000		Defer				Defer										
Teratology																	
Rabbits	4,500		Defer				Defer										
TOTAL:	$49,975																
NEED NOW:			$20,475				$20,475										
DEFERRED:			$29,500				$29,500										

(Repeat)

* Control group cost $2,100

SCM 044589

TOWOLDMON0055099

027

PCB - Japan

MITSUBISHI MONSANTO CHEMICAL COMANY

FROM LOCATION Tokyo

DATE December 28, 1970

SUBJECT

REFERENCE Your Memo Dec. 21, 1970

TO Mr. W. B. Papageorge
St. Louis, Mo.

c Messrs.
J. Mason
H. Bergen
E. Wheeler

Animal feeding studies sponsored and paid for by Monsanto are the property of Monsanto, obviously.

Although Kanegafuchi is asking, they also are testing to see how far Monsanto will go in giving away information. Refusal to give them details will have no real effect on our relationships with Kanegafuchi here in Japan. If Monsanto files any of its data, with FDA or other governmental agencies, Kanegafuchi will try that route too.

MMK will work closely with Kanegafuchi to try to establish a PCB marketing plan in Japan that is consistent.

In the absence of limitations on use by country in the form of regulations or laws, it will be impossible to prevent exports. We can persuade them to limit applications in Japan from self interest, but cannot significantly influence exports to a country which has no regulations. I'm afraid this includes the U.S.A. until formal regulations issue.

J. R. Durland

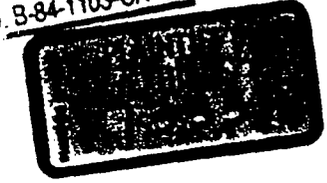
JRD:fu

027254

SCM 044851

PLAINTIFF'S DEPOSITION EXHIBIT 2 5-18-94 VMF

C.A. No. B-84-1103-CA



Monsanto INDUSTRIAL CHEMICALS CO.

FROM (NAME & LOCATION): W. M. Mees - T2F

DATE: October 10, 1972

SUBJECT: TRIP REPORT

REFERENCE:

TO: E. S. Tucker
T2F

cc: R. E. Keller - T1B
R. H. Munch - T1B
W. B. Papageorge - B2NA
W. R. Richard - T3A
J. F. Stapleton - B2SA
R. A. Stohr - A3SB
E. P. Wheeler - A2SA

Meeting: Symposium on PCBs - 164th ACS National Meeting, New York

Date: August 29 and 30, 1972

For Monsanto: W. M. Mees

Purpose of Trip: To keep abreast of the research being carried out on the environmental aspects of PCBs. To identify future problems with PCBs for Monsanto.

Summary:

The twenty-six papers presented were divided into three categories: ubiquity (6), analysis and degradation (7), and toxicity (13).

I. Ubiquity

Researchers continue to document the presence of PCBs in the environment and the transport of these materials to the higher members of the various food chains. The papers dealt primarily with aquatic systems, and in several cases significant decreases in the PCB levels were noted. Decreased PCB levels were observed: by Dr. Y. A. Greichus in the Lake Poinsett, South Dakota ecosystem (~50%, '70 vs '71), by Dr. O. W. Berg in sediments from lakes and rivers in Ontario, and by Dr. D. R. Nimmo in samples from Escambia Bay, Florida (10 fold, '70 vs '71).

Dr. Hans J. Crump - Weisner reported on the U.S. Geological Survey's monitoring of surface waters for PCB contamination (10 states). The levels found ranged between 0.1 and 4 ppb. Confirmation was accomplished by gas chromatography-mass spectrometry.

Dr. A. R. Yobs of the EPA who has been monitoring human adipose samples, reported the results of a larger sampling.

PCB in Human Adipose Tissues

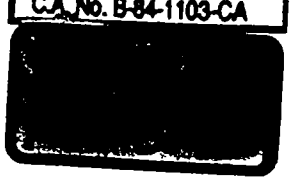
Negative	1001	45.7%
Trace - <1 ppm	370	16.9%
1-2 ppm	651	29.8%
>2 ppm	167	7.6%
	2189	100.0%



SCM 054138

No comment was made regarding the significance of the PCB levels found in humans.

C.A. No. B-84-1103-CA



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TOWOLDMON0055101

II. Analytical and Degradation

The papers dealing with analytical techniques, often quite exotic, netted very little useful information.

Dr. D. L. Stallings, using GC/MS, has verified a significant decrease in the penta isomer content of Aroclor 1016 vs Aroclor 1242. He is planning to publish his data in JAOAC soon.

Dr. O. Hutzinger discussed his photochemical degradation experiments with pure isomers. Using both lab and natural conditions he has observed isomerization, condensation, polymers, polar materials, higher PCB formation and terphenyls. Experiments were carried out with thin films in the presence of water. Alteration of the 2,2',5,5' tetrachloro homolog was complete in 80 hours. No alteration was observed with the 2,2',4,4',5,5' hexachloro homolog.

III. Toxicity

One day was devoted to papers on toxicity studies with the Aroclors. The feeding studies discussed involved Aroclor 1016, Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 5460 with invertebrates - fish, birds, and mammals. The data presented was at times confusing and occasionally contradictory. Considerable effort was directed toward detailing the various changes occurring in animal systems upon exposure to the Aroclors. Much less effort was spent on detailing the reversal of the toxic effects observed. Metabolism of the Aroclors in birds and mammals appears to proceed as expected via hydroxylation without the loss of chlorine. No hydroxylated metabolites were observed in excretions of rats and pigeons exposed to the 2,2',4,4',5,5' hexachloro biphenyl. No hydroxylated metabolites were detected in any of the studies with trout. Somewhat surprising were the unusually high levels of PCB found in the brain tissues of birds and mink. The significance of this observation was not discussed.

Dr. D. Nimmo reported Aroclor 1016 was as toxic as Aroclor 1242 to shrimp, oysters and fish in chronic dynamic bioassays.

Dr. R. Ringer reported on the growth and reproduction problems of mink apparently caused by PCB contamination of Lake Michigan coho salmon. All of the animals orally exposed to the Aroclor died during the test. A total of 45 mink were divided into 3 groups (12 females and 3 males per dietary treatment group). The treatments were a basal diet containing ocean fish, substitution of coho salmon for the ocean fish, and the basal diet supplemented with 10 ppm each of Aroclors 1242, 1248, and 1254. Additional feeding studies are being carried out with Aroclor 1254.

SCM 054139

027825

TOWOLDMON0055102

A discussion on directions for future PCB research was led by Dr. J. C. Street. Perhaps the most significant comment was to the effect that researchers should look for impurities, specifically dibenzofurans, in the Aroclors to explain the erratic toxicity data.

Dr. A. C. Kolbye discussed FDA regulation of PCBs as well as the prospects regarding future PCB tolerance limits. His presentation amounted to a justification of the FDA's proposed guidelines on the basis of available animal and human toxicity data.

Dr. Kolbye made favorable comments about Monsanto's restrictions on sales and uses. He indicated that, in his opinion, Monsanto has acted responsibly and the restrictions should minimize the levels of PCB in the environment.

Dr. Kolbye alluded to the fact that consumption of sport fish could be potentially hazardous to humans, primarily because at this point, it is an unregulated area.

In summary, the academic community appears anxious to initiate more research on the PCBs and to use the PCB problem as a source of research funds. The regulatory agencies, notably the FDA, seem to view the PCB situation as a problem which currently is under control.

W. M. Mees

db

SCM 054140

027826

TOWOLDMON0055103

Monsanto

FROM (NAME & LOCATION) W. B. Papageorge B2SK

DATE (1) December 6, 1974

SUBJECT (2) Return D Wood PCBs - CHLORINATED DIBENZOFURANS

REFERENCE

TO : J. P. Mieure - T2B

cc H. S. Bergen
R. E. Keller
O. J. Levinskas
W. R. Richard
J. R. Savage
P. L. Wright
E. P. Wheeler

(1) X.C. D Wood

2) T Gossage

Attached is a copy of a paper which is being offered for publication in the "Bulletin of Environmental Contamination and Toxicology." Dr. Kimbrough has solicited our comments. If you or any of the recipients of copies of this memo have any comments to offer, please submit them to me by December 16.

W. B. Papageorge /pw
W. B. Papageorge

DEC 12 1974

/pw

Bill briefly - what is significance of Chlorodibenzofurans when material was found in Bayer/Rodelic product what was pressure to reduce

D. Wood.

Chlorodibenzofurans are very highly toxic. Many effects on birds and animals noted and originally attributed to PCBs when later found to be due to furan content. There is currently no legal or regulatory pressure to reduce. Subject, however, is very emotional and could result in further pressures to eliminate PCBs from all uses.

WB Papageorge

028331

SCM 068595

IM - 10 REV. 1/72

[redacted]

[redacted]

TOWOLDMON0055104

D. Wood - St. Louis

R Keller

June 16, 1975

(2) CHLORINATED DIBENZYLFURANS

H. S. Bergen - B2SL
W. B. Papageorge - B2SK
J. Mieure - T2F
R. H. Munch - T1B
C. Paton - B2SC

J. N. Haggart
5040

John,

You will recall that Dutch researchers (Voss et al) found furans in chlorinated biphenyls produced by Prodelec and Bayer some four years ago.

Recently FDA has claimed to have detected these products in Aroclor and we will possibly see increased publication about these toxic contaminants develop.

It would be appropriate to establish a technical dialogue with Bayer if they have carried out "in house" work in this area and Ralph Much will be writing to Dick Baxter about this.

We need to develop our own methods to determine if indeed the chlorinated dibenzylfurans are present and what is the potential hazard. I am asking Ralph to send copies to you when he contacts Dick in case there are any business implications in establishing such a technical contact of which we are not aware.

Regards,

D. Wood

/pep

Bob - As I recall Ralph or Ralph and yourself [illegible] were going to follow up on my advice to Brussels product group

David

I suggest you write to Baxter referencing my [illegible] to Haggart.

C.A. No. B-84-1103-CA

SCH 088865

028565







TOWOLDMON0055105

Monsanto INDUSTRIAL CHEMICALS CO.

FROM (NAME & LOCATION) R. E. Keller - T1B - St. Louis

DATE August 15, 1975

SUBJECT CHLORINATED DIBENZOFURANS

REFERENCE

TO : R. Baxter
LLN - 5045

cc H. S. Bergen - B2SL
R. A. Lidgett - LLN - 5045
J. P. Mieure - T2F
R. H. Munch - T1B
W. B. Papageorge - B2SK
W. R. Richard - T3A
D. Wood - B2SD

Dick,

In June this year a plan was developed with Bill Papageorge and others to learn more about chlorinated dibenzofurans in our Aroclor products. As a part of this plan it was decided that furans standards should be prepared and analytical methodology developed for the detection of at least 0.1 ppm for each furan homolog. Laboratory mixtures of monochloro- through hexachlorodibenzofurans have been prepared and characterization for homolog distribution is underway. Also, we have about one-man continuous effort on the method development work.

As part of the plan it was decided that we should determine if Bayer has carried out "in-house" work of this type. The attached June 16 memo from Dave Wood to J. N. Haggart covers a request for this information. We have had no reply to this correspondence to our knowledge. Any information or assistance you can provide on this point will be appreciated.

During the past week a publication has appeared in the literature entitled "Identification of Chlorinated Dibenzofurans in American Polychlorinated Biphenyls" by R. W. Risebrough et al. of the University of California. A copy of this paper is attached. It shows the identification of chlorinated dibenzofurans in our Aroclor products except Aroclor 1016. We are now anxious to develop our own data for comparison with this publication.

Regards,

Bob K

R. E. Keller

ss
Attachments(2)

028631

SCM 068698

Xc

① R Keiler

D. Wood - St. Louis

June 16, 1975

② CHLORINATED DIBENZYLFURANS

H. S. Bergen - B2SL
W. B. Papageorge - B2SK
J. Mieure - T2F
R. H. Munch - T1B
C. Paton - B2SC

J. N. Haggart
5040

John,

You will recall that Dutch researchers (Voss et al) found furans in chlorinated biphenyls produced by Prodelec and Bayer some four years ago.

Recently FDA has claimed to have detected these products in Aroclor and we will possibly see increased publication about these toxic contaminants develop.

It would be appropriate to establish a technical dialogue with Bayer if they have carried out "in house" work in this area and Ralph Much will be writing to Dick Baxter about this.

We need to develop our own methods to determine if indeed the chlorinated dibenzylfurans are present and what is the potential hazard. I am asking Ralph to send copies to you when he contacts Dick in case there are any business implications in establishing such a technical contact of which we are not aware.

Regards,

D. Wood

/pep

Bob - As I recall Ralph or Ralph and yourself jointly were going to follow up on my advice to Brunels product group.

David

I suggest you write to Baxter referencing my Hoeme to Haggart

SCM 068699

028632



TOWOLDMON0055107

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... San Francisco. These conditions would lead to increased tree growth during the following growing season (Fig. 4).

Autumn and winter climatic anomaly features, combined with spring climate and the year-to-year autocorrelation of tree-ring widths, produce the other ring-width anomaly features in Fig. 4 for the following growing season. Narrow ring widths south of San Francisco, for example, imply below normal precipitation—an expected feature since winter precipitation in the Pacific North-west is negatively correlated with winter precipitation in southern California[6].

The reconstructed values of albacore catch distribution data (Fig. 3) and inferred population distribution also seem to exhibit long term changes over intervals of 100 yr or more, which suggest the possibility that long term fluctuations in the ocean-atmosphere system may be involved.

The success of the calibration of tree rings with albacore catch indicates the possibility of relating tree-ring variations to any type of biological variations which are affected by large scale climatic fluctuations. Such relationships may be quantified and used to reconstruct objectively other climatically-caused biotic variations in the past.

N. E. Clark

National Oceanic and Atmospheric Administration,
National Marine Fisheries Service,
Southwest Fisheries Center,
La Jolla, California 92037

T. J. Blasing
H. C. Fritts

Laboratory of Tree-Ring Research,
University of Arizona, Tucson, Arizona 85721

Received December 5, 1974; accepted May 6, 1975.

1 LaMarche, V. C., *Science*, 183, 1043–1048 (1974).
2 Namias, J., *Mon. Weath. Rev., U.S. Dep. Agric.*, 97, 173–192 (1969).
3 Laurs, R. M., *et al.*, *Report of Joint National Marine Fisheries Service–American Fisherman's Research Foundation Albacore Studies Conducted During 1971* (National Marine Fisheries Service, Southwest Fisheries Center, La Jolla, 1974).
4 Clemens, H. B., and Craig, W. L., *Calif. Dept. Fish and Game, Fish Bull.*, 128 (1965).
5 Sette, O. E., *Calif. Coop. Oceanic Fish. Invest. Rept.*, 7, 181–194 (1960).
6 Pyke, C. B., *An Investigation of some precipitation patterns in California and adjacent regions* (University of California Water Resources Center, 1966).

Oats may grow better in water depleted in oxygen 18 and deuterium

While growing oats at different temperatures in water of different ^{18}O and deuterium (D) abundances, we noticed that oats grown in Antarctic water in which is depleted in ^{18}O and D by −49‰ and −400‰ relative to standard mean ocean water (SMOW used as a comparative reference in hydrogen and oxygen isotope studies), showed initial growth 1–2 weeks sooner than did oats grown in water containing greater ^{18}O and D concentrations. The oats seemed to grow better in water which was most depleted in the stable isotopes throughout the growth period.

The oats were grown from the same batch of seeds in two sealed glass-covered glass jars (approximately 10 l). Twenty-five oat seeds were added to each jar, containing the same amount of vermiculite and 500 ml water to which 5.0 g Rapid-Gro, a commercial fertiliser, had been added. One jar contained melted glacial ice from the Antarctic with isotope concentrations of −49‰ $\delta^{18}O$ (SMOW) and −400‰ δD (SMOW). The other jar contained distilled ocean water with +1.0‰ $\delta^{18}O$ (SMOW) and +17‰ δD (SMOW). Both jars were placed in the chamber at the same time.

The experiment was repeated three times with new materials: once the growth chamber was maintained between 1.7 and 3.3 °C; once between 24 and 26.6 °C; and once the temperature fluctuated between 1.7 and 26.6 °C. Each time the oats in the jar containing water depleted in the heavy isotopes showed germination 1–2 weeks earlier and seemed to grow better throughout the growth period, than oats grown in distilled ocean water.

Using oats grown at 15 °C, the first sign of germination in the jar containing water depleted in the heavy isotopes was 4 d after planting. On the day 6, eight plants (out of 25) had attained a height of 6 cm. The first sign of germination in the jar with water containing the heavier isotope concentration, was after 17 d. By the time five plants had attained a height of 6 cm in this jar, in that with water depleted in the isotopes, 23 plants that had reached the top of the jar (approximately 25 cm).

Kashutin[1] observed that snow-water depleted in D increases the yield of cucumbers, radishes and spring wheat compared with controls grown in ordinary water of unspecified isotopic composition. He cites experiments on the egg productivity of hens and the weight gain of suckling pigs. In both cases water depleted in D was especially efficient in promoting productivity.

Although much has been done on the effect of D-enriched water on biological systems, we suggest that research on the effect D-depleted water on plant and animal growth may prove fruitful. A major source of water depleted in D by over 400‰ (40%) compared with SMOW is snow and ice from the Antarctic polar plateau. Water depleted by 150–180‰ is readily available in the USA from Rocky Mountain snow precipitating above 10,000 feet elevation.

Jim D. Gleason
Irving Friedman

US Geological Survey,
Denver, Colorado 80225

Received February 10; accepted June 3, 1975.

1 Kashutin, K., *Priroda (USSR)*, 58, 107 (1969).

Identification of chlorinated dibenzofurans in American polychlorinated biphenyls

Mortality of embryos has contributed to the reproductive failures of several bird species, including the sparrowhawks (*A. nisus*) of southern Scotland[1], the white-tailed eagles (*Haliaeetus albicilla*) of Schleswig Holstein[2], and the herring

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gulls (*Larus argentatus*) of Lake Ontario[3]. Suspected ... include *p,p'*-DDE (2,2-*bis*-(*p*-chlorophenyl)-1,1-dichlor... lene), other chlorinated biocides and/or their deriv...es, and the polychlorinated biphenyls (PCBs), all of which are present as contaminants in the eggs[1-3]. PCBs are present in high concentrations in the bird populations which suffer embryonic mortality[1-3]. Other organochlorine compounds which may be present in food webs include the chlorinated dibenzodioxins and the chlorinated dibenzofurans (*Fig. 1*), which are toxic to embryos in amounts[4-7] less than 1 μg. They are therefore among the most toxic substances known and are possible causes of the observed mortality.

The chlorinated dibenzodioxins and chlorinated dibenzofurans, however, have proved exceedingly difficult to detect in environmental samples in the concentrations at which they are expected to be embryotoxic[8-10]. The chlorinated dibenzodioxins enter the environment as contaminants in preparations of the herbicide 2,4,5-T (refs 5 and 11) and the fungicide pentachlorophenol[12,13]. Chlorinated dibenzofurans have been found in a French (Phenoclor DP6) and a German (Clophen A60) PCB and were shown to be the active embryotoxic agent in these preparations[8]. The techniques used, however, did not detect chlorinated dibenzofurans in an American PCB, Aroclor 1260. We report here the presence of chlorinated dibenzofurans in Aroclor PCB, widely used in North America and Great Britain, and in the same Aroclor 1260 preparation examined previously with negative findings[8].

Samples of PCB examined include: Aroclor 1248, 1254, and 1260 (1969); Aroclor 1254 (1970); Aroclor 1016 (1972); and the same three preparations studied by Vos *et al.*[8]: Aroclor 1260, lot No. AK-3; Clophen A-60, lot No. 912434; and Phenoclor DP-6, lot not specified. The latter three PCBs were obtained from Dr Vos, the others from the Monsanto Company in the years indicated in parentheses.

PCBs extracted from environmental samples most often have gas chromatographic profiles similar to those of PCB formulations containing approximately 48, 54 or 60% chlorine. In the Aroclor series, the former two PCBs are equivalent to Aroclor 1248 and Aroclor 1254, respectively. Aroclor 1260, Phenoclor DP6, and Clophen A60 all contain approximately 60% chlorine.

Chlorinated dibenzofurans were identified in all Aroclor preparations except Aroclor 1016, as well as in Clophen A60 and Phenoclor DP6. Aroclor 1016 is a PCB mixture containing

Fig. 1 Skeletal structures of: *a*, chlorinated biphenyl, $x+y = 1$–10; *b*, chlorinated dibenzofurans, $x+y = 1$–8; *c*, chlorinated dibenzodioxins, $x+y = 1$–8.

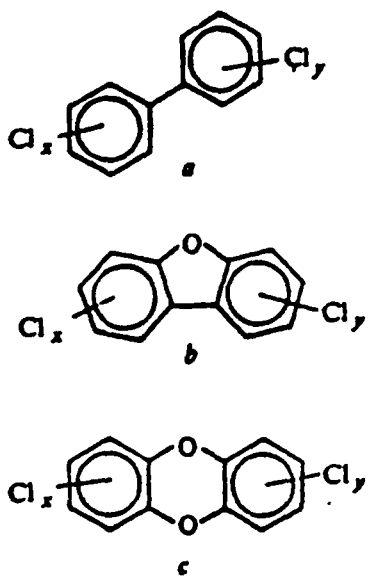

Table 1 Chlorinated dibenzofuran concentrations* in Aroclor, Clophen and Phenoclor

PCB	4-Cl	5-Cl	6-Cl	Total
Aroclor 1248 (1969)	0.5 (25)	1.2 (60)	0.3 (15)	2.0
Aroclor 1254 (1969)	0.1 (6)	0.2 (12)	1.4 (82)	1.7
Aroclor 1254 (1970)	0.2 (13)	0.4 (27)	0.9 (60)	1.5
Aroclor 1260 (1969)	0.1 (10)	0.4 (40)	0.5 (50)	1.0
Aroclor 1260 (lot. AK3)	0.2 (25)	0.3 (38)	0.3 (38)	0.8
Aroclor 1016 (1972)	ND	ND	ND	—
Clophen A-60	1.4 (17)	5.0 (59)	2.2 (26)	8.4
Phenoclor DP-6	0.7 (5)	10.0 (74)	2.9 (21)	13.6

*Expressed as μg g^{-1} PCB. Values in parentheses represent quantity as percentage total dibenzofuran.
ND, not detected (< 0.001 μg g^{-1}).

Amounts of PCB ranging from 1.0 to 2.0 g were dissolved in 400 ml hexane, placed on a Florisil column (130 g, internal diameter 31.5 mm), and eluted with: an additional 1,600 ml hexane, and successive 800 ml volumes each of 5% diethylether–hexane, 25% diethyl-ether–hexane and acetone, at a rate of approximately 7 ml min^{-1}. The major portion of the PCB was eluted in the hexane fraction, which was discarded. On addition of the 5% mixture, the eluates were collected in six successive 400 ml volumes. To eliminate the polar solvents, each eluate was evaporated twice just to dryness and taken up each time in a minimal amount of hexane. Each fraction, in 1 ml hexane, was placed on a microalumina column[14] and eluted with 10 ml each of 1% and 20% methylene chloride in hexane. These were also taken twice just to dryness and made to up a volume of 1 ml in hexane to eliminate the methylene chloride before gas chromatographic analysis. Aliquots of all fractions obtained before and after partitioning on alumina were injected into a six foot glass column containing 3% OV1 on 100–120 mesh Supelcoport in Tracor MT220 and Hewlett-Packard 5700 gas chromatographs equipped with ^{63}Ni electron-capture detectors. PCBs were found to be present in each fraction eluted from the Florisil column in amounts sufficient to interfere with the detection of trace contaminants. Partitioning on the alumina columns separated most of the PCB interference into the 1% methylene chloride fractions. On removal of this interference, different peak patterns appeared in the chromatograms of the 20% methylene chloride fractions. Compounds eluting in the 20% methylene chloride fraction were collected for mass spectrometric analysis using a 20:1 effluent splitter, and a trap consisting of a capillary tube (1 mm internal diameter, 100 mm long) bent to a U shape, immersed in a liquid nitrogen bath. Methylene chloride (20%; 4 μl) in hexane was injected into the capillary as a rinse, removed with a 10 μl micropipette, and placed directly on the mass spectrometer probe. The probe was inserted into a GEC AEI MS702 high resolution mass spectrometer and the solvent removed by the force pump. The probe was rapidly inserted into the ion source and multiple scans were recorded in the on-line high resolution mode[15].

approximately 42% chlorine and has replaced Aroclor 1242 in many applications, principally as the dielectric fluid in capacitors[16]. Values reported in Table 1 represent the total of those compounds found in 400 ml Florisil fractions 2–6. A total of 10–12 isomers was identified in each PCB. Two chlorinated dibenzofuran contaminants have been reported for the Clophen and Phenoclor previously[8]; our first analyses of the Clophen revealed an additional five chlorinated dibenzofurans[9]. The structures contained four to six chlorine atoms. Other dibenzofurans including those chlorinated to a lesser extent may have been present in the first 400 ml fraction but this was not examined in detail as it contained substantial PCB interference. Recently synthesised 2,3,7,8-tetra-, 2,3,4,7,8-penta- and 2,3,4,6,7,8-hexachlorodibenzofuran were used to quantify tetra-, penta-, and hexachlorodibenzofurans, respectively. The former two authentic standards had retention times on the OV1 column the same as those of two dibenzofurans isolated from the PCB.

Vos *et al.*[8] detected no chlorinated dibenzofurans in an Aroclor 1260 preparation at a detection limit of 1 p.p.m. Fractionation and examination of the identical Aroclor 1260 in our study confirm their findings based on the stated limit, but reveal the presence of 11 chlorinated dibenzofurans in the preparation, having a total concentration of 0.8 μg g^{-1} PCB (Table 1). The same workers also found diethyl ether extracts of the Clophen A60 and Phenoclor DP6 to be much more toxic to chick embryos than diethyl ether extracts of Aroclor 1260. Our study confirms those findings on the basis of chlorinated

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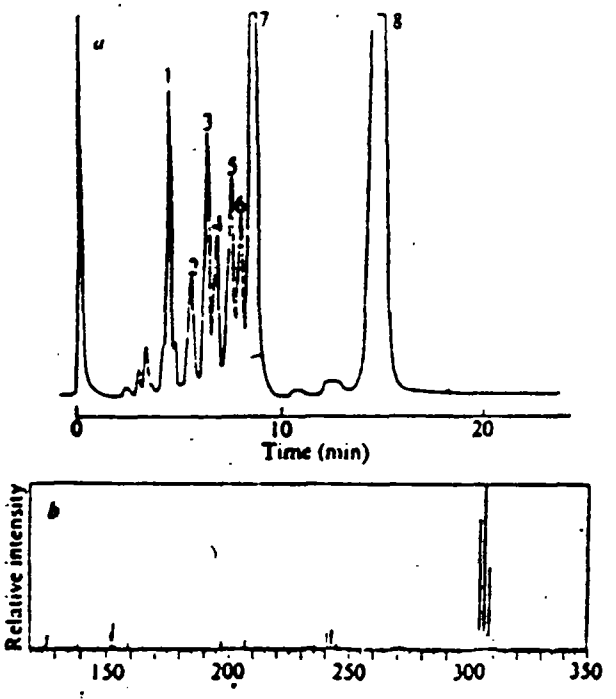

Fig. 2 *a*, Gas chromatogram of a fraction of Aroclor 1254 containing a mixture of chlorinated biphenyls, dibenzofurans, and naphthalenes. Identities of peaks are given in the text. *b*, Mass spectrum of peak 2, a tetrachlorodibenzofuran.

dibenzofuran content: the identical Clophen and Phenoclor contain 11 and 17 times more total chlorinated dibenzofurans, respectively, than the Aroclor 1260.

A gas chromatogram showing components derived from the Aroclor 1254 obtained in 1969 is represented in Fig. 2. The components were eluted in the second 400 ml Florisil fraction and recovered from the alumina column in 20% methylene chloride–hexane. Each of the numbered peaks was trapped as described here, and identified by mass spectrometric analysis. A nominal mass plot of the high resolution mass spectrum of peak 2 is shown in Fig. 2. The plot includes all the ions with elemental compositions ranging to the maximum empirical formula $C_{12}H_6O^{35}Cl_3^{37}Cl_1^{13}C_2$. The molecular ion cluster at nominal *m/e* 304–310 fragments by successive losses of Cl to yield the ions at *m/e* 269–275 and CO to the ions at *m/e* 241–245. A minor loss of Cl from the peaks at *m/e* 269–275 also occurs to yield the ions at *m/e* 234–238, followed by CO elimination to *m/e* 206–210.

The group of peaks at *m/e* 152–154 are the doubly charged molecular ions. An identical spectrum was obtained from an authentic standard of 2,3,7,8-tetrachlorodibenzofuran. This latter compound has a retention time identical to that of peak 4. Peak 2 is, therefore, a positional isomer. The accurate mass measurements for the characteristic ions are within 2 p.p.m. of the calculated exact masses. Peaks identified on this chromatogram and their retention times relative to dieldrin are as follows: a mixture of tetra- and pentachlorobiphenyl (1.02); tetrachlorodibenzofuran (1.30); pentachlorobiphenyl (1.46); tetrachlorodibenzofuran (1.57); hexachloronaphthalene (1.75); pentachlorobiphenyl (1.86); hexachloronaphthalene (2.00); and heptachloronaphthalene (3.46). An aliquot of combined fractions derived from the same Aroclor 1254 was treated with diazomethane to assess whether any chlorinated ortho-hydroxybiphenyls (pre-furans) were present. Gas chromatographic analysis of the sample before and after treatment resulted in identical chromatograms.

As large quantities of PCBs have entered the global environment[17–20], it may be assumed that the contaminant dibenzofurans also have been ...ed in proportional amounts. Their persistence, effects, a... significance remain to be determined.

We thank J. A. Burke, M. L. Porter and J. G. Vos for discussions; A. S. Kende for standards of chlorinated dibenzofurans; and F. C. Walls for assistance with the mass spectrometry. This work was supported by the Canadian Wildlife Service, National Science Foundation, and NASA.

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Received February 13; accepted May 28, 1975.

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Niche breadth in Bryozoa as a test of competition theory

COMPETITION theory predicts that intraspecific and interspecific competition should often have opposite effects on the use of resources by a population, the former increasing, the latter decreasing, the range of resource actually used[1–3]. Field data supporting these predictions are well known for the interspecific case[3–6] but are scarce for the intraspecific condition, and we have been unable to find any reference demonstrating both effects within a single species. We therefore report here the verification of both predictions in respect of competition for space by the epiphytic bryozoan *Alcyonidium hirsutum*; less extensive data suggesting the same effects within other bryozoans are also reported.

Intraspecific competition should result in an increase in the range of a resource spectrum used by a species, as at high population levels the advantages to any individual of being at the competition-free optimum of a resource gradient are offset by the intense intraspecific competition found there (Fig. 1*a*); this is the 'principle of equal opportunity' of MacArthur[1]. Interspecific competition, on the other hand, should tend to restrict the range of the resource spectrum used by a species, as individuals attempting to exploit marginal resources cannot do so as efficiently as

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Monsanto

FROM (NAME & LOCATION) G. J. Levinskas - A2SC

DATE September 25, 1975

SUBJECT PCBs

REFERENCE

cc H. S. Bergen - B2SL
D. R. Bishop - B1ND
W. B. Papageorge - B2SK
R. G. Potter - B3SA
W.W. Withers - B2SA

TO

G. Roush, Jr.
A2SA

The attached represents a final (?) version of the toxicity statement on PCBs. This takes note of all the comments which have been received since the version mailed to you on August 29, 1975.

This was discussed on the phone with Wayne Withers, and he agreed that it was acceptable. Since Wayne was the only one who had comments regarding the August 29 version, this should be satisfactory to all concerned.

George J. Levinskas

/bkp

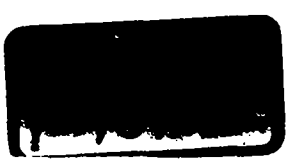
att.





C.A. No. B-84-1103-CA

SCM 019716



PCBs

Recently, we were informed that liver carcinomas were observed in female Sherman strain rats fed AROCLOR 1260 for 20½ months. This prompted us to re-examine livers from male and female rats of the Charles River strain which had been fed AROCLOR 1242, AROCLOR 1254 or AROCLOR 1260 for 2 years in earlier studies conducted for Monsanto Company.

There are 4 elements which are closely interwoven in this matter: (1) differences in test procedures, (2) differences in results obtained by various investigators, (3) definition of what is a cancer, and (4) evaluation of potential risks, if any, to man. These will be summarized briefly.

(1) Several animal studies have been conducted with various brands of PCBs. In some studies, the test material has been identified by trade name (AROCLOR, KANECLOR). In others, there was just a general reference to PCB. Consequently, the quality of test material with respect to the amounts and nature of contaminating impurities or by-products cannot be determined in [redacted] case. In addition, several strains of test animals were used, the duration of the experimental periods varied, and there was a wide range in the depth of detail with which the observations were reported. Consequently, it is difficult to make comparisons between these studies.

(2) In general, studies have shown mice to be more susceptible than rats and females to be more sensitive than males to the liver effects of PCBs. Beyond these generalizations, the results have not been consistent. Some investigators have



TOWOLDMON0055112

reported liver carcinomas. Others have observed only benign tumors. Several have noted changes in liver tissue without detecting tumor formation. For the reasons just cited, it is difficult to determine the bases for these different results. The most direct comparison can be made between the 2 studies on AROCLOR 1260 since the same high dosage level of the same lot of AROCLOR 1260 was employed in both experiments. In the studies reported to us, liver carcinomas occurred in approximately 8% of female rats of the Sherman strain (the only sex used), In Monsanto's study, none of the liver lesions had progressed beyond the stage of benign tumors (hepatomas) despite a slightly longer duration of feeding of AROCLOR 1260 to rats of Sprague Dawley, Charles River strain. The Monsanto study employed rats of both sex and it did confirm the previously noted greater sensitivity of female rats to liver effects of PCBs.

(3) A review of the liver alterations seen in all 3 AROCLORS in Monsanto's studies shows that the lesions were benign in character in the traditional pathologic sense. An evaluation of all information available to us, including the contradiction between the recent data showing AROCLOR 1260 to be a carcinogen and our earlier negative results on the same product, leads to a conclusion that AROCLOR 1260 is not carcinogenic to all commonly used strains of laboratory test animals.

(4) In 1972, the manufacture of AROCLOR 1260 was discontinued in the United States and the sale of AROCLORs was restricted to a single use, i.e., as dielectric fluids. As such they are used in closed systems which will at least minimize additional environmental contamination. Considering the

high degree of fire risk associated with this use, and recognizing that AROCLOR 1260 may have a weak carcinogenic potency which has not been fully proven and that AROCLORS 1242 and 1254 have not been shown to be carcinogens, it is concluded that the continued use of AROCLORS 1242 + 1254 as dielectric fluids will not present an unreasonable human health hazard.

SCM 019719



TOWOLDMON0055114

Monsanto

1 file copy

FROM (NAME & LOCATION): G.J. Levinskas - A2SC

DATE: November 20, 1975

CC:

SUBJECT:

REFERENCE: DRB, 11/17/75

TO:

D. R. Bishop - B1ND
T. H Bottini - B2CA
W. R. Corey - B2SA
P. O. DeGarmo - A2SA
F. J. Fitzgerald
W. C. Hammann - B3SA
E. H. Harbison - D1K
J. P. Mieure
W. B. Papageorge - B2SK
C. Paton - B2SC
R. G. Potter - B2SB
G. Roush - A2SA
J. C. Weber - B1ND
W. W. Withers - B2SA
D. Wood - B2SD
P. L. Wright - A2SC

This will confirm in writing the message given to each of you or your secretaries by Mrs. Brenda Parker via telephone on Wednesday, November 19, 1975.

The news release prepared by Dan Bishop which accompanied his memo of November 17, 1975 should not be released. It should be destroyed to prevent its inadvertent use or misuse.

In the cover memo, it stated that the final version was to be cleared with Dr. Pour. Both Dr. Pour and his superior, Dr. Shubik, director of the Eppley Institute for Research in Cancer, do not want to be embroiled in a public controversy, and they do not want the Institute's name to be bandied about in the press.

Dr. Pour had agreed that we could present his findings to scientists in the regulatory agencies, and he is willing to defend his judgement in scientific circles. His reports have been made available to the regulatory agencies. The Department of Medicine and Environmental Health feels that this is the proper and best use that can be made of his studies. Since we do not want to compromise his position, and we do not want to jeopardize our future relationship with him or the Eppley Institute, the proposed news release should be destroyed.

GJL

George J. Levinskas

/bkp

[redacted]

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C.A. No. B-84-1103-CA
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[redacted]

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TOWOLDMON0055115

Elmer P. Wheeler, Medical Department

January 29, 1970

J. S. Barrett, London
~~H. St Bergen, Belgium~~
W. B. Papageorge, WPAPA

Status of Aroclor Toxicological Studies

D. S. Cameron
Brussels

Enclosed is a copy of the reports from our consulting laboratory indicating the status of the animal toxicity studies. I have summarized the pertinent findings separately and as indicated in the table.

We have given copies of these data to one U. S. customer, the U. S. FDA and one or two other state agencies. I don't see why this information cannot be released with discretion in Britain or Europe.

Our interpretation is that the PCB's are exhibiting a greater degree of toxicity in this chronic study than we had anticipated. Secondly, although there are variations depending on species of animals, the PCB's are about the same as DDT in mammals.

We have additional interim data which will perhaps be more discouraging. We are repeating some of the experiments to confirm or deny the earlier findings and are not distributing the early results at this time.

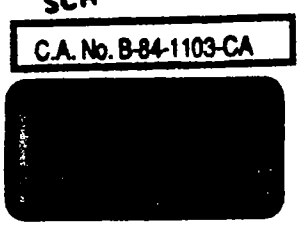
Elmer P. Wheeler

EPW:ju

Enclosure







(Airmail)

St. Louis

December 17/51

Mr.W.E.Hamer, Ruabon
Mr.W.H.Ritchie, Ruabon
Dr.H.R.Newman, Ruabon
Mr.S.M.Kulifay, Krumrich
Dr.D.S.Weddell, St.Louis
Mr.F.T.Marshall, St.Louis

Mr. P. J. C. Haywood HR

Newport (Airmail)

F ⇒ AROCLORS: TOXICITY

Since writing my note of Dec.11/51 I have chanced to learn that Anniston people had quite serious skin troubles: boils, blackheads and the like, among workers in Aroclors, especially 1269, around 1933.

A little browsing into the literature reveals quite a history of skin troubles and liver troubles (including some fatal cases) attributed to heavy exposure to chlorinated diphenyls.

The chlorinated diphenyls are stated to be worse than chlornaphthalenes, and to be more harmful the more chlorine they contain. I still think, however, that the exposure in ordinary analytical work should not cause any trouble.

E. Mather

tm

RECEIVED
24 DEC 1951
RUABON

[redacted]

C.A. No. 8-84-1103-CA

SCM 048767

[redacted]

025650

Blcc: Dr. D.V.N. Hardy

MR. H.K. MASON, St.Louis (2) 8th September, 1955.

JWB:VEH AROCLOR TOXICOLOGY

cc: Dr. H.R. Newman.

Dear Howard,

You will readily appreciate that we are very much concerned with the toxicology of Aroclors, particularly as our development sales efforts in this field of Monsanto products have, in the last six months or so, really begun to pay off.

Recently we received through Dr. Kelly the findings of the Kettering Laboratory which as far as we were concerned included entirely new data. In particular, the toxicity of Aroclor 1254 was demonstrated with a range of animals at a level of 1.5 mgrm./cu.m. At the same time there was no toxicity found for 1242 at concentration of 1.9 mgrm./cu.m. This in itself might be said to be surprising and perhaps indicate some specific differences between the toxicities of various grades of Aroclor. We would be most anxious to learn from you whether you accept the Kettering results as fully significant in a broad way, and whether this data is going to be made available to all.

Fortunately, our Chief Medical Officer, Dr. H.R. Newman, is visiting St.Louis and will be discussing the significance of this Kettering work with Dr. Kelly. Here there is a convention that a factor of 10 is used in translating animal toxicities to human toxicities. In other words there would be an interpretation that Aroclor 1254 should not be used where atmospheres containing a quantity something less than 0.15 mgrm./cu.m. results.

Both Sales and Development here are very anxious to handle this awkward problem in the right way and to remain in complete liaison with you on actions which might be necessary. Perhaps it is particularly important to us as a very large proportion of our present sales do go to surface coating uses.

[redacted]

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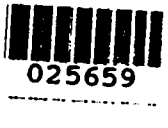

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We had been giving consideration to getting some toxicological data established for us on the Aroclors by Battelle in Germany who have good facilities for this type of work. However, we would certainly not do this without full discussion with you. To us there seems the necessity of establishing quite a lot more data and we would be willing to arrange for some of this to be obtained if you think that this is a reasonable suggestion. Dr.Newman's visit is particularly appropriate at this stage and of course it would be possible for me to discuss the matter broadly during my visit in late October. However, meanwhile we would be most grateful to gain as much of the M.C.C. point of view as possible.

J.W. BARRETT.

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TOWOLDMON0055119

COPY

Dr. D.V.N. Hardy
Dr. H.R. Newman.

Monsanto Chemical Company

St. Louis, Missouri

September 20, 1955

Dr. J.W. Barrett

London

Your memo September 8 to Mr. Nason

AROCLOR TOXICITY

Howard Nason has given me your memo of September 8. I will be happy to discuss this with Dr. Newman during his visit here. I think, however, there are several points that I can answer you now.

You comment upon the difference in toxicity between Aroclor 1254 and 1242. This is not particularly surprising because in the earlier work it was found that toxicity increased with chlorination. Of course, from the standpoint of volatility in the case of inhalation or absorption from the gut from the point of view of ingestion are important. Frankly, there was not too great a difference between the two compounds, however. As you know, the maximum allowable concentrate is 0.1 ml/cubic meter in the case of 1254, and as high as 10.0 mgm in the case of 1268. I think the former is too low and the latter is too high. In this country they don't use the MACs very routinely, but certainly in England I think it would be alright to consider 0.2 mgm/cubic meter as perfectly safe.

I don't know how you would get any particular advantage in doing more work. What is it that you want to prove? I believe your work should be directed towards finding out what the concentrations are of Aroclor during different operations whether it is industrial or painting. The reports you have seen from Kettering Laboratory are the result of approximately $15,000 to $20,000 expenditure by MCC.

MCC's position can be summarized in this fashion. We know Aroclors are toxic but the actual limit has not been precisely defined. It does not make too much difference, it seems to me, because our main worry is what will happen if an individual developes any type of liver disease and gives a history of Aroclor exposure. I am sure the juries would not pay a great deal of attention to MACs.

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COPY

We, therefore, review every new Aroclor use from this point of view. If it is an industrial application where we can get air concentrations and have some reasonable expectation that the air concentrations will stay the same, we are much more liberal in the use of Aroclor. If, however, it is distributed to householders where it can be used in almost any shape and form and we are never able to know how much of the concentration they are exposed to, we are much more strict. No amount of toxicity testing will obviate this last dilemma and therefore I do not believe any more testing would be justified.

Let's see what our discussions with Dr. Newman and yourself bring out.

R. Emmet Kelly, M.D.

REK:k

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COPY

Dr. D.V.N. Hardy
Dr. H.R. Newman

Monsanto Chemical Company

St. Louis, Missouri.

September 22, 1955

Dr. J.W. Barrett

London Office

AROCLOR TOXICITY

On rereading my memo of September 20 to you I noticed an error in the second paragraph. I feel that this correspondence is sufficiently important to correct this paragraph.

This paragraph should read:

> You commented in your letter about the difference in toxicity between Aroclor 1254 and 1242. These differences are not surprising because in the earlier work it was found that toxicity increased with degree of chlorination. Of course, the volatility is important in the case of inhalation toxicity, and absorption into the intestinal tract is important from the point of oral toxicity. Frankly, there was not a great deal of difference between the two subject compounds. As you know, the maximum allowable concentration is 0.1 mg/cubic meter in the case of 1254 and is as high as 10.0 mg/cubic meter in the case of 1268. I think the former is too low and the latter is too high. In the United States they don't use maximum allowable concentrations (MAC) very routinely but certainly in England I think it would be alright to consider 0.2 mg/cubic meter as perfectly safe.

R. Emmet Kelly, M.D.

REK:k



TOWOLDMON0055122

CONFIDENTIAL

TO: DR. J.W. BARRETT.

6th December 1955

DVMH/MEB

AROCLORS - TOXICOLOGICAL EXAMINATION

c.c. Dr. J.A. Gardner.
Dr. W.McG. Morgan.
Mr. W.E. Hamer.
Mr. C.G. Wickham
Dr. H.R. Newman
Dr. D.S.P. Roebuck
Mr. J.S. Hunter
Mr. E.L. Pirton
Mr. H.G.H. Thomas.
Mr. J.A. Brindle.

Since my communication of 19th August 1955, when I summed up the position confronting us following the receipt of the reports of the Kettering Laboratory, Dr. Newman has discussed with Dr. Kelly the significance of the Kettering results in relation to M.C.C. thought and policy.

M.C.C.'s immediate action is to submit the reports to the American Conference of Governmental Industrial Hygienists in support of a claim that the official table of maximum permissible vapours concentrations should include the items:-

42%	Chlorinated Diphenyl (Aroclor 1242)	2 agrms./m^3
54%	" " (Aroclor 1254)	1 agrm./m^3

The Kettering results indicated in brief that prolonged exposure to Aroclor 1242 vapour at 1.9 agrm./m^3 gave no sign of damage to the test animals but that Aroclor 1254 at 1.5 agrm./m^3 caused slight but positive signs of injury. You will note that M.C.C. do not introduce a safety factor in translating these animal test results to human beings, and in fact regard such a factor as unnecessary in animal tests of such thoroughness as those carried out at Kettering.

It will be sometime before we know the decision. In my view it would not be unrealistic to assign a value of 2 agrm./m^3 to Aroclor 1242 but the case for setting the limit at 1 agrm./m^3 for Aroclor 1254 is not so logical. After all 1254 can cause slight but perceptible damage at 1.6 agrm./m^3 and who can say whether it would be harmless at

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1 agrm./m^3. However, if the M.C.C. recommendations are accepted there will be an implication that Aroclor toxicity increases with chlorine content, a reversal of the position suggested in M.C.C. technical literature. M.C.C. Application Data Bulletin No. P-115 states "If Aroclors are used at elevated temperatures such as 200° or 300°C. in open systems methods must be designed to exhaust any vapours arising from these open systems. This applies especially to lower chlorinated Aroclors where experimental work on animals indicates that the maximum safe concentration in workrooms is in the range of 0.5 - 1.0 milligrams per cubic meter of air. In the case of more highly chlorinated Aroclors such as Aroclor 1268 the allowable limit is about 10 milligrams per cubic meter of air and accordingly. Aroclors of this type are believed to be of a much lower order of toxicity.

Whatever the outcome, there will be no impact on M.C.C. policy regarding the use of Aroclors in paints since M.C.C. have long ceased to recommend the use of Aroclors for this purpose. However, M.C.L. has continued to offer Aroclors for use in paints on the basis that the evidence for rejection was slim, and that the risk is reduced by resorting to the use of more highly chlorinated Aroclors. This was thought to have the dual advantage of using a material of (a) lower intrinsic toxicity (b) lower vapour pressure. It is now clear that toxicity increases with degree of chlorination and that this effect may cancel or even outweigh the advantage due to decreased vapour pressure.

We have tended to draw a distinction between the use of Aroclors in latex paints on the one hand and in conventional paints on the other, the concensus of opinion being that the rate of volatilisation from the former is greater than from the latter, and as a result we are no longer recommending Aroclors for latex paints. The decision now before us is whether we should continue to sell Aroclors for use in conventional paints.

On this issue, the recent decision by I.C.I. to discontinue their usage of Aroclors in ordinary paints is considered to be an indication of the line that may well be taken by our other customers. Broadly speaking the main objections are that the paint manufacturer cannot control the paint user who may apply in the form of spray, and may use on hot surfaces. In either case a degree of risk must be admitted. As to how serious the risk may be it depends naturally on the total time for which any individual is exposed during his life time. There must clearly be circumstances under which the use of Aroclor containing paints will constitute a health hazard, particularly to individuals who for one reason or another are constitutionally less resistant than the norm. The I.C.I. decision must have been influenced quite materially by a letter from Dr. Kelly to Mr. Roy Mitterschein (dated 15.7.55.), a copy of which reached them through Canadian Industries Ltd. The relevant passages are as follows:-

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"Aroclor should not be sprayed on the job in an industrial plant where there are plant personnel who can breathe the vapours. There is no danger at all if the material is brushed on, and there is no danger in spraying it if the workers use a booth or use an approved respirator and no one inhales the spray.

"Aroclor fumes at room temperature very probably would not present any hazards. Mist or spray, however, is another problem entirely and that is the reason for the above recommendation. After all, the toxicity of Aroclor must take into consideration how much can get into the air. It is our belief that at room temperature not enough can get into the air to cause any troubls. At elevated temperatures and if the material is dispersed as a mist or aerosol a different interpretation has to be placed on its toxicity".

The passages of particular significance to I.C.I. Paints are underlined and may be considered to be reflected in their conclusions which I now quote below:-

"In brief

(a) The spraying of Aroclor paints appears to involve precautions which would be so inconvenient as to limit unduly their application by this method.

(b) Apart from questions of spraying there appear to be cases where Aroclor-containing paints would involve toxic hazards either during application or subsequently, and where cautionary advice would be appropriate. The need for special precautions would limit the use of Aroclor paints in these cases.

(c) As far as the paints in question are concerned it is impossible to know how any particular can may be eventually used, so every can would need to show the warnings and precautions for all foreseeable eventualities. The presence of these warnings would tend to deter people from using the paints even in cases where no special precautions were needed."

With reference to the impression generally given that cold Aroclors are safe, recent determinations of vapour pressure (Southern Research Institute Final Report to M.C.C. on Project 526 by W.M. Nolan) permit the saturated vapour concentrations to be calculated as follows:-

	Vapour Concentration (agrs./m^3)	
	20°C.	25°C.
Aroclor 1242	4.7	6.2
Aroclor 1248	2.1	3.0
Aroclor 1254	0.8	1.1

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Hence air saturated with cold Aroclor is at or above the maximum permissible concentration.

In general we have to accept Dr. Kelly's leading remarks and the conclusions of I.C.I. Paints, but any consideration of the risk under a given set of conditions must involve the total exposure factor as well as the concentration. It is in this area that constructive answers could be made if the necessary background of data were available. However, the issue before us is whether M.C.L. should align its policy on the use of Aroclors in paint with that of M.C.C., and as I see it we have little alternative when M.C.C. can be quoted against us.

The use of Aroclors in paints based on chlorinated rubber warrants special consideration in view of the following circumstances (a) Aroclors are of such value for the purpose that the manufacturers might well be embarrassed if we withdraw our recommendation (b) they are not used for ordinary decorative and protective purposes in domestic and industrial premises, but to protect metals from corrosion, (c) they are not applied to hot surfaces under conditions which would constitute a hazard to nearby personnel.

My recommendations are accordingly as follows:-

1. M.C.L. continues to sell Aroclors for use in the manufacture of paints based on chlorinated rubber.

2. M.C.L. continues to sell Aroclors for production of paints intended for exterior application.

3. M.C.L. discontinues the sale of Aroclors for use in the manufacture of all other paints.

D.V.N. HARDY

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TOWOLDMON0055126

DR. J. W. BARRETT - London. 27.2.54.

WEH/GK. AROCLOR TOXICITY.
Your memo of February 23rd.

c.c. Dr. D.V.N. Hardy.
Dr. W.McG. Morgan.
Dr. H.R. Newman.

After going through our files at Ruabon and Newport we have only been able to find one Aroclor report containing data on Aroclor Toxicity.

This report No. 2215, Final Report on 'Aroclor Data Book', by R.R. Enright, dated April 27th, 1948 has a small section on physiological effects.

The first deals with skin effects and is based on information from BIOS reports. It indicates how such troubles as chloracne and internal sickness experienced in the early days when people were handling chlorinated hydrocarbons could be avoided by adoption of suitable methods of hygiene, and the use of a suitable barrier cream.

The second section which is taken from The Journal of Industrial Hygiene and Toxicology, Volume 20, Number 2, February 1938, gives a brief description of the systemic toxicity effect which chlorinated hydrocarbons including chlorinated byphenols can cause. Liver damage is of course the outstanding effect and of the various chlorinated/chlorinated hydrocarbons tested, diphenyl gave evidence as being the most toxic. It is indicated that in white rats breathing air containing around 0.57 mgms. per cu. m. over a period of 134 - 143 days caused liver injury.

W. E. HAMER.

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COPY

Dr. H.R. Newman. February 12th, 1954.

Newport, England.

We do not know what the maximum allowable concentration of Aroclor is. One milligram per cubic meter has been set up. We have run animals for about 60 days at 7 times this and found some liver damage. We are now running this at a lower level.

We have never found any liver trouble in any of the workers in our plant, but we watch the control of the fumes in our customers' plants and always recommend exhaust ventilation. I am sure you realise that 1 mg per cubic meter is recommended for an 8-hour day for indefinite periods of time. In painting a room we have found 1 - 2 mg for a day or so, but after that the level drops down to nothing.

What we were really worrying about was the possibility that a man would develop hepatitis on an idiopathic, viral, or serum basis and on questioning would recall that he had painted a room with Aroclor paint and state that he had smelled it very strongly. I am afraid then we might be convicted by association even though we were sure one could not get a level high enough to cause trouble. We have, however, been concerned with the level of Aroclor during spray painting, but I think that level can only be determined by actual measurements.

Please do not worry about asking me these questions because we certainly want you to have the entire picture about Aroclor toxicity. As soon as I get a report on the work at Kettering, I will let you know.

R. Emmet Kelly, M.D.

REK/MFL.

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TOWOLDMON0055128

Monsanto

4

FROM (NAME & LOCATION) George Roush, Jr., M. D.

DATE July 30, 1975

SUBJECT PCB's

REFERENCE Memo HSB to FJF 7/17/75

TO H. S. Bergen
B2SL

cc G. L. Bratsch - B3NA
D. L. Eby - A3NA
J. T. Garrett - A2SA
T. L. Gossage - B2SL
G. J. Levinskas - A2SC
W. B. Papageorge - B2SK
R. G. Potter - B3SA
K. W. Easley - 1920
W. W. Withers - B2SA

Attached is a draft for the toxicity section of the Monsanto statement under Action No. 5 of the reference memo.

I believe this draft contains the essentials which must be included. It will undoubtedly need to be revised before it becomes a part of the final statement which should be completed in late August.

Comments are solicited.

GR

George Roush, Jr., M. D.

GR/ln
att.

[redacted]

C.A. No. B-84-1103-CA

[redacted]

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PCBs

Recently, we were informed that liver carcinomas were observed in female Sherman strain rats fed AROCLOR 1260 for 20 1/2 months. This prompted us to re-examine livers from male and female rats of the Charles River strain which had been fed AROCLOR 1242, AROCLOR 1254 or AROCLOR 1260 for 2 years in earlier studies conducted by Monsanto. In addition, we have discussed our findings and those reported to us with scientists working in the field of carcinogenicity.

There are 4 elements which are closely interwoven in this matter: (1) differences in test procedures, (2) differences in results obtained by various investigators, (3) definition of what is a cancer, and (4) evaluation of potential risks, if any, to man. These will be summarized briefly.

(1) Several animal studies have been conducted with various brands of PCBs. In some studies, the test material has been



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identified by trade name (AROCLOR, KANECLOR). In others, there was just a general reference to PCB. Consequently, the quality of test material with respect to the amounts and nature of contaminating impurities or by-products cannot be determined in all cases. In addition, several strains of test animals were used, the duration of the experimental periods varied, and there was a wide range in the depth of detail with which the observations were reported. Consequently, it is difficult to make comparisons between these studies.

(2) In general, studies have shown mice to be more susceptible than rats and females to be more sensitive than males to the liver effects of PCBs. Beyond these generalizations, the results have not been consistent. Some investigators have reported liver carcinomas. Others have observed only benign tumors. Several have noted changes in liver tissue without detecting tumor formation. For the reasons just cited, it is difficult to determine the bases for these different results.



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The most direct comparison can be made between the 2 studies on AROCLOR 1260 since the same high dosage level of the same lot of AROCLOR 1260 was employed in both experiments. In the studies reported to us, liver carcinomas occurred in approximately 8% of female rats of the Sherman strain (the only sex used). In Monsanto's study, none of the liver lesions had progressed beyond the stage of benign tumors (hepatomas) despite a slightly longer duration of feeding of AROCLOR 1260 to rats of Sprague Dawley, Charles River strain. The Monsanto study employed rats of both sexes and it did confirm the previously noted greater sensitivity of female rats to liver effects of PCBs.

(3) In the traditional pathologic sense, liver alterations seen with all 3 AROCLORS in Monsanto's studies were benign in character. Lesions of the type seen may be induced by other chlorinated aromatic and aliphatic hydrocarbons such as aldrin, dieldrin, and carbon tetrachloride. In fact, the experts whom we consulted expressed opinions that the potential carcinogenicity of PCBs was comparable to that of DDT, aldrin, dieldrin and carbon tetrachloride.

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The Environmental Protection Agency (EPA) and the National Cancer Institute (NCI) have redefined the traditional concept of benign and malignant tumors. Those agencies now view any tumor induced by a chemical as malignant despite the absence of the classical histologic features of malignancy. The legal division of EPA has used this redefinition of carcinogenicity to cancel the registrations of dieldrin and aldrin and it is about to launch litigation against chlordane and heptachlor. In this connection, it should be noted that, by virtue of their intended use as pesticides, these materials were intended to be used in a dispersive manner.

(4) Commenting upon EPA's reclassification of tumors, the Food and Drug Administration's (FDA) Associate Commissioner of Science remarked that . . . "It should be emphatically emphasized that there is by no means universal acceptance of . . . the above . . . classification of tumors." In addition, it should be noted that FDA has had the microscope slides of tissues, including livers from

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rats on the Monsanto studies with the 3 AROCLORS for about three years, and that the FDA has been informed of the more recent study on AROCLOR 1260. To this date, no adverse comments have been received.

After a review of all information available to us, we conclude that AROCLOR 1260 has been shown to be a carcinogen in one strain of rat. It is not carcinogenic in the traditional meaning of that word to all commonly used strains of laboratory test animals. Our overall interpretation of the available data is that AROCLOR 1260 has a carcinogenic potency comparable to that of DDT and carbon tetrachloride.

AROCLORS 1242 and 1254 have not been shown to be carcinogens.

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TOWOLDMON0055134

Monsanto

FROM (NAME & LOCATION) W. B. Papageorge - General Offices

DATE April 17, 1970

SUBJECT Earth Day -- The Question of PCB?

REFERENCE

TO : Regional Vice Presidents
Plant Managers
District Sales Managers
U.S. Subsidiaries
U.S. Plant Communicators

As a result of recent publicity about polychlorinated biphenyl (PCB) and the possible threat this chemical poses to the environment, we have prepared background information for your use on Earth Day, April 22. We have anticipated some questions you might be asked and provided some answers.

Please do not present any Teach-In "visitors" with prepared handouts on PCB. You may use this information in verbal conversations should the occasion arise.

Press queries on PCB may be answered with a copy of the attached news release. Press queries for further information should be directed to E. V. John, Organic division public relations manager, in St. Louis.

W. B. Papageorge

W. B. Papageorge

stw

Attachment

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TOWOLDMON0055135

QUESTION AND ANSWER SHEET ON POLYCHLORINATED BIPHENYL

This question and answer sheet, for verbal use only by Monsanto personnel, is accompanied by our recent news release replying to charges that PCB threatens the environment.

1. How was PCB first identified in the environment?

   Late in Feb., 1969, the San Francisco Chronicle carried a major feature story about "a menacing new pollutant" found in the San Francisco Bay area. The article was based on research done by Dr. Robert Risebrough of the University of California. In his search for residues of pesticides (DDT and DDE) he encountered "interfering substances."

   A few years prior to Dr. Risebrough's work, two Swedish scientists at Stockholm University's Institution of Analytical Chemistry reported they, too, had encountered these other substances. The Swedish scientists were able to identify some of these materials as polychlorinated biphenyls or PCB.

   Based upon this work, other scientists, in this country and throughout the world, have looked for and identified PCB.



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They subsequently asked themselves two questions -- is PCB a threat to the environment, and, how is PCB entering the environment?

Since PCBs are not broadcast or spread around the land, as are pesticides, the scientists theorized the source must be industrial wastes.

Monsanto Company has been in contact with many of these scientists and agencies throughout the world. Monsanto is as concerned as anyone about this potential problem. We are continuing our own research programs as well as cooperating fully with other studies.

Since Monsanto is the sole manufacturer of PCB in this country (there are other producers, worldwide), it was obvious from the beginning that we would be singled out for criticism.

2. Is PCB as hazardous to the environment as recent charges would indicate?

The question of hazard to the environment is relative. Some scientists have discovered it is harmful to certain species of fish and birds. Whether it is harmful to man is a question which is still under study.

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Recent charges, regarding the hazard to man, have been based upon technical bulletin toxicity descriptions and warning labels carried on shipping containers. These warnings are common throughout the industry. Users of industrial chemicals are accustomed to handling these materials with caution. As far as we know, at this time PCBs are not a threat to the world population.

3. What is Monsanto doing about this possible threat to the environment? (See attached news release.)

When the subject first came to our attention in 1968, we began a six-point program. The program consists of:

A. Working with scientists around the world to properly identify and measure PCB in the environment. Our contacts have resulted in meaningful exchanges of scientific data. This effort has been directed toward locating the source of PCB emissions.

B. One possible source of PCB in the environment could be from manufacturing facilities. For this reason, we have been modernizing many of our manufacturing techniques installing new pollution abatement devices and generally have "tightened up" our plant techniques.

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C. Earlier this year, we alerted all our customers to the possible threat posed to the environment by PCB. At the same time, we offered our technical services to assist them in the proper handling, use and disposal of these products.

D. We have had under way for nearly a year toxiological studies to determine the effect of higher chlorinated hydrocarbons on animals. Early results from these studies indicate PCB is not highly toxic as has been charged.

E. We have also begun studies to determine the biodegradability of PCB. We have come to early conclusions which indicate lower chlorinated products are degraded in the environment. Higher chlorinated substances do appear to resist degradation. We are on the trail of some promising leads to solve this problem.

F. Finally, we are working toward the introduction of alternate products which will be either new formulations or rapidly degrading compounds which retain the functional characteristic of PCB but pose no threat to the environment.

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4. Is the public in any immediate danger?

It is our opinion that the public is not faced with any immediate danger to its health from PCBs. Contrary to the sensational headlines of recent days, PCB is not commonly found around the household.

The major market for PCB-containing products is in electrical equipment. It is also used in closed system heat-transfer applications. The "plasticizer" uses are very limited and are restricted to specialty products.

5. Since PCB does linger in the environment and could be a long-term threat similar to DDT, should it not be banned?

Monsanto Company and the electrical industry believe these products are so vital to our society that they should not be banned. One major electrical equipment manufacturer has told us that a ban on the use of PCB-containing products would mean major power failures throughout the world. We believe that strict control over the use and disposal of PCB, and substitution in uses that cannot be controlled, is the answer to this problem. We are working toward this solution.

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6. If PCB is only used in specialized or "closed systems", why would Monsanto publish a bulletin which said PCB is used in many other ways?

Our bulletin O/PL-306, referred to in recent publicity, was first published in 1960 when there was no evidence that PCB could be a threat to the environment. When the possible threat was brought to our attention two years ago, we discontinued circulation of the bulletin.

The bulletin was designed to be a "sales tool." It had many suggested applications in order to increase our sale of these chemicals. Monsanto is not unique in this marketing approach. To our knowledge, PCB has never been used in all these applications as has been charged.

7. Where does Monsanto produce its Aroclor products?

Monsanto produces Aroclor products containing PCB at its William G. Krummrich Plant, Sauget, Ill., and its Anniston, Ala., plant.

8. How long has the company produced these chemicals?

About 40 years.

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9. How much PCB has been produced?

Monsanto's production figures are confidential and will be released only to the appropriate governmental agencies.

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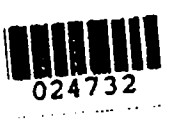

TOWOLDMON0055142

NEWS

Monsanto

FOR RELEASE

E. V. John
(314) 694-2891
PUBLIC RELATIONS DEPARTMENT
Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166

MONSANTO REPLIES TO CHARGE THAT PCB THREATENS ENVIRONMENT

ST. LOUIS, April 10 -- Monsanto Company said today it was well aware of the concern over possible environmental contamination by polychlorinated biphenyl (PCB), an industrial chemical made by the company. The company began a six-point program in 1968 to properly identify and measure PCB in the environment. Steps have been taken to strictly control use of the chemical and replace those grades of PCB which linger in nature.

Monsanto's statement came in response to charges by Congressman William F. Ryan (Dem.) of New York that the discovery of PCB in the ecology represented a major threat.

Howard L. Minckler, Monsanto vice president and general manager of its Organic Chemicals Division, said, "We have and will continue to cooperate fully with governmental agencies investigating this problem. We also have been in close contact with our customers. Monsanto has spent over $1 million to verify or correct scientific reports, monitor the use of PCB and search for substitute products where needed. This program will be successfully concluded this year.

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--2 MONSANTO: REPLY TO PCB CHARGE xxx year.

"It is unfortunate that Congressman Ryan evidently did not have all this information at his disposal. Just last month we participated in a U.S. Department of the Interior meeting where we exchanged ideas with some 40 scientists and told them of our findings and actions," Minckler said.

The Monsanto executive also noted that the use of PCB is misunderstood by some investigators. "For example, we do not know of any current use of PCB in insecticides. Even so, we are asking the U.S. Department of Agriculture to reject any insecticide which has PCB as an inert carrier," Minckler said.

"PCB is not a household product, as some have suggested," Minckler continued. "To our knowledge, it is not used in plastic food wraps, house paints, cellophane, asphalt or tires. The principal market is electrical applications where the chemical performs a vital function as an insulating fluid. In this use, PCB is completely sealed in a metal container. Other major markets employ similar closed systems."

Monsanto's PCB program was initially directed at proper identification of chlorinated hydrocarbons appearing in the environment. This research, confirmed by others, found only the higher chlorinated materials. At the same time, Monsanto undertook animal feeding studies which show PCB is not a highly toxic material.

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SCM 042325



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--3 MONSANTO: REPLY TO PCB CHARGES material.

The second part of Monsanto's investigation was coordination with all customers on a rigid critique of its PCB manufacturing units. Although loss of PCB during manufacturing was negligible, production techniques were further modernized and new pollution abatement devices are continually being upgraded.

Monsanto has concentrated its further research on those few PCB compounds which degrade slowly. Alternate products for these grades, which retain the functional properties of PCB and present no potential threat, will be introduced later this year.

Minckler concluded, 'Monsanto is seeking the best solution to this potential environmental problem. Action not based on reason and scientific facts can only result in greater problems. For example, we have been advised by one electrical equipment manufacturer that an immediate ban on PCB would result in major power failures throughout the world. This is not the answer. Proper use of this vital chemical and substitution, where appropriate, is the answer.'

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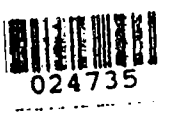
SCM 042326



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