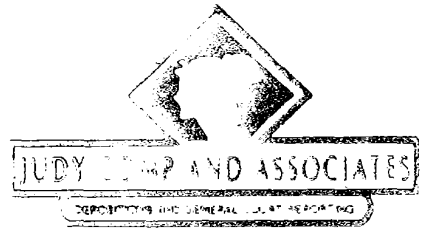
COPY

EXHIBITS

to the Deposition of

E. SCOTT TUCKER, Ph.D taken by the Plaintiff on the 23rd and 24th days of June, 1992.

Conference Room
Video



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PLAINTIFF'S EXHIBIT

317 Tucker

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Q Now, on your response to Mr. Lorant's question with respect to metabolism I wasn't trying to force you yesterday to say that you had to be able to elucide the chair between the metabolism, between the material metabolized and the metabolite; but you would agree, wouldn't you, that in order to show metabolism you should be able to find something which you could call a metabolite, even though you may not be able to trace it back to the material metabolized?

A I agree.

MR. ECKERT: No further questions.

JUDGE SWEENEY: You are excused.

(Witness excused.)

MR. PARK: Could we have a short recess, sir?

MR. ECKERT: It's up to Judge Sweeney. I would just as soon move it to Dr. Tucker. We're short of time.

Whereupon,

tucker

E. SCOTT TUCKER

took the stand as a witness and, having been first duly sworn, was examined and testified as follows:

CROSS-EXAMINATION

XXXXX

BY MR. ECKERT:

Q Dr. Tucker, as I understood your background, you are an analytical chemist, is that correct?

A Yes.

Q Which analytical technique is used for the

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measurement of PCB's, the quantitative measurement of PCB's?

A The dominant technique that is employed is electron capture gas chromatography. There are, however, other techniques.

Q Now, is that technique more sensitive in the measurement of higher chlorinated homologs?

A There is a dependence in the sensitivity on the degree of chlorination as well as the substitution or the position of the chlorine in the biphenyl molecule.

Q So that the more chlorines in the molecule, the lower the level at which you would expect you would be able to detect residues; is that correct?

A That's correct.

May I add something to that? With the sensitivity of the electron capture detector there's hardly any problem in detecting monochloro biphenyls through deccachloro. There's adequate sensitivity to detect, with this technique, to detect any isomers including the monochloro biphenyl.

Q Right. But wouldn't the limit of detection for each isomer change with respect to the number of chlorine atoms?

A Yes, I believe we've established that in your first question.

Q Do you have a rough idea for comparative purposes of what the limit of detection would be for a homolog with

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six chlorine atoms or five chlorine atoms as opposed to one with two?

A When you talk homolog, are you talking an isomer or a homolog? I think we should define it.

Q Well, let me ask you what's a homolog?

A A homolog, well, if you're talking about six chlorines you could have -- well, let's talk about three because I forget how many homologs there are in the six; but if you have, say, two chlorines in a molecule, I think you can have upwards of 12 isomers.

Now, all of those 12 isomers constitute a homolog or dichloro biphenyl. So, now, if you're talking about the sensitivity of a homolog, then you may talk about 1 to 12 isomers which would, of course, improve your sensitivity in a sense.

If you are talking about the detection of a specific isomer then you're into the area where we really don't have any information that indicates specific sensitivities of this sort. So, I think very honestly the question should be clarified if you're going to pursue this.

Q I am glad you did clarify that, and I was asking about homologs rather than isomers.

As I understand it, it's much more difficult to identify individual isomers than it is to identify homologs?

A Yes, but isomers are available and you can

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measure them and you can run them through an electron capture gas chromatograph.

Q Well, could you give me, just for comparative purposes the limit of detection for 5 chlorine atoms in the homolog as opposed to three?

A Okay.

I believe -- and with your permission, of course -- that it might be better to talk about detections in terms of, say, 54 chlorinated biphenyl, which people say is a pentachloro biphenyl, or, say, a 42 percent chlorinated.

If you take something like a 42 percent chlorinated biphenyl and assume unity at the detection limit, and you go to something like a 1248, which is 48 percent chlorinated biphenyl, you get, I think, a factor of about 1.542 increase in sensitivity.

If you go to a pentachloro biphenyl, or a 54 percent chlorinated biphenyl you may get upwards of a factor of 5, and so on. But it is one order of magnitude difference between monochloro in homolog sense, and a deccachloro or, in terms of sensitivity.

Q So let me pose you a hypothetical:

Assume that we have measured in the environment a level of very close to the detection limit of 1254; wouldn't it be quite possible that there might be 1242 there in a concentration of roughly one-fifth that which would not

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be picked up by the detection method?

A Since your question is hypothetical I would have to answer yes. However, under actual laboratory conditions when you're operating near your limit of detection there are ways of getting more of the material into the instrument, and I believe that you would sincerely have some indication that there was chlorinated -- lower chlorinated materials there.

So in the real sense, no; hypothetically, yes.

Q Well, what is this technique for getting more of the material into the instrument?

A Concentrated sample by evaporation, injecting a larger amount, increasing the sensitivity of the detector.

Q Well, when you speak of concentrating by evaporation, do the vapor pressures of the various homologs vary?

A You have two questions here.

Q Well, let's speak of the formulation of 1254, 1242, 1216, do the vapor pressures in the formulations vary?

A Yes, obviously.

Q And is it true, as a general rule, that the lower chlorinated formulations have a higher vapor pressure than the higher chlorinated formulations? TRAN 028528

A Yes.

Q So that if you were to evaporate a sample concentrate you would expect, would you not, to lose more of

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the lower chlorinated formulations?

A If you were not an analytical chemist and did not perform these analyses, you might; that is not the case.

Q Well, I don't understand your answer.

A The answer is that, no, under the conditions of evaporation that are applied by most analytical chemists you do not lose the monochloro biphenyls.

Q How is it done?

A You generally blow a stream of nitrogen or air across a hexane containing solution. Now, hexanes' boiling point is so low relative to a monochloro biphenyl that you don't lose it, the monochloro biphenyl.

Q Now, in the process is salicic acid used as a clean up?

A There are some procedures, and I believe it was initiated by the EPA where salicic acid is used as a solid absorbant for clean up.

Q Is this a procedure that you use?

A No.

Q Is it a procedure that might widely be used?

A It is a procedure that has been used. There are some problems with it, if that's what you're alluding to.

Q Well, could you describe the problems?

A The problems are that if you are not quite careful in terms of the type of solvents and things of that sort

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that you use, you lose the PCB's from the solvent absorbant. The potential exists to lose some of the monochloro biphenyls or the lower chlorinated biphenyls.

However, as you go to more polar solvents, when you load a salicic acid column, you do get these materials, and most analysts who have been in the business for a while are aware of this fact, and are very careful to avoid the loss of the lower chlorinated materials in their work-up of samples.

Q Now, I would like to turn to your paper on bioaccumulation -- on bacterial degradation, rather.

A What number is that, please?

Q I'm just trying to find it myself.

It's number --

A No. 21, I believe.

Q Right. That's correct.

Now, a general question first: In conducting this test did you make a budget of precisely what happened to the PCB's that were used in the test?

A Yes. There is a budget here in a sense. In other words you're putting in so much, you're measuring what's left, and the other disappears; so, therefore, you can accoun for 100 percent. And that's a budget in a sense.

Q That is a budget in a sense; but do we know exactl what happens to that which disappears?

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A These particular experiments deal with primary biodegradation. I think that's fairly well spelled out in this particular article. In studying the biodegradation of materials this is probably one of the things that you look at initially, because, after all, if it does not undergo primary biodegradation, I mean, a minute change, then there isn't much sense in looking at it in any further extensive tests.

However, if I will be allowed, I will say that as time has become more available, and in our laboratory we have conducted other tests which do show that a number of polychlorinated biphenyls undergo ultimate biodegradation.

By "ultimate biodegradation," I mean complete mineralization to CO_2, water, and mineral salts; and they do so at a rate that is equivalent to glucose.

Q Which formulations?

A These primarily are the lower chlorinated ones. We've been dealing with monochloro biphenyl mixtures. We worked with Aroclor 1221, and we're working our way up the scale.

Now, I will tell you very honestly that as we get into the more higher chlorinated materials, I do not anticipate complete, ultimate degradation, nor would any microbiologist.

Q How have you -- well, you've stated that it undergoes complete degradation to CO_2; how have you identified

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the CO_2 as being resulting from the degradation?

A Well, there are two techniques that are generally employed to do this type of thing. One is, of course, the radio-label techniques; the other -- well, actually, there are three.

One is stable isotope techniques, Carbon-13; one is radio-label techniques, Carbon-14; and another is just simply to use a nutrient pour! system which has a low endogenous respiration rate and produces little CO_2. And then you add your carbon source, so, therefore, most of the CO_2 comes from your carbon source. And you can do a budget analysis.

The particular test that was employed is the test Thompson and Gunthie. It is a test that is used by the Soap and Detergent Association; it's well-established, and it been around for, I would say, perhaps, maybe 10, 15 years.

Q These recent tests thatshow the complete, the ultimate biodegradation, they are not included in the exhibits you have?

A I am sorry, they are not; but I felt they were worthy of mentioning and I did ask your permission.

Q Yes.

Well, unfortunately, we can't examine you on those because we haven't read them. Are they written up so they can be supplied?

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A I can provide you with handwritten or maybe even notebook pages. I will have to check to make sure that this information can be released; but at this point in time I see no reason why it cannot be provided to you.

Q Now, in the tests that you did here you vigorously aerated the sample for a period of 48 hours; isn't that correct?

A That's correct.

Q Now, isn't it possible during that aeration that some of the PCB's simply evaporated?

A This is a rather obvious possibility, yes.

Q Did you use glass containers?

A Excuse me. If you are not going to pursue that, I would like to make a comment with your permission?

Q You may clarify your answer.

A Each time this test is run we take the total effluent, gas effluent, from this unit and scrub them through scrubbers. The scrubbers are then analyzed to determine what the volatility losses are. And I believe if you look into the paper in detail the volatility losses are spelled out.

Q What did you use to scrub the gases?

A The scrubbers were three hexane scrubbers in series, and what was done was they were analyzed, each one was analyzed; in other words, No. 1 was analyzed, No. 2 was

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analyzed, No. 3 was analyzed. These scrubbers are put in series to insure that you are not blowing them through, completely through; and in all cases the last scrubber contai a very insificant amount, which means we were trapping any volatilized PCB's.

So volatility losses are not contributing to the primary biodegradation rates states.

Q Were glass vessels used for this experiment?

A Yes.

Q Do PCB's adsorb onto glass?

A Yes.

Q Was this accounted for in any way in your results?

A Yes.

There's a little trick in this kind of game, that when you're dealing with water and soluble materials you obviously run into this problem, and I'm glad you brought it out.

We operate these units until we achieve what is called a steady state, by which I mean that the surfaces in the system, for example, the glass and things of this sort, have actually -- there has been actually enough material introduced into the system that you read a steady state, i.e. your active adsorption sites on the glass are not -- are fully covered. And so your losses are not due to mechanical reasons.

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Q In this experiment, in this particular experiment, you di not identify the metabolite; did you?

A To answer your question, no; there is a reason that we didn't.

Q You can explain.

A Okay.

We manufacture well over -- you see, the scope of my group is a little bit broader than PCB's, although we do have direct responsibility for the analytical portion of PCB's and the biodegradation and things of this sort. The company itself manufactures in the thousands of products and we are attempting to develop tests which will tell us about the environmental compatibility of our products.

And so time is of essence. So the first thing to do is obviously establish that we do get primary biodegradation. The second thing was to see if we get ultimate degradation.

I currently have one new Ph.D. who is in the process of attempting to elucidate what some of the metabolit are, and what the mechanism is for the breakdown of PCB's.

Q Now, after this 48 hours continuous aeration, what percentage of the PCB's that were used in the experiment were degraded?

A Well, I would refer you to the paper. Unfortunate they are not numbered because the journal to which it was

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submitted said "put it lightly in blue" and that does not Xerox.

But there is a graph in here, and it's about halfway through, and in it we plotted average degradation rate per 48 hour cycle versus the percent chlorine, which, of course, is on a weight-weight basis.

Did you find the graph?

Q Yes, I have the chart before me.

Could you describe each of these formulations in terms of the number of chlorine atoms?

A Yes, I can.

The initial one, biphenyl, obviously has zero chlorine atoms.

Aroclor 1221 I believe has approximately -- in between, say a mono and a dichloro biphenyl. I think it leans a little bit toward the dichloro biphenyl.

MCS 1043 is a research compound that was utilized becausse it fit in between and will give us a point so we can get a trend. It is sort of a di-tri compound.

Aroclor 1242 is a trichloro biphenyl. It's considered that on a percent chlorine weight basis.

Aroclor 1016 is of course the version that has the higher molecular rate, more persistent PCB isomers removed, and it would correspond to, say, something less than a trichloro biphenyl, since you obviously remove some of the

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heavier chlorinated materials.

And Aroclor 1254 is a material that has, it's a pentachloro biphenyl, and which has for sometime now most closely represented what researchers are finding in the environment. However, I hesitate to say that with Aroclor 1254 even some of the earlier peaks which are tetrachloro biphenyls, and even maybe some pentas, are not found in the environmental samples.

Is that an adequate description of the compounds studied?

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2 A fls

Q Yes.

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2A ebl

JUDGE SWEENEY: We'll take a 15-minute recess at this time.

(Recess.)

JUDGE SWEENEY: Back on the record.

BY MR. ECKERT:

Q Dr. Tucker, I have a couple of questions on bioaccumulation but before we get into that, I have a couple more questions on your experimental data.

Have you made any attempt to sample environmental conditions to substantiate or correlate your findings in the laboratory?

A Yes, in a sense. I think because, again, of the lack of manpower and the scope of the problem we are dependent a great deal upon the government and the academic people to provide this kind of information.

And I think yesterday when you were referring to references 2 through 13 in our testimony, there is adequate information that supports the kind of biodegradation data and the tissue accumulation data that we've been able to generate with our resources.

Q I'd like to turn to Exhibit 12.

A What page of our testimony is that referred to, please?

Q Well, you've referred to Exhibits 2 through 13 at page 6.

TRAN 028538
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A Right, page 6.

I'd like to refer to it in context to our testimony, so I'd like to have it handy.

Exhibit 12?

Q That's right.

Now the statement in the text of the testimony is that:

"Environmental monitoring programs have clearly demonstrated that, with the exception of direct high-level controllable release near points of manufacture or use, the PCB's found in our environment are the more highly chlorinated ones, i.e., those containing predominantly five or more chlorine atoms per biphenyl molecule."

A Excuse me. I've been attempting to put these references back in order so that I can find them in a rapid fashion, so if you would be kind enough, can I have the question repeated, or the statement or whatever it was? I'm sorry, I wasn't listening.

Were you reading a statement out of the text here?

Q I was reading the third paragraph on page 6, the last sentence of the paragraph, beginning "Environmental monitoring programs."

A Okay.

Q Now with reference specifically to Exhibit 12,

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to your knowledge are these eagles which were sampled eagles which were found near points of manufacture or use?

A I have no knowledge of that, no. I do not believe it is stated in the article. However, I could be wrong. I'd have to take time to read the article to answer that question. I do not have knowledge of there being near the point source discharge.

Q I'd like to have you look at page 254 of that article. Now this is a chart representing the mass spectrum of analysis of tissues of the eagle, is it not?

A Yes. This is I think a GC mass spectrum.

Q Now on Figure 2, can you identify what the peak is that is labelled M-256?

A That's the M/E I believe, as indicated in the figure for the empirical formula $C_{12}H_7Cl_3$, and by the isotopic abundance pattern, a fragmentation pattern, I would probably say it's a trichloro biphenyl.

Q So here's an instance where a biphenyl containing less than five chlorine atoms was found in the environment; isn't that correct?

A I would like to clarify-- Okay.

Yes, to your question. But can I digress for a second and sort of describe what Aroclors are, just very briefly?

Q If you think it will help explain.

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A I really do, and after all, we are all here to try and clear this up.

In each of any chlorinated biphenyl product which is produced by direct chlorination you'll find a little bit of Aroclor 1221, a little bit of Aroclor 1242, a little bit of Aroclor 1254, a little bit of Aroclor 1260. The point is that they are dominantly one or the other.

In other words, when you chlorinate a biphenyl directly you get a distribution so the potential exists to have any one of 210 isomers in any of the products.

I think that's an important point; at least it is to me.

Q That is an important point. Doesn't that seem to indicate that no matter which PCB you are discharging, it will be probably contain some of all the PCB's?

A I think this is an obvious point that has been established, yes.

Excuse me. Are you going to move on from this article?

Q If you have some additional explanation of this article, please go ahead.

A Okay.

I believe this article was included here in support of the statement and I think there is actually a better demonstration of the fact that this article does support the

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conclusion which has been our objection. It can be seen if you look at the graphs on page 253.

These are of course-- I believe these are electron-capture chromatograms of Arocore 1254 products or what I prefer to call 54 percent chlorinated biphenyl, and then that which was isolated from the eagle carcasses.

And I think you'll see that there is a definite difference in the pattern of peaks between the standard and those which were isolated from the eagle. So that if you would look at it going from left to right, in Chromatogram A you will see the early eluding peaks, which of course would be the lower chlorinated materials in that particular product, and if you go to the Chart B and starting from the left-hand side again, you'll see that they are highly attenuated, which indicates that they have been -- they may have been metabolized and/or excreted, which is a point which is being made in that particular paragraph.

Q Well, now, you stated that these are attenuated. Could the attenuation be accounted for by the lower rate at which the lower chlorinated biphenyls accumulate in tissue?

A I think-- I heard that mentioned yesterday and I think while there's a difference in, say, the hydrophobic character of these, I think they are close enough together that they pretty well accumulate to the point where you would see them; so, No.

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Q Well, you are seeing them here, aren't you, even though they are attenuated?

A The authors of this paper did see a trichloro biphenyl; yes, sir, but the fact that the material was not the same as the standard indicates that something has occurred that has altered the pattern.

Q Now on Exhibit 37 I believe, the paper by Baxter et al., --

A I have the exhibit.

Q In general is it a fair summary to say that this paper shows that very little, if any, degradation of hexachloro biphenyls occurs?

A Yes, that is a fair statement; in the time frame that they used, I might add.

Q Now with respect to time frames, these experiments were all done under what might be described as ideal conditions for bacterial degradation. Isn't that correct?

A I think in these particular experiments -- and I would have to review it -- that they used a basal medium, and I'm not so sure that you consider it "ideal" conditions.

You might consider it a nutrient pour system, but I would have to review the paper again, however.

Q Well, I suppose I should ask the question differently.

Are you likely to encounter in the environment

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circumstances as conducive to bacterial degradation as the circumstances induced in these experiments?

A I would say that you would find in the environment a spectrum of these types of things. In other words, for example, in river water you have a nutrient pour system. In activated sludge you have a nutrient -- a highly active system. So I'd say you can find these conditions in the environment.

Q Now you described the gas recapture or cleanup phase of your old experiments.

A You mean where we checked to make sure we did have volatility losses?

Q Yes.

A Okay.

Q Was the same procedure followed in this experiment?

A I would have to check.

As I recall, Jean Mainprize was the one, the microbiologist involved, and Ron Lidgett. They did check for volatility losses. I think they found they weren't significant. I don't know whether it is in this specific article, but through personal communication with these people, since they are part of our company, of course I have discussed their work extensively with them.

Q On page 7-- And hold the Baxter paper, if you will, to one side.

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A Page 7, not of--

Q Page 7 of your affidavit.

A All right.

Q A definition is proposed of polychlorinated biphenyls, and it identifies them as those having gas chromatographic retention times greater than 60, relative to -- and I don't know how to read that.

What does this define? Can you describe in lay terms what this means?

A Okay.

First of all it is defined in terms of what I would say is the recommended EPA methodology which I believe has come out of the Cincinnati Laboratory that Jim Lichtenberg has worked on and that they are in the process of validating.

So the "60" refers to a retention time relative to a standard compound para para prime DDE.

The cut point which is defined by 60 gets down into-- It starts-- There are some tetrachloro biphenyls and then of course the ones that are further up, the persistent ones, the ones that are long lived in the environment.

Is that adequate?

TRAN 028545

Q I think I understand.

In other words, this is generally those having four or more chlorine atoms, or is it more than four?

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A What you said was correct. These are the polychlorinated biphenyls that have generally -- start with tetrachloro biphenyls and then go up.

However, just below 60 there might be a minor amount of a totrachloro biphenyl or something of that sort, but it is sort of a point where you are cutting at the tetrachloro biphenyl and up.

Q Now it's not your contention, is it, that the lower chlorinated biphenyls are not toxic?

A You know, it is not my contention that anything is not toxic. You have to be real careful when you talk about toxicity. I'm not a toxicologist and I don't want to be trapped into acting like I am one.

Let me explain-- Do you want to know why we proposed this definition?

Q Yes.

A Okay. All right.

The definition is proposed because we sincerely believe that the predominant problem with polychlorinated biphenyls is the persistence of some of the higher chlorinated ones in the sense that if they persist for exceedingly long periods of time and can bioaccumulate, then there is the potential possibility that they could achieve, if they continue to be released, that they could achieve a level in higher organisms that could have a toxic impact. And this is

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true of anything that accumulates.

So we are focusing on this.

Now unfortunately in this testimony, it is not stated clearly that we are not recommending that we shovel the lower chlorinated biphenyls out into the environment. We are only saying "Let's restrict ourselves to the problem at hand," and we believe persistence to be the dominant problem.

And you have to look at this document in combination of all things that are suggested and not just isolated points. In other words, clean up, restrict and release, restricted use, and things of this sort.

Q Well, if we had to cut off somewhere, wouldn't we want to cut off at a point which included those which have been found in the environment? For example, the ecodata showed that some of the free chlorine--

A Well, first of all, let me back up.

You asked me if I could establish that those eagles were collected near a point source discharge. I said No. Can you establish that they were not?

Q Well, I think that the burden of proof here, if I can be so bold, ought to be on those who are putting this stuff out.

A All right. I may be overstepping my bounds. If I am, I apologize.

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I don't know that those eagles -- how close those eagles were to a point source discharge so therefore, I can't have any idea whether or not they could have gotten the trichloro biphenyls because they were directly exposed to it or because it came up through the food chain.

Q Well, what about Jensen's papers?

A You've only cited one reference to me that shows one example of finding one trichloro biphenyl in an environmental sample.

Q Well, I'll cite another one. How about Jensen's paper? I believe that's Exhibit 4.

A Yes, Exhibit 4.

MR. LORANT: Are you referring to Reference 4?

MR. ECKERT: Reference 4 to his exhibit.

BY MR. ECKERT:

Q Now on page 248 of that paper it states:

"We found that the principal PCB components were PCB numbers 7 to 14 but the mussels also contained the lower numbers."

Do you know what lower numbers he's talking about?

A Well, as I understand it -- and I've have to go back and look, of course, but Gunther Widmark, who works with Soren Jensen -- He does not work with him now, but they were at the University of Stockholm. They developed a numbering system for the polychlorinated biphenyls so the numbers 7

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cb12

through 14 don't necessarily designate 7 -- a biphenyl that contains seven chlorines.

And I think if you really read this statement and think about it a little bit, I don't think the implication is necessarily there that they are finding the lower chlorinated materials, i.e., monochloros, dichloros, trichloros. It's just saying that they are finding the lower numbered peaks as witnesses by their numbering system.

End 2A

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If you will go further, and if I may read this:

"The results suggest that the low PCB numbers are metabolized or excreted faster than the higher numbers, so there is an increase of the latter as it passes through a food chain."

This is also so in Jensen's statement.

Q Turning to page 9 of your affidavit, you describe a procedure that was done to evaluate the accuracy of these analytical techniques.

Do you know what the solubility of Aroclor 1242 is?

A Yes, I do.

In pristine distilled water, you know, solubility with these types of compounds is kind of a shaky thing, but in pristine distilled water, I believe, the solubility of Aroclor 1242 is on the order of 200 parts per billion.

Q How about 1254?

A 1254, I think, drops -- there is a linear relationship, incidentally, which is very nice and interesting -- I think 1254 is on the order of about 50, but I am coming from memory now.

Q And 1260?

TRAN 028550

A At 25.

Q In other words, the distilled water used in these experiments was spiked with between two times and twenty times

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the amount which it could solubilize.

Isn't that about right?

A That is correct.

Q Could the insolubility of the PCB's account in part for the differences between the results obtained by the labs?

A No, it could not, and I will explain why.

In the instructions, as I said, the actual whole experimental design which we set up -- the details are available -- in the instructions to the other laboratory that participated in the test, since they were instructed to extract the bottles with hexane each time and then combine the hexane extracts, then this would effectively take all the insoluble PCB's out of the bottle.

As you point out, the problem in preparing analytical standards of this sort with the water-insoluble materials is really a real difficult one. Even if you would put it in below the solubility limit of the Aroclor in question in the water, in distilled water, some of it would still go out on the glass, be preferentially adsorbed on the glass.

So to answer your question, no, that could not account for the variability that was seen.

Q Well, would the hexane extraction take the adsorbed PCB's off the glass?

A I am laboratory B, incidentally. I think we did

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a pretty good job. We got 93.7 percent, and that's a fair amount in this kind of game.

Q Was the variability different for 1254 or 1260 or 1242 alone, as opposed to the mixtures of all three components, sir?

A Let me refresh my memory here.

(Pause.)

These limits which are stated, the 95 percent confidence limits and the repeatability limits that were obtained through analysis of variance refer to the whole works.

These data are all the data. In other words, they include the mixtures, too. We did do an additional experiment which is not mentioned here, in terms of could you or could you not identify whether you had a 1254, a 1242, and a 1260? There was some variability there.

However, the manner in which these were quantitated is the exact manner which the FDA recommends, and it's probably one of the better ways in terms of doing it when you're dealing with rough mixtures, so that when we had a sample that had all three of the Aroclors in it it was simply broken down into three regions, and three different standards were employed.

So I would not think it would contribute -- in other words, I do not think it would skew the variability.

Q Now, there is a report that was published by Holden

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which involved a collaborative study of PCB's.

Did Monsanto participate in that study?

A Was this the ideal baseline study or the OECD work?

Q The OECD work, I believe.

A I do not know whether Monsanto participated in it. My laboratory did not. We may have in Europe, but I don't know.

Q Are you familiar with the findings of thes study, Doctor?

A I'm familiar with it in a cursory sense, but I am not familiar with the actual samples or how they were prepared or how they were distributed or the instructions that were given and how they should be handled, and things of this sort, so I'm not prepared to address myself to that at all.

Q Well, just addressing yourself to your own results, your recovery of 93.7 plus or minus 19.2 percent: would you say that that is a pretty reasonable degree of accuracy of analysis?

A It represents accuracy and precision, and I would say quite honestly in a laboratory like ours where we've been doing it for seven years and where the same person did the analysis on the same day on the same instrument, that yes, these are pretty good results, and these are the kind of results that a laboratory can achieve if they do it careful

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enough in their own laboratory with well-trained analysts and good equipment, good, well-tuned equipment -- and also with pristine clear distilled water samples.

Q Now, are you familiar with any processes by which furans can be formed through oxidation of polychlorinated biphenyls?

A As an organic analytic chemist, yes, I am very familiar with organic chemistry and with the fact that you can make furans.

Q Now, Exhibit 8 to the Monsanto testimony is the paper by Crosby.

A I have it.

Q I will put to you the same question that I put to Mr. Papageorge.

On page 374 and 375, the statement is made that:

"Irradiation of chlorinated biphenyls dispersed in water, followed by GC/MS, revealed identifiable traces of 2-chlorodibenzofuran as a photolysis product --"

I won't read the rest of the sentence.

Do you have the sentence in front of you?

A Yes.

Q Does this indicate to you that under irradiation fr the sun in the environment, furans could be formed from PCB's after discharge?

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A I will say yes, the possibility exists, if I am allowed to qualify that statement.

In the experiment that Crosby performed, he could have easily produced what they call phenyl phenols, ortho-phenyl-phenols; and when you put an ortho-phenyl phenol in a gas chromatograph in an injection port that's hot -- and I don't care whether it's glass or metal or what -- and you have another chlorine that is ortho to that, you stand a good chance of producing in the instrument a furan; and I've discussed this problem with many people.

I'd also like to go on in this particular article and read some more of his quotations, because I want to make sure that the relevance of this to an environmental situation is established.

First of all, on page 373, to indicate that you can form phenyl phenols through hydroxylation, and that all these things are subject to photodegradation -- even the furans if they are indeed produced in the environment, and there have been people who have looked for them and not found them -- it says:

"Previous work in this laboratory demonstrated that chlorinated aromatic compounds are reductively dechlorinated readily in organic solvents when irradiated with UV light at sunlight wavelengths. Under similar conditions, irradiation

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in aqueous media results in replacement of the chlorine by hydroxyl as well as by hydrogen."

This points out the fact that there is a possibility of forming phenyl phenols which, as I indicated, if you treat them -- if you heat them you can condense them and produce furans in the instrument. So you have to be damn careful on this type of thing.

I would like to also turn to page 375 -- and let me just review this very, very shortly.

(Pause.)

Okay. The bottom paragraph starting out, as I said, on page 375, it starts out, and I would like to read it:

"The photodecomposition of the lower chlorinated PCB isomers in both polar and nonpolar solvents reveals the operation of environmental mechanisms which could effectively degrade these widespread decontaminants."

The point is, we can have other than biological degradation that accounts for peaks not appearing in residues and in water; and I would say, as he goes on he says:

"Indeed, the notable absence of the lower chlorinated biphenyls from most environmental samples --"

And he is referencing our reference 9 which is this

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huge, magnificent study that was carried out by some real competent people.

"-- is suggestive of an important role of decomposition in the environmental fate of PCB's, the interpretation of their source and movement, and prediction of toxic effects on aquatic life," i.e., he is again saying there is a mechanism other than biodegradation for degradation of these materials.

And, incidentally enough, the higher chlorinated biphenyls absorb the kind of light that passes through our atmosphere to a greater extent than the lower chlorinated ones, because you get a shift toward higher wavelengths, absorption wavelengths, as you increase the chlorination of the biphenyl molecule.

Q Doctor, your testimony has been very helpful, and I want to thank you.

MR. ECKERT: I have no further questions.

MR. PARK: Could I have one half minute?

JUDGE SWEENEY: Yes.

(Pause.)

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I do have one question.

REDIRECT EXAMINATION

BY MR. PARK:

Q Dr. Tucker, yesterday you may recall there were a few questions concerning sampling and the problems that might be created by improper sampling, or, perhaps, improper handling of samples.

Could you clarify this subject of sampling and analysis of samples, please?

A Yes. I think it is an important thing that we're all approaching, and something we ought to address ourselves to is, we ought to resolve sampling problems and, of course, analytical differences in our laboratories, if we're going to get into the enforcement area which -- we aren't there, obviously.

But it was touched on yesterday, and it was asked, you know, sort of, why was sampling such a problem? And we've done a lot of sampling in our plants. And we have found that -- and to make the statement in here, and I would like to just add to it a little bit.

We found that the type of sampling that one applies can affect drastically the results that you get in terms of what's coming out of the plant. So obviously, if it doesn't represent what's there, it can be the high or low, so you can have real problems. So you have to design the system for

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each plant; in other words, you have to go in and look at it and make sure you're doing it right.

Also, I note that there's a frequency designated in the Federal Register for sampling. And I think that this should be looked at very closely, as to wether or not it is the correct frequency for sampling.

We have also found that, in sampling our discharges that the depth at which you sample -- I mean vertically, also horzontally -- can make the results vary by orders of magnitude. We've found that if we sample where turbulence versus where we have quiescenct conditions, you can get just total differences.

Also, the particulates are extremely important in terms of how you sample -- the size of the particulates in the stream, and things of this sort.

Also, I think that in industrial effluents, especially industrial effluents like Monsanto's, that the effluent is extremely more complex than you find out in Lake Michigan or in other areas. So that you have to be exceedingly careful in the identification and the quantification of what you see; because in the world there are a lot of other things that are electron-capture active.

I also think that we're really going to have to look at whether grab sampling, which is recommended, is reall right and whether or not we shouldn't really get into isokine

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tic continuous sampling, which is probably the ultimate in this kind of thing.

At the same time, in terms of frequency, we mentioned the rainwater problem that brings up backgrounds and things of this sort that can give erroneous results. All I can say is that as we go down the road, that we've got an awful lot of work to do, and I hope we can all cooperate.

MR. PARK: That would conclude our examination here, your Honor, but I would like to just make sure the record does contain my objection to the failure by the EPA to question Dr. Wright on toxicology, since he is here present, and ask him the questions he had asked of Mr. Papageorge. I object if they fail to do so now, since he is available.

JUDGE SWEENEY: You're excused, Dr. Tucker.

(Witness excused.)

MR. ECKERT: Do you recall specifically the questions?

I have my questions all laid out.

MR. PARK: There were a few related to page 11, Mr. Eckert. I think the bottom two thirds, perhaps.

MR. ECKERT: Oh, yes. Right.

MR. PARK: I think if Dr. Wright could testify for just a few minutes, it would be appropriate.

MR. ECKERT: All right. I think a couple of questions for Dr. Wright would put this in place.

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