A Primer for EPA Employees: Presenting Scientific Evidence

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Preface

This primer is the result of a dialogue between the Assistant Administrator for Research and Development and the Assistant Administrator for Enforcement and General Counsel requesting closer interaction between the research and legal elements of EPA. The primer was developed to supplement a seminar program held at the various National Environmental Research Centers during the fall of 1974.

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1. Introduction

This document is not intended to be used as a legal reference. The purpose of this primer is to give practical guidance to scientists as to what to expect when they become involved in some form of litigation in which they are asked to present the results of their research or investigation. The discussion is directed primarily at water pollution control because most of the adversary type proceedings in which a scientist may be called upon to testify will be related to water pollution and because most of the practical lessons have been in this field. To avoid making this presentation unduly long, many generalizations have been made and fine points of evidentiary rules, for example, have been ignored. The intent is to point out in a general way what one will be asked by the government attorney and on cross-examination so that laboratory or field investigation procedures may be tailored to avoid the tragedy of having valuable scientific work rendered less useful for failure to follow a protocol. The specific preparation of a particular witness for a particular hearing, of course, necessarily must take place with the government trial counsel in the time immediately before he is to testify and is shaped largely by the substance of his testimony.

I have placed a great deal of reliance on actual examples of testimony, both good and bad, in attempting to make points. The names of witnesses have been deleted; none of them is an EPA employee.

2. Types of Proceedings

a. Trials in Court

The traditional way in which environmental issues are litigated is in a courtroom, either federal or state. There have been hundreds of cases in which the state or federal government brought actions against a polluter either for violation of specific statutory or regulatory requirements or for violation of some public nuisance concept. The Reserve Mining case is the supreme example of this: the federal government based its claim for relief on the pre-1972 Federal Water Pollution Control Act and the water quality standards promulgated thereunder; the plaintiff states sued largely on the basis of public nuisances ("unreasonable interference with the public's right to use and enjoy the environment").

There will be fewer court cases, involving water pollution at least, in which expert witnesses will be called upon to testify. Or at least the witnesses will be called upon to present less sophisticated proof than before.

This is because the country is gradually moving to the National Permit Discharge Elimination System (NPDES)1/ under which most contested facts will be resolved in hearings before the Agency instead of in trial before a judge. Thus, whether the waste from a particular discharge will interfere with oyster reproduction, and therefore what maximum effluent discharge restrictions should be contained in the permit, is an issue which will be addressed in hearings before the Agency's Administrative Law Judges. If a discharger is violating its permit, the Justice Department -- or the State Attorney General if the NPDES program is being administered by the State -- will bring an action. Here the issue will be simply whether the effluent levels have exceeded the permit terms; it will be much like a license violation case: the factual issue will be whether the permit was violated -- basically a monitoring chore -- not whether deleterious effects occur by discharging at that level. (This change in the burden of proof was one of the major reasons for amending the Act to employ the permit system).

Of course, even with the NPDES program, there will be court actions and the basic rules of evidence for presentation of expert testimony will come into play. These rules will be examined below in the section dealing with adjudicatory administrative hearings.

b. Administrative Trial-Type Hearings

Increasingly EPA is holding administrative trial-type hearings. Mention has already been made of the NPDES procedures. There also will be a great need for expert testimony in FWPCA section 316(a) hearings in which power companies will attempt to demonstrate that the "effluent limitation proposed for the control of the thermal component of any discharge from such source will require effluent limitations more stringent than necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made...." The first of these hearings will begin this fall.

The third section of the recently enacted water pollution legislation, which has already generated substantial litigation, is section 307(a), establishing effluent standards for toxic water pollutants. 2/ This section is unusual in that Congress has called for a legislative rule-making hearing to take on many of the trappings of a trial. Most importantly, the procedures for section 307(a) hearings call for cross-examination of witnesses.

The category of hearing which probably has thus far generated the greatest workload for EPA scientists is the pesticide cancellation hearings. These have been held for DDT and are being conducted for Aldrin/Dieldrin

1/The basic statutory framework is set out in sec. 402 of the Federal Water Pollution Control Act, as amended.

2/The first list of toxic water pollutants consisted of Aldrin/Dieldrin, DDT, Benzidine, Cadmium, Mercury, Cyanide, PCB's, Endrin and Toxaphene.

and Mirex under the Federal Insecticide Fungicide and Rodenticide Act (FIFRA). Traditionally these battles last for months and are fought by the manufacturer and EPA, although the parties also include environmental groups, users, and smaller companies who package various formulations using their own labels.

The rules for presenting the expert testimony in trials and adjudicatory type administrative proceedings really differ little. In each situation the scientist is asked to testify as to his knowledge on technical questions relevant to the issues being tried. It may be helpful to remember that conclusions and opinions generally are not permissible forms of testimony and that an exception to this rule is made for expert testimony under the theory that laymen would be unable to draw conclusions in difficult technical areas without the assistance of experts. But is only when the expert testifying is truly expert in the field, is drawing upon his expertise in making a conclusion, and laymen (judge or jury), given the same facts, could not render a conclusion, that his opinion testimony is permitted.

Except on rare occasions the expert will not be asked to render an opinion on the ultimate question; for example, he will not be allowed to give his opinion that the permit for a power plant discharge should call for a mixing zone of 1500 feet. If he is a biologist he will, however, be allowed to say what the effect of use of a 1500' mixing zone on the zooplankton would be. The expert witness in his proper role is merely providing a part of the technical base upon which decisions are made. For him to render a judgment on questions in which other disciplines come into play is to enter fields in which he is not expert and in which he cannot render assistance to the trier of fact.

In the pesticide cancellation hearings, the Agency Administrative Law Judges have been allowing scientists to state their views as to whether a product should be banned, the ultimate question to be decided, but have also said that they will not give this testimony great weight. In a court trial, such testimony would not be allowed at all.

Perhaps the major difference between expert testimony in the court trial and in an adjudicatory administrative proceeding is the extent to which hearsay is allowed. Hearsay evidence is

> ...testimony in court, or written evidence of a statement made out of court, the statement being offered as an assertion to show the truth of matters asserted therein, and thus resting for its value on the credibility of the out-of-court asserter. 3/

3/McCormick on Evidence, 2nd Ed., 1972, p. 584.

It is important to remember that the hearsay rule applies to both oral and written statements by an out-of-court party. In a traditional suit, then, a witness testifying on the proper analytical methods for detecting methoxychlor, for example, could not refer to a paper by another scientist confirming the appropriateness of his methods if the purpose is to suggest that the substance of that paper is true. Nor could a witness testify that his results were confirmed by Dr. Jones, with whom he talked last week.

In administrative proceedings the hearsay rule is relaxed substantially. In the proceedings held to date before EPA administrative law judges, hearsay expert testimony has been allowed if there is a "nexus" between the witness's expertise and the subject of the paper -- authored by another -- to which he wishes to refer. The witness in the hearing room must, however, be prepared to stand some cross-examination on the document. Thus, if he cannot say whether the analytical methods used by the other investigator were acceptable, he may not be allowed to use the paper.

c. Administrative Legislative Hearing

Quick mention is made of those administrative proceedings in which "generic" rules are being considered. This may be in an EPA rule-making hearing or in federal or state legislative proceedings in which proposed statutes are being debated. There is usually only informational questioning not in an adversary setting. Often scientists appear in panels and most of the time the bulk of the testimony has been prepared in advance.

d. Presenting Direct Evidence

The direct testimony in a court trial is usually given orally, often with reference to a written report and always with access to written factual data upon which the expert is relying in rendering his conclusions. And almost always the direct testimony relates to the effects of the discharges from a specific plant or outfall.

In administrative proceedings quite often now the direct testimony is in written narrative form and only the cross-examination is done orally. There are many advantages to this: the witness and his lawyer can be sure that the important points are covered, and difficult concepts can be presented with more precision than is usually possible in oral testimony. The opposition is usually given a week or two to study the document before the witness appears. This allows them to narrow the areas of cross-examination and to prepare for the often intricate questioning of the scientific data. It allows the cross-examiner to have his own expert go over the material with a fine-toothed comb. The end result is a more organized hearing. It also allows the hearing to go forward without the necessity of elaborate "discovery," since the tender of written direct testimony well in advance of the hearing serves the basic purposes of pre-trial discovery: avoidance of surprise.

Unfortunately, one of the by-products of the use of written direct testimony which is entered into the record without reading, is a feeling by some witnesses that their testimony did not hold up well. This is because the experienced cross-examining attorney chooses to question the witness only on points on which he thinks the witness is not capable of giving firm, well documented answers. Thus witnesses have gone an entire day without being asked to discuss their basic research. Nevertheless, that research will be used if it is adequately presented in the written testimony.

More than any other problem encountered by EPA trial lawyers is the natural resistance on the part of scientists to write complete narratives rather than short precis of their work. There may be an assumption that whatever the rules at the hearing they will get to elaborate orally on the presentation. In several instances the opposition attorneys have not cross-examined at all because otherwise dangerous witnesses did not present a statement worthy of the underlying research or investigations. The rule to remember in writing direct testimony is to put on paper everything you want to say. It is far easier for your lawyer to cut you back if you said too much than it is for him to interpolate in a difficult scientific area. An example of a good written presentation is attached as Appendix A. Appendix B is an example of a statement that, while short, attempts to say too much (see the last paragraph). Note in the well written statement that reference is made to Appendix A, B, C, etc. Documentary evidence relevant to the witness's presentation is usually physically attached to the written testimony and referred to in the body of the presentation. Sometimes these attachments are referred to as exhibits rather than appendices.

It has often been said that the direct testimony of an expert witness consists of four parts: (a) his qualifications (by education and/or experience) as an expert, (b) the material from which he fashions his opinion, (c) the process or reasoning by which he gets from the material at hand to his conclusion or opinion, and (d) the conclusion or opinion itself. Usually there is little dispute over an expert's personal background and that information comes in without question. In many cases the presentation of raw data itself or with a clear statistical explanation is enough for one to draw a conclusion, and logical step-by-step delineation of how the experiment was conducted or how the field samples were analyzed is vital to showcase this data. Rather than belabor points (b)-(d) in abstract terms, actual examples will be presented in the later discussion of cross-examination to show what should and should not be done.

3. <u>Discovery</u>

Discovery is a general term used to describe the process by which one side in litigation finds out what the factual basis for the other side's case is. In federal or state court actions there are several procedures by which this can be accomplished. The most frequently used procedure is the taking of oral depositions. Under this procedure, the potential witness is placed under oath before a court reporter and asked a wide range of questions designed to prepare the opposing lawyer for his testimony at the trial.

The deposition is also an opportunity for the opposition to ask about reports, memos, maps, lab books, pictures, etc., which the "deponent" knows of or may have in his possession and which he does not intend to use in the trial, i.e., material which the other side may wish to use. By use of a subpoena duces tecum (very roughly "you are ordered to appear and bring all the following documents with you") the opposing party can force an EPA scientist to collect all material arguably applicable to the issue. The lawyer may precede the "noticing" of a deposition by filing a motion to inspect all the documents related to the question. This helps prepare him to take the deposition.

Another less often used procedure is the use of written questions served upon the opposition and to be answered under oath (interrogatories). Sometimes this is used to initiate discovery by asking "who are the scientists who have any knowledge on this subject" or "where are your freshwater laboratories located," or "who have you consulted in bringing this lawsuit"?

Scientists are virtually united in their horror of the all powerful discovery procedures, drafted and enacted by lawyers, which can force them to photoduplicate massive amounts of material. Some lawyers have argued that, unlike conspiring executives in an antitrust case, scientists should not be put through the ordeal of having filing cabinets raided. Actually, the Federal Rules of Civil Procedure, applicable in federal courts but adopted intact by most states, provide for restricted discovery of an expert's data. Rule 26(b)(1) states the basic rule:

> Parties may obtain discovery regarding any matter, not privileged, which is relevant to the subject matter involved in the pending action, whether it relates to the claim or defense of the party seeking discovery or to the claim or defense of any other party, including the existence, description, nature, custody, condition and location of any books, documents, or other tangible things and the identity and location of persons having knowledge of any discoverable matter. It is not ground for objection that the information sought will be inadmissible at the trial if the information sought appears reasonably calculated to lead to the discovery of admissible evidence.

From this base, the Rules in section 26(b)(4) set forth an exception for experts:

> Discovery of facts known and opinions held by experts, otherwise discoverable under the provisions of subdivision (b)(1) of

> this rule and acquired or developed in anticipation of litigation or for trial, may be obtained only as follows:
>
> (A)(i) A party may through interrogatories require any other party to identify each person whom the other party expects to call as an expert witness at trial, to state the subject matter on which the expert is expected to testify, and to state the substance of the facts and opinions to which the expert is expected to testify and a summary of the grounds for each opinion. (ii) Upon motion, the court may order further discovery by other means, subject to such restrictions as to scope and such provisions, pursuant to subdivision (b)(4)(C) of this rule, concerning fees and expenses as the court may deem appropriate." (Emphasis supplied.)

What the Rules giveth (in the form of protection to scientists) the trial judges usually taketh away, in response to motions to have full discovery of expert witnesses and documents. The theory advanced by most of these judges is that in large complex cases, in order not to unduly drag out the trial, it is essential to have the parties do the exploratory questioning prior to trial. It must be remembered that most civil litigation in the United States is between two private parties and may involve one or two experts at the most; the EPA scientist is likely to appear, if at all, in a major suit or hearing in which the government and a large business are the parties and in which a dozen or more experts will testify. In such situations it is unlikely that discovery will be restricted.

Are any materials privileged and not subject to disclosure? Increasingly the answer is, virtually nothing. Memos between researchers in a laboratory, draft reports, memos of telephone calls, and letters have all been held to be discoverable. Only a very limited category of documents which fall in the category of attorney "work product" are privileged. What falls under this heading cannot be stated with precision but they are essentially those analyses of the law and/or facts produced by the attorney or at his direction in preparation specifically for this litigation. This author has seen very few works of a scientist which have fallen within this category. That your work is probably susceptible to discovery should not be a deterrent to candor: no one can be faulted for stating what he knows. But it should be a deterrent for hastily formed opinions or personal comments which may be misunderstood if taken out of context.

No rigid distinction can be drawn in the above discussion between trials in courts and administrative proceedings because increasingly lawyers have used the Freedom of Information Act (FOIA) to obtain those documents discoverable under court rules. The EPA regulations on the FOIA reveal how this can be done. Once having complied with the mechanical requirements of 40 CFR Part 2, such as making a request in writing at the right office, a party is entitled to review and copy all materials except those

1. -- specifically exempted from disclosure by [some other] statute.

2. -- trade secrets and commercial or financial information obtained from a person and privileged or confidential.

3. -- interagency or intra-agency memorandums or letters which would <u>not</u> be available by law to a party other than an agency in litigation with the agency.

4. -- geological and geophysical information and data, including maps, concerning wells.

Emphasis has been added to category 3 to show why lawyers can argue that the broad rules of the Federal Rules of Civil Procedure should be employed in FOIA interpretations. The complete list of exemptions are in 40 CFR §2.105(a). If there is doubt whether all or part of the requested material should be disclosed, the procedures set forth in 40 CFR §§2.104 - 2.107 should be followed.

4. <u>Procedures of Laboratory Research and Field Investigations Which Are Subject to Attack</u>

a. <u>Chain of Custody</u>

The scientist or technician who fills water bottles in a stream just below a potential defendant's outfall must take precautions to insure that at trial the sample bottle he refers to can be shown to correspond to a sample taken at a certain time and a certain place. The often elaborately stated rules of chain of custody are nothing more than a means of guaranteeing the integrity of the identification of field samples. McCormick's <u>Handbook of the Law of Evidence</u> states simply that the expert witness must <u>be able to trace the chain of custody</u> "with sufficient completeness to render it improbable that the original item has either been exchanged with another or been contaminated or tampered with." This requirement must be met before the evidence can be received at all; it does not simply affect the weight to be given to the evidence.

The Legal Support Division of the Office of Enforcement and General Counsel in May of 1972 prepared a rather detailed guide for scientists gathering field samples. What follows is largely taken from that primer.

Stream and effluent samples should be obtained by using standard field sampling techniques. The chain of custody record tag should be attached to the sample container at the time the sample is collected and should contain the following information: sample number, date and time taken, source of sample (include type of sample and name of firm), the preservative and analyses required, name of person taking sample and witnesses. An actual tag is shown in Appendix C, and a sample transmittal sheet is reproduced in Appendix D. The pre-filled side of the card should be signed, timed and dated by the person sampling. The sample container should then be sealed with a pre-printed, gummed seal containing the Agency's designation, date and sampler's signature. The seal should cover the string or wire tie of the chain of custody tag so that the tag cannot be removed and the container cannot be opened without breaking the seal. The tags and seals must be filled out legibly in ballpoint (waterproof ink).

Blank samples should be collected in containers with and without preservatives so that laboratory analyses can be performed to show that there was no container contamination. A bound field notebook, or log, should be used to record field measurements and other pertinent information necessary to refresh the sampler's memory in the event he later becomes a witness in an enforcement proceeding. A separate set of field notebooks should be maintained for each survey and stored in a safe place where they can be protected and accounted for at all times. A standard format should be established to minimize field entries and should include the date, time, survey, type of samples taken, volume of each sample, type of analysis, sample numbers, preservatives, sample location, field measurements such as temperature, conductivity, DO, pH, and any other pertinent information or observations. The entries should then be signed by the field sampler. The responsibility for preparing and retaining field notebooks during and after the survey should be assigned to a survey coordinator, or his designated representative.

The field sampler is responsible for the care and custody of the samples collected until properly dispatched to the receiving laboratory or turned over to an assigned custodian. He must assure that each container is in his physical possession or in his view at all times, or stored in a locked place where no one can tamper with it.

Color slides or photographs are sometimes taken of the outfall sample location and any visible water pollution in the vicinity. Written documentation on the back of the photo should include the signature of the photographer, time, date, and site location. Photographs of this nature, which may be used as evidence, should be handled according to the established chain of custody procedures.

When transferring the possession of samples, the transferee must sign and record the date and time on the chain of custody record tag. Custody transfers, if made to a sample custodian in the field, should be recorded for each individual sample. Every person who takes custody must fill in a standardized "Receipt of Sample" form (see Appendix C). To prevent undue proliferation of custody cards, the number of custodians in the chain of possession should be as few as possible.

Mailed packages should be registered with return receipt requested. If packages are sent by common carrier, a Government Bill of Lading should be obtained. Receipts from post offices, and bills of lading or other common carrier receipts should be sent to and retained by the laboratory custodians as part of the permanent chain of custody documentation.

The laboratory should designate an employee or employees as a sample custodian. In addition, the laboratory should designate a clean, dry, isolated room that can be securely locked from the outside as a "sample storage security area." The sample custodian must maintain a permanent log book in which he records, for each sample, the person delivering the sample, the person receiving the sample, date and time received, source of sample, sample number, how transmitted to lab, and a number assigned to each sample by the laboratory. A standardized format should be established for log book entries.

Samples should be handled by the minimum possible number of persons. Distribution of samples to laboratory personnel who are to perform analyses should be made only by the custodian. The custodian should enter into the log the laboratory sample number, time and data, and the signature of the person to whom the samples were given.

Laboratory personnel are responsible for the care and custody of the sample once it is handed over to them and should be prepared to testify that the sample was in their possession and view or securely locked up at all times from the moment it was received from the custodian until the tests were run. Once the sample testing is completed, the unused portion of the sample, together with all identifying tags and seals, should be returned to the custodian who will make appropriate entries in his log. The returned tagged sample should be retained in the sample room until it is required for trial. Strip charts and other testing documentation also should be turned over to the custodian.

b. Laboratory Research Techniques

Volumes have been written on proper laboratory techniques, so there will be no attempt here to indicate in even a general way what procedures should be followed in examining a particular substance. The purpose of this section is more to emphasize the role proper (or arguably improper) sampling technique plays in a case. If a lawyer determines that an expert witness can do harm to his client's case, and that the substance of what the witness has to say is probably correct, or at least difficult to attack, then he will attempt to cast doubt upon the analytical methods employed by that scientist. It is imperative that accepted laboratory techniques be followed to the letter and that if the methods are not presented in depth in the research paper itself, at least detailed records are kept so that questions going to those methods can be answered. The increasing number of environmental disputes has generated a lawyer-specialist who (a) knows where to find consultants and (b) knows how to use their expertise, in ways which can seriously discredit researchers who are not careful.

Improper cleanup before use of gas chromatography, failure to run blanks or controls, failure to measure other possible stresses on the organisms beside the test toxicant, have either totally impeached or seriously questioned scientific work.

The statistical significance of test results is often taken for granted, yet several witnesses who have appeared in recent EPA hearings have had their published work seriously questioned by skillful use of desk calculators and accepted statistical analyses. Normit, probit and "t" tests are now common terms in lengthy proceedings.

What follows is an excerpt from part of the Aldrin/Dieldrin proceeding. It is not one of the several examples in which the witness was totally trapped by improper methods; it is a more typical case in which a "question" is raised in the mind of the trier of fact:

> Q. First of all, I would like to discuss the methodology that you employed in this particular experiment. In particular, I would like to discuss the reliability and the weight to which you give to the levels of dieldrin and aldrin that you found...I would like to focus on the methodology.
>
> In particular I want to ask you, Dr. ______, whether in the techniques that you employed for analyzing the presence of aldrin and/or dieldrin, whether you used any separation techniques, or so-called clean-up techniques, in order to eliminate the presence of DDE, or PCB, or any other artifacts which could have caused interference on the GLC columns, and, therefore, exaggerated or made too large the results which you found for aldrin and/or dieldrin?
>
> A. Really there are two components to the question. One is the sampling and one is the in-house analysis of the sample.
>
> You are asking once the sample is in-house, and in a correctly identified manner, how it is analyzed?
>
> Q. That is correct.
>
> A. In this particular investigation, some of the peculiarities of saltwater chemistry said it really wasn't that necessary to go through elaborate separation schemes with the type of gas chromatography, the type of detector that

was employed. We did use different columns so we wouldn't catch any of these places where one type of compound overlaps another, or one reacts in a column and produce a spurious peak of one sort or another.

In other types of work, sometimes medium clean-up, extensive cleanup, might be needed, but not in this case.

Q. Are you saying that because the samples were taken from saltwater, in this case it was actual seawater, wasn't it --

A. That is correct.

Q. -- that there were no artifacts that could have been present in the seawater?

A. Oh, there may have been many artifacts. But using the particular column, the inlet design, the type of detector, the sensitivity settings, the thermal settings, flow rates, all of those parameters, there was no interference at this point. There were lots of other items that could be seen on some of the chromatograms, but they weren't of interest for this particular paper.

Q. Did you separate the PCB's from your sample?

A. I really don't recall in this particular case.

Q. You don't recall whether you used separation techniques?

A. No. Let me restate that. I do not recall whether the conditions were such that PCB's were occurring with the detector sensitivities, et cetera. In other words, the conditions under which the instrument was set up. There was no specific procedures, again going through column separations and things of this sort, to try to separate out different groups of compounds in this case.

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Q. You said earlier, I believe, that there was no specific separation of PCB's?

A. In this case.

Q. In this case. Can you state --

A. In other words, we were not looking for PCB's.

Q. I understand that.

Now can you state that it was your belief that there were no PCB's in the samples that you took?

A. No, I have no real feeling one way or the other as to what might have been.

It must be emphasized that a judge cannot easily determine what is "harmless analytical error"; as a lawyer in a strange field, he must rely upon certain procedures which others in the field have called the standard methods for analysis. If the witness cannot tick off the requisite procedures he should be prepared to explain why he used a different method, and preferably be able to point to some published work which sanctions the method he used. There is an aura of "peer acceptability" that surrounds published work which does not attach to unpublished research. If at all possible, the extra time and effort should be made to publish your work, preferably not just in an EPA circular. Although probably unjustified, the greater weight given by lawyers and judges to glossy papered finished reports will no doubt continue.

5. What to Expect in Cross-Examination

When scientists think of trials or administrative proceedings in which they are to appear they may not think of the purpose of the hearing, or even the purpose of his testimony. They may not think of the novel scientific legal issues involved. Often, their main concern is how bad cross-examina-will be. To some scientists cross-examination is a forceful wrenching from the world of the reasonable and polite to the world in which word games prevail over accepted fact. In some trials, unfortunately, this has been true, but a witness can control the cross-examination to a remarkable extent by being adequately prepared. Most of this preparation should be directed by his lawyer, but there are some general points which apply to most situations. The following guidelines have been used in preparing witnesses for the headquarters hearings on pesticides and section 307(a) of the FWPCA:

1. You have no obligation to answer a question which you do not feel qualified to answer. You are not a defendant in a criminal trial required to answer. An "I am not qualified to answer that" or "I do not have enough facts to answer that" is perfectly acceptable.

2. Do not be lured into areas beyond your field.

3. Ask for clarification of a question if you have any doubt what is being asked.

4. When a hypothetical question is posed, make sure all elements of the hypothetical needed for you to be able to answer are present.

5. Take your time in responding to questions.

6. Do not elaborate beyond what is necessary to give a complete answer -- on the other hand, do not allow yourself to fall into trap of giving an "out of context" answer -- an answer which, in and of itself, is true but which has a misleading implication if further comment is not given. If you cannot answer with a "yes" or "no", make it plain you need to qualify your answer.

7. You may be asked to comment on works of other scientists you do not know or have not read recently -- e.g., "I show you this list of pesticide residue figures from Iowa -- aren't they awfully low?" You probably need to know how the research was conducted, the details of the methods, before you can comment accurately.

8. Don't respond to a challenge by boasting.

9. Don't try to render major societal decisions ("all pesticides are bad or corporations mislead the public").

10. You may be confronted with statements made by you at an earlier date which are too broad. If those statements were your personal opinions and not your professional scientific opinion you should say so. Scientists are allowed personal opinions but are allowed to testify in court in opinion and conclusion form only as to matters within their scientific realm, upon which a layman would be unqualified.

11. Don't get angry at the interrogator if he becomes arrogant or insulting. This invariably is because he dosen't have any way to crack your testimony scientifically and is trying to rattle you. Allow your lawyer to attempt to put him in his place.

12. The good lawyer will not ask a question in an opposing party's witness' strongest ground. Do not feel upset if you are not challenged on work you want to discuss.

13. Don't be drawn into an argument with opposing counsel. He isn't being called to testify.

14. If you feel discomfort, ask the judge for a recess. Don't use this an an excuse -- your counsel will ask for a recess if he sees you need a chance to collect your thoughts. Only for necessity will the court interrupt a cross-examination.

15. Most importantly, remember you know more about what you are talking about than anyone else in the courtroom. Your "home ground" is your data -- do not stray too far from it.

There have been notable examples in each major administrative hearing held by EPA or court trial in which EPA was a party, of witnesses who have fallen into one or more of the traps mentioned above.

The ideal expert witness has facetiously been characterized by some as a white haired gentleman with a pipe and elbow patched tweed sport coat who understates most answers he gives and never changes his mood of academic detachment. This picture is not altogether misleading, for the best expert witnesses seem to be those who are never caught exaggerating, never lower themselves to the rancor of the hearing room, and never deviate from their area of expertise. Judge E. Barrett Prettyman gives this advice to experts:

> Don't argue. Don't fence. Don't guess. Don't make wisecracks. Don't take sides. Don't get irritated. Think first, then speak. If you do know the answer to a question, say so. If you do not know the answer but have an opinion or belief on the subject based on information, say exactly that and let the hearing officer decide whether you shall or shall not give such information as you have. If a 'yes or no' answer to a question is demanded but you think that a qualification should be made to any such answer, give the "yes or no" and at once request permission to explain your answer. Don't worry about the

effect an answer may have. Don't worry about being bulldozed or embarrassed; counsel will protect you. If you know the answer to a question, state it as precisely and succinctly as you can. The best protection against extensive cross-examination is to be brief, absolutely accurate, and entirely calm.

The skillful witness also knows when to concede a point, even if it reflects poorly on his work. To struggle with a lawyer on a line of questioning, only to agree with him later, highlights the concession and places the other answers of the witness in an unfavorable light. What follows is the aftermath of a cross-examination on a point on which a witness refused to yield until the last possible moment. The expert then became argumentative and refused to answer questions clearly within his area of expertise. The questions deal with possible sources dieldrin found along the Atlantic coast:

Q. Looking at Table 5, I notice that New York is the most frequent reporter of residues of dieldrin in mollusks. Are you able to account for that?

A. No; that is an interesting observation, but I am not able to account for it.

Q. Why is it interesting?

A. It just interests me as a person.

Q. What does it suggest to you?

A. I have no further comment.

Q. Refer to the New York section of the paper. This begins at page 303.

A. Yes.

Q. You will notice the sites of the monitoring stations are fringed around the island of Long Island, not notorious as one of the world's great feed corn granaries. Does that suggest anything to you?

A. I am not in position to comment on that.

Q. You are not even in position to comment on whether or not these sites are adjacent to urban areas?

A. No comment.

Q. No comment?

A. No.

Q. Are you able to comment, for example, with respect to page 304 and let's say, for example, the Mamaroneck data which shows residues, if you allow a subjective judgment, for example, in 1967, a fairly constant rate throughout the year and tell us whether or not that indicates to you that these are agricultural or nonagricultural sources?

A. No, I have no basis for comment.

Q. Let's go back to page 243 and notice in the next column of Table 5 that Georgia is the state reflecting the maximum value in ppb. Are you able to comment about that?

A. No, I am not.

Q. If you will turn to the Georgia section and particularly the Lazareth Creek data, Station Number 1, for example; are you able to advise us as to the existence of one or more wool treatment plants on this creek?

A. No, I am not.

To some people, giving testimony as an expert witness is a challenging experience which starts the adrenalin pumping and prompts an attempt to answer all questions which are posed. A good lawyer will endeavor to draw an expert away from his area of expertise to a topic on which the witness knows enough to want to answer the questions but not enough to avoid being trapped. The witness also can be led into this unfortunate situation by a client and lawyer who wish to prove a point by forcing the witness to "expand a little upon this expertise." The example which follows is of a witness who rose to bait offered by the interrogator. The witness, who was a chemist, had just presented data on the runoff of pesticides from a cornfield during a heavy rain.

Q. Over the course of five years, Doctor, how many days would you expect that kind of rainfall to occur of that intensity? Did you have any way of making an estimate? Iowa weather?

A. Yes, I could make an estimate.

Q. Out of five years, what would your estimate be?

A. Well, I won't be numerical.

Q. Well, could you try -- how many days?

A. With considerable frequency. It is not uncommon. Several times a year, at the appropriate seasons; sometimes a couple of times a week it's happened.

****

Q. Would you identify that for the record and tell me what you see, whether you recognize that?

(indicating.)

A. Yes, I recognize it. It is a publication, 1969, by the Iowa Academy of Sciences, entitled, "Water Resources of Iowa."

Q. Now I direct your attention to figure 8, done in exactly the same method.

A I understand this figure, Doctor, and I ask you to correct me if I am incorrect, we can expect a four-inch rainfall in a 24-hour period once in five years; is that correct?

A. Yes, sir.

Q. Thank you.

The second example of a witness leaving his area of knowledge was probably the fault of his lawyers, who assisted in the drafting of an overly-broad written statement. The witness was attempting to rebut an EPA position in the Aldrin/Dieldrin hearings that much if not most of the residues of these pesticides come from agricultural runoff rather than point sources. Shell Chemical Company was attempting to show that sloppy handling by formulation and fertilizer blenders was the cause of the pollution. (If this were so, the argument goes, EPA could reduce pollution measurably by enforcement actions against certain plants and would not need to ban the pesticide. Another more immediate purpose was to throw doubt upon the EPA studies showing high residues in those agricultural areas in which Aldrin is used.) A company chemist was put in the uncomfortable position of carrying this torch:

Q. Are any of your publications related to the material you talk about in your statement?

A. No.

Q. So to shorten this up you have never published in the fields of -- stop me if you have, I am just going to read a list, aquatic toxicology, kinetics of aldrin-dieldrin degradation, the adsorption of aldrin-dieldrin to soil particles, erosion problems, the fate and effect of aldrin-dieldrin in fresh water moving stream environment, or the relationship between turbidity and aldrin-dieldrin concentrations in a moving fresh water stream.

Have you ever published in those areas?

A. No.

Q. Do you know how many tons of soil leave an average American corn field according to the U.S. Department of Agriculture?

A. No.

Q. Don't you think that would be a good figure to have in mind when you are talking about the relative pollution of Iowa corn streams?

****

A. I don't see the need to know that figure.

****

Q. Did you have any data on the distance an aldrin or dieldrin molecule can be transported in various size streams?

A. No. But I would guess it could go from one end to the other.

****

Q. You have no data on that, do you?

A. No.

Q. You have no data on how far it would travel in a highly turbid drainage ditch or turbid Iowa stream of 500 cfs, do you?

A. No.

****

Q. Doctor, do you have any example of a number in parts per million or pounds per day for any formulating plant in the Midwest at any time of the year?

A. No.

Q. Do you have any number for the pounds per day or parts per million from any municipal outfall in the Midwest?

A. No.

Q. Dr. _______, have you been in any of the eight major Shell formulating plants in the United States?

A. No.

****

Q. Let me run to Figure C, the map of fertilizer blenders, and so on. I take it you have no knowledge of whether the formulators on that map ever discharged a drop of dieldrin to the water, is that correct?

Q. I mean in normal operations.

A. I have no personal knowledge.

Q. And you have no knowledge of any type of numbers in parts per millions or pounds per day from any of these plants?

A. No.

Q. So, you do not know if they are polluting the water in Iowa or not, basically, do you? They could be all closed systems for all you know, right?

A. Right.

There are, unfortunately, many examples of expert witnesses who have violated one or more of the fundamental rules for presenting evidence. The chances of doing so, however, are far less if the potential witness has viewed at least a day or more of the proceedings prior to giving testimony. This accomplishes several things: it gives the "tone" of the hearing, it usually indicates what general type of questions to expect, and most of all, it reassures the witness. If you are called upon to testify you should make every effort to arrive enough before your appearance to view the proceedings.

Unfortunately, simple fatigue can undo the best of research. Experts have likened giving testimony before good lawyers to a lengthy oral dissertation defense without the usual opportunity to give complete answers. By the end of a day of hard questioning, the witness' concentration and the precision of the answers fall off markedly. Good lawyers may save the most aggressive and most important questioning for after the midafternoon break. It is also at this time that the skillfully phrased leading question has its greatest effect. Lawyers are not allowed to "lead" their own witnesses, but may phrase long rhetorical questions when facing witnesses for the opposition. These often begin with "I take it we can agree that..." or "I assume you are aware that..." or some form of a lead-in which calls for a yes or no answer to an often lengthy proposition. The prepared cross-examiner will know where he wants to go, and roughly how many leading or hypothetical questions it will take to get there. In most cases the final answer will not be the conclusion the witness anticipated when he conducted his research, i.e., it may be a consistent extrapolation from his original work. Or it may be a conclusion not truly in line with the data, but the inevitable result of the skillful questioning.

The latter result, most frustrating to good scientists, can happen when the leading or hypothetical questions are 95% accurate and the respondent is either too tired or too timid to demand the correction of the 5%. As any scientist knows, a 5% error compounded several times leads to substantial deviation: this simply is what happens when a witness is not careful with leading questions. He should demand that all elements of a hypothetical question he needs to reply are indeed included in the question or that all elements of a leading question do indeed reflect the state of facts. This training best comes from actual experience, but intensive mock cross-examination by his own lawyer can give a fair idea of what to expect.

It is often a good idea at the end of a day of hearing or trial for attorney and witness to review the past testimony in addition to preparing for likely cross-examination to come the next day. Witnesses and their lawyers often disagree as to what was said, or how it was interpreted, or whether that was really what the witness wanted to say. If there has been testimony that could be misinterpreted or was simply mis-spoken, the government attorney should try to correct the misimpression by well phrased "re-direct" question. These are traditionally questions which deal with issues raised in the cross-examination, not with "new matters". It is helpful to trial counsel if the witness keeps a mental note of areas of cross-examination in which he feels he needs to say more, and if the witness can suggest appropriate questions to his lawyer.

In some of the bigger trials and trial-type administrative hearings in which EPA has been a party, a daily transcript is made and is usually available to the parties four or five hours after the close of the day's hearings. Reference to the actual recorded answers, of course, greatly facilitate the correction of misimpressions and the protection of a precise record.

Appendix A

STATEMENT OF ______________

My name is ________________. I am a physiologist at the Fish-Pesticide Research Laboratory of the Bureau of Sport Fisheries and Wildlife, U.S. Department of the Interior at Columbia, Missouri. My duties there involve supervisory physiological, histopathological, and nutritional research dealing with the chronic effects of environmental pollutants on the physiology and biochemistry of fishes. I have been employed by the Fish-Pesticide Research Laboratory since 1969.

My educational background is as follows: I received my B.A. in Biology from Southwestern at Memphis, Memphis, Tennessee, in 1967, my M.A. in Zoology in 1969 and my Ph. D. in Agricultural Chemistry in 1971 both from the University of Missouri at Columbia.

My testimony will be taken from three papers which I coauthored. These are:

1. "Serum Amino Acids in Rainbow Trout (Salmo gairdneri) as Affected by DDT and Dieldrin" which appeared in Comparative Biochemistry and Physiology in 1971, Volume 38B, pages 373 to 377. This is attached as Appendix A.

2. "Ammonia Detoxifying Mechanisms of Rainbow Trout Altered by Dietary Dieldrin", a manuscript accepted for publication in Toxicology and Applied Pharmacology. This is attached as Appendix B.

3. "Phenylalanine Metabolism Altered by Dietary Dieldrin", appeared in Nature, Vol. 238, pages 462 to 463 in 1972. This is attached as Appendix C.

My papers deal with the effect of dieldrin on amino acid metabolism, ammonia detoxifying mechanisms, and phenylalanine and phenylketo acid metabolism of rainbow trout.

DIELDRIN AND AMINO ACID METABOLISM

Amino acids are organic molecules which are utilized for energy as well as for molecular components of proteins. Proteins are exceedingly important to all living organisms; they serve both structural and functional capacities in living organisms. The twenty naturally occurring amino acids normally found in organisms are considered important building blocks for life processes. Thus recognizing the importance of amino acids in biological systems, we initiated studies to elucidate the effect of dieldrin, a common environmental contaminant, on amino acid metablism of rainbow trout.

Each of three groups of rainbow trout was fed a diet containing 7.1 ug DDT/gm food, 7.1 ug dieldrin/gm food, or a diet containing neither DDT or dieldrin (control group). The dieldrin dosage was 143 ug/kg body weight per day. The fish were fed in three separate 570 liter fiberglass tanks for 140 days. After 140 days, whole body residue analyses were performed on 4 fish from each group, serum amino acids were analyzed from 6 fish in each group, and 12 trout from each group were subjected to forced swimming to determine the effects of DDT and dieldrin on serum amino acids after the trout were exercised. Six fish from each group were analyzed after 6 hours and 6 fish after 24 hours of forced swimming. The fish were exercised by placing them in a stamina tunnel which forces the trout to swim against a current of water. The velocity of water was 2 ft/sec, which is similar to velocities encountered by trout in many natural streams. Appendix A contains the references for the methods used. Table 1, Appendix A, presents the results of this study.

The concentration of each amino acid in the control group, except alanine, decreased after the fish were exercised. It is assumed that this is a result of the fish's energy needs, i.e., amino acids were being utilized in response to forced swimming.

Dieldrin altered the concentrations of 11 amino acids. The level of seven amino acids and the total amino acids concentration were elevated, while the concentration of four other amino acids were decreased by dieldrin. The effect of dieldrin could have been on the amino acid in question or perhaps on a metabolic pathway which affects a particular amino acid via a "feedback" mechanism.

There was a significant interaction between dieldrin treatment and forced swimming. The concentration of fewer amino acids were significantly lower after exercise in the dieldrin group than in the control group. Leucine and serine did not decrease in either of the exercised dieldrin groups, whereas in the control exercised group both amino acids significantly decreased. The concentration of methionine, hydroxyproline and aspartate increased in the dieldrin exercised group, but decreased in the control exercised group. The accumulation of these five amino acids in the serum suggests that the utilization was inhibited by dieldrin. The mechanism that caused these dieldrin-induced changes is unknown, but our results can be considered indicative of the subtle, biochemical effects of dieldrin that may alter rainbow trout in our aquatic environment.

DDT also had a significant effect on amino acid metabolism, but these results will not be discussed in this testimony.

DIELDRIN AND AMMONIA DETOXIFICATION

The second study involved the relationship between dieldrin and ammonia metabolism in fish. Ammonia is a natural end-product of protein and amino acid metabolism, and it manifests a strong cytotoxicity in living cells. The following biosynthetic reactions are responsible for detoxifying and maintaining low, non-toxic levels of ammonia in fish:

Reaction 1

$$\alpha\text{-oxoglutarate} + NADH + H^{+} + NH_4^{+} \rightleftharpoons \text{Glutamate} + NAD + H_2O$$

Glutamate
Dehydrogenase
(GDH)

Reaction 2

$$\text{Glutamate} + ATP + NH_4^{+} \rightleftharpoons \text{Glutamine} + ADP + \text{Orthophosphate}$$

Glutamine
Synthetase
(GS)

Reaction 1 occurs in both the liver and brain of fish, whereas the second occurs only in the brain. Thus, the brain has both biosynthetic reactions, and the liver has only one. Regulation of these two reactions is extremely important in maintaining low, non-toxic, ammonia levels in fish. This study was initiated to elucidate the effects of dieldrin on the ammonia detoxifying mechanisms and brain amino acid metabolism of rainbow trout.

Each of five groups of rainbow trout was fed a diet containing 0, 0.36 1.08, 3.6 or 10.8 µg dieldrin/gm of food. This equals to 0, 14, 43, 143 or 430 µg dieldrin/kg body weight of fish per day. The trout were fed daily rations equivalent to 4% of their body weight per day for 240 days, after which liver, blood and brain were taken for biochemical analyses. Each group of fish was weighed monthly and feeding rates were adjusted accordingly during the exposure.

The activity of the enzymes glutamate-oxaloacetate transaminase (GOT), glutamate-pyruvate transaminase (GPT), and glutamate dehydrogenase (GDH) were measured in both the liver and brain of fish from each group after 240 days. Also, glutamine synthetase activity (GS) (measured as glutamine transferase) was measured in the brain of fish from each group. The methodology, results, statistics, and discussion of data are presented in Appendix B. A summary of the data along with implications will be presented in this testimony.

The whole-body dieldrin residues after 240 days of exposure were 0.39, 0.62, 2.0, and 5.86 µg/gm (ppm) in the 14, 43, 143, and 430 µg/kg dosage groups, respectively. The dieldrin residues resulting from the three lowest dosages were in the range of those reported in fish from the National Pesticide Monitoring Program. We therefore suggest that results from this study are indicative of biochemical effects of dieldrin that could be occurring in fish in our aquatic environment.

Liver GOT and GPT activities were not significantly altered by dieldrin except for GOT in the highest dosage group. These two enzymes are indicative of the amount of ammonia being transaminated by the liver. These results suggest that dieldrin did not alter the transamination of amino nitrogen in the liver. However, brain GOT and GPT activities were significantly decreased by dieldrin except for GOT activity in the lowest dosage group. Decreased activity of these enzymes could cause a concomitant increase in concentrations of the amino acids aspartate and alanine. Analyses of the concentration of free amino acids in the brain confirmed that both aspartate and alanine concentrations were significantly increased in fish from the two highest dosage groups, but not in those fed less than 143 μg/kg/day (3.6 μg/gm food). Nine of the 16 amino acids measured in the brain were altered in the 143 μg/gm group, whereas 12 of the 16 amino acids were altered in the 430μ g/kg group. The significance of these individual changes in amino acid concentrations is not completely understood, but we can conclude that brain amino acid metabolism was significantly altered by chronic, dietary dieldrin exposure.

The enzymes concerned directly with ammonia detoxification, GDH and GS, were significantly altered by dieldrin. Liver GDH was significantly stimulated by all dieldrin dosages, which suggests that the ammonia detoxifying capabilities of the liver were increased. Because GDH is located exclusively in the mitochondrial matrix, these data indicate that mitochondrial metabolism was stimulated by dieldrin.

Electron microscopic analyses of liver cells showing changes in mitochondrial morphology give further evidence that dieldrin has an effect at this site. An electron photomicrograph representative of the control group (0 dosage) is shown in Figure 1, Appendix B. In comparison, the lowest dieldrin dosage caused swelling of mitochondria with no apparent disruption of membranes (Figure 2, Appendix B). However, the highest dieldrin treatment caused more pronounced effects on the mitochondrial (Figure 3, Appendix B). The mitochondria were swollen, mitochondrial membranes were disrupted, and the matrices of several mitochondrial appear severely damaged. The electron microscopic examinations were correlated with the altered GDH activity, and our interpretation offers an explanation as to why the lowest dieldrin-treated group had slightly greater GDH activity than the highest treated group. The mitochondria of the low dosage group were swollen, which suggests stimulated mitochondrial metabolism, whereas those of the high dosage group were not only swollen, but the outer membranes were disrupted which results in the mitochondria being inactive.

Brain GDH activity was decreased significantly by all doses of dieldrin. The inhibition of brain GDH suggests decreased ammonia detoxification, which could have increased ammonia concentrations in the brain. However, dieldrin had no effect on brain ammonia concentrations. In contrast, serum ammonia increased significantly at the two highest doses of dieldrin. Because brain ammonia is metabolized sequentially by glutamate dehydrogenase and glutamine synthetase, we feel that the inhibition of GDH activity placed a greater load of ammonia on the glutamine synthetase system. In all groups exposed to dieldrin, glutamine synthetase activity (as assayed by glutamine transferase) was stimulated, and compensated for the loss in ammonia detoxifying function performed by GDH. Thus, glutamine synthetase in the brain of dieldrin-dosed fish in this study is likely responsible for maintaining brain levels of ammonia within physiological limits. When this compensating mechanism is exhausted or exceeded, then the toxic effects of ammonia are perhaps manifested.

The dieldrin-induced change in brain GDH activity of rainbow trout may account for the stimulation of brain glutamine synthetase activity, increase in serum ammonia, and the increase in liver GDH activity. The ammonia liberated from the brain in the low dosage group (14 μg/day) did not result in a detectable increase in the concentrations of either brain or serum ammonia. This suggested that the ammonia liberated due to decreased brain GDH activity was either bound by brain glutamine synthetase or transported from the brain to blood, and then either excreted or detoxified by the liver. The ammonia liberated from the brain probably accounted for the stimulated liver GDH activity. In the second lowest dosage group (43/day), this same trend was apparent. The two highest doses of dieldrin (143 and 430 μg/day) caused an increase in serum ammonia, which suggests that the excretion and liver detoxification capabilities were being exceeded. Although the excess ammonia load was not toxic to the trout, it caused the ammonia detoxifying mechanisms to be continually taxed.

The implication that brain ammonia detoxifying mechanisms of fish play such an important role in maintaining ammonia levels within physiological limits demonstrates the impact that dieldrin could have on fish and their ability to adapt to their environment. However, the most serious implications on fish involve the interaction of dieldrin and other environmental chemicals that may also alter ammonia metabolism, as well as the interaction of dieldrin and elevated ammonia concentrations in water. Ammonia is one of the most common poisons discharged into the aquatic environment and has been a subject of much concern in fish toxicology. Results from our study suggest that fish carrying body burdens of dieldrin would be less tolerant to increased levels of ammonia in water.

DIELDRIN AND PHENYLALANINE METABOLISM

Further research was done with rainbow trout which involved determining the effects of dietary dieldrin on the metabolism of one particular amino acid, phenylalanine. The concentration of phenylalanine was altered by dieldrin in our first study. Changes in the metabolism of phenylalanine have been related to altered activity of brain enzymes and mental deficiency in mammals. Although little is known about the situation in fish, we evaluated the effects of dietary dieldrin on metabolic pathways of phenylalanine in rainbow trout (*Salmo gairdneri*).

In this experiment, we fed each of 5 groups of rainbow trout diets containing dieldrin at the following concentration: 0, 0.36, 1.08, 3.6 or 10.8 μg dieldrin/gm food. This corresponded to 0, 14, 43, 143, or 430 μg dieldrin/kg body weight/day, respectively. The fish were fed daily rations equivalent to 4% of their body weight for 300 days. The trout were weighed each month, and we adjusted the feeding rates accordingly.

At the end of the experiment liver phenylalanine hydroxylase, serum phenylalanine and urinary phenylpyruvic acid were measured. The techniques used in this study are noted in Appendix C.

Growth rates were not affected during the 300 day exposure period. Whole body dieldrin residues after 300 days were 0.41, 0.79, 2.10 and 6.23 μg/gm (ppm) in the 14, 43, 143, and 430 μg/kg groups, respectively. It is important to note that residues in fish at the three lowest exposure levels were in the range reported for fish in the aquatic environment by the National Pesticide Monitoring Program.

The concentration of phenylalanine in blood was increased by all dosages of dieldrin. The effects of dieldrin on serum phenylalanine are given in Figure 2, Appendix C.

Liver phenylalanine hydroxylase is an enzyme which converts phenylalanine to tyrosine. This enzyme is responsible for maintaining the normal concentration of blood phenylalanine. Our study showed that all doses of dieldrin decreased the activity of this enzyme (Figure 1, Appendix C). These results are consistent with our finding of increased serum phenylalanine, i.e., the enzyme was less active and phenylalanine was not being converted to tyrosine.

Dieldrin's effect on phenylalanine hydroxylase activity appeared to be persistent, for the liver enzyme activities in the group given the largest and smallest doses of dieldrin were still significantly ($P<0.05$) lower than the control group after the trout were fed control diets (0 dosage) for 4 months after the initial 300-day exposure. The half-life of dieldrin in trout has been reported to be 44 days. Thus, after approximately three half-lives, the enzyme activity was still decreased.

Urinary phenylpyruvic acid, a phenylketo acid metabolite of phenylalanine, increased in concentration in the groups receiving the three highest dosages of dieldrin. There was a significant correlation between decreased phenylalanine hydroxylase activity and increased urine phenylpyruvic acid concentration among the various dosage groups ($r=0.860$, $P<0.01$). Thus, as dieldrin caused a decrease in hydroxylase activity, there was a concomitant increase in the urinary phenylketo acid metabolite.

Phenylketouria is an inherited defect in phenylalanine metabolism of mammals characterized by an inhibition of phenylalanine hydroxylase, increased blood phenylalanine, increased urinary phenylketo acids, and mental deficiency. Our study indicated that dieldrin has a marked effect on phenylalanine metabolism and can induce the biochemical manifestations of phenylketouria; however, the effects of dieldrin on learning ability in fish remain to be tested.

Appendix B

My name is ______________ and I am currently assistant professor of environmental studies at __________________________. My formal education includes BSc and MA degrees from the University of Missouri and a PhD degree from Montana State University. I have had experience as a research assistant at the University of Missouri and as a pollution biologist with the Tennessee Game and Fish Commission. A list of my research contributions and a curriculum vitae are attached for your review. The information I will present below stems from a research project conducted at the University of Missouri during the late 1960's under the supervision of __________________. This work dealt with the effects of selected pesticides (including dieldrin) on planktonic algae.

As you know, all life on this planet depends upon the energy of the sun which is "fixed" or converted into a useable form via the activity of green plants. Our goal in this research project was to determine if certain chemicals, which were widely used at the time of the project had any effect upon the ability of green plants to perform their important role of energy fixation. We choose a green algae (Scenedesmus quadricauda) as the test organism. Our experimental design consisted of exposing laboratory cultures of this plankton organism to various concentrations of specific pesticides and over a period of approximately 10 days determining what influence, if any, that chemical had on the ability of the test organism to grow (i.e., increase in numbers within the cultures) and to fix energy. The methods used during this study were such that sublethal effects of any of the tested compounds could be determined. In other words, the test organism did not have to turn brown and die in order to determine whether or not the compound under investigation had an adverse effect.

Growth was measured simply by counting the number of plankton algae cells in a 1 ml aliquot of the control and pesticide treated cultures at two day intervals. The rate of energy fixation (photosynthesis) was determined with the aid of radioactive carbon-14 (C^{14}) in the form of sodium carbonate. Aliquots of each culture were withdrawn at two day intervals and incubated with C^{14} for four hours. The cells were filtered, washed, dried and the amount of radioactive carbon which had been "fixed" was determined by liquid scintillation.

A summary of the results from the dieldrin part of the study are presented in Table I.

Table I. Percentage differences cell number, carbon assimilation and biomass between dieldrin treated cultures and controls at 0, 2, 4, 6, 8, and 10 days. Carbon assimilation expressed as unit volume = cpm C^{14} per 50 ml of culture. * = significant difference (p = 0.05, N=4).

		Time in Days					
0.1 mg/l		0	2	4	6	8	10
	Cell number		-32*	-23*	-26*	-17*	-9
	Unit volume	+5	+ 1	-20*	-42*	-25	+35
	Biomass						-22
1.0 mg/l							
	Cell number		-37*	-29*	-38*	-23*	-11
	Unit volume	+3	+ 1	-33*	-51*	-32*	+33
	Biomass						-32

These data show the percentage change of treated cultures from controls as to the number of cells, the amount of carbon-14 taken up and the biomass. Thus, by the second day of the experiment, the number of cells in the dieldrin treated cultures (0.1 mg/l) was 32% less than the control cultures while the amount of radioactive carbon being assimilated was about the same (1% greater than controls). At a concentration of 1.0 mg/l on this same day, the number of cells was 37% less than the control cultures and again carbon uptake was about the same (1% greater than controls). By the sixth day of the experiment cell number at the lower concentration (0.1 mg/l) was 26% below the controls and the rate of carbon fixation was 42% less than the control cultures. At the higher concentration of 1.0 mg/l the number of cells in the treated cultures were 38% lower than in the control cultures and the rate of carbon uptake 51% below the control rate. By the end of the experiment, total biomass was 22% lower than control cultures in the 0.1 mg/l treatment group and 32% lower in the 1.0 mg/l group.

My conclusion from this information is that the compound dieldrin has an adverse effect on the green plankton algae S. quadricauda. There was a significant decrease in the growth and energy fixing abilities of the test organism. Total biomass of the treated cultures was lower than controls at the end of the test period.

I feel that dieldrin has fairly widespread effects. As other witnesses have testified, this compound affects many diverse types of organisms. As I have found, members of the plant kingdom are adversely affected. The ramification of this is that dieldrin may have a very subtle yet widespread influence on an ecosystem. I therefore would support a complete ban on the pesticide dieldrin while encouraging an increased research effort into more species-specific pest control methods.

Appendix C

CHAIN OF CUSTODY RECORD

ENVIRONMENTAL PROTECTION AGENCY

SAMPLE NO.	TIME TAKEN	DATE TAKEN

SOURCE OF SAMPLE	PRESERVATIVE

NAME OF PERSON TAKING SAMPLE

WITNESS(ES) TO TAKING SAMPLE

ANALYSIS REQUIRED:

Front

RECEIPT OF SAMPLE

I hereby certify that I received this sample and disposed of it as noted below.

RECEIVED FROM	DATE REC'D	TIME REC'D
DISPOSITION OF SAMPLE	SIGNATURE	

RECEIPT OF SAMPLE

I hereby certify that I received this sample and disposed of it as noted below.

RECEIVED FROM	DATE REC'D	TIME REC'D
DISPOSITION OF SAMPLE	SIGNATURE	

DISPATCH OF SAMPLE

I hereby certify that I obtained this sample and dispatched it as shown below.

DATE OBTAIND	TIME OBTAIND	SOURCE
DATE DISPATED	TIME DISPATED	METHOD OF SHIPMENT
SENT TO		SIGNATURE

Back

Appendix D

SAMPLE TRANSMITTAL SHEET

TO: (Laboratory Name & Address)

FROM: (Field custodian or Field Sampler)

Sample No.	Lab Number	Preservative	Analysis Required

To be completed in field:

Prepared by: ____________________ Date: ____________________
Signature

Field Notebook No. ____________________ Time: ____________________

To be completed by Laboratory:

Received by: ____________________ Date: ____________________

Time: ____________________

Distribution: Orig. & copy - Accompany shipment
1 copy - mail directly to Laboratory
1 copy - mail to Data Management
1 copy - Survey Coordinator Field Files