10th Volume

AQUATIC TOXICOLOGY AND HAZARD ASSESSMENT

ADAMS/CHAPMAN/LANDIS, *editors*

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Aquatic Toxicology and Hazard Assessment: 10th Volume

William J. Adams, Gary A. Chapman, and Wayne G. Landis, editors

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Foreword

This publication, *Aquatic Toxicology and Hazard Assessment: 10th Volume,* contains papers presented at the Tenth Symposium on Aquatic Toxicology and Hazard Assessment, which was held in New Orleans, 4–6 May 1986. The symposium was sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate. William J. Adams, Monsanto Co., presided as symposium chairman and is a coeditor of this publication. Gary A. Chapman, Environmental Protection Agency, and Wayne G. Landis, USA Aberdeen Proving Grounds, also served as symposium cochairmen and were coeditors of this publication.

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Overview

The last ten years have been exciting for the science of aquatic toxicology. The intent of the tenth symposium was to reflect on past accomplishments of a decade and to consider what new directions are needed for the future.

During the past ten years we have watched the field of aquatic toxicology grow from its infancy and a need to deal with acute problems to a mature field of science capable of dealing with long-term and sophisticated issues of national importance. Ten years ago there was a feeling of crisis; rivers burned, fish kills made the headlines, and legislative tools had just been put in place for effective enforcement. The science of aquatic toxicology was just emerging and was learning how to assist the nation in solving its water quality problems.

Many of the papers in the early symposia dealt with methods and case studies. Over the years many of the acute problems have been effectively eliminated. Consequently, the emphasis has changed to the long-term chronic perturbations that can have just as damaging an environmental and economic effect. An example of such an effect has been the destruction of the Rock Bass fishery in the Chesapeake Bay. Apparently a combination of eutrophication, point and nonpoint pollution, habitat destruction caused by development, and overexploitation has destroyed an important economic resource. Sediment contamination, acid precipitation, groundwater pollution, and hazardous waste sites have all gained increasing emphasis. Consequently, the prediction of long-term effects has become more and more important. More recently biotechnology has opened the door to many new scientific frontiers and offers the prospect of new chemicals including medicines, pesticides, growth hormones, and industrial chemicals. Biotechnology also holds promise as a means for hazardous waste site and effluent cleanup through the modification of microbial communities to enhance biodegradation. At the same time it offers the prospect of new effluents and the release, either accidentally or intentionally, of genetically altered microorganisms. This presents a challenge to the scientific community to find appropriate ways to assess the risk associated with biotechnology without stifling creativity.

The symposium certainly reflected the state of aquatic toxicology in 1986. The leadoff session, "Aquatic Toxicology: Ten Years in Review and a Look to the Future," may eventually be looked upon as a marker for the end of the adolescence of aquatic toxicology. *Dickson* described the change in emphasis of the papers of each volume, showing the shift from new methods to refinements and papers coupling laboratory and field experiments. Many of the speakers emphasized the rapid progress of the science and the cooperation of its participants from government, industry, and academia. The last speaker, *Mount*, looked to the future and emphasized that aquatic toxicology needed to evolve into a science able to offer alternatives, risks, and technologies to preserve what has already been accomplished coupled to a responsiveness to the future.

Sessions on biotechnology and paleolimnology set off two aspects of aquatic toxicology new to most participants. Biotechnology is in many ways a game with a different set of ground rules and detection technologies. Risk assessment must take into account the reproductive potential of the organisms and the promiscuous nature of genetic exchange among procaryotes. Paleolimnology is a way of looking at truly long-term changes in ecosystem dynamics, on a range from tens to thousands of years.

Sediments constitute an enormous problem in the assessment and evaluation of hazard. The

session on sediments was dominated by papers characterizing sediments, evaluating risks, and managing dredge material. Several papers concerning sediments and dredge materials were also included in the poster session.

The poster session received an increased emphasis in the tenth symposium. The session took advantage of the opportunity for hands-on demonstrations of techniques and the chance to interact with the experimenter. Among the demonstrations was the video by *Sabourin* and *Dawson* on the use of Xenopus embryos for the screening of materials for teratogenicity. Posters on biomonitoring, sediment toxicity, microcosm research, and the evaluation of chronic toxicity were also presented.

Sessions on the biomonitoring of complex effluents, environmental monitoring and exposure assessment, short-term indicators of chronic toxicity, laboratory and field comparisons, aquatic toxicology, waste site hazard assessment and biodegradation, and research beneficial to the standards-setting process all indicate the diversity of the field. The examples below serve to illustrate the diversity of the symposium. *Van der Schalie et al.* demonstrated the benefits of using parameters other than ventilatory frequency in monitoring the effects of trinitrobenzene on bluegill sunfish. Progress on interlaboratory testing on the Standardized Aquatic Microcosm was presented by *Taub*. In the hazardous waste site arena, *Portier* presented data on the enhancement of PCB degradation by the enrichment of the bacterial inoculations using aminopolysaccharides.

This short overview reflects the state of the science of aquatic toxicology in 1986. This diverse field incorporates parts of many disciplines including ecology, chemistry, physiology, algology, and limnology, to mention only a few. Compared to the many disciplines, the number of aquatic toxicologists is relatively few.

Attendance at the symposia has remained about 200 for the last several years. However, aquatic toxicology has played a crucial and influential role in the progress made in the improvement in the environment during the last decade. The research emphasis is now moving on to new problems and to finding long-term solutions for environmental contamination.

We see several areas of basic research that need to be addressed. Aquatic toxicology is still to a large extent an empirical science. Only a small body of work exists on developing a theory of how toxicants affect ecosystems. A suitable theory would be of dramatic practical impact. Such a workable theory would help to extrapolate a series of data from a microcosm to a larger ecosystem. Short-term methods could be modified, if necessary, to more accurately present information relevant to evaluating risk to an ecosystem. Toxicity of complex effluents is a crucial research area. Most chemicals enter an ecosystem as a mixture or soon become part of the complex mix of synthetic and natural chemicals that exist in the environment. We need to learn how to assess the hazard of chemical mixtures. Clean up of waste sites is an issue of national importance. Biological methods have the potential to reduce costs and in some cases make cleanup possible in environments inaccessible to current methods. In the near future organisms with altered genomes will be entering the environment. An understanding of the potential, if any, of these organisms for disruption of ecosystem processes or the degradation of toxic materials needs to be understood. Aquatic organisms are already playing an important role in the search for alternatives to using mammals as test organisms. Research in this area will also emphasize the need for aquatic toxicologists to look closely at mechanisms and physiological parameters related to toxicity and environmental health.

Aquatic toxicology has an interesting future ahead. But we are also concerned that a new generation of scientists may not be coming forward to participate. Currently, the mechanisms of support for graduate students do not meet the need, and recruitment into the science appears to have slowed. Members of the community of aquatic toxicology need to encourage and find support for the new generation. There are a lot of existing problems yet to solve, and we need to put in place the basic research structure that will enable us to deal effectively with the key issues that

will face our nation ten years from now. In short, we have an exciting future ahead and need to insure that the next generation of researchers is being developed to continue the work that has begun.

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Introductory Paper

Patrick R. Parrish,[1] *Kenneth L. Dickson,*[2] *Jerry L. Hamelink,*[3] *Richard A. Kimerle,*[4] *Kenneth J. Macek,*[5] *Foster L. Mayer, Jr.,*[6] *and Donald I. Mount*[7]

Aquatic Toxicology: Ten Years in Review and a Look at the Future

REFERENCE: Parrish, P. R., Dickson, K. L., Hamelink, J. L., Kimerle, R. A., Macek, K. J., Mayer, F. L., Jr., and Mount, D. I., **"Aquatic Toxicology: Ten Years in Review and a Look at the Future,"** *Aquatic Toxicology and Hazard Assessment: 10th Volume, ASTM STP 971,* W. J. Adams, G. A. Chapman, and W. G. Landis, Eds., American Society for Testing and Materials, Philadelphia, 1988, pp. 7–25.

ABSTRACT: This symposium marks the tenth time that we have gathered as a group of professional scientists who share common goals and ideas concerning the protection of our nation's aquatic resources. This tenth symposium seems like a fitting time to reflect on our origins, our successes, and our plans for the future. To that end, several people who have been instrumental in shaping the science of aquatic toxicology and hazard (risk) assessment were invited to present their views on the growth of this science and their ideas about its future. This paper is, then, a collection of those viewpoints, which are set down in writing so that others may benefit from the experience of the authors and so that newcomers to this field may benefit by knowing about the roots of aquatic toxicology and hazard assessment. The fact that the science has persisted and grown over the past ten years is a tribute to all those who have contributed their time, energy, and intellect.

KEYWORDS: aquatic toxicology, review, ASTM symposia, hazard (risk) assessment

Introduction—P. R. Parrish

The special session of this symposium was planned to allow several of the "movers and shakers" in aquatic toxicology and hazard (risk) assessment to share their thoughts about the progress of our science during the past ten years and to project their views of the future. It was difficult to limit the number of speakers—there were others who were instrumental in the formation of this symposium and in the science of aquatic toxicology and hazard assessment. Chuck Stephan, Rick Cardwell, John Eaton, Rich Purdy, Gene Kenaga, Dean Branson, Rita Comotto Bahner, Leif Marking, Al Hendricks, Gareth Pearson, Bob Foster, Bill Bishop, Barb Heidolph, Howard Alexander, Bill Peltier, and others have contributed. Symposium chairman Bill Adams and I

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agreed, however, that the special session speakers represented a little of every perspective from which our science can be viewed.

It has been ten years since the first ASTM symposium. That's three thousand, six hundred, and fifty-two days. (There were two leap years.) This two-hour session will be about 23 parts per million of that time. Not much, is it? But most of us work with chemicals whose concentrations cause effects in the parts-per-million range, so we can relate to such a small amount. Will we see an effect after tonight's session? Should we consider this a pulse exposure? Have we been prestressed and will that confound our responses (all of which will be sublethal, I trust)? Speaking personally, there has been some stress since that day in Memphis, Tennessee, in the Holiday Inn from which you could watch the tugboats pushing barges laden with grain on the Mighty Mississippi, that day when Don Mount informed and amused us with his clever cartoons in that tunnel of a room. Some others who share the platform tonight have been stressed, too. There have been job changes aplenty and one career change. Administrators have become researchers and researchers have become administrators. (Will we *ever* learn?) There have been divorces, near divorces, a couple of marriages, and more divorces. People have moved from Missouri to Florida, from Florida to Rhode Island, and from Virginia to Texas. There has been the graying of hair (I would never stoop so low as to mention the loss of same), the weakening of eyes, and the spreading of middle-aged midriffs.

But there has been joy and reward and growth and learning. Toddlers have grown to teenagers and 10-year-old boys to 20-year-old men. (I have examples sitting in the audience. And they are with their mother, my lovely wife of 23 years, who was in Memphis ten years ago and had a whale of a good time!) There have been professional accomplishments and personal achievements. We have partied together, eaten great food together, and have come to know and appreciate and, yes, to love each other. We get along well together, I think, because professionally we are alike (that's not to say, of course, that we don't occasionally disagree), but personally we are different. The diversity of this group is amazing. There's a Texan from Texas, a stubborn Dutchman from Michigan, a St. Louis native of German descent, a Polish kid who grew up in South Boston, an Oklahoman whose ancestors were the original inhabitants of this country, an Ohio farm boy, and a fifth-generation Florida cracker. From such diversity has come much of the strength of our science and of this symposium.

I choose to begin this technical meeting with personal comments and remembrances because I think that anniversaries are times to reminisce and to be retrospective. When we consider the magnitude of changes in our lives and in our science during the past ten years, it is appropriate to stop for a moment and to consider where we have been and where we are going.

Review of ASTM Symposia Proceedings–K. L. Dickson

My purpose is to analyze the types of papers that have been published in the first eight ASTM symposia proceedings. I have attempted to categorize each of the 242 papers that have been published, and the results are as indicated in Table 1.

Perspective

These papers challenge us to think about aquatic toxicology as a science. They attempt to identify our strengths and weaknesses. Examples of perspective papers are:

1. Don Mount's humorous presentation entitled "Present Approaches To Toxicity Testing—A Perspective" [*1*] published in the first proceedings.
2. John Zapp's paper entitled "Historical Consideration of Interspecies Relationships in Toxicity Assessment" [2] published in the third proceedings.

TABLE 1—*Types of papers published in first eight ASTM symposia proceedings.*

Type of Paper	Number	Percentage
Perspective	17	7
Methods	58	24
Results	97	40
Interpretation	13	5
Hazard assessment	11	5
Fate modeling	14	6
Regulatory	7	3
Laboratory-field validation	8	3
Bioavailability	6	2
Water quality criteria	11	5
	242	100

3. Wes Birge and J. A. Black's paper on "Research Needs for Rapid Assessment of Chronic Toxicity" [*3*] published in the eighth proceedings.

There is a definite increasing trend in perspective papers (Fig. 1). This is excellent and should continue; it will lead to qualitative growth in our discipline rather than to simple quantitative growth. As Ken Macek so vividly reminded us five years ago in the fifth proceedings [*4*], if we are to remain a viable discipline, we must grow qualitatively. I see signs that we are, in fact, growing qualitatively, and I take the increasing trend in perspective papers as a very positive sign of maturity.

Methods

It is not surprising that many (24%) of the papers published in the proceedings have dealt with toxicity testing methods. An in-depth examination of these papers reveals the trend shown in Fig. 2. At the first few symposia, there were a large number of "new methods" papers. However, the number has decreased dramatically. Interestingly, the major area of new method development in recent symposia has dealt with rapid assessment methods. Ten different rapid methods to predict chronic toxicity have been published; this is in recognition of the extreme importance of no-observed-effect concentrations in making hazard (risk) assessment decisions. The search needs to continue for rapid and inexpensive means of predicting chronic effects of toxicants. It is in this area and in the sediment toxicity area where we need to place more of our efforts. I am particularly concerned that we do not have adequate methods to assess the effects of sediment-associated chemicals, particularly in light of the movement to develop numerical sediment criteria.

Method Refinement

While the trend line for the development of new methods is definitely decreasing, there is an increasing trend in papers that refine and evaluate existing methods (Fig. 3). These papers range from studies about the effects of diet on brood size and weight of *Daphnia* to studies that evaluate the sensitivity of various chronic testing endpoints and test duration for *Ceriodaphnia* toxicity tests.

Methods refinement is an extremely important area in aquatic toxicology. If one considers the magnitude of the decisions that often rests on the use of our aquatic toxicity data, then it is