Overview

The longest running series of books on aquatic toxicology, the ASTM Special Technical Publications (STPs) on Aquatic Toxicology and Risk [Hazard] Assessment, is now in its thirteenth volume. The series has reflected changes in both the state of the art and in the perceptions of what are the important questions in aquatic toxicology. We were both involved in the organization of the tenth symposium in 1986, and a discussion of the changes in the field in the past three years may be useful.

Some aspects of our science remain essentially unchanged. Aquatic toxicology is very much an applied science, its driving force being toxicity testing for compliance with the Federal Clean Water Act; the Federal Insecticide, Fungicide, and Rodenticide Act; the Toxic Substances Control Act; and the Comprehensive Environmental Response Compensation and Liability Act. The conduct of basic research in order to understand underlying mechanisms and to improve our ability to perform risk assessments is still, judged by total economic outlay, a relatively small effort. In 1986, however, the agencies that funded and conducted fundamental research in environmental toxicology were recovering from the budgetary constraints of the early 1980s. As in 1986, the number of students coming into the science is low, but there are signs of an increase. Three years ago job opportunities for graduates with advanced degrees were few and very difficult to find. Some graduates from this period are only now finding permanent positions. Support for graduate education in environmental science was minimal. In contrast, at the 1989 meeting there was talk of expansion, graduate support, and new positions opening up in industry, academia, and consulting firms. Enrollment in environmental toxicology programs has also increased, although financial support for these students remains insufficient.

The tenth volume contained a multi-author paper reviewing the first ten years of symposia and predicting the future.[1] One of the most interesting trends, reported by *Dickson,* was the decline in methods papers and the increase in interpretive, perspective, and laboratory-to-field papers. This trend may have been due to the optimization of the first round of toxicity testing techniques and to our trying to understand the implications of data generated by these tests. One of the more disturbing trends noted was the lack of integrative papers in the first ten symposia. On a positive note *Hamelink* reported on the rapid growth of aquatic toxicology programs within industry. A mixed report made by *Kimerle* emphasized our dramatic increase in knowledge but lamented our slow pace of methods approval. *Mayer* and *Mount* were cautionary in tone. The former used the terms "magic bullets" and "test-of-the-month club" to describe the faddish nature of our science in the 1980s. The latter emphasized that the easy jobs had been accomplished and that aquatic toxicology in future should emphasize a positive and proactive stance. The difficult tast of removing the "albatross called regulatory judgement" by educating the regulators was discussed by *Macek.*

[1] 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.

Comparing the contents of the papers contained in this volume with the trends observed three years ago may be useful. This volume reflects the increasing emphasis on the development of new techniques to examine the molecular and cellular effects of toxicants. *Shugart* reports on the use of DNA damage with bluegill sunfish as an indicator of pollution. A similar technique was developed by *Daniels et al.* using chromosomal aberrations in *Cyprinodon* to look at the effects of oil drilling in coastal waters. Immune responses are a critical physiological function of an organism, and *Anderson et al.* looked at the immunosuppression of fish exposed to phenol. A developing interest in the field of biomarkers and the response of stress proteins to toxicant exposure is exemplified in the paper by *Bradley*. These new techniques evaluate organism response to toxic exposures in ways that our traditional acute and chronic assays cannot. As with the more traditional techniques, these methods must be integrated into a hazard and risk assessment framework. What we may be seeing is a second round of technique development similar in magnitude and intensity to the development of standard toxicity tests.

We still lack sufficient integrative papers. *Pratt* attempts to integrate ecological principles into the measurement and forecast of ecosystem responses. This is a difficult task due to our lack of basic knowledge of aquatic ecosystems. In spite of insufficient data and even without an integrative framework, hazard and risk assessments must be performed. *Suter* gives an excellent comparison of hazard and risk assessment. *Walker* presents a day-to-day perspective on hazard and risk assessment within the U.S. Environmental Protection Agency. An emphasis on risk assessment is an encouraging development in aquatic toxicology.

Sediments and biodegradation remain an important part of aquatic toxicology. A session was held at the thirteenth symposium that included data and methodology development for marine and freshwater systems. *Nelson's* method of *in situ* biological monitoring may have considerable importance in the study of sediment pollution and partially avoids laboratory-to-field extrapolation. Papers by *Cripe and Pritchard, Carson et al.*, and *Haley et al.* review various techniques including microcosms for conducting chemical biodegradation studies.

As in previous volumes, this volume contains papers that report toxicities of a variety of materials. Although not so glamorous as some of the other aspects of the field, these papers provide important information for conducting hazard and risk assessments.

Since Kimerle's criticism of our inability to produce consensus methods, many new methods have been developed by ASTM Subcommittee E47.01. As subcommittee chairperson, Dr. Ursula Cowgill played an important part in that increase by pushing the passage of new standards through the ASTM consensus system. It is hoped that this progress can be sustained.

The comments of Mayer are still relevant. We are still subject to a "test-of-the-month club" mentality. An example is the current emphasis on biomarkers. While biomarkers may prove useful, their limitations must be recognized and their relevance to aquatic populations and systems must be demonstrated. The question we must ask is: Where is aquatic toxicology headed? Using aquatic toxicology we can diagnose a problem, but it is much more difficult to effect a cure. More emphasis should be placed on the recovery of damaged ecosystems.

One of my (WGL) biggest concerns is that aquatic toxicology remains a science whose theoretical basis is that of ecology and molecular biology. Few attempts have been made to tie these two aspects together, yet that is essentially what we do as aquatic toxicologists. Discussions along these lines have not been heard in a long while. At times I think that because aquatic toxicology is a science without a theory it cannot be a science. Perhaps some bright researcher(s) can bring together the disparate parts of aquatic toxicology and provide that framework.

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