Summary

The papers in this volume were organized to reflect new research thrusts on the validation and predictability of methods for contaminant assessment using laboratory microcosms, single species laboratory bioassays, and computer modeling techniques. The paper by Lewis et al compared two second-order transformation rate coefficients for disappearance of the insecticide, methyl parathion; the plasticizer, diethyl phthalate; and the herbicide, 2,4-dichlorophenoxyacetic acid butoxyethyl ester (2,4-DBE) in (1) a large-scale, flow-through laboratory microcosm colonized by heterotrophic bacteria and periphytic algae; and (2) by field collected microbiota. The rate coefficients of most of the chemicals were similar among microcosm and field-collected samples; however, not all the field-collected communities were able to transform methyl parathion or diethyl phthalate.

Portier compared the relative rates of degradation of methyl parathion, several phenols, and kepone in laboratory microcosms and in an estuarine environment. He found significant correlations indicating structural and functional similarity of the microbial communities that developed in the laboratory microcosm with their counterpart in the natural environment. Comparison of the half-lives of seven organic contaminants revealed a differential ability of the laboratory to reproduce results in the field ranging from within 10%, to compound degradation under laboratory conditions but none in the field. Half-life of the seven compounds was greater in the microcosms when a saline environment was maintained.

Adams et al used three-phase aquatic microcosms incorporating sediment, water, and a gaseous headspace for estimations of the fate and effects of several hydrocarbons under some simulated field conditions. Their results indicated that pollutants, especially several crude oils, suppressed primary production and total biomass production, chiefly due to restricting the cycling of critical nutrients. The distribution and fate of hydrocarbons in the microcosms was comparable to results from similar studies in the environment. The two factors identified as responsible for differences in results from laboratory microcosms and field experiments was the low light intensity and absence of ultraviolet light in the laboratory.

Levy et al compared the ability of laboratory microcosm communities with different levels of physical agitation to mimic characteristics of the communities in a natural environment. Microcosms that received no agitation or were gently agitated by bubbling maintained a high degree of similarity among the dominant species of the phytoplankton and zooplankton community to the source ecosystem for four to six weeks. Communities in the microcosms that were mechanically agitated became dissimilar. The authors concluded that properly designed microcosms could mimic major attributes of community structure in pelagic lentic ecosystems for intermediate periods of time.

Harrass and Taub compared the effects of different doses of copper on trophic interactions in the Standardized Aquatic Microcosm. Community-level processes such as algae-grazer interaction were used as a basis for comparing the results of the microcosm community to responses of aquatic community in natural ecosystems. Recovery of treated microcosms after inactivation or isolation of the contaminant was manifested by populations in the microcosm communities attaining densities equivalent to controls. Comparison with published studies of natural communities treated with copper indicated similar trophic interaction and that field studies were more variable than data from microcosms in the laboratory.

Stay et al also used the Standard Aquatic Microcosm to evaluate the effects of the herbicide atrazine on a number of parameters of community metabolism, the most sensitive of which appeared to be the photosynthetic rate per unit chlorophyll *a*. The grazing pressure on the phytoplankton community by *Daphnia magna* increased the sensitivity of response of the phytoplankton community to the herbicide.

Experimental pond ecosystems were used by deNoyelles and Kettle to evaluate bioassay accuracy. Short-term batch phytoplankton tests predicted the herbicide effects of atrazine for the first 24 h; however, neither the batch bioassays nor the Standardized Aquatic Microcosm in the previous paper predicted the rapid recovery of resistant phytoplankton species in the ponds. Moreover, deNoyelles and Kettle found that longer-term bioassays with *in situ* chemostats better predicted long-term effects in experimental ecosystems.

Tentative conclusions derived from microcosm research presented in these papers indicates that model experimental ecosystems are capable of providing realistic approximation of the fate, including rates of degradation, and effects, including secondary ecosystem effects. It appears that two research thrusts are being developed using microcosms: (1) site-specific microcosms where the laboratory seeks to emulate specific types of aquatic ecosystems, and (2) generic microcosms where the laboratory seeks to establish a specialized model ecosystem with a high degree of statistical precision and replication of results.

Giddings and Franco compared the effects of a synthetic coal-derived crude oil in outdoor ponds, indoor pond-derived microcosms, and single species laboratory bioassays. Their results indicated that primary and secondary effects were similar in ponds and microcosms, and they suggest that carefully constructed laboratory microcosms may be able to replace the outdoor pond studies that require more time and expense. Safe exposure levels determined from ecosystem experiments were accurately predicted by an application factor 0.03 to the most sensitive laboratory data.

The two papers by Finger et al and Boyle et al presented the laboratory and field tests for comparisons of fluorene toxicity. Algal and invertebrate laboratory toxicity data compared with data from pond studies indicated that these organisms were more sensitive to fluorene in the laboratory than organisms from representative communities in the ponds. However, the two species of fish in the ponds were more sensitive to fluorene than in routine laboratory tests. The only laboratory tests that anticipated the low-level fish response in the ponds was the behavioral feeding test performed after 30 days of chronic exposure in the laboratory.

Swartz et al compared the macrobenthic community structure at eight stations along a sewage pollution gradient on the Palos Verdes Shelf of California to toxicity data from laboratory tests of the amphipod, *Rhepoxynius abronius*. Sediment toxicity was significantly greater than the control station at the three stations closest to the sewage outfall. There were significant increases in the concentration of most sediment contaminants and significant decreases in the incidence and abundance of benthos at stations where sediment was acutely toxic to *Rhepoxynius abronius*.

Two papers addressed aspects of validation of computerized fate models. Burns' paper deals with increasing the site-specific predictability of contaminant fate models by incorporating the effects of environmental determinants such as ionic and sorptive equilibria, advective and dispersive fluid transport, benthic uptake and release, volatilization, hydrolysis, photochemical processes, redox reaction, and microbial transformations. Burns recommends the use of these fate models both as predictive tools and as a framework for future research.

Overton and Lassiter presented an application of their concept of the prognostic model assessment with three steps: (1) screening of chemicals to determine which require further examination, (2) use of the model to determine which environmental variable and what type of aquatic ecosystem would render chemicals potentially hazardous, and (3) formal review by panel of experts. The authors of this paper also presented an argument against the need for field testing of models that are designed for diagnostic screening use. They assert that verification of these models should be considered only from the standpoint of theory and laboratory experiments.

Porcella et al presented a framework for the integrated use of mathematical models and microcosms for comprehensive assessment of the effects of environmental contaminants. In their study, microcosms were used to identify critical system level variables to be incorporated into an ecosystem level model. In one example, data from a microcosm experiment indicated ammonia absorption from the air was important, but was not initially part of the mathematical model. Output from the mathematical model was then used to facilitate experimental design and optimize sample collection.

The paper by Malanchuk and Kollig represents another study combining microcosms and mathematical modeling assessment procedures to determine the effects of the herbicide atrazine on system level variables in aquatic ecosystems. They concluded that system level effects dealing with parameters of nutrient cycling can be used in combination with process-oriented models to predict ecological effects of toxicants in the environment.

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