the industrial plant was operational, the team did studies to determine the effects, if any, of the actual waste discharges.

These toxicity tests were predictive (estimated damage), and the river surveys were reactive (identified damage after it occurred). Clearly, methodology for determining ecotoxicological effects in natural systems using attributes of ecosystems, such as nutrient and energy transfer, would have been desirable. Also badly needed were methodologies to determine the condition of natural capital, especially the delivery of ecosystem services upon which human survival depends. Similarly, laboratory systems (e.g., microcosms and mesocosms) must more closely resemble complex natural systems or the predictive models will not work well. In short, until ecotoxicology has robust predictive models for complex, multivariate ecosystems, it will not reach maturity.

In my opinion, the major obstacle to achieving this desirable state is contextual. This state will not be readily achieved by merely bringing scientists (e.g., ecology and toxicology) together. Such a gathering would be commendable, but time is short and solutions to global problems (e.g., toxins and climate change) require a multiplicity of contexts combined in one master global context. Developing this global context will not be easy since the 20th century was an age of specialization, thus the context for graduate students has been that of their major discipline. The rites of passage for each discipline (i.e., courses, prelims, finals, thesis, and dissertation structure) have reinforced the context in which students viewed the complex, natural world. This view is not always the best one. When the academic world had fewer individuals, the disciplines were far less isolated from each other. In fact, the famous academic British “eating clubs” and their counterparts in other countries often met weekly and comfortably had what would now be called transdisciplinary discussions.

These individuals were clearly transcontextual. If they existed when science was young, they can exist again. The global systems context is more daunting than the earlier contextual viewpoints, but the requirement is the same—multicontextual individuals. In summary, ecotoxicology has the potential to be vastly more contextual than it now is. The transition will not be automatic—it will only result from an organizational effort (e.g., SETAC). Synthesis will be impaired if the number of contexts is expanded too rapidly.

REFERENCE


DUCKWEED TOXICITY TESTS ARE APPROPRIATE FOR ERA

Neil Rentz and Mark Hanson*
University of Manitoba, Winnipeg, MB, Canada
*hansonm@cc.umanitoba.ca

Introduction

An ongoing challenge in ecological risk assessment (ERA) is the selection of representative test species (Breitholtz et al. 2006). By evaluating one or only a few species within a class as surrogates for all other organisms, the concern is that the range of responses in the field will not be captured, resulting in unintended nontarget effects. This argument has been cited as a deficiency in the current characterization of aquatic macrophyte toxicity in ERA (Davy et al. 2001; Hanson and Arts 2007).

Currently, the duckweeds, Lemma spp. (typically L. minor), are the only macrophytes used in the lower tiers of ERAs around the registration of plant protection products and other chemicals in North America, Europe, and elsewhere (Davy et al. 2001). The exclusive use of Lemma spp. is a concern because 1) duckweed does not root in sediment, thus this means of exposure is not accounted for; 2) duckweed is a monocot, so it may not be representative of herbicides that are selective for dicots; and 3) the toxicity test mimics eutrophic conditions, which may not be representative of responses in meso- or oligotrophic systems. As evidence of these concerns, various studies have reported other macrophytes as being more sensitive than Lemma spp. (e.g., Fairchild et al. 1998; Van den Brink et al. 2006) and there have been calls in this forum and others for an expansion in the number of species tested (Davy et al. 2001; Hanson and Arts 2007). The concerns listed can be summed up as “laboratory results do not predict field observations,” but is this really the case? To try to ascertain this, we compared the response of Lemma spp. in the laboratory and field, specifically microcosm studies, along with the response of other macrophytes tested in the same manner. In addition, we reexamined results that have been frequently cited as evidence of the lack of sensitivity of Lemma spp.

Data collection and evaluation

To evaluate the predictive ability of Lemma spp. for results in the field, a Boolean search of the published peer-reviewed literature in the databases Web of Science (ISI) and Biological Sciences (CSA) was performed for duckweed studies conducted under field conditions where a clear concentration response was reported. Once the data were collected, the same endpoints (frond number, plant number, wet mass, frond growth rate, dry mass) at the EC_{50} were contrasted between Lemma spp. laboratory data (located in the US Environmental Protection Agency EcoTox database or the peer-reviewed literature) with Lemma spp. field results. As field data ranged in duration from 7 to 42 d and laboratory data were 7 d in duration, Haber’s rule (EC_{50} by exposure duration equals a constant) was used to normalize field data to laboratory data. Field data for other macrophytes exposed to the same substances were also collected for comparable endpoints to Lemma spp. laboratory data (wet and dry mass), which were also corrected for time with Haber’s rule. Data were then contrasted and the Pearson correlation coefficients were calculated.

Surprisingly few studies reported on Lemma spp. under field conditions (7 in total). Microcosm studies were found that reported concentration–response relationships for L. gibba only to monensin (antibiotic), tylosin (antibiotic), diuron (herbicide), atrazine (herbicide), perfluorooctane sulfonic acid (PFOS; surfactant), monochloroacetic acid (disinfection by-product), dichloroacetic acid (disinfection by-product), 10:2 fluorotelomer alcohol (FTOH) acid (fluorinated polymer by-product), and chlorodifluoroacetic acid (hydrochlorofluorocarbon [HCFC] by-product). In order to supplement the data collected, unpublished toxicity data from dissertations related to these compounds were also included.

Are laboratory Lemma spp. data protective of impacts in the field?

When data were compared, laboratory and field results for L. gibba were within an order of magnitude of each