MITE-RN: NEW DEVELOPMENTS IN THE ECOLOGICAL RISK ASSESSMENT (ERA) OF METALS AND METALLOIDS

The following new developments are grouped by ERA phase, and include significant changes to how such assessments will be done in future for metals and metalloids. Periodic updates will be provided via this newsletter; complete details will be provided in papers from individual researchers and in synthesis papers focusing on ERA.

Hazard Identification (Sources Domain)

Under the direction of Grant Edwards (Univ. Guelph), methods are being developed and applied to differentiate natural from anthropogenic sources of metals for air particulates and gaseous atmospheric mercury. In addition, the data collected will provide models, emission factors and the deposition rates needed for assessing the risk to ecosystems from these sources. Marc Lamoureux (St. Mary's Univ.) is working on procedures to fingerprint air particulates, to determine the chemical speciation of metal-containing airborne particulates, and to investigate the persistence of such particulates. Such information should also be useful for estimating bioavailability based on aerial exposures to dusts containing metals. *Because metals and metalloids are natural substances, differentiating natural from anthropogenic sources is critical. Current MITE-RN research will improve our ability in this regard.*

Exposure Assessment (Sources and Processes Domains)

Studies directed by Richard Carignan (Univ. Montréal) have found that Hg mobility in pore waters and lake sediments is much higher than previously suspected, which means that diagenesis may play a stronger role than previously appreciated in explaining mercury profiles in the sediments of remote lakes. *These findings modify previous ERA assumptions of mercury cycling, which focused almost exclusively on historical increases in Hg deposition from the atmosphere as the cause of surface enrichment in the sediments of remote lakes.*

Studies directed by Beverley Hale (Univ. Guelph) and William Hendershot (McGill Univ.) have found that, in northern forest ecosystems, trace metal dynamics are controlled by tree and shrub species that dominate plant community biomass. Furthermore, the fine roots of these species dominate annual plant metal cycling. Studies directed by Martine Savard (NRCan, CGC-Québec) have led to a new method for evaluating metal and metalloid concentrations in standing wood, and have also shown the importance of root compared to foliar uptake. *These studies are particularly important because ERAs are not as well developed for the terrestrial as for the aquatic environment.* These studies are literally breaking new ground for ERA.

Studies in freshwaters directed by Landis Hare and André Tessier (INRS) support the idea that food is an important metal exposure route. *Historically, ERAs have focused on uptake from water for most metals and metalloids. In doing so, they have ignored dietary exposure, particularly in estimates of the Predicted No Effect Concentration (PNEC).* Temperature has been found to influence Cd accumulation by changing the rate of prey

ingestion. *These findings point to the need to consider seasonality in ERA and, more importantly, suggest that pharmacokinetics differ between water and dietary exposures.* Further, species of *Chaoborus* differ in their ability to accumulate Cd. *The tendency in ERA is to group organisms; this research indicates that at least some groups of organisms may have to be treated individually.* Finally, exposure of sediment burrowers to metals in sediments is related to their behaviour. *This work builds on previous pioneering work by Dr. Hare, confirming that exposure routes for sediment organisms include overlying waters.*

Studies directed by Les Evans (Univ. Guelph) and Miriam Diamond (Univ. Toronto) have found that aqueous speciation of Zn varies over time, such that freshwater lakes can change from sinks to sources related to the oxic status of the lakes, sediment resuspension, and sediment to water diffusion. *These findings provide critical information for modeling the speciation and fate of zinc in contaminated freshwater bodies.*

Effects Assessment (Impacts Domain)

Studies directed by George Dixon (Univ. Waterloo) and Uwe Borgmann (NWRI) have developed critical body residues (CBRs) for chronic toxicity in the widely used test and assessment species, *Hyalella azteca*, for ten individual metals/metalloids. The CBR concept underpins the Biotic Ligand Model (BLM) which has great promise for predicting metals toxicity. *This work provides predictions of chronic toxicity from body burdens.*

Studies directed by Chris Wood and Gordon McDonald (McMaster Univ.) have developed mechanistic data for metals uptake by trout and yellow perch, and have determined that fish nutritional status, particularly ion levels in the food, may influence metal uptake and elimination, and thus tissue concentrations. For example, in Cd-impacted field situations fish might switch from piscivory to crustacean/mollusc grazing, thereby gaining increased dietary calcium and resulting protection from waterborne Cd uptake. Similarly, higher dietary sodium levels may reduce Cu uptake from the water. *This work also indicates that body burden data used in ERAs need to consider not only dietary metal intake but also feeding regimes, because nutrient and metal uptake do not necessarily co-vary.* ERAs typically focus on direct effects; this work indicates that indirect effects may be important and cannot be ignored. *Such factors should be taken into account in environmental regulatory strategies (e.g., in PNEC development-, and in further refinement of the Biotic Ligand Model).*

Studies directed by Peter Campbell (INRS), Alice Hontela (UQAM) and Joe Rasmussen (McGill Univ.) indicate that the classical metallothionein (MT) spillover model may not apply to chronic exposures. These researchers' studies also support the importance of indirect effects; metals have been shown to affect the food chain by influencing the quantity and quality of fish forage food resources. *ERAs need to consider both bioenergetics, in this case food-web mediated effects where the consumer is affected by the low abundance or poor nutritional quality of their prey, and protection of key forage species.* Thus, determining key food chain linkages assumes greater importance for ERA.

Studies directed by Laurie Chan (McGill Univ.) indicate that environments with high concentrations of mercury sulfide do not necessarily result in fish with toxicologically high methyl mercury concentrations. *These studies emphasize the importance of metals speciation related to bioavailability and toxicity.*

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