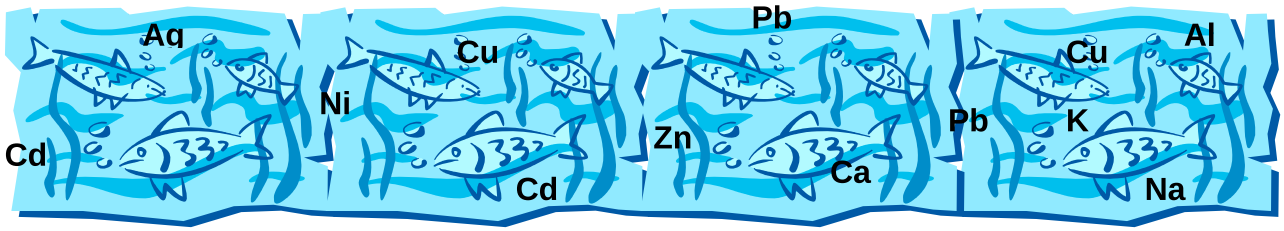
NSERC – Industry Strategic Project on Metal Bioavailability
Research Newsletter



Vol. 8: No. 1 | ***McMaster University*** | **January 2004**

HAPPY NEW YEAR !
Wishing you all a successful 2004

News

New members in the lab: Lara Alves and Adeola Ojo have recently joined our group as M.Sc. students. Lara graduated with her Honours B.Sc. in Biology and a minor in Biochemistry from McMaster University. She is currently working on the dietary effects of lead in rainbow trout. Adeola, who completed her B.Sc in Zoology from the University of Ilorin, Nigeria, will be working on brancial and gastrointestinal uptake of copper, zinc, cadmium, silver, lead and nickel in rainbow trout. Welcome aboard!

Congratulations to Joe Rogers, who successfully completed his M.Sc. in 2003 and recently graduated. His work examined the acute toxic mechanism of lead in rainbow trout. Joe continues to remain close to home, presently working in the McMaster Office of Research Services, and doing some part-time projects in the lab.

Congratulations also to Eric Pane, who was awarded Best Student Platform Presentation in the field of water and atmospheric research at the recent SETAC Asia-Pacific meeting in New Zealand for his paper entitled, "Chronic respiratory impairment in nickel-exposed rainbow trout (*Oncorhynchus mykiss*)."

Conference presentations

The following papers or posters were presented by the Metals Bioavailability Group at the annual meeting of the Society of Environmental Toxicology and Chemistry (SETAC) Annual Meeting in North America, Austin, Texas, November 9-13, 2003.

- **Grosell, M., Smith, R.W., Amstrup, J., Larsen, E.H., Morgan, T.P., and Wood, C.M.** Copper uptake by (fish) gills – apical entry.
- **Dethloff, G.M., Naddy, R.B., Stern, G.R., Wood, C.M., Kramer, J.R., Bell, R.A., and Gorsuch, J.W.** Toxicity of silver to rainbow trout during early-life stage studies.
- **Gillis, P.L., Chow-Fraser, P., Ranville, J.F., Ross, P.E., and Wood, C.M.** Comparison of tissue metal concentrations and toxicity in *D. magna*, before and after removal of easily-mobilized sediment-associated metals.
- **Naddy, R.B., Stern, G.R., Rehner, A.B., Bell, R.A., Kramer, J.R., Wood, C.M., Paquin, P.R., Wu, K.B., Stubblefield, W.A., and Gorsuch, J.W.** Toxicity of silver to three freshwater organisms and effects of potential mitigating factors.

The following papers were presented at the annual meeting of the Society of Environmental Toxicology and Chemistry (SETAC)/Australasian Society of Ecotoxicology (ASE) Asia-Pacific Meeting in Christchurch, New Zealand, September 28-October 1, 2003.

- **Wood, C.M., and Pane, E.F.** Biotic Ligand Models and physiological mechansisms of toxicity: applicability of nickel?
- **Pane, E.F., and Wood, C.M.** Chronic respiratory impairment in nickel-exposed rainbow trout (*Oncorhynchus mykiss*).

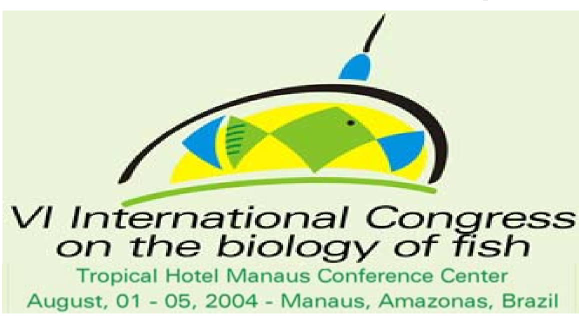
The following interactive poster was presented at the 30th Annual Aquatic Toxicity Workshop, Crown Plaza, Ottawa, Canada, September 28-October 1, 2003.

- **Niyogi, S., Kamunde, C., Baldisserotto, B., Grosell, M., McDonald, D.G., and Wood, C.M.** Acclimation effects of different dietary factors on metal uptake and toxicity in freshwater fish.

The following papers were presented at the Water Environment Research Foundation Multi-Metals Meeting, Miami, Florida, October 22-25, 2003.

- **Wood, C.M., McDonald, M.D., Walker, P., Grosell, M., Playle, R.C., and Walsh, P.J.** Effects of salinity on short-term bioavailability and distribution of silver in the gulf toadfish (*Opsanus beta*).
- **Glover, C.N., Playle, R.C., and Wood, C.M.** Natural organic matters: heterogeneity of silver toxicity amelioration by humic substances.

Conference announcement



We would like to draw your attention to a symposium, titled "*Behaviour, physiology and toxicology interactions in fish*", that is to take place at the International Congress on the Biology of Fish meeting, August 1-5, 2004 in Manaus, Brazil. As can be seen from the list of invited speakers that follows, the session covers a wide range of areas where behaviour, physiology and toxicology interlink, including predator/prey interactions, social hierarchies, hypoxia, transport across the gill epithelium, the modelling of ligand-binding phenomena at the gills and how these parameters are influenced by aquatic toxicants, with a particular emphasis on metals. In addition to the invited presentations, the symposium will include contributed presentations and a poster session. At present, we are soliciting contributed presentations and posters for the symposium. We would like to take this opportunity to encourage you, as well as your post-docs and students, to contribute oral presentations and/or posters. The deadline for early registration is February 28th, 2004. We would like to receive titles for presentations, with an indication of whether you would prefer an oral or poster slot, by 1st of February. Contributors are then asked to submit an extended abstract by March 1st, 2004. Further information on the meeting as well as the registration form can be found at http://www.fishbiologycongress.com.br. If you have further questions please do not hesitate to contact either Kath Sloman (Katherine.Sloman@brunel.ac.uk) or Chris Wood (woodcm@mcmaster.ca).

Speakers and titles:

Colin Brauner (Vancouver) - The effect of silver on growth and ionoregulatory development in the early life stages of rainbow trout.
Kevin Brix (Miami) - The effects of metals on ionoregulation and reproduction in zebrafish fed field contaminated diets.
Bernardo Baldisserotto (Santa Maria) – Dietary calcium affects dietary and waterborne cadmium uptake in rainbow trout.
Larry Crawshaw (Portland State) - Tolerance and withdrawal in fish.
Gudrun de Boeck (Antwerp) - Waterborne copper exposure: a stressful event for freshwater fish.
Martin Grosell (Miami) - Copper transport across the gill epithelium.
Edward Little (Missouri) - Behavioural indicators of sublethal toxicology in fish.
Dave Randall (Hong Kong) - Hypoxia: behavioural and physiological effects.
Kath Sloman (Brunel) - Fish social behaviour and the effects of trace metal contaminants.
Ted Taylor (Birmingham) - Trout swim slowly on exposure to sub lethal levels of copper: The problem is ammonia.
Dal Val (Manaus) - Petroleum, metals and fish of the Amazon – behavioural and physiological effects.
Patrick Walsh (Miami) - Ammonia toxicity and urea excretion in the GulfToadfish: Linkages to behaviour.
Dan Weber (Wisconsin-Milwaukee) - Mercury-induced neurobehavioural deficits in zebrafish.
Judith Weis (Newark) - Physiological alterations associated with impaired behaviour in *Fundulus heteroclitus* from a contaminated environment.
Peddrick Weis (New Jersey) - Can altered predator/prey behaviour be used as a behavioural biomarker for contaminants in fish?
Rod Wilson (Exeter) - Influence of social hierarchy and gender on physiology and response to toxicants in salmonid fish.
Chris Wood (Hamilton) - The Biotic Ligand Model: predicting metal toxicity to fish in the real world.

Research Highlights

This issue will highlight research led by Vicky Kjoss, a research technician in the lab of Chris Wood. Results from this work are soon to be been submitted for review in *Journal of Fish Biology*.

Dietary Na does not reduce dietary Cu uptake by juvenile rainbow trout

V.A. Kjoss, C.N. Kamunde, S. Niyogi, M. Grosell and C.M. Wood

Industrial operations such as mining and smelting contribute to the mobilization of metals, including copper (Cu), into watersheds. Cu is an essential micronutrient required by most organisms for proper growth and development (e.g., Peña et al.,1999), but it can be toxic at higher levels (for review, see Handy, 1996). Similarly, sodium (Na) is an essential macronutrient, but it can also have detrimental effects at levels that exceed biological requirements. While most animals acquire these nutrients only through the diet, fish can take up both Cu and Na by two routes of exposure: through the diet as well as across the gills. Although the waterborne route is usually considered dominant for Na and the dietary route is considered dominant for Cu, both natural and experimental situations exist in which the two routes may become equally important (e.g., Na: Smith et al., 1989; Cu: Kamunde et al., 2002).

Waterborne Na and Cu are thought to enter the fish gill, at least in part, via the same channel (e.g., Grosell & Wood, 2002). Therefore, changes in waterborne Na concentration may affect the amount of Cu taken up by fish via the gills. Pyle et al. (2003) reported that as a result of increased dietary Na intake, branchial uptake of Na was reduced, accompanied by a reduction in branchial Cu uptake. These studies lend support to the hypothesis that Na and Cu share a common branchial uptake route.

However, despite these recent findings on the role that waterborne and dietary Na play in reducing the effects of branchial Cu uptake, the effects of dietary Na on dietary Cu uptake by fish remain unknown, and the relationship, if any, between Na and Cu transport mechanisms in the gut remains unclear. In mammals, Na is thought to play a role in Cu uptake through the gut, i.e., through Na-mediated Cu transport across intestinal epithelia (e.g., Wapnir & Stiel, 1987), although the nature of the interaction is uncertain. In African walking catfish (*Clarias gariepinus*), removal of Na tends to slow Cu absorption in the intestine (Handy et al., 2002), suggesting a shared mechanism for the uptake of these two nutrients. To our knowledge, however, the possible interactions between dietary Na and dietary Cu in fish have yet to be investigated. The objective of this study was therefore to characterise these interactions. Specifically, we investigated whether increased levels of Na in the diet of juvenile rainbow trout would lead to altered Cu uptake from the diet, at either control or experimentally elevated levels of Cu in the food. To test this hypothesis, we exposed rainbow trout (*Oncorhyn-chus mykiss*) fry in moderately hard water to control or high levels of dietary Cu (~6 and ~580 ug Cu/g food) at one of three levels of Na (1.5, 3.0, or 4.5%) in the diet, i.e., six experimental groups over 28 days. We found no consistent differences in weights, lengths, or indices of body condition among any of the groups on any sampling day. [Cu] was significantly higher in tissues of Cu-exposed groups, although within treatment types (control Cu vs. high Cu diet), it did not differ consistently among groups that received different levels of dietary Na (Fig. 1).

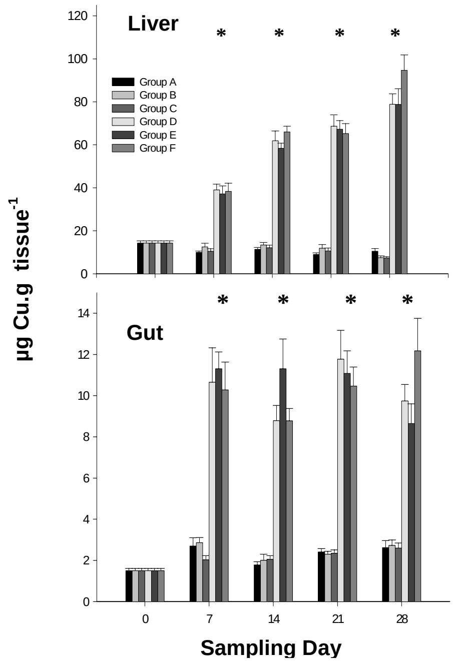


Figure 1. [Cu] in liver and gut of juvenile trout exposed to low (groups A-C) or high (groups D-F) dietary Cu. Asterisks indicate significant differences between the two treatments.

Tissue [Na] did not differ among any of the groups and did not show any marked changes over time. In Cu-exposed groups, the proportion of total body Cu burden contained in the liver approximately doubled over time, from ~30% on day 7 to ~60% on day 28. In unexposed fish, the liver maintained ~25-30% of the total Cu burden throughout the experiment (Fig. 2). In contrast, the proportion of the total body Cu burden contained in the gut decreased somewhat over time in Cu-exposed fish, from ~40% on day 7 to ~30% on day 28, and remained fairly stable at ~25-30% in control groups, i.e., approximately equal to liver values (Fig. 2). In all groups, the carcass contained by far the largest portion of the total Na content (>80%). Measurements made 36 hours post-feeding indicated that all six groups had much higher Na efflux and net flux rates relative to Na influx, suggesting that the fish were eliminating excess Na taken up from the diet, and differences in Na influx rates were small. Na efflux rate was significantly higher in the high Cu/high Na group than in the high Cu/low Na group.

Our results indicate that at the concentrations used in this experiment, dietary Na has little effect on dietary Cu uptake by juvenile trout, and dietary Cu has little effect on Na homeostasis. This suggests that the mechanisms for Cu uptake at the gut differ from those at the gill, i.e., Cu transport via Na channels and/or other Na transport pathways may not be involved in the gut (cf. Handy et al., 2002). However, our conclusions may be relevant only in ion-rich hard water, where the compensatory ability of the gill may mask any effects. We are therefore repeating the experiment in soft water that is more representative of the environmental conditions found in contaminated Canadian Shield lakes.

(*This work was funded by the Human Health Program of the International Copper Association and an NSERC Strategic grant. CMW is supported by the Canada Research Chair program.*)

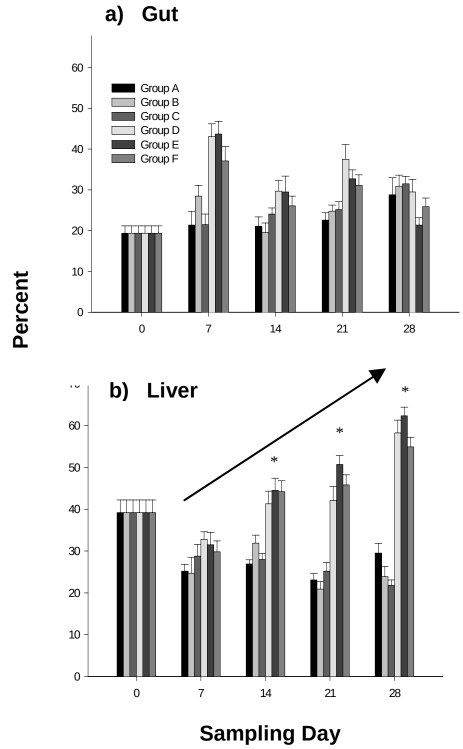


Figure 2. Mean percent of whole-body Cu burden contained in the gut (a) and liver (b) of juvenile trout fed low (groups A-C) or high (groups D-F) dietary Cu. Asterisks indicate significant differences between the two treatments.

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For more information regarding this project, please contact Vicky Kjoss at kjossv@mcmaster.ca or call 905-525-9140 ext. 26389.

Vox Salmonis**:** The lab of Chris Wood hosts a weekly seminar series entitled "*Vox salmonis*." Presentations cover a range of topics in physiology, toxicology, and behaviour of aquatic organisms. We cordially invite anyone who is interested in attending and/or presenting a talk to join "*Vox*" on Tuesdays from 12:00-13:30 on the campus of McMaster University. Please contact Dr. Patricia Gillis (email: gillisp@mcmaster.ca) for more information.

Editor's Desk: *This newsletter is distributed by the Metals Bioavailability Group, Department of Biology, McMaster University. If you know of others who would enjoy this newsletter, or if you no longer wish to receive it yourself, please contact:*

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