Toxicity of Thallium to Aquatic Organisms Of the North American Great Lakes

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Legitimate ambient water quality standards for thallium are not present in any current regulations protecting the Great Lakes watershed. The use of this heavy metal is increasing in our society chiefly through the burning of coal, but is also entering the environment through its use in biotechnology industries. There is little known about the toxicity, accumulation, transport and speciation of thallium in natural waters. Toxicity assays performed this summer on species native to the Great Lakes will boost the database of thallium toxicity and help achieve a reliable water quality standard for the heavy metal. Assays performed in the past have shown that ambient potassium is a crucial factor in predicting the toxicity potential of thallium, yet vital information like this is not included in the New York State Department of Environmental Conservation water quality standards.

Aquatic toxicity assays were performed using the rotifer *Brachionus calyciflorus*. This rotifer has been shown to be an excellent indicator species in aquatic environments and the basis of other published research. The 96-hour reproductive assay used in conjunction with this rotifer has proven to be reliable and accurate. Accordingly, I have used this 96-hour assay developed by B. Preston and T. Snell at the Georgia Institute of Technology(Snell 2000). The assay used this summer consisted of varying concentrations of thallium and potassium in the growth mediums of the rotifers and the ratio of these concentrations calculated to obtain a repeated LD50 for *Brachionus calyciflorus* to thallium as a function of potassium concentration. Potassium concentrations ranged from 0.5 μM to 20 μM and thallium concentrations in the growth

medium ranged from 0 nM (as a control) to 400 nM. These ranges were designed to simulate both the likely concentrations of Great Lakes water and the effect of an increased accumulation of thallium. The concentration range also probed the toxic effects of thallium and the influence that potassium concentration has on toxicity. Results from this toxicity assay showed the expected relationship between thallium and potassium as previously established for the algae Chlorella (Chafin 2003). An increased level of potassium in the growth medium saturates the uptake sites in the cell membrane of the rotifer and protects the organism from toxic thallium intake.

		Potassium Concentration			
		20 µM	**2.5 µM**	**1 µM**	**0.5 µM**
[Tl]	**0 nM**	23 (100%)	36 (100%)	5 (100%)	5 (100%)
	20 nM	22 (96%)	14 (39%)	1 (20%)	1 (20%)
	40 nM	20 (87%)	4 (11%)	0 (0%)	1 (20%)
	80 nM	20 (87%)	0 (0%)	0 (0%)	0 (0%)
	400 nM	9 (39%)	0 (0%)	0 (0%)	0 (0%)

Table 1: This table shows the total *Brachionus calyciflorus* counted during each toxicity assay performed (percentage of control). These counts are after 96 hours and represent the summation of 5 replicates.

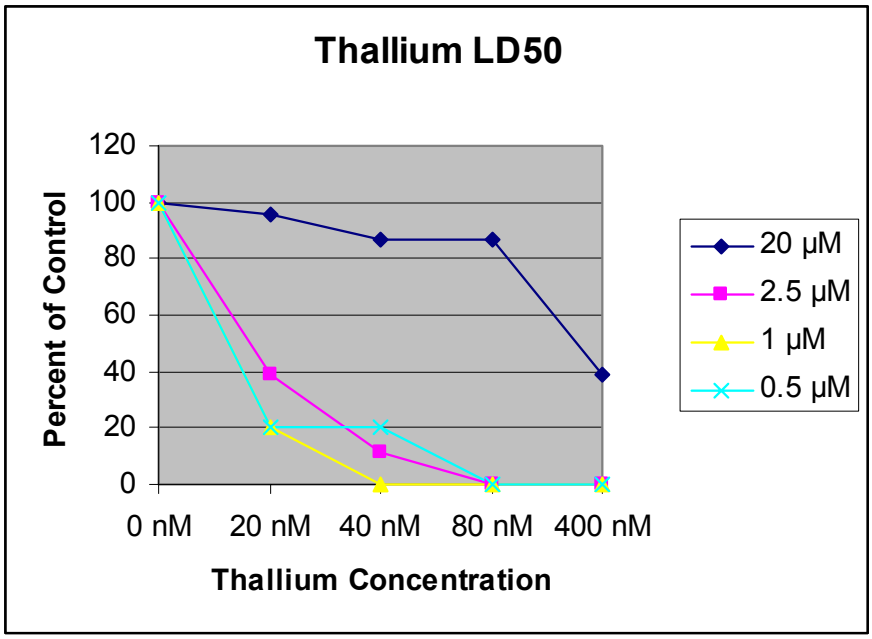

Figure 1: This figure shows the percent survivorship of *Brachionus calyciflorus* as a percentage of the individual controls.

The above table clearly shows the influence of potassium on the toxicity of thallium to this rotifer. As potassium levels decrease and thallium levels increase there is an increase in rotifer fatality. This evidence furthers the asseveration that potassium concentration should be incorporated into the development of a new ambient water quality standard for thallium. The LD50 of thallium can be calculated by using Figure 1. Once the LD50 has been estimated using Figure 1 the ratio of the LD50 concentration compared to the corresponding potassium concentration can be calculated. This provides a useful reference ratio to predict when toxic effect of thallium will be observed. The ratio of all four experiments fell close to the 1:100 [K+]:[Tl] predicted with Chlorella (Chafin 2003).

To substantiate this research the speciation of thallium in natural waters will also be analyzed. Predicting the amount of ambient Tl (I) in natural waters is vital to understanding the amount of potentially harmful bioavailable thallium.

Chafin, Ryan D., and Michael R. Twiss. "Effects of Potassium on Thallium Toxicity to Phytoplankton." Clarkson University, Department of Biology. 2003.

Snell, Terry W., and Benjamin L. Preston. "Use of Freshwater Rotifer *Brachionus calyciflorus* in Screening Assay for Potential Endocrine Disruptors." Environmental Toxicology and Chemistry 19 (2000): 2923-2928.

Twiss, Michael R., and Benjamin S. Twining. "Bioconcentration of Inorganic and Organic Thallium by Freshwater Phytoplankton." Environmental Toxicology and Chemistry 23 (2004): 968-973.

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