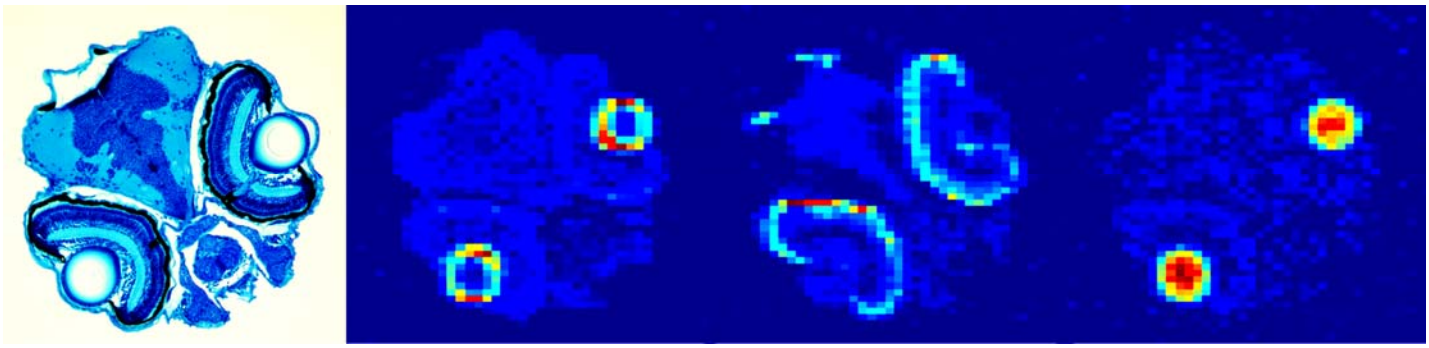
Science in Synch

Canadian Light Source Inc.

# Little Fish Shed Light on Mercury Poisoning



Images of a zebrafish head, comparing a stained thin-section under visible light *(far left)*, an XRF map for mercury, showing the element's concentrated presence in the fish's eye lenses *(centre left),* along with maps showing distribution of calcium *(centre right)* and sulphur *(far right)*.

Images courtesy of M. Korbas, University of Saskatchewan.

The dangers of toxic mercury exposure are well known – from the dementia of the Mad Hatter in *Alice in Wonderland* to recent concerns about mercury levels in the fish we eat, particularly for pregnant women and children. While scientists know that mercury is bad for us, the exact mechanism of mercury's toxicity and how it infiltrates cells remains a mystery. Recently, scientists using the Canadian Light Source and the Stanford Synchrotron Radiation Laboratory shed some light on the types of cells that absorb the most mercury – with some surprising results.

The University of Saskatchewan-based scientists, led by postdoctoral researcher Malgorzata Korbas, working with Canada Research Chairs Graham George and Ingrid Pickering, and Jarislowski Chair Patrick Krone, published their findings in August in the *Proceedings of the National Academy of Sciences*. The study reported the first elemental maps showing the localization of mercury in the tissues of a test animal, the zebrafish.

Newly hatched zebrafish larvae were raised in water containing methylmercury, from one to three days. The team first looked at whole larvae, using synchrotron X-ray fluorescence (XRF) mapping to obtain the distribution maps of mercury and other elements within the live fish.

"XRF mapping is the ideal technique for this kind of research, as it makes possible to see where exactly an element is concentrated in cells, tissues,organs or in a whole animal," explains Korbas. "We started our analysis with whole live fish, and saw that a lot of mercury was accumulating in the eye lens – even more than was present in the liver or other digestive organs."

The finding was striking as it pointed to a possible cause, beyond nerve

## Fast facts:

- Synchrotron X-ray fluorescence (XRF) mapping is a new tool for mapping the distribution of elements in the cells, tissues and organs of living things.
- XRF mapping reveals the presence of high concentrations of mercury in tissues made up of rapidly dividing cells—in the case the epithelial cells that responsible for growing the eye lens in zebrafish.
- The finding has important implications for our understanding of the impact of mercury exposure in developing animals, including humans.

Reference: M. Korbas, S.R. Blechinger, P.H. Krone, I.J. Pickering, G.N. George. 2008. *Proceeedings of the National Academy of Sciences* 105, no. 34, pp. 12108—12112.
www.pnas.org/cgi/doi/10.1073/pnas.0803147105

damage, for blindness reported in some people suffering from mercury poisoning. Further scans using thin sections of the five millimeter-long fish revealed an even bigger surprise – that the mercury in the eye lenses was actually confined to the margins of the lens surface layer, which is composed of rapidly dividing epithelial cells.

"We didn't believe what we were seeing at first," remarks Korbas. "We had started with fairly high concentrations of mercury because we hadn't expected to see anything. We've since gone as low as 1000 times less than our starting concentration, and we haven't reached the lowest limit yet. There is just a huge amount of mercury being absorbed at the cellular level."

"One interesting thing about these little fish is that when they hatch they are still very undeveloped – for example, they don't have proper eyes," says George. "In order to find food and avoid being eaten, they have to develop their eyes very early on; it's a high priority. So, these lens epithelial cells are a very rapidly dividing type of cells in these fish."

If mercury is preferentially absorbed by rapidly dividing cells in larval zebrafish, the researchers contend that it is also likely to be quickly taken up by rapidly dividing cells in developing human fetuses. The finding has implications, both for our understanding of mercury toxicology in general and for developmental biology, where the risks of prenatal exposure to mercury and other toxic substances such as arsenic and lead are an ongoing worry.

Synchrotron XRF mapping can also study how nutrients, such as calcium and zinc, are distributed in tissues and organs.

"This new approach is a powerful tool that can be used to study a wide variety of heavy metals and other important elements," says George. "This technique is just loaded with information."