Finding the origin of toxic mercury in the Arctic Ocean

Seals are a key source of nutrition for many people in the Arctic, but every bite they take comes with a side of poisonous mercury. How it gets there is poorly understood. What's known is that inorganic mercury is released into the environment via natural and man-made emissions, and then travels over long distances into the Arctic Ocean. Once there, it can take on its most dangerous form, methyl mercury. This neurotoxic compound then accumulates in the food chain and puts inhabitants' health at risk.

Even after studying mercury's pathways and mechanisms for three decades, the question of how and where it turns into methyl mercury still puzzles researchers. Now the community is setting its hopes on one international study to offer clues, but the devil is in the details.

In summer 2015, the GEOTRACES multi-ship operation will embark to measure key trace metals in the Arctic Ocean. Three boats – the German Polarstern, the American CGC Healy, and the Canadian CCG Louis Saint Laurent – will traverse the sea at the same time, and international research teams will take water samples for analysis. The data they collect will help the researchers make out mercury sources, understand its cycle, and hopefully offer clues into the production of methyl mercury in the ocean. "This is a unique opportunity," says chemical oceanographer and mercury expert Lars-Eric Heimbürger from the University Bremen, who will be onboard the German research vessel.

"Most importantly we have to make sure that our measurements are of the same quality so that they're comparable across the entire Artic Ocean," says Heimbürger. Mercury is one of the least concentrated elements in the oceans, and even small differences in measurement techniques may or may not make a big difference in the end.

What the teams are looking for is a rather small number in itself: they need to measure, interpret and understand variability in mercury concentration, which is often as low as 10 percent. It then gets even trickier because of the metal's unique properties. It exists in many forms: some are in a gaseous state and some are unstable if hit by light. That's why GEOTRACES labs regularly compare their analytical performance by each measuring a sample taken from the same source.

Heimbürger is hoping for reliable and comparable data as a building block for further research, but is worried: "Filtration might be another issue with mercury." Some researchers filter all seawater samples prior to measuring mercury, while others don't. He explains that water samples are usually filtered to remove particles and gases aren't – but mercury can exist as both.

In previous studies, Heimbürger noticed significant differences between teams that filtrated their methyl mercury samples, and those that didn't. To raise awareness for this issue, Heimbürger asked his peers on ResearchGate about the right method in their opinion. Most experts said filtration was superfluous, while others reassured that they tested both ways and it didn't make a difference. Heimbürger is happy with the outcome: "The discussion was a good starting point that triggered the conversation among experts – which means we're one step closer to reaching a consensus."

Arctic mercury research already has a turbulent history. For more than 20 years the research community focused on the concept that man-made mercury emissions from mid-latitudes were carried to the Arctic by winds in the atmosphere. "For many people this was a very convenient explanation for the high mercury concentrations in Arctic organisms," says Heimbürger

Three years ago a model study revealed a new hypothesis. It supposed mercury was flushed into the Arctic with spring floods of river waters – about 100 tons every year. These findings were considered a paradigm shift in the community. It's a model that still needs to actually be tested, says Heimbürger, but it brings light into the question how the mercury arrives in the Arctic Ocean. How exactly and where it's then turned into its more toxic form, methyl mercury, still remains unclear.

It's a crucial question to answer, because one thing has become evident: methyl mercury accumulates in the food chain. The longer the organism's life-span, the more toxins it harbors. A recently published study shows that more than 75 percent of the women of child-bearing age in Nunavik, Northern Quebec, have dangerously elevated methyl mercury levels. It's a risk that's passed on to the next generation. Their unborn children are more likely to suffer from visual, cognitive and behavioral impairments.

There are a handful of possibilities how the transformation from mercury to methyl mercury could go about. "We have at least three factors that come to play, all of which might change with time," says Heimbürger. Inorganic mercury and bacteria likely play a part, together with other organic particles like phytoplankton.

On top of that, the transformation process into methyl mercury also seems to be volatile to Climate Change: "A warming climate may trigger changes of phytoplankton and bacteria dynamics; let alone the declining Arctic sea ice cover," says Heimbürger. In other oceans researchers have already detected a rise of mercury levels due to manmade emissions. So the race to solve the puzzle in the Arctic Ocean is on – and ups the hopes for a safer diet for its people.

Image of seal: CC courtesy of Smudge 9000, flickr

Image of Lars Eric-Heimbürger: courtesy of Lars-Eric Heimbürger