# Uncovering Pieces of the Arctic Mercury Puzzle

How does mercury find its way into Arctic animals? Data from a recent expedition to the central Arctic Ocean suggest that bacteria close to the ocean surface convert mercury to its toxic form and feed it into the food web.

Written byLars-Eric HeimbürgerRead time Approx. 4 minutes

Spring break-up of the ice on the Yenisei River near Igarka, Krasnoyarsk Krai, Russia.*Tomcar, Roman Teisserenc*

Mercury is the only heavy metal that exists as gas. It occurs naturally on Earth, released mainly from volcanic emissions and marine hydrothermal vents, and can travel great distances through the atmosphere, reaching regions very far away, including the Arctic. But since the beginning of the industrial revolution (around 1850), our man-made releases have outweighed natural ones by a factor of 10.

At around the same time, after several industrial incidents, we came to realize that mercury is a potent neurotoxin that can cause mental confusion, muscle weakness and even death. Low levels of exposure also pose serious health risks, especially during fetal development. We are all exposed to mercury when we eat fish from the ocean, especially larger predatory ones like tuna and swordfish. They reign in the marine food chain and accumulate mercury from small plankton (algae), shrimp (zooplankton) and small fish. But only one form of mercury, methylmercury, is accumulated this way.

Scientists are still trying to understand where in nature toxic methylmercury is produced. Research over the past several decades has shown that methylmercury can be generated by some bacteria that thrive in oxygen-deprived sediments.

However, recent large-scale ocean basin cruises, like those within the Geotraces program, indicate that methylmercury can also be produced in well-oxygenated seawater in the middle of the ocean. We find the highest proportion of methylmercury, often up to 50 percent in the subsurface waters where sinking particles of dead algae and other fragments are eaten up by bacteria. The depth at which this occurs varies from ocean to ocean, and depends mostly on the differences in temperature and salinity, which leads to water masses of varying densities layering the ocean. On a recent Geotraces cruise in the North Atlantic Ocean we found that methylmercury is produced at a rather deep level (around 1,000 meters, [3,300 feet]).

The situation is drastically different in the Arctic. Most investigations have focused on atmospheric mercury sources. The idea has taken hold that the Arctic is a global sink for increased man-made mercury emissions from North America, Europe and now Asia that travel through the atmosphere to the Arctic. For many years, those atmospheric mercury inputs have been held responsible for the high mercury levels in Arctic animals.

But long-term data on mercury levels in Arctic animals hasn't always matched up with man-made emissions, meaning other factors must be at play. In fact, new research suggests that we still haven't found the largest source of mercury in the Arctic Ocean.

Rivers could be this source, especially during spring flood of Siberian rivers that drain into the Arctic Ocean. We have started investigating the mercury discharge of one of the Yenisei, one of Siberia's largest rivers, as well as the smaller and more accessible Severnaya Dvina River, and found that indeed a large portion of Arctic mercury budget must come from the rivers. It's possible that as the permafrost thaws, more mercury is being released from the soils into the rivers that discharge into the Arctic Ocean.

During our Geotraces cruise on RV Polarstern to the central Arctic Ocean in 2015, we tried to find out what happens to the mercury from those Siberian rivers. The freshwater from the river is less dense than salt water and remains at the surface of the ocean. The boundary, called a pycnocline, that separates the layer of fresh river water from the salty Atlantic-originated waters, lies at around 150 to 200 meters (500 to 650 feet) deep. This is exactly where we find methylmercury levels at their peak.

This is still an active area of study, but here's why we think that the peak occurs here: The sinking particles are slowed down at the pycnocline, which gives the bacteria the opportunity to convert the inorganic mercury carried by the particle into the toxic methylmercury. This production of methylmercury is shallow enough to be close to the surface, where algae thrive, allowing the methylmercury to be taken up into the base of the Arctic food chain. We believe this is an alternative explanation for why the Arctic animals contain such high mercury levels.

Data from several cruises in the Geotraces program and others have showed that emissions from human activities have led to an increase in inorganic mercury in the global oceans. At the same time, a warming climate and melting sea ice is likely to play havoc with Arctic algae and microbes that are able to take up methylate mercury and transform it into toxic methylmercury. But we still don't know what will this mean in the future.

Lars-Eric Heimbürger stands at the North Pole. (Lars-Eric Heimbürger)

Today, I leave on a two-month long Geotraces cruise to investigate mercury changes in the Arctic. I will be on board the German icebreaker Polarstern, invited by the Alfred Wegener Institute for Polar and Marine Research, and we will sail to the Fram Strait, between Greenland and Svalbard. The implications of the research are important. While southerners can choose to change our diets and move away from eating tuna and other large fish, northern people living in the Arctic rely on marine wildlife for food.

*The views expressed in this article belong to the authors and may not reflect those of Arctic Deeply.*