New method tracks contaminant accumulation in Arctic marine mammals

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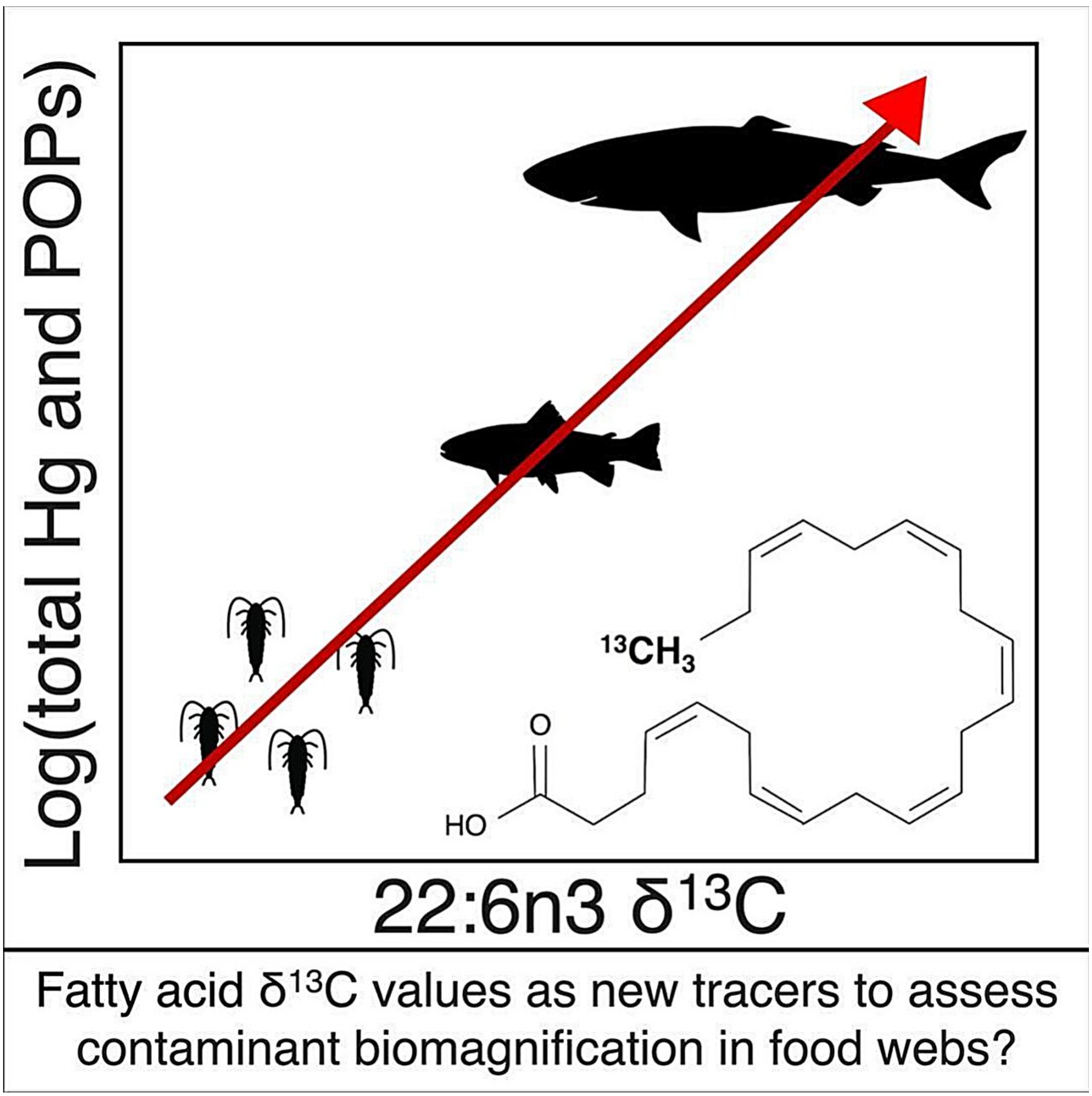

Graphical abstract. Credit: *Science of The Total Environment* (2025). DOI: 10.1016/j.scitotenv.2024.178232

A new method of tracking the dietary habits and contaminant exposure of animals in Arctic marine ecosystems is providing critical insights as climate change reshapes the region's food web.

A team of researchers led by Adam Pedersen, a recent Ph.D. graduate from McGill University's Department of Natural Resource Sciences, outline the approach in a new study. Their method uses carbon isotopes of fatty acids to better understand what migratory species, such as killer whales, and Arctic predators, such as polar bears, eat and how they accumulate harmful contaminants.

"Our method addresses key limitations of traditional approaches," said Pedersen, the study's lead author. "It's particularly effective for species like killer whales, which shift their diets as they migrate northward into the Arctic. Understanding these shifts is crucial in the context of climate change."

The findings, recently published in *Science of the Total Environment*, offer a higher-resolution alternative to the traditional use of bulk stable isotopes, a method that falls short when studying species that travel vast distances across diverse ecosystems.

As Arctic temperatures rise, species like killer whales are venturing further into the region, encountering new prey, including other marine mammals. Unlike the fish-based diet they typically consume in the North Atlantic, the marine mammals the whales might encounter in the Arctic waters, such as seals, are at a higher level in the food chain and carry significantly more contaminants.

Similarly, with decreasing sea ice in the Arctic, the polar bear diet in the region may be shifting to more contaminated seal. Pedersen's research reveals that their new approach may better trace these dietary changes and how contaminants accumulate in food webs than traditional approaches. These shifts in diet may also result in much higher contaminant levels in killer whales and polar bears, a phenomenon with troubling implications for both the animals and people who might eat them.

Also, through their waste, when they die, or when they are consumed by humans, contaminated killer whales and polar bears may spread pollutants into the environment, which can harm other species, disrupting the ecological balance.

"These contaminants biomagnify up the food chain, meaning marine mammals—and by extension, their predators—can contain orders of magnitude more harmful substances than fish," Pedersen said. "Our method provides clearer insights into how these contaminants accumulate, which is vital for conservation efforts."

A new tool for conservation and policy

Pedersen and his team analyzed small blubber samples from whales harvested by Indigenous subsistence hunters in Greenland. Using gas chromatography, a method used to separate and analyze components in a mixture, and isotope ratio mass spectrometry, a way of detecting the carbon isotopes of the separated substances, the team extracted and analyzed fatty acids to reconstruct dietary patterns and used these to interpret contaminant variation across the food web. These high-resolution insights could eventually guide policies aimed at mitigating contaminant exposure in Arctic food webs.

"This research has the potential to inform contaminant management practices," said Melissa McKinney, Associate Professor in the Department of Natural Resource Sciences, Canada Research Chair (Tier 2) in Ecological Change and Environmental Stressors, and Pedersen's Ph.D. supervisor. "By better understanding how contaminants accumulate through food webs to high levels in top predators, we can better predict contaminant dynamics under climate change, for instance."

Despite the promising results, Pedersen emphasized the need for further validation. "This method has only been tested in one food web so far," he said. "More studies are needed to confirm its broader applicability. Still, the initial findings are exciting and could encourage other researchers to adopt this approach."

The researchers emphasized the importance of using real-world samples collected in collaboration with local communities.

"Working with Indigenous hunters allowed us to gather the data we needed without disrupting the natural ecosystem," Pedersen said.

More information: Adam F. Pedersen et al, Fatty acid carbon isotopes as tracers of trophic structure and contaminant biomagnification in Arctic marine food webs, *Science of The Total Environment* (2025). DOI: 10.1016/j.scitotenv.2024.178232

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