Crawfish could transfer ionic lithium from their environment into food chain

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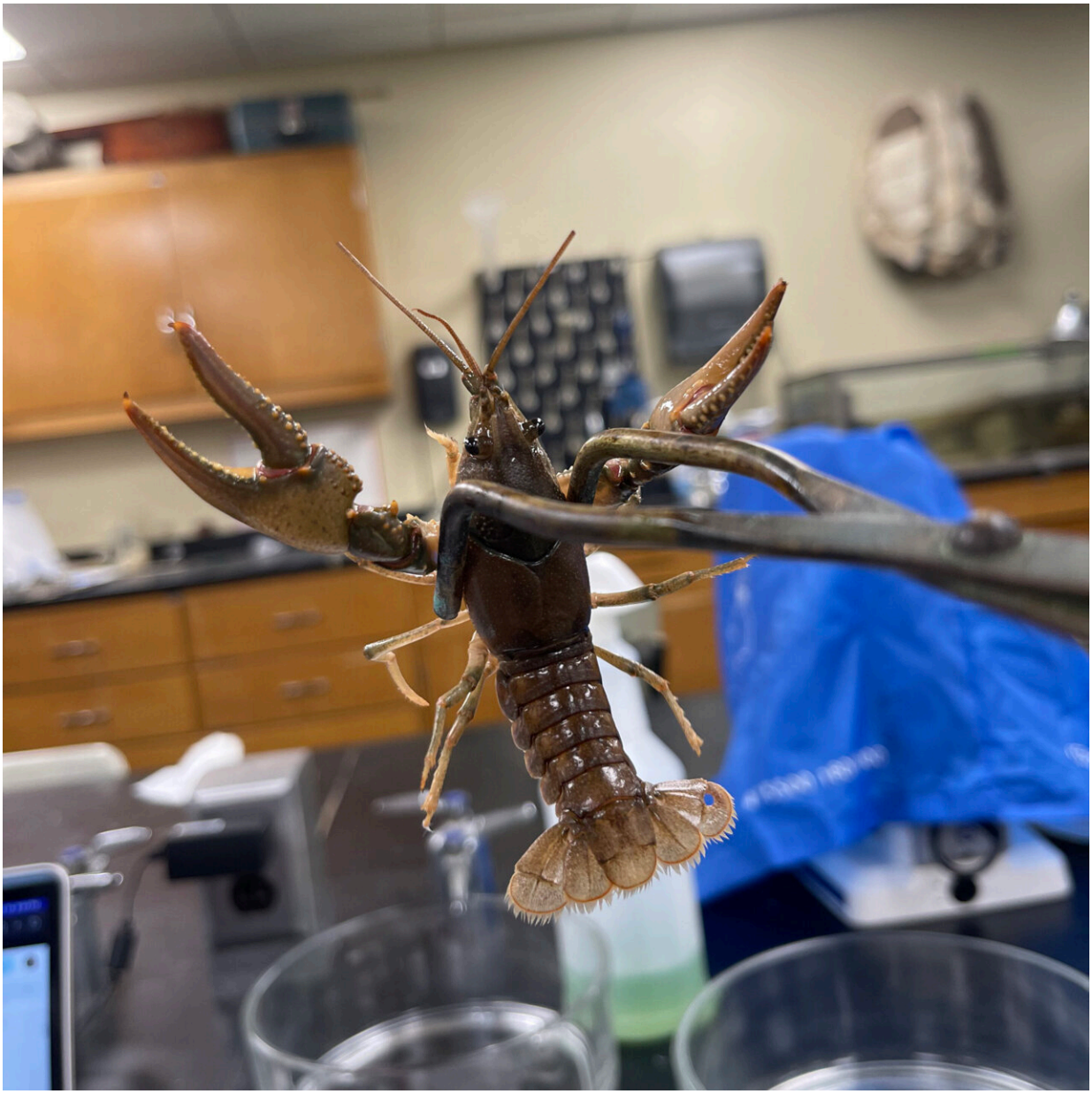

Crawfish can accumulate lithium, an environmental contaminant that is expected to increase as battery use grows, and that could affect the people who eat them. Credit: Javian Ervin

From cell phones to watches to electric cars, lithium-ion rechargeable batteries power a plethora of devices. The increased use of this technology means more lithium could find its way into the environment as consumers discard electronic products.

Now, researchers describe how lithium can accumulate in a common Southern crustacean: the crawfish. As the season for catching and eating mudbugs comes into full swing, the researchers' findings highlight the potential implications for public health and the environment.

The researchers will present their results today at the spring meeting of the American Chemical Society (ACS).

"As aquatic organisms, crawfish can take up large amounts of lithium dissolved in water. Because other creatures—including people—eat crawfish, looking at them allows us to see how lithium moves through the food chain and potentially into us," says Joseph Kazery, a professor of biology.

Two undergraduate students in Kazery's lab at Mississippi College, Andrew Doubert and Javian Ervin are presenting the results of their experiments on the uptake of ionic lithium by different crawfish organs, as well as the impact of seasonal temperatures. "If crawfish are raised near a landfill or a polluted site, runoff could expose them to lithium, with effects we don't yet fully understand," Ervin says. "I myself eat crawfish, so this issue is important to me."

Lithium contamination is not new. Even before lithium-ion batteries became widespread, lithium was, and still is, used as a medication to treat mood disorders. It enters the water supply in those applications because typical wastewater treatment does not remove drug contaminants.

"At high levels, lithium can have toxic effects on human health, including potentially damaging heart muscle cells, as well as causing confusion and speech impairment. In other animals, it can cause kidney damage and hypothyroidism. Studies have also shown that when lithium accumulates in plants, it can inhibit their growth," Kazery says.

Although the U.S. Environmental Protection Agency recommends discarding lithium-ion batteries at dedicated collection points, Kazery says they often end up in landfills. Soaring demand along with lax disposal practices suggests lithium is on the verge of becoming a significant environmental contaminant, he says.

As fully aquatic organisms that spend their lives within a relatively small area, crawfish (Procambarus clarkii) reflect local lithium contamination and could serve as powerful bioindicators of its presence in an environment. The lithium they contain could be passed through the food chain to predators, including humans, either directly or indirectly through crawfish-eating fish that people consume.

For its experiments, the team purchased crawfish bred for research. Knowing that the liver collects toxins from the human body for subsequent removal, Doubert wondered whether lithium would accumulate in the crawfish version of this organ: the hepatopancreas. To find out, he added ionic lithium to food for five crawfish while giving another five lithium-free foods.

He then examined the amount of lithium present in four of their organs

after one week. He found, on average, the most lithium in the gastrointestinal (GI) tract, followed by the gills, the hepatopancreas, and, finally, the abdominal muscle in the tail.

The researchers think the GI tract likely contained the highest level because the lithium-spiked food remains there during digestion. Meanwhile, the gills and the hepatopancreas both pick it up while removing it from the body. People predominantly eat the tail, which appears to take up lithium, but not as readily as the other body parts studied.

Doubert also found that 27.5% of the lithium he fed them had passed from the animals' GI tracts into other tissues. Animals further up the food chain can accumulate higher levels of toxic substances if they eat contaminated prey, so lithium will likely become more concentrated in the predators of crawfish. The researchers expect the high rate of absorption Doubert saw to exacerbate this accumulation in both humans and the other animals that eat crawfish.

The water temperature that crawfish inhabit varies significantly throughout the year. Those shifts affect the animals' metabolism, even causing them to become inactive during winter. Knowing this, Ervin decided to look at the effects of temperature on lithium uptake. He placed crawfish in tanks kept at temperatures as low as 50 degrees Fahrenheit and as high as 90 degrees Fahrenheit and added a consistent concentration of ionic lithium to the water.

After five days, he found that lithium uptake by the abdominal muscle and a part of the crawfish that Doubert did not study—the animals' exoskeleton—increased in the warmest tank. These results suggest that the animals may contain the most lithium during the warm months, according to Ervin.

The crawfishes' weight also decreased in warmer water. At this point, it's not clear how or whether the crawfishes' weight loss was connected to the lithium they accumulated, Ervin says, noting that the team plans to follow up on these results.

"A lot of people think the use of lithium-ion batteries is a good thing right now, but it is important to explore the effects that may be coming down the road," Doubert says.

More information: Abstract: Temperature effects on adsorption of a new pollutant in crayfish.

Provided by American Chemical Society

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