Nematodes: Nature's Tiny Lead Filters?

A study performed at the National Synchrotron Light Source has revealed evidence that members of a family of tiny soil-dwelling roundworms, called nematodes, may naturally help lower soluble-lead levels in metal-contaminated soils.

Researchers from the University of Georgia and the University of Chicago exposed the worms to lead in solution and used x-rays to "see" how the metal distributed within their bodies. They found that the lead concentrated in the nematodes' pharynx regions, or throats, in the form of a solid crystalline material — pyromorphite, a lead-containing mineral. The results are described in the August 1, 2005 edition of *Environmental Science & Technology*.

"The nematodes seem to 'trap' the lead, somehow converting it into crystalline pyromorphite. We think this is the first report of this occurring," said the study's lead researcher, Brian Jackson, an environmental scientist now at the Center for Environmental Health Sciences at Dartmouth College, formerly with the University of Georgia's Savannah River Ecology Laboratory.

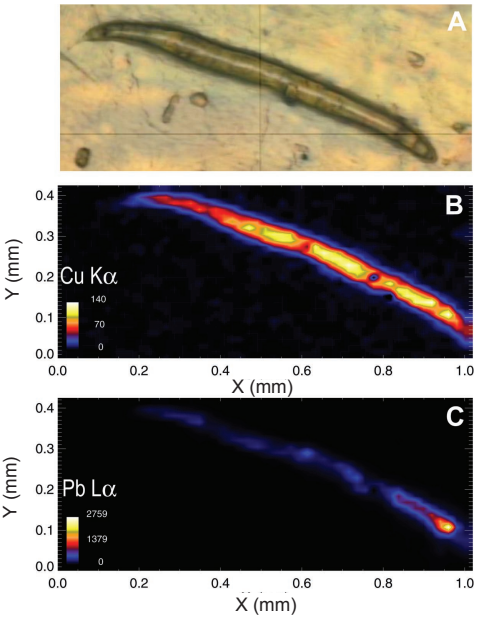
Brian Jackson

The results also suggest that the nematodes took in the lead via ingestion using the same mechanism they use to feed. This may explain the high concentration of lead in the pharynx.

A nematode is typically less than one millimeter in length with a pharynx of only 10 – 20 micrometers, or millionths of a meter, in diameter. To characterize the distribution of lead within the organism Jackson and his group used a synchrotron x-ray "microprobe," a tool that can produce very narrow, intense beams of x-rays. The group then used a technique called x-ray fluorescence (XRF) to create an image of the distribution of lead within the worm (areas of high lead concentration in the nematodes are bright and low concentrations are darker).

In XRF, a beam of high-energy x-rays is aimed at a sample, which absorbs the rays and almost instantly re-emits them. The emitted x-rays have varying energies depending on the types of atoms in the sample. Lead atoms, for example, emit x-rays with a different energy than any other element. Scientists use a device called a spectrometer to analyze the emitted rays and determine which elements, and approximately how much of each, are present in the sample or in parts of the sample.

Once the team identified areas of high lead content in the nematodes, they then used another research method, called x-ray diffraction, to identify the lead-rich areas of the worm as pyromorphite. In this technique, x-rays passing through the mineral emerge in a pattern as a result of diffracting through the closely spaced lattice of atoms in the crystal. Each crystalline solid has a characteristic x-ray diffraction pattern, much like a unique "fingerprint."



Optical (A) and XRF (B and C) images of a nematode exposed to both copper (B) and lead (C).

The researchers also tested the nematodes' response to copper and found that, unlike the lead, the copper did not localize in a specific area. Instead, it dispersed evenly within the worms.

"Given the high numbers of nematodes in soil, their ability to convert lead in pyromorphite may help detoxify lead in contaminated soils and mediate lead in non-contaminated soils," said Jackson.

He continued, "In the future, we will look to see if lead in these invertebrates becomes absorbed by predators or, because pyromorphite is so insoluble, if the lead could pass through the digestive system of a predator unchanged."

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For more information, see: B.P. Jackson, P.L. Williams, A. Lanzirotti, and P.M. Bertsch, "Evidence for Biogenic Pyromorphite Formation by the Nematode Caenorhabditis elegans," Environ. Sci. Technol., ***39(15)****, 5620-5625 (2005).*

— Laura Mgrdichian