

Researcher shows how a common fungus eliminates toxic mercury from soil and water

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A University of Maryland researcher and colleagues found that the fungus *Metarhizium robertsii* removes mercury from the soil around plant roots, and from fresh and saltwater. The researchers also genetically engineered the fungus to amplify its mercury detoxifying effects.

Mercury pollution of soil and water is a worldwide threat to public health. This new work suggests *Metarhizium* could provide an inexpensive and efficient way to protect crops grown in polluted areas and remediate [mercury](#)-laden waterways.

The study, which was conducted by UMD professor of entomology Raymond St. Leger and researchers in the laboratory of his former post-doctoral fellow, Weiguo Fang (now at Zhejiang University in Hangzhou, China), was published in *Proceedings of the National Academy of Sciences (PNAS)* on November 14, 2022.

"This project, led by Dr. Fang, found that *Metarhizium* stops plants from taking up mercury," said St. Leger. "Despite being planted in polluted soil, the plant grows normally and is edible. What's more, the [fungus](#) alone can quickly clear mercury from both fresh and saltwater."

Metarhizium is a nearly ubiquitous fungi, and previous work by the St. Leger laboratory had shown that it colonizes [plant roots](#) and protects them from herbivorous insects. Scientists have known that *Metarhizium* is often one of the only living things found in soils from toxic sites like mercury mines. But no one had previously determined how the fungus survived in mercury polluted soils, or if that had implications for the plants the fungus normally lives with.

St. Leger and other colleagues had previously sequenced the genome of *Metarhizium*, and Fang noticed that it contains two genes that are very similar to genes present in a bacterium known to detoxify, or bioremediate, mercury.

For the current study, the researchers ran a variety of laboratory experiments and found that corn infected with *Metarhizium* grew just as well whether it was planted in clean soil or mercury-laden soil. What's more, no mercury was found in the plant tissues of corn grown in

polluted soil.

The researchers then genetically modified the fungi, removing the two genes that were similar to those in mercury remediating bacteria. When they replicated their experiments, modified *Metarhizium* no longer protected corn plants from mercury-laden soil, and the corn died.

To verify that the genes were providing the detoxifying qualities, the researchers inserted them into another fungus that does not normally protect corn from mercury. The newly modified fungus performed like the *Metarhizium*, protecting the plants from mercury-laden soil.

Microbiological analyses revealed that the genes in question expressed enzymes that break down highly toxic organic forms of mercury into less toxic, inorganic mercury molecules. Lastly, the researchers genetically engineered *Metarhizium* to express more of the detoxifying [genes](#) and increase its production of the detoxifying enzymes.

In their final experiment, the researchers found they could clear mercury from both fresh and [salt water](#) in 48 hours by mixing in *Metarhizium*.

The next step will be to conduct experiments in the field in China to see if *Metarhizium* can turn toxic environments into productive fields for growing corn and other crops. Current methods of remediating polluted soils require toxins to be removed or neutralized from entire fields before anything can be planted. That can be very expensive and take a long time. But *Metarhizium* simply detoxifies the [soil](#) immediately surrounding the plant roots and prevents the plants from taking up the toxin.

"Allowing plants to grow in mercury-rich environments is one of the ways this fungus protects its plant home," St. Leger explained. "It's the only microbe we know of with the potential to be used like this, because

the bacteria with the same genetic capabilities to detoxify mercury don't grow on plants. But you can imagine simply dipping seeds in *Metarhizium*, and planting crops that are now protected from mercury-rich soils."

In addition to its potential as a cost-effective tool for reclaiming polluted lands for agriculture, *Metarhizium* may help clear mercury from wetlands and polluted waterways that are increasingly threatened by mercury pollution as [climate change](#) and melting permafrost accelerates the release of the toxic metal into soils and oceans.

More information: Congcong Wu et al, Bioremediation of mercury-polluted soil and water by the plant symbiotic fungus *Metarhizium robertsii*, *Proceedings of the National Academy of Sciences* (2022). [DOI: 10.1073/pnas.2214513119](https://doi.org/10.1073/pnas.2214513119)

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