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CLEANING UP HEAVY METAL POLLUTION WITH HELP FROM PLANTS

A conversation with **SHENGLIAN LUO**, environmental scientist, and president of National-Local Joint Engineering Research Center of Heavy Metals Pollutants Control and Resource Utilization

In Jiangxi, a province in China rich in nonferrous metals, researchers at Nanchang Hangkong University have been developing novel bioremediation methods that use microorganisms and plants to mop up heavy metal pollutants. Shenglian Luo, environmental scientist and president of National-Local Joint Engineering Research Center of Heavy Metals Pollutants Control and Resource Utilization, discusses new ways to remove toxins from soils. This could help industry clean up its act and meet regulatory standards, while also recycling valuable heavy metals.

Why is heavy metal remediation from wastewater so challenging?
Industrial wastewater, especially from mining and smelting, is laden with heavy metals, pollution from which can pose significant health risks, especially if wastewater seeps into groundwater.

This is challenging on several fronts. The total volume of wastewater being discharged into rivers is huge — an average of 500 million tonnes per year from nonferrous metals industry in China alone. The wastewater often contains complex mixtures of pollutants including multiple heavy metals, such as lead, copper and chromium.

What are some of your achievements in treating heavy metal remediation?
In the late 1990s, a powerful trapping agent together with the water stabilizer we designed helped the industry efficiently treat and recycle target heavy metals. Later, we developed a breakthrough wastewater treatment process consisting of a short flow pipe network system and a coordination-slag reduction process, significantly reducing the accumulation of minerals and rust inside water. These devices now have been adopted by several leading companies in the nonferrous metal industry, alleviating heavy metal pollution.

In the following 20 years, we further investigated functional absorbents for selective metals, and explored bioremediation — using plants to treat wastewater to remove heavy metals.

What inspired you to use plants to treat heavy metal pollution?
The Chinese government has been enforcing limits on levels of heavy metals in wastewater since the late 1990s. We soon realised that it was virtually impossible to meet these regulatory limits through the sole use of chemical methods that repeatedly purify and circulate wastewater.

We subsequently discovered that some plants, such as sorghum and black nightshade could thrive in mining sites contaminated with heavy metals. After studying these plants and various microbes in them, we found that the heavy metals didn't accumulate within the plant cells, but instead inside bacteria and fungi known as symbiotic endophytes that live in the plants. These endophytes play a key role in boosting their hosts' tolerance to heavy metal contamination.

How did you shed further light on this potential bioremediation method?
Our first major challenge was to obtain culturable endophytes from the plants. Then, we exposed the microbes to different stressors to make them even better at absorbing heavy metals. We were delighted when our efforts were successful, so we took the next step to re-introduce the altered microbes into the host plants by soaking and spraying their seeds and seedlings with solutions rich in microbes. The plants containing the modified endophytes could absorb five to ten times more heavy metals from polluted soil. Plants containing both the native and the altered endophytes grew more vigorously, indicating potential industrial application for endophytes to be used as biofertilizer.

What are the possible applications of this bioremediation method?
We believe that growing plants that can absorb heavy metals is a good method for remediating vast areas of contaminated soils, while enabling the recovery and recycling of valuable heavy metals through a heat treatment known as pyrometallurgy.

We are also looking at ways to use the modified endophytes directly in wastewater treatment processes by embedding them inside chemical adsorption materials and membranes. Using this method, we hope to be able to increase the amount of wastewater that can be recycled up to 95%.

What do you have planned for the future?
We want to diversify the species of endophyte we are working with so that they can absorb a wider variety of heavy metals and treat a wider range of wastewater mixtures. We also want to compare the performance of different endophytes when paired with different plants, so that we can identify the best combinations for different applications. Finally, we hope to develop bio-sourced fertilizers based on endophytes to replace chemical fertilizers, mitigating pollution from agriculture.

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