Plants That Can Eat Arsenic

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Environmental arsenic pollution is a serious and growing environmental problem, especially on the Indian subcontinent. Researchers at the University of Georgia had, several years ago, used genetic techniques to create "arsenic-eating" plants that could be planted on polluted sites.

There was a problem, however. The arsenic sequestered from soil remained largely in the roots of the plant, making it difficult to harvest for safe disposal. Now, the research team, led by geneticist Richard Meagher, has discovered a way to move the arsenic from roots to shoots. The payoff could be a new and effective tool in cleaning up thousands of sites where arsenic presents serious dangers to human health.

The research was just published in the Proceedings of the National Academy of Sciences (PNAS). Other authors of the paper include Om Parkash Dhankher and Elizabeth McKinney from the department of genetics at UGA and Barry Rosen of Wayne State University.

"High levels of arsenic in soil and drinking water have been reported around the world," said Meagher, "but the situation is worst in India and Bangladesh, where around 400 million people are at risk of arsenic poisoning. Unfortunately, the high cost of using excavation and reburial at these sites makes these technologies unacceptable for cleaning up the vast areas of the planet that need arsenic remediation. As a result, the overwhelming majority of arsenic-contaminated sites are not being cleaned up."

The problem is vast. The World Health Organization (WHO) predicts

that long-term exposure to arsenic could reach epidemic proportions, the PNAS paper reports. The WHO says a staggering 1 in 10 people in northern India and Bangladesh may ultimately die of diseases resulting from arsenic-related poisoning.

The new strategy is part of what researchers call phytoremediation--the cleaning of polluted soils through the use of plants that sequester poisons, make them less harmful, and which can then be harvested--and has the potential to be of use on millions of acres of arsenic-polluted lands worldwide.

In research reported in 2002 in Nature Biotechnology, Meagher's team inserted two unrelated genes from the bacterium E. coli called arsC and ECS into Arabidopsis, a model lab plant and small member of the mustard family. This allowed the plants to resist the toxic effects of arsenic and sequester three-fold more arsenic in their shoots than normal plants. Still this was too ineffective to allow planting of the transgenic plants on arsenic-polluted sites, since far more arsenic needed to be moved into the plant leaves for safe harvesting and disposal.

In the just-reported research, the team identified a single gene, ACR2, in the Arabidopsis genome as one that allows the plants to move sequestered arsenic in roots. By engineering plant lines with a silenced ACR2 gene, they discovered they could get 16-fold more arsenic in shoots than in natural wild-type Arabidopsis. This experiment identified the active mechanism for sequestering arsenic in roots.

"We want a 35- to 50-fold increase in these plants' ability to sequester arsenic," said Meagher, "and now that we understand the mechanism, we believe that is possible." Indeed, it appears possible to create arsenic-eaters among tree, shrub and even grass species, using the new knowledge.

The problem of arsenic pollution is especially severe all over the Ganges River basin in India. During the so-called "Green Revolution" of the '60s and '70s, the cultivation of rice in flooded fields became pervasive, and workers dug open wells all over India through soil and rocks with naturally occurring arsenic. The result was widespread arsenic pollution from contaminated water. The problem is thus extremely widespread and not the result of industrial accidents or practices.

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