

## Pollution-Busting Plants

*Transgenic trees and plants may break down the pollutants left behind at sites ranging from former factories to firing ranges.*

By David Biello <http://www.sciam.com/article.cfm?id=genetically-modified-plants-suck-up-pollution>

A French hybrid of an aspen tree may one day rid water supplies of the industrial degreaser—and human carcinogen—trichloroethylene (TCE), one of the most common contaminants at toxic waste sites in the U.S. And the tiny, but tractable, *Arabidopsis* plant may mop up the residue of RDX, a military explosive blasted into the soils at firing ranges.

"Plants are a good method for remediating soil and water," says Stuart Strand, an environmental engineer at the University of Washington who has worked on creating the genetically modified pollution-gobbling aspen tree. Even in their natural state, such trees and plants absorb environmental contaminants and break them down into harmless components—all with the power of the sun.

To boost this natural process, researchers introduced a cytochrome known as P450 2E1, an enzyme that ordinarily breaks down many contaminants in the livers of humans and other mammals, allowing them to be harmlessly excreted in urine. The problem is that this breakdown can precipitate the formation of so-called free radicals or ionized molecules, which can cause damage in the liver and elsewhere that may lead to cancer. "We figured we would put [P450 2E1] into plants and let it happen outside our bodies," Strand says.

The researchers used a bacteria to insert the genetic code for this cytochrome isolated from rabbits into the genetic instructions of the hybrid aspen tree, which belongs to the poplar family. When the resulting cuttings, placed in vials, were dosed with TCE, they sucked the contaminant out of the water 53 times faster than unaltered aspens—and removed between 51 and 91 percent of it by the time they were done drinking the poison. "The best of our transgenic poplars lines degrade TCE 121 times better than the average control plants," says University of Washington biochemist Sharon Doty, who led the research, which was published online in *Proceedings of the National Academy of Sciences*.

Because the cytochrome P450 2E1 works on a variety of contaminants, it also boosted the tree's ability to absorb the chloroform left over after cleaning drinking water, the industrial solvent carbon tetrachloride and even vinyl chloride—although the latter blackened the leaves of the young aspen cuttings. And the benefit was not limited to water. "When we tested if they could remove some of these volatile chemicals directly from air," Doty says, "we discovered that they could remove benzene, a known human carcinogen, 10 times faster than control plants."

European and Canadian biologists working with the *Arabidopsis* plant, a flowering weed, successfully demonstrated that inserting a variant of cytochrome P450 isolated from battlefield bacteria allowed it to break down the RDX left behind in the soil of firing ranges. Such altered *Arabidopsis*, when drinking RDX-laced water, removed 90 to 97 percent of it, the researchers write in *Proceedings of the National Academy of Sciences*.

Such tiny weeds, however, do not have the root structure to reach deeper contaminated groundwater, as aspens do. Studies of actual trees in the field will follow as well as how the trees might affect wildlife, such as insects, Strand says.

The ultimate goal, he adds, is to create trees that provide a low-cost option for cleaning contaminated groundwater and sites that might not otherwise be purified due to the expense of chemical and microbial treatments. And, because this aspen only flowers after seven years—and can regrow when cut to the root—such altered trees could be confined to areas where they are needed to consume contaminants over decades. "This ability to prevent flowering is good because we don't want to release the transgene into the environment," Strand says. "By using our trees, you could clean up a site at less cost than any other method. Otherwise, you might not want to clean it up at all."