Mobilizing Microbes in Defense of the Environment

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Bioremediation, the use of microorganisms to clean the environment, is green in both purpose and content. Compared with the chemical or nuclear industries, its potentialities are offset by few apparent drawbacks. Rarely has a novel technology been so well poised for public, political and regulatory acceptance.

How strange, therefore, that even some of its exponents seem rather timorous regarding future applications. The contrast between such nervousness and the great promise of the technology is, I believe, one reason why the Organization for Economic Cooperation and Development (OECD) is holding a major workshop on the subject on November 19-22 in Amsterdam. Its aims include improving the diffusion of bioremediation, shaping recommendations to policy makers about its greater use and promoting communication with governments and the public.

With the OECD meeting upcoming, it was timely that the U.K.'s Society for General Microbiology and the American Society for Microbiology selected bioremediation as a topic for their first-ever joint meeting, held recently in Aberdeen, Scotland. Several papers given on that occasion show just how strongly the science underlying microbiological cleanup is advancing.

One talk was by Derek Lovley of the U.S. Geological Survey in Reston, Virginia. He discussed dissimilatory metal reduction, a novel form of microbial metabolism with great potential for dealing with both metal and organic contaminants in ground water and waste streams. Lovley and others have found that certain organisms can grow by oxidizing organic compounds of hydrogen, using metals as the electron acceptor. The process seems to play a major role in the natural cycling of metals and organic matter in sedimentary environments, where iron and manganese are the primary electron acceptors.

There are two reasons why dissimilatory metal reduction is also an attractive basis for bioremediation. First, microorganisms conducting this type of metabolism can use a variety of toxic metals as electron acceptors. Second, several contaminant metals and metalloids are either less soluble or more volatile in the reduced state than in the oxidized state. It may be possible, therefore, to precipitate or volatilize such metals from polluted waters.

Uranium is a pertinent example, being extremely soluble in the oxidized form but highly insoluble when reduced. Lovley and his colleagues have demonstrated that *Desulfovibrio desulfuricans* removed uranium very efficiently from several contaminated waters, including groundwater from the U.S. Department of Energy's Hanford site near Richmond, Washington. The advantages of this approach over rival technologies include recovery of the uranium in a highly concentrated and pure form, and its suitability for in situ bioremediation. Engineers at Pacific Northwest Laboratories are now scaling up the process, recently patented by the US Geological Survey.

Another of the Aberdeen reports came from Perry McCarty of Stanford University, who is interested in harnessing the scavenging power of native microorganisms rather than introducing new ones. He is currently planning a major cleanup operation on trichloroethylene-contaminated land at Edwards Air Force Base in Southern California, following a highly successful smaller project at Moffett Naval Air Station in Mountain View, California. Trichloroethylene, widely used as a solvent over the last half-century, has become a major groundwater contaminant in these two locations and indeed at many other sites in many countries. McCarty believes that indigenous organisms can cleanse such terrain if they are provided with oxygen and appropriate nutrients.

In the initial field tests at Moffett, McCarty and his collaborators introduced oxygen and phenol into the subsurface, to provide growth and energy requirements for a native population of organisms which then cometabolized both the trichloroethylene and the phenol with exceptional efficiency. Equally effective has been recent work in which hydrogen peroxide proved to be a more convenient source of oxygen, while phenol was supplanted by toluene. With the system established, the concentration of toluene was well below the U.S. Environmental Protection Agency's maximum contaminant level, and below odor and taste thresholds too.

Rivalry between the two approaches exemplified by these projects—the introduction of dedicated scavengers and stimulation of an indigenous flora—remains and unresolved issue in bioremediation. Yet both versions of the technology are now burgeoning with possibilities. There will be a lot to talk about in Amsterdam later this month. ///