



Society has reached the stage of development where the stresses and strains produced by its own speed of technological advances are not only overtaking man's powers of adaptability...but are endangering his very survival.

Joint Statement of Swiss Ecologists, *Experientia*, 1971

CANCER

Plants Provide Prevention

Worldwide, approximately 473,000 new cases of liver cancer are diagnosed annually, with 80% occurring in the developing world. Two risk factors work synergistically to greatly increase the risk of liver cancer: chronic infection with hepatitis B virus (HBV), which affects approximately 350 million individuals, and chronic exposure to aflatoxins, especially aflatoxin B₁, highly potent liver toxicants produced by molds that contaminate dietary staples. Both risk factors are especially prevalent in the developing world, but one step toward reducing this threat may be chemoprevention, the use of drugs or dietary supplements to derail aflatoxin exposure effects. In a study published in the 4 December 2001 issue of *Proceedings of the National Academy of Sciences*, scientists found that chlorophyllin, an artificially produced water-soluble salt of the plant pigment chlorophyll, shows promise as such a chemopreventive agent.

Thomas Kensler, a professor of environmental health sciences at the Johns Hopkins Bloomberg School of Public Health in Baltimore, Maryland, directed the chlorophyllin trial. He says a two-pronged approach is needed to combat the problem: HBV vaccination—the most important part—for the viral component, and chemoprevention for the aflatoxin component. “Since there is this multiplicative interaction between the chemical and the virus, if either one can be knocked down, there can be a pretty dramatic impact, at least in theory, on cancer burden,” he says.

As a step toward proving that theory and to test the efficacy of chlorophyllin as a chemopreventive agent, researchers looked to the Chinese city of Qidong, where liver cancer is the leading cause of cancer death and accounts for up to 10% of all adult

deaths in some rural townships. The researchers recruited 180 individuals from villages near Qidong, all of whom had demonstrable aflatoxin exposure but were healthy. They were randomly assigned to take either a placebo or a 100 mg dose of chlorophyllin three times daily, 20 minutes before each meal, for 16 weeks.

The key finding came from urine samples collected in week 12. These samples revealed a significant decrease in urinary aflatoxin-*N*⁷-guanine, a biomarker of aflatoxin-induced DNA damage, in the treated group compared to the placebo group. The level of this biomarker allows researchers to assess chemoprevention efficacy. In the Qidong trial, participants who



Green medicine. New research suggests that chlorophyllin, a chemical made from the chlorophyll of leafy green plants, may be useful in preventing the carcinogenic effects of chronic aflatoxin exposure.

received chlorophyllin had approximately half as much urinary aflatoxin-*N*⁷-guanine as those in the placebo group. A study published by University of Washington researcher Lawrence A. Loeb in the 15 April 2001 issue of *Cancer Research* suggests that reducing aflatoxin-induced DNA damage by this margin might delay liver cancer development for decades.

Chlorophyllin's mechanism of action is still unclear, but there is some indication that it attaches to the aflatoxin, thereby impeding absorption and shuttling the toxin through the digestive tract. Kensler says other mechanisms may be involved as well. What makes chlorophyllin especially attractive is that it's inexpensive and safe. There were no side effects reported by the study group other than darker-than-normal stool. The sole drawback appears to be the number of times the treatment must be taken each day.

According to Kensler, the next question is whether chlorophyllin can reduce the incidence of liver cancer itself. “We're taking tentative steps to moving in that direction, but that's a major undertaking so we want to make sure we know exactly how to [design and conduct the study] to [get] the best likely outcome,” he says.

“Chlorophyllin is certainly a promising chemopreventive compound for aflatoxin exposure reduction, given the dramatic effects seen on DNA damage levels observed in the Chinese study,” say Paul Turner and Christopher Wild, molecular epidemiologists at the University of Leeds School of Medicine in Great Britain, whose own research has focused on the HBV-aflatoxin relationship and alternative aflatoxin intervention approaches in West Africa.

Although HBV vaccination will have the greatest influence on reducing liver cancer incidence, Turner and Wild emphasize that addressing the problem of aflatoxin exposure is also important. Aflatoxin exposure itself probably contributes to the incidence of liver cancer independently of HBV infection, they say, and vaccination will provide no protection for the millions who already

carry the virus. In addition, say the researchers, “despite World Health Organization recommendations, economic and logistic problems result in only one percent of children in Africa currently having access to HBV vaccination. For these groups of people, aflatoxin exposure intervention could significantly reduce their liver cancer risk.” —**Julia R. Barrett**

LIVESTOCK ISSUES

Overpowering Manure

U.S. Department of Agriculture (USDA) scientists have lab-tested a cheap method for killing pathogenic bacteria in dairy cattle manure. If the technique passes upcoming field tests, it could help address growing concerns about the spread of disease by animal manure, and could possibly someday be used with other nondairy manures as well.

High concentrations of cattle urine can kill many bacteria in manure. Ammonia once got credit for the bactericidal effect, but research published in the 1 April 2000 issue of *Environmental Science & Technology* by a team under USDA research microbiologist James Russell indicates that carbonate ions released during enzymatic degradation of urea (a natural product of protein metabolism found in urine) are responsible. Russell says carbonate ions react with magnesium, an element essential to bacterial survival, forming magnesium carbonate and depriving the pathogens of magnesium.

To increase carbonate levels, Russell created the mild (pH 8.5) alkaline conditions necessary for carbonate to react with magnesium in dairy cow manure, then added sodium carbonate, a cheap and readily available chemical. Within 5 days, 4 grams of sodium carbonate per kilogram of manure reduced counts of *Escherichia coli* O157:H7 from several million per gram to less than 10—below the detection limit of their equipment. Russell found that sodium carbonate also kills many other human pathogens, including *Salmonella typhimurium*, *Staphylococcus aureus*, and *Enterococcus faecalis*.

The need for decontamination of manure is growing. *E. coli* O157:H7 is a deadly, hemorrhagic variant of the common bacterium that killed six people in Walkerton, Ontario, in 2000 when the municipal water supply was contaminated by farm manure runoff. A 1996 survey by the U.S. Environmental Protection Agency found *E. coli* bacteria in 40% of rural wells

(however, most of that *E. coli* is not the O157:H7 variety, and not all *E. coli* comes from animal manure).

Dairy cattle alone produce more than 100 billion kilograms of manure per year. The increasing concentration of livestock operations, where thousands of animals produce large amounts of waste that are often spread at high concentrations on nearby farmland, is raising concerns about odor, overfertilization, and pathogens. Scientists now realize that *E. coli* can move rapidly through soil, a medium that was once thought to immobilize the bacteria. Researchers have found that *E. coli* can percolate down through the soil and eventually reached groundwater, says Russell.

Mark Sobsey, a professor of environmental microbiology at the University of North Carolina at Chapel Hill, has studied contamination by animal wastes. In a paper delivered at the 3–5 October 2001 international symposium “Addressing

Animal Production and Environmental Issues,” held in Research Triangle Park, North Carolina, Sobsey wrote that millions or billions of human pathogens may live in 1 gram of fresh feces. “Therefore,” he wrote, “the pathogens in animal manure and other wastes pose potential risks to human and animal health both on and off animal agriculture production facilities if the wastes are not adequately treated and contained.”

Russell calculates that the carbonate treatment would cost \$10 per cow per year. He expects that it might first be adopted in city watersheds or areas such as western New York State, where cow manure fertilizes vegetables.

Although human illnesses are seldom blamed on manureborne pathogens, Russell says the number of hidden cases could be substantial. “It’s known that the vast majority of [foodborne illnesses] are not reported to epidemiologists; people just think they got a case of stomach flu,” he says. “Whether or not the same pertains to water supplies, I don’t know. There are probably cases where people get diarrhea and don’t know the source at all. In some cases, [contaminated] water is probably the source.” —David J. Tenenbaum



Managing manure. Treating manure with carbonate can neutralize pathogens that can be dangerous to human health.

Fuel Cells Take Off

Boeing Commercial Airplanes researchers in Madrid, Spain, are investigating the use of fuel cells as primary and auxiliary power sources for aircraft. Fuel cells, which can generate twice as much electricity as gasoline-powered turbine generating units using the same amount of fuel, are also quieter, emit less particulate matter, and use less gasoline.

The researchers are looking first at small aircraft, where they plan to replace gas-powered engines with fuel cells and electric motors to power propellers. Next they will develop fuel cells to replace auxiliary electric systems for larger aircraft. Preliminary test flights are scheduled to begin early in 2004.



Europe Assumes Authority over Food Safety

On 12 January 2002, the European Commission (EC) unanimously approved the formation of the European Food Safety Authority, which will be charged with implementing regulations for both human food and animal feeds. The authority's main duty will be to provide independent scientific information in developing any EC regulations and policies that pertain to food and feed safety. It will also issue public safety warnings when risks in the food chain are identified. Also approved was a set of guiding principles for European Union food legislation, including rules requiring traceability of all human and animal food items. Plans are under way to appoint a 14-member management board by next fall.

Deposit for Profit

A 17 January 2002 report by Businesses and Environmentalists Allied for Recycling on beverage container recycling says the United States could double recycling of such containers at a cost savings using a deposit program. Industry giant Coca-Cola participated in the study, as did Waste Management, Inc., one of the country's largest waste services corporations. The report estimates that just 41% of containers sold are recycled.

The report claims the sale of recycled materials combined with unredeemed deposits would offset program costs, and cited California's redemption system as turning a profit when unredeemed deposits were factored in. GrassRoots Recycling Network executive director Bill Sheehan said these findings may show a way to achieve environmental performance with the cost savings industry wants.



RISK ASSESSMENT

Genes Express Dissatisfaction with Environment

In an even newer use for a hot new biotech tool, environmental scientists are using gene expression signatures to monitor, chart, and predict how common toxicants affect the genes of animals living in polluted ecosystems. In gene expression signatures, the activity of genes is analyzed to determine how contaminants change their function. Developmental neurobiologist

Charles Ide, director of the Environmental Institute at Western Michigan University in Kalamazoo, and neuroscientist Anna Jelaso, an assistant professor also at that institute, have used such signatures to show that tadpoles exposed to polychlorinated biphenyls (PCBs) undergo changes in gene expression that predict impending health problems.

The tadpoles were exposed to Aroclor 1254, a PCB mixture once used by the electrical power industry, at levels reflecting PCB concentrations contaminating sediments and animal tissues in the Kalamazoo River and other waterways. The scientists then measured expression of several key genes involved in neurologic function,

apoptosis, endocrine function, cell cycle regulation, cell structure, and metabolism.

They found that tadpoles exposed to the highest concentration of Aroclor 1254 quickly developed symptoms of toxicity, and the majority died. In addition, the activity of most of the analyzed genes dropped significantly. Tadpoles exposed to the lowest concentration of Aroclor 1254 showed similar but less severe drops in gene expression, and no obvious health abnormalities. However, with prolonged exposure even to low doses of Aroclor 1254, adverse health effects and death occurred. The findings will be published in an upcoming issue of *Environmental and Molecular Mutagenesis*.

METAL TOXICITY

Unwell Water in South Carolina

Last February, South Carolina health and environmental officials found that three wells used for drinking water by residents in the Simpsonville area contained fifty times the federal government's 30 ppb maximum allowed level of uranium. In the next seven months, the state tested 948 public and private wells in Pickens, Greenville, and Oconee counties for uranium and found that 92 of the 616 private wells and 7 of the 327 public wells tested also didn't meet the federal drinking water standard for uranium. Public wells are sunk by the state and must meet stricter federal and state regulations.

"The South Carolina Department of Health and Environmental Control's [DHEC] Bureau of Environmental Services is still studying the problem," says Stephanie Brundage, district health director for the Appalachia II Public Health District. "We really don't know how extensive it is."

The uranium contamination is from a natural source and not the result of industrial pollutants. Uranium occurs in most rocks, usually in concentrations of about 2–4 ppm, and is relatively common in the earth's crust. Geologists believe the contamination arose because uranium is a naturally occurring radioactive metal present in bedrock formations of the South Carolina Piedmont region. "Similar geological features extend from Alabama to Virginia, so we can't rule out the possibility of similar uranium concentrations in other states," says David G. Baize, an official with DHEC's Bureau of Water.

Last July, DHEC released the results of urine analyses conducted on 105 people who had been drinking the contaminated well water; 94 of them had elevated levels of uranium that exceed the state and federal maximum contaminant level (MCL) for public water, which is 30 ppb. Although this MCL does not govern private wells, it is used as a benchmark to gauge well water quality, says Robert Olive, an environmental scientist with the U.S.

Environmental Protection Agency (EPA) Water Management Division, Region IV, in Atlanta. "We have advised people with contaminated wells to stop drinking the well water or to filter their water to remove the uranium," says Brundage.

As a heavy metal, uranium can cause health problems. "Uranium doesn't give off much radiation, and it's not known as a carcinogen, but it's a heavy metal, and so it can have an effect on the kidneys," says Daphne Neel, who is assistant bureau chief of the DHEC Bureau of Environmental Services.

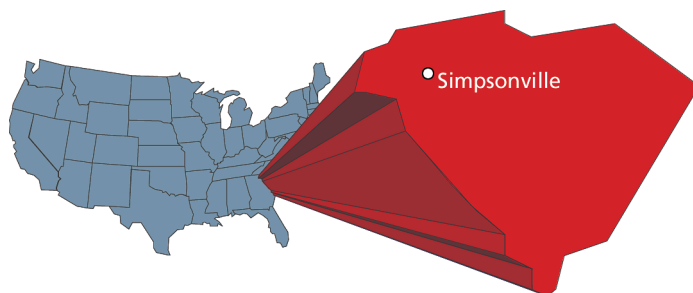
Brundage adds that South Carolina health officials don't expect serious health effects to result from the uranium contamination. "In fact," she says, "we haven't been able to identify any people who have developed kidney problems."

The state of South Carolina has earmarked \$5.64 million to deal with

the problem. The state plans to spend \$2 million for a geologic study, \$2 million on infrastructure (mostly public water lines), \$1.25 million for sampling, analysis, and public education, and \$500,000 for a public health investigation. The South Carolina congressional delegation is seeking \$1.5 million from the EPA to help the state study the local geology to identify reasons for the contamination.

Meanwhile, researchers at Clemson University are studying filtration systems to see how effective they can be in ensuring the safety of the water supply. "I have done a lot of experiments, and the use of activated carbon filters seems to work the best," says Jim Navratil, a professor of environmental engineering and science at Clemson. "They cost a few hundred dollars, only have to be changed occasionally, and can be thrown out with the regular household waste."

South Carolina officials have also been encouraging residents in the contaminated area to have their well water tested. "For a twenty-five dollar charge, they can be sure that their drinking water isn't going to make them sick," Brundage says. —Ron Chepesiuk



Metal in the wells. High levels of uranium found in drinking water wells in South Carolina have both regulators and residents worried about potential health effects.

This proof-of-concept experiment shows that changes in gene expression correlate with health effects, says Ide, and may indicate impending health effects long before damage becomes apparent. The method appears applicable to fish, birds, and other creatures living in polluted ecosystems.

The current system for monitoring the risk of PCB damage involves collecting water, sediment, and biologic tissue samples, analyzing them for PCBs, then using risk numbers derived from the scientific literature on species that may not even live in the ecosystem under study. "It's better to make decisions using data on species actually exposed in a given environment," says

Brian von Gunten, a biologist and Superfund site manager for the Michigan Department of Environmental Quality in Lansing. He foresees the technology being useful for pinpointing areas where PCBs are especially bioavailable, prioritizing areas to be cleaned up, and monitoring the recovery of the ecosystem over time, with less need for collecting species from an ecosystem that has already been devastated by pollution.

Gene expression signatures are predicted to revolutionize human health as well. "This is what medicine will be in ten years," says Ide, and "we're applying the same technology to ecosystem health."—**Carol Potera**



Silicon Valley Toxics Coalition

The area in California now known as Silicon Valley was once an agricultural landscape covered in fruit orchards, but over the past several decades it has become a center for one of the world's largest industries: computer manufacturing. Unfortunately, computer manufacturing produces more than profits—it has left Santa Clara County, the center of Silicon Valley, with more Superfund sites than any other county in the United States and more than 150 polluted groundwater sites.

To counteract the environmental problems resulting from the industry—including groundwater contamination and toxic gas emissions—the Silicon Valley Toxics Coalition (SVTC) was formed in 1982. The membership now consists of environmental and neighborhood groups, labor unions, and government officials, among others. The group works within communities and workplaces worldwide to prevent and clean up toxic hazards and to promote environmental justice and an environmentally sustainable economy. The SVTC's Web site, located at <http://www.svtc.org/>, provides in-depth resources to educate and encourage action on electronics-related environmental issues.

The site's Resources page links to the Toxic Hotspots page, which has 34 different site-level interactive maps of Santa Clara County detailing contaminated sites, as well as demographic maps of the county and a list of the sites by city. Also accessible from the Resources page is the archive of the group's biannual SVTC Action newsletter, which contains articles on the group's campaigns and programs, as well as pieces on such topics as the future of corporate responsibility, strategies for building clean computers, and international environmentalism.

The Programs page features an historical overview of the organization and links to pages for each of the SVTC's areas of action. The Clean Computer Campaign page provides links to SVTC's 2001 Computer Report Card, which rates 28 computer manufacturers on corporate responsibility in terms of making products less toxic to make, use, and dispose of. Also accessible from the Clean Computer Campaign page is the report *Poison PCs/Toxic TVs*. Published in 2001, this report discusses the toxic materials—including brominated flame retardants and heavy metals such as lead, mercury, chromium, and cadmium—contained in computers and monitors, and the hazards and costs of manufacturing and disposing of them.

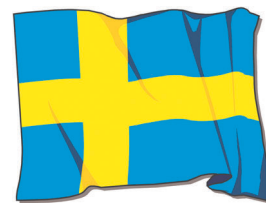
The Green Design page, also available through the Clean Computer Campaign page, defines the concept of eco-labeling, shows pictures of the various labels in use, and provides guides to and comparisons of the growing number of eco-labeling programs for computers in Europe. The page also explains terms used on eco-labels, such as "CFC-Free" and "Halogen-Free," and lists various manufacturers' actions to limit or ban such chemicals.

Back at the Programs page, the International Campaign for Responsible Technology link goes to news about efforts to make vital information on electronics and the environment more readily available to the public. The Networking page describes this campaign and activities in the countries where it is being implemented, including Costa Rica, Scotland, Ireland, and Taiwan. Also on offer here, under the I-CRT Projects link, are a list of "Silicon Principles" proposed by the SVTC for the international high-tech industry to reduce its impact on the environment and links to U.S. Environmental Protection Agency programs such as the Design for the Environment Printed Circuit Board Project, which seeks to research and develop new and safer materials and technologies for use in manufacturing circuit boards.—**Erin E. Dooley**



Swedish Sweep

A Swedish ban on landfilling of combustible wastes, including almost all household waste, went into force on 1 January 2002. Sweden was already landfilling about 25% of its household waste, but this percentage is estimated to drop to 5–10% within the next three years. Many municipalities plan to treat organic waste such as food and yard waste using anaerobic digestion and composting facilities. Although current capacity for such biologic treatment is less than 400,000 metric tons per year, officials expect this number to more than double by the year 2010, and the Swedish Environmental Protection Agency has requested government funding for more biologic waste treatment facilities.



Pollutants on Ice

Although only 1,200 people live in Antarctica year-round, an estimated 300,000 tons of waste such as spent batteries, oil, and chemicals have accumulated in the region since Britain established its first research base there in 1944. In 1991, 42 countries operating on the continent agreed to clean up this growing waste problem, but the process until now has been slow.

To help complete the cleanup effort, the European waste disposal company Onyx is donating 240 specially developed leak-proof containers at a cost of more than \$1 million. Australia, which claims 40% of Antarctica's land mass and is shouldering the bulk of the trash removal, will use the containers first at its Casey research station, where 2,000–3,000 tons of waste waits to be removed.

Pulling the Rug out from under Waste

To help keep the 2.5 million tons of carpet discarded in the United States each year out of landfills and waste incinerators, the National Carpet Recycling Agreement was signed on 8 January 2002 by stakeholders from industry, government, and environmental groups. The agreement seeks to increase carpet recycling from the current 4% to 40% by 2012, and encourages manufacturer responsibility for reducing the environmental impacts of carpet from its point of sale to disposal. Most carpet components are reusable, thanks to new chemical recycling processes. The carpet industry has established the Carpet America Recovery Effort to help oversee collection programs and assess progress made toward the goals of the agreement.

