

We must each find the answer, not only in our political, economic, and social systems, but also in our own consciences.

Antony Christianarvis

Environment Liaison Centre International, 23 January 1979

PERSISTENT ORGANIC POLLUTANTS

Environmental Stain Fading Fast

Shocked that chemical offshoots of his company's products were winding up in polar bears and seals, the CEO of 3M put an end to the existing version of Scotchgard® in 2000. Business observers were struck by how quickly this multinational corporation removed a flagship commodity worth hundreds of millions of dollars from the market. Now some scientific observers are becoming impressed by how quickly the degradation products that prompted this move appear to be disappearing from the environment.

University of Toronto chemist Scott Mabury has been among those identifying a decline in the presence of agents such as perfluorooctane sulfonate (PFOS), one of a class of manufactured chemicals that feature chains of carbon atoms bonded to fluorine atoms. In an *Environmental Science & Technology* paper published online 30 November 2006, Mabury and colleagues report a significant drop in PFOS levels in Arctic ringed seals over the last two years to about a third of what they were in 2000, along with ongoing declines in levels of related fluorine-based compounds.

Mabury notes that change has followed hard on the heels of 3M's withdrawal of its old version of Scotchgard, which consisted of precursors to PFOS and other perfluorinated carboxylic acids, part of a class of perfluorinated chemicals (PFCs). PFCs have come under fire since their ubiquity and persistence were confirmed in the late 1990s, although their toxicological potential as carcinogens and hormone disruptors is still being investigated. PFOS and its cousin perfluorooctanoic acid (PFOA) have been found in blood samples from humans living all over the world and animals in Arctic, temperate, and tropical regions.

For several decades, PFCs had found widespread use in applications such as nonstick coatings for metal and paper surfaces, as well as stain and water repellants on textiles and carpeting. After its accidental discovery in the early 1950s, Scotchgard became one of the best known and

most popular of these products, appealing to consumers who wanted to keep wine stains off their upholstery and an even more substantial industrial client base with highly technical goals, such as optimizing the performance of microchips.

John Giesy, now the holder of a Canada Research Chair in Environmental Toxicology at the University of Saskatchewan and the researcher who first reported PFCs in the environment, was with Michigan State University in 1997 when 3M asked him to offer opinions on the state of the knowledge of compounds produced by the company. This led to joint research projects to answer specific questions such as whether PFOS, the



Creating a bright spot. The reformulation of Scotchgard has led to rapidly declining levels of PFCs in the Arctic environment and in the bodies of animals including the ringed seal.

major degradation product of many of the company's chemistries, was present in the general environment.

Working together with 3M, Giesy and colleague Kurunthachalam Kannan had soon analyzed several thousand samples from remote locations and confirmed the presence of PFOS in the environment. The first mass spectrometry systems capable of such analysis on fluorine—incorporating innovations such as electrospray and triple quadrupole design—were just becoming available, and 3M helped Giesy take advantage of these developments by providing methods and access to instruments.

Giesy vividly recalls the climax of these efforts, when he was invited to bring his findings directly to 3M officials, who subsequently reported the information to the EPA and announced they would voluntarily

cease essentially all production of PFOS-containing products. "They were very courageous, they made the right decisions," he says, noting that because he had been able to investigate the toxicity of other PFCs, he was able to help the company swiftly reformulate Scotchgard in a way that drastically minimized the release of PFCs.

Such efforts are shaping regulatory regimes internationally. At the start of 2006, following an expert advisory panel report citing PFOA as a likely carcinogen, the EPA began inviting fluoropolymer and telomer manufacturers to join the agency's new stewardship program on this and related chemicals. The participants—eight major firms including 3M/Dyneon, Ciba Specialty Chemicals, and E.I. duPont de Nemours & Company—formally committed to reducing PFOA from emissions and product content by 95% by 2010, with the ultimate goal of eliminating PFOA from emissions and products by 2015.

Meanwhile, Canada, which in 2004 placed a two-year ban on four fluorinated polymers containing telomer alcohols, recently proposed extending this measure to a permanent ban on the manufacturing, sale, and importation of these chemicals. Nevertheless, this proposal does not cover consumer products containing these chemicals, which may be imported from other markets.

As for PFOS, the Stockholm Convention on Persistent Organic Pollutants proposed a global ban on this and closely related substances in June 2005. Sweden and the United Kingdom had earlier taken national bans on PFOS to the European Commission, urging a European Union-wide ban. That drive resulted in a proposed directive to restrict the use of PFOS in carpets, textiles, clothing, and other items, which is expected to go into effect in the next couple of years.

To Mabury, these efforts can only benefit from the relatively rapid results being seen in affected environments, even as he continues to explore the processes behind those results. "This first data set suggests a very rapid response in a remote environment near the top of the food chain, from an industrial change happening just a few years before," he says. "I view that as a fabulously good news story." —**Tim Lougheed**

MERCURY

Forest Fire Fallout

In the summer of 2005, wildfires raged over 3.4 million hectares of Alaska and Canada's northern boreal forests, according to combined figures from the Canadian Large Fire Database and the Alaska Large Fires Database. It was the region's second worst fire season on record. The worst was the year before, when 5.7 million hectares burned. The number of very large "megafires" in the circumpolar region is increasing, says Merritt Turetsky, an assistant professor in the Department of Plant Biology at Michigan State University. But alongside the obvious hazards posed by smoke and flames is one perhaps unexpected risk: emissions of mercury (Hg) released from the peat that is relatively common in these northernmost forests.



For peat's sake. Peatlands in boreal forests act as natural sponges of atmospheric mercury. Significant amounts of mercury are thus released when such forests burn, a more frequent occurrence due to climate change.

About 80% of the world's peatland is located at high latitudes. Peat soils absorb more Hg than other soils because the Hg is buried by the accumulating peat after it falls to the soil surface. This Hg can then be transformed to methyl Hg (MeHg), which accumulates as it goes up the food chain. The EPA has deemed MeHg a possible carcinogen and set a limit of 2 ppb Hg for drinking water; the FDA put the limit for MeHg in seafood at 1 ppb.

Because they are far from human populations, boreal forest fires can burn for weeks before they are reported, and are allowed to burn longer than their southerly counterparts. "We've seen more than a doubling of burn area per year since the 1950s," says Turetsky. Dry seasons being up to a month longer than in the past—partly a result of climate change—are a big factor, Turetsky and coauthors argue in volume 33, number 16 (2006) of *Geophysical Research Letters*. The authors estimate that as the scale of the fires increases, exacerbated by projected global warming, the impact of Hg on the food chain also will increase.

"Any changes in carbon cycling will influence the release of this mercury to

the environment," notes Richard Bindler, an assistant professor of ecology and environmental science at Umeå University, Sweden. "The real health concern lies in the aquatic food chain and the concentrations of mercury in the fish we eat."

Turetsky began to notice high rates of MeHg in her work on carbon storage. She and coauthor Jennifer Harden have quantified organic matter and Hg concentrations in samples of frozen peat cored from sites across western Canada. Their samples, taken from sites that varied in forest canopy, soil drainage, and forest age, were augmented with comparable samples recorded in a database of organic matter storage across the boreal region. They used a 20-year record of the extent and timing of fires and a simple fire emission model to estimate how much of this stored Hg could potentially be released into the atmosphere as a result of wildfire activity across western Canada. They found

Hg emissions 15 times higher than previous estimates, which had not accounted for peat's ability to store Hg.

"Many peatlands in interior North America are forested and have very dense soils," says Turetsky. "This forested peat can store a lot of carbon from the atmosphere, which is good, and it can store a lot of mercury from the atmosphere as well, which is also good—until these fire emissions occur." The emissions affect both the atmosphere and runoff into northern lakes and streams.

Turetsky and colleagues have gone a step further than previous emissions models, says Bindler, who calls their model and ideas "conceptually very sound." For him, a question remains, though: to what extent do the study's estimates of soil Hg represent other boreal forests?

Turetsky hopes the study will call attention to the startling increase of wildfires across northern North America. "We really should be paying attention to growing toxicities in the north as well," she says. "In the Great Lakes, where I am, we catch lots of salmon. Increasingly, those catches carry mercury warnings." —David A. Taylor

Hazardous Hookahs

Trendy waterpipe cafes have sprung up across the Middle East and are starting to appear in the United States, especially in college towns.

According to Georgetown University researcher Christopher Loffredo,

patrons of these spots often think the practice of smoking a waterpipe, or hookah, is less harmful than smoking cigarettes. His work has shown that in a typical 30- to 60-minute smoking session, smokers could be inhaling the equivalent of a pack of cigarettes. Loffredo says the practice exposes users to larger amounts of nicotine, carbon monoxide, and other toxicants. Because the tobacco is burned at a lower temperature, smokers find it more tolerable to inhale deeply, and the fact that it takes more pressure to pull air through the waterpipe means tobacco smoke goes deeper into the smoker's lungs.



Asthma Puts the Squeeze on Purses

Asthma-related medical costs in the United States have been estimated at nearly \$12.7 billion per year. A new study published in the August 2006 issue of the *Journal of Occupational and Environmental Medicine* has used figures from a large insurance database to get an even more realistic estimate of the costs. The results showed that direct medical costs for persistent asthma sufferers, defined among other criteria as persons experiencing asthma attacks at least twice a week, averaged around \$6,500 a year compared to slightly more than \$2,000 for patients without asthma. The study also found high indirect costs arose from disability and missed work—more than \$900 higher annually for workers with asthma.

Sewage in Saltwater

The UNEP released its *State of the Marine Environment: Trends and Processes* report in October 2006. This look at

oceans and coastal zones states that although a great deal of progress has been made over the past 20 years in reducing oily wastes and industrial chemicals, the marine environment in developing areas is still confronted with the huge problem of sewage. Some 80–90% of sewage entering coastal zones in these areas is raw and untreated. According to the report, this threat, along with the rise in coastal populations and inadequate treatment infrastructure, is jeopardizing not only human health and wildlife but also livelihoods such as fishing and tourism.



RECYCLING

Building on Fly Ash Waste

The quantity of fly ash—a waste product from coal smoke—is growing along with the steady global increase in coal use. According to Obada Kayali, a civil engineer at the University of New South Wales (UNSW) Australian Defence Force Academy, only 9% of the 600 million tons of fly ash produced worldwide in 2000 was recycled; most of the rest was landfilled. Now Kayali and colleagues have patented a technique for converting fly ash into Flashag™, an aggregate that can be mixed with sand, water, and portland cement to make concrete.

Flashag is made by heating fly ash until it crystallizes. In a presentation at the April 2005 World of Coal Ash Conference, Kayali said the patented process produces irregularly shaped aggregate that makes concrete with 25% more compressive strength than concrete made with fly ash pellets. Kayali and co-inventor Karl Shaw, also of UNSW, say

Flashag concrete is also 21% lighter and up to 21% stronger than conventional concrete.

The higher strength is largely due to the presence of tiny craters on the aggregate, which allow the cement to attain a stronger bond. Stronger concrete means less is needed for a given application, reducing building weight, the quantity of material needed, and the energy used in transportation and handling. And thinner building components leave more space for occupancy.

Greater strength may also translate into fewer greenhouse gases, a major by-product of the high temperatures required for portland cement production. “A rough estimate yielded a possible reduction in greenhouse gas emission by around twenty-two percent,” Kayali says. Cost estimates for the Flashag process have not been worked out; what is known is that the process converts a major waste stream into a salable material.

A second UNSW patent involves heating a mix of fly ash, water, and a plasticizer to make bricks and other building materials. Only about two-thirds as much energy would be needed to make a brick that supports the same load as a standard clay brick.

Fly ash is not considered hazardous waste under the U.S. Resource Conservation and Recovery Act, and its composition can vary. But one primary constituent is carcinogenic silica, which can cause lung disease if inhaled. According to a study in the April 1987 *Water Resources Bulletin*, fly ash can also contain the toxic metals cadmium, copper, chromium, nickel, lead, mercury, titanium, arsenic, and selenium. However, tests showed no significant leaching from the new aggregate, according to Kayali and Shaw.

“This is an excellent idea,” says Tuncer Edil, who studies the reuse of coal combustion products at the University of Wisconsin–Madison. “Recycling fly ash, which is produced in large quantities, is important. It saves landfill space and cost, and alleviates the use of natural materials. It also leads to significant energy savings from crushing and transportation, and less environmental damage by quarrying. For the initial acceptance of Flashag, however, cost will be an important consideration, and current cost analyses do not account for certain environmental savings such as reduced emissions.” —David J. Tenenbaum

INFECTIOUS DISEASE

Dilemma for Trachoma Treatment?

The WHO estimates that trachoma has blinded approximately 8 million people worldwide and threatens the vision of 84 million more, primarily in developing countries. Now a report in the 27 September 2006 issue of *JAMA* claims that treatment with azithromycin, a cornerstone in the WHO's strategy to eliminate trachoma, may hinder development of protective immunity and eventually lead to increased disease prevalence. Some experts in trachoma control, however, disagree that the study data support such a conclusion.

Trachoma arises from repeated eye infection with *Chlamydia trachomatis*, spread by contact with infected persons and by flies. The WHO implemented its SAFE strategy—surgery (S), antibiotics (A), face washing (F), and environmental improvements (E)—in 1997. Community-wide dosing with treatments such as oral azithromycin significantly reduces infection rates. However, reemergence of infection after treatment is common.

The *JAMA* study, led by postdoctoral fellow Berna Atik of the Children's Hospital Oakland Research Institute (CHORI) in California, compared three multi-village communes in Vietnam, each receiving a different SAFE-based treatment: surgery only, surgery and antibiotics, or all four components. Compared to the S commune, the SA and SAFE communes had significantly higher reinfection rates two years after final antibiotic treatment.

“Our finding that there was reemergence of infection isn't surprising, but no one had performed a longitudinal analysis of risk factors for reemergence, including new infection, reinfection, or continuing infection,” says coauthor Deborah Dean, a senior scientist at CHORI.

According to Thomas Lietman, an associate professor of ophthalmology at the University of California, San Francisco, and coauthor of a review of the study to be published in the April 2007 *Archives of Ophthalmology*, the study reflects trachoma researchers'



A Vietnamese man rests after eye surgery for trachoma.

concerns about immunity, but it's inadequate to show a problem exists. “One of the things we really should be looking for in our trachoma programs is if there's a loss of immunity, but they didn't . . . account for just chance variation between the different communities,” he says.

This reaction puzzles Dean. “There was very little variation among the villages or communes as detailed in the article,” she says. “The two statistical models we used for longitudinal analyses are extremely robust and took into consideration variation in infection for all villages and communes at each six-month time point of the study.”

Paul Emerson, technical director of the Trachoma Control Program at the Carter Center in Atlanta, is concerned that antibiotic treatment may now mistakenly be considered counterproductive. “The concern I have is that [this study] will actually reduce the small amount of support going to trachoma control programs,” he says. Dean responds that the research team supports the SAFE program. However, she adds, “The ‘A’ component needs to be further evaluated longitudinally for its risks and benefits, especially with published evidence of chlamydial resistance to azithromycin.” —Julia R. Barrett

ehpnet

NIOSH Safety and Health Topic: Lead and Lead Exposure in Adults: A Guide for Health Care Providers

Given the well-documented toxicity of lead, it is important to understand how to identify and avoid exposure. NIOSH and the New York State Department of Health are two entities that have posted lead-related information on the Internet in an effort to educate the public and clinicians about this health threat.

As part of its mission to educate the public about exposures to toxic materials in the workplace, NIOSH has pulled together a variety of resources on the topic of lead exposure and effects and made them available at <http://www.cdc.gov/niosh/topics/lead/>. This collection starts with a brief overview of how workers can be exposed to lead and the range of health effects caused by exposure. Next is a link to lead-related entries in the institute's NIOSHTIC-2 bibliographic database of publications, grant reports, and journal articles supported in whole or part by NIOSH. Currently, there are more than 770 entries related to lead. The entries are arranged by date of publication, and most entries include links to the full text of the resource listed.



The NIOSH lead page also provides a link to the Adult Blood Lead Epidemiology Surveillance (ABLES) program page. This voluntary state-based program works to measure trends in adult blood lead levels and to minimize lead exposure. The ABLES program page lists the 37 participating state programs, with links to publications

generated by each state. The page also has the latest compiled blood lead level data and a list of relevant publications, reports, and other resources.

The NIOSH lead page also lists selected publications as well as instructions from the *NIOSH Manual of Analytical Methods* for sampling and analysis of lead in different media. There are also numerous resources related to take-home lead exposure and its prevention. Lead poisoning, neurological effects, and mental retardation in family members have been linked to lead brought home by workers on their clothing and in vehicles.

A separate resource geared especially toward health care providers is available through the New York State Department of Health at <http://www.health.state.ny.us/nysdoh/lead/hlthcare.htm>. This page, which is also available in PDF form, provides a more in-depth overview of the adverse health effects of lead exposure. It briefly discusses the effects seen at different levels of lead exposure. It also provides information on the responsibilities of health care providers in reporting and evaluating elevated blood lead in patients they see, and advises clinicians on how to help their patients prevent dangerous exposures. The page outlines the New York State voluntary guidelines for controlling lead in workplaces and looks at how lead poisoning is treated clinically.

Clinicians can consult lists of exposure routes, including those associated with the workplace, hobbies (such as target shooting and stained-glass art), and use of substances (such as some folk remedies and moonshine whiskey). The page also has a rundown of six steps that health care providers can give to patients who work in places where lead is present to help reduce their own and their families' exposure to lead. —Erin E. Dooley

How Much Water Did Your Food Require?

During World Water Week in August 2006, Anders Berntell, head of the Stockholm International Water Institute, suggested that labeling foods to show the amount of water used to produce them could raise awareness among consumers about how much H₂O it takes to bring food to market. The UN estimates that it takes a little more than 500 quarts of water to produce a pound of meat, while the same amount of grain takes between 2 and 20 quarts. A report published in August 2006 by the International Water Management Institute states that one-third of the world's population lives in a region beset by water shortages, and projects that demand for water may double by the year 2050.



Copper and Nickel in Chinese Soil

The economic boom in China has increased the consumption of metals by the country's industrial and manufacturing sectors. A new Australian and Chinese industry-sponsored research effort was launched in Beijing in September 2006 with the aim of developing scientific guidelines for safe levels of copper and nickel in Chinese soils. Earlier studies in Southeast Asia found that soils in the region have low background metal concentrations but ecologically are very sensitive to the addition of metals, as reflected in effects on plant growth and soil microbe function. Under the project, field and laboratory experiments will be conducted on a range of soil and environmental conditions in China to determine the behavior and toxicity of copper and nickel in the soils. The data will be meshed with previously collected data from many other countries to develop toxicity models.

Too Many Full Tanks?

According to DHHS data, the weight of the average American increased by more than 24 pounds between the years 1960 and 2002. In the October–December 2006 issue of *The Engineering Economist*, scientists from the University of Illinois at Urbana–Champaign and Virginia Commonwealth University calculate that the strain this extra body weight puts on fuel economy means Americans are now pumping 938 million gallons of fuel more per year than they were in 1960—a total of \$7.7 million worth each day at \$3 per gallon. The authors ruled out factors such as increased cargo weight and decreased fuel efficiency resulting from poor maintenance, and predict these costs will rise further as rates of obesity increase.

