

Good judgment comes from experience,
and a lot of that comes from bad judgment.

Will Rogers (1879–1935)

PESTICIDES

Toward DDT-Free Malaria Control

An increased international effort to reduce the incidence of malaria around the globe while reducing reliance on DDT was announced 6 May 2009 at the fourth meeting of the Conference to the Parties to the Stockholm Convention on Persistent Organic Pollutants (POPs). With funding of more than US\$70 million, the United Nations Environment Programme and the World Health Organization have launched 10 projects to help test integrated vector management (IVM) systems for malaria control. These systems could provide sustainable, effective, and cost-effective alternatives to reliance on DDT. The aim is to reduce DDT application by 30% over current usage by 2014, with a complete phaseout by the early 2020s. About half the funding for the projects comes from the Global Environment Facility (GEF), the financial arm of the Stockholm Convention, which provides financial and technical assistance to help countries phase out and reduce releases of POPs.

DDT is banned for all uses in all countries that are signatories to the Stockholm Convention except for spraying inside buildings in developing countries where malaria is a problem. This practice, known as indoor residual spraying (IRS), is increasingly relied upon in Africa and Asia, given the resurgence in malaria in recent decades. Reports also exist that, on occasions, some developing countries contravene the Stockholm Convention and spray DDT on a larger scale.

However, growing evidence of mosquito resistance to

DDT as well as adverse human health effects has prompted a search for alternatives.

“There is a large and growing body of literature on the potential human health effects of DDT,” says Brenda Eskenazi, a professor of epidemiology and maternal and child health at the University of California, Berkeley. “Evidence suggests that exposure to DDT and its breakdown product DDE at levels substantially lower than that experienced in communities that use IRS may be associated with breast cancer, diabetes, spontaneous abortions, decreased semen quality, and impaired child neurodevelopment.”

Great care is taken and safeguards followed in the new projects—which involve 40 countries across Africa, the Eastern Mediterranean, and Central Asia—to ensure that malaria incidence does not increase in the project areas, says Laurent Granier, coordinator of the Chemicals Cluster for the GEF. The new projects follow a successful pilot project in Mexico and Central America that achieved an overall 63% reduction in the incidence of malaria and a more than 86% reduction in the most severe form of malaria, that caused by *Plasmodium falciparum*. This success has rekindled hopes that an end to DDT reliance is possible.

IVM achieves such reductions with strategies such as using insecticide-treated bed nets, draining standing water from ditches, adding fish that feed on mosquito larvae to water supplies, clearing vegetation cover for adult insects, and improving diagnostic and treatment capacity to reduce the reservoir of blood parasites in the human population. According to the Centers for Disease Control and Prevention, the only insecticides approved for use on bed nets are pyrethroids, which are less acutely toxic to mammals than other pesticides.

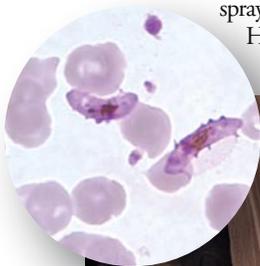
From a public health viewpoint, IVM needs to match DDT in terms of controlling malaria. But other comparisons are more difficult, due in part to a lack of cost-effectiveness data from communities that currently use IRS. “Comprehensive cost-effectiveness analysis is very laborious, requiring large-scale trials to accurately determine the effect on disease in targeted populations,” explains Henk van den Berg, an entomologist and visiting scientist at Wageningen University. “Moreover, the effects measured in one place may not have wide-scale application value because they are influenced by local variables. Also, costs should not be limited to program costs but include indirect costs due to side effects.”

One way to tackle this complex issue is to study how each intervention affects vector and disease transmission in different locations, says van den Berg. In a project being undertaken in Kenya, Tanzania, and Uganda, researchers from Duke University are developing the Malaria Decision Analysis Support Tool (MDAST), which applies existing knowledge and evidence about specific malaria interventions to help officials predict the probable outcomes of different combinations of malaria control strategies and weigh the risks and benefits. They can then make the best choices for disease management and vector control given the environmental and societal parameters of specific situations.

“Controlling malaria requires a coordinated adaptive decision-making approach based on the best available evidence from the field,” explains MDAST developer Randall Kramer, a professor of resource and environmental economics at Duke. Kramer and colleagues described the MDAST in an article published 6 April 2009 ahead of print in *Health Policy*.

A potential problem faced by IVM is the lack of sustained interest by communities that are responsible for the maintenance of IVM strategies—for instance, ensuring that water does not re-collect in ditches. But properly implemented IRS strategies also require sustained input as well as an expensive-to-maintain infrastructure. Hopefully, the results of these projects will allow developing countries to reduce their dependence on DDT, thus avoiding its potentially harmful effects on human health and the environment, while reducing the prevalence of malaria—a disease that has killed five children in the time it took you to read this article.

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Kerfi, eastern Chad (inset: *P. falciparum*). Treated bed nets are one potentially safer alternative to DDT in fighting malaria.

WHO/Benoist Carpentier, inset: CDC/PHIL

MARINE AND COASTAL SCIENCE

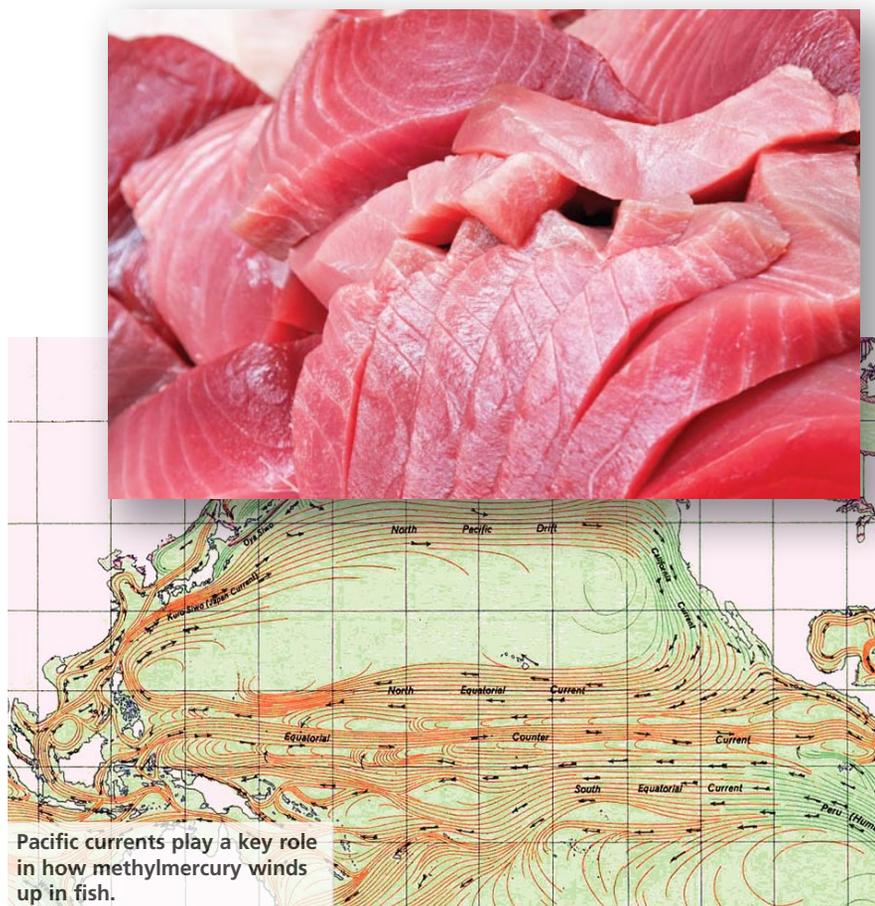
Ocean Currents Key to Methylmercury in North Pacific

Mercury emitted from Asian coal-fired power plants travels long distances via ocean currents and raises mercury levels in the North Pacific Ocean, report researchers who measured mercury at 16 ocean sites between Hawaii and Alaska. Their findings may explain why mercury levels are increasing in waters of the eastern North Pacific when no local source of mercury is apparent and suggest, moreover, that fish mercury levels may respond in kind. By 2050, wrote Elsie M. Sunderland and colleagues, mercury levels in the North Pacific could double relative to 1995 levels if anthropogenic emissions remain at their present levels, including coal use in Asia. The study, reported in the 1 May 2009 issue of *Global Biogeochemical Cycles*, is the first to document methylmercury formation in the Pacific Ocean.

About 24% of U.S. mercury intake comes from Pacific tuna, according to research published in the February 2007 issue of *EHP* by Sunderland, now a research associate at Harvard University. Mercury is readily transformed into methylmercury, a potent, persistent neurotoxicant. Methylmercury impairs neurodevelopment in children and raises the risk for cardiovascular disease in adults. Methylmercury, the only form of mercury that bioaccumulates in fish, accounts for more than 95% of the total mercury in predatory species such as tuna, says Sunderland.

In water samples collected by the researchers, methylated mercury species were particularly elevated at intermediate depths (200–700 m) but not in surface or deeper waters. Moreover, mercury levels had increased up to 30% since 1995, but only in intermediate-depth samples. “That left us scratching our heads,” says coauthor David Krabbenhoft, a research hydrologist with the U.S. Geological Survey. The conventional thinking has been that ocean mercury comes from direct atmospheric deposition onto the sea surface or from deep underwater volcanoes, yet Krabbenhoft and colleagues detected little mercury in surface and deep waters.

The mystery was solved by atmospheric and ocean circulation models created by Sunderland and coauthor Sarah Strode of the University of Washington in Seattle. The data pointed to emissions from the heavily populated coast of Asia as the source of mercury. The toxic metal was deposited in



the western Pacific, then ocean currents carried it to the eastern North Pacific study sites within two years, according to the model.

The authors found that the majority of mercury settles to mid-level waters because it sticks to surface algae that die and sink. When underwater bacteria degrade the algae in the presence of mercury, methylmercury is produced. The team confirmed that the highest methylmercury levels at intermediate depths coincided with high organic carbon utilization and oxygen depletion, markers for microbial decomposition. Larger species of tuna also live in the 200- to 1,000-m mesopelagic zone, according to the Food and Agriculture Organization of the United Nations.

A few days after publication, an independent team of French scientists released nearly identical results for the Mediterranean Sea in the May 2009 issue of *Limnology and Oceanography*. They also found maximum methylmercury concentrations at intermediate depths produced by bacterial breakdown of organic matter. Vincent St. Louis, a professor of biological sciences at the University of Alberta, and colleagues reported similar findings for Arctic waters in the 15 November 2008 issue of *Environmental*

Science & Technology. Most aquatic mercury research has focused on lakes, and “people are just starting to understand what’s going on in the ocean,” says St. Louis. The new findings “help us to understand where methylmercury is produced in oceans,” he says.

The studies also shed light on the environmental riddle of why fish caught in some waters have high mercury levels despite the lack of a local source. Alaska’s Fish Monitoring Program evaluates marine mercury levels statewide. State Veterinarian Robert Gerlach has observed up to a 150% rise in mercury levels in halibut from the Bering Sea compared with 1976 levels, but halibut from the southeastern Gulf of Alaska have shown only small increases in mercury. “My assumption is that the increase is due primarily to atmospheric deposition from coal-fired power plants in Asia and long-range transport on ocean currents,” says Gerlach. Sunderland’s models suggest that Asian ocean currents travel northeast over the Bering Sea but bypass the Gulf of Alaska, supporting Gerlach’s idea.

Montana-based **Carol Potera** has written for *EHP* since 1996. She also writes for *Microbe*, *Genetic Engineering News*, and the *American Journal of Nursing*.

HAZARDOUS WASTE

TVA Spill's Chemical Legacy

When the holding pond at the Tennessee Valley Authority's (TVA) Kingston coal-burning power plant broke on the morning of 22 December 2008, it released more than 5.4 million yd³—some 50 years' worth of accumulation—of coal ash slurry into the neighboring lands and the Emory River. High levels of arsenic and mercury in the spilled slurry could pose serious environmental and human health risks, according to the first peer-reviewed assessment of the chemical contamination from this spill, published 1 August 2009 in *Environmental Science & Technology*.

Scientists have studied the chemical composition of coal ash for decades. They have a general understanding of how coal ash constituents travel through the environment but lack data on how spills translate into long-term human and ecologic health hazards. So environmental scientists Avner Vengosh and Laura Ruhl of the Nicholas School of the Environment at Duke University visited Tennessee in the months after the spill to collect samples of coal ash slurry, sediments, and water from various sites along the Emory and Clinch Rivers, which flow into the Tennessee River, the primary source of drinking water for some 410,000 Tennesseans.

Data reported by the Tennessee Department of Environment and Conservation showed the ash contained elevated levels of arsenic and mercury. With time, wrote Vengosh and colleagues, as the mass of slurry begins to dry, these toxic elements might become airborne and pose a health threat to local communities. However, investigating whether this is indeed happening would require long-term air monitoring, says Vengosh.

Trace elements including arsenic, selenium, lithium, and boron were measured at elevated levels in a tributary of the Emory that was dammed by the spill and turned into a standing pond. The concentration of dissolved arsenic in this pond was as high as 86 µg/L, whereas unaffected upstream waters contained 0.1–0.4 µg/L. Concentrations of these elements were significantly lower at the downstream Emory and Clinch River sites but were above background concentrations, suggesting that leaching of these toxicants was balanced by massive river dilution.

Although dilution improved the water quality, it could not control the deposition of ash in the river sediments. The mercury levels in sediments a couple miles downstream of the spill were almost as high as those in the coal ash itself, around 92–130 µg/kg. Anaerobic bacteria living in these sediments could convert this mercury to its more bioaccumulative and toxic form, methylmercury.

Frank Huggins, an environmental chemist at the University of Kentucky, isn't convinced we yet know the real risk to humans and wildlife. The authors use the word "potential," he notes. "Sure there is always a lot of potential, but . . . the actual risk is a much more difficult topic to address." Huggins is just beginning to analyze some samples from the spill site for the TVA. He says complementary and longer-term analyses of the elements, their speciation, and how they behave over time and under different physical conditions in sediments and water will reveal the true hazards.

Ecotoxicologist William Hopkins of Virginia Polytechnic Institute and State University says future studies will need to investigate which of the trace elements measured by Vengosh and colleagues are bioavailable to biota in the area as well as the severity of any effects resulting from exposure. Some such investigations have already begun. The TVA recently hired Hopkins as a consultant to begin looking at issues of bioaccumulation and toxicity. Similarly, ecophysicologist Shea Tuberty of Appalachian State University is studying how the spill has affected levels of selenium and other elements in fish tissue, and how that in turn affects fish populations. His preliminary work has established baseline selenium levels in local fish populations that are already close to levels that cause reproductive failure in most aquatic species—possibly the result of decades of selenium leaching from the holding ponds, he says.

Vengosh and colleagues agree that much more research is needed to evaluate the long-term environmental and human health effects of the spill. With the support of a new project funded by the National Science Foundation, the Duke team will continue to investigate these effects.

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The Beat by Erin E. Dooley

Hearing Loss Express?

Richard Neitzel et al. report in the August 2009 *American Journal of Public Health* that New York City subways are loud enough to increase the risk for noise-induced hearing loss, an irreversible condition affecting about 250 million people worldwide. Subway



platforms were the noisiest of the environments studied, with decibel levels higher than that of a chainsaw, but other forms of mass transit also were loud enough to present a risk of hearing loss with prolonged exposure. The researchers suggest that mass transit riders reduce noise exposure using earplugs or earmuffs—but not headphones or earbuds, since wearers often turn up the music to drown out ambient noise.

Cell Phones Banned in French Schools

The French government has banned cell phones from primary school grounds and directed manufacturers to offer handsets that allow only text messages and phones that work only with headsets. The decision follows a six-week review of mobile phone use and wireless radiation, including reports of an association between childhood use of cell phones and increased risk of adult cancer published 4 April 2009 by Lennart Hardell et al. ahead of print in a special issue of *Pathophysiology*. But even these measures are deemed inadequate by advocates seeking a complete ban on mobile phone use by children

under age 14 and limits on the power and siting of cell phone masts and towers.

Workshops for African Medical Journal Editors

The African Journal Partnership Project (AJPP), established in 2004 by the National Library of Medicine and the Fogarty International Center, promotes capacity-building efforts for medical journals in Africa. To advance its goals, the AJPP is now planning four train-the-trainer workshops—a September 2009 workshop in Ghana will combine training for editorial and computer support staff; later workshops in Ethiopia, Uganda, and Zambia will focus on scientific writing and reviewing skills. More information about the AJPP is available at <http://www.ehponline.org/international/>. AJPP member *EHP* has partnered with *Mali Médical* since the project's inception.

Cozy Cancer Risk

The EPA's 2002 *National-Scale Air Toxics Assessment*, released in June 2009, shows that the polycyclic aromatic hydrocarbons released by

RESEARCH ISSUES AND INITIATIVES

Agreement Could Speed Reductions in Animal Use

A Memorandum of Cooperation signed by representatives of the agencies responsible for evaluating and recommending alternative toxicity testing methods in the United States, the European Union, Japan, and Canada represents a major step forward in the use of improved alternatives to animal testing. The agreement will enhance international cooperation and coordination in the validation of alternative test methods, the execution of independent peer-review meetings and reports, and the development of harmonized test method recommendations for regulatory consideration.

“Early and consistent cooperation in these three critical areas will greatly enhance the likelihood of international acceptance of alternative test methods determined to be useful for safety evaluations,” says William Stokes, director of the National Toxicology Program Interagency Center for the Evaluation of Alternative Toxicological Methods (NICEATM) and executive director of the Interagency Coordinating Committee on the Validation of Alternative Methods (ICCVAM). “Most importantly, there will be international discussion and agreement on the design of validation studies, including test method protocols and chemical selection, before studies are initiated.”

Linda Birnbaum, director of the National Toxicology Program and the NIEHS, signed the agreement 27 April 2009 on behalf of NICEATM, along with representatives for the European Centre for the Validation of Alternative Methods, the Japanese Centre for the Validation of Alternative Methods, and the Environmental Health Science and Research Bureau of Health Canada. “It’s a big step to have agreement between the Europeans, the Japanese, the Canadians, and us in terms of approaching the evaluation of alternative test methods,” says Birnbaum. “There will be more sharing of information because of the agreement, and hopefully that will lead to more rapid decision making.”

That’s not to say that enhanced international cooperation and leveraging of resources will guarantee acceptance of new test methods. “Because each regulatory agency has different legislative authority within their own country, I don’t foresee this as being an automatic, across-the-board acceptance,” says Jodie Kulpa-Eddy, vice chair of ICCVAM and a senior staff veterinarian with the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture. “Each group is going to have to take a look at the data and determine whether or not a test is going to be applicable under their umbrella.”

Still, speedier and more coordinated consideration of new test methods is expected to increase the likelihood that methods will be accepted by individual regulatory agencies. The benefits, says Stokes, will include a reduction in the use of animals for product safety testing and improved public health with the availability of more predictive toxicity tests achieved through advances in understanding of toxic mechanisms and incorporation of new technologies. He adds that the initiative has received “very positive support and feedback” from all stakeholders, including the animal welfare community and industry.

Many companies with a global focus stand to benefit from the international cooperation. “Instead of having to validate test methodologies multiple times, you can now potentially do it once and have it applied to multiple markets,” says Syed Ahmed Mustafa, director of sales and marketing at CeeTox, Inc., an *in vitro* safety testing company in Michigan. “This will enable multinational companies to only have to do one test to cover all of their operating regions.”

According to Birnbaum, this agreement and other recent advances in the field have brought about substantial progress in the development of alternative test methods. “It took a long time to get to this point; there was a great deal of evaluation that needed to be done,” she says. “And now we’re at the point where I think things are beginning to move much more rapidly.”

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wood-burning fireplaces and stoves contribute the most to the cancer risk from breathing Oregon’s air. Oregon ranked third in the nation after New York and California in the number of people living in census tracts with elevated population exposures, but this ranking may be due to Oregon’s unusually thorough documentation of wood stove and fireplace use, which is particularly popular for home heating in the western half of the state. To minimize toxic emissions, the American Lung Association

recommends burning only clean, dry, seasoned hardwood and regular maintenance to prevent creosote buildup in flues.

CO Damages Fetal Rat Brain Cells

In work published 27 May 2009 in *BMC Neuroscience*, Ivan A. Lopez et al. found that chronic fetal exposure to 25 ppm carbon monoxide (CO) permanently damaged rat brain cells through oxidative stress, leading to a decrease in proteins essential for proper functioning. The authors say this exposure simulates the potential CO exposure of a human fetus whose mother is a “mild to modest” smoker. Other indoor CO exposure sources include gas appliances, fireplaces, and attached garages. There are no EPA standards for CO in indoor air.

Better Oversight for Bottled Water

Given rising consumption of bottled water, the Government Accountability Office (GAO) evaluated the extent and strength of FDA regulations for this product. In June 2009, the GAO reported that FDA standards generally reflect those of the EPA except in the case of

di(2-ethylhexyl) phthalate, a compound used to make plastic bottles, for which the FDA has no standard. The GAO recommended that the FDA issue a standard or publish reasons for not doing so, and that water bottlers provide more labeling information for consumers on the quality and safety of their products. Currently, companies (unlike water utilities) are not required to disclose positive tests for contaminants.

