

History is a race between education and catastrophe.

H.G. Wells (1866–1946)

LEAD

From Devastation Comes Hope

Even as the Gulf Coast grapples with possibly its worst environmental catastrophe ever, a silver lining has emerged from the devastation of the stormy summer of 2005: both soil lead levels and children's blood lead levels fell dramatically across New Orleans, Louisiana, after Hurricanes Katrina and Rita swept in clean sediment over the city's lead-contaminated soil.¹ This positive outcome bolsters the case for soil remediation as a way to protect children from lead poisoning.

Howard Mielke, a research professor at the Tulane/Xavier Center for Bioenvironmental Research, says he and his colleagues “took advantage of a catastrophic natural event to examine changes in the environment and health.” Along with Sammy Zahran at Colorado State

University and colleagues, Mielke measured soil lead levels at 46 New Orleans sites in 2000 and in 2006. The researchers obtained pre- and post-hurricane blood lead data for 13,306 children aged 6 years and younger from the Louisiana Childhood Lead Poisoning Prevention Program.

After the hurricanes, only 6 of the 46 sites had soil lead concentrations above 400 mg/kg, compared with 15 of 46 sites before the hurricanes. The 400 mg/kg (ppm) cutoff is the point at which the U.S. Environmental Protection Agency recommends remediation of bare soil in children's play areas; a cutoff of 1,200 ppm is recommended for other bare soil areas. Median soil lead levels fell 46% (from 328.54 mg/kg to 203.33 mg/kg), and median blood lead declined 33% (from 5.14 $\mu\text{g}/\text{dL}$ to 3.45 $\mu\text{g}/\text{dL}$). In neighborhoods where soil lead declined by 50% or more, blood lead dropped by 53% on average. Children born after Katrina and Rita had the lowest blood lead levels of all those studied.¹

“There's a tremendous amount of lead in New Orleans' soil—and all cities,” says Mielke. This toxic reservoir, which accumulated when lead was added to paint and gasoline, is constantly being redistributed by rain, wind, and construction activity. The hurricanes' blanket of cleaner soil—sediment from Lake Pontchartrain and nearby wetlands that was carried through the city's breached levees by the storm surge—likely will not persist, predicts Mielke. However, the natural effect of the blanket of sediment is duplicated by soil remediation, in which clean soil with no more than 5 ppm lead is hauled in and deposited on a geotextile barrier. The barrier allows water to pass through but contains the lead and prevents anyone from digging into contaminated soil underneath.

Soil is often an underappreciated source of childhood lead exposure in cities, relative to lead paint in homes,² yet “both are to blame for childhood blood lead elevation,” says Rudolph Jaeger, a research professor of environmental medicine at New York University Medical School. Exposure to lead in soil contributes to elevated blood lead, which in turn is associated with reduced educational outcomes.³

Mielke has worked with New Orleans area child-care centers where soil has contained 500–5,000 mg/kg lead. “If we pay attention to environments where children play in the very early years of life, we may reduce their blood lead levels,” Mielke says.

Mielke also thinks the current blood lead level of concern of 10 $\mu\text{g}/\text{dL}$ —the level at which the Centers for Disease Control and Prevention recommends medical intervention—is too high. Studies show that just 2 $\mu\text{g}/\text{dL}$ adversely impacts the heart,⁴ kidney,⁵ and child intelligence,⁶ and many researchers believe there is no safe level of exposure.⁷ “If we lower this threshold, there may be more interest in primary prevention measures like soil remediation,” Mielke says.

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

REFERENCES

- Zahran S, et al. *Env Sci Technol* 44(12):4433–4440 (2010).
- Laidlaw MAS and Filipelli GM. *Appl Geochem* 23(8): 2021–2039 (2008).
- Zahran S, et al. *Neurotoxicology* 30(6):888–897 (2009).
- Navas-A A, et al. *Environ Health Perspect* 105(9):472–482 (2007)
- Fadrowski JJ, et al. *Arch Intern Med* 170(1):75–82 (2010)
- Jusko TA, et al. *Environ Health Perspect* 116(2):243–248 (2008)
- Lanphear BP, et al. *Environ Health Perspect* 113(7):894–899 (2005).

**400 ppm**

Soil lead concentration at which the EPA recommends remediation of bare soil in children's play areas

1,200 ppm

Soil lead concentration at which the EPA recommends remediation of bare soil in other home areas

CHILDREN'S HEALTH

Soy Formula of "Minimal Concern"

In May 2010 the National Toxicology Program (NTP) released its draft opinion on the potential of soy infant formula to cause adverse human developmental effects, labeling its concern level as "minimal," or a 2 on the 5-level scale used by the NTP. This draft opinion was based primarily on the conclusions of an expert panel evaluation of the existing literature in humans and laboratory animals, although many of the studies included in the review were not considered by the expert panel to be useful for the evaluation. For instance, none of the 80 human studies reviewed were considered "high utility," and only 28 were considered of "limited utility."¹

Soy formula is a relatively small component of the U.S. formula market, comprising 12% of sales between June and September 2009.¹ Infants fed soy formula receive higher daily intakes of isoflavones (plant-derived compounds with biological activity similar to that of estrogen) than not just other infants but also subpopulations (such as Asians and vegans) that consume soy-rich diets.¹

Results from some animal studies (e.g., Cimafranca et al.²) point to impairment of reproductive development in female rodents treated with genistein, the best studied soy isoflavone. However, according to the panel, very few studies have analyzed the potential reproductive or other long-term health effects in people who consumed soy formula during infancy. This lack of data made it impossible for the expert panel to assess whether soy formula causes adverse effects in humans. At the same time, the evidence of effects in animals made it impossible to find soy formula free of any health threat.

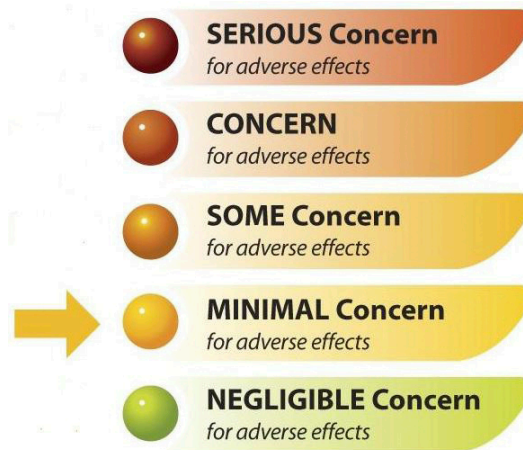
Marisa Salcines, manager of communications for the International Formula Council, says the organization agrees with the "minimal" concern level rating. "Soy formulas have been used for over fifty years without reports of negative reproductive or developmental effects," she says. Ed Carney, a developmental toxicologist at the Dow Chemical Company and member of the NTP Board of Scientific Counselors (which reviewed the draft report in May), agrees. "Decades of real-life clinical experience have not resulted in any overt 'red flags' for developmental toxicity," he says. "Given the high levels of exposures and vast numbers of children exposed for so many years, one would expect that some hints of adverse effects [would have been seen] if they were really there." Some research even suggests beneficial protection against cancer in rodents fed soy protein isolate.³

Despite this track record, Elaine Faustman, a professor of environmental and occupational health sciences at the University of Washington School of Public Health and member of the NTP Board of Scientific Counselors, says more weight should be attributed to data showing estrogenic effects in animal studies. "The data should not be downplayed or discounted," she says, cautioning that in addition to soy formula, children may be exposed to soy in other foods as well. "We should consider the variety of . . . mixed, real-world exposures such as cereal, yogurt, soy milk, and other foods in [the older] infant diet," she explains.

The draft brief outlines proposed future research, which will focus on exposing animals to a mixture of isoflavones to better mirror infants' actual exposure to soy formula. Carney agrees with this approach, saying it should include feeding complete soy formula to animals, but questions the relevance of the rodent models used in the majority of the animal studies reviewed. He says animal studies should include pigs, which "are much better models of humans exposed to soy formula."

Two ongoing studies in human infants may fill some of the data gaps, although they will not necessarily address the potential long-term impacts on female reproductive function identified in the laboratory animal studies. The ongoing Arkansas Children's Nutrition Center Prospective Cohort Study (The Beginnings Study) is following children from age 4–8 weeks through 6 years,⁴ while the recently launched Infant Feeding and Early Development (IFED) study, conducted by NIEHS researchers in collaboration with pediatricians at the Children's Hospital of Philadelphia, will follow 600 infants over their first two years of life.

"The IFED study uses detailed, specific measures of estrogen exposure, similar to those used in the laboratory, to evaluate human infants," says principal investigator Walter Rogan, head of the NIEHS Pediatric Epidemiology Group. "Their main exposure to estrogen has been from their own mothers, who had very high levels of estrogen in their blood while they were pregnant." Rogan says normal infants respond to this estrogen—for example, all newborns have



The NTP, which assigns levels of concern on a 5-point scale, has judged soy formula to be of "minimal concern" for human health.

breast buds—but the effects wane after birth. "We think that a slower disappearance of those effects is a very sensitive way of measuring whether the baby is exposed to any estrogen." Rogan says the IFED study will aid in translating the effects seen in laboratory experiments into predictions for human health, not just for soy formula but also for other chemicals such as phthalates and bisphenol A.

Still more studies will be necessary, says Susan Schantz, chair of the Pharmacology/Toxicology Division at the University of Illinois at Urbana–Champaign. "Adverse effects of early exposure to the dietary estrogens in soy may not manifest themselves during the first year of life," she explains. "In order to completely and adequately assess the health risks, infants who consume soy infant formula need to be followed prospectively to puberty and beyond."

So what is the bottom line on soy formula use? The American Academy of Pediatrics states there is no conclusive evidence that dietary soy isoflavones harm human development, reproduction, or endocrine function, but notes that soy formula should be used only in limited circumstances in place of cow's milk formula, such as in cases of infant lactase deficiency.⁵ Meanwhile, the final NTP opinion is expected by fall 2010.

Tanya Tillett, MA, of Durham, NC, is a staff writer/editor for *EHP*. She has been on the *EHP* staff since 2000 and has represented the journal at national and international conferences.

REFERENCES

1. National Toxicology Program, National Institute of Environmental Health Sciences. Draft NTP Brief on Soy Infant Formula. Washington, DC: National Institutes of Health, U.S. Department of Health and Human Services (2010).
2. Cimafranca MA, et al. *Biol Reprod* 83(1):114–121 (2010).
3. Badger TM, et al. *J Am Coll Nutr* 24(2):1465–1495 (2005).
4. Arkansas Children's Nutrition Center Prospective Cohort Study (The Beginnings Study) homepage. Available: <http://www.uams.edu/acnc/beginnings.html> [accessed 13 July 2010].
5. Bhatia J, et al. *Pediatrics* 121(5):1062–1068 (2008).

RESEARCH ISSUES AND INITIATIVES

Cancer Report Examines Environmental Hazards

In its new report, *Reducing Environmental Cancer Risk: What We Can Do Now*, the President's Cancer Panel (PCP) for the first time highlights the contribution of environmental contaminants to the development of cancer.¹ The panel also points out the great need for increased research on environmental risk factors. In a letter to the President that prefaces the report, the panel wrote that "the true burden of environmentally induced cancer has been grossly underestimated."

The PCP was established in 1971 by the National Cancer Act, the first salvo in former President Nixon's "war on cancer." The panel annually reports to the president on the activities of the National Cancer Program, which Jennifer Burt, special assistant to the PCP, describes as "anything that has to do with cancer in the United States." Current panelists are Margaret Kripke of the University of Texas MD Anderson Cancer Center and LaSalle D. Leffall of Howard University College of Medicine, both appointed by George W. Bush; an open third position awaits appointment by the Obama administration, Burt says.

Past PCP reports have focused on the contribution of lifestyle to cancer, but Kripke says those reports were criticized for not reviewing the contribution of environmental exposures. The panel therefore chose to dedicate this report to environmental risk factors. In developing the report, the panel reviewed more than 400 scientific reports and heard testimony from 45 invited experts at four public meetings.

The report outlines research on consumer products, combustion by-products, and agricultural chemicals used in residential and commercial landscaping. It highlights cancer attributable to radiation and points out that military activities and unnecessary medical X rays are sources of exposure that can increase cancer risk, especially among children.

Although 60% of U.S. cancer deaths are attributed to lifestyle factors such as smoking, lack of exercise, and poor diet,² the factors

contributing to the remaining 40% are a mystery, Kripke says. But the panel did not attempt to characterize the percentage of cancers that might be linked to environmental exposures. "We don't have any real idea of the contribution of environmental factors to human cancer," Kripke says. The report points out that most cancer research focuses on genetic and molecular mechanisms behind the disease.¹

Several environmental scientists were relieved to see the report take such an honest tone about the need for research. "They really point out where we have huge gaps of data," says Deborah Swackhamer, a professor of environmental chemistry at the University of Minnesota and chair of the U.S. Environmental Protection Agency's independent Science Advisory Board. "I think the science they used to back up the report is very mainstream," she adds.

The American Cancer Society (ACS) agrees with 85–90% of the panel's report, says Otis Brawley, ACS chief medical officer. Yet Brawley and other cancer researchers fear the emphasis on environmental factors may divert the general public from making positive lifestyle changes at a time when an estimated 41% of Americans will develop cancer during their lives and 21% will die of the disease.³ Michael J. Thun, vice president emeritus of epidemiology and surveillance research for the ACS, says, "It would be unfortunate if the effect of this report were to trivialize the importance of other modifiable risk factors that, at present, offer the greatest opportunity in preventing cancer."⁴

Catherine M. Cooney, a science writer in Washington, DC, has written for *Environmental Science & Technology* and *Chemical Watch*.

REFERENCES

1. Reuben SH. *Reducing Environmental Cancer Risk: What We Can Do Now: 2008–2009 Annual Report*, President's Cancer Panel. Bethesda, MD:National Cancer Institute (2010).
2. Reuben SH. *Promoting Healthy Lifestyles: Policy, Program, and Personal Recommendations for Reducing Cancer Risk: 2006–2007 Annual Report*, President's Cancer Panel. Bethesda, MD:National Cancer Institute.
3. Horner JM, et al., eds. *SEER Cancer Statistics Review, 1975–2006* [Internet]. Bethesda, MD:National Cancer Institute; based on November 2008 SEER data submission, posted to the SEER Web site, 2009 [cited 2009 Jul 19]. Available: http://seer.cancer.gov/csr/1975_2006/.
4. Sampson D. 2010. Cancer and the environment [blog entry]. 6 May 2010. Available: <http://acspressroom.wordpress.com/2010/05/06/cancer-and-the-environment/> [accessed 13 July 2010].

The Beat

by Erin E. Dooley

FDA Urges Judicious Use of Antimicrobials in Livestock

In June 2010 the U.S. FDA issued draft guidance calling on food animal producers to use medically important antibiotics for food-producing animals only when necessary and with veterinary oversight.¹ The agency

proposes to phase in voluntary measures that would limit antimicrobial use in animals in a bid to limit the development of drug-resistant bacteria. The FDA is most concerned about limiting the use of drugs given to promote growth in animals and those that are administered continuously through feed and water. The draft guidelines will be open for comment through the end of August.

Link Between Air Pollution, Temperature, and Sleep-Disordered Breathing

Researchers have found novel evidence for a link between air pollution and diminished sleep quality, a potential intermediate step toward cardiovascular disease.² Using data from the Sleep Heart Health Study, the researchers found evidence that increases in PM₁₀ and temperature independently affected nighttime hypoxia and sleep-disordered breathing, a group of conditions that includes sleep apnea and may affect up to 17% of U.S. adults. Although sleep-disordered breathing and air pollution have

both been linked separately to an increased risk for cardiovascular disease, it is not yet known whether or how air pollution might adversely affect cardiovascular risk by increasing sleep-disordered breathing.

Some Organic Pesticides Not So Clean

A two-year study has found that, compared with several new synthetic insecticides, some organic insecticides were more harmful to predator organisms (which help control target pests) and had a more negative overall environmental impact.³ In addition, in order to effectively control pests, organic pesticides often were used in higher volumes. The authors conclude that all pesticides must be evaluated using an empirically based risk assessment, "because generalizations based on chemical origin do not hold true in all cases."

Gulf Oil Spill Response Map

Geoplatform.gov/gulfresponse is a new online resource developed by NOAA



REMEDIATION

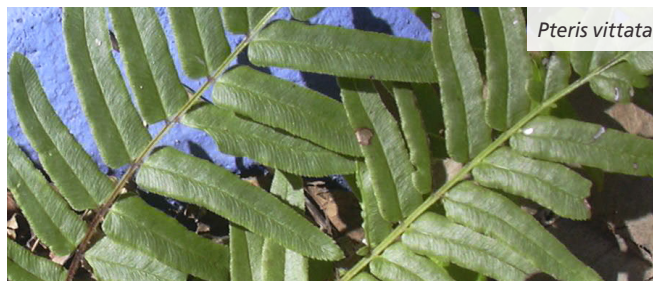
The Gene behind Arsenic Hyperaccumulation

Pteris vittata (brake fern) has been shown to accumulate large amounts of arsenic taken up from soil,¹ in one study removing more than a quarter of the soil arsenic within 20 weeks.² Now researchers have isolated the gene responsible for this feat: *ACR3*, which encodes a protein that pumps the metal into the vacuoles of plant cells.³ “Plants sequester toxicants in these vacuoles—we call them the plant’s trash can,” says principal investigator Jo Ann Banks, a professor of botany at Purdue University.

ACR3 is an arsenite efflux transporter gene found only in gymnosperms (nonflowering plants).³ Banks and horticulturist David Salt, also of Purdue University, identified *ACR3* in *P. vittata* by using a mutant yeast strain that lacks *ACR3* and dies when exposed to arsenic. The team inserted thousands of genes from *P. vittata* and found the one that corrected the deficiency, allowing the mutant to tolerate arsenic. They also showed that arsenic exposure stimulated *ACR3* activity. Fern gametophytes grown in an arsenic-laced medium produced 35 times more *ACR3* transcripts than those grown without arsenic. Moreover, ferns grown hydroponically in arsenic medium confirmed that *ACR3* activity was also highly induced in the roots.

As for what happens when the arsenic-laden plants die, Banks says, “The plants are ashed or composted to reduce biomass. There are a few labs researching how to convert the leftover arsenic into nontoxic organic arsenic compounds.”

Ferns are not the only plants that sequester arsenic. Crops such as rice have been shown to accumulate levels of arsenic high enough to threaten human health,⁴ making it important to learn how plants transport, store, and tolerate arsenic. Such information could lead to ways to manipulate rice plants to restrict arsenic to the roots and prevent contamination of edible grains. “Or we may even devise a way to keep rice plants from taking up arsenic at all,” says Banks.



“If this gene can be cloned into problematic crops such as rice, arsenic burdens in edible parts may be greatly reduced,” agrees Andrew Meharg, chair of biogeochemistry at the University of Aberdeen, United Kingdom. He adds that the new study “is a major advance in our understanding of how plants that concentrate high levels of arsenic are able to tolerate the toxic element.”

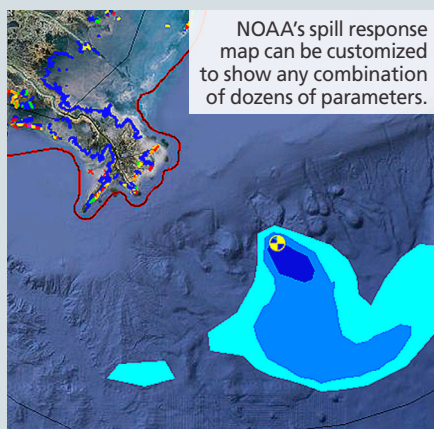
Landscapers currently plant *P. vittata* to clean up soils contaminated with arsenic from pesticides and pressure-treated lumber.⁵ However, the fern naturally grows only in warm climates such as Florida. Perhaps cold-tolerant plants could be programmed with *ACR3* to hyperaccumulate arsenic, too. Joseph Graziano, a professor of environmental health at Columbia University in New York City, notes, “It seems possible that the discovery of this gene could lead to the creation of genetically modified plants or trees with the ability to remove significant amounts of arsenic from contaminated soils.”

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

REFERENCES

1. Ma LQ, et al. *Nature* 409(6820):579 (2001).
2. Tu C, et al. *J Environ Qual* 31(5):1671–1675 (2002).
3. Indriolo E, et al. *Plant Cell*; doi:10.1105/tpc.109.069773 [online 8 June 2010].
4. Zhu YG, et al. *Environ Pollut* 154(2):169–171 (2008).
5. EPA. Crozet Phytoremediation. Contaminated Site Clean-Up Information [website]. Washington, DC:U.S. Environmental Protection Agency. Available: <http://cluinfo.org/studio/video/#701> [accessed 13 July 2010].

Forest Starr & Kim Starr



in partnership with other agencies and stakeholders to offer near real-time data on the federal response to the *Deepwater Horizon* oil spill in the Gulf of Mexico. Visitors can use an interactive map to plot the latest available information about the spill’s trajectory, fishery closures, wildlife data, and locations of deployed research vessels. The map also highlights coastal areas where oil and tar balls have been observed

and gives details about the extent of these problems and the environmental sensitivity classification of the affected areas.

EPA Proposes New Power Plant Pollution Regs

Emissions from power plants can be transported hundreds of miles, affecting the health of populations far from the pollution’s source. The U.S. EPA has proposed regulations to curb emissions of sulfur dioxide and nitrogen oxides at their source.⁴ The proposed regulations would take the place of the 2005 Clean Air Interstate Rule, which the DC Circuit Court ordered the EPA to revise in 2008. The proposed regulations outline three possible approaches for emissions reductions, all of which involve some version of a cap-and-trade system.

Oil Spills May Affect Seawater Arsenic Levels

Recently published work suggests oil pollution may render the seafloor unable to filter out arsenic that occurs naturally

in the ocean and is introduced by drilling operations and oil spills.⁵ Sediments on the seafloor naturally bind arsenic, removing it from seawater. The authors of the new laboratory study found that low pH levels in seawater created a positive charge on samples of goethite (an iron oxide that is one of the most abundant compounds in ocean sediments), which then attracted negatively charged arsenic. Adding oil to the water created a physical barrier on the goethite and weakened the attraction between the two minerals. If oil pollution causes similar effects in ocean waters, the authors speculate arsenic may concentrate in the food chain to potentially harmful levels.

REFERENCES

1. FDA. The Judicious Use of Medically Important Antimicrobial Drugs in Food-Producing Animals. Draft Guidance. Washington, DC:Center for Veterinary Medicine, U.S. Food and Drug Administration. 28 June 2010.
2. Zanobetti A, et al. *Am J Respir Crit Care Med*. doi:10.1164/rccm.200912-1797OC [online 27 May 2010].
3. Bahlai CA, et al. *PLoS ONE* 5(6):e11250. doi:10.1371/journal.pone.0011250 (2010).
4. EPA. Air Transport [website]. Available: <http://www.epa.gov/airtransport> [accessed 13 July 2010].
5. Wainippee W, et al. *Water Res*. doi:10.1016/j.watres.2010.05.056 [online 9 June 2010].

NOAA