

It is in the admission of ignorance and the admission of uncertainty that there is a hope for the continuous motion of human beings in some direction that doesn't get confined, permanently blocked, as it has so many times before in various periods in the history of man.
Richard Feynman, U.S. physicist (1918–1988)

MARINE AND COASTAL SCIENCE

Red Tide Chokehold

The waters of the Gulf of Mexico regularly erupt with algal blooms known as Florida red tides, caused by overgrowth of the dinoflagellate *Karenia brevis*. These particular red tides release potent neurotoxins called brevetoxins. Several recently published papers help to clarify the health effects of shoreline brevetoxin aerosols, particularly for asthmatics and pregnant women. The papers were published by a team of researchers from seven institutions and funded by the NIEHS, the CDC, and the Florida Department of Health.

People who eat brevetoxin-contaminated bivalves (such as clams and oysters) develop acute gastrointestinal and neurological symptoms. When brevetoxin aerosols blow ashore, people may experience irritated eyes, coughing, and wheezing. Symptoms generally subside in healthy people once they leave the beach or enter air-conditioned buildings. Asthmatics, however, are more vulnerable to red tide aerosols, reports Lora Fleming, an epidemiologist at the University of Miami School of Medicine and Rosenstiel School of Marine and Atmospheric Sciences, with her colleagues in the January 2007 issue of *Chest*.

The team measured aerosol brevetoxin exposures and monitored symptoms in 97 asthmatics who visited Sarasota's Siesta Beach during two active *K. brevis* blooms and three lull periods. Lung function was measured by spirometry before and after one-hour beach outings. During blooms, all participants reported an increase in symptoms (especially chest tightness) after beach exposure, and spirometry values uniformly decreased. No differences in symptoms or spirometry values were detected during lulls in *K. brevis* blooms. People with more severe asthma showed greater changes in pre- and post-beach spirometry values during red tide blooms, compared to those with mild/moderate asthma. Fleming advises sensitive people to avoid beaches when *K. brevis* is blooming and winds are blowing toward shore.

Pregnant women, too, should consider avoiding beaches during *K. brevis* blooms. Janet Benson, an inhalation toxicologist at the Lovelace Respiratory Research Institute, coordinated the first study ever of placental transfer of brevetoxins, published in the December 2006 issue of *Toxicol.* Pregnant mice received a radioactive form of brevetoxin-3, a major component of brevetoxin aerosols detected along beaches. The toxin and its by-products were identified in fetuses and uterine and placental tissues 48 hours

later, as well as in the stomachs of nursing pups born to brevetoxin-exposed mothers. "The doses given pregnant mice were high and not representative of what humans are exposed to," says Benson. Still, the results suggest that pregnant or nursing women exposed to brevetoxins may pass them to their fetuses or babies.

Animal experiments have shown that brevetoxins localize in the cerebellum, though little was known about how inhaled brevetoxins affect the brain. In the December 2006 issue of *Inhalation Toxicology*, however, the team reports that when mice inhaled brevetoxin-3 for two days, neuronal damage was observed largely in the posterior cingulate/retrosplenial cortex, but no behavioral changes occurred. The findings add to accumulating evidence that inhaled brevetoxins disperse to several body sites, though coauthor Daniel Baden, director of the Center for Marine Science at the University of North Carolina, Wilmington, says it's too early to extrapolate to humans.

Baden, who has studied brevetoxins since 1973, says Florida red tides are occurring more frequently and often last for months. Although largely confined to the coastline along the Gulf of Mexico, *K. brevis* can travel as far north as North Carolina. Onshore concentrations of brevetoxin aerosols associated with reported respiratory symptoms range from 0.5 to 108 ng/m³. However, Baden says, "As far as we're concerned, there is no dose that is low enough to not be of concern." People have reported experiencing symptoms associated with brevetoxin exposure even when levels of the toxins were so low as to be undetectable by sophisticated monitors.

Are changes in global climate adding to the problem of Florida red tides? Scientists are studying whether changing ocean temperatures, currents, and weather patterns associated with climate change may be affecting Florida red tides. "Climate change is a concern, especially with recent blooms lasting longer, but we don't have hard data yet," says Barbara Kirkpatrick, manager of the Environmental Health Program at the Mote Marine Laboratory in Sarasota and a coauthor of the *Chest* paper. Her colleagues at the Mote Marine Laboratory have placed different types of sensors in several locations to monitor Florida red tide blooms and climate conditions. "It's going to take long-term data sets to make conclusions," Kirkpatrick says. —Carol Potera



A *K. brevis* bloom approaches Coquina Beach, Florida, in 2006

WOMEN'S HEALTH

Mining for Glyceollins

In recent years, agricultural scientists have begun to explore novel strategies for isolating plant compounds of potential medicinal value. One such strategy involves exploiting the defense mechanisms of the plant in order to elicit the production of novel antimicrobial compounds called phytoalexins, which the plants synthesize in response to infection, freezing, and other forms of stress. A recent study spearheaded by researchers at the Tulane Cancer Center and Center for Bioenvironmental Research demonstrates that glyceollins, the main phytoalexins produced by soybeans, may prove to be highly effective in blocking the growth and spread of gynecologic cancers.

Glyceollins are metabolites of the well-studied isoflavone daidzein, and they appear to have more potent bioactivity than the isoflavones in standard soy protein. In work published 1 December 2006 in *Clinical Cancer Research*, the researchers used a procedure developed at the USDA's Southern Regional Research Center in New Orleans to isolate a mixture of glyceollins I, II, and III. The compounds were extracted from newly germinated soybeans that had been challenged with the food-safety fungus *Aspergillus sojae*.

Previous research by the same team, published in the April 2001 issue of the *Journal of Clinical Endocrinology & Metabolism*, had shown that glyceollins had a marked antiestrogenic effect on estrogen receptor signaling. The new study focused on the effect of the glyceollin mixture on the growth of human estrogen-dependent MCF-7 breast cancer cells and BG-1 ovarian cancer cells. Malignant cells were grafted onto female ovariectomized mice, which were then divided into four treatment groups: control, estradiol only, glyceollins only, and estradiol plus glyceollins. All doses were 20 mg/kg/day.

The researchers report that the glyceollins suppressed MCF-7 tumor growth by 53.4% and BG-1 tumor growth by 73.1%, compared to estradiol alone. In addition, the glyceollins completely suppressed estradiol-induced expression of progesterone receptors in MCF-7 cells and partially suppressed their expression in the BG-1 cells. Thus, glyceollins seem to exert their anticancer activity, in part, by interfering with the cancer cells' ability to respond to estradiol, the most potent

endogenous estrogen and a major growth stimulus for breast and ovarian cancers.

Tulane cancer researcher and report coauthor Matthew Burow asserts that the compounds may eventually play a role in breast cancer prevention and treatment. "Of particular interest is the fact that glyceollins seem to be acting like pure antiestrogens," he notes. "They show antiestrogen effects in the absence of significant estrogenic or uterotrophic activity. This distinguishes them from other phytoestrogens and more importantly from the antiestrogen drug tamoxifen, which is widely used [for breast cancer control] but has been linked with increased risk of uterine cancers."

Burow adds that some women resist using tamoxifen and other antiestrogenic drugs because of the potential side effects, and for this reason the chemopreventive potential of glyceollin-enriched soy merits further study. He cites a study that he and colleagues from Wake Forest University published in volume 56, issue 1 (2006) of *Nutrition and Cancer*, which found that glyceollin-enriched soy protein had antiestrogenic effects on normal breast tissue in postmenopausal female monkeys.

Another medical application that may stand to benefit from glyceollin research is hormone replacement therapy, which remains the most effective means for staving off menopausal symptoms and chronic diseases such as osteoporosis. However, hormone replacement therapy carries with it a small increase in breast cancer risk. "The Tulane findings, coupled with the findings from our recent primate study, point to the possibility that the co-administration of soy enriched with glyceollins might diminish the breast cancer risk associated with hormone replacement therapy for peri- and postmenopausal women," says Thomas B. Clarkson, a professor of comparative medicine at Wake Forest University.

The Tulane research has illuminated new opportunities for both drug development and a greater understanding of environmental influences on biological systems. "This study is a fascinating example of the potential for mining the biochemistry of plants," says J. Mark Cline, a pathology professor at Wake Forest University who collaborated with Burow and Clarkson on the primate study. "It tells us that we should be paying attention not only to diversity between plant species, but also to biochemical differences within [the same] type of plant under different conditions of culture or stress." —**M. Nathaniel Mead**

Global Map of Malaria Risk

Scientists from the University of Oxford and the Kenya Medical Research Institute have just completed the first data-gathering stage of the Malaria Atlas Project, which will identify populations most at risk for malaria and predict the disease's impact.

Malaria data have been gathered from more than 3,000 communities in 79 countries. A final map will be generated using data from satellites, censuses, and other sources, with statistical methods filling in data gaps.

Policy makers and funding agencies can utilize this information to better target resources. The open-access project is described in the December 2006 edition of *PLoS Medicine*.



China Top CO₂ Producer by 2010

An International Energy Agency report issued in November 2006 estimates that China will overtake the United States as the largest producer of carbon dioxide by 2010, a decade sooner than earlier studies projected. A large percentage of the carbon dioxide emitted in the world comes from coal consumption. Seventy percent of China's energy comes from coal, which is cheap and abundant in that country. China has stated it will try to limit coal production to 2.6 billion metric tons by 2010, but experts say this goal will probably not be met—the Chinese government is planning 500 new coal-fired power plants to meet the nation's energy demands.

Airline Rules Stir Up Controversy

In December 2006 the European Commission proposed new rules to regulate greenhouse gas emissions from the airline industry. Such emissions have increased 87%

since 1990, and by 2020 are expected to more than double over present levels. The regulations place a cap on carbon dioxide emissions, with each airline receiving a set number of pollution allowances each year. Those using up their allowances must buy carbon credits from companies that still have them. As proposed, the rules will apply by 2012 to all flights to and from airports within the European Union. However, U.S. industry and government officials feel the rules violate international trade agreements and may fight the regulations if they are passed.



INITIATIVES

New Voice for the Environment

Intelligent design or Darwinian evolution? Life created in seven days or evolving over billions of years? Religion and science have traditionally been at loggerheads over issues like these, but in January 2007 a group of scientists and evangelicals put aside their differences to battle environmental woes such as climate change and species extinction. Under the auspices of the Harvard Medical School Center for Health and the Global Environment and the National Association of Evangelicals (NAE), scientists including biologist E.O. Wilson, climate researcher James Hansen, and botanist Peter Raven have joined forces with evangelical leaders to form a new group to educate law makers and the public about global environmental threats.

The coalition grew out of a lunchtime conversation between Eric Chivian, director of the Harvard center, and Richard Cizik, vice president for governmental affairs of the NAE, in which they realized that scientists and evangelicals shared a deep concern about the planet's future and felt a moral obligation to act. "Whether you believe life was created in a millisecond or over three and a half billion years—that wasn't the issue," says Chivian. "The issue was that life on Earth is imperiled, and that we had to do something about it together." The result was a retreat for 28 leading scientists and evangelicals in late November 2006, out of which the coalition was born.

Cizik says the NAE represents more than 45,000 U.S. churches with more than 30 million members who will now be further encouraged to work on environmental issues. Members of the coalition have already begun meeting with congressional representatives. The churches themselves are organizing various education efforts to mobilize their congregations. For example, a group of pastors are working on a packet that will be distributed to NAE member churches, which will include information such as ten things anyone can do to take care of the environment.

The coalition "makes perfect sense," says Ben Campbell, project director for the Conservation International Faith-Based Initiative, which works cooperatively with religious groups to achieve conservation goals in countries including Columbia, Tibet, and Indonesia: "[Harvard] provides the background science and research, and [the evangelicals] present it in a context that makes sense from a religious standpoint." As Cizik puts it, "We cannot love our neighbor if we allow the consequences of climate change, pollution, habitat destruction, species extinction, and the spread of human infection diseases to go unabated."

The evangelical group's decision to battle climate change has met with some internal opposition from two dozen of the movement's more conservative Christian leaders, who wrote the NAE in early March that environmental issues would take away from the group's other work on core moral issues, such as abortion. But at a meeting later in the month the NAE board of directors reaffirmed the group's stance on environmental issues. —**Nancy Bazilchuk**

PESTICIDES

Toxic Legacy

An ongoing prospective cohort study in New York City reveals for the first time that prenatal exposure to the pesticide chlorpyrifos damages children's neurodevelopment with negative impacts on cognition, motor skills, and possibly behavior. These findings, published in the December 2006 *Pediatrics*, mirror animal studies of the chemical, which the EPA banned for residential use in 2001. Concern persists, though, because children exposed prior to the ban may experience lifelong consequences, and population exposure continues through nonresidential uses.

The cohort study, begun in 1997, focuses on prenatal exposure to ambient and indoor pollutants and effects on neurocognitive development and other end points. The study population comprises inner-city minority women recruited during pregnancy and their children born between February 1998 and May 2002; data collected include biological samples, exposure assessments, maternal interviews, and developmental testing of the children. Of 254 children who had reached their third birthday, those with the highest prenatal chlorpyrifos exposure had significantly

lower scores on mental and motor indices and more problems associated with attention deficits, hyperactivity, and pervasive developmental disorders. Effects were most marked in motor development.

"I'm not surprised that they showed the motor effects as more robust, because at an early age that's mostly what one sees," says Edward Levin, a professor of psychiatry and psychological and brain sciences at Duke University. Development of language and other cognitive skills comes later, as does the ability to control behavior. "It actually follows in very well with the preclinical work identifying the developmental neurotoxicity of chlorpyrifos," Levin says.



Not over yet. Although chlorpyrifos was banned for household use in 2001, today's children still face the threat of neurotoxic effects.

Much of that work was conducted by Theodore Slotkin, a professor of pharmacology and cancer biology at Duke, who characterizes the current study as landmark. "There's a large underpinning of animal research for organophosphate pesticides, and particularly for chlorpyrifos, that points to bad outcomes in terms of effects on brain development and behavior," he says. Extrapolating results from animal studies to human health can be difficult, but this study pinpointed exposures and controlled for numerous variables that generally confound epidemiologic study. Further, he says, the study confirms that all the animal findings that led to the decision to ban use in the home turned out to be true.

"In animal studies [chlorpyrifos-induced] behavioral effects are not reversible. We don't know in children whether the kind of attention problems that appear to be associated with chlorpyrifos exposure are treatable," says lead author Virginia Rauh, an associate professor of clinical population and family health at Columbia University. The researchers will follow the children until they are 10 to 11 years old and possibly longer. "It's important to continue," says Rauh. "The [current] ban is likely not sufficient. We don't know that chlorpyrifos is safe at any level." —**Julia R. Barrett**

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Climate Institute

The Washington, DC-based Climate Institute is a nonprofit organization whose mission is to inform a broad spectrum of decision makers around the world about climate change, to raise international awareness of the issue, and to identify practical means of achieving significant reductions of greenhouse gas emissions. Toward these ends, the organization sponsors conferences, symposia, and ministerial briefings. As the Climate Institute has evolved, it has also begun promoting clean and renewable energy sources as a way to reduce greenhouse gas emissions. These efforts are described online at <http://www.climate.org/>.

The homepage is divided into several sections, including Steps Forward and Steps Back. These two sections contain information ranging from commentaries to meeting reports that describe achievements and challenges in the quest to lessen adverse human



influence on the climate. There is also a What's at Risk? section that addresses issues including how climate change is already affecting the Arctic and how it is likely to affect storm, flood, and drought activity in North America. Popular Culture is the focus of yet another section of the site featuring information on films about climate

change as well as articles on topics such as how religious groups are becoming involved in the climate change issue and how climate change has become a popular theme even for cartoons.

The Programs section of the site describes the Climate Institute's work in climate impacts, energy, international cooperation on climate change issues, and "environmental refugees"—people displaced as a result of problems such as drought, erosion, desertification, and deforestation. The institute also sponsors the Gordon MacDonald Environmental Leadership Program, which offers topical seminars and helps place students and recent graduates in internships and research positions. If monies are secured, the program will also fund the salary of a scientist or policy maker to work at the Climate Institute as well as the travel and living expenses of young scientists from participating institutions as they work on projects with the potential for a significant public impact.

Links in the left-hand column include tools for individuals, such as a personal environmental impact calculator that estimates the yearly impact of individuals and families in the areas of transportation, recycling, water usage, and energy usage. Topic links for sea level rise, extreme weather, ecosystems, air quality, ozone depletion, human health, and more lead to essays and other resources on how these topics relate to climate change. The site also offers educational materials for students from kindergarten through postdoc level. Resources are grouped by age, with an additional section on useful graphics and other teaching tools such as a climate impacts map. —Erin E. Dooley

The Sting of Climate Change

The number of people treated for jellyfish stings in Australia doubled to 26,000 between 2005 and 2006. An Australian jellyfish expert warns that the number of people stung each year could continue to rise as rising ocean temperatures may result in longer jellyfish seasons and larger jellyfish populations. Lisa-Ann Gershwin, an advisor to Surf Life Saving, also says that jellyfish, an ancient species, are "very good at taking advantage of changing conditions." The nonstinging *Mnemiopsis leidyi*, for instance, thought to have been introduced to the Black and Caspian Seas via ballast water, has flourished to the point of decimating local ecosystems.



Antimicrobial Nanoparticles to Be Regulated

The U.S. EPA announced in November 2006 that it would begin regulating consumer items made with nanoparticles of silver, the first time the agency has regulated any nanomaterial. Among the products made with these bactericidal nanoparticles are food-storage containers, air fresheners, shoe liners, and washing machines. Environmentalists worry that the growth of this technology may contribute to the killing off of beneficial bacteria and aquatic organisms, with adverse ramifications for human health. Only products that claim to kill germs will be affected by the rules.

Asbestos Found in Korean Subways

Inspectors with the Seoul Metro subway in South Korea found asbestos in passenger-accessible sections of 17 of 30 subway stations they inspected in the winter of 2006.

This follows a January 2004 *Environment International* study that found that Korean repair workers were being exposed to chrysotile and tremolite fibers in the subway. Asbestos was used in the construction of the stations to absorb noise and vibration from trains and is mainly present in ceiling tiles and insulation. Seoul Metro issued a statement on 22 January 2007 that it will remove the asbestos, though experts in Korea say the lack of trained asbestos removal specialists in the country will make it difficult to complete the job safely and effectively.

