EDCs in Singapore Seawaters

Mixtures May Multiply Effects

A number of chemicals that end up in the waste stream—pesticides, some polychlorinated biphenyls, dioxins, synthetic steroids, and excreted drugs—can disrupt hormone signaling in vertebrates. These endocrine-disrupting compounds (EDCs) can interfere with both androgens and estrogens, which are responsible for the development of male and female sex characteristics, respectively. This month, Yinhan Gong and colleagues at the National University of Singapore report that enclosed marine waters near industrial areas can contain high concentrations of EDCs [***EHP* 111:1448–1453**]. In addition, complex mixtures of compounds in these waters can dramatically amplify the effects of androgens and estrogens in human cells.

Gong and colleagues collected seawater samples from 21 locations off the Singapore coast near industrial sites such as shipyards and petrochemical plants. Samples were collected from enclosed areas with little tidal action to disperse pollutants as well as from areas with greater tidal flow.

In their experiment, the researchers used human cell lines expressing the androgen receptor (AR) and the two estrogen receptors (ER-α, which is expressed primarily in reproductive tissues such as the breast and uterus, and ER-β, which is found in other parts of the body, including the cardiovascular and nervous systems). They exposed the cell lines to several different types of samples: (1) seawater extracts from each sampling area, (2) extracts from each area in combination with dihydrotestosterone (DHT), an androgen with many of the same effects as testosterone, (3) extracts from each area in combination with 17β-estradiol (E_2), the primary form of estrogen produced by vertebrates, (4) DHT alone, and (5) E_2 alone. As controls, cells were exposed to ultrapure water and tap water from the Singapore water system.

All of the seawater extracts caused some EDC activity in the cell lines. Samples derived from enclosed waters caused the greatest activity; the researchers calculate that in the open waters, the activity would be the equivalent of up to 3% of the AR activity caused by DHT alone. When the cells were exposed under similar assay conditions to the extracts from enclosed waters in combination with DHT, AR activity increased to 200–900% of that caused by DHT alone, an interaction the researchers call an "exaggerated additive effect."

Results were similar for ER-α. Samples derived from enclosed waters stimulated ER-α activity by the equivalent of up to 7% of that caused by E_2 alone, but activity increased ninefold in cells that were exposed to the extracts in combination with E_2. Samples from more open waters did not cause this exaggerated additive effect. None of the seawater samples caused a significant increase in the activity of ER-β receptors, either alone or in combination with E_2.

The authors conclude that the combined, holistic effects of EDCs in complex marine environments may be strikingly different from what can be predicted from the constituent compounds. Because many vertebrates and some shellfish respond to the same hormones, compounds that disrupt hormone signals in marine fish and shellfish may do the same in humans. According to the researchers, the levels of hormone activity generated by the waters off Singapore may be high enough to affect hormone signaling in marine life, especially after prolonged exposure or bioaccumulation in the food chain. For example, the highest levels of ER-α activity calculated for raw seawater were in the range of the sera of women in mid–menstrual cycle. These results may also have implications for human health, because the waters off Singapore are used for seafood farming and recreation, and have been considered as sites for desalination plants. **–Kris Freeman**

Singapore synergy. New research provides evidence of a synergistic effect of endocrine-disrupting compounds in seawater off the coast of Singapore.

The Simple Truth about MCS

Low-Tech Solutions for Real Suffering

Multiple chemical sensitivity (MCS), characterized by a hypersensitivity to common household chemicals such as cleaning agents and pesticides, is becoming an acknowledged medical disorder, although debate continues as to whether a psychological component underlies development of the illness. Because MCS is not well understood, no one is sure how best to treat it. This month, researchers led by Pamela Reed Gibson of the James Madison University School of Psychology present survey findings that shed light on what best helps MCS sufferers, as well as the lengths to which they will go for relief [***EHP* 111:1498–1504**].

The investigators surveyed 917 people with self-reported MCS, whom they contacted through the Chemical Injury Information Network, a nonprofit support and advocacy organization. The survey included questions about demographics, the impact of having MCS on the respondent's finances, the number of practitioners seen, and efficacy ratings for any of 108 different treatments the respondent might have tried. The treatments fell into nine categories: environmental medicine and "oasis" techniques (e.g., creating environments with fewer chemical exposures), holistic therapies (e.g., aromatherapy), nutritional supplements (e.g., vitamin E), detoxification techniques (e.g., removal of mercury-containing fillings), Eastern-origin

Photodisc

techniques (e.g., tai chi), body therapies (e.g., massage), so-called newer therapies (e.g., eye movement desensitization and reprocessing), prescription drugs (e.g., Prozac, Valium), and other remedies (e.g., prayer, psychotherapy).

The investigators found that, over the course of their illnesses, the respondents had consulted a mean of 12 health care providers and spent a mean total of $51,000 on MCS-related health care costs. The remedies the participants tried met with mixed success, but a full 95% of survey respondents rated reducing exposure to chemicals as somewhat or very helpful. Treatments that participants rated as least effective and most harmful given potential side effects were taking various types of antidepressants, antiseizure medications, and tranquilizers.

Evidence that the best strategies are also fairly noninvasive and low-risk may be welcome news to MCS sufferers (however, with respondents reporting spending an average of $57,000 to lessen chemical exposures in their homes, these strategies are still quite expensive). The survey results may also be used by those affected by MCS to help weed out fraudulent treatments that are often offered to desperate MCS sufferers.

Gibson's findings dovetail with those of another new study presented in this issue, in which Georgia researchers Stanley M. Caress and Anne C. Steinemann found both that MCS is a common and serious condition and that sufferers had little history of depression, anxiety, or other emotional problems before MCS was diagnosed [***EHP* 111:1490–1497**]. The researchers found in a random sampling of 1,582 individuals from the Atlanta metropolitan area that 12.6% of respondents reported a hypersensitivity to common chemicals. Among 13.5% of these, the problem was so bad that they lost their jobs. Only 1.4% of respondents reporting MCS had a history of emotional problems before their physical symptoms occurred, but 37.7% reported developing such problems afterwards, suggesting that MCS has a physiologic and not a psychologic etiology. **–Renée Twombly**

Coiled to strike? Although effective at combatting mosquitos, chemical-emitting coils may pose unintended hazards to respiratory health.

A Downward Spiral?

The Hazards of Mosquito Coils

In many tropical and subtropical countries, burning mosquito coils is a key strategy for reducing mosquito bites. But while mosquito bites can be particularly dangerous in these areas due to endemic mosquito-borne diseases such as malaria, the prophylaxis may pose its own hazards. In this issue, Weili Liu of the University of Medicine and Dentistry of New Jersey and colleagues present a laboratory study of the indoor air pollution created by six popular brands of mosquito coils from China and Malaysia [***EHP* 111:1454–1460**].

Coils typically contain 0.3–0.4% pyrethrin insecticides by weight, with the balance being combustible materials chosen for their ability to smolder without flame. Although the plant-derived pyrethrins are relatively nontoxic to humans, the health effects of burning the binders, fillers, and dyes composing the other 99%-plus of the coils are uncertain, especially considering the intensive, long-term exposure: coils are typically burned all night for several months or even all year (depending on mosquito conditions) in rooms where ventilation is often limited to increase the coils' effectiveness.

The researchers burned the test coils in a 0.15-cubic-meter chamber and a 32-cubic-meter room, and periodically withdrew air samples for analysis of concentrations of particulate matter, polycyclic aromatic hydrocarbons, aldehydes, and volatile organic compounds.

The particulate concentrations peaked in two size ranges, 0.01–0.1 micron and 0.2–0.3 micron. These ultrafine and fine particles lodge deep in the lung, and in other studies have been implicated in lung disease and premature deaths from all causes. The researchers calculated that 1 coil released as much particulate matter 2.5 microns in diameter or smaller ($PM_{2.5}$) as would be released from 75–137 cigarettes. In terms of estimated ambient room concentrations, the researchers made a "conservative estimate" that $PM_{2.5}$ was six times higher than the U.S. National Ambient Air Quality Standard for 24-hour exposure.

The smoke contained three polycyclic aromatic hydrocarbons classified by the U.S. Environmental Protection Agency as probable human carcinogens—benzo[*a*]pyrene, benzo[*b*]fluoranthene, and benzo[*k*]fluoranthene. The researchers also found relatively high concentrations of volatile organic compounds such as benzene, a neurotoxicant and carcinogen that can affect bone marrow with chronic exposure.

In addition to the possible long-term damage that many of the mosquito coil pollutants may cause, the researchers concluded that significant acute health effects, including asthmatic reactions and eye and respiratory irritation, could be expected from exposure to the combustion product acrolein.

The incomplete combustion seen in mosquito coils also occurs when biomass fuels such as cow dung, crop residue, and wood are burned. In other studies, use of these fuels has been correlated with respiratory diseases including chronic obstructive pulmonary disease. However, in making their analysis, the authors did not try to evaluate the overall health impact of mosquito coils—they did not, in other words, balance the benefits of reduced exposure to malaria and other mosquito-borne diseases against the smoke-related impacts of the coils.

They did note, however, that the Chinese coils emitted significantly less particulate matter, perhaps due to the material used as a smoldering agent (the Chinese products were thought to contain more sawdust, whereas the Malaysian coils were based on coconut husks and shells). The researchers suggest that the health impact of mosquito coils could be reduced, regardless of whether smokeless mosquito controls (such as window screens) are adopted, by switching to a less-polluting formulation. **–David J. Tenenbaum**

Junfeng Zhang