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CONTENTS

Click on title to link directly to article.

RESEARCH

Comprehensive Report on EDCs Published.....3

Function of Microzooplankton in Aquatic Food Webs Explained.....4

New Chemicals Biomarkers Found in Microorganism Causing Red Tides.....5

Ecological Stress Indicators Analyzed in 345 Northeastern Lakes.....6

PUBLICATIONS

Proceedings Issued on Arsenic Exposure and Health Effects 7

Ultra-Low Levels of PAHs Measured in Seawater Above Contaminated Sediments..8

AWARDS

Division Director Presents Award Lecture.....9

RESEARCH

Comprehensive Report on EDCs Published

Dr. Lawrence Reiter, Director of the National Health and Environmental Effects Research Laboratory (NHEERL), chaired a 14-member international steering committee that provided oversight, expertise, and guidance for the first international assessment of endocrine-disrupting chemicals (EDCs), recently published as a draft report entitled "Global Assessment of the State-of-the-Science of Endocrine Disruptors." More than 1,500 publications are cited in the References section. Issued by the International Programme on Chemical Safety of the World Health Organization/United Nations Environment Programme/International Labour Organisation, this draft report, a global, comprehensive review of the publicly available scientific literature on EDCs, is available at http://ehp.niehs.nih.gov/who/ . The final hard copy version will be published soon.

Dr. Robert Kavlock, Director of the Reproductive Toxicology Division (RTD), served on the steering committee and was one of the editors. Drs. Earl Gray of RTD and Gary Ankley of the Mid-Continent Ecology Division prepared portions of chapters on endocrine modes of action and on effects on amphibian populations, respectively.

The draft report covers critical issues related to EDCs, including dose-response relationships, role of natural and plant hormones, endocrine mechanisms of action, wildlife and human health effects, exposure assessment, and research needs. A framework is then developed for judging whether the weight of the evidence for a particular adverse health outcome is related to a particular chemical exposure, and whether an endocrine-disrupting mode of action is likely to be responsible for the outcome. While the draft report states that there are a number of examples in which wildlife populations have been adversely impacted by exposure to EDCs, the evidence for similar effects in humans is generally considered to be weak. However, the report also states that there is an urgent need for studies in vulnerable populations, particularly

infants and children, because exposure to EDCs during critical developmental periods may have irreversible effects.

EDCs may interfere with hormones that play key roles in the growth, development, reproduction, and behavior of humans and wildlife. Since the early 1990s, EPA research has been addressing several of the key areas of scientific uncertainty identified in this draft report. EPA's in-house laboratories are studying the impact of environmental exposures to EDCs during early development on a variety organisms, including invertebrates, amphibians, fish, and rodents. Through its Science to Achieve Results program, EPA also has funded numerous research grants to academic institutions searching for adverse effects caused by EDCs in exposed populations of humans and wildlife.

Function of Microzooplankton in Aquatic Food Webs Explained

A 16-month field study conducted by Gulf Ecology Division (GED) scientists in Pensacola Bay, Florida, described complex interrelationships among several types of plankton in an aquatic food chain. Dr. Michael Murrell, Dr. Emile Lores, Dr. Guy DiDonato, and Roman Stanley, all of GED, and Dr. D.A. Flemer, formerly of GED and now with the EPA Office of Water, published their research in the February 2002 issue of *Estuaries*.

Historically, an aquatic food chain was thought to be a simple three-step process: (1) Phytoplankton (microscopic plants) are the primary food producers; (2) phytoplankton are consumed by zooplankton; (3) zooplankton are consumed by fish and other higher organisms. This research showed that the "chain" is more complex and web-like because microzooplankton, a diverse group of microscopic organisms, were found to consume a large number of phytoplankton, thus functioning between Steps 1 and 2 of this fish production model.

On average, the microzooplankton in this study directly consumed 62% of the phytoplankton primary food production, which is a very high percentage. This strong biological linkage helps to describe the function of the plankton community, and, ultimately, the functioning of the entire aquatic community. A literature review revealed that microzooplankton play similar roles in a wide variety of aquatic environments, ranging from estuaries to the open ocean. Developing a better understanding of these aquatic food webs is an important research activity at EPA. The results will be used to develop food web models to evaluate the ecological health of estuaries and coastal waters.

New Chemical Biomarkers Found in Microorganism Causing Red Tides

An invited paper from the Gulf Ecology Division (GED) to be published in a summer issue of *Phycologia* describes new biomarkers found in *Karenia brevis*, the principal microorganism causing harmful algal blooms (HABs) or "red tides" in waters off the west coast of Florida. These HABs are responsible for massive fish kills, neurotoxic shellfish poisoning, public health advisories, and large economic losses.

Written by former GED postdoctoral fellow Dr. Jeffrey Leblond and Dr. Peter Chapman of GED and Dr. T.J. Evens of the U.S. Department of Agriculture, the paper reviews the literature on fatty acids and sterols in these marine algae and describes how two unusual new sterols, previously identified by the authors in *Karenia brevis* and several of its closest relatives, are the same two sterols found almost exclusively in samples of algal blooms recovered from the waters of the Gulf of Mexico. The only distinctive chemical biomarkers known previously for *Karenia brevis* and closely related organisms were a few unusual photopigments.

This research provides additional tools to track the development of algal blooms and to investigate the environmental conditions that determine their formation. Knowledge of the physiological and genetic bases for HABs can lead to better

understanding of their responses to environmental stressors, development of predictive models, and, eventually, to implementing plans for mitigation of their harmful effects. One current view on mitigation proposes applying specific clays to adsorb HABs, causing them to settle into sediments. However, the consequences of widespread application of clays and associated agents, with or without adsorbed HABs, to bottom-dwelling organisms are yet to be determined.

Ecological Stress Indicators Analyzed in 345 Northeastern Lakes

Regional-scale analysis of broad environmental changes caused by non-point source nutrient pollution, habitat alteration, introduction of non-natives species, and other stressors is a complex challenge – especially evaluating the relative impacts of the stressors. Although stressors such as non-native fish and human alteration of shorelines are not generally part of environmental monitoring programs, an article published in the March 2002 issue of *BioScience* shows that these stressors may cause more impact than changes resulting from nutrient pollution or acidification. Among the co-authors are Drs. Steven Paulsen, David Larsen, Spencer Peterson, and Philip Kaufmann, all of the Western Ecology Division (WED).

EPA's Environmental Monitoring and Assessment Program (EMAP) began evaluating a multitude of stressors, both traditional and non-traditional, in the 1990s with a survey of 345 lakes in the 8 Northeastern states. Nearly half of the lakes are human-made impoundments, most in lowland ecoregions. As members of the EMAP team, WED scientists quantitatively assessed 5 issues of concern to lake ecosystems: nutrient enrichment (eutrophication), metal contaminants in fish tissue, invasions of non-native species, shoreline disturbances, and acidification.

Sediment data indicated that natural lakes in the Northeast were rarely eutrophic in the past, whereas, in the 1990s, an estimated 24% of lakes and impoundments were considered degraded because they were eutrophic or hypereutrophic. Fish in 24% of

the lakes had mercury concentrations exceeding levels considered safe to human health. The loss of native fish appears to be strongly related to the introduction of non-native fish, which outcompete native fish for food and other resources. Only 21% of lakes had no non-native fish. EMAP data revealed that 23% of lakes had significant human-caused shoreline modifications, such as roads, buildings, lawns, and alteration of natural vegetation. These shoreline modifications are stressors to lake systems via a number of routes, including increases in runoff of soil and nutrients, alteration of cover for lake biota in near-shore waters, and changes in near-shore light and water temperature. Acidification was the least widespread stressor analyzed, with only 2% of lakes found to be acidic and another 12% acid-sensitive.

PUBLICATIONS

Proceedings Issued on Arsenic Exposure and Health Effects

Five NHEERL scientists were among the contributors to a recently published 467-page book, *Arsenic Exposure and Health Effects IV*, the proceedings of the Fourth International Conference on Arsenic Exposure and Health Effects, held in San Diego, CA, June 18-22, 2000. The book, ISBN: 0 08 044067 3, is published by Elsevier Science, Ltd. Dr. Rebecca Calderon of the Human Studies Division (HSD) was one of the presenters and editors; Dr. Dina Schreinemachers and Edward Hudgens of HSD, and Drs. David Thomas and E.M. Kenyon of the Experimental Toxicology Division also gave papers.

The meeting, which focused on the international impact of arsenic, mechanisms of carcinogenesis, metabolism, water treatment technology, and intervention and medical treatment, summarized the state-of-the-art of arsenic worldwide. Co-sponsors included EPA, Society of Environmental Geochemistry and Health, University of Colorado at Denver, International Council on Metals in the Environment, Electric

Power Research Institute, Kennecott Corporation, and the United Nations Children's Fund.

Ultra-Low Levels of PAHs Measured in Seawater Above Contaminated Sediments

Scientists from the Western Ecology Division (WED) and the U.S. Navy have developed a method for measuring ultra-low levels of toxic polycyclic aromatic hydrocarbons (PAHs) released from the surface of contaminated sediments on the sea floor to the seawater immediately above. A benthic flux sampler, developed by the Navy, can be programmed to collect up to six half-liter samples from an enclosed volume of water above a contaminated sediment. Whereas other PAH methods often require 10 or more liters of water, the extraction/quantitation method developed at WED uses only half-liter samples to measure concentrations of PAHs below one nanogram per liter (one part per trillion).

These procedures were tested at the Naval Shipyard in Puget Sound, Washington, where relatively high concentrations of PAHs from petroleum and other fossil fuels were known to occur in the top layer of sediment. During the 2-day sampling periods, toxic PAHs were clearly observed to migrate from the surface of the sediment to the seawater directly above. The resultant concentrations of PAHs in the seawater, however, were no more than 1/1000 of those reported to have any toxic effects on marine organisms.

Drs. David Young and Robert Ozretich of WED and Dr. Bart Chadwick of the Navy Environmental Science Division published this research in Chapter 15 of *Chemicals in the Environment: Fate, Impacts, and Remediation,* American Chemical Society Symposium Series 806, Oxford University Press, 2002.

AWARDS

Division Director Presents Award Lecture

Dr. R. Julian Preston, Director of the Environmental Carcinogenesis Division, delivered the 26th Annual Taylor Lecture to the National Council on Radiation Protection and Measurements (NCRP) in Arlington, Virginia, April 19, 2002. The title of his lecture was “Developing Mechanistic Data for Incorporation into Cancer and Genetic Risks: Old Problems, New Approaches.” Dr. Preston received a commemorative plaque at the reception following his presentation.

Taylor Lecturers have demonstrated a career of excellence in the broad area of radiation protection. Dr. Preston’s lecture showed how mechanistic data could aid in conducting cancer and genetic risk assessments for exposures to ionizing radiations and environmental chemicals. He also predicted that the use of computational biology approaches now being developed would assist in understanding the underlying mechanisms of cancer induction at the tissue level, rather than just at the cellular level.

NCRP is a nonprofit corporation chartered by Congress in 1964 to inform the public on issues related to radiation protection and the interactive effects of radiation with environmental chemicals. The lectures are named for Dr. Lauriston Taylor, the first president of NCRP, who celebrated his 100th birthday this year.