A Wave of Momentum for Toxic Algae Study

As blooms of blue-green algae proliferate in U.S. lakes and rivers, deadly liver and nerve toxins produced by these cyanobacteria loom large on the radar of officials charged with ensuring safe drinking water. Water utility managers commonly treat affected waters to correct taste and odor problems associated with the algae, but scientists are worried about traces of toxins that slip through water treatment processes and their long-term health effects in humans, especially given an increased reliance on surface waters to meet drinking water demands. In Florida, for instance, water treatment officials anticipate that groundwater demands will exceed supply by the year 2020; currently 10–15% of Florida's drinking water is supplied by surface waters.

At a two-hour forum held 12 January 2001 at the NIEHS campus in Research Triangle Park, North Carolina, key players in the study of and fight against cyanobacteria species including *Microcystis*, *Cylindrospermopsis*, and *Anabaena* had the chance to meet and plant the seeds for possible future collaborations in new cyanobacteria research. Arranged by NIEHS staff scientist Gary Boorman, the informal meeting was attended by about 70 people, including public utility managers, water quality officials, and representatives from the U.S. Environmental Protection Agency (EPA) and the U.S. Geological Survey.

The meeting came on the heels of a recommendation for federally sponsored toxicity studies of the most commonly found cyanotoxin, microcystin-LR. The Interagency Committee for Chemical Evaluation and Coordination (ICCEC)—an external review body of the National Toxicology Program (NTP) composed of representatives from the major federal agencies involved in health research—had recommended in October 2000 that microcystin be evaluated by the NTP for chronic toxicity and carcinogenicity in humans. Following a public comment period and subsequent review by appropriate committees, a decision could be made as early as spring 2001 as to whether the chemicals should be studied by the NTP. Boorman says the ICCEC will consider the need to evaluate the toxin cylindrospermopsin this spring.

Florida's situation illustrates the need for more and better information on the human health effects of cyanobacteria. Florida surface waters are significantly contaminated by toxin-producing cyanobacteria. Of 167 samples taken from Florida waters in a 1999 study, 88 samples representing 75 individual bodies of water contained significant levels of toxic cyanobacterial species, says John Burns, Jr., an environmental scientist for the St. Johns River Water Management District in Palatka, Florida. Seventy-eight percent of samples with measurable levels of microcystins and cylindrospermopsin were lethal when injected into mice, and 80% of the microcystin-laden samples showed potential tumor-producing properties.

High levels of cylindrospermopsin also were measured in finished drinking water samples, says Burns. "This suggests that this particular toxin does pass through the drinking water treatment process, at least in some of these plants," he says. Spikes in microcystins have also been found in the state's treated drinking water samples. "I know we have at least one sample that was 10 times the provisional World Health Organization guideline for microcystins [of 1.0 microgram per liter]," he says. Many factors may account for toxins passing through treatment processes, says Burns—the choice of filtering agent, for instance, or the concentration of toxin entering a plant. In addition, Burns says, "A water treatment plant may remove toxins with activated carbon when treating for taste and odor, but if they don't monitor for toxin type and concentration entering the plant, the methods used may not remove or reduce these compounds to safe levels."

Cyanobacteria and their associated toxins are listed on the EPA's Drinking Water Candidate Contaminant List, which includes contaminants being considered for

Creature from the blue-green lagoon. NTP scientists are moving to study the effects of exposure to toxic cyanobacteria. Toxins released by the blue-green algae may be responsible for alligator deaths in Florida and may cause adverse health effects in people who are exposed through drinking water.

Left to right: Dwayne Carbonneau; Paul Kempter

regulation under the Safe Drinking Water Act. A global health issue for decades, toxic cyanobacteria are a relatively recent concern in the United States. Australia has had a management program in place for at least a decade. In Brazil, where microcystins caused the deaths of 56 dialysis patients in 1996, law makers have recently set regulatory levels for cyanotoxins in drinking water, says Wayne Carmichael, a professor of aquatic biology and toxicology at Wright State University in Dayton, Ohio, and a presenter at the forum. (Carmichael's research article on the Brazil deaths is slated for publication in the July 2001 issue of *EHP*.) Carmichael collaborated on the 1999 Florida study and continues to help local officials track cyanotoxins.

Another conference presenter, Hans Paerl, Kenan Professor of Marine and Environmental Sciences at the University of North Carolina's Institute of Marine Sciences, has helped investigate Florida's toxic algal blooms, which are the prime suspect in die-offs of American alligators on Lake Griffin, in the center of the state. Nutrient enhancement associated with increased development and runoff is a primary cause of excessive cyanobacterial productivity, but Paerl points out that environmental factors such as temperature and the degree of stagnation and movement of water into and out of a system also play a role.

Determining routes of human exposure and estimating health risks should be important research priorities, says Lorraine C. Backer, an epidemiologist at the Centers for Disease Control and Prevention in Atlanta, Georgia. Besides ingestion from drinking water, humans come into contact with blooms through swimming, boating, and shoreside activity. Respiratory illness, gastroenteritis, and skin irritation are frequently reported symptoms following such exposures. Links also have been made between respiratory illness in humans and inhalation of aerosols through contact with tap water, Backer says.

Some people voluntarily consume blue-green algae as dietary supplements, purportedly to increase energy and concentration. Traces of toxins have been documented in commercial blue-green algae supplements. However, the potential effect of these trace toxins is unknown. Backer says blue-green algae dietary supplements are widely used. "The algae in these supplements is primarily *Aphanizomenon* [harvested from Klamath Lake in Oregon]," she says. "At least periodically the bloom does include *Microcystis*. Microcystins have been found in samples of the supplement as well." She adds, "Whenever we do any kind of human epidemiology we need to account for this other potential exposure for people."

Supplemental information. Dietary supplements containing blue-green algae are taken by people searching for a way to combat a variety of health problems. Researchers want to find out if trace toxins in the supplements themselves may cause adverse health effects.

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Revised approaches in utility management may also be needed to combat the blue-green algae problem. Burns says water utilities already inadvertently treat for cyanotoxins through the addition of powdered activated carbon to remedy taste and odor problems. But some water managers may unknowingly exacerbate the problem by simultaneously attacking blooms with chemicals such as copper sulfate, an herbicide that causes some cyanobacteria to release toxins that would otherwise be bound within algal cells. As scientists continue to learn more about cyanobacteria, water managers can expect more effective treatment strategies to emerge. **–Carla Burgess**