

Pea soup. Hans Paerl samples cyanobacteria in ailing Taihu Lake.



ECOLOGY

Doing Battle With the Green Monster of Taihu Lake

In attempting to subdue a vicious algal bloom, scientists aim to restore the health of a major lake in China and hone strategies for heading off toxic soups elsewhere

TAIHU LAKE, CHINA—As the motorboat glides through a carpet of fetid algae, Hans Paerl leans over the side and scoops up some of the tea-green muck with a plastic sampling bottle. In early June, a bloom of cyanobacteria, also called blue-green algae, fanned out across Taihu, China's third-largest lake. The growth was unchecked when a team led by Paerl, a cyanobacteria expert at the University of North Carolina, Chapel Hill, arrived last month to help colleagues at the Nanjing Institute of Geography and Limnology combat the foul bloom.

Much is at stake. Taihu, fed by the Yangtze River, helps irrigate millions of hectares of grains and cotton in a lush agricultural region between Shanghai and Nanjing. When it's healthy, the lake also provides drinking water for more than 2 million people, and it sustains one of China's most important fisheries for crabs, carp, and eels. The bloom that has turned Taihu into a toxic nightmare shows no signs of abating and may last until winter, experts say.

The ecological drama has far-reaching consequences. "It's safe to say that it's a pretty serious problem, and not just in China," says Paerl. At one time a villain largely confined to small lakes, algal blooms have of late gotten serious footholds in larger water bodies. Paerl warns that lakes such as Victoria in Africa and Erie and Okeechobee in the United States could be on the brink of becoming perennial algal soups.

That could pose a grave health risk. Some cyanobacteria, such as *Microcystis aeruginosa*, make toxins that can damage the liver, intestines, and nervous system. "Toxic cyanobacteria in drinking-water supplies pose a direct threat to public health," says Brett Neilan of the University of New South Wales in Sydney, Australia. *Microcystis* causes symptoms including diarrhea and liver failure. Reining in the algae at Taihu, Neilan says, could help prevent disasters elsewhere.

It wasn't long ago that Taihu enjoyed a cleaner reputation. A popular 1980s song, "Taihu Beauty," boasted of "white sails above the water, green reeds along the water, fish and shrimp below the water." Back then, says Paerl, Taihu rarely suffered blooms. Now they arrive like clockwork every summer, forcing locals to resort to bottled drinking water.

The root cause of Taihu's ills is an accumulation of nutrient-rich sewage and agricultural runoff in the shallow lake. That resulted in severe eutrophication: a surfeit of minerals and organic nutrients that nourishes algal growth. Unusually hot, dry conditions in early summer appear to have been the spark that ignited this year's bloom.

After the bloom reached nightmarish proportions 2 months ago, cleanup crews skimmed more than 6000 tons of algae from the lake and laid a polyvinyl chloride barrier to prevent algae from getting swept into pipes

that funnel water to a drinking-water plant. But some organisms still seep through, says Qin Boqiang of the institute in Nanjing, and currents cannot flush away algae in water enclosed by the barrier.

Simply "cleaning out the algae" will not solve the problem, says Qin. He emphasizes the need to reduce nutrients, especially phosphorus and nitrogen, in the agricultural runoff and sewage. Paerl and Qin are conducting experiments to determine how much nutrient concentrations must fall to arrest a bloom. They also hope to unravel the dynamics of bloom formation. "The reason we developed this collaborative effort is that we have similar problems in the United States," says Paerl. "We thought, 'Why not combine our expertise?'"

Other researchers are probing the molecular biology of cyanobacteria toxins. With global temperatures rising, warmer surface water leads to less mixing, which favors the growth of toxic cyanobacteria. Deciphering the toxins' biological role and how the environment influences their production may suggest strategies for making blooms less venomous, Neilan says.

Cyanobacteria have a long history of acquiring remarkable adaptations, such as nitrogen fixation and gas vesicles that keep them afloat and enable them to outcompete diatoms and green algae for light and nutrients. They can lie dormant in extreme conditions—surviving droughts and freezing—then roar to life when conditions improve. Cyanobacteria are "very tough," Paerl says. "They're the cockroaches of lakes."

To control Taihu's little green pests, the government in the nearby city of Wuxi crafted an aggressive recovery strategy. The plan promulgates tough emissions standards for phosphorus and nitrogen for factories near Taihu and requires the installation of facilities that remove nutrients from sewage. Nutrient-rich agricultural runoff would be stemmed by banning chemical fertilizers, pesticides, and detergents that contain phosphorus or nitrogen. The amount of clean water pumped from Taihu is projected to reach 1 million tons per day by the end of 2008, and industries in Wuxi must meet a water-recycling rate of 78% by 2010.

"There's no doubt that Taihu is going to be a challenge," says Paerl. Degradation of the lake's water quality was a slow-motion train wreck that played out over several decades. It may take many more years to banish the blooms and bring back the Taihu Beauty of yore.

—LUCIE GUO

Lucie Guo is a freelance writer based in Boston.