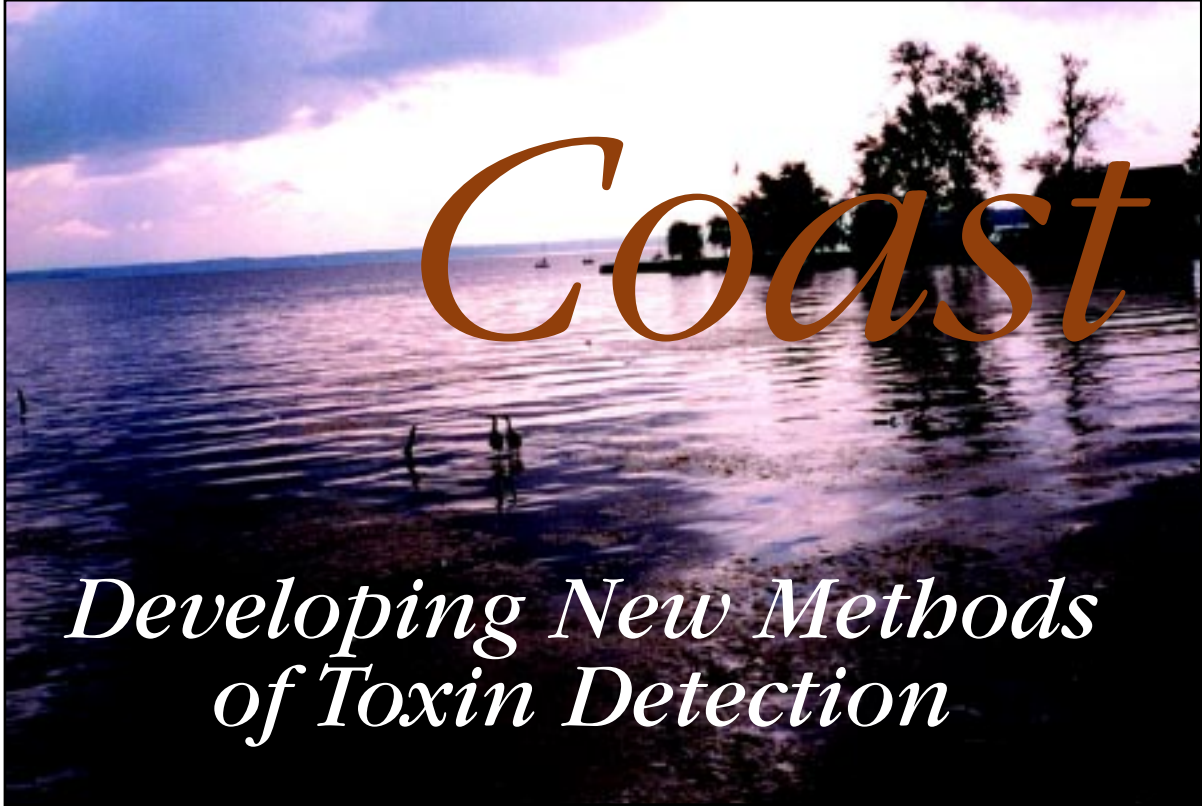

These birds are wading in a blue-green algal bloom in shallow water. Are most blooms near shore? Dr. Greg Boyer's results from last summer should give a clue.

Photo by Xingye Yang

Coast

Developing New Methods of Toxin Detection

Algae and cyanobacteria blooms are a worldwide problem. Australia and Brazil report bloom toxins that can cause severe sickness—even death. A NYSG researcher is making breakthroughs in toxin detection so we can monitor for safe waters in NY and elsewhere.

In New York's vast marine and freshwater systems, algae and plankton form the critical base of each ecosystem's food web. But these living communities are dynamic. In the water column, the dominant plankton changes with each season. When one particular species dominates the usually mixed plankton community, the ecosystem experiences a "bloom" –sometimes with harmful effects especially if the species produces toxins that get into the food chain. Under bloom conditions, certain freshwater plankton can threaten the quality of the drinking water supply. In the ocean, toxins from harmful algal blooms can cause contamination and closure of economically important shellfish beds.

Sea Grant Scholar **Xingye Yang** collects algae with a pole sampler.

Photo by Greg Boyer

In a series of related projects, New York Sea Grant researcher **Dr. Gregory Boyer** of SUNY College of Environmental Science and Forestry is designing and developing cutting-edge technologies to detect these harmful toxins from algae. His earlier project focuses on a method of detecting one group of toxins, the saxotoxins. Saxotoxins can occur in blooms of *Alexandrium*, a microscopic organism known as red tide that is found along the Atlantic coast from Maine to the Gulf states. Shellfish that feed on toxin-producing algae and then are, in turn, consumed by humans can cause a condition known as paralytic shellfish poisoning, or PSP. Symptoms of PSP include tingling, numbness, fever, drowsiness, and in most severe cases, respiratory failure and even death. PSP is a major problem for the shellfish industry because the closure of shellfish beds exposed to the toxic algae means economic loss of several million dollars each year. Monitoring programs that protect the public from PSP can cost up to $200,000 annually nationwide and are labor-intensive requiring specialized personnel.

Before Boyer began working on new methods for PSP detection, the laboratory standard was the use of High Performance Liquid Chromatography (HPLC) coupled with a rather complex laboratory protocol vulnerable to methodological errors — post-column chemical reactions system or PCRS. Since 1999 with NYSG funding, Dr. Boyer has developed and constructed a portable

Boyer uses a pole integrated water sampler while Honglin Gao, a visiting scholar from the South China Sea Institute of Oceanography, reads the dissolved oxygen meter.

Photo by Elizabeth Patchett

Watch

Boyer and an assistant take water samples; 20% of water samples taken from 100 different sample locations in NY waters tested positive for cyanobacteria toxins with microcystin being the most common. Several samples exceeded the WHO guidelines of 1 part microcystin per billion. Photos by Jamie Lescinski

prototype PSP analyzer that employs an electrochemical replacement for the PCRS portion of the test. His technique, electrochemical oxidation coupled with fluorescent detection or ECOS, is less temperamental and more cost-effective than the traditional HPLC-PCRS detection method. Currently, the method that couples HPLC with ECOS is undergoing international interlaboratory trials and there is interest in this technique from nearly a dozen countries that have PSP-related problems in their waters. Boyer's ultimate goal is acceptance and validation of this methodology by the Association of Analytical Communities.

Building on the success of the PSP protocol, in his newly-funded research beginning in early 2002, Boyer is now developing analytical techniques to measure field concentrations of anatoxin-a, in New York State's freshwater sources of drinking water. Anatoxin-a and microcystin are two of over 60 different and extremely bioactive toxins produced by blue-green algae, or cyanobacteria blooms. Because these organisms are primary producers in freshwater lakes, they are eaten by other organisms creating the potential for their toxity to transfer up the food chain. The World Health Organization has established an allowable level of only 1 part microcystin per billion in drinking water. Current detection methods for these toxins are costly, complicated, labor intensive and may require tests on live animals.

As with the PSP toxins, the ability to detect and quantify cyanobacteria toxins such as anatoxin-a involves a multi-tiered laboratory approach. As was done for the PSP toxins, Boyer is currently developing antibody assays and standards for anatoxin-a, establishing background data on the distribution of such toxins and toxic algal species in Lake Ontario and elsewhere. Says Boyer, "We are developing effective monitoring measures that can be employed by water quality managers, conservation agents and health officials to rapidly screen for the presence of cyanobacterial toxins." The monitoring measures will include an antibody "dipstick" style test resembling a home pregnancy kit. Boyer will also investigate to what extent zebra mussels act as a key vector for the transfer of organic materials such as algal toxins into crabs, fish and other organisms higher in the food chain.

For the long term, Boyer's cheaper, easier and more reliable methodologies for detecting PSP toxins will move toward international acceptance and his work with cyanobacteria will improve drinking water testing methodologies and establish baseline data on their occurrence and impact on freshwater ecosystems.

—Patrick Dooley, Project Assistant
Barbara Branca, Communicator

SUNY Plattsburgh undergraduate Trevor Carpenter uses a plankton net aboard Lake Champlain Research Consortium's *R/V Monitor*.

Selected Publications

Dr. Boyer's NYSG-funded research on a PSP toxin analyzer has resulted in nearly a dozen peer-reviewed journal publications to date as well as several doctoral dissertations and other university-based articles. Here is a sample of selected publications. Find a complete list at: www.nyseagrant.org

Boyer, G.L. and X. Hu. 1996. The electrochemical detection of PSP toxins. *Canadian Technical Report of Fisheries and Aquatic Sciences* 2138:1-5.

Boyer, G.L. and G.D. Goddard. 1999. High performance liquid chromatography coupled with post-column electrochemical oxidation for the detection of PSP toxins. *Natural Toxins* 7(6):353-359.

Boyer, G.L., and L.E. Brand. 1998. Trace elements and harmful algal blooms. Pages 489-508 in D.M. Anderson, A.D. Cembella, and G.M. Hallegraeff editors. Physiological Ecology of Harmful Algal Blooms. Springer-Verlag, Berlin.

Boyer, G.L., J.J. Janiszewski, and X. Hu. 1998. A comparison of electrochemical methods for the HPLC analysis of PSP toxins. pages 515-518 in B. Reguera, J. Blanco, M.L. Fernandez, and T. Wyatt, editors. Harmful Algae. Xunta de Galicia and Intergovernmental oceanographic commission of UNESCO 1998.

Goddard, G.D., K. Haya, and G.L. Boyer. 1999. Electrochemical oxidation system for the analysis of Paralytic Shellfish Poisoning (PSP) toxins in natural shellfish samples. Pages 58-62 in Proceedings of the Sixth Canadian Workshop on Harmful Marine Algae.

Hu, X., and G.L. Boyer. 1996. Effect of metal ions on the quantitative determination of hydroxamic acids. *Analytical Chemistry* 68(10):1812-1815.

Hu, X., and G.L. Boyer. 1996. Siderophore-mediated aluminum of uptake by *Bacillus megaterium* ATCC 19213. *Applied and Environmental Microbiology* 62(11):4044-4048.