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Understanding Domoic Acid and Toxic Diatom Blooms

Mary Silver

University of California, Santa Cruz

Background

In general seafood is safe, tasty and nutritious, but there are some naturally occurring toxins that can make seafood dangerous for consumers. One such toxin is domoic acid, a potent neurotoxin produced by microscopic diatoms of the genus *Pseudo-nitzschia*.

Diatoms are single-celled, photosynthetic organisms, and as the sea's primary fixers of carbon, form the base of the marine food chain. Although fish and shellfish that consume diatoms accumulate domoic acid without apparent harm, people who ingest contaminated seafood can suffer permanent brain damage, characterized by permanent memory loss, a condition known as amnesic shellfish poisoning. Domoic acid poisoning may also cause seizures, coma and, in rare cases, death. In mild cases, symptoms are indistinguishable from those of generic food poisoning.

As researchers work to understand what triggers domoic acid production in diatoms, two pieces of information are worth considering. Sediment cores suggest that *Pseudo-nitzschia* diatoms have lived off the California coast for the last 1,000 years. Yet, the first documented case of domoic acid poisoning on the West Coast occurred relatively recently, in 1991, after an analysis of a series of strange bird die-offs in California tied the deaths to contaminated anchovies.

The Project

Dr. Mary Silver, a professor in the Department of Ocean Sciences at the University of California at Santa Cruz, was funded to trace domoic acid through the marine food web.

Her project was prompted by a 1998 die-off of sea lions in Central California.

The project began with researchers collecting anchovy specimens from California fishing boats. Sea Grant Trainee Dr. Kathi Lefebvre, now a researcher at the NOAA laboratory in Seattle, then showed that the anchovies were contaminated with domoic acid. Sea lion feces were also found to be high in domoic acid. Necropsies of sea lions revealed that the animals' stomachs were full of tiny skeletons of *Pseudo-nitzschia* diatoms. The analysis left little doubt that anchovies that had eaten contaminated diatoms had in turn poisoned sea lions. This was a significant finding because it established the toxicity of domoic acid in large marine mammal predators.



Dr. Mary Silver, Professor of Ocean Sciences, University of California, Santa Cruz.

In a separate study, the scientists tried to identify environmental factors that might promote domoic acid production. Specifically, they looked at the role of natural levels of nitrate and silicate on domoic acid production.

It is not known why diatoms



Although domoic acid is harmless to fish, it can be deadly to pelicans and marine mammals that ingest contaminated fish. The first documented domoic acid outbreak in California occurred in 1991 and caused a rash of pelican and cormorant deaths. A second outbreak in 1998 was fatal to sea lions. In 2002, dolphins fell prey to the toxin for the first time. Photo: California Sea Grant.

produce domoic acid, but one theory is that domoic acid may help diatoms absorb iron, when nutrient levels are unusually low.

Consistent with the theory that domoic acid production is not enhanced by nutrient pollution, they found that domoic acid production was highest when nutrient levels were lowest. That is, nutrients in fertilizer do not appear to contribute to domoic acid production.

"It is not at all clear that there is any connection between human activity and toxin production, in this particular case," Dr. Silver said. "There may or may not be any human connection. The reservoirs of iron in the sea, so far, seem to have relatively little to do with human activity."

Applications

The data collected during this project were shared with the California Department of Health Services. In response to the information, the agency closed the anchovy fishery

until domoic acid levels returned to safe levels.

Although fishery closures are undesirable for fishing communities, they benefit fishers in the long run by maintaining the safety and reputation of California's seafood products.

Anchovies are not only eaten by people but are also ground into fish meal for poultry and pig feed. Without the information gathered during this project, domoic acid poisoning might have killed people and contaminated aquaculture and meat products.

Domoic acid has recently been identified as a problem in the viscera of Dungeness crab, tanner crab, red rock crab, and anchovies along the West Coast.

Publications

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For more information:

Dr. Mary Silver
Professor, Ocean Sciences
University of California, Santa Cruz
Tel.: (831) 459-2908
Email: msilver@cats.ucsc.edu

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Russell A. Moll, Director • Dolores M. Wesson, Deputy Director • Paul Olin, Interim Associate Director for Extension
• Marsha Gear, Communications Coordinator

University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0232
Phone: (858) 534-4440 Fax: (858) 453-2948 Web site: <http://www-csgc.ucsd.edu>