Monitoring Phytoplankton Communities: An Ecosystem in Flux

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Model: Disturbance to the Microbial Community

This past September, the Orange County Sanitation District (OCSD) conducted repairs on its main discharge pipe, forcing discharge to be diverted for three months to a sewage outfall located much closer to the coastal environment. Dr. David Caron, a professor of marine environmental biology at the USC Dornsife School of Letters, Arts, and Sciences, is currently coordinating with other universities to track influences of the effluent on the coastal ecosystem.

Because of its importance to life, water remains central to Dr. Caron's research. Billions of the planet's inhabitants lack access to clean water and basic sanitation methods, leading to millions of deaths from water-related illnesses. These water wars are fought on two fronts, as both underdeveloped and advanced communities struggle with waterborne illness. Dr. Caron's research focuses on the ecology of marine protistan communities as well as the potential harmful impacts of protistans found in coastal waters.

The Caron Lab focuses on "natural experiments" that demonstrate the connections within the microbial food web. Introduction of a new source of water to an ecosystem allows researchers the chance to track the changes in population in a natural format. During the OCSD diversion, phytoplankton communities were exposed to nutrient-rich effluent, inducing possible algal

blooms. The diversion offered a chance to witness the events that occur when a new source of nutrient-rich water is introduced to a coastal ecosystem.

Protistan Impact

The structure of the marine web relies on the nutrient composition existing in the ecosystem. With the provision of normally limiting nutrients – nitrogen and phosphorus in the nutrient-rich effluent – the microbial community has the potential to increase greatly in biomass. The current monitoring has analyzed the compositional changes in the phytoplankton community, but a more pressing issue is the possibility of harmful algal blooms.

An image of *Alexandrium catenella*, a harmful algal species known to produce saxitoxin, one of the most toxic biologically produced chemicals.

Along the Pacific coast, harmful algal blooms have had an indirect but profound negative impact on human populations. Isolated genera of dinoflagellates *Alexandrium*, *Gymnodinium*, and *Pyrodinium* have been identified to produce neurotoxins causing paralytic shellfish poisoning, possibly leading to paralysis and death through respiratory arrest. Saxitoxin, a neurotoxin produced by these dinoflagellates, has been banned by the Geneva Conference as a weapon for chemical warfare due to its ability to shut down normal function of voltage-gated sodium channels. Diatoms of the genus *Pseudo-nitzschia* have caused cases of amnesiac shellfish poisoning in humans, inducing occasionally permanent short-term memory loss. Domoic acid,

the neurotoxin produced by *Pseudo-nitzschia*, leads to activation of AMPA and kainite receptors, resulting in heightened concentrations of calcium leading to cell degeneration. This especially degenerates the cells of the hippocampus and the amygdala, damaging short-term memory. Toxins produced by harmful algae not only threaten human health, but also threaten natural resources, destabilizing marine animal populations. Sea lion deaths, mammal and bird illnesses, and depletion of fish resources have all been recorded with algal blooms alongside the coast.

Although the diversion has ended, continued analyses of assemblages from surface waters off of the Newport Beach pier are continuing. Microscopy determination of algal species abundance and composition combined with processing of phytoplankton biomass by chlorophyll extraction has begun to show population response to the new water source. Should the samples exhibit toxin-producing species, toxin analysis will be conducted by ELISA assay to determine presence and relative concentration of either saxitoxin or domoic acid.

Additional incubation experiments have been conducted. Control bottles containing natural seawater and filtered seawater and bottles containing 1:10, 1:100, and 1:1000 dilutions of natural seawater with effluent were incubated at standard environmental temperatures in standard environmental light. These simulations intend to replicate the "natural experiment" occurring with the OCSD diversion, allowing Caron Lab to pinpoint a model for relative dilution levels leading out from the sewage pipe outfall.

Environmental Monitoring

Though algal blooms constitute a natural event in the marine environment, the possible influence upon environment and public health mandates consistent monitoring equipment stationed around the testing site five miles offshore. USC Dornsife is coordinating with the Southern California Coastal Ocean Observing System, OCSD, and scientists from UC Irvine, UCLA, UC Santa Cruz, UC Santa Barbara, Scripps Institute of Oceanography, Southern California Coastal Water Research Project, Monterey Bay Aquarium Research Institute, Moss Landing Marine Laboratories, and Liquid Robotics Incorporated to continue tracking water quality. Current hopes for analyses are to interpret incubations in the context of normal phytoplankton temporal fluctuations and to attribute the nutrient concentrations to growths of certain populations. This research will help us better understand and repair the harm caused by algal blooms.