A Potential Novel Link Between Organic Nitrogen Loading and *Pseudo-nitzschia* Blooms

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Abstract

Recent blooms of the toxigenic microalgae *Pseudonitzschia australis* have led to mass mortality among dolphins, sea lions and birds along the California coast, due to domoic acid poisoning. These blooms have the potential to cause substantial harm to local fisheries and the local ecosystem due to the broad range of affected organisms. The occurrence of these toxic diatoms appears to be a relatively new phenomenon along the California coast and was first reported in the Monterey Bay in 1991. Although sediment records from Scripps Pier suggest that these diatom species have been present in California coastal waters at least since the early 20th century no information is available as to previous occurrences of domoic acid producing blooms.

For other harmful bloom events such as red tides, eutrophication has been recognized as one of the major culprits for the increased frequency of these harmful blooms. Some evidence suggests that sewage effluent or runoff could trigger *Pseudo-nitzschia* blooms. Traditionally, this link between eutrophication and algal blooms has been explained by the increased inorganic nitrogen (nitrate and ammonia) loading to the euphotic zone stimulating nitrate-limited photoautotrophic algal growth. However, recent work suggests that many algal species have the ability to use organic sources of nitrogen to enhance photoautotrophic nutrition. Additionally, certain organic nitrogen and carbon compounds have been shown to allow some phytoplankton species to grow in the absence of light. Therefore in addition to inorganic nutrients, organic nitrogen and carbon could enhance algae growth both in the surface mixed layer as well as at depth, in the dark.

Our research aims to discern the role of organic nitrogen and carbon in the nutrition of the toxigenic diatom *Pseudonitzschia spp.* Our results suggest that organic nutrients encountered after the bloom, during dark survival, could significantly alter the viability of the population and result in an increased viable seed population during a subsequent upwelling event. We found that glutamate and glutamine additions were taken up quickly in the dark and lead to increased growth rates during subsequent light recovery. A delay was observed between the return to the light and the start of the exponential growth phase. The delay was significantly longer for cells in the organic treatment and suggests a switch in their metabolism in response to the addition of glutamate and glutamine.

Consequently, inorganic and organic nutrient availability both in the upper mixed layer as well as below could play a key role in bloom initiation. Therefore monitoring inorganic and organic nitrogen concentrations could proof valid in determining factors leading to these harmful algal blooms and should be considered as a standard

measurement in monitoring programs. Concurrent monitoring of nutrients (inorganic and organic) and phytoplankton species should allow an assessment of the potential role of eutrophication in bloom initiation. Subsequently, if eutrophication is implicated, mitigation efforts should be considered to decrease anthropogenic nitrogen loading from sources such as terrestrial runoff, sewage effluent, and air pollution.

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