Effects of Ocean Conditions on the Production of Domoic Acid from *P. nitzschia*

**Introduction**

Domoic acid (see Figure 1) is a naturally occurring neurotoxin produced in cell culture by *Pseudo nitzschia* (see Figure 2), a type of a pennate phytoplanktonic diatom or algae (Mos, 2001). Domoic acid biomagnifies through consumption, domoic acid is passed from bivalves (mussels, clams, etc.), anchovies and other birds and domoic acid host to consumers. The first-level organisms are affected mildly or not at all by domoic acid which accumulates in their digestive glands and tissues (Mos, 2001), while the mammals and other birds who consume them may experience severe or fatal effects. Domoic acid has had a number of devastating effects on humans. Acute gastrointestinal symptoms include: nausea, vomiting, and diarrhea (Teilbaum et al., 1990); and neurological symptoms, include: confusion, disorientation, long-term amnesia, seizures, and comas (Perl et al., 1990). A large outbreak of neurologic abnormalities among people who had eaten cultured blue mussels (*Mytilus edulis* L.) in eastern Prince Edward Island in Canada brought attention to domoic acid poisoning. Since then, outbreaks of domoic acid have appeared all over the world including off the coast of California, Argentina, Uruguay, and in the Gulf of Mexico. Using data from NOAA, this study is a comparison of domoic acid concentrations with ocean temperature, salinity, pH, oxygen, phosphate, and silicate concentrations. Results show ocean conditions have little to no effect on the production of domoic acid from *Pseudo nitzschia*; however these results indicate further research be conducted.

**Abstract**

In 1987, scientists began to investigate blue mussels (*M. edulis L.*) sold by restaurants and stores in Prince Edward Islands after many reports of sickness among consumers and the death of three elderly consumers. Samples of these mussels presented traces of a toxicotin diatom, called domoic acid. Researchers soon discovered that it was produced by an algae, *Pseudo nitzschia*, in nearby waters and when consumed is responsible for amnesic shellfish poisoning. Since then, outbreaks of domoic acid have appeared all over the world including off the coast of California, Argentina, Uruguay, and in the Gulf of Mexico. Using data from NOAA, this study is a comparison of domoic acid concentrations with ocean temperature, salinity, pH, oxygen, phosphate, and silicate concentrations. Results show ocean conditions have little to no effect on the production of domoic acid from *Pseudo nitzschia*; however these results indicate further research be conducted.

**Research Question & Hypothesis**

**Research Question:** Do ocean conditions affect the growth of *Pseudo nitzschia* and production of domoic acid?

**Alternative Hypothesis:** Domoic acid concentrations will be higher in areas with increased temperature, salinity, dissolved oxygen, phosphate, silicate, and nitrate because these conditions provide nutrients that aid to the growth of plants and algae.

**Null Hypothesis:** Domoic acid concentrations will not be higher in areas with increased temperature, salinity, dissolved oxygen, phosphate, silicate, and nitrate.

**Methods**

Determining the ocean conditions in which *Pseudo nitzschia* blooms thrive and produce domoic acid, will allow us to predict future concentrations in various locations. Knowing the factors which help the algae grow and produce domoic acid, will help determine what action should be taken to end or restrict future growth and production of domoic acid.

**Results**

Table 1. Pearson Correlation Coefficients (r).

<table>
<thead>
<tr>
<th></th>
<th>Domoic Acid in H₂O</th>
<th>Domoic Acid in Bivalves</th>
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</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>.309</td>
<td>-.162</td>
</tr>
<tr>
<td>Salinity</td>
<td>.234</td>
<td>-.057</td>
</tr>
<tr>
<td>Oxygen</td>
<td>-.367</td>
<td>.395</td>
</tr>
<tr>
<td>Phosphate</td>
<td>-.278</td>
<td>-.030</td>
</tr>
<tr>
<td>Silicate</td>
<td>-.225</td>
<td>-.024</td>
</tr>
<tr>
<td>Nitrate</td>
<td>-.263</td>
<td>.110</td>
</tr>
</tbody>
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**Discussion**

The goal of the study was to determine if there is a correlation between ocean conditions and the concentrations of *P. nitzschia* or domoic acid. The steeper slope (-2.48E2) of Figure 4d shows that as the amount of phosphate in the water increases, the amount of *P. nitzschia* decreases and because of this low phosphate levels can be used as a predictor for a growth in *P. nitzschia* blooms. Cellular domoic acid in H₂O (Figure 5), was not strongly impacted by any of the ocean conditions as the slopes ranged from -4.63E3 to -A2. The Pearson correlation coefficient ranged from -.057 to -.395, showing that there is a very slight linear correlation. In Figure 5, data points seemed to have a stronger correlation and higher Pearson correlation coefficients despite one outlying value for domoic acid in bivalves (74 µg p-1). The simple linear regression analysis models shows that *P. nitzschia* concentration had very minimal effects on the domoic acid content in water (Figure 7a) (slope -.292E-4). The Pearson correlation in bivalve tissues (Figure 7b) (slope -1.41E3). However there was a lack of significance noted in the T test, so the null hypothesis- ocean conditions have little to no effect on the *P. nitzschia* growth and domoic acid concentrations can be retained. One potential source error occurred when receiving data from the WOA 13, each of the latitude and longitude value had to be rounded to the nearest degree.

**Conclusion**

Results indicate that there is little correlation (-.768 < r < .395) between ocean temperature, salinity, oxygen, phosphate, silicate, nitrate, and *P. nitzschia* or DA concentration. However patterns indicate that further work should be conducted.

**Further Work**

Results of this study was inconclusive as ocean conditions proved to not be statistically significant factors in *P. nitzschia* or domoic acid content, however certain patterns cannot be ignored and further investigation. Further studies need to aim to collect various data points from the same location over a series of several months to see if there is a change in toxin or algae concentration within the same region. In addition, fisheries concerned with bloom potential need to collaborate with NOAA to assure that further studies on the issue can be conducted.

**Acknowledgements**

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**References**