Multi-Year Analysis of Microbial Populations in the Rochester-Lake Ontario Embayment

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Abstract
The composition of freshwater bacterial populations is affected by a wide variety of factors. Temperature, acidity, organic matter, and environmental pollutants like industrial chemicals and antibiotics are a few examples. The impact that bodies of freshwater have on human activity and the wider ecosystem warrants the systematic identification of microbial flora, and in particular of species known to be pathogenic in plants and animals. In order to achieve the long term goal of using satellite imagery to predict the occurrence of specific bacterial species, our team is in the process of creating a multi-location, multi-year microbial flora database for the Rochester Lake Ontario embayment and nearby bodies of water. Our collaborators at the Rochester Institute of Technology have provided us with water samples collected at these locations during the summers of 2013 and 2014. In this work we present and analyze data from said samples. Using 16S ribosomal DNA data we characterize bacterial populations, determine their geographical distribution, establish genera prevalence and discuss the presence of and investigate antibiotic resistance in several pathogenic species. The scope of our long term project and the summer of 2015- sample collection are also considered.

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Disciplines
Biology

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Multi-Year Analysis of Microbial Populations in the Rochester-Lake Ontario Embayment

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Our aim is to characterize the microbial flora present in related bodies of freshwater over time. In the long term we intend to use this knowledge to predict the occurrence of bacterial species using remote sensing data.

Abstract

The composition of freshwater bacterial populations is affected by a wide variety of factors. Temperature, acidity, organic matter, and environmental pollutants like industrial chemicals and antibiotics are a few examples. The impact that bodies of freshwater have on human activity and the wider ecosystem warrants the systematic identification of microbial flora, and in particular of species known to be pathogenic in plants and animals. In order to achieve the long-term goal of using satellite imagery to predict the occurrence of specific bacterial species, our team is in the process of creating a multi-location, multi-year microbial flora database for the Rochester Lake Ontario Embayment and nearby bodies of water. Our collaborators at the Rochester Institute of Technology have provided us with water samples collected at these locations during the summers of 2013 & 2014. In this work we present and analyze data from said samples. Using 16S rDNA data we characterize bacterial populations, determine their geographical distribution, establish genera prevalence and discuss the presence of and interactions among bacterial species in several environments.

The scope of our long term project and the summer of 2015- sample collection are also considered.

Table 1

<table>
<thead>
<tr>
<th>DATE</th>
<th>GENUS</th>
<th>PATHOGENICITY</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUMMER 2013</td>
<td>Aeromonas</td>
<td>Human &amp; fish pathogen</td>
<td>16S rDNA</td>
</tr>
<tr>
<td>SUMMER 2013 &amp; 2014</td>
<td>Enterobacter</td>
<td>Human opportunistic pathogen</td>
<td>16S rDNA</td>
</tr>
<tr>
<td>SUMMER 2013 &amp; 2014</td>
<td>Pseudomonas</td>
<td>Human opportunistic pathogen</td>
<td>16S rDNA</td>
</tr>
<tr>
<td>SUMMER 2013 &amp; 2014</td>
<td>Aeromonas</td>
<td>Human opportunistic pathogen</td>
<td>16S rDNA</td>
</tr>
<tr>
<td>SUMMER 2013 &amp; 2014</td>
<td>Bacillus</td>
<td>Fish pathogen</td>
<td>16S rDNA</td>
</tr>
<tr>
<td>SUMMER 2013 &amp; 2014</td>
<td>Entrobacteriaceae</td>
<td>Opportunistic human, chemical plants</td>
<td>16S rDNA</td>
</tr>
<tr>
<td>SUMMER 2013 &amp; 2014</td>
<td>Curtobacterium</td>
<td>Opportunistic human, chemical plants</td>
<td>16S rDNA</td>
</tr>
<tr>
<td>SUMMER 2013 &amp; 2014</td>
<td>Enterobacteriaceae</td>
<td>Opportunistic human, chemical plants</td>
<td>16S rDNA</td>
</tr>
<tr>
<td>SUMMER 2013 &amp; 2014</td>
<td>Pantoea</td>
<td>Not considered pathogenic</td>
<td>16S rDNA</td>
</tr>
<tr>
<td>SUMMER 2013 &amp; 2014</td>
<td>Enterobacteriaceae</td>
<td>Not considered pathogenic</td>
<td>16S rDNA</td>
</tr>
</tbody>
</table>

Table 2. Pathogenicity of genera found in samples.

Figure 1. Landsat 8 OLI satellite imagery courtesy of NASA Goddard Space Flight Center and U.S. Geological Survey.

Figure 2. Summers of 2013, 2014 & 2015 sample collection and flora identification in the Rochester-Lake Ontario Embayment. The samples were collected at the surface of the water.

Conclusion and future direction

In 2015 we repeated the process of several different species in the designated collection sites. We found that the presence of certain genera of bacteria correlated with the amounts of organic matter in the water. Here we sampled some of the same sites a year later. However, we found limited overlap between 2013 & 2014. Our 2015 sample processing is still underway. Our long term goal is to construct a database in which bacterial species are associated with water parameters that can be measured through the use of satellite imagery. We intend to expand flora identification efforts through further sampling and characterization during the summer of 2016.

We also plan to add water parameter data to this analysis. With enough data points we expect to be able to perform statistical analyses that lead us to predict the presence of specific microbial flora in bodies of water in real time by analyzing satellite images.

References


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CLASSIFICATION OF ANTIBIOTICS UTILIZED FOR EXPERIMENTS

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Class</th>
<th>Microorganism</th>
<th>Spectrum of Activity</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampicillin</td>
<td>β-lactam</td>
<td>Enterobacteriaceae</td>
<td>Broad</td>
<td>Cell wall</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>Fluoroquinolone</td>
<td>Enterobacteriaceae</td>
<td>Broad</td>
<td>Nucleic acid synthesis</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>Macrolide</td>
<td>Enterobacteriaceae</td>
<td>Broad</td>
<td>Cell wall</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>Aminoglycoside</td>
<td>Enterobacteriaceae</td>
<td>Broad</td>
<td>Nucleic acid synthesis</td>
</tr>
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<td>Sulfamethoxazole</td>
<td>Sulfonamide</td>
<td>Enterobacteriaceae</td>
<td>Broad</td>
<td>Cell wall</td>
</tr>
</tbody>
</table>

Fig. 1. Landsat 8 and OLI satellite imagery. This satellite and associated optical data is publicly available. Hyperspectral analysis provides information on water parameters like organic matter content and suspended particles.