A STUDY OF THE DIATOM COMMUNITIES IN THE UPPER MAIN STEM OF THE SUSQUEHANNA RIVER DURING AN UNUSUALLY WET SUMMER

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Abstract

The upper main stem of the Susquehanna River is formed by the confluence of the West and North Branches, each of which is chemically and physically distinctive. The upper main stem retains the signatures of the two branches due to weak lateral mixing, and we refer to them as the North Branch plume (NBP) and West Branch plume (WBP). Thus, characterization of the diatom communities required samples taken from sites that occur in the plumes of both branches. Since 2009 when our river monitoring program began on the upper main stem, the summer of 2015 was an unusually wet year. Furthermore, monthly average discharge levels of the river during July exceeded those of any year during the 77 years of USGS records for the upper main stem. Indeed, the high water required that we reduce the scope of active sampling to one set of collections at each site together with artificial substrates. Our samples were taken from an established transect that straddles Byers Island near Shamokin Dam, PA and below the Adam T. Bower inflatable dam at Sunbury, PA. Diatom samples from diatometers, stones and other substrates were prepared for examination by electron microscopy. Within the plumes of the two branches, we focused on three particular habitats: stone, sediment, and diatometer. Overall, we identified approximately 95 different species in this study, but the overlap between habitats was relatively low. Habitats of the NBP were dominated by a small centric and biraphid species (e.g. Discostella pseudotentigera and Rhoicosphenia abbreviata) and similar habitats of the WBP were dominated by monoraphid species (e.g. Achnanthidium deflexum, Achnanthidium minutissimum, and Cocconeis placenta),

Introduction

• Diatoms, a dominant group of algae and major component of the river biofilm communities, are used to evaluate water quality (Werner 1977).
• Diatoms are hypersensitive towards their environments (Pan et al. 1996), and, therefore are good biological indicators (Stevenson et al. 2008).
• The purpose of this study is to use diatoms, periphyton and phytoplankton (metaphyton) in the continuing assessment of water quality at the Byers Island Transect on the upper main stem of the Susquehanna River as well as to compare periphyton communities found in the environment as opposed to those found in periphytometers.

Site Description

The Byers Island Transect (Figure 1) straddles Byers Island 4km south of the confluence of the West and North branches of the Susquehanna River. Sites 1 and 2 are below the low head dams at the Sunbury Generation plant. Periphyton was sampled at sites 1-5 (each labeled with a star). Additionally, a 500m reach was established along the banks of site 1 and 2, which is denoted by green dots. Our sampling was focused on Sites 1 and 2 in order to observe differences between the West Branch Plume (WBP, Site 1) and the North Branch Plume (Site 2).

Methods

• Active field collections were made at the marked locations at 100M intervals above sites 1 and 2 (see Figure 1).
• Stones were collected and placed in containers.
• Samples were returned to the lab and cleaned using the following procedure:
  • 5% acetic acid plus heating
  • Concentrated Potassium Permanganate + concentrated HCl
  • Concentrated (30%) Hydrogen Peroxide
• Diatom ID confirmed by JEOE JSM 6010LV SEM.
• Counts performed using the JEOE JSM 6010LV and NIKON Eclipse DIC light microscope (300 cell minimum) or until 25 fields had been reached at each site.
• Pollution Tolerance Index (PTI) calculated according to Stephenson et al. (2008).
• Water on the transect was monitored on a weekly basis for 8 weeks (June 5 - July 24) using a YSI 556 Multimeter and a Secchi Tube to measure turbidity.
• Water was collected for alkalinity and future water chemistry analysis.

Results

• Diatoms are a major component of the river biofilm communities.
• The results are percentages compiled from pooled counts from all six locations at each site.

Table 1. Physical parameters collected from sites 1 and 2 that show the chemical and physical differences between Sites 1 & 2.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Site 1</th>
<th>Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity</td>
<td>215.89</td>
<td>264.44</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>689.62</td>
<td>1053.5</td>
</tr>
<tr>
<td>Secchi</td>
<td>89.62</td>
<td>68.00</td>
</tr>
</tbody>
</table>

Table 2. All of the diatom species observed in samples taken from stones and sediment from specific locations in the WBP and NBP at the Byers Island Transect (see Figure 1). All centric diatoms in the table are underlined. The cells are color denoted by the Shannon Diversity Index (SDI) values and those with diatoms having a PTI value of 2.866 or less at each site are in bold.

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Site 1</th>
<th>Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diatometer</td>
<td>5.45</td>
<td>5.96</td>
</tr>
<tr>
<td>Sediment</td>
<td>3.95</td>
<td>4.56</td>
</tr>
<tr>
<td>Stone</td>
<td>2.95</td>
<td>3.46</td>
</tr>
</tbody>
</table>

Table 3. Pollution Tolerance Index and Shannon Diversity Index values determined from diatometer, sediment, and stone samples at Sites 1 & 2.

<table>
<thead>
<tr>
<th>Site 1</th>
<th>Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTI</td>
<td>3.036</td>
</tr>
<tr>
<td>SDI</td>
<td>2.715</td>
</tr>
</tbody>
</table>

Table 4-A Proportional Bray-Curtis Similarity Index table comparing percent similarity between diatom communities in the habitats sampled. ST1 = stone, SE1 = sediment, DM1 = diatometer; numbers 1 and 2 designate sites 1 and 2.

Conclusions

• Physical parameters confirmed the separation between NBP and WBP (Table 2).
• PTI values for sites 1 and 2 were similar, while PTI values for site 2 sediment showed an overall greater pollution tolerance, augmented by the more pollution tolerant centric diatoms (Table 2).
• Collected and identified 95 different diatom species from all collection sites.
• 15 species were exclusive to the WBP, while 48 species were exclusive to NBP including small centrics (Table 2).
• Dominant taxa (>10%) were Achnanthes minutissimus, Achnanthes deflexum, Nitzschia palea, Cocconeis placenta, Rhicosphenia abbreviata, and Diastella pseudotentigera (Table 2 and Figure 2).
• Shannon Diversity index values for sites 1 and 2 were similar, and stone samples have higher SDI values than sediment or diatometer samples (Table 3).
• Proportional Bray-Curtis index showed that diatom communities comparison between natural substrate were at or below 51% and most were less than 20%.
• Only diatometers exhibited high overlap (Table 4).

Acknowledgments

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References available upon request.

Figure 1. Map of the collection sites. Those locations marked with a red dot were actively sampled for diatom biofilms.

Figure 2. Scanning electron photomicrographs of dominant species in the study. A) Achnanthes minutissimus, B) Achnanthes deflexum, C) Nitzschia palea, D) Cocconeis placenta, E) Rhicosphenia abbreviata, and F) Discostella pseudotentigera.

Figure 3. Results of the Proportional Bray-Curtis Similarity Index Table comparing percent similarity between diatom communities in the habitats sampled. ST1 = stone, SE1 = sediment, DM1 = diatometer; numbers 1 and 2 designate sites 1 and 2.