A Study of Diatom Communities in Five Headwater Streams in Central Pennsylvania

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Abstract

During June and July 2015 we sampled five headwater streams that flow down the north slope of Penns Creek Mountain (Bald Eagle State Forest, western Union/Snyder counties), each in a separate cut along the ridgetop. The streams drain a perched water table underlain by impervious sandstone and are approximately two meters wide and wadeable. Throughout the reaches studied the streams are shaded by a mixed forest of hemlock and birch with a substrate of small boulders, cobble, and sand. Because of the uniform geology, hydrology, and land use, the chemical and physical properties of the streams are very similar. Conductivity (19.4-31.9 µs/cm) and buffering capacity are very low (63-313 µeq/L), and pH rarely exceeds 6. Stones and sediment were collected at each sample site and biofilms were removed chemically. Diatoms were cleaned by a standard method using HCl and H₂O₂, identified to species, and counted using a JEOL 6010 SEM. Because of the uniform conditions of the streams and the size of the streams, we expected that the communities would be relatively depauperate and dominated by one or two common taxa. However, the diatom communities show a high Shannon Diversity (SDI: 2.6-3.3) and the number of species is high (35-52 taxa in 300 valves). In general, the dominant morphological classifications are eucuestas and monoraphids, most of which are pollution intolerant. Though many taxa co-occur in the streams, dominant taxa (>10%) seem to vary stream to stream. Diversity and water quality indices identify all five streams as having high water quality with very specific communities; however, despite the similarities of the streams, particular members of the communities vary in occurrence and importance such that the Bray-Curtis similarity indices describe communities whose average similarity is only 32% (8-53%). Thus, there is not a defined diatom community for these headwater streams that are adjacent to each other and whose abiotic parameters are quite similar.

Introduction

• Diatoms, a dominant group of algae and major component of stream 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) of water quality.
• The purpose of this study is to use diatom periphyton in an assessment of five headwater streams and to define a headwater stream diatom community.

Site Description

Five headwater streams drain a perched water table on the north slope of Penns Creek Mountain (western Union/Snyder counties). The rock is impervious sandstone and the streams have a substrate that ranges from small boulders and cobbles to sand. The streams can be accessed by Hunter Road on the ridge top and are in Bald Eagle State Forest (Figure 1) with a mixed canopy mainly of hemlock and birch. Each stream is about 2m wide with mixed riffles, runs and pools, rarely more than 0.5m deep.

Methods

• Field collections of active biofilms were made at the marked sites (see Figure 1).
• Stones were collected and placed in containers.
• Sediment was collected using a turkey baster and placed in a 90ml Falcon tube.
• Samples were returned to the lab and cleaned using the following procedure:
  • 5% acetic acid plus heating
  • Concentrated Potassium Permanganate
  • Concentrated Hydrochloric Acid
  • Concentrated (30%) Hydrogen Peroxide
• Diatom ID confirmed by JEOL JSM 6010LV SEM.
• Counts performed using the JEOL JSM 6010LV at least 300 valves.
• Pollution Tolerance Index (PTI) calculated according to Stephenason et al. (2008).
• Shannon Diversity (natural log) and Shannon Evenness (SDI & SDE, respectively)
• Trophic Diatom Index (TDI) and Generic Diatom Index (GDI) calculated according to Kelly (2013)
• Proportional Bray-Curtis Similarity (BCI) was calculated according to Bloom (1981).
• Water at each site was monitored on a weekly basis for 8 weeks (June-July) using a YSI 556 Multimeter (recorded temperature, conductivity, oxygen concentration and pH) and a Secchi Tube to measure turbidity.
• Water was collected for alkalinity and some was filtered in the laboratory and frozen in whirl-pics for future water chemistry analysis.

Results

Table 1. A composite list of the 122 species of diatoms found on stones (ST) and sediment (SE) at the headwater streams: Little Weikert, Green Gap, Luck Run, Coral Run and Henstep (see Figure 1). The following table compares the relative abundance of taxa at each study site from counts of at least 300 valves. Note that relative abundance is coded according to the key at right.

Table 2. Table of important descriptive parameters for each of the streams. Values given are mean ± 1 SD.

Table 3. Diatom-derived metrics describing each of the streams. The first number in each cell is the metric followed by the maximum value for that metric.

Table 4. A Proportional Bray-Curtis Similarity Index table comparing percent similarity between diatom communities of all five streams. Only one pair (Luck-Henstep) had high overlap. The others had moderate to low overlap. Little Weikert-Green Gap had only 15% similarity though they were neighboring streams.

Conclusions

• Collected and identified 122 diatom species from all collection sites (Table 1).
• Of the taxa found, only 10 had >10% occurrence (Table 1 and Figure 2).
• pH and conductivity were quite similar across all of the stream sites, but alkalinity was more variable (Table 2).
• Diatom-derived metrics generally showed that the communities came from streams with high water quality (Table 3).
• The Proportional Bray-Curtis Similarity scores (Table 4) were relatively low given the physical/chemical similarities between the sites (Table 2). These results suggest that although the streams are very close together (within 10km), there is not a defined diatom community for these headwater streams. This has further implications for the reference stream concept.

Acknowledgments

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