ARE AQUATIC MACROPHYTES A SIGNIFICANT SOURCE OF ORGANIC MATTER TO LAKE ECOSYSTEMS?

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Introduction:
Aquatic macrophytes of Cougar Lake (the SIUE campus lake, Fig. 1) currently consist mostly of large beds of Myriophyllum spicatum (Eurasian watermilfoil, a well-known invasive species, Fig 2). Cougar Lake had very few aquatic macrophytes before 2002 when Large Mouth Bass (Leopomis macrochirus) were introduced into the lake. At the same time, aquatic macrophytes began to spread throughout the lake. There are two possible reasons why this happened. One is that the aquatic macrophytes were contaminants in the water containing the bass when it was released into the lake. The other is that the aquatic macrophytes were always present but were unable to compete with the phytoplankton until bass were stocked in the lake. When the bass were introduced into the lake they may have indirectly influenced the phytoplankton by reducing the number of zooplanktivorous fish. The subsequent reduction in phytoplankton might have given Myriophyllum a chance to spread (Ottensmeier 2005).

Discussion:
The hypothesis was that δ13C concentration would increase as a direct result of increased aquatic macrophytes in the lake. The 2001 samples were taken prior to the overwhelming growth of aquatic macrophytes. The samples varied very little with depth in the 2001 dataset. The 2007 samples were taken after Large Mouth Bass were introduced and after the aquatic macrophytes spread throughout the lake. The data indicate that the δ13C was highest in areas that would have large mats of aquatic macrophytes consisting mostly of Myriophyllum spicatum. The graph of the 2007 samples vs. the 2001 samples implies that there is a big difference in the sample sets. The biggest difference in the data was observed in depths under 4m. The results strongly suggest that the increase in δ13C concentration is directly associated with the increase of aquatic macrophytes in the lake. The strongest evidence was found when the samples were mapped. The map showed a strong correlation in δ13C values. The difference in δ13C between the two samples allows me to track sources of organic matter to the lake sediment (Ottensmier 2005).

Materials and Methods:
Samples were taken from Cougar Lake during Fall 2006 and Spring 2007. All of the samples were taken from a boat at depths ranging from 0.5 m to 11.5 m. The depths for each sample were determined by using both an electronic depth sounder and by using a lead. The samples were taken close to samples that had been made by Chu Guo (2002). Both sets of samples were located using a Garmin GPS V geographic positioning unit with an accuracy of 15 m. Figure 3 shows the locations of my samples and Chu Guo’s samples. Samples were taken using an Ekman Dredge. The sediment was then placed into a whirl pack bag and frozen to be saved for later use. In the lab an aliquot of the sample was dried overnight 75°C. Once dry, the samples were ground using a hand grinder. The grinder was washed after each sample to ensure that the samples would not be contaminated. The ground sample was poured into a 1 mL plastic vial using a funnel to ensure that very little of the sample was lost. The vials were put into beakers and set into an evaporating chamber above 12M HCl to remove carbonate from the sample. The samples were then sent to Cornell Isotope Labs for analysis.

Stable Isotopes of Carbon
Carbon has two major isotopes 12C and 13C. Terrestrial C3 plants and aquatic plants discriminate against 13C for photosynthesis (Wang et al. 1998). C4 plants do not discriminate as strongly against 13C (Table 1). Although aquatic plants are C3 plants, they use 13C for photosynthesis when the availability of inorganic carbon is limited. Because they live in dense beds, carbon is frequently limited. Under these conditions they produce organic matter with 13C similar to C4 plants. Phytoplankton, on the other hand, discriminate very strongly between isotopes of carbon because they do not reduce inorganic carbon to limiting levels. Thus phytoplankton have lower 13C values. The difference in 13C between phytoplankton and aquatic macrophytes allows me to track sources of organic matter to the lake sediment (Ottenmier 2005).

My hypothesis is that the increase in aquatic macrophytes should lead to an increase in δ13C in the lake sediment. The shallow water sediments where aquatic macrophytes are abundant should have an increased 13C. The data collected in 2007 can be compared to data collected by Chu Guo (2001). His samples were collected before the recent expansion of macrophytes in the lake.

Results:
The data show a decrease in δ13C from shallow depths to the deepest part of the lake (Fig. 4). This result is in direct contrast to the data collected in 2001 by Chu Guo (2001) which suggests a slight increase in δ13C from shallow samples to the deepest samples from the lake (Fig. 4). The areas located closest to the shore from the 2007 samples showed higher δ13C (Fig 5) whereas the 2001 samples showed little difference in δ13C throughout the lake (Fig 6).

Conclusions:
The data strongly support the hypothesis that the increase of δ13C in shallow water sediment is due to an increase in aquatic macrophytes.

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References:

Table 1: 813C Values for common substances

<table>
<thead>
<tr>
<th>Source</th>
<th>δ13C</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3 Plants</td>
<td>20 to -35</td>
<td>Wang et al. 1998</td>
</tr>
<tr>
<td>CAM Plants</td>
<td>Between C3 and C4</td>
<td>Wang et al. 1998</td>
</tr>
<tr>
<td>C4 Plants</td>
<td>9 to -17</td>
<td>Wang et al. 1998</td>
</tr>
<tr>
<td>Atmospheric CO2</td>
<td>-8</td>
<td>Wang et al. 1998</td>
</tr>
</tbody>
</table>

Figure 1: Cougar Lake
Figure 2: Myriophyllum spicatum
Figure 3: Map of location of 2001 samples and 2007 samples
Figure 4: Plot of δ13C versus depth in Cougar Lake
Figure 5: Map of 2007 samples
Figure 6: Map of 2001 samples