

AN EXAMINATION OF SEDIMENT MICROBIAL BIOMASS AND THE IMPACT OF SEASONAL VARIATION

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ABSTRACT

Microbial biomass is an important measure of the health and viability of a soil but also of a sediment as well. It is a required measure for the OECD 308 Guideline 'Aerobic and Anaerobic Transformation in Aquatic Sediment Systems' and the EPA Guideline OCSP 835.4300 'Aerobic Aquatic Metabolism'. It is used for the same purpose for soil toxicity testing in the OECD 216/217 Soil Microorganisms: Nitrogen and Carbon Transformation Test Guidelines. These guidelines state that a well-established microbial population in soil and one that is appropriate for testing equals 1% of the soil's organic carbon content. There is no such defined value for sediments however, and their values are typically less than 1% of their organic carbon content due to the restrictive access to oxygen. Even still, this measure provides some indication to the viability of the sediment when collected and its appropriateness for testing.

A collection of initial sediment microbial biomass values based on the units "mg Carbon/100 g of sediment" has been summarized and presented based on their time of collection during the year. Conclusions are extrapolated from trends in the data set concerning seasonality.

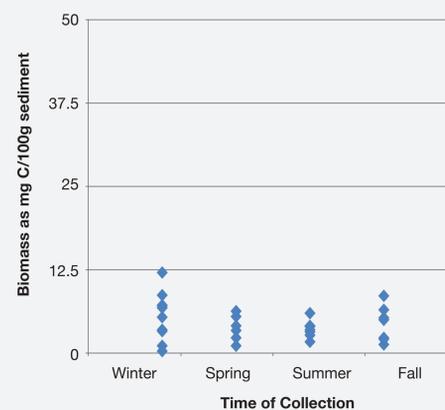
EXPERIMENTAL METHODS

Investigational design:

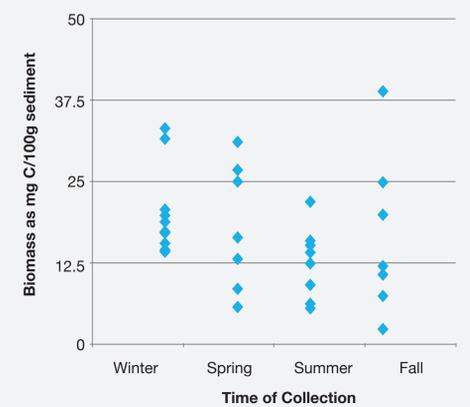
- Factors affecting microbial biomass may include: climate, time of collection, handling, sediment type, % moisture, sediment pH, % clay, % sand and sediment carbon content
- Post-handling biomass results of two well characterized sediments, determined by fumigation/ extraction method (Vance et. al, 1987) are presented.
- All graphical microbial biomass results are presented based on "mg Carbon/100 g of sediment."
- Microbial biomass can also be expressed as the percent of organic carbon content of the sediment. The basic equation is the quantity of biomass (in mg) per 100 g of sediment divided by the quantity of organic carbon (in mg) per 100 g of sediment x 100%.
- Typical characteristics of the two sediments are given below:

Sediment ID	Sediment Type	pH	% Sand	% Clay	% Silt	% OC
Weveantic River - USA	Sandy Sediment	4.0 to 6.0	90	5	5	0.5 to 1.5
Taunton River - USA	Loamy Sediment	5.0 to 6.0	40	10	50	3.0 to 4.0

Post-handling Microbial Biomasses (mg C/100g sediment) of Weveantic Sandy Sediment



Post-handling Microbial Biomasses (mg C/100g sediment) of Taunton Loamy Sediment



DISCUSSION

- Sediments with higher organic carbon contents generally have higher microbial mass in quantity due to the increased nutrients. However, biomass values of higher organic sediments are not necessarily higher when the sediment microbial biomass values are adjusted to their organic carbon content. For this presentation, values were not adjusted for organic carbon content since testing guidelines do not have percentage criteria for sediments like there is for soils.
- Both of these sediments have pH values below neutral. Previous work with soils have shown that low pH seems to have microbial biomass values that are less than, equal to or greater than pH neutral soils and therefore low pH has no influence on soil microbial biomass in general.
- One noticeable result in this study is that the summer values are generally more consistent than the other seasons and have the lowest high point of all the seasons for both sediment-types. No statistical difference in microbial mass was observed across seasons in either Weveantic Sandy Sediment (ANOVA, $p = 0.413$) or Taunton Loamy Sediment (ANOVA, $p = 0.135$), likely due to within-season variability.
- Variation was lowest in the winter season for the loam sediment which could be a function of buffering capacity of the higher organic carbon content. Whereas variation was highest in the winter in the sandy sediment which again might be contributed to having less carbon content and less buffering capacity against temperature extremes.

Other factors:

- Handling conditions: All sediments were collected at an approximate depth of 30 cm of overlying water. Sediments were passed through a 2-mm stainless steel sieve and generally stored in a refrigerator for 1-3 days prior to microbial biomass analysis. All measurements were based on "dry weight". Collections took place for this data between January 2013 to March 2018 in Southeastern Massachusetts, USA.

CONCLUSIONS

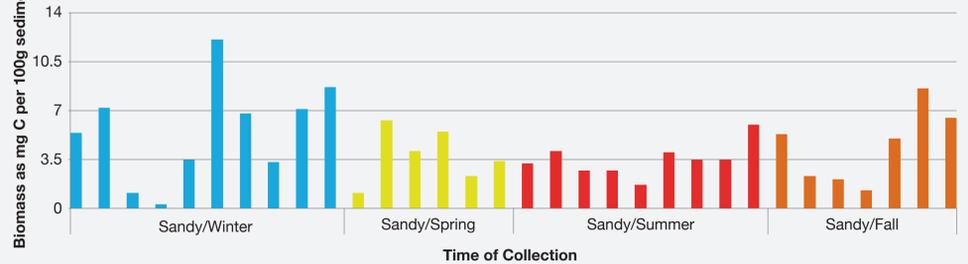
USA (New England) Sediments:

- The winter season appears to have the highest variability for the low carbon content, Weveantic Sandy Sediment. It had the highest high point and the lowest low point, with the largest standard deviation. With this said, the winter values still had the highest overall mean microbial biomass.
- The winter season also had the highest mean microbial biomass in the high carbon content, Taunton Loamy Sediment. In this case the values were fairly consistent and didn't show the variability that was seen in the sandy sediment. Winter variation maybe influenced by the buffering capacity of organic carbon content against temperature extremes. Higher mean winter values debunks the idea that sediment microbial biomass is dead in the winter.
- The lower trending microbial biomass results in the summer may be due to reduced oxygen concentrations. It may be interesting to note that organic carbon contents are slightly lower in the winter for both sediments, which is most likely due to reduced biodegradation rates of leaf-litter and other detritus.
- Both sediments showed the most consistency in the summer season although the overall mean microbial biomass was at the lowest part of the year.
- The highest variability overall and for the loamy sediment occurred in the fall. This could be due to recovering microbial biomass values from the lower summer values to the slightly higher values in the early winter.

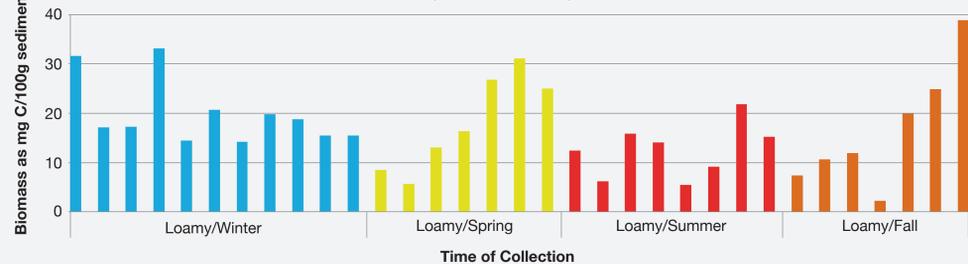
Overall Seasonal Impact on Sediments:

- Overall, based on the scatter plot graph, it appears that microbial biomass is fairly consistent throughout the year with the highest microbial biomass occurring during the cooler months and the most consistent but lower values occurring in the summer.

Posthandling Microbial Biomasses (mg C/100g sediment) of Weveantic Sandy Sediment



Posthandling Microbial Biomasses (mg C/100g sediment) of Taunton Loamy Sediment



Sediment	Microbial Biomass (mg C/100 g sediment)			
	Winter	Spring	Summer	Fall
Weveantic - Sandy				
mean	5.55	3.78	3.49	4.44
st.dev.	3.59	1.95	1.20	2.66
c.v.	65%	51%	34%	60%
Taunton - Loamy				
mean	19.84	18.09	12.54	16.59
st.dev.	6.56	9.71	5.48	12.40
c.v.	33%	54%	44%	75%

Note: Winter season was defined as Dec. 20th to March 19th. Spring was defined as March 20th to June 20th. Summer was defined as June 21st to Sept. 20th. Fall was defined as Sept. 21st to Dec. 19th.

REFERENCE

Vance et al., 1987. An extraction for measuring soil microbial biomass C. Soil Biol Biochem. 19 (1987) 703-707.

ACKNOWLEDGEMENTS

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