Title: Tillage history drives changes in the dynamics of microbial respiration, assimilation and growth in soil upon addition of dissolved organic carbon (as ^{13}C-xylose)

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Project Goals: Short statement of goals. (Limit to 1000 characters)

Project Goals: This research program will reveal fundamental aspects of soil C-cycling and provide ecological and metabolic insights on diverse non-cultivated soil microorganisms that play major roles in the global C-cycle. Specific goals include: 1) Map the C assimilation dynamics for thousands of non-cultivated microorganisms in soil by harnessing a full cycle microbial food web mapping approach that employs an array of ^{13}C-labeled molecules; 2) Map the C assimilation dynamics of soil microorganisms across soil systems as a function of soil characteristics; and 3) Evaluate ecological and seasonal patterns of activity and abundance for discrete microbial taxa across gradients of soil characteristics and as a function of their C-assimilation dynamics. These goals will be achieved by employing a newly developed microbial food web mapping approach, enabled by advances in ^{13}C-stable isotope probing of nucleic acids and next generation sequencing.

Bacteria are essential to the cycling and storage of carbon in the soil ecosystem. Tillage decreases soil organic matter content and changes the composition of soil microbial communities. Differences in microbial ecology between no-till vs tilled soils may contribute to differences in organic matter loss pathways, however mechanistic linkages between microbial community structure and function remain unclear in soils.

Microbial contributions to the degradation of both dissolved (as ^{13}C-xylose) and particulate (as ^{13}C-cellulose) carbon compounds were contrasted in no-till and tilled soils by using high resolution DNA stable isotope probing (HR-SIP) to evaluate the temporal dynamics of carbon assimilation and respiration in a series of soils from a long-term tillage experimental in Chazy, NY. Additionally, we used high throughput sequencing of 16S rRNA gene amplicons to assess seasonal variation in microbial community composition at field scale in relation to tillage history. For each OTU, patterns of isotope incorporation in HR-SIP experiments were assessed in relation to variation in OTU relative abundance as a function of season, tillage history, and their interaction.

Using analysis of variance of Unifrac distance matrices (PERMANOVA), we see that bacterial communities vary significantly (R^2 = 0.12, p = 0.001) with tillage, as well as with season (R^2 = 0.06, p = 0.001). We find that no-till soil has significantly higher rates of soil respiration and higher rates of ^{13}C-xylose, but not ^{13}C-cellulose, mineralization relative to tilled soil. The set of bacteria that incorporated ^{13}C xylose differed between tilled and no-till soils at the beginning of the experiment (days 1,3) but became more similar over time. In contrast, the set of bacteria that incorporated ^{13}C cellulose remained similar between tilled and no-till soils throughout the experiment. However, the number of OTUs that incorporated ^{13}C cellulose differed, with 195 OTUs incorporators in the no-till treatment as compared to 136 in the plow-till treatment.

Comparing the incorporation of ^{13}C from cellulose and xylose into the bacterial community in tilled vs. no-till soils shows that the bacteria participating in carbon transformation differ as a function of soil management history, with implications for carbon fate. The diversity of bacteria that incorporate xylose, and rates of xylose respiration varied with respect to tillage. The diversity of bacteria that incorporate cellulose also varied with tillage but, in contrast, no corresponding differences were observed in rates of cellulose respiration. These results suggest that changes in the structure of the microbial community affects xylose degradation but not cellulose degradation. It is possible that this outcome may be a consequence of the form in which the carbon is delivered as either dissolved or particulate organic carbon.

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