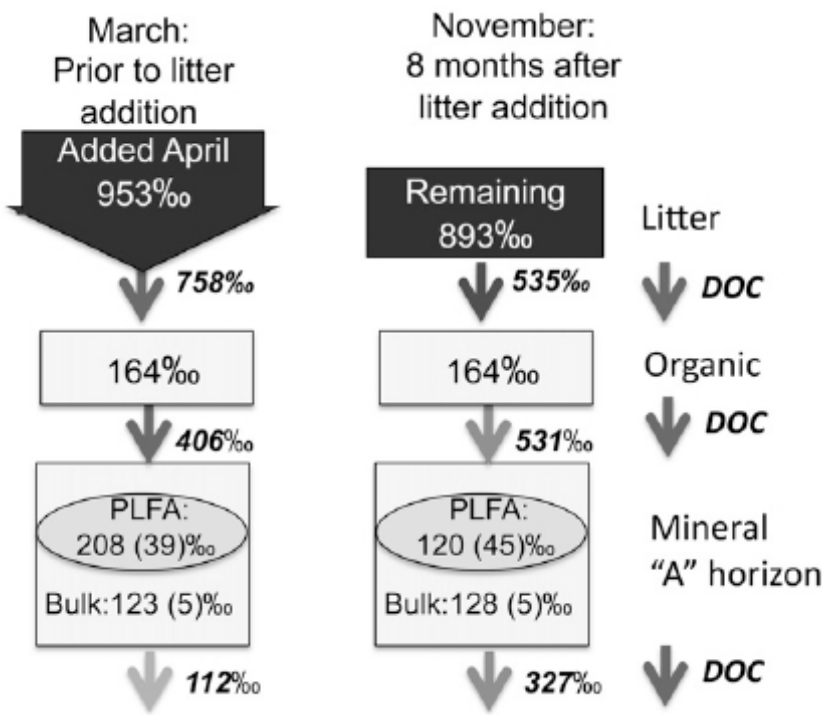
Recent Leaf-Litter-Derived Carbon Is Not a Major Source for Mineral Soil Microbial Communities

Contact: Paul J. Hanson, 865-574-5361, hansonpj@ornl.gov
Funding: DOE Office of Science, Biological and Environmental Research

- Soil microbial communities survive based on a mixture of young and old carbon fixed from higher plants.
- A study tracking the fate of ^{14}C-labled carbon from native temperate forest vegetation in multiple year manipulations provided the opportunity to isolate the dominant form of carbon supporting mineral soil microbial communities.
- In situ manipulations and a mesocosm study both showed that forms of carbon leached from fresh forest leaf litterfall were not a detectable carbon source for the underlying mineral soil microbes.
- The results provided quantitative evidence that root-derived C is the major (>60%) source of C for microbes in temperate deciduous forest soils.



Example tracer results from the mesocosm study

U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Recent Leaf-Litter-Derived Carbon Is Not a Major Source for Mineral Soil Microbial Communities

Contact: Paul J. Hanson, 865-574-5361, hansonpj@ornl.gov
Funding: DOE Office of Science, Biological and Environmental Research

Abstract:

Microbial communities in soil A horizons derive their carbon from several potential sources: organic carbon (C) transported down from overlying litter and organic horizons, root-derived C, or soil organic matter. We took advantage of a multi-year experiment that manipulated the ^{14}C isotope signature of surface leaf litter inputs in a temperate forest at the Oak Ridge Reservation, Tennessee, USA, to quantify the contribution of recent leaf litter C to microbial respiration and biomarkers in the underlying mineral soil. We observed no measurable difference (<~40& given our current analytical methods) in the radiocarbon signatures of microbial phospholipid fatty acids (PLFA) isolated from the top 10 cm of mineral soil in plots that experienced 3 years of litterfall that differed in each year by ~750 per mil between high-^{14}C and low-^{14}C treatments. Assuming any difference in ^{14}C between the high- and low-^{14}C plots would reflect C derived from these manipulated litter additions, we estimate that <~6% of the microbial C after 4 years was derived from the added 1−4-year-old surface litter. Large contributions of C from litter< 1 year (or >4 years) old (which fell after (or prior to) the manipulation and therefore did not differ between plots) are not supported because the ^{14}C signatures of the PLFA compounds (averaging 200 − 220 per mil) is much higher that of the 2004−5 leaf litter (115 per mil) or pre-2000 litter. A mesocosm experiment further demonstrated that C leached from ^{14}C-enriched surface litter or the O horizon was not a detectable C source in underlying mineral soil microbes during the first eight months after litter addition. Instead a decline in the ^{14}C of PLFA over the mesocosm experiment likely reflected the loss of a pre-existing substrate not associated with added leaf litter. Measured PLFA $\Delta^{14}C$ signatures were higher than those measured in bulk mineral soil organic matter in our experiments, but fell within the range of ^{14}C values measured in mineral soil roots. Together, our experiments suggest that root-derived C is the major (>60%) source of C for microbes in these temperate deciduous forest soils.

Citation:

Kramer C, Trumbore S, Froberg M, Cisneros-Dozal LM, Zhang D, Xu X, Santos G, Hanson PJ (2010) Recent (<4 year old) leaf litter is not a major source of microbial carbon in a temperate forest mineral soil. Soil Biology and Biochemistry 42:1028-1037.