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The Fate of Methanotrophically Fixed Carbon in Soils

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Soil microorganisms are central to the cycling of organic matter, with the complexity of the microbial community being universally acknowledged. However, major challenges exist in assessing changes in community structure and dynamics due to the unculturable nature of the major proportion of such populations. This places considerable emphasis on the use of indirect approaches, e.g. field or laboratory based gas flux measurements, and/or culture independent methods. Gene probes provide phylogenetic information or identify specific groups of microorganisms. Complementary to the latter approaches are phosphoslipid fatty acid (PLFA) analyses; the results of which provide broad chemotaxonomic classifications and bacterial biomass estimates, which can be related to various soil properties/environmental influences. The PLFA approach can be refined through the introduction of ^{13}C-labelled substrates to soils, followed by the analysis of ^{13}C-labelled PLFAs to provide information concerning the group(s) of microorganisms utilizing a given substrate.

One substrate of particular significance is the greenhouse gas CH_4. A century of study has demonstrated the importance of methanotrophic bacteria in the Earth system as a sink for atmospheric CH_4 (high affinity methanotrophs) and as a robust barrier against CH_4 flux to the troposphere from anoxic environments (low affinity methanotrophs). However, incubation of soils with $^{13}CH_4$ opens up a range of new opportunities to probe the activities of the methanotrophic population in hitherto unattainable detail. $^{13}CH_4$ is a particularly appealing substrate to apply to study the structure and dynam-

ics of soil microbial populations since it is readily introduced into soils under nature realistic conditions, thereby allowing the molecular fate of carbon captured by the methanotrophic biomass to be investigated (Bull *et al*., 2000).

Application of this stable isotope probing approach will be illustrated with examples drawn from recent work on CH_4 oxidizing bacteria. A recent development has been the use of a flow through system, which allows long-term exposures of soils to $^{13}CH_4$ in order to determine growth kinetics *in vitro* and the size of high affinity methanotrophic populations (Maxfield *et al*., 2006). Cell number estimates are based on a ^{13}C-labelled PLFA conversion factor, indicating that this key group of bacteria (the terrestrial CH_4 sink) constitutes $<$0.1% of the total soil microbial biomass and is highly susceptible to disturbance and inorganic fertilizer treatments.

References

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