Geophysical Research Abstracts
Vol. 17, EGU2015-3394, 2015
EGU General Assembly 2015

The use of biomarkers to trace carbon transformations and input in soils

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Tracing the origin of soil organic matter is an important tool to unravel mechanisms that lead to (de)stabilization of organic carbon in soil systems. To this end biomarkers, i.e. (groups of) specific molecules that can be linked to (groups of) specific plant species or plant parts are often used. A good example is the use of suberin and cutin as biomarkers to distinguish organic matter with a root origin from organic matter with a leaf origin. However, the use of biomarkers to trace the origin of soil organic matter is also subject of fierce scientific debate. On the one extreme end there are those colleagues who see biomarkers as a cure-all solution to all organic matter tracing problems. On the other end of the spectrum there are experts who claim that the concept of biomarkers is so intrinsically flawed that it can never yield meaningful information about carbon transformations except in the most specific cases.

We believe that neither vision is correct. In our presentation we discuss the merits and drawbacks of using biomarkers to trace root versus leaf derived organic matter in soils. For this we use a 1-year incubation experiment with fine root and leaf material of six temperate tree species as a case study. We discuss the abundance, or lack thereof, of root and leaf derived biomarkers and the development of their concentration over time. Specifically, we found that the specificity of root and leaf specific biomarkers depended strongly on the amount and diversity of studied species. For instance, four molecules were identified to be leaf biomarkers for some species, while serving as root biomarkers for others. This could result in serious misjudgment of root and leaf specific biomarkers if the boundary conditions, including species of interest, are not well known. On the other hand, our results show that cutin and suberin derived biomarkers can indeed be successfully used to distinguish root from leaf input in certain situations, such as an ecosystem dominated by the six forest species tested.

We will link the incubation study to our experience with the application of biomarkers in podzols and plaggic anthrosols, and place it in the context of similar attempts by other groups . Thus we hope to stimulate a broader discussion about the merits and drawbacks of the use of biomarkers to trace the origin of soil organic matter.