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Incorporation of 13C labelled root-shoot residues in soil in the presence of Lumbricus terrestris: An isotopic and molecular approach

Alix Vidal (1), Marie Alexis (1), Thanh Tu Nguyen Tu (1), Christelle Anquetil (1), Véronique Vaury (2), Sylvie Derenne (1), and Katell Quenea (1)

(1) UMR Metis, UPMC/CNRS, Paris, France (alix.vidal@upmc.fr), (2) UMR IEES, Paris, France

Litter from plant biomass deposited on soil surface can either be mineralized; releasing CO_2 to the atmosphere, or transferred into the soil as organic compounds. Both pathways depend on biotic factors such as litter characteristics and the of soil organism activity. During the last decades, many studies have focused on the origin of organic matter, with a particular attention to the fate of root and shoot litter. It is generally admitted that roots decompose at a slower rate than shoots, resulting in a higher carbon sequestration in soil for compounds originating from roots. Earthworms play a central role in litter decomposition and carbon cycling, ingesting both organic and mineral compounds which are mixed, complexed and dejected in the form of casts at the soil surface or along earthworm burrows. The simultaneous impact of earthworms and root-shoot on soil carbon cycling is still poorly understood.

This study aimed at (1) defining the rate of incorporation of root and shoot litter with or without earthworms and (2) characterizing the molecular composition of soil organic matter upon litter decomposition, after one year of experimentation. A mesocosm experiment was set up to follow the incorporation of 13C labelled Ryegrass root and shoot litter in the soil, in the presence of anecic earthworms (Lumbricus terrestris). Soil samples were collected at 0-20 and 40-60 cm, as well as surface casts, at the beginning and after 1, 2, 4, 8, 24 and 54 weeks of experiment. Organic carbon content and δ13C values were determined for all the samples with Elemental Analysis – Isotope Ratio Mass Spectrometry. Lipid-free soil and cast samples after 54 weeks of incubation were analyzed with Pyrolysis-Gas Chromatography-Mass Spectrometry. Pyrolysis products were grouped into six classes: polysaccharides, lignin derived compounds, phenols, N-compounds, aliphatic compounds and sterols. Each pyrolysis product was quantified thanks to its peak area, relative to the total area of the quantified peaks. A factor analysis is in progress on pyrolysis quantitative data.

Roots and shoots were incorporated in the 0-20 cm soil layer during the year of experiment, the carbon from labelled litter (Clab) reaching 11.4 % after 54 weeks. On the contrary, no significant incorporation was observed in the 40-60 cm layer. An earthworm effect on litter incorporation was observed in casts from the very first weeks of experiment (Clab from 34.8 to 51.4 % after 2 weeks and in soil after 24 weeks. Earthworms accelerated root and shoot decomposition in soil. Roots decomposed at a slower rate compared to shoots. However, after one year, earthworms erased the difference between residue types in casts and to a lesser extent in soil, revealing their capacity to decompose both roots and shoots. The chemical composition of organic matter in soil and casts will provide additional information on the potential role of the difference in chemical composition between root and shoot litter in these processes.