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X-ray computed microtomography to predict CO2 emissions in casts of 6 earthworm species (Lumbricidae)

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Plant residues are the main precursors of soil organic matter (SOM) and soil macrofauna is an important driver of ecological processes involved in the sequestration of carbon (C) in soils. In particular, earthworms are one of the largest contributors to soil matter formation in most terrestrial ecosystems. In the short term, they may increase the rate of OM turnover by mineralization, fragmentation and stimulation of microbial activity. On the other hand they may reduce OM degradability by forming stable aggregates and organo-mineral complexes protecting C from mineralization for longer time scales. Earthworms are classified in three main ecological groups depending on their behaviors and on their morpho-functional traits. However, their intra- or inter- ecological group effect on C stabilization needs to be investigated.

In this study, we explored the impact of earthworm diversity (composed of several species belonging to different ecological groups) on the physicochemical properties of casts, related to CO_2 emissions. We hypothesized that C mineralization in casts would be related to the ecological category.

We studied casts of 6 species (2 anecic species: Lumbricus terrestris & Aporectodea nocturna, 2 endogeic species: Allolobophora icterica & Aporrectodea caliginosa and 2 epigeic species: Lumbricus castaneus & Eisenia fetida) produced in a silty subsoil with addition of plant litter. Casts were incubated for 140 days under similar laboratory conditions. We measured CO_2 mineralization, pH, elemental composition and physical cast organization by X-ray microtomography (resolution of 9.49 µm voxel) at 7, 42, and 140 days.

Our results showed lower CO_2 mineralization in aggregates produced without earthworms than all earthworm casts. In the beginning of the incubation casts showed similar CO_2 emissions and specific physicochemical properties as OC content and pH. After 140 days, CO_2 emissions were

earthworm species specific with Aporectodea nocturna showing highest CO_2 emissions, and Aporrectodea caliginosa the lowest values. Microtomographic analyses showed that this is due to an increase of cast porosity with increasing cast age coupled with a concurrent decrease particulate organic matter (POM) structures. Our first results seemed to suggest that earthworms belonging to the same ecological category influence similarly C mineralization through their impact on the cast organization.