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The role of extracellular polymeric earthworm mucus for the formation of organo-mineral associations in soil

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Plant-derived mucilage and microbially produced extracellular polymeric substances (EPS) by fungi or bacteria are known to be crucial for the formation and stabilization of organo-mineral associations and soil aggregates (Six et al., 2004; Totsche et al., 2018). Especially the interactions between organism-produced complex mixtures of macromolecules (e.g. microbial EPS) and typical constituents of the soil mineral phase like iron oxides and clay minerals were intensively investigated. Although the role of earthworms in improving soil quality has been stated already by Charles Darwin (Brown et al., 2000), surprisingly little is known on the interactions of earthworm mucus with the soil mineral phase and experimental studies are vastly lacking. With our study, we contribute to closing this knowledge gap by studying the interactions between soil minerals (goethite and illite) and earthworm mucus with completely mixed batch reactor experiments. Mucus is a nutrient rich extracellular polymeric substance excreted by earthworms to facilitate their movement through soils. We focused on mucus from anecic (Lumbricus terrestris) and endogeic (Aporrectodea caliginosa) earthworm species, mainly composed of proteins and carbohydrates. For both mucus types, we observed strong adsorption to the mineral phases of goethite and illite. A fractionation of mucus between the solid (minerals) and liquid (supernatants) phase was determined that resulted from preferred adsorption of phosphorus-containing mucus constituents to goethite. This adsorption results in the formation of organo-mineral associations which serve as composite building unit for soil microaggregates. Mucus adsorption further alters the isoelectric point (IEP) of the associate compared to the pure mineral phases. The IEP of organo-mineral associations with goethite decreased, while that with illite increased in comparison to the bare minerals. The adsorption of organic carbon and the specific accumulation of phosphorous to goethite points to the importance of earthworm influenced organo-mineral associations for the nutrient cycles. Additionally, the specific surface properties of these organo-mineral associations could influence their paths and translocation in the soil massively, with regard to preferential flows inside the earthworm formed burrow systems.

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