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Diffusion characteristics and molecular size of DOM in plant and soil extracts

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The main sources of dissolved organic matter (DOM) in soil are plant litter, root exudates, soil fauna, and the un-dissolved soil organic matter pool. A strong spatial heterogeneity of these sources, even on the microscale, is observed in soil. Consequently diffusion of DOM is an important transport process, which connects "hot-spots" of microbial activity and substrates. Therefore an experiment was conducted in order to measure diffusion constants of DOM and 2 inorganic nutrients. Furthermore, hydrodynamic diameters were calculated from these constants, which give an approximation of molecular size.

The diffusion characteristics of several parameters in aqueous extracts of two soils and of barley were investigated. They were: Ammonium, nitrate, dissolved organic nitrogen (DON), dissolved inorganic carbon, dissolved organic carbon (DOC), and 3 different fluorophore groups associated with DOM. The fluorophore groups were identified and quantified from fluorescence excitation emission spectra with the PARAFAC model. Two of the groups resembled groups, which have been used to imply the presence of humic substances (HS). Our results give reason to believe these groups can be regarded as indicators of dissolved HS in aqueous extracts only with caution. The other group, enriched in the barley extract, was the "tryptophan" group. However, its diffusion constant differed markedly between the soil and barley extracts, indicating that compounds other than tryptophan contributed to this fluorophore in soil extracts.

When the Stokes-Einstein equation was applied to the diffusion coefficients of DOC (in all extracts about 0.27 x 10-5 cm2 s-1 at 4 °C), a mean hydrodynamic diameter of 1.0 nm for the DOC was calculated. The diffusion constants for the other DOM parameters were also similar, regardless of source, with the exception of the "tryptophan" fluorophore group from barley, which diffused about 1.5 times faster than that from the soils and was in good agreement with the theoretical diffusion coefficient of tryptophan. There was no evidence of macromolecules in DOM.

The diffusion of the inorganic nitrogen species was up to 4 times as rapid as that for DOC. Therefore, where in situ metabolism is fuelled by diffusion, diffusion rates of dissolved nitrogen are not likely to be the limiting factor.