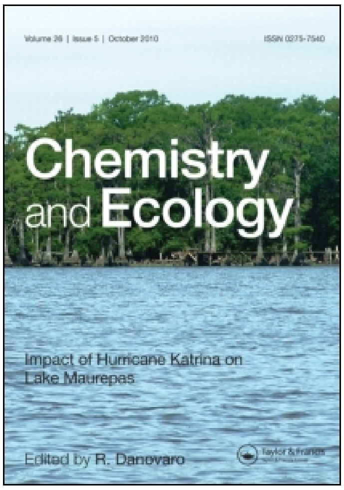

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DISSOLVED ORGANICALLY-BOUND CARBON IN TEMPERATE ECOSYSTEMS

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The chemistry of soil organic matter, and its role in creating an environment suitable for the microflora, macrofauna and plant roots to flourish, has fascinated chemists for over two hundred years. Progress in understanding its chemistry has been constrained, on the one hand by the complexity of the organic material and the interactions between it and the mineral components, and on the other by the lack of adequate techniques for extraction and suitable analytical methods. Early attempts to extract organic matter from soils with water failed because the quantity dissolved was too small to measure. More conventional techniques that were chemically more aggressive had to be adopted, and for most soils extraction with dilute sodium hydroxide has become the classical extractant. Even the organic material deposited naturally from soil solution in the B horizon of a podzol becomes insoluble in water and can only be extracted by dilute acid. Absorption of the organic material on to mineral surfaces is the explanation given for its reduced solubility. Where mineral material is virtually absent, as in the case of a peat soil, a dark brown solution can be squeezed out of a saturated sample. That fraction was originally called 'fulvic acid', but the term is now used to describe the alkali- and acid-soluble organic material extracted from soils.

Despite the insolubility of the mass of soil organic matter, many of the reactions involving organic compounds in soils must occur in water solution. Elluviation and illuviation are important processes in soil formation. Much of the organic material in mineral soils is adsorbed on to external and possibly inter-layer surfaces of minerals. For this absorption to occur the organic components must have been in water solution. Chelation of metal ions by water soluble ligands provides plants with an available supply of micronutrients whereas chelation by water insoluble ligands reduces their toxicity. Loss of dissolved organic matter from soils occurs through leaching to river systems. Interest in this general area has increased in recent years as a consequence of the improved methods of isolation and analysis together with the increasing awareness of the role soluble organic material plays in a wide range of environmental issues. Ecologists are interested to quantify carbon losses and/or gains between various parts of individual ecosystems to measure the impact of change. Schnitzer's work has shown that hydrophobic pesticides may be rendered water soluble through reaction with water-soluble fulvic acids. Marine chemists want to know if organic material orginates from internal sources or external inputs to the marine system. There are also many commercial and industrial interests. Dissolved organic material in potable water, although a localised problem related to the source of water and soil type, offends the consumers, while chlorination may produce products that are potential carcinogens. The presence of organic material causes serious problems in the generation of superheated steam and where the level exceeds the maximum permitted level of 2 to 5 $\mu g\ ml^{-1}$ dissolved-C, a clean-up stage may be required before the water enters the boilers.

Where does the soluble organic material originate? Soluble exudates from leaves enter forest soils by throughfall and may survive to pass through to the drainage water. Production of organic exudates from plant roots has been measured and some of the compounds identified. ^{14}C labelling studies show that much of this exudate provides a carbon source for the soil microflora. A small proportion has, however, been described as 'similar to humic material' which may confer upon it a degree of resistance to microbial attack. Some may simply 'spill out' from dead or damaged cells and some will result from microbial decomposition of animal and plant residues.

What is the survival rate of water soluble materials in soils? Where microbial activity is high, simple compounds will be 'pounced' on as a carbon source for microbial cells and are unlikely to escape. Small quantities of sugars, amino acids and amino sugars have been identified in water extracts of soils. Quantitative extraction of amino compounds can be increased by including a salt in the extract to release the charged compounds from exchange sites. A water extraction dissolves simple compounds present in soil at that particular moment. It is not known whether they would survive movement through the soil profile to be removed in drainage water. Microbial decomposition of humified, or partially humified, material may release soluble polymers sufficiently complex chemically to survive further microbial attack. However, in a mineral soil such products will almost certainly be adsorbed on to mineral surfaces. Small amounts of organic nitrogen, phosphorus and sulphur compounds are also extractable by water from soils. Little information is available to indicate in what form those compounds are present.

Soil is a complex system but slowly, with the aid of improved techniques and more sensitive methods of analysis, we are building up an understanding of the chemical, microbial and physical reactions which occur within its pores and on solid surfaces. Developments in our knowledge of the chemistry of dissolved organically-bound carbon compounds have come mainly from the freshwater and marine chemists. The introduction of macroporous XAD-resins, ultrafiltration techniques and improved detection systems has renewed interest in the organic solutes in soil solution and in water leached out of soils. It is therefore timely that a special edition of Chemistry and Ecology should be devoted to this problem to bring us up-to-date with the progress made on a number of different fronts.