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Photo- and Biolability of Pyrogenic Dissolved Organic Matter: A Laboratory study of Thermal Series of Laboratory-Prepared Char Leachates

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Pyrogenic carbon (pyC) or fire-derived organic C (e.g., charcoal and soot), while generally considered stable in soils and sediments, can leach into pore waters forming dissolved pyrogenic organic carbon (pyDOC). This pyDOC may be exported to the ocean (about 10% riverine DOC may be pyrogenic). Yet, the processes which control this export and how pyrogenic dissolved organic matter (pyDOM) lability is related to its chemical composition are poorly understood. Thus, pyDOM was leached from a thermal series of oak and grass chars (250-650 °C) and photoirradiated in a solar simulator. About 10-20% of oak char leachate pyDOC was mineralized over five days, with greater proportions lost from leachates of higher temperature parent chars. Proton NMR revealed decreased relative amounts of aryl-C and increased low molecular weight C1 and alkyl-C components during the photo-incubation. Quantification of benzenepolycarboxylic acid (BPCA), molecular markers for condensed aromatic carbon (ConAC), indicated that 75-94% of ConAC was lost during the first five days of photoincubation, the majority of which occurred within the first 2 days, with a preference toward loss of ConAC of larger cluster sizes. Over 96-day microbial incubations, 37 to 48% of pyDOC was lost with modelled half-lives of about 13 days. Much of this was low molecular weight C1 compounds, while only 1 to 2% of ConAC was lost, with a preference for losses of smaller cluster size ConAC. Slightly greater proportions of both total pyC and ConAC was lost from pre-photodegraded pyDOM leachates. These results highlight the large portion of pyDOM that is potentially remineralized or transformed in aquatic systems at short timescales, and the need to examine both condensed and non-condensed portions of pyDOM to understand the effects of fires on aquatic biogeochemistry.