A CASE STUDY OF THE PHYSICAL, CHEMICAL AND BIOLOGICAL FACTORS AFFECTING DISSOLVED ORGANIC CARBON IN THE WARREN RESERVOIR, SOUTH AUSTRALIA

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A thesis submitted for the degree of Doctor of Philosophy
April 2004

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ABSTRACT

The dissolved organic carbon (DOC) present in a reservoir comprises allochthonous inputs from the catchment and autochthonous inputs generated within the reservoir itself. The Warnes Reservoir, South Australia, is characterised by elevated DOC concentrations and elevated water colour. Inventories and dynamics of DOC concentration and nature in the Warnes Reservoir were analysed between April 1997 and August 2001, in order to establish the origins of the reservoir DOC, and determine how the DOC contribution from different sources affects water quality in the Warnes Reservoir on a seasonal timescale. During the course of the study, increased DOC levels were accompanied by changes in the nature of the DOC. Between 1997 and 2001, the nature of the DOC pool changed from being dominated by the allochthonous input of coloured organics, to being dominated by the autochthonous input of DOC with lower composition of the coloured material. It is proposed that increased DOC concentrations in the Warnes Reservoir and decreased levels of coloured DOC are caused by higher levels of phytoplankton growth during the later part of the study. In addition to annual increases in DOC, seasonal peaks in DOC concentration were observed during summer and winter periods. Summer peaks were found to be a result of increased phytoplankton growth, whereas winter peaks in DOC concentrations were due to increased inflow of water from the catchment into the reservoir. Winter inputs of allochthonous DOC were also found to comprise high levels of coloured organics.

During this study, emphasis was also placed on studying the potential of two natural processes, photochemical degradation (using UV-B radiation) and bacterial decomposition, to remove DOC from the surface waters of the Warnes Reservoir. DOC samples were found to be both labile and refractory towards the processes of biotic and/or abiotic degradation and decomposition depending on seasonality, and thus the nature of the DOC material. Exposure of DOC to UV-B radiation resulted in enhanced DOC bioavailability, particularly in the case of allochthonous-dominated winter DOC pool, whereas the summer DOC pool showed enhanced level of direct photo-mineralisation compared to the winter DOC pool. It is proposed that the enhanced DOC bioavailability observed during this study was likely due to the UV-B induced cleavage of higher molecular weight DOC compounds into smaller units. Exposure of reservoir DOC to UV-B radiation was also found to produce changes in the structure of reservoir bacterial communities, as indicated by denaturing gradient gel
electrophoresis (DGGE) analysis of bacterial 16S rDNA sequences, suggesting that certain bacteria may be better able to utilize certain types of DOC compared to others.

As UV-B radiation, which forms a natural component of the solar radiation, is known to be harmful to aquatic organisms including bacteria, further studies were conducted to test the likely effects of UV-B radiation on bacterial communities in Warren Reservoir waters. This was done on the assumption that, although UV-B radiation increased the bioavailability of reservoir DOC, the resulting substrates might not be utilised and degraded by bacterial species in the in situ surface waters, as their growth can potentially be inhibited by UV-B radiation. Thus in terms of the cycling of DOC in the Warren Reservoir, it was important to study the response of native bacterial communities to UV-B radiation in order to be able to determine whether lack of bacterial activity, as a result of UV-B inhibition, is likely to cause DOC accumulation in the reservoir in the long term. The combined findings of a laboratory study and a diurnal in situ reservoir study suggested that UV-B radiation is unlikely to affect the overall growth of reservoir bacteria whereas it has potential to alter its community structure, most likely through its effects on the DOC cycle.