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Compositional and Structural Dynamics of Dissolved Organic Matter during Cyanobacteria (Microcystis aeruginosa) Bloom in Taihu Lake, China

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Taihu lake is the third largest lake in China with a surface area 2250 square kilometers and a remarkable average depth of 1.9 m. It represents an internationally recognized example of recurring algal blooms – a consequence of eutrophication caused by urban and agricultural development in the lake catchment area. These conditions resemble those in many lake catchments on earth and therefore can be considered of global relevance.

The lake Taihu algal bloom event season 2007 was followed by high-resolution organic structural spectroscopy. NMR spectra indicated extensive molecular alteration throughout all structural regimes during processing of algal matter into dissolved organic matter (DOM) with loss and synthesis of carbohydrates, fundamental alteration of aromatic compounds and progressive formation of carboxyl-rich alicyclic compounds (CRAM). FTICR mass spectra indicated near absence of algal extract molecules in summer DOM, and almost complete transformation of biological metabolite signature within the five consecutive months. Contributions of CHNO molecules to continuous molecular series typical of natural organic matter increased during DOM transformation. Metabolic pathway annotation by means of high-resolution mass analysis provided a wide range of rather elaborate pathways associated with biomolecules in DOM and more basic ones characteristic of algal extract metabolites. The time-dependent individual molecular signature of Lake Taihu DOM was likely dominated by microbial metabolism rather than abiotic chemistry.

High-resolution organic structural spectroscopy is clearly capable to resolve meaningful molecular detail out of very complex real environmental mixtures. Here, it has contributed to expand the description of algal blooms from bulk to molecular resolution. Opportunities to considerably improve the significance of future functional biodiversity studies are clearly visible and might lead to a novel unified perception of biodiversity and biogeochemistry.