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pH change induces shifts in the size and light absorption of dissolved organic matter

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Abstract Dissolved organic matter (DOM) influences inland water ecosystems through its light absorbing qualities. We investigated how pH affects light absorption by DOM with pH manipulation experiments and with data from two lake surveys. We hypothesized that: (1) light absorption and photobleaching of DOM would increase with increasing pH, and (2) as a result of photobleaching, molar absorption (i.e. light absorbance at 440 nm/dissolved organic carbon concentration) would decrease among lakes with increasing pH. In experiments with filtered lake water both initial light absorption and photobleaching rates increased at higher (i.e. more basic) pH along with a concomitant shift in the size of DOM toward larger colloidal materials measured by dynamic light scattering (DLS). Both scanning electron microscopy (SEM) and atom force microscopy (AFM) revealed large colloidal to particulate-sized organic matter in alkaline relative to acidic treatments. In the lake surveys, molar absorption coefficients were negatively related to pH across gradients similar to the experiments. Our results are consistent with a conceptual model in which at low pH DOM polymers and colloids are condensed limiting exposure of chromophores to light; at higher pH, polymers and colloids are expanded exposing chromophores to light resulting in greater initial light absorption and faster photobleaching. Hence, water transparency, which is significantly controlled by DOM, is sensitive to environmental changes that influence the pH and chemical composition of inland waters.

Keywords Dissolved organic matter · Light absorption · pH · Lakes · Photobleaching · Colloids · CDOM

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