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Entrapped Sediments as a Source of Phosphorus in Epilithic Cyanobacterial Proliferations in Low Nutrient Rivers

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Abstract:

Proliferations of the benthic mat-forming cyanobacteria *Phormidium* have been reported in rivers worldwide. *Phormidium* commonly produces natural toxins which pose a health risk to animal and humans. Recent field studies in New Zealand identified that sites with *Phormidium* proliferations consistently have low concentrations of water column dissolved reactive phosphorus (DRP). Unlike other river periphyton, *Phormidium* mats are thick and cohesive, with water and fine sediment trapped in a mucilaginous matrix. We hypothesized that daytime photosynthetic activity would elevate pH inside the mats, and/or night time respiration would reduce dissolve oxygen. Either condition could be sufficient to facilitate desorption of phosphates from sediment incorporated within mats, thus allowing *Phormidium* to utilize it for growth. Using microelectrodes, optodes and pulse amplitude modulation fluorometry we demonstrated that photosynthetic activity results in elevated pH (> 9) during daytime, and that night-time respiration causes oxygen depletion (< 4 mg L^{-1}) within mats. Water trapped within the mucilaginous *Phormidium* mat matrix had on average 320-fold higher DRP concentrations than bulk river water and this, together with elevated concentrations of elements, including iron, suggest phosphorus release from entrapped sediment. Sequential extraction of phosphorus from trapped sediment was used to investigate the role of sediment at sites on the Mangatainoka River (New Zealand) with and without *Phormidium* proliferation. Deposition of fine sediment (< 63 μm) was significantly higher at the sites with the most extensive proliferations and concentrations of biological available phosphorus were two- or four-fold higher. Collectively these results provide evidence that fine sediment can provide a source of phosphorus to support *Phormidium* growth and proliferation.

Keywords: Cyanobacteria, *Phormidium*, dissolved reactive phosphorus, photosynthetic activity, respiration, phosphorus release