Ecological and biogeochemical controls on blooms of cyanobacteria

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Blooms of toxic nitrogen fixing cyanobacteria are a significant ecological problem in many lakes and estuaries throughout the world. The formation of these blooms depends on physical conditions as well as the avialability of phosphorus. The source of phosphorus feeding such blooms is typicall internal, derived from stores released from the sediment during hypoxia and anoxia. It has recently been suggested that the invasion of the Baltic Sea by *Maranzelleria spp*. worms may have enhanced phosphorus retention in the sediment through sorption onto iron oxydydroxides associated with the burrows of these organisms [1]. The fate of this sorbed phosphorus over hypoxic and anoxic events is, however, unclear.

We quantified the pool of iron bound phosphorus (Fe-P) in the top 20 cm of sediment at a site in the Gippsland Lakes, SE Australia, subject to periodic hypoxia and colonised by the polychaete *Capitella capitata*. During oxic periods, profiles of Fe-P were relatively uniform with depth down to ~20 cm at concentrations of ~5 μmol P g DW sed^{-1}. After the onset of hypoxia, this concentration rapidly dropped to ~0 and a simple mass balance showed this was consistent with this phosphorus being released to the water column and assimilated by a subsequent bloom of the nitrogen fixing cyanobacterium *Nodularia spumigena*.

To explore the system scale implications of this observation, we used a 3D coupled hydrodynamic biogoechemical model implemented with sediment Fe-P, and nitrogen dynamics as well as bioirrigation and phytoplankton including *N. spumigena*. Model simulations showed good agreement with observed sediment Fe-P dynamics, however, that without bio-irrigation, the rapid release of phosphorus to the water column could not be reproduced and the magnitude of the N. spumigena bloom was reduced by 70%, highlighting the important interaction between ecology and geochemistry in controlling ecosystem reponse to eutrophication.

[1] Norkko, et al (2012) *Global Change Biology* **18,** 422-434.