Do 'cable bacteria' enhance dissimilatory nitrate reduction to ammonium in a periodically anoxic estuary?

PERRAN COOK[1], KERYN ROBERTS[1], ADAM KESSLER[1], FILIP MEYSMAN[2], LAURINE BURDORF[2], BO THAMDRUP[3] AND ELIZABETH ROBERTSON[3]

[1]Monash University, Australia, perran.cook@monash.edu, keryn.roberts@gmail.com, adam.kessler@monash.edu
[2]Netherlands Institute of Sea Research, filip.meysman@nioz.nl, laurine.burdorf@nioz.nl
[3]University of Southern Denmark, bot@biology.sdu.dk, robertson@biology.sdu.dk

The increasing prevalence of hypoxia in many estuaries worldwide has lead to great interest in how this effects key biogeochemical cycles such as nitrogen, which is a key driver of estuarine productivity and hypoxia [1]. In our studies of the periodically anoxic Yarra Estuary, we have consistently observed increased rates of (DNRA) relative to denitrification during oxic conditions and lower rates during anoxic conditions in the water column [2]. Further controlled laboratory studies of depth profiles of $^{15}N\text{-}N_2$ and $^{15}NH_4^+$ using novel gel samplers confirmed these observations. Moreover, we observed DNRA rapidly recommenced after the sediment was re-oxidised. Slurry incubations of sediment taken from the site suggest DNRA was linked to Fe^{2+} oxidation. We hypothesise that under anoxic conditions Fe^{2+} is both lost from the sediment to the water column and bound up as FeS leading to a reduction in rates of DNRA. Upon re-aeration of anoxic cores we observed a rapid development of pH maxima and minima indicating the presence of 'cable bacteria' performing electrogenic suphur oxidation within the sediment. We hypothesise these organisms enhance DNRA through the liberation of Fe^{2+} near the sediment surface. Sediments in periodically hypoxic estuaries, may therefore have increased rates of DNRA relative to denitrification, potentially exacerbating the problem of hypoxia as bioavailable nitrogen is recycled in the form of NH_4^+, rather than being lost as N_2.

[1] Diaz, R.J., Rosenberg, R. 2008. *Science* **321**, 926-929 [2] Roberts, K., Eate, V., Holland, D., Eyre, B.D., Cook, P.L.M. (2012), *Limnology & Oceanography* **57**, 1427-1442