Phylogenetic and functional potential links pH and N2O emissions in pasture soils

Mr Md Sainur Samad[1], Dr Sergio E. Morales[1], Dr Ambarish Biswas[1], Prof Lars R. Bakken[2], Prof Timothy J. Clough[3], Dr Cecile A. M. DeKlein[4], Dr Karl G. Richards[5], Dr Gary J. Lanigan[5]

[1]Department of Microbiology and Immunology, University of Otago, [2]Department of Environmental Sciences, Norwegian University of Life Sciences, [3]Department of Soil and Physical Sciences, Lincoln University, [4]AgResearch , [5]Teagasc, Environmental Research Centre, Johnstown Castle

Denitrification in soils is mediated by microbial and physicochemical processes leading to nitrogen loss via N2O and N2 emissions. Soil pH is known to be a proximal regulator influencing the reduction of N2O to N2, however, it can also be a distal regulator, affecting factors such as microbial community composition and their functional potential. In this study we test the effect of pH as a distal regulator of both community composition and the N2O emission ratio (N2O/(NO+N2O+N2)) in 13 temperate pasture soils. Physicochemical analysis, gas kinetics, 16S rRNA amplicon sequencing, metagenomic and quantitative PCR (of denitrifier genes: nirS, nirK, nosZI and nosZII) analysis were carried out to characterize each soil. We found strong evidence linking pH to both N2O emission ratio and community changes. Soil pH was negatively associated with N2O emission ratio, while being positively associated with both community diversity and total denitrification gene (nir & nos) abundance. The pH was significantly associated with the abundance of the nosZ (Clade II) gene encoding the N2O reductase responsible for conversion of N2O to N2. Abundance of nosZII was positively linked to pH, and negatively linked to N2O emissions. Our results suggest that pH imposes a general selective pressure on the entire community, and provides both a distal, as well as the previously demonstrated proximal, regulatory role. Our data also support the general model that with increased microbial diversity efficiency increases, in our case resulting in lowered N2O emission ratio through more efficient conversion of N2O to N2.