FUNCTIONAL ECOLOGY OF METHANOTROPHS:
An Adaptive Response to Afforestation and Reforestation in New Zealand

THE MACAULAY LAND USE RESEARCH INSTITUTE

THE UNIVERSITY OF WARWICK

Loïc Nazaries [a,d], Kevin R. Tate [b], Des J. Ross [b,†], Jagrati Singh [b], John Dando [b], Elizabeth M. Baggs [c], Peter Millard [a], J. Colin Murrell [d], Brajesh K. Singh [a,c]

[a] The Macaulay Land Use Research Institute, Aberdeen, Scotland. [b] Landcare Research, Palmerston North, New Zealand. [†] Deceased.
[c] University of Aberdeen, Scotland. [d] University of Warwick, Coventry, England.

Email: l.nazaries@macaulay.ac.uk

INTRODUCTION

- Methanotrophs use methane (CH_4) as sole source of carbon, and are responsible for the soil sink of atmospheric CH_4
- Competition between type I and type II methanotrophs is responsible for variation of CH_4 fluxes
- Afforestation and reforestation can improve CH_4 uptake by soils

OBJECTIVE

Examine the adaptive response of methanotrophs to afforestation of pastures and reforestation after burning.

HYPOTHESIS

Methanotrophs in native forest soils survive changes in land use, to rapidly re-establish under new forests when soil conditions are favourable.

SITES & VEGETATION

North Island, New Zealand, all sites developed on volcanic ash soils of similar age.

- **Turangi site:** 5- and 10-year-old forests (*Pinus radiata*) and adjacent pastures; 47- and 67-year-old manuka-kanuka shrublands
- **Puruki site:** 7-year-old forest (*Pinus radiata*) and adjacent pasture; native forest of mixed species (podocarp)

RESULTS

- Afforestation of patures at both sites increased the CH_4 sink (Fig.1, top)
- CH_4 oxidation rates were comparable under regenerating shrublands (Fig. 1a) and native forest (Fig. 1b)
- Enhanced soil CH_4 oxidation under forests was related to an increase in type II methanotrophs (Fig.1, bottom)

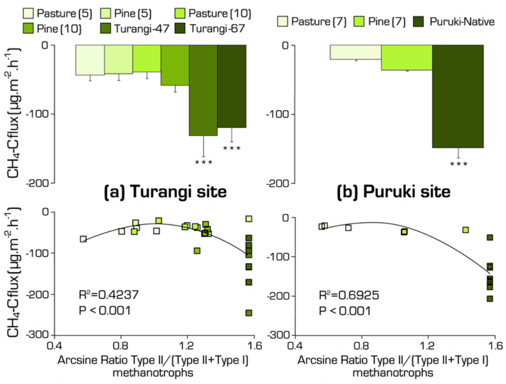

Figure 1: CH_4 fluxes from closed-chamber experiment (top); and relationship with the methanotroph community structure (bottom) in Turangi (a) and Puruki (b).

- PLFA-SIP data (Fig. 2) supported above findings
- PLFA 18:1w7 contained most of the ^{13}C labelling
- Indication that type II methanotrophs were the most active at oxidising atmospheric concentrations of CH_4

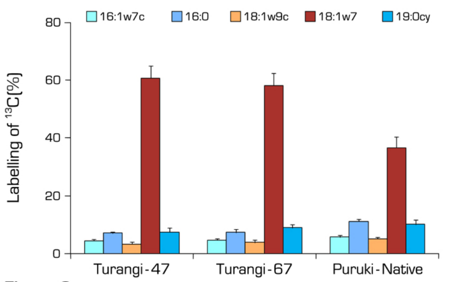

Figure 2:
Percentage incorporation of ^{13}C into the most abundant PLFAs following incubation with ~50 ppm of ^{13}C-CH_4.

- Most type I methanotrophs present in the pastures were closely related to *Methylococcus capsulatus* (cloning and sequencing data)
- Most type II methanotrophs present in the forests (pines, shrubs and native) were distantly related to *Methylocapsa acidiphila*
- At both sites, the relative abundance of type I methanotrophs decreased with forestation and the age of the forests; and type II methanotrophs became more dominant (Fig. 3)

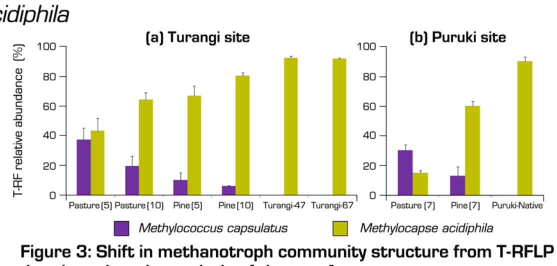

Figure 3: Shift in methanotroph community structure from T-RFLP data based on the analysis of the *pmo*A gene.

CONCLUSIONS

- Afforestation and reforestation enhanced the soil CH_4 sink
- Increase in soil CH_4 oxidation rates was related to a shift in the methanotroph community
- Our data suggests that <47 years were needed for an active methanotroph community and soil CH_4 oxidation rates to become comparable to those in a mature native forest soil
- Our data also supports the hypothesis that type II methanotrophs in the forested soils survived through a period of pasture conversion to become dominant again when the pasture was afforested with pines