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Ammonia oxidising archaea and their role in soil nitrification: Can we control them?

Jim Prosser

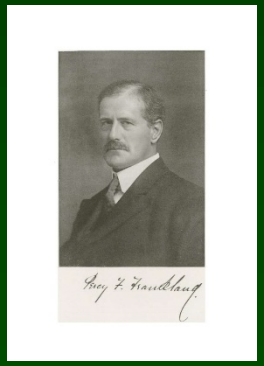
University of Aberdeen

The role of microorganisms in nitrification

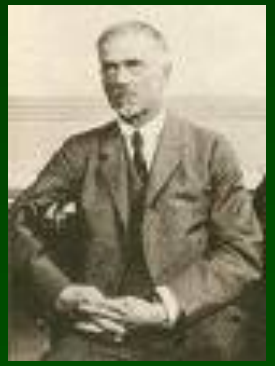
1874-91 Demonstration of 2-stage process
1890 Isolation of ammonia oxidisers (bacteria?):

Robert Warington

Percy Faraday Frankland



Sergei Winogradsky



Norman Walker, Rod Macdonald, Koops & Harms, Stan Watson

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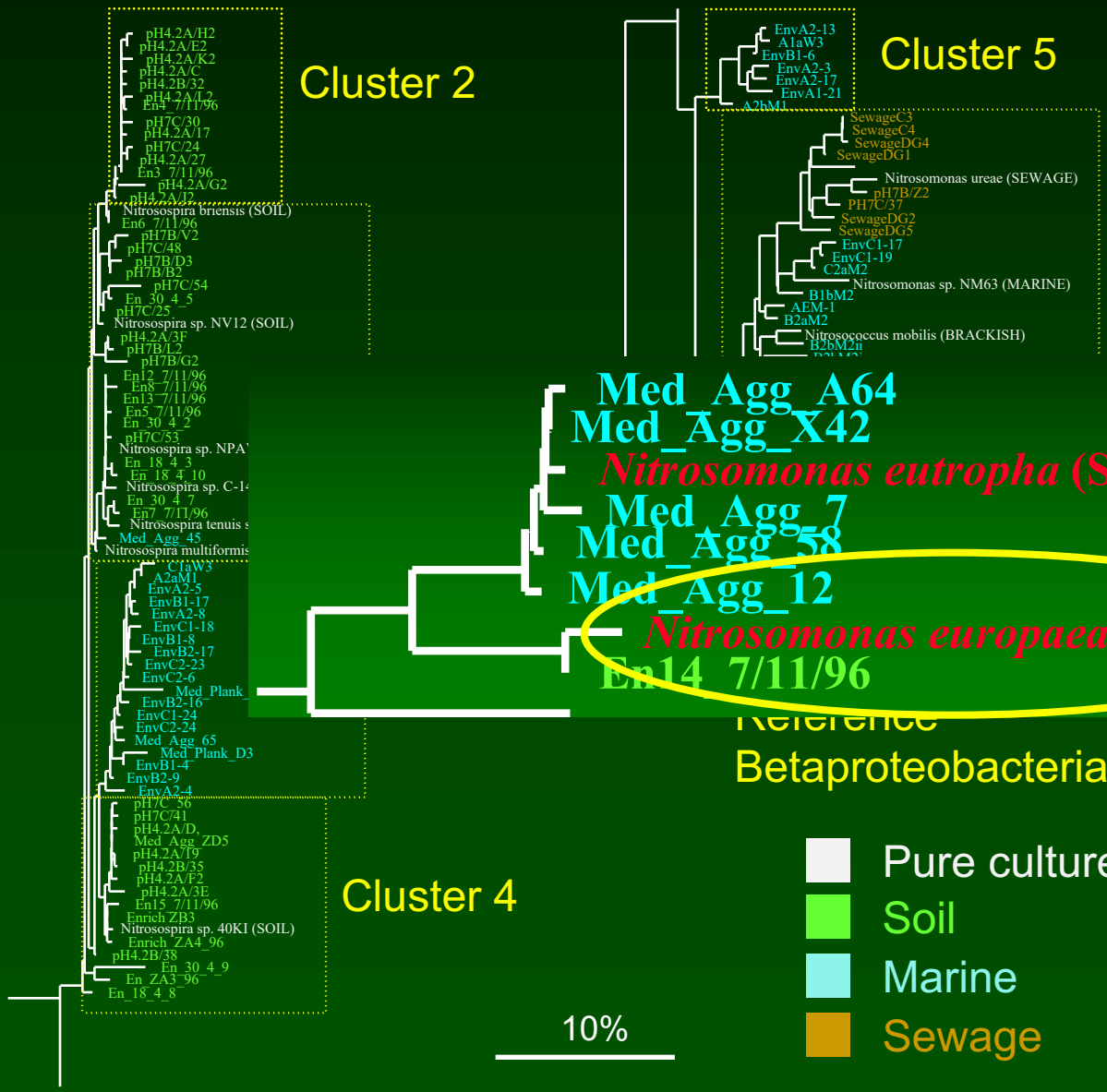
Bacterial ammonia oxidiser diversity

Nitrosospira *Nitrosomonas*



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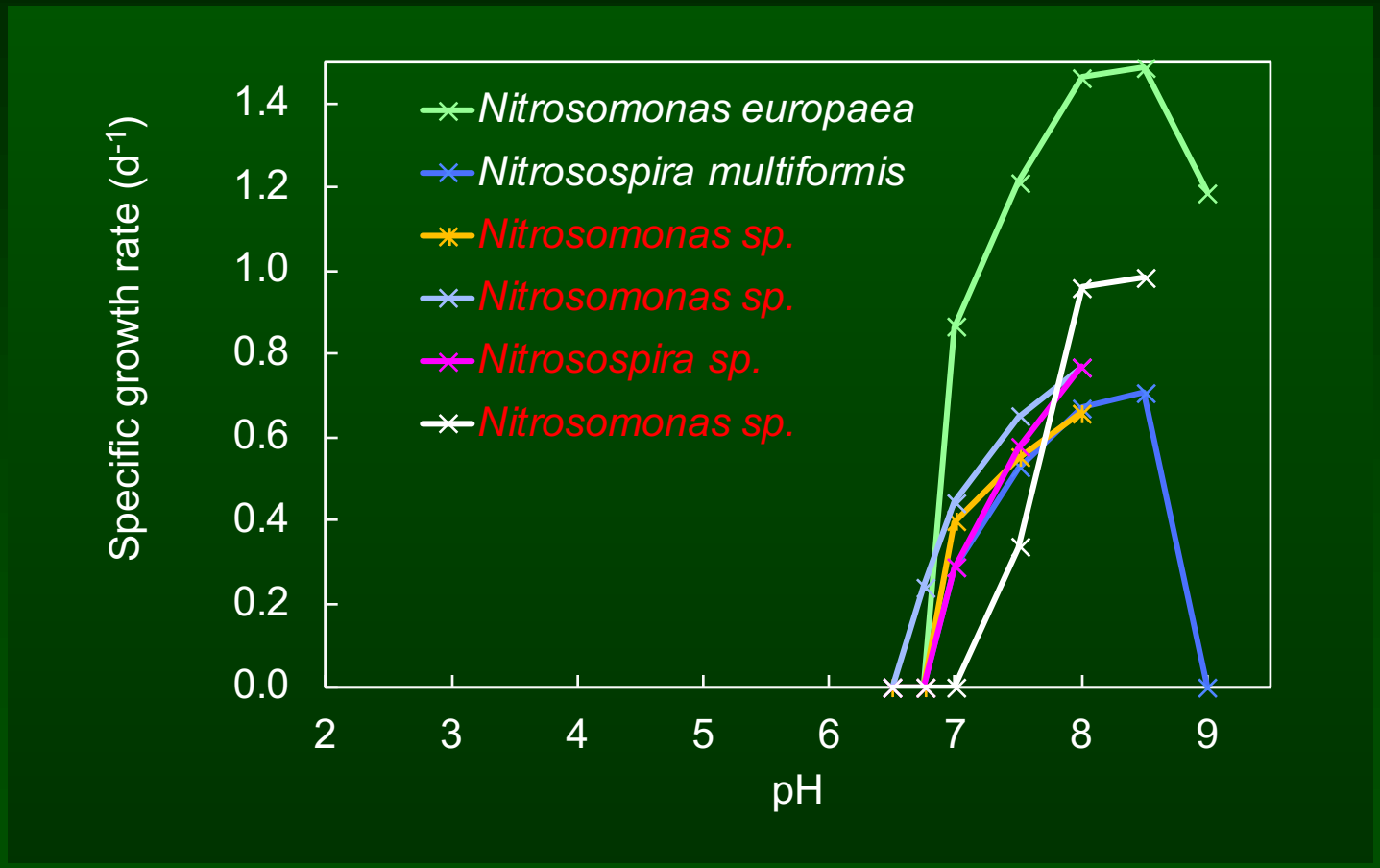
Stephen *et al.* 1996 *Appl. Env. Micro.* 62, 4147-4154
NERC

Influence of pH on specific growth rate of soil bacterial ammonia oxidisers



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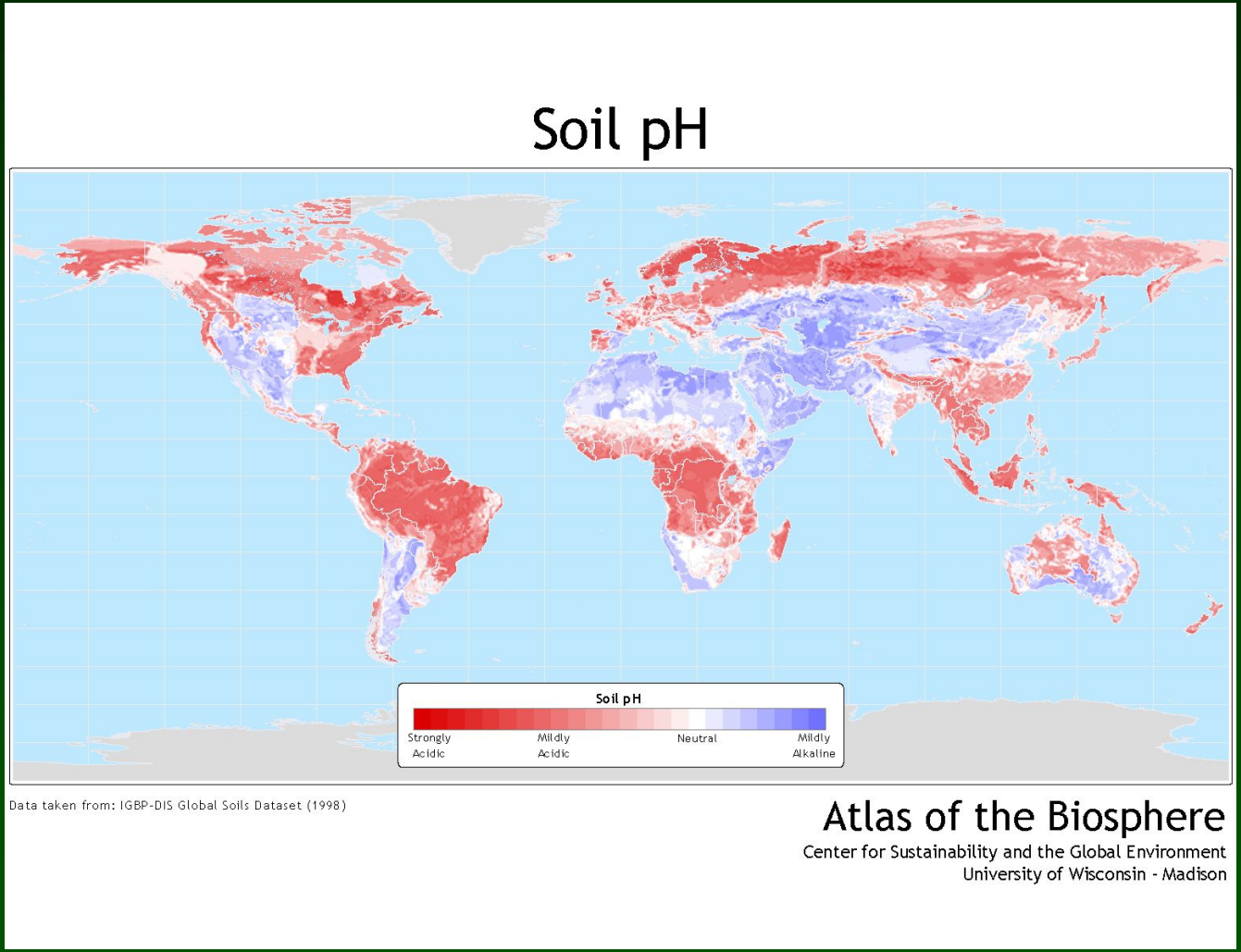
Allison & Prosser 1991 *SBB* 23, 45-51

NERC

Global distribution of acid soils



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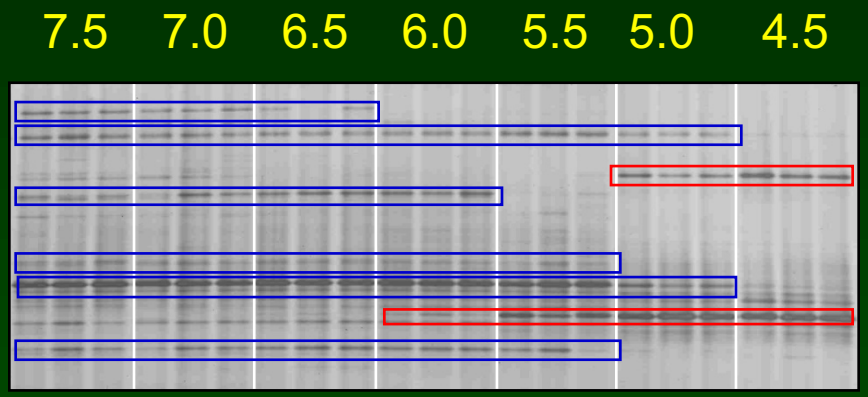
Ammonia oxidiser response to soil pH (long term)

Ammonia oxidising bacteria 16S rRNA genes



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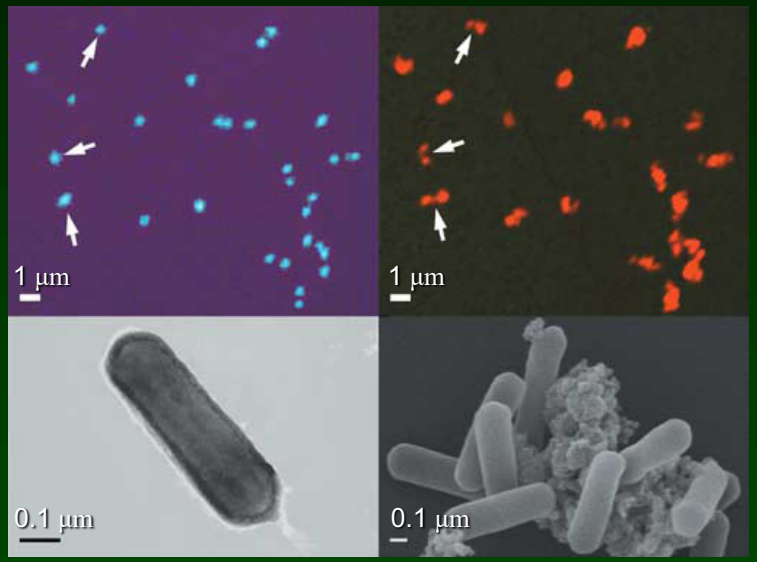
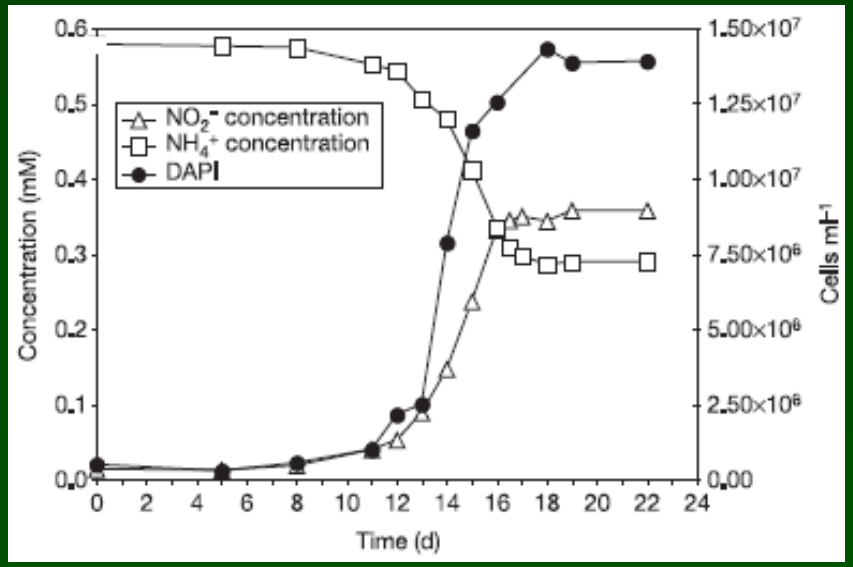
Nicol *et al.* 2008, *Env. Micro.* 10, 2966-2978

NERC

Isolation of *Nitrosopumilus maritimus*





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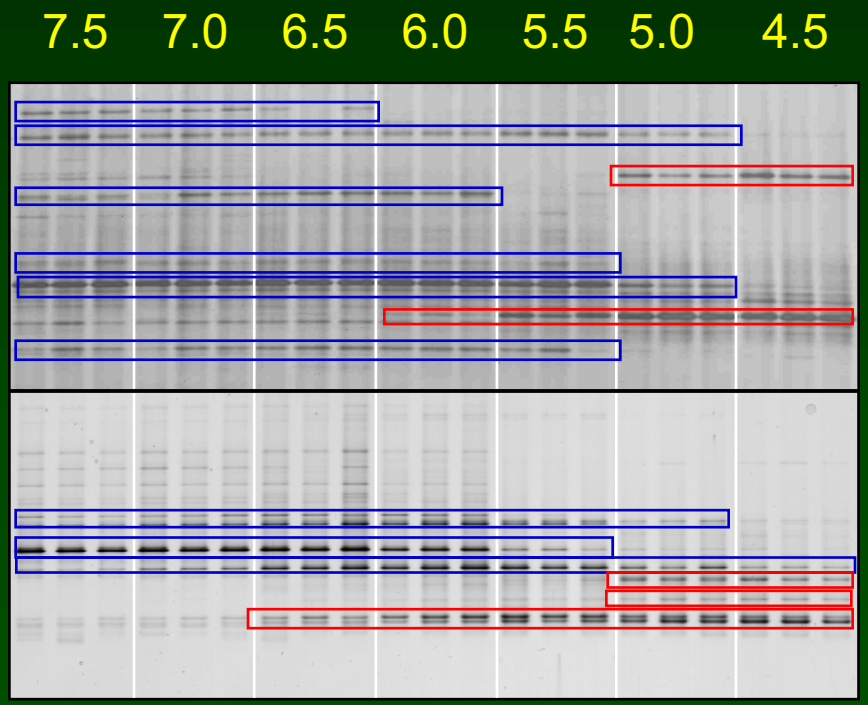
Kőnneke *et al.* 2005, *Nature* 437, 543-546.

Ammonia oxidiser response to soil pH (long term)



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Nicol *et al.* 2008, *Env. Micro.* 10, 2966-2978

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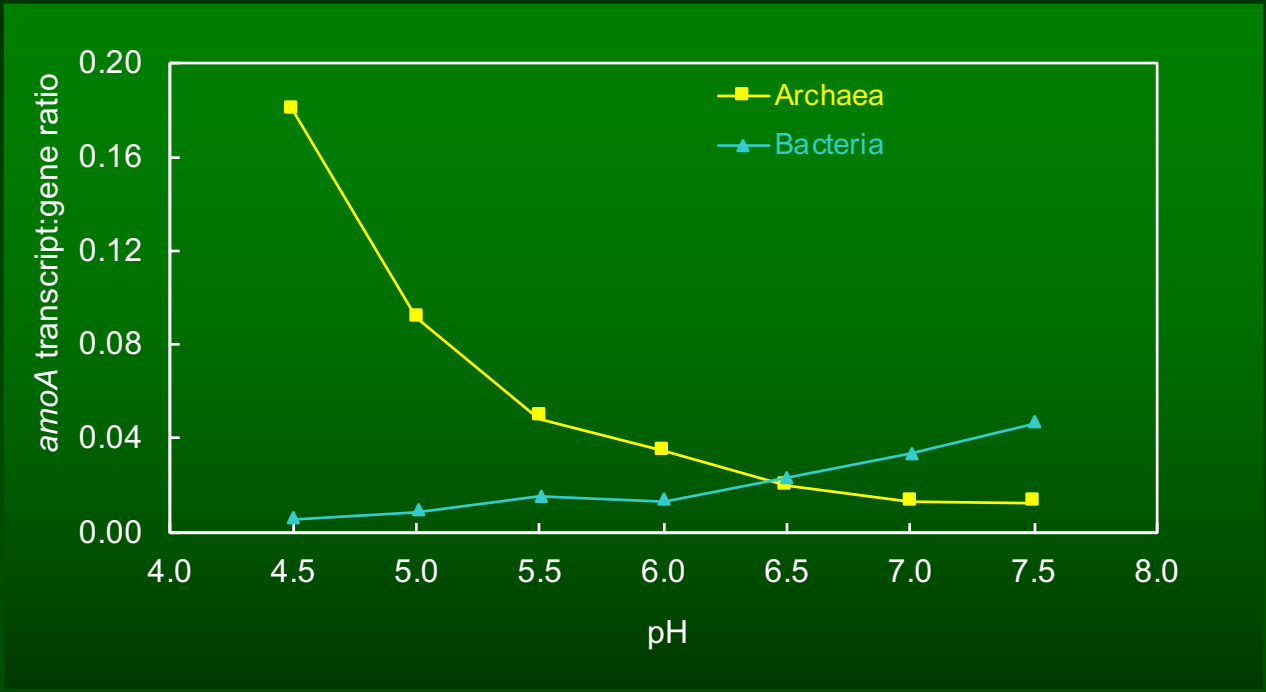
Archaeal and bacterial *amoA* transcript:gene ratio



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Nicol *et al.* 2008, *Env. Micro.* 10, 2966-2978.

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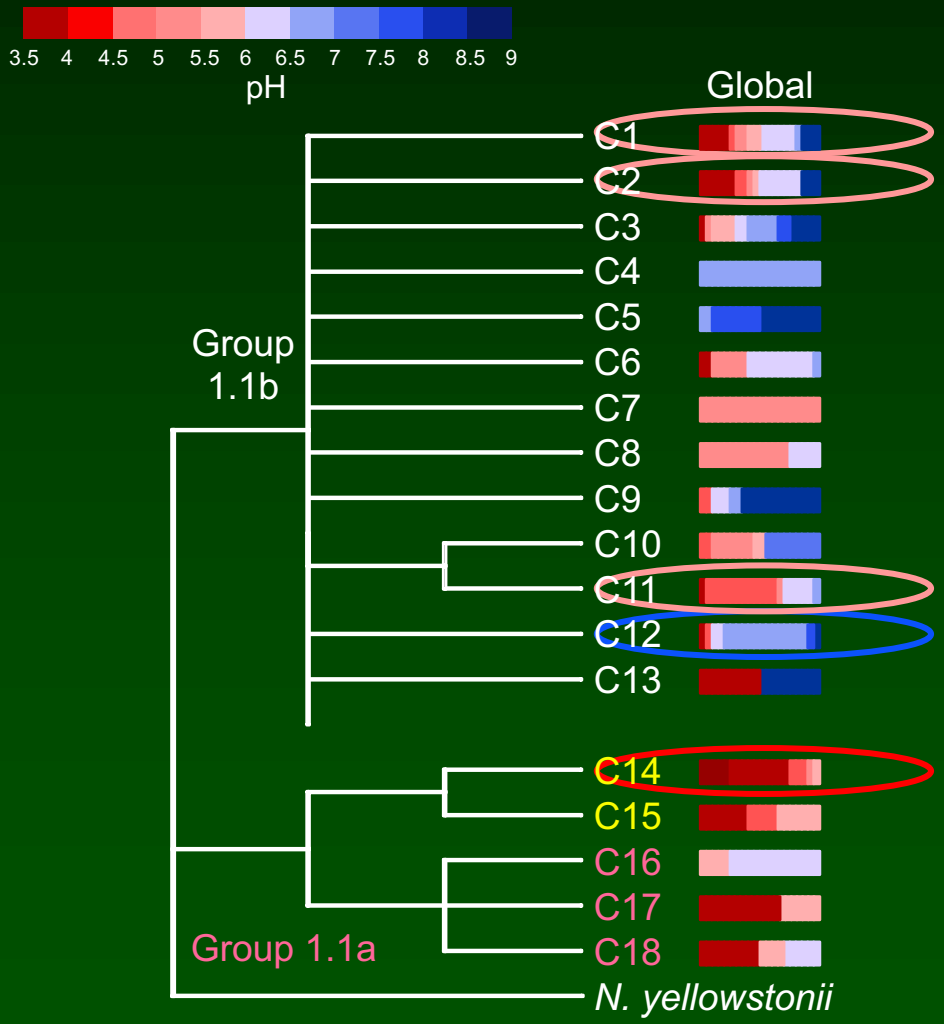
Global pH-distribution of archaeal *amoA* sequences



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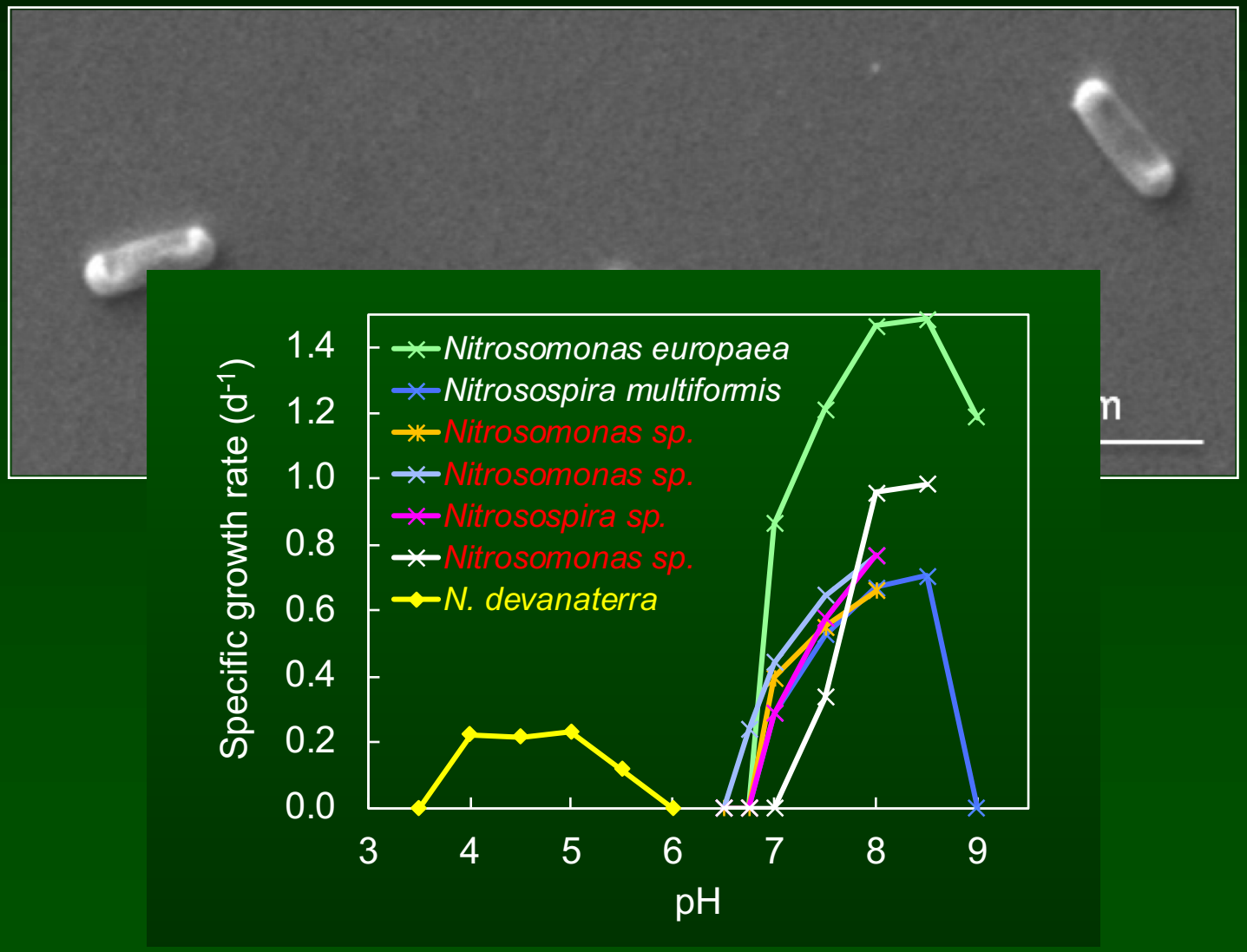
Gubry-Rangin *et al*. 2011 *PNAS* 108, 21206-21211.

NERC

Candidatus *Nitrosotalea devanaterra*



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Lehtovirta-Morley 2011 *PNAS* 108, 15892-15897

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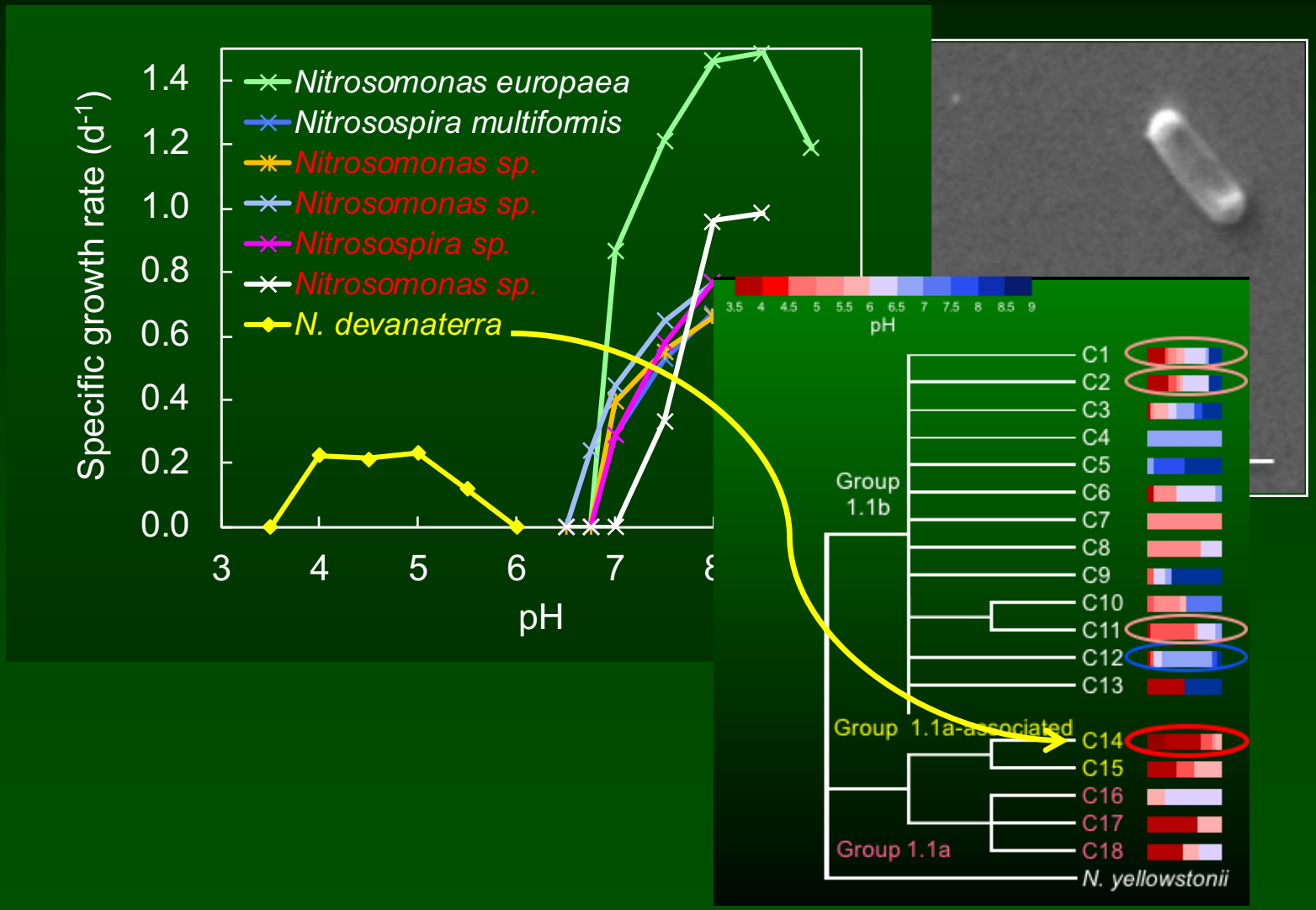
Candidatus *Nitrosotalea devanaterra*



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Lehtovirta-Morley 2011 *PNAS* 108, 15892-15897

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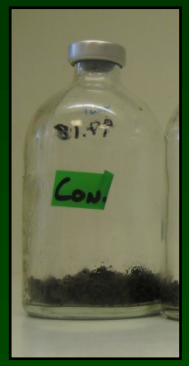
Stable isotope probing (SIP)

$^{12}CO_2$ / $^{13}CO_2$
5% headspace



Extract DNA

Ultracentrifugation

^{12}C

^{13}C

qPCR analysis of *amoA* genes

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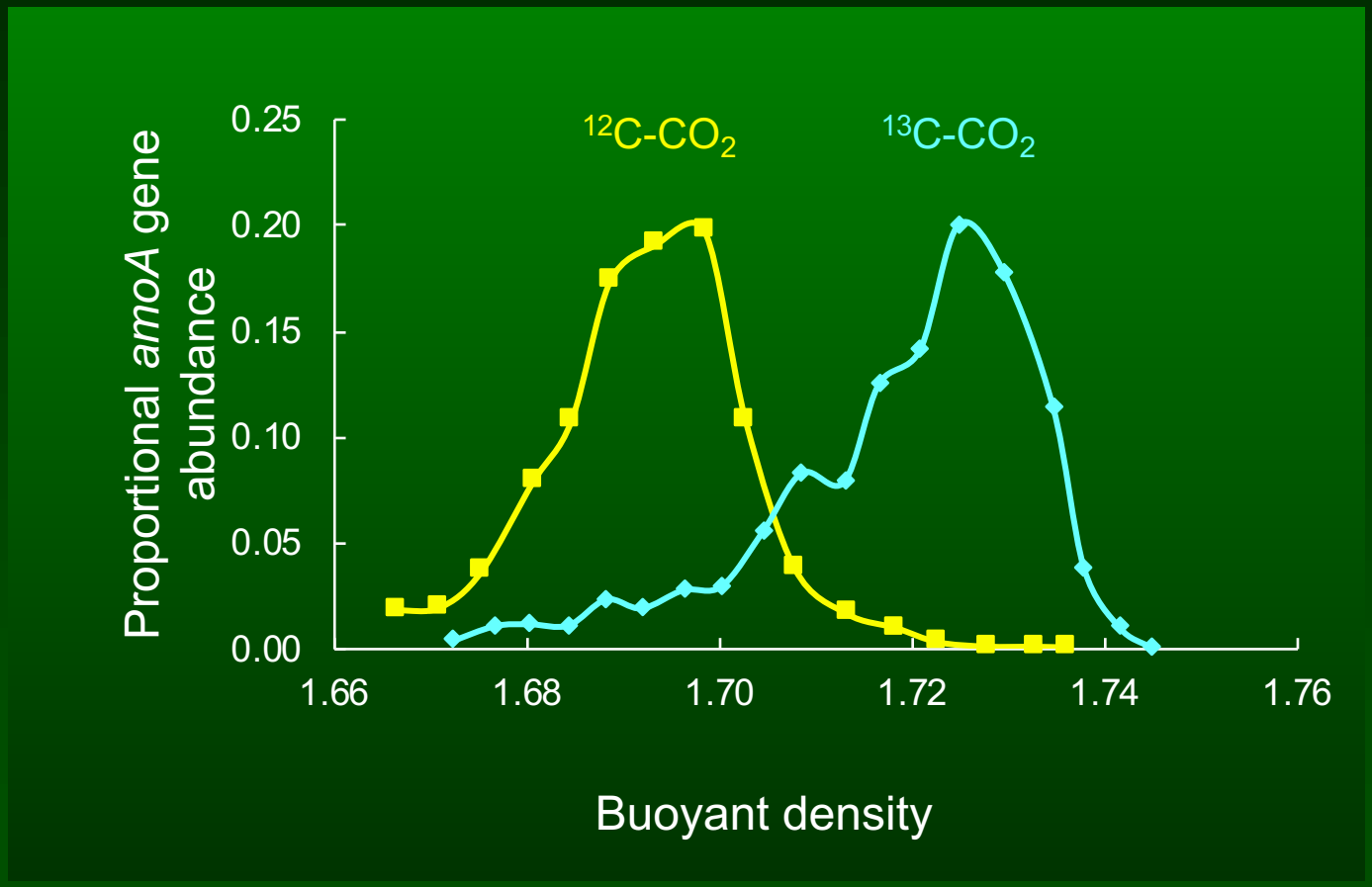
Autotrophic growth of *Nitrosotalea* in soil



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Lehtovirta-Morley 2011 *PNAS* 108, 15892-15897
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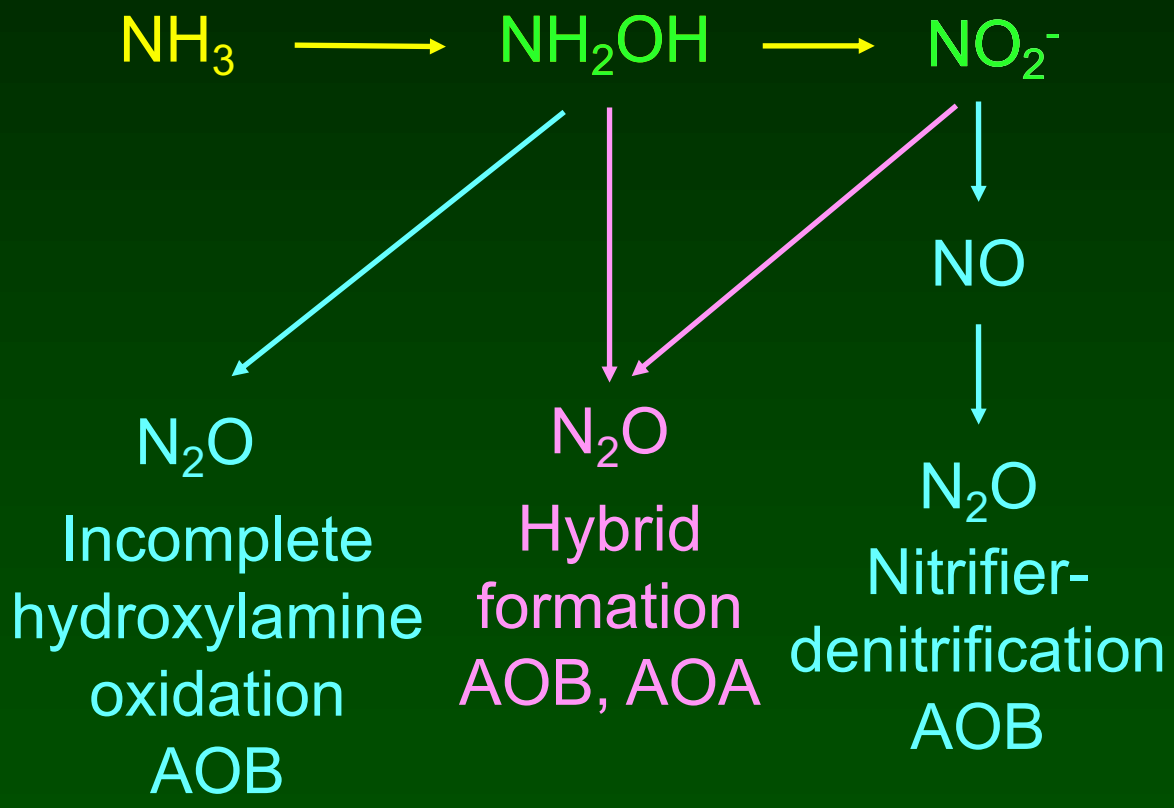
Nitrous oxide production



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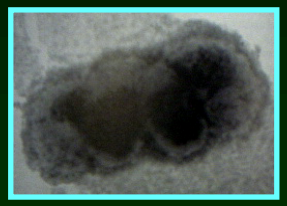
Ammonium supply, AOA and AOB



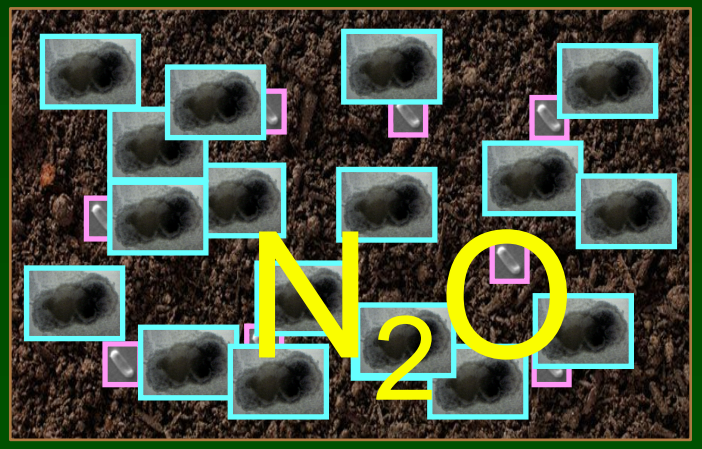
AOB

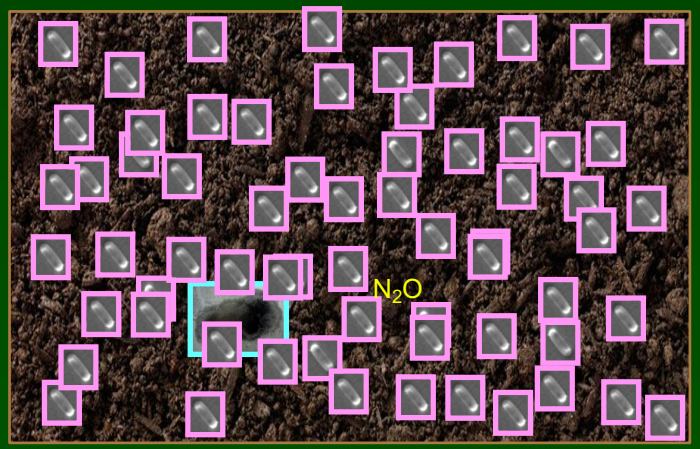
AOA

Single application

Slow release

NH_4^+





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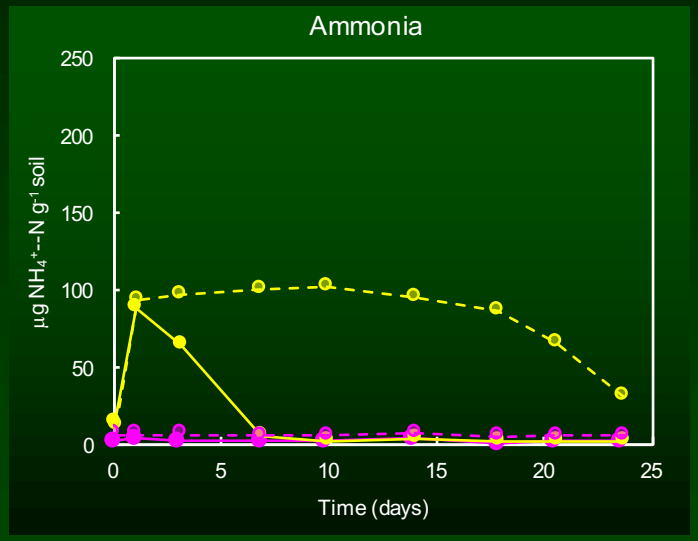
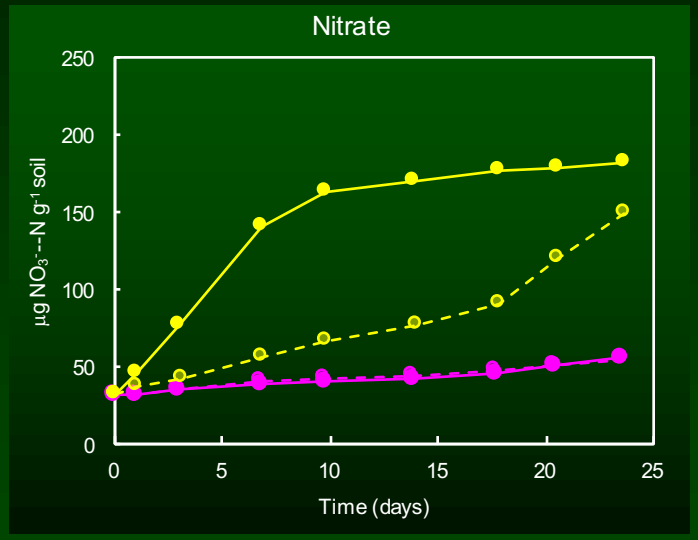
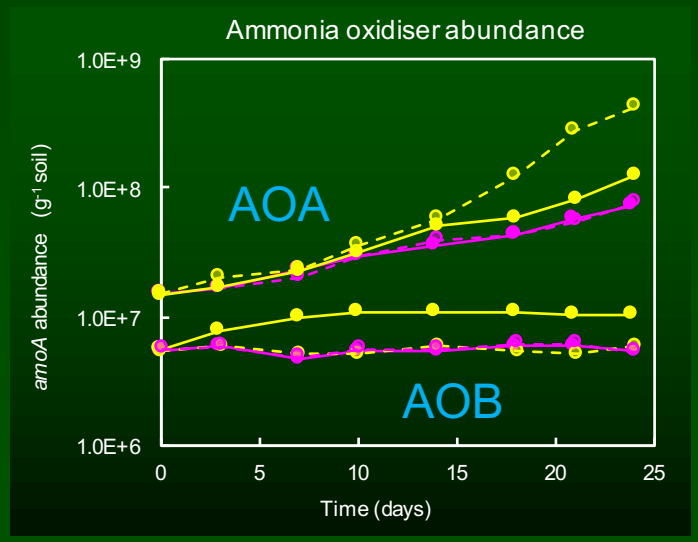
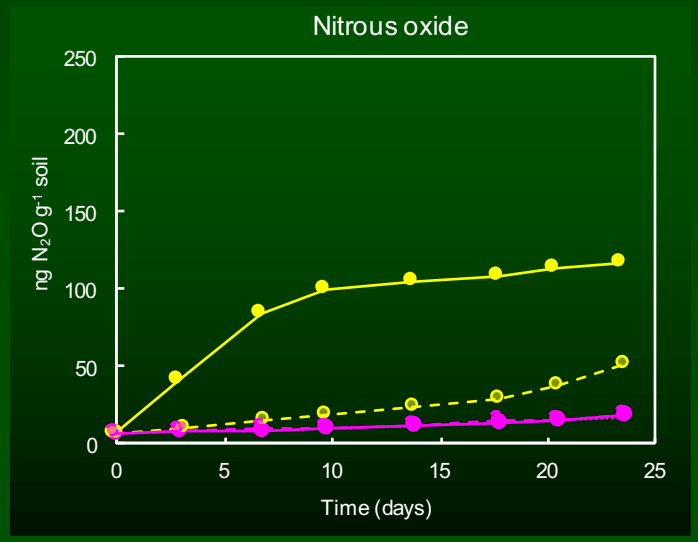
Fertilised soil: 3 days

Nitrification inhibitor inhibits AOB, only AOA active









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Hink *et al.* 2018 *ISMEJ* 12, 1084–1093

EC Marie Curie