Do plant species and climate warming influence nitrification and ammonia oxidizing bacteria (AOB) community structure?

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Introduction

Currently, ecosystems face two major changes : an increase in temperature and a loss of biodiversity. Despite the potentially strong influence of plant species and climate warming on soil microbial communities (through ie. rhizodeposition and/or litter decomposition) information on this topic is scarce. This investigation focused on ammonia oxidizing bacteria (AOB), responsible for the first, rate limiting step of the nitrification process. The **aims** of this study were to observe the impacts of climate warming and plant species on community structure of AOB, to compare microbial diversity in rhizosphere and bulk soil and to establish a link between the nitrification process and community structure of AOB.

Methods

Potential nitrification: rate of N-NO_3 production (30℃, excess of ammonia, 30h, shaken soil slurry method, Hart *et al.*, 1994) representing the potential activity of AOB present at time of sampling.

Community structure of AOB: Denaturing gradient gel electrophoresis (DGGE) following extraction of genomic DNA, PCR amplification using primer CTO (Kowalchuck *et al.* ,1997) specific of the 16S rDNA of AOB and sequencing.

Experimental design

Rhizosphere and bulk soil were sampled from cores containing sieved soil (76.3% loam, 14.8% clay and 8.74% sand; pH 6.45). The containers (24x60cm) were placed in climate-controlled (ambient, ambient +3℃) chambers at the University of Antwerp, Belgium (De Boeck *et al.,*2006; Lemmens *et al.,* 2005). The plant species belonged to three functional group : grasses (G:*Dactylis glomerata* L., *Festuca arundinacea* Schreb., *Lolium perenne* L.), N fixing dicots (F:*Trifolim repens* L., *Medicago sativa* L., *Lotus corniculatus* L.) or non-N fixing dicots (NF:*Bellis perennis* L , *Rumex acetosa* L, *Plantago lanceolata* L.). This study focused on the monocultures and unplanted soil. Each soil core was divided into upper (0-4cm) and median (10-14 cm) layers.

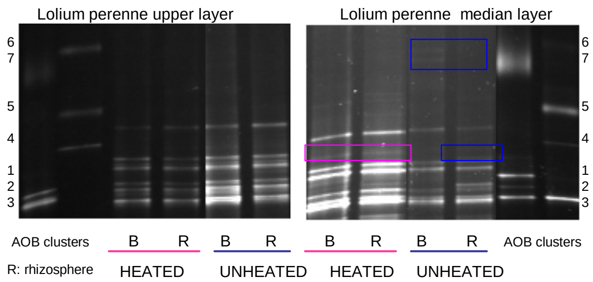
Results

1. Presence of AOB clusters in the upper layer

	Species	AOB clusters					
		I	II	III	IV	VI	VII
G	Dactylis	X	X	X			
	Festuca	X	X	X			
	Lolium	X	X	X			
F	Bellis	X	X	X		X	X
	Rumex	X	X	X		X	X
	Plantago	X	X	X		X	X
NF	Trifolium	X	X	X			X
	Medicago	X	X	X			X
	Lotus	X	X	X			X
	Soil	X	X	X			

Clusters I-IV: *Nitrosospira like* clusters

Clusters V-VII: *Nitrosomonas like* clusters



R: rhizosphere

B: bulk soil

2. Presence of AOB clusters in the median layer

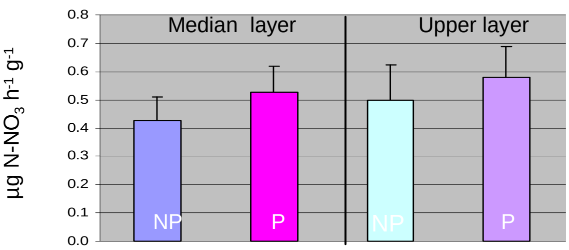
	Species	AOB clusters					
		I	II	III	IV	VI	VII
G	Dactylis	X	X	X	XB	X	X
	Festuca	X	X	X	XR	B	
	Lolium	X	X	X	XB	R	R
F	Bellis	X	X	X	R	RB	B
	Rumex	X	X	X		X	
	Plantago	X	X	X		X	X
NF	Trifolium	X	X	X	B	RB	BB
	Medicago	X	X	X	X	X	XB
	Lotus	X	X	X	XB	X	XB
	Soil	X	X	X	X	X	X

black: present in heated and unheated chamber,
Pink: present in heated blue: present in unheated,
X: presence in bulk and rhizosphere
B: presence only in bulk soil R: presence only in rhizosphere

1. Presence of AOB clusters linked to functional group
No rhizosphere or temperature effects

2. Presence of AOB clusters in rhizosphere or bulk soil depended on plant species and temperature, but no clear pattern emerged

3.Potential nitrification for cores without plants (NP) or with 1 species (P)



3. Potential nitrification in bulk soil significantly increased through the presence of plants

Conclusions:

The link between plant species and presence of AOB clusters differed between the upper and median layer :

In the upper layer, the presence of AOB clusters was linked to the functional group

In the median layer, the presence of AOB clusters in rhizosphere or bulk soil depend on plant species and temperature, but no clear pattern emerged

There was no rhizosphere effect and no temperature effect in the upper layer

A temperature increase of 3℃ did not influence potential nitrification

The presence of plants increased potential nitrification

There was no clear link between potential nitrification and AOB community structure

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De Boeck *et al. (2006) Environmental and Experimental Botany, 58;* Hart *et* al. (1994) In Methods of Soil Analysis, Part II:985-1018;Kowalchuk *et al.* (1997) Applied and Environmental Microbiology, 63; Lemmens *et al.* (2005) Environmental and Experimental Botany 56(3): 245-254