



**HAL**  
open science

## Acidification of headwater streams: structural and functional assessment of microbial communities associated with decaying leaves

Hugues Clivot, Michael Danger, Christophe Pagnout, Philippe Rousselle, Philippe Wagner, Pascal Poupin, François Guérold

### ► To cite this version:

Hugues Clivot, Michael Danger, Christophe Pagnout, Philippe Rousselle, Philippe Wagner, et al.. Acidification of headwater streams: structural and functional assessment of microbial communities associated with decaying leaves. ASLO/NABS Summer Meeting, Jun 2010, Santa Fe, United States. hal-03518695

**HAL Id: hal-03518695**

**<https://hal.inrae.fr/hal-03518695v1>**

Submitted on 10 Jan 2022

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License



Zone  
Atelier  
Moselle



Agence Nationale de la Recherche  
ANR



# Acidification of headwater streams: structural and functional assessment of microbial communities associated with decaying leaves.

Hugues Clivot, Michael Danger, Christophe Pagnout, Philippe Rousselle,  
Philippe Wagner, Pascal Poupin and François Guérol

**Laboratoire des Interactions Ecotoxicologie, Biodiversité, Ecosystèmes**  
CNRS UMR 7146, Université Paul Verlaine, Rue du Général Delestraint, 57070 Metz, France  
[hugues.clivot@umail.univ-metz.fr](mailto:hugues.clivot@umail.univ-metz.fr)



# Introduction

- Acid depositions → forested headwater streams in the Vosges Mountains (North-eastern France)
- Heterotrophic ecosystem ← leaf-litter
- Leaf-litter breakdown = key ecosystem process  
→ assess functional alterations
- Acidification → impairs leaf breakdown
- Micro-organisms = pivotal role in organic matter processing

# Objectives

## Acidification of headwater streams

- Microbial communities associated with decaying leaves
- Microbial activities (organic C and nutrients acquisition)
- Explain reduced leaf-litter breakdown

# Methods

Maple leaf disks (18 mm)  
(*Acer platanoides*)



Fine mesh bags

6 headwater streams (3 neutral / 3 acidified)

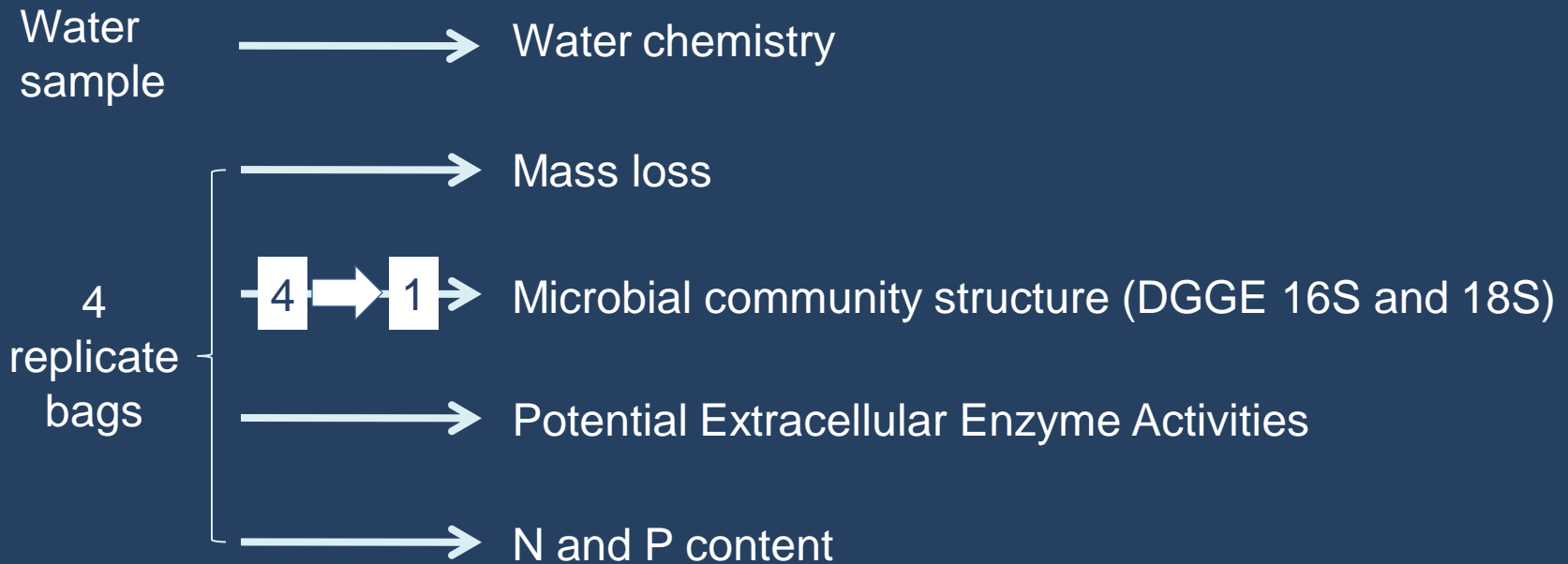


Nov 2009

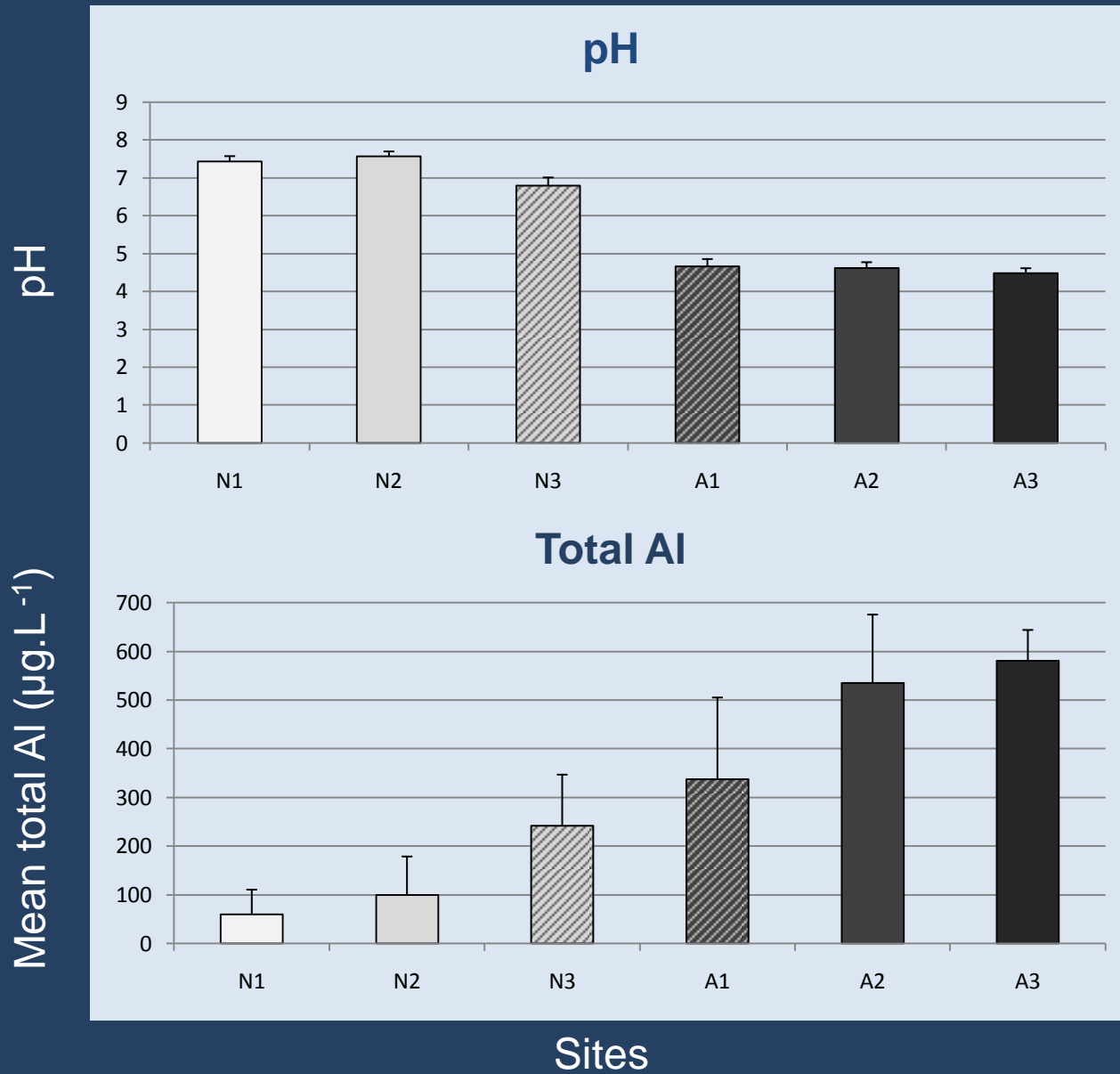


Jan 2010

7 13 21 28 49 70d

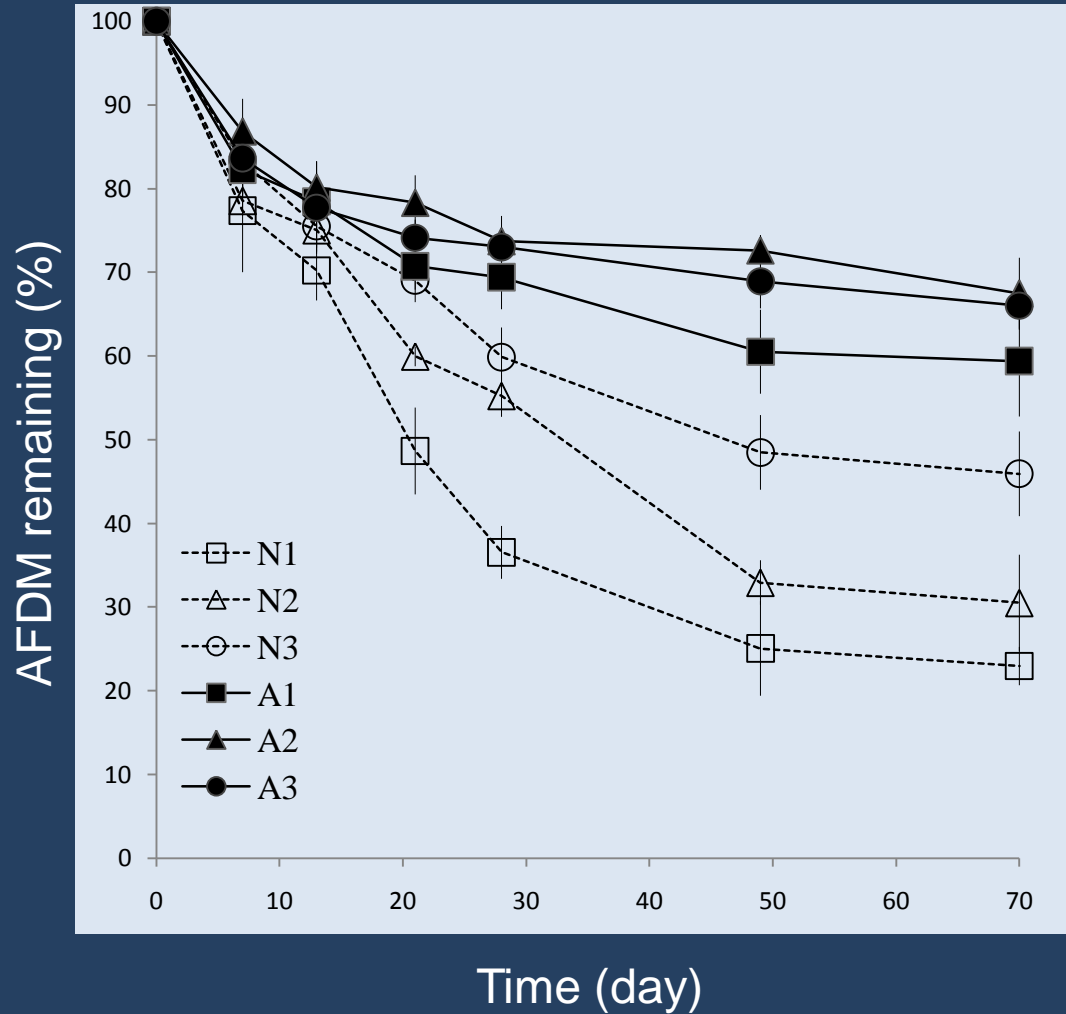


# Water chemistry

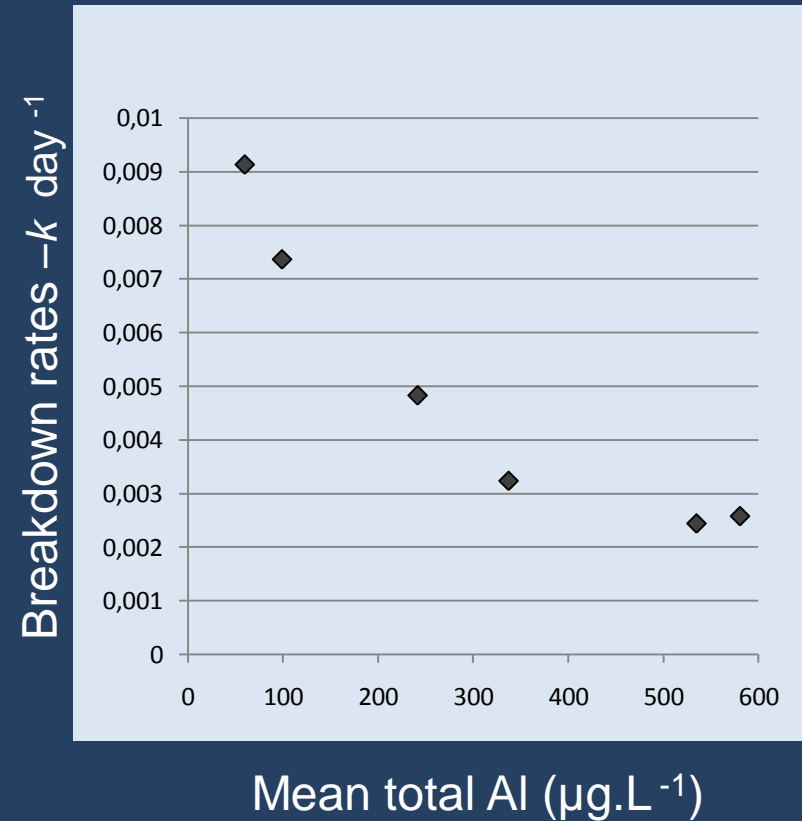


# Maple leaf breakdown

## Mass loss of leaf disks



## Relationship between breakdown rates (exponential model) and mean total aluminium

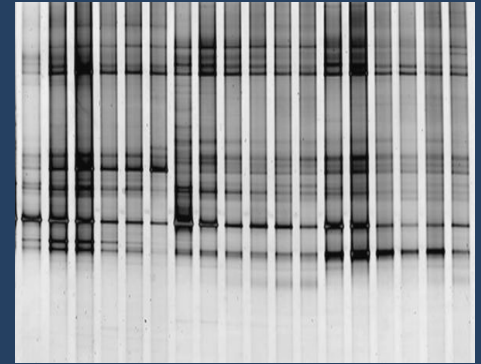
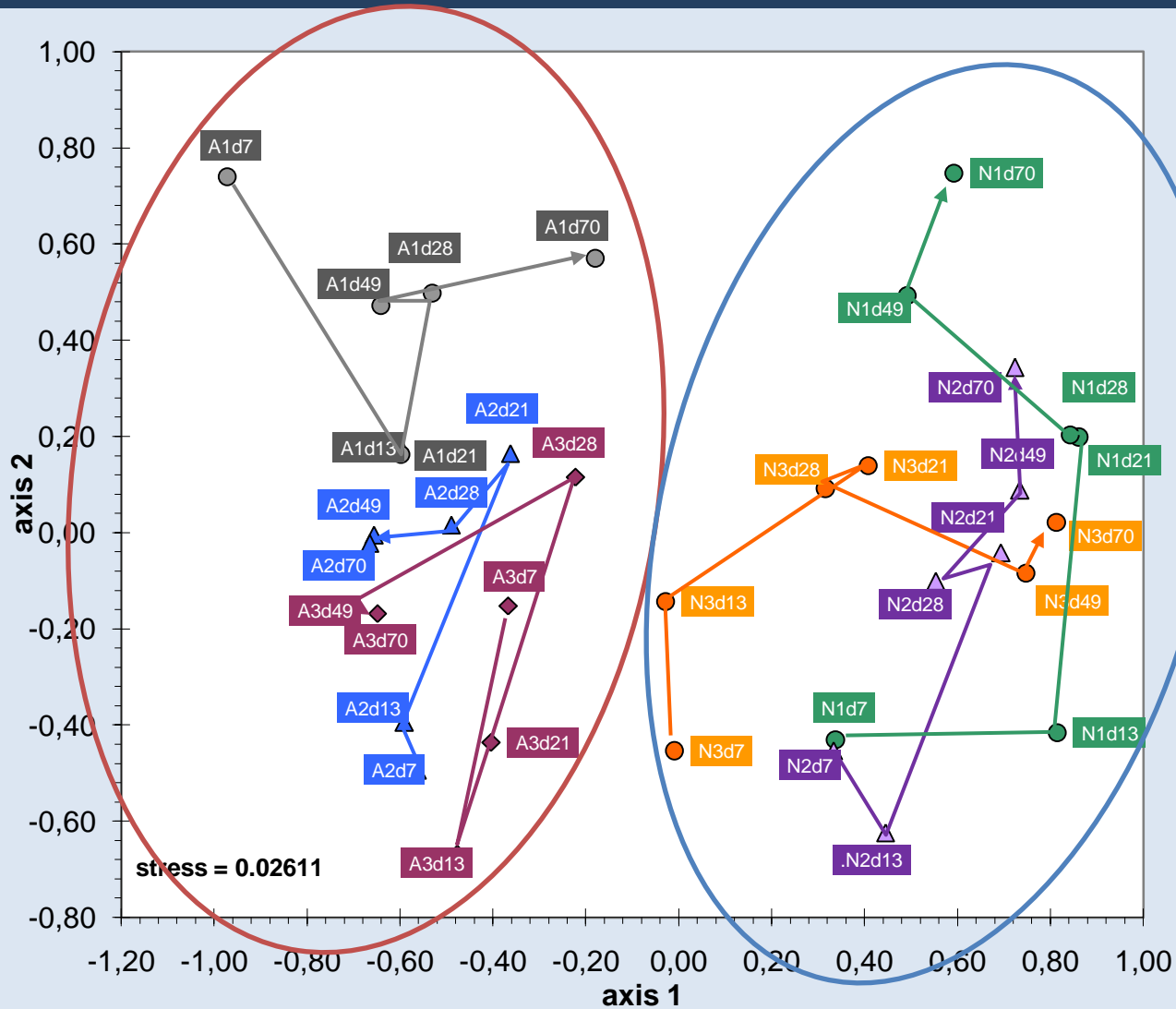


# Microbial community structure



# Bacterial community structure

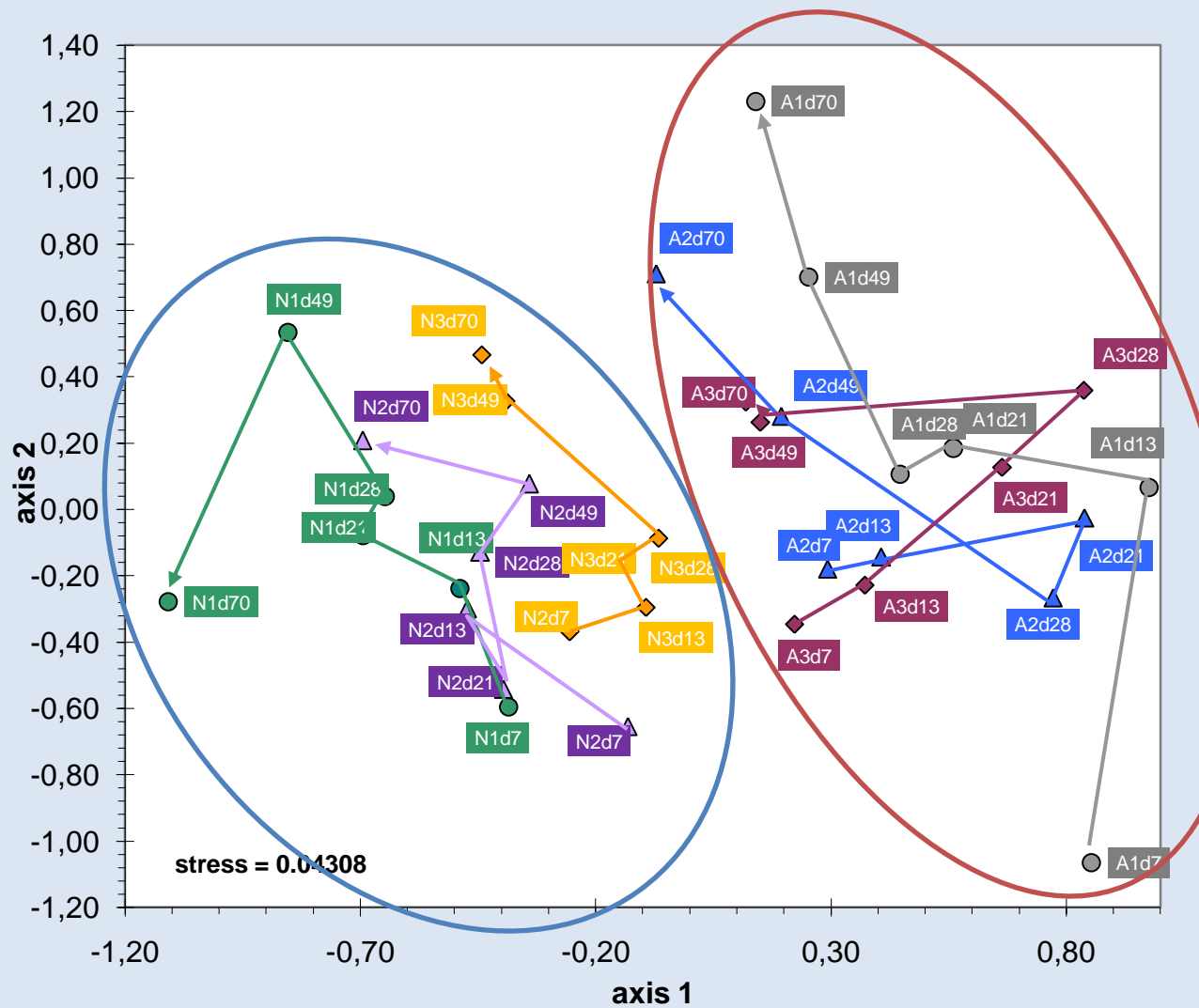
nMDS plot based on 16S rDNA DGGE profiles



Stream	Phylotype richness
N1	17
N2	15
N3	22
A1	22
A2	28
A3	26

# Fungal community structure

nMDS plot based on 18S rDNA DGGE profiles

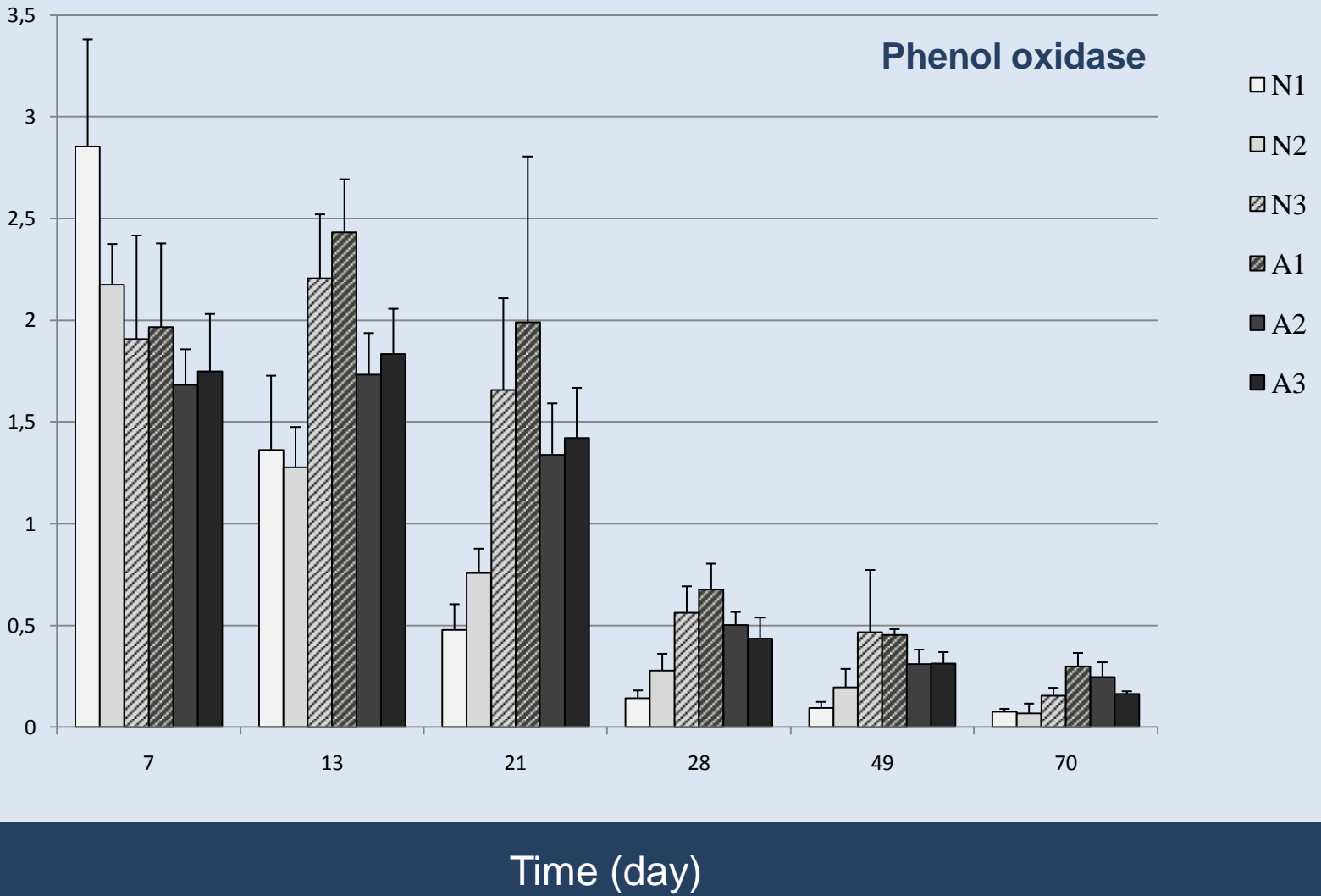


Stream	Phylotype richness
N1	19
N2	20
N3	20
A1	14
A2	16
A3	14

# Lignocellulolytic Enzyme Activities

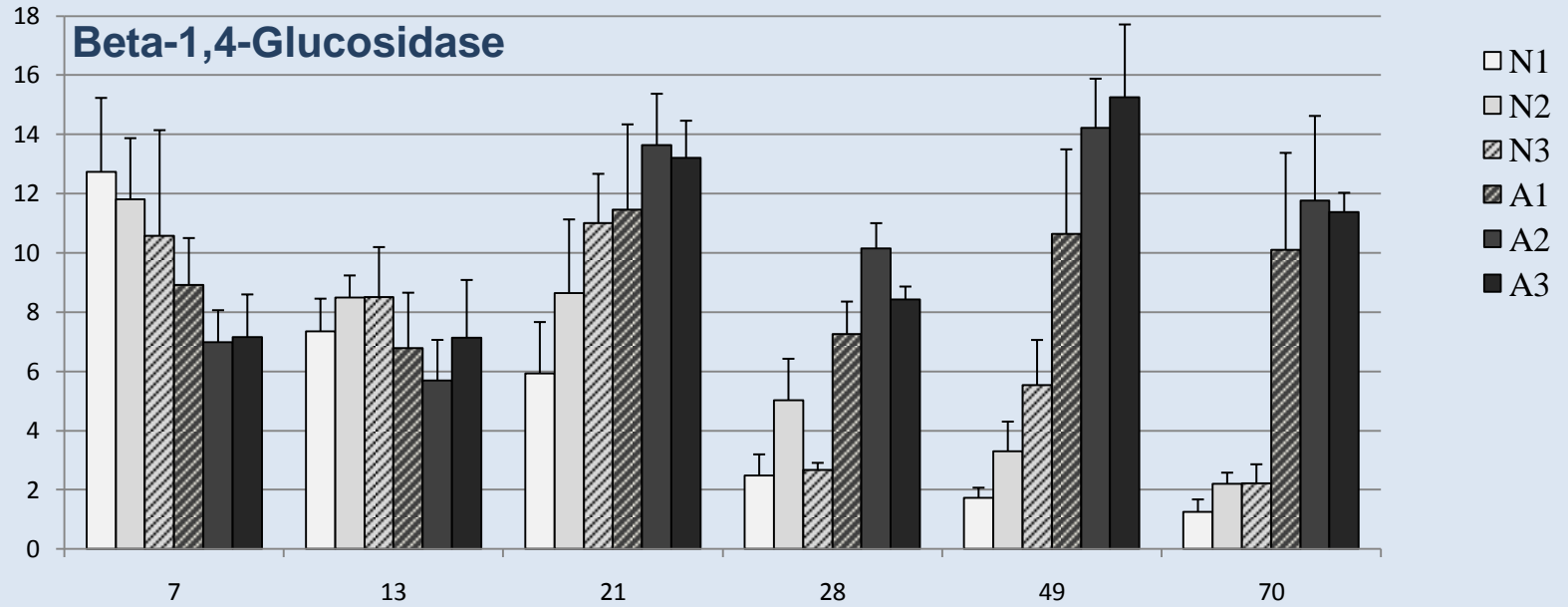
# Phenol oxidase

Enzyme activity (ABTS)  
 $10^{-2} \mu\text{mol}\cdot\text{min}^{-1}\cdot\text{g}^{-1}$  AFDM

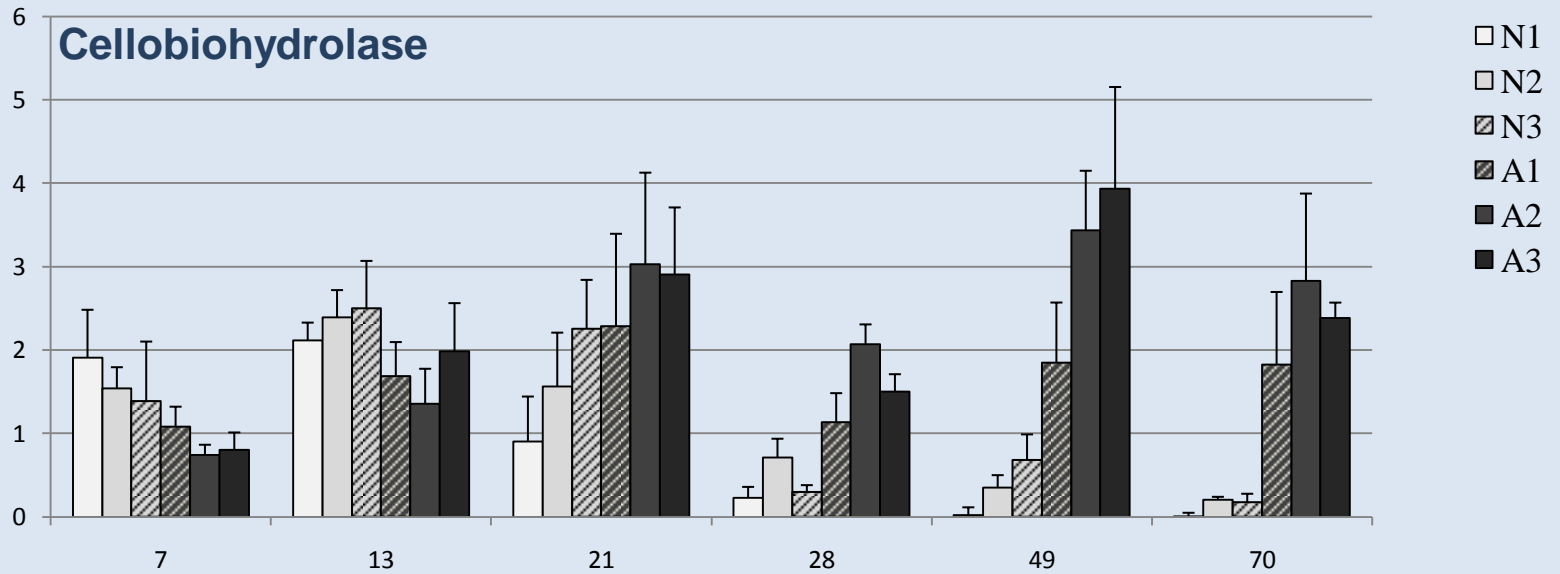


# Exocellulase

Enzyme activity  
 $\mu\text{mol}\cdot\text{h}^{-1}\cdot\text{g}^{-1}$  AFDM

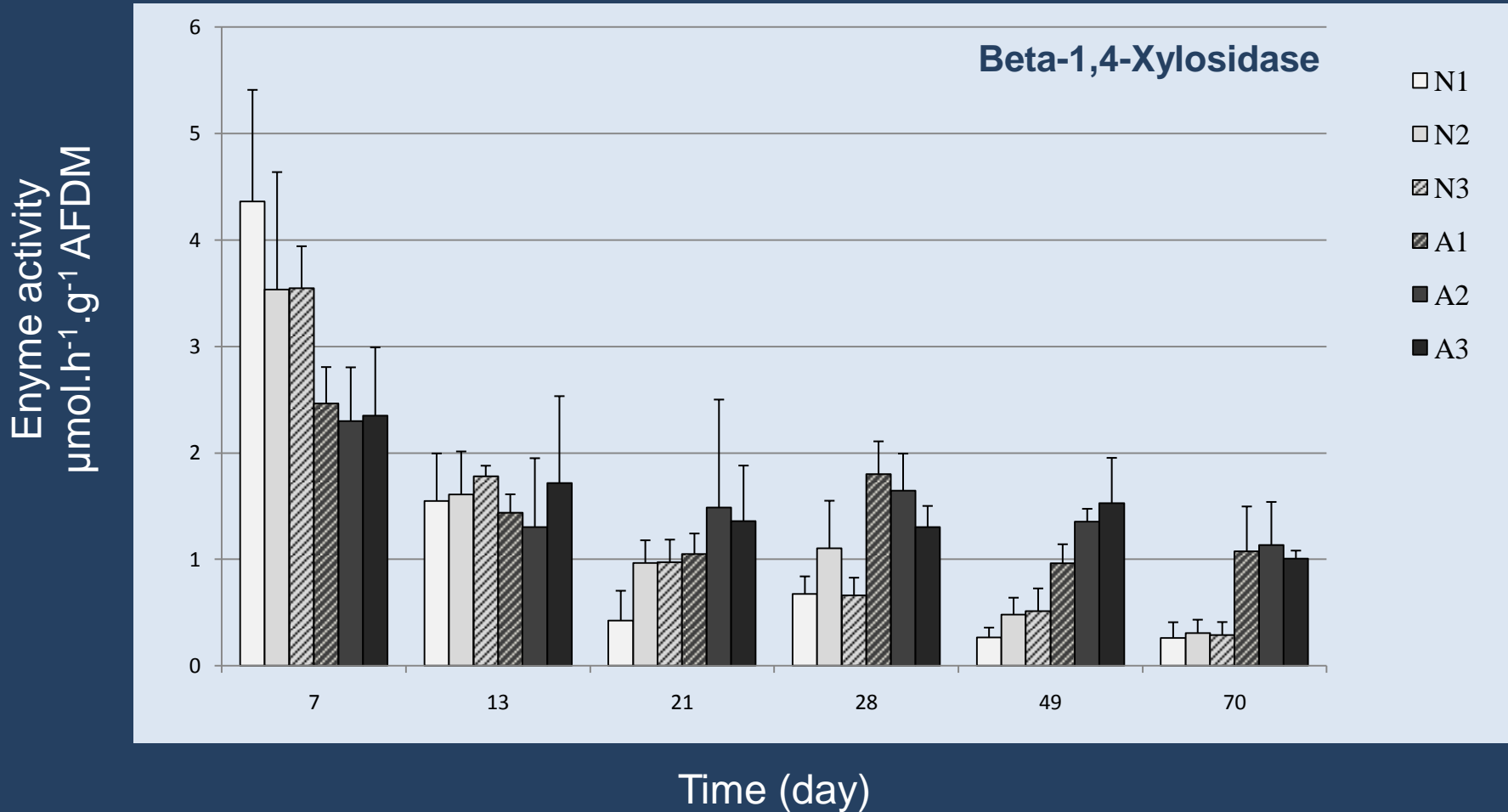


Enzyme activity  
 $\mu\text{mol}\cdot\text{h}^{-1}\cdot\text{g}^{-1}$  AFDM



Time (day)

# Hemicellulase

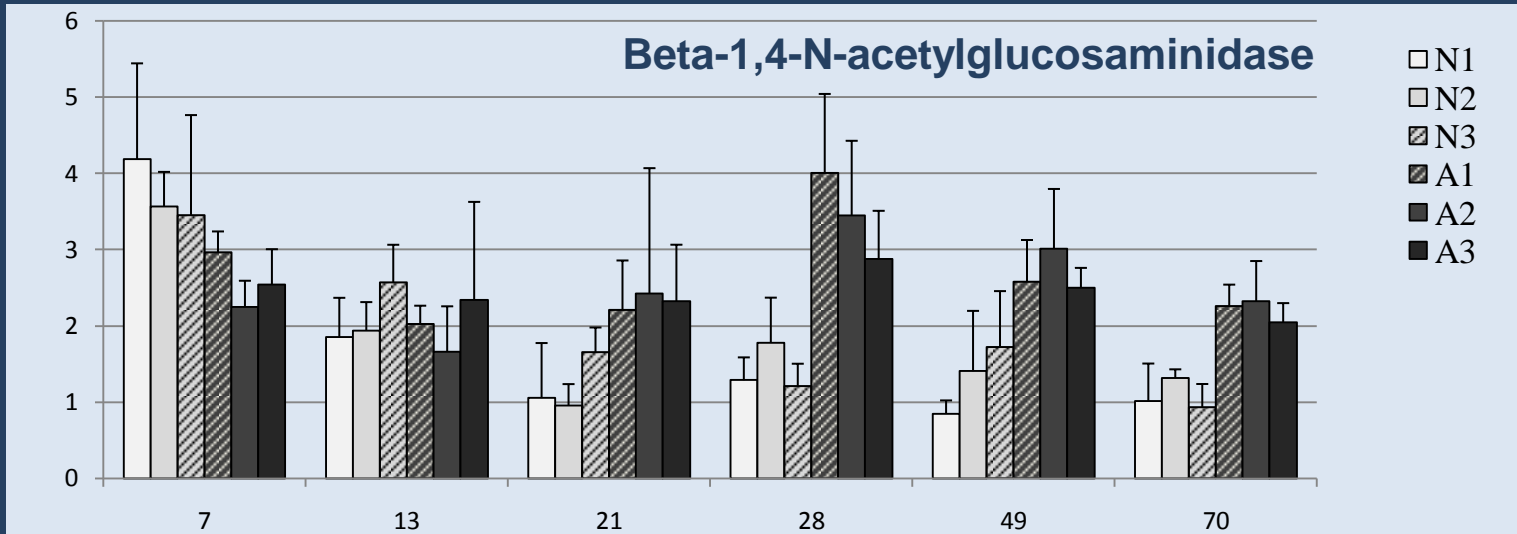


Important potential activities in acidified streams  
→ enzyme production not reduced

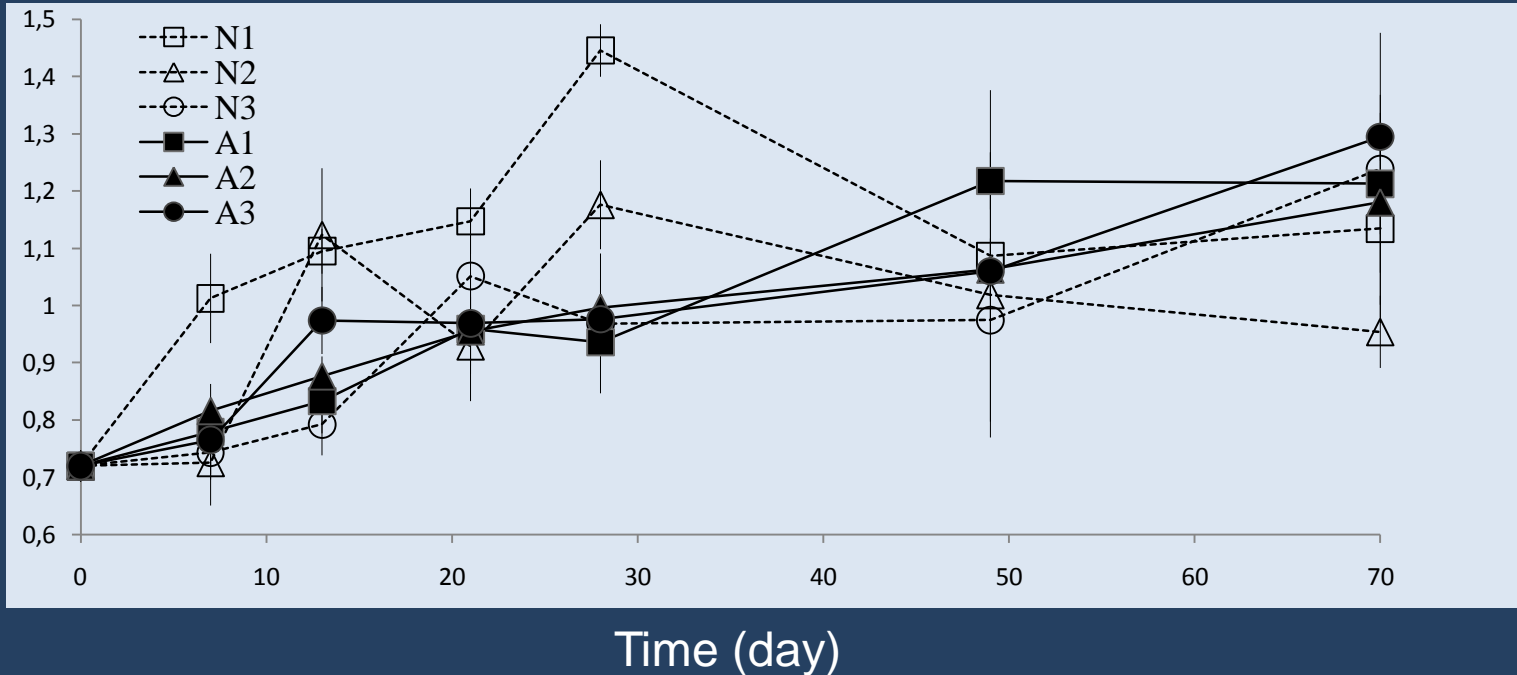
# Microbial nutrient acquisition

# Nitrogen uptake

Enzyme activity  
 $\mu\text{mol}\cdot\text{h}^{-1}\cdot\text{g}^{-1}$  AFDM

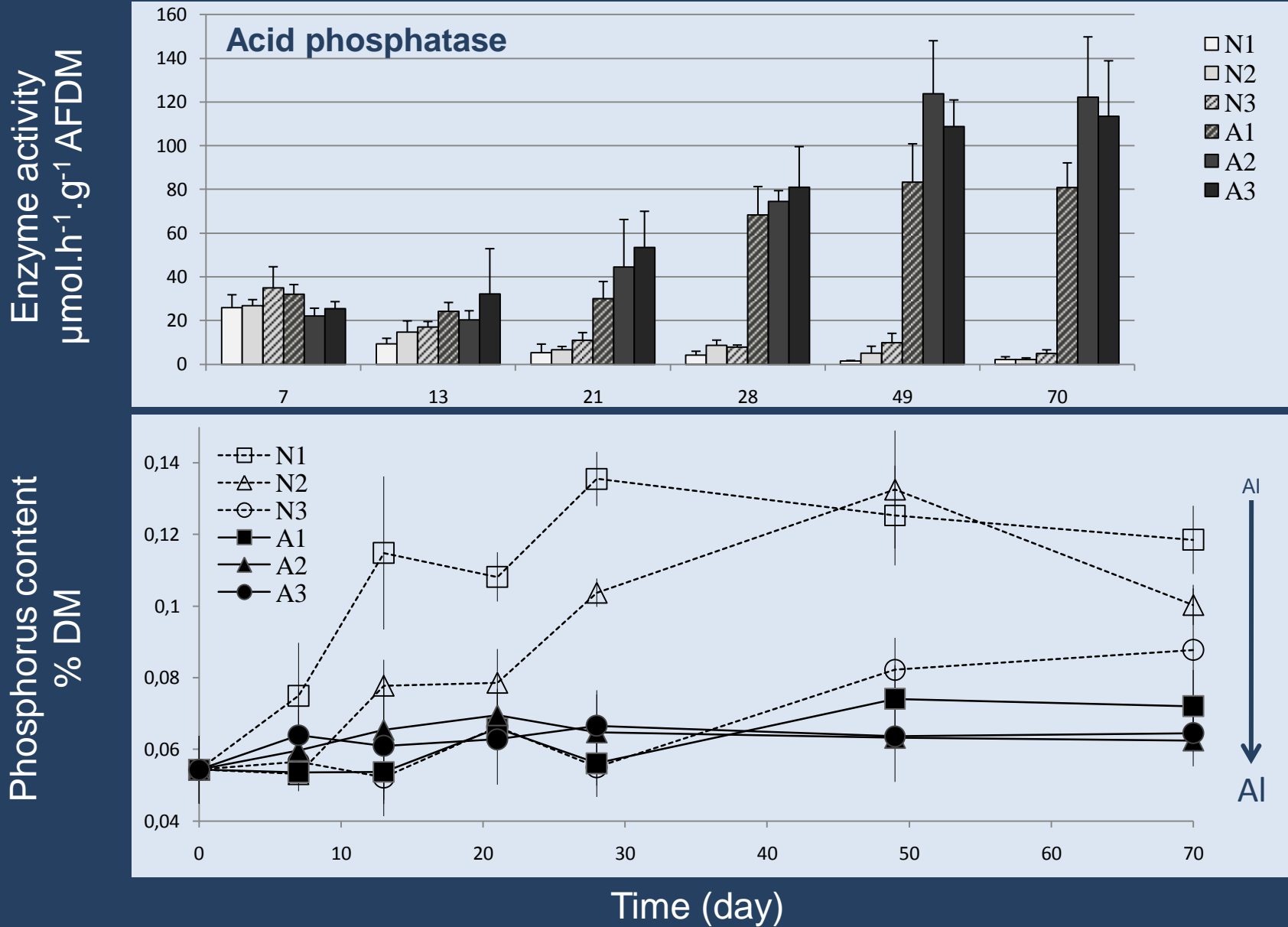


Nitrogen content  
% DM





# Phosphorus uptake



# Conclusion

- Relationship Al concentration / Leaf processing
- Environmental factors controlling :
  - Microbial succession and diversity
  - Patterns of potential Extracellular Enzyme Activity
- Nutrients acquisition:
  - N uptake non limiting
  - Acidic streams : Increasing enzymatic effort for P acquisition + uptake reduced with increasing Al concentration

# Discussion

- Microbial diversity → Enzyme Activities
- Leaf breakdown not related to Enzymatic effort in acidic streams
  - Enzyme production controlled by abiotic and biotic factors
  - Microbial activity constrained by nutrients availability
- P limitation (Sequestration of P with high Al concentration)
- Direct and indirect microbial interactions with Al
- Repercussions in the stream food webs

# Perspectives

- Ergosterol contents
  - confirm fungal growth in acidic streams
- Identify differences in microbial community composition



Zone  
Atelier  
Moselle



Agence Nationale de la Recherche  
ANR



# Acidification of headwater streams: structural and functional assessment of microbial communities associated with decaying leaves.

Hugues Clivot, Michael Danger, Christophe Pagnout, Philippe Rousselle,  
Philippe Wagner, Pascal Poupin and François Guérol

**Laboratoire des Interactions Ecotoxicologie, Biodiversité, Ecosystèmes**

CNRS UMR 7146, Université Paul Verlaine, Rue du Général Delestraint, 57070 Metz, France

[hugues.clivot@umail.univ-metz.fr](mailto:hugues.clivot@umail.univ-metz.fr)