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

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 Guérold

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

S15 ASLO / NABS 2010 Summer Meeting, Santa Fe

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

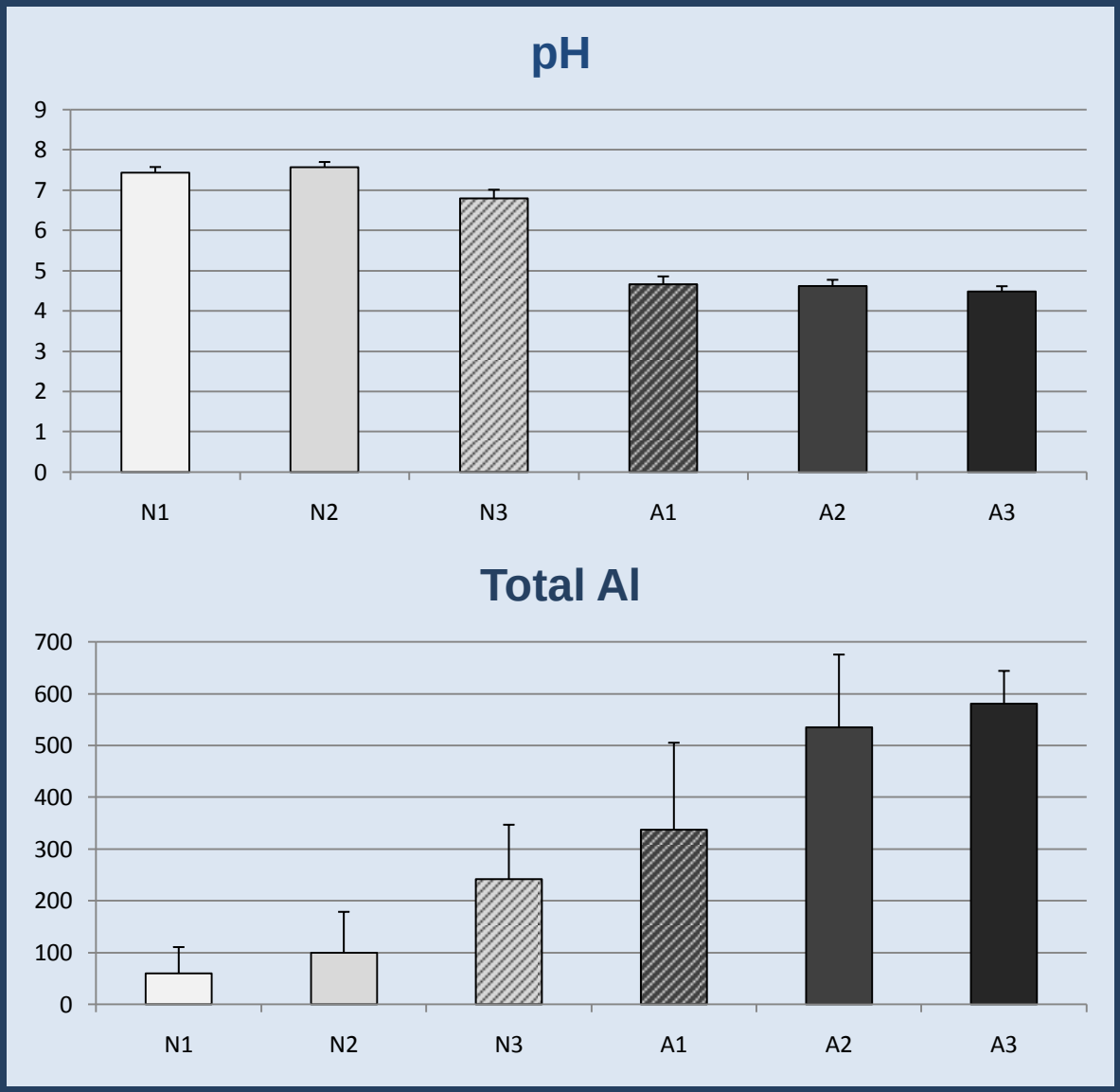
7 13 21 28 49 70 d

Water sample → Water chemistry

4 replicate bags:

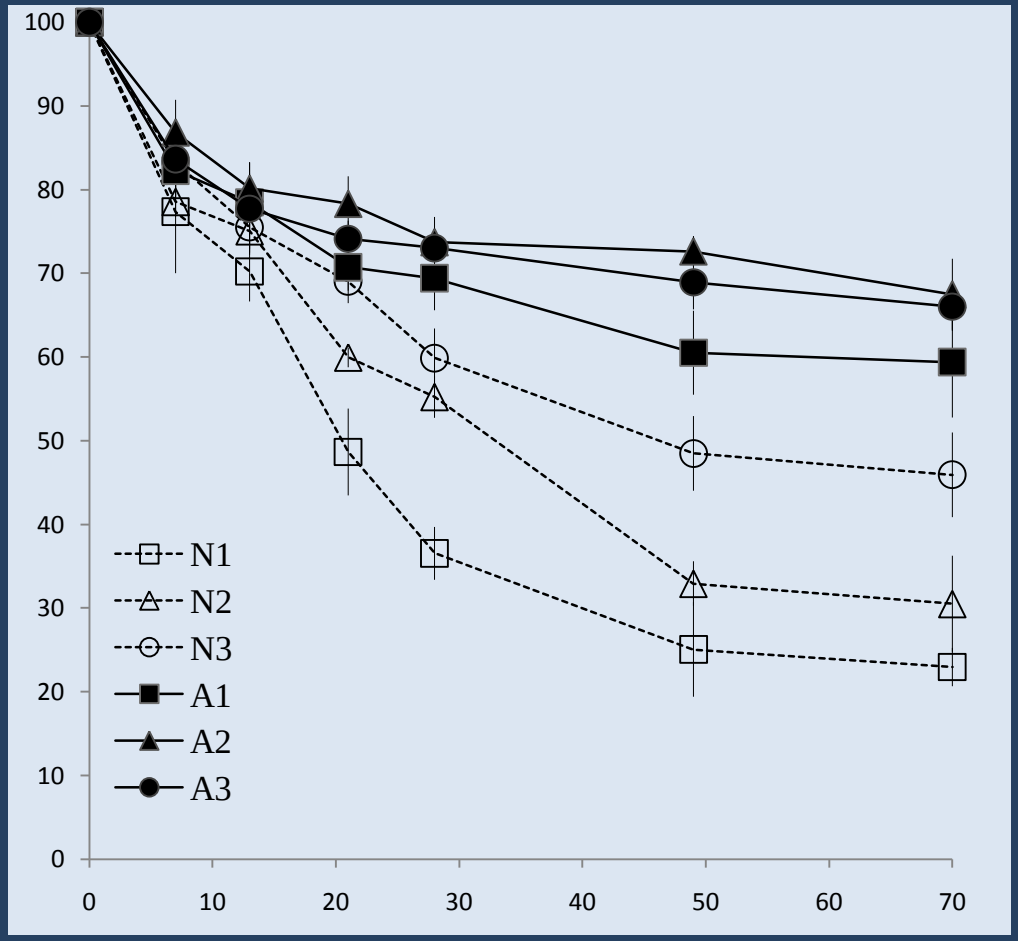
- → Mass loss
- 4 → 1 → Microbial community structure (DGGE 16S and 18S)
- → Potential Extracellular Enzyme Activities
- → N and P content

Water chemistry

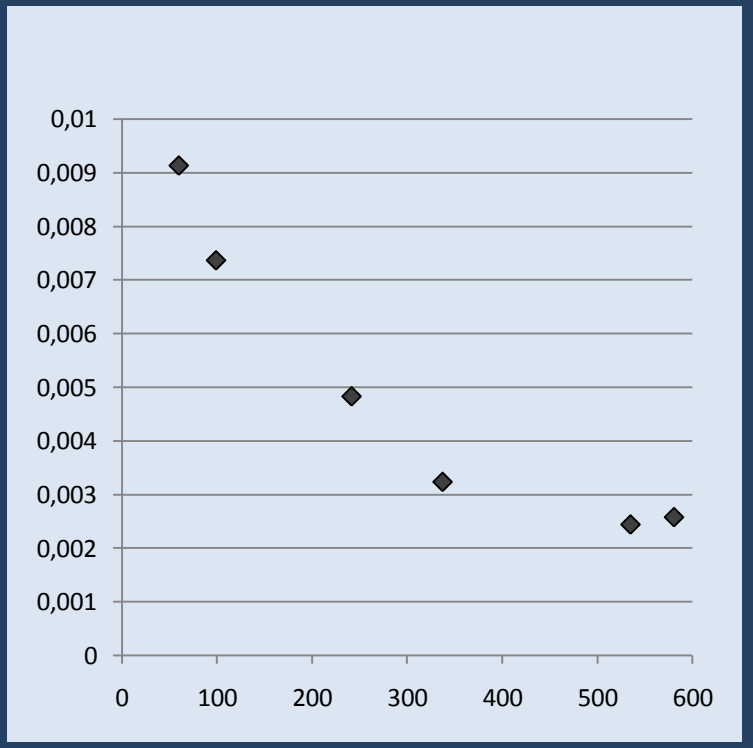


Maple leaf breakdown

Mass loss of leaf disks



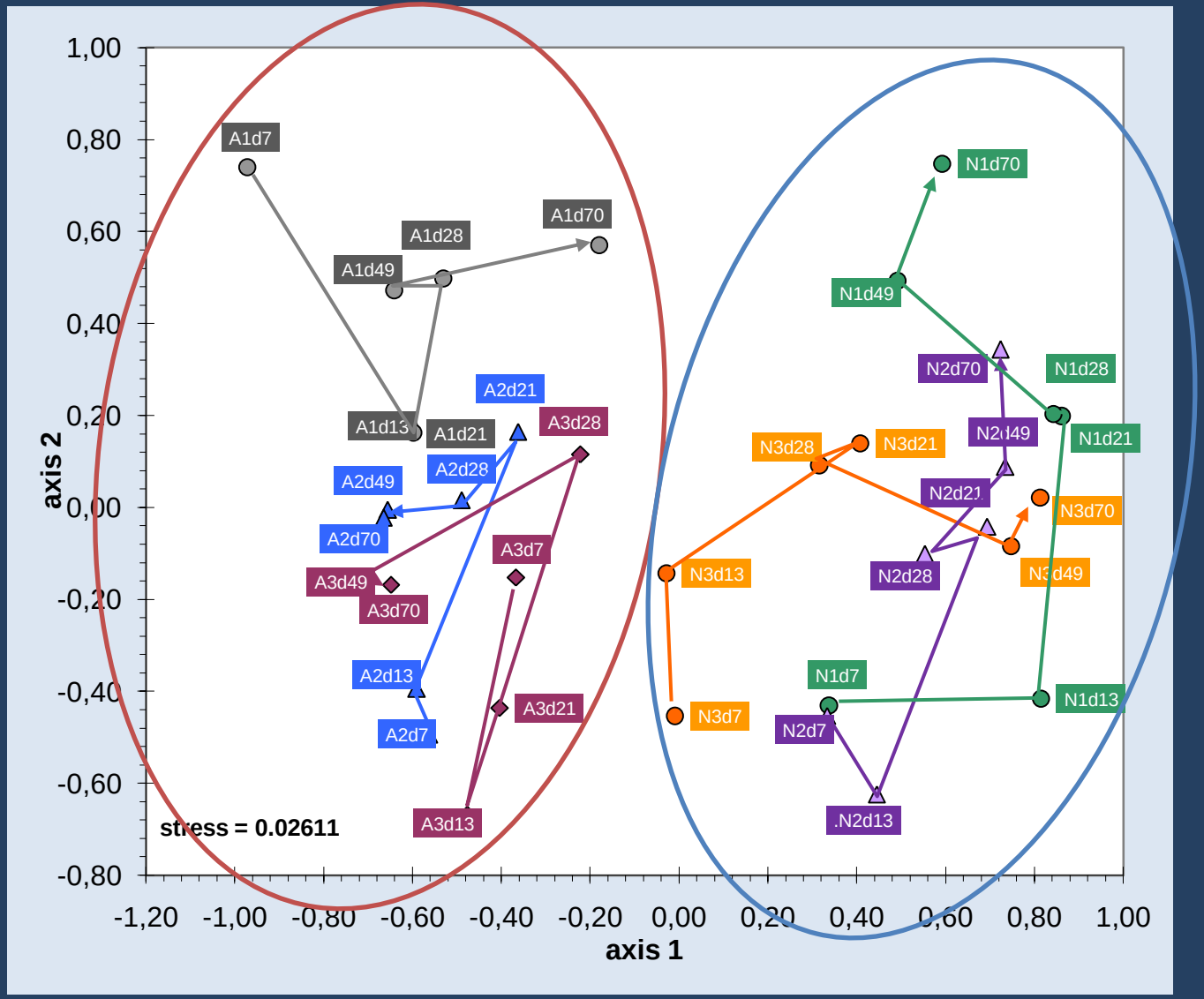
Relationship between breakdown rates (exponential model) and mean total aluminium

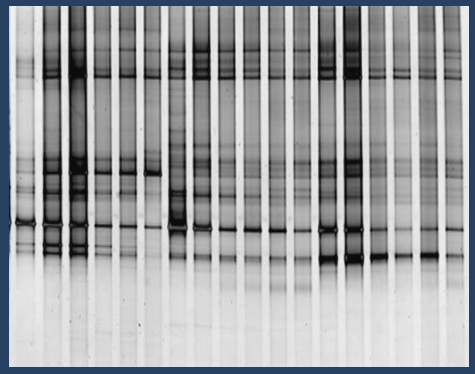


Microbial community structure

Bacterial community structure

nMDS plot based on 16S rDNA DGGE profiles

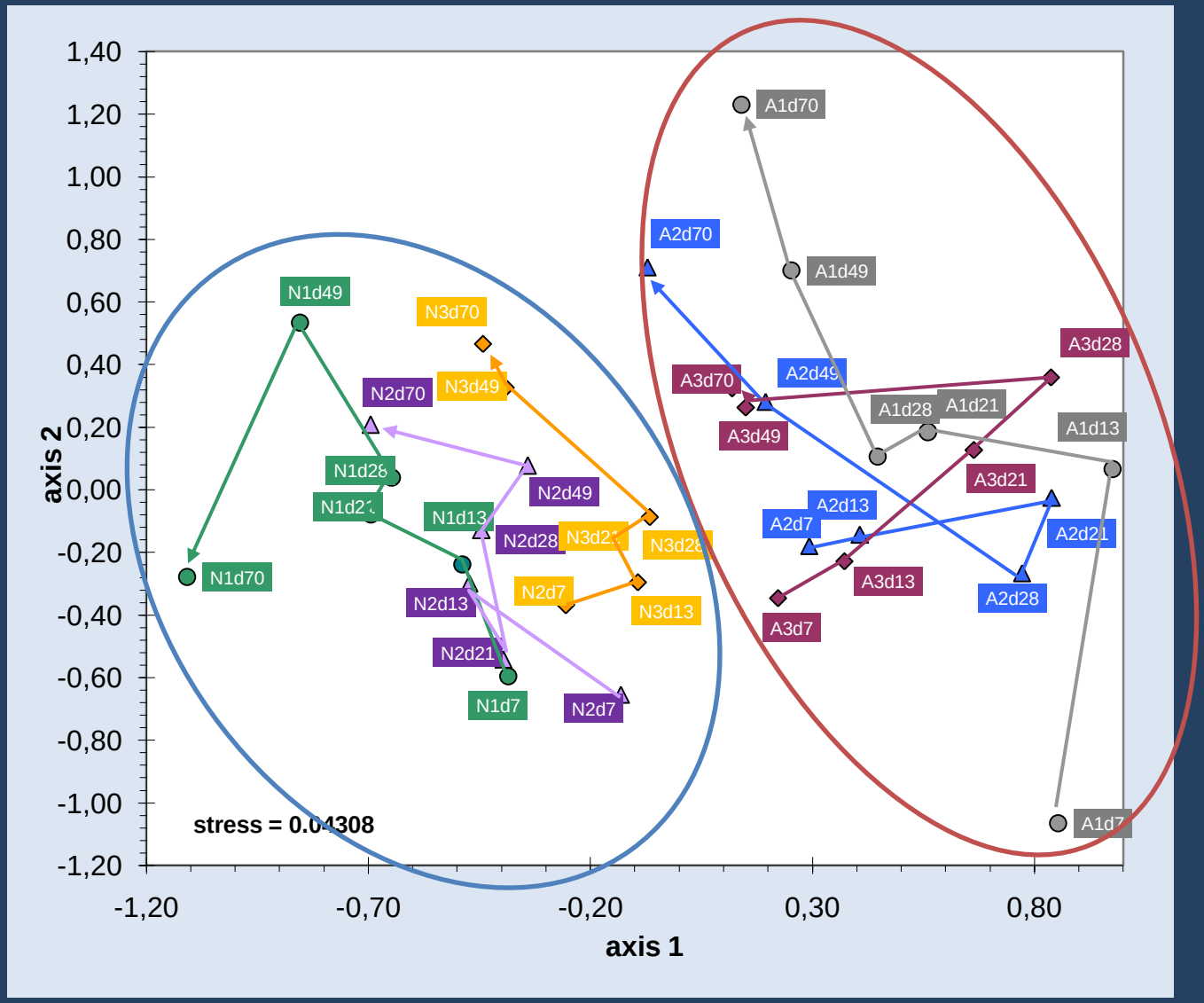


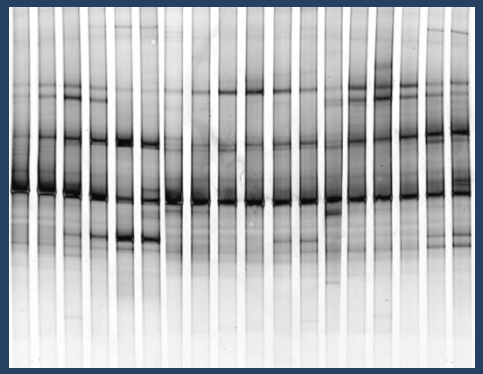


Stream	Phylotype richness
N1	17
N2	15
N3	22
A1	22
A2	28
A3	26

Fungal community structure

nMDS plot based on 18S rDNA DGGE profiles

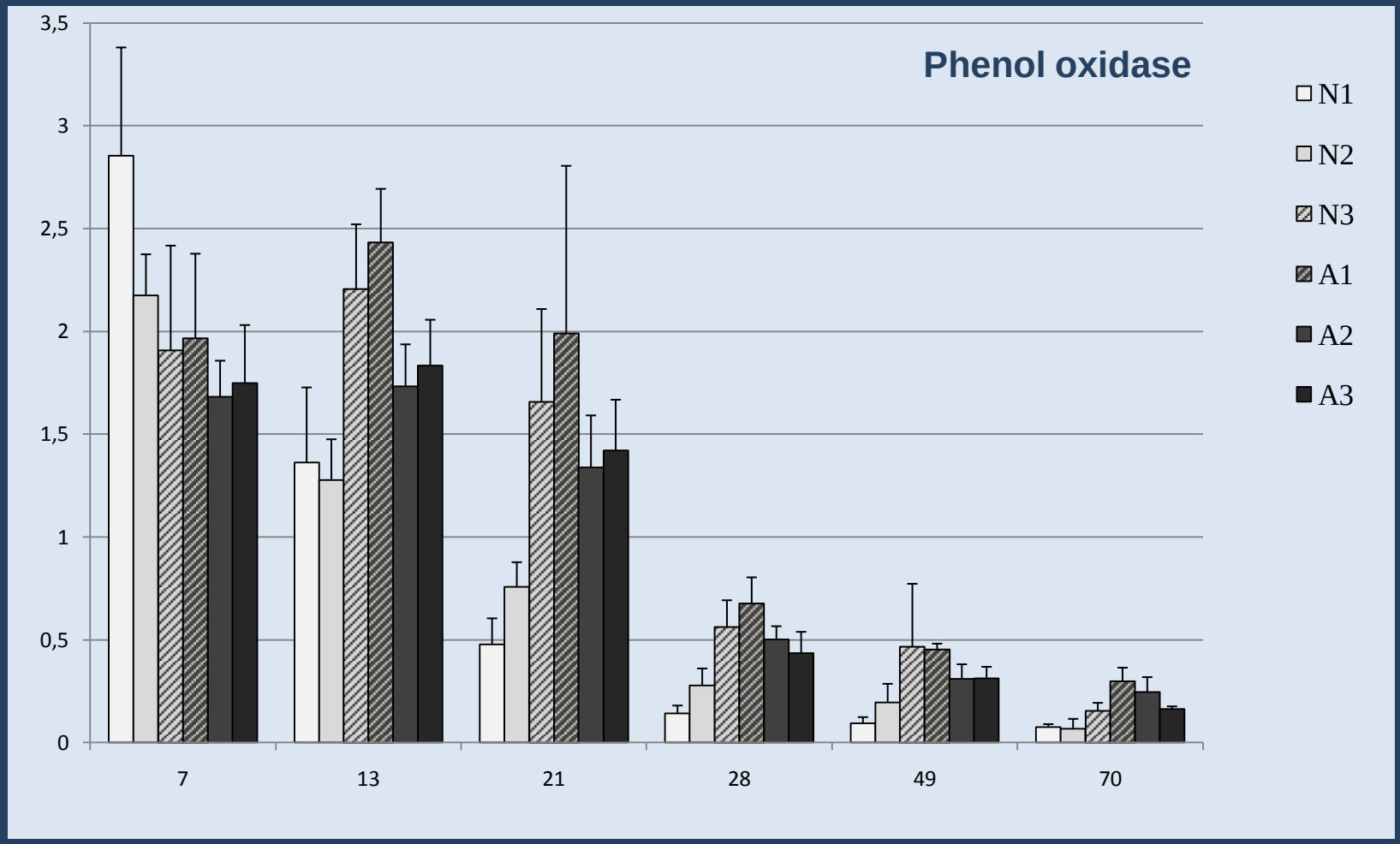




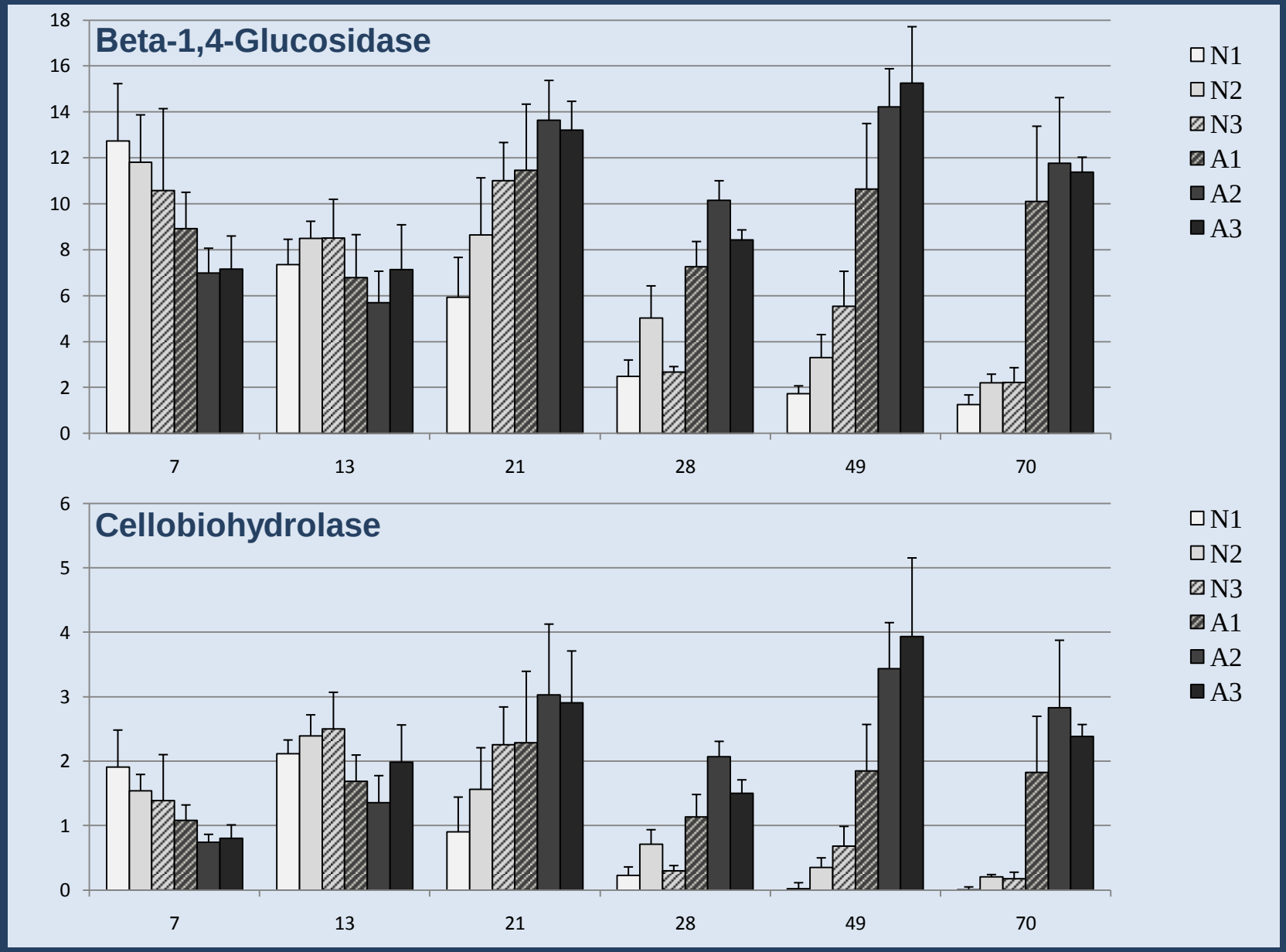
Stream	Phylotype richness
N1	19
N2	20
N3	20
A1	14
A2	16
A3	14

Lignocellulolytic Enzyme Activities

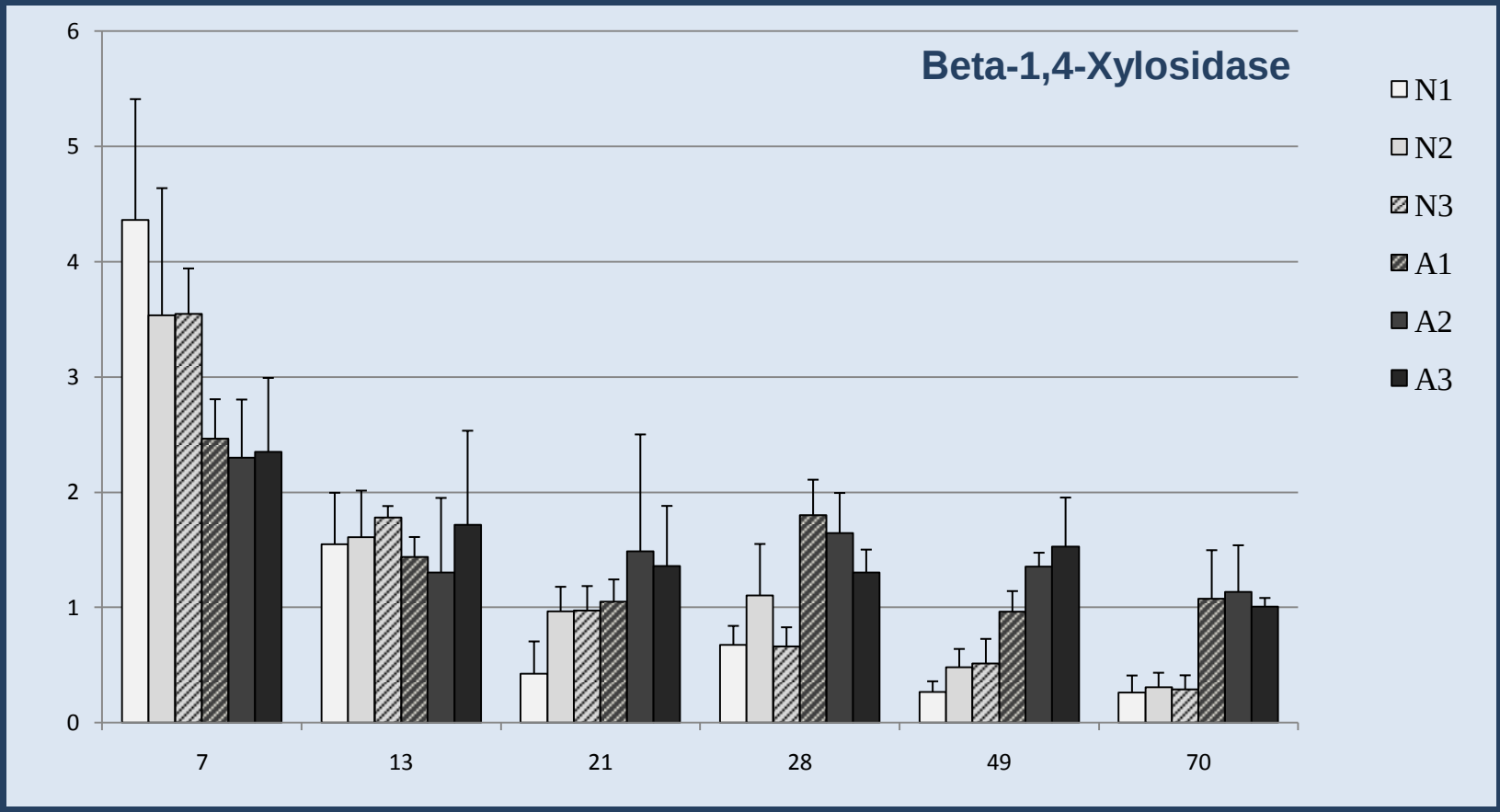
Phenol oxidase



Exocellulase



Hemicellulase

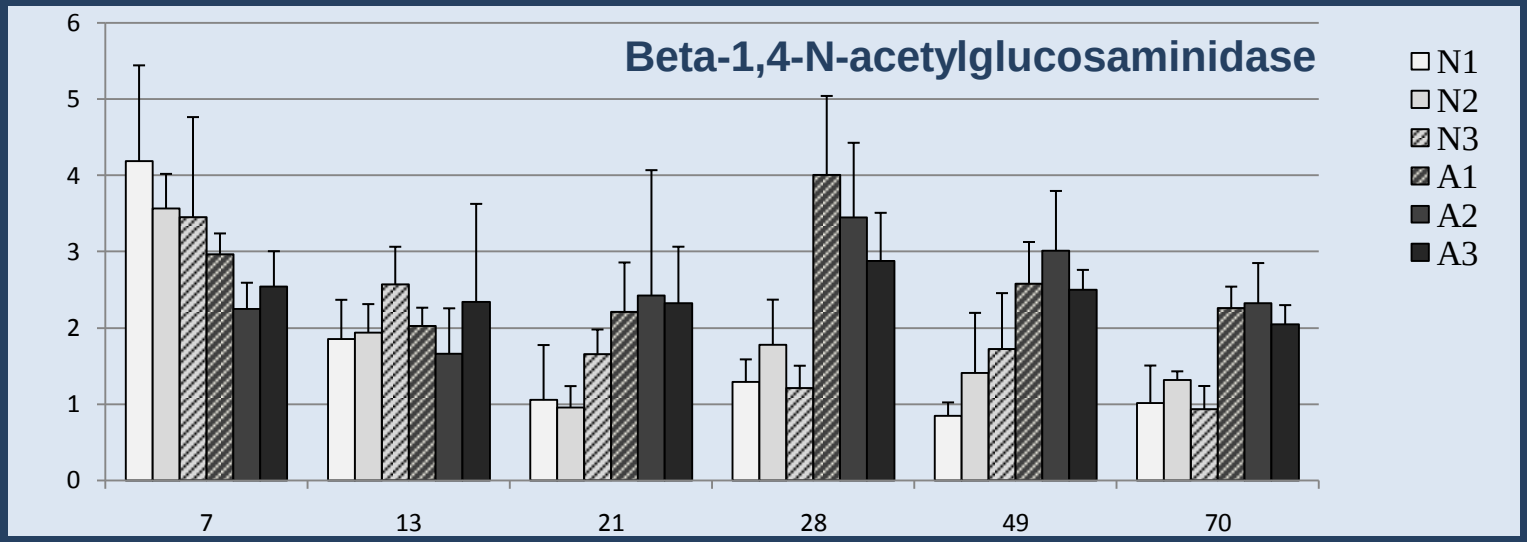


Important potential activities in acidified streams
→ enzyme production not reduced

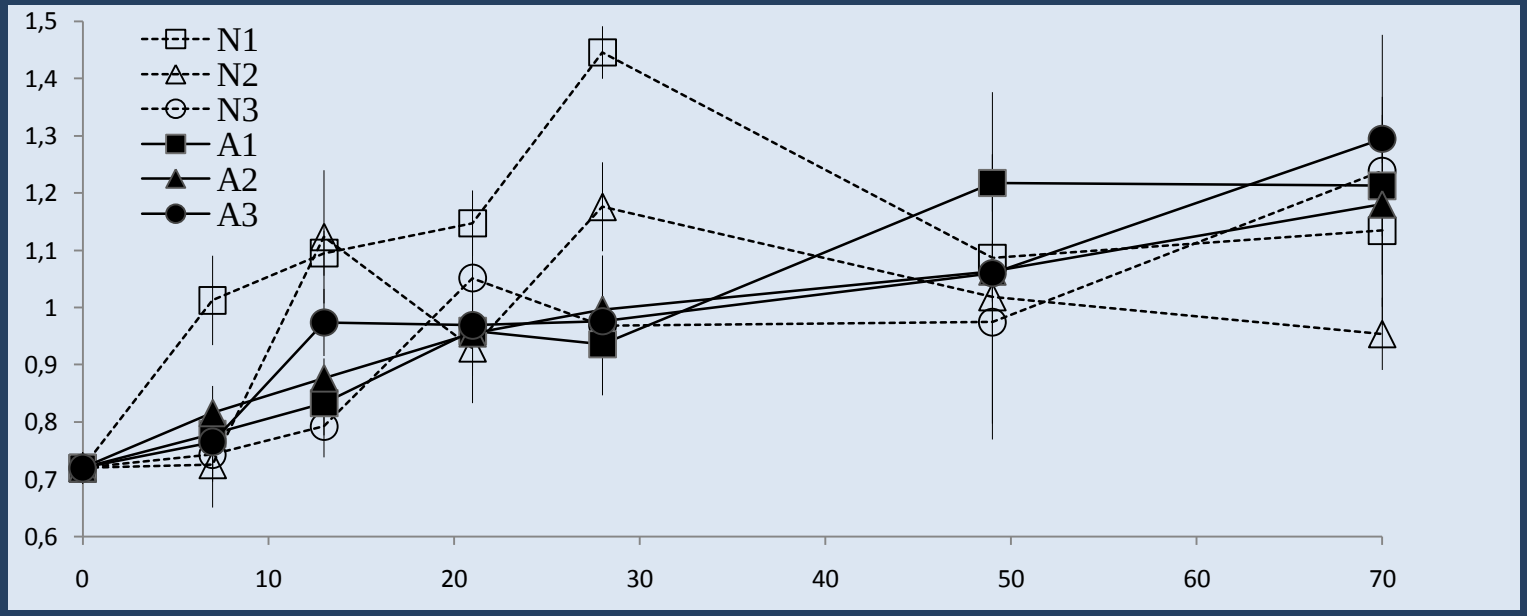
Microbial nutrient acquisition

Nitrogen uptake

Enzyme activity
µmol.h^{-1}.g^{-1} AFDM

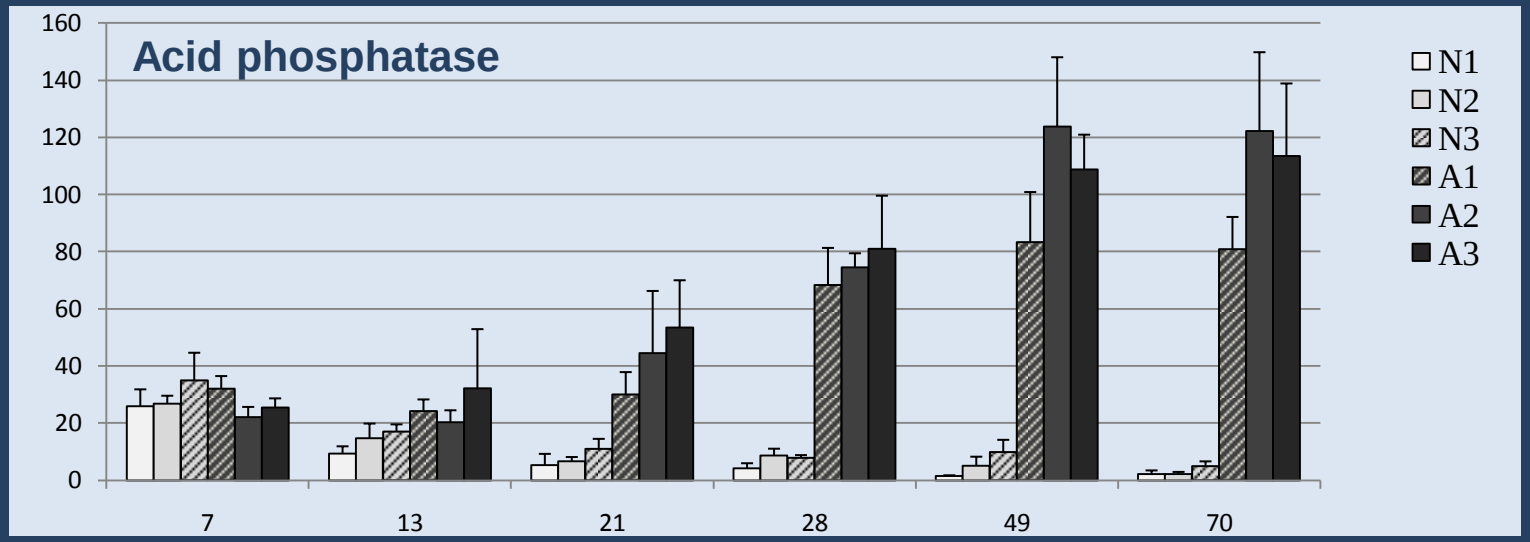


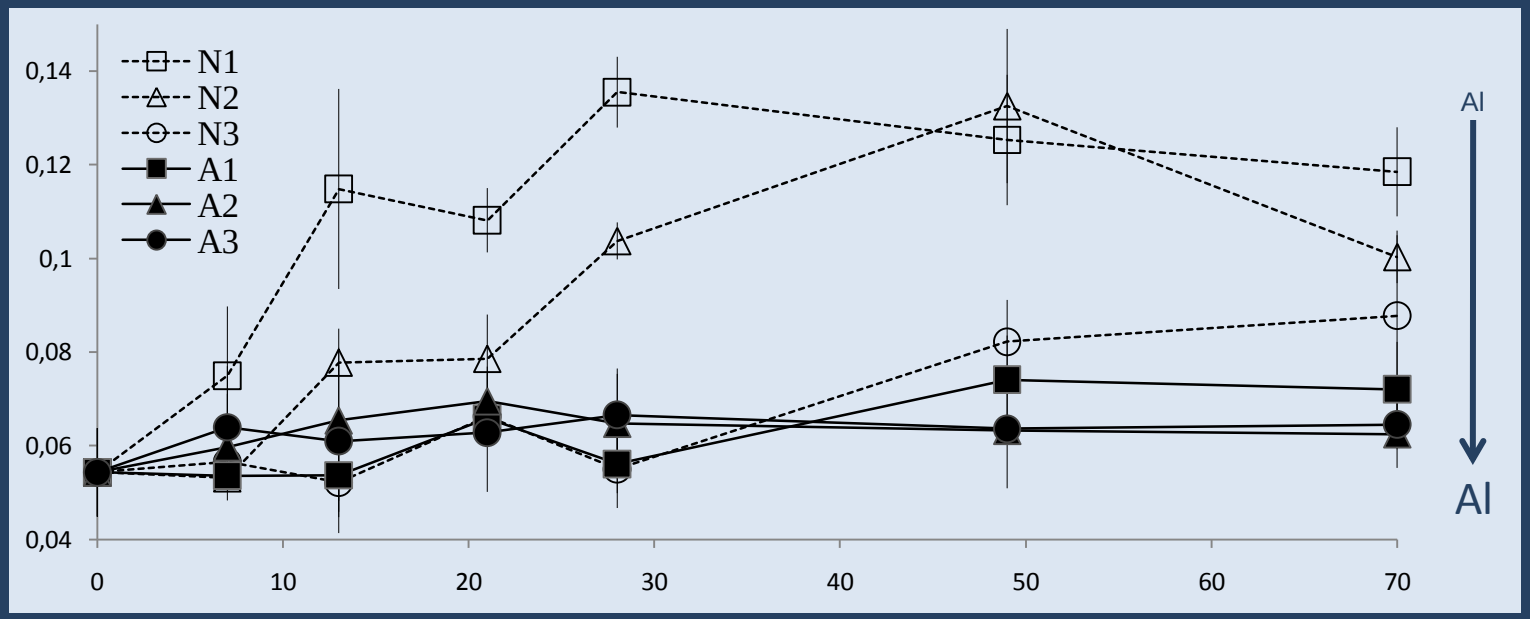
Nitrogen content
% DM



Time (day)

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 acquisiton + 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

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 Guérold

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

ASLO / NABS 2010 Summer Meeting, Santa Fe