



Zone
Atelier
Moselle



Agence Nationale de la Recherche
ANR



Diversity and activities of fungal communities associated with decaying leaves in acidified headwater streams

Clivot H.^{1@}, Cornut J.^{2,3}, Gierlinski P.¹, Danger M.¹, Pagnout C.¹,

Poupin P.¹, Elger A.^{2,3}, Chauvet E.^{2,3} and Guérolld F.¹

¹Laboratoire des Interactions Ecotoxicologie Biodiversité Ecosystèmes; CNRS; Université Paul Verlaine; F-57070 Metz, France.

²Université de Toulouse; INP; UPS; EcoLab; F-31062 Toulouse, France.

³CNRS; EcoLab; F-31062 Toulouse, 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
→ assessing functional alterations

Low pH and **elevated aluminium concentrations**
→ **reduce sporulating aquatic hyphomycete diversity**
(Baudoin et al., 2008, *Microbial Ecology*)

→ **impair leaf litter breakdown**
(Dangles et al., 2004, *Journal of Applied Ecology*)

I. Would a study combining traditional and molecular methods confirm a loss of fungal diversity?

I. Methods

Litter bag experiment in 5 streams along an AI gradient

Nov 2008 → Dec 2008

Benthic zone

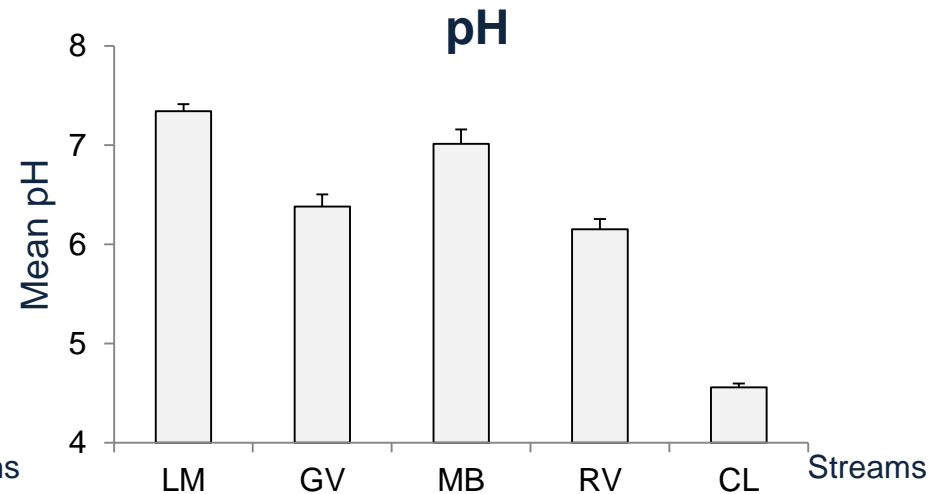
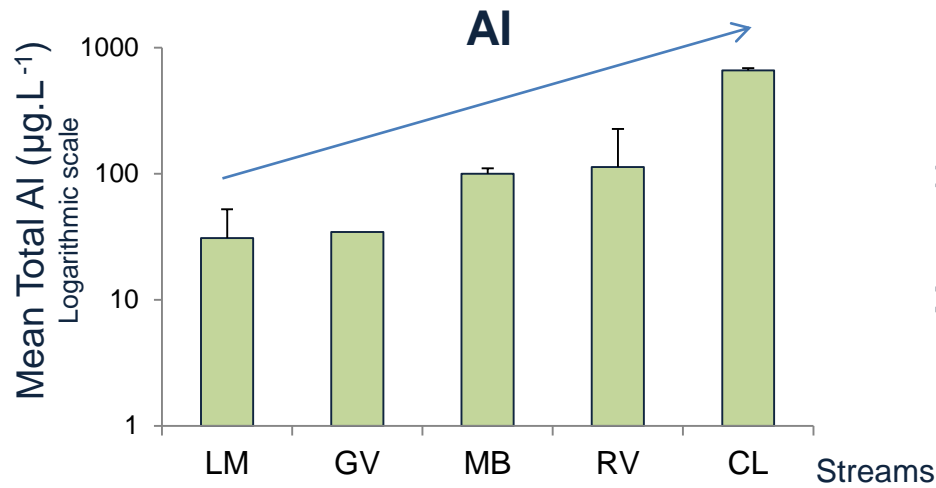
Hyporheic zone
(i.e. buried in the sediment of the streambed)

4 sampling dates (4 replicate bags)
7, 14, 21 and 28 days

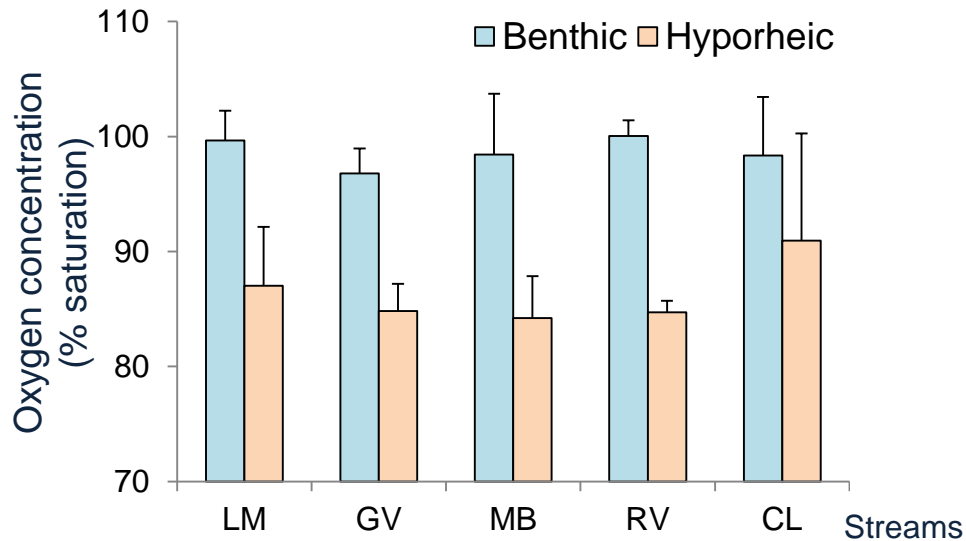
Conidial identification
PCR-DGGE

I.Fungal diversity

I. Water characteristics



Dissolved oxygen

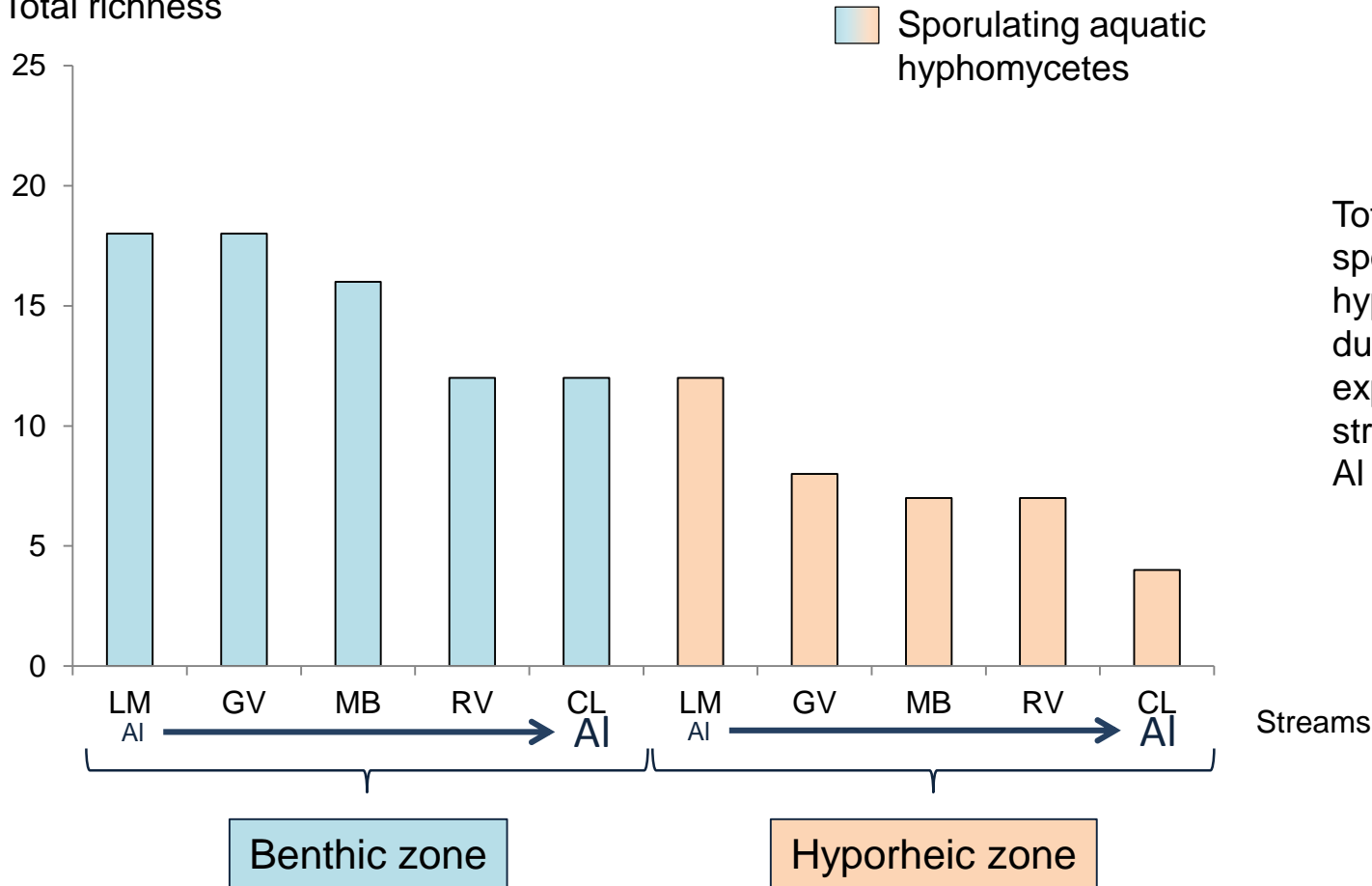


Streams were classified along the
AI gradient

**Dissolved O_2 decreased in
hyporheic zone**

I. Fungal diversity

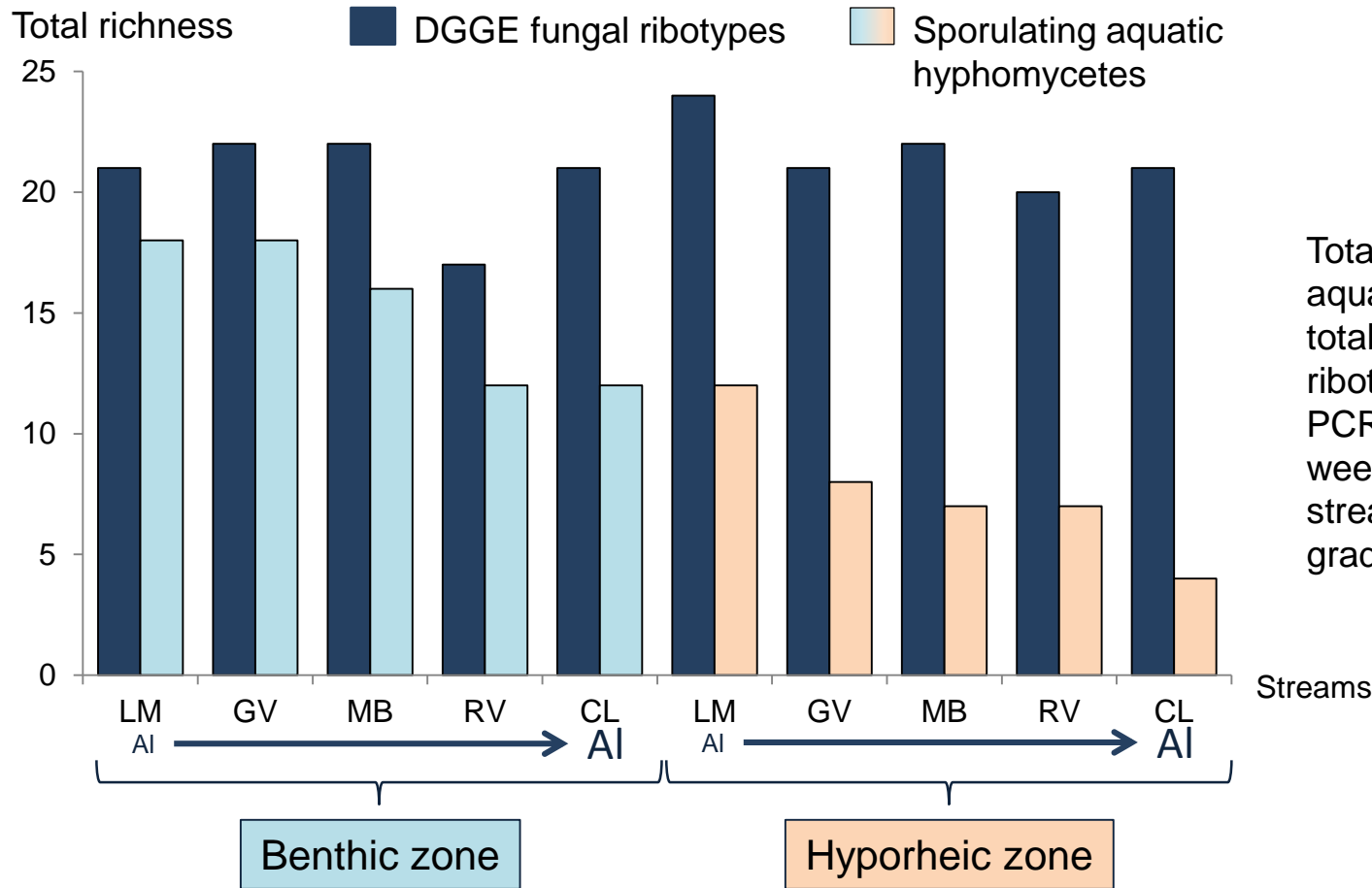
Total richness



Total richness of sporulating aquatic hyphomycetes during the 4-week experiment in 5 streams along an Al gradient.

Species richness of sporulating aquatic hyphomycetes **decreased** along the aluminium gradient (Benthic > Hyporheic)

I. Fungal diversity



Total richness of sporulating aquatic hyphomycetes vs total number of fungal ribotypes (rRNA 18S) in PCR-DGGE during the 4-week experiment in 5 streams along an AI gradient.

Species richness of sporulating aquatic hyphomycetes **decreased** along the AI gradient (Benthic > Hyporheic)

Fungal ribotype richness investigated by PCR-DGGE was comparatively higher and was **unaffected** by the AI gradient (Benthic \approx Hyporheic)

I. Discussion

Molecular method

- traditional method underestimates fungal diversity
- aquatic hyphomycete species not in good conditions for reproductive activity under elevated aluminium concentrations?

Conidial identification

- Relevant method to assess environmental pollutions

Total richness of sporulating species:

- Correlated to total Al concentration (benthic $r=-0.95$, $p=0.01$; hyporheic $r=-0.97$, $p=0.005$)
- Lower in the hyporheic zone ← Oxygen concentration?

Low oxygen concentration inhibits sporulation (Medeiros et al., 2009, *Freshwater Biology*) and affects species richness of aquatic hyphomycetes (Rajashekhar & Kaveriappa, 2003, *Hydrobiologia*).

II. What shift(s) in microbial activities could explain reduced leaf litter breakdown?

II. Methods

Litter bag experiment in 6 streams along an AI gradient

Nov 2009 → Jan 2010



6 sampling dates (4 replicate bags)

7, 13, 21, 28, 49 and 70 days

Mass loss

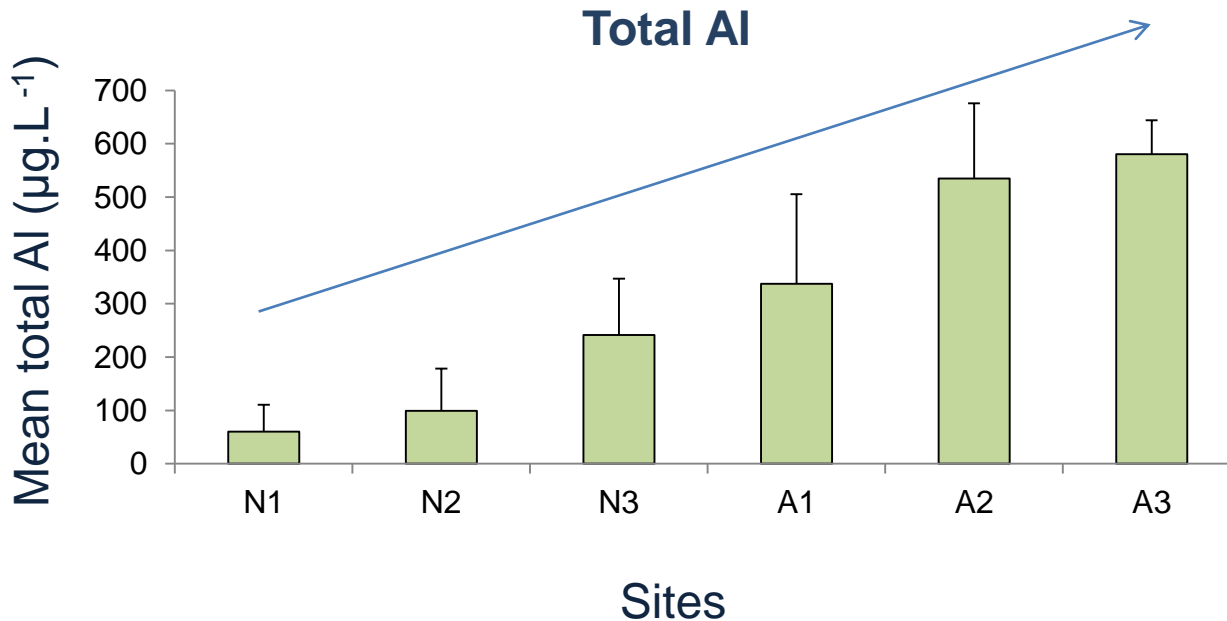
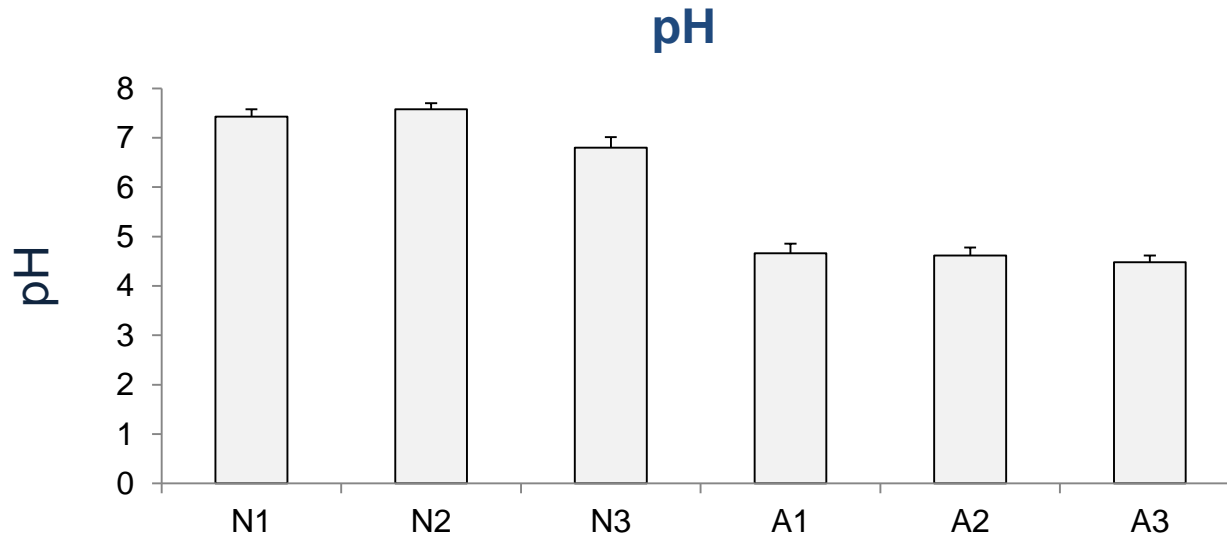
Potential Extracellular Enzyme Activities

N and P content



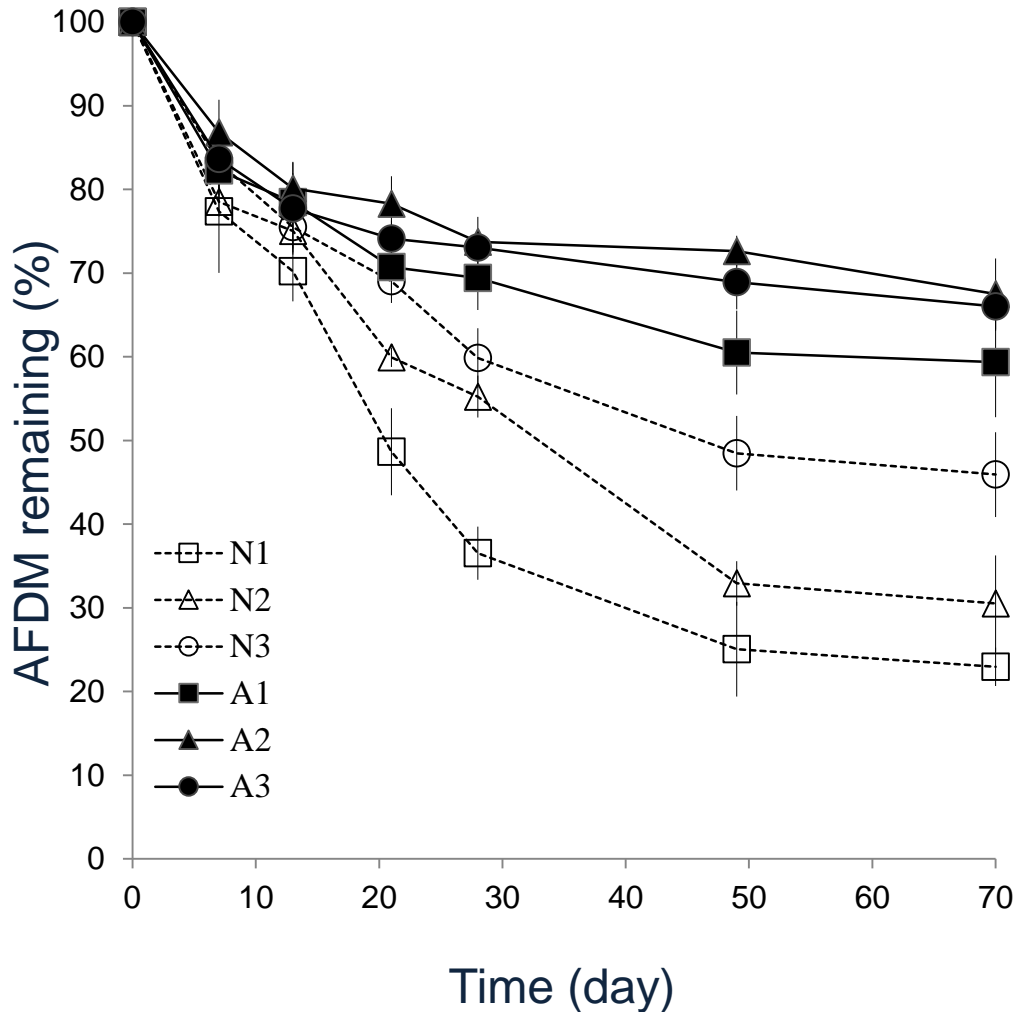
II. Microbial activities

II.1. Water characteristics

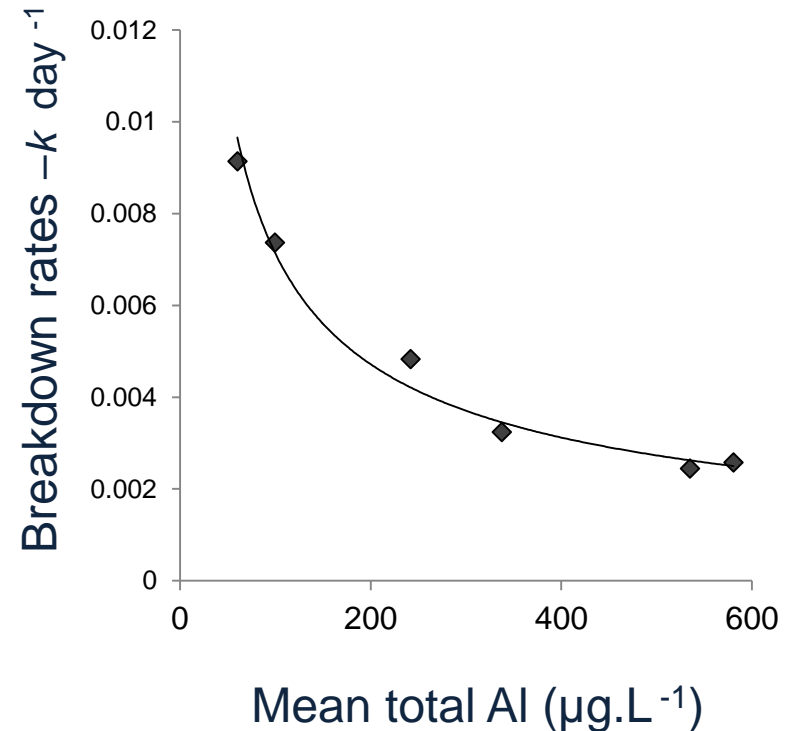


II.1. Leaf litter breakdown

Mass loss of leaf disks

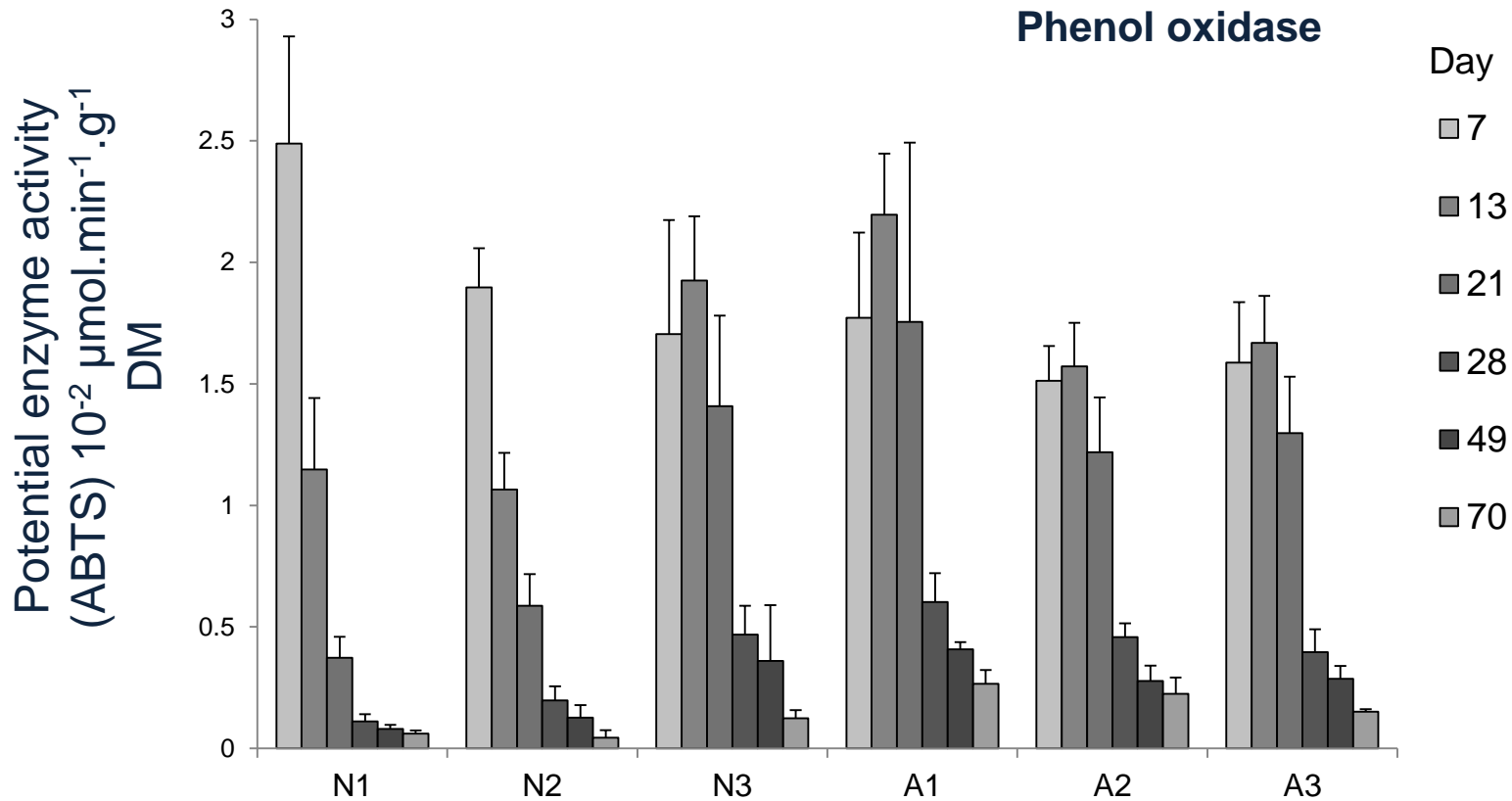


Relationship between breakdown rates (exponential model) and mean total aluminium

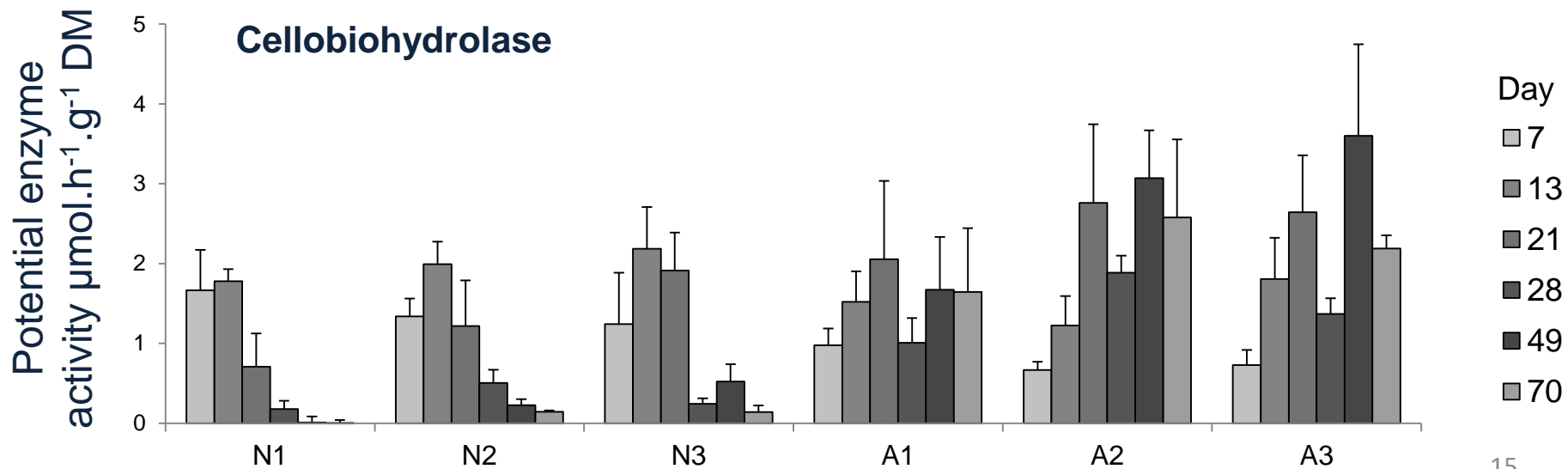
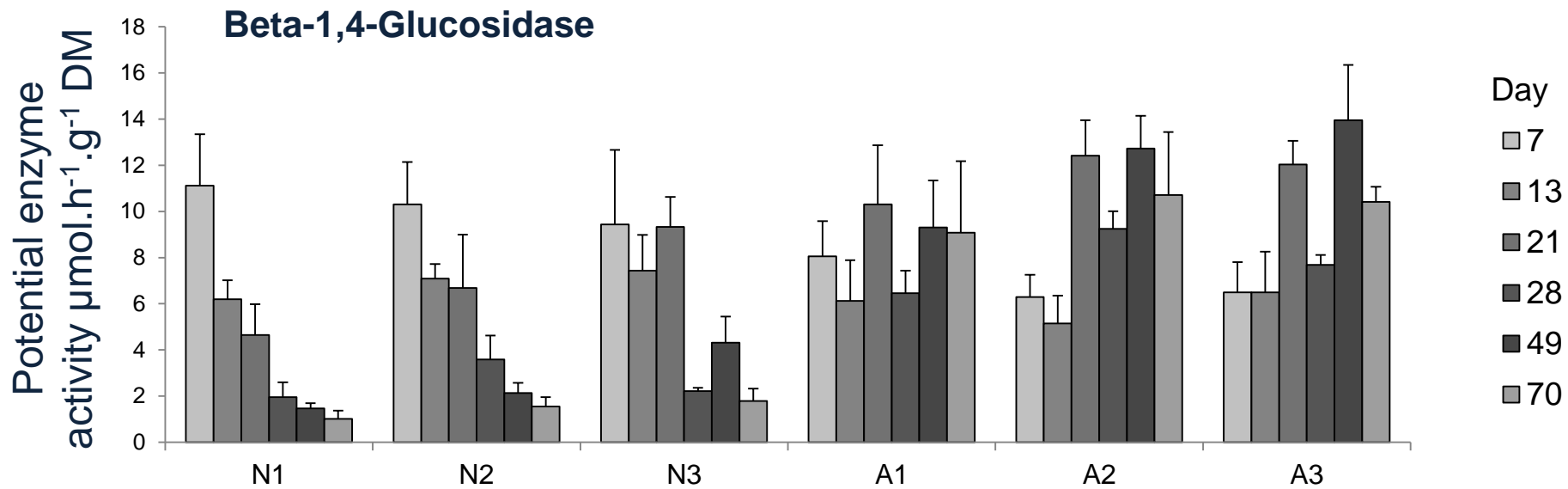


II.2. Lignocellulolytic enzyme activities

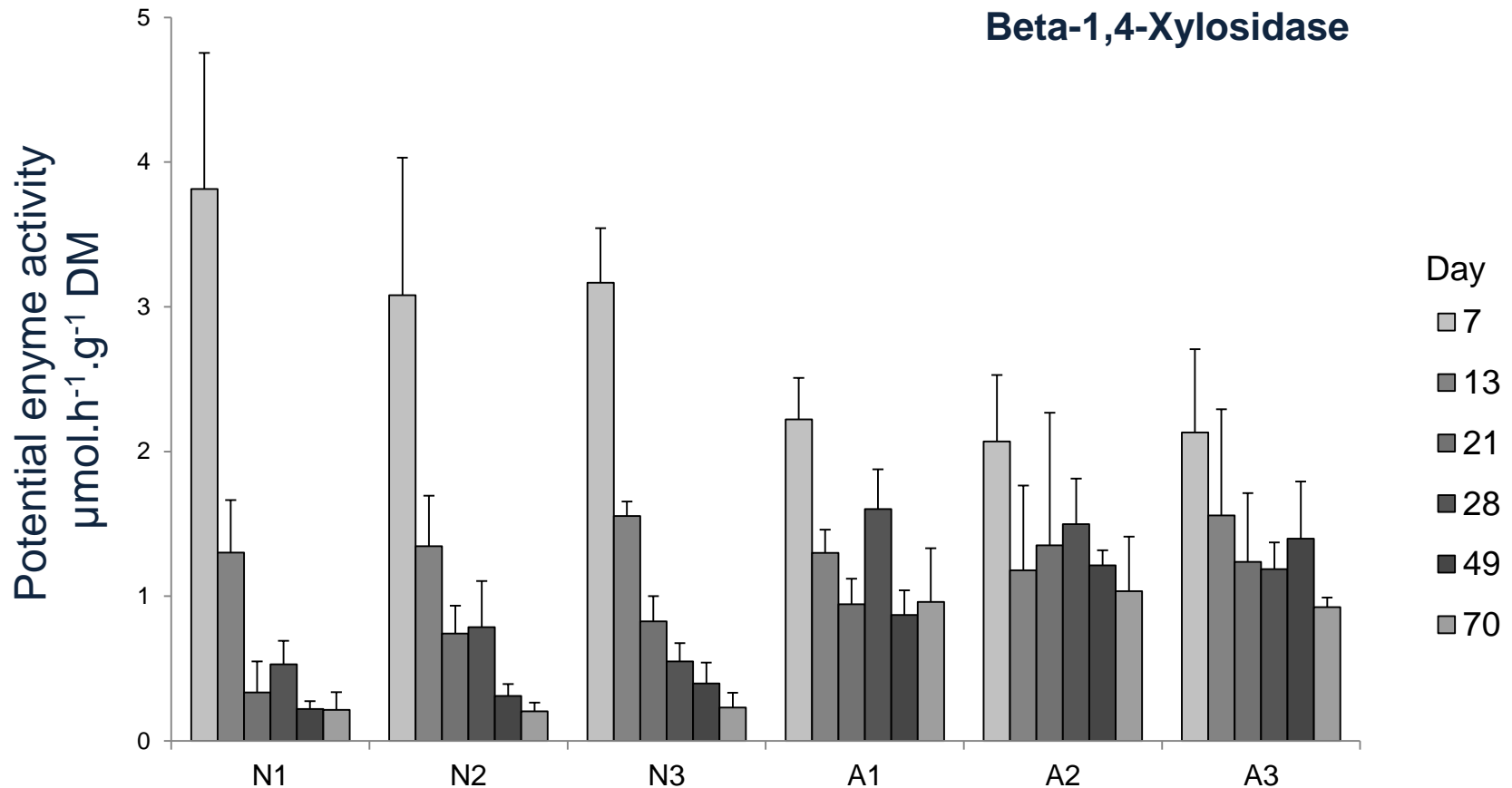
II.2. Phenol oxidase



II.2. Exocellulase



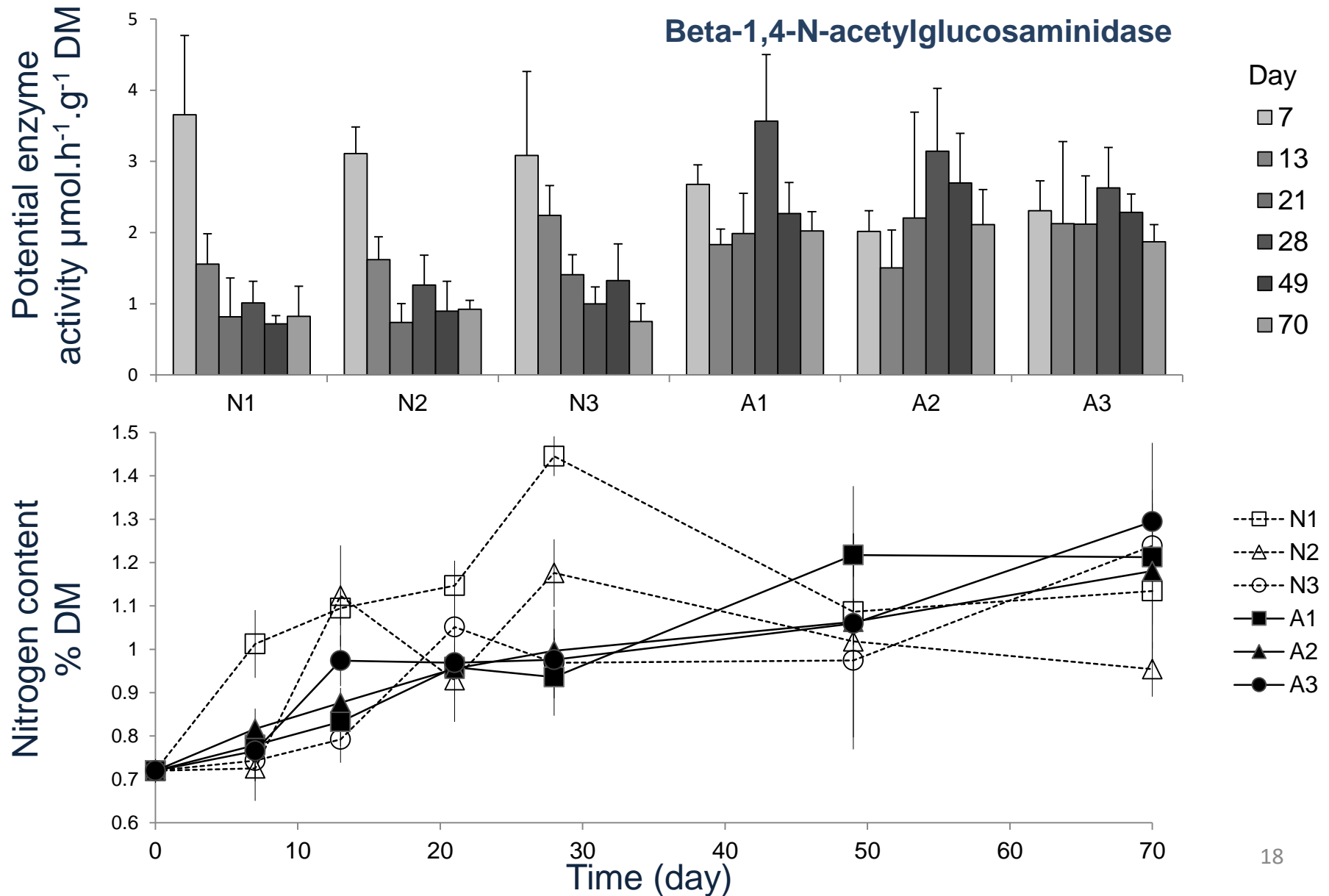
II.2. Hemicellulase



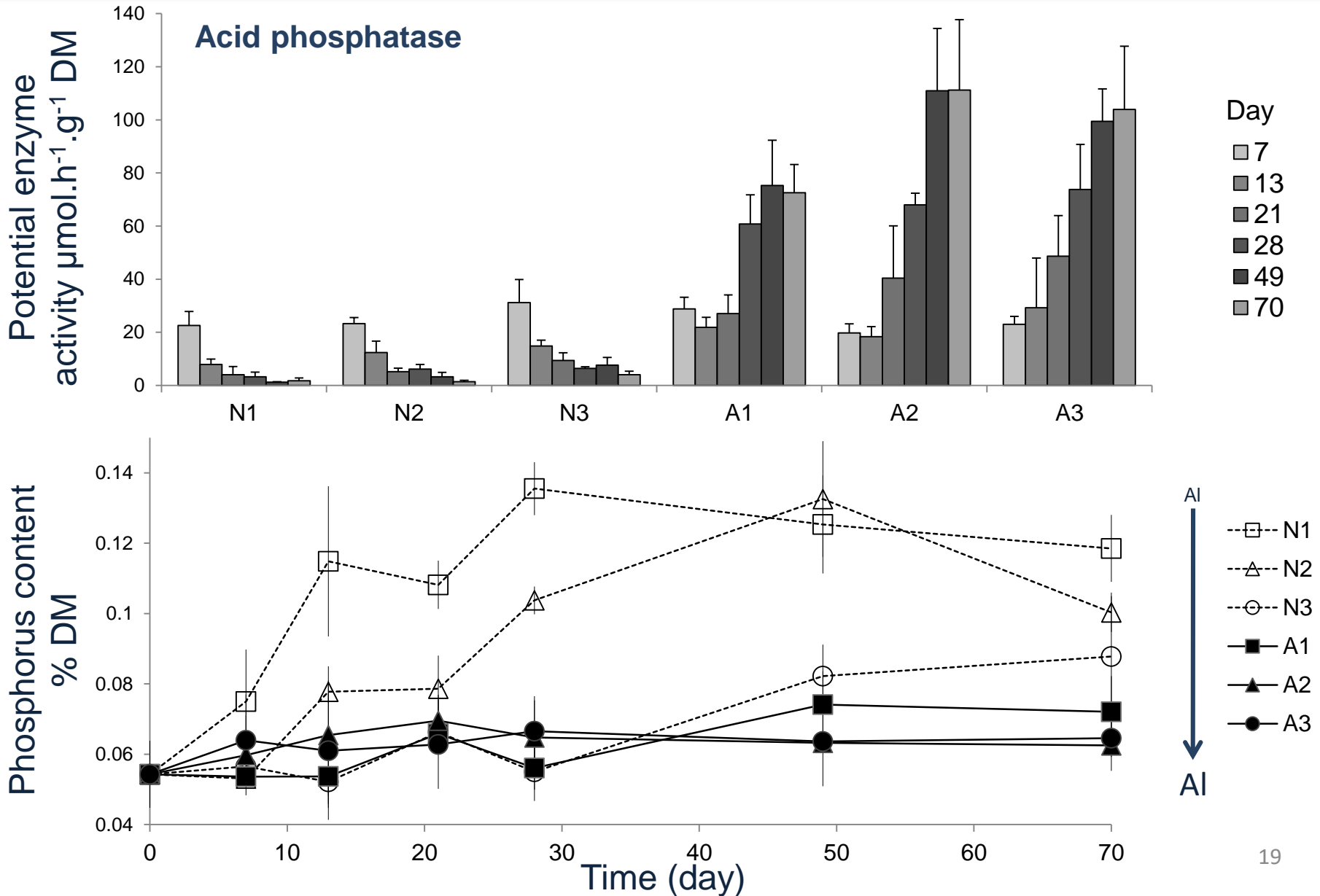
Important potential activities in acidified streams
→ enzyme production not reduced

II.3. Microbial nutrient acquisition

II.3. Nitrogen uptake



II.3. Phosphorus uptake



Potential extracellular enzyme activities

→ Enzyme production was not reduced in acidified streams

Nutrient uptake

→ N uptake unaltered

→ Increasing enzymatic effort for P acquisition

→ P uptake reduced with increasing aluminium concentration

Aluminium affects

→ Litter decomposition ($r=-0.94$, $p=0.006$)

→ Phosphorus immobilized ($r=-0.96$, $p=0.002$)

Conclusion

Leaf breakdown not related to enzymatic effort

Enzymatic efficiency controlled by abiotic and biotic factors

Microbial activity constrained by nutrient availability

Phosphorus limitation

P correlated to litter decomposition ($r=0.97$, $p=0.001$)

Impact on aquatic hyphomycete diversity?

« *Nutrient addition stimulates the reproductive activity of aquatic hyphomycetes, their colonization success and fungal-mediated leaf-litter decomposition.* » (Gulis & Suberkropp, 2004, *Mycologia*)

Direct and indirect effects of Aluminium

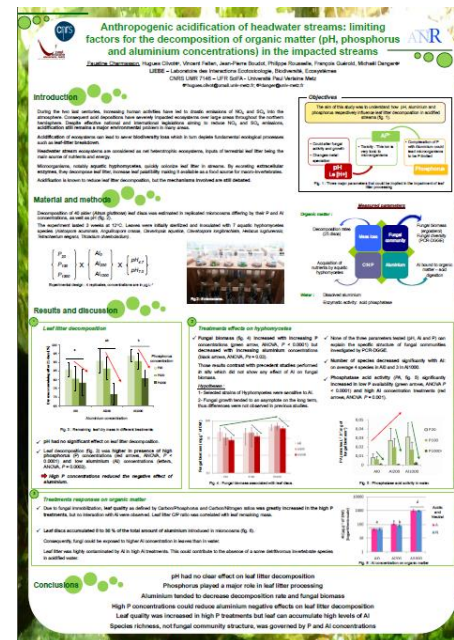
Toxicity under acidic conditions

Interactions with P cycle

Perspectives

- More in-depth analysis of fungal diversity (clone libraries)
- Why is leaf decomposition not related to enzymatic production?
- Investigations on effects and interactions between Al and P during leaf processing

Poster SAME 12
Charmasson et al.





Zone
Atelier
Moselle



Agence Nationale de la Recherche
ANR



Diversity and activities of fungal communities associated with decaying leaves in acidified headwater streams

Clivot H.^{1@}, Cornut J.^{2,3}, Gierlinski P.¹, Danger M.¹, Pagnout C.¹,

Poupin P.¹, Elger A.^{2,3}, Chauvet E.^{2,3} and Guérolld F.¹

¹Laboratoire des Interactions Ecotoxicologie Biodiversité Ecosystèmes; CNRS; Université Paul Verlaine; F-57070 Metz, France.

²Université de Toulouse; INP; UPS; EcoLab; F-31062 Toulouse, France.

³CNRS; EcoLab; F-31062 Toulouse, France.

@hugues.clivot@umail.univ-metz.fr