Labile substrate availability shapes interactions in a synthetic chitin-degrading soil bacterial community

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SSS 4.7 - Microbial growth, turnover and functioning in soils: modelling and experimental advances

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TERRESTRIAL ECOSYSTEM RESEARCH

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European Research Council
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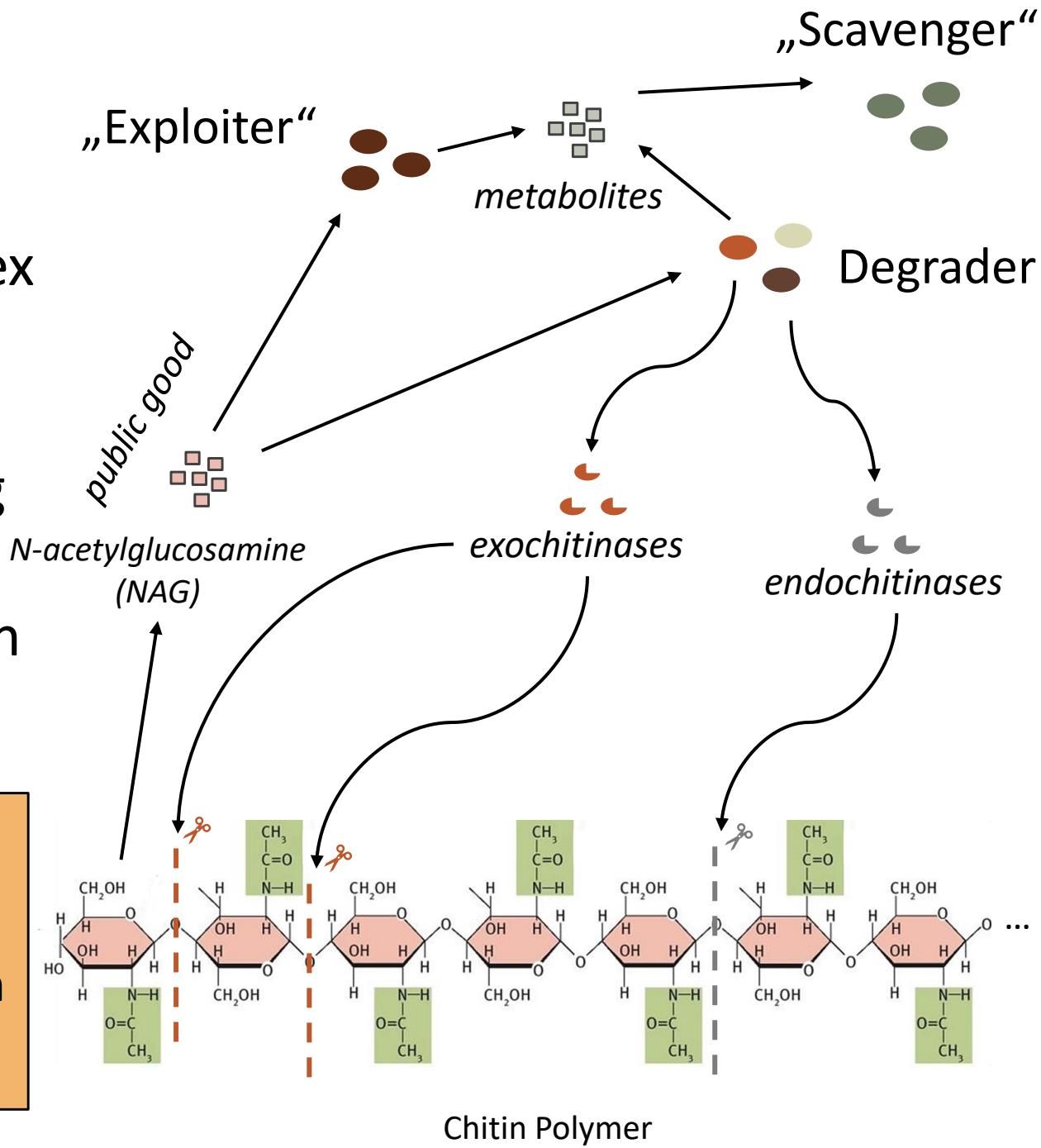
Chitin Degradation

- Chitin decomposition is a complex process
- “Social” interactions are often observed within chitin-degrading communities
- Interactions affect decomposition efficiency

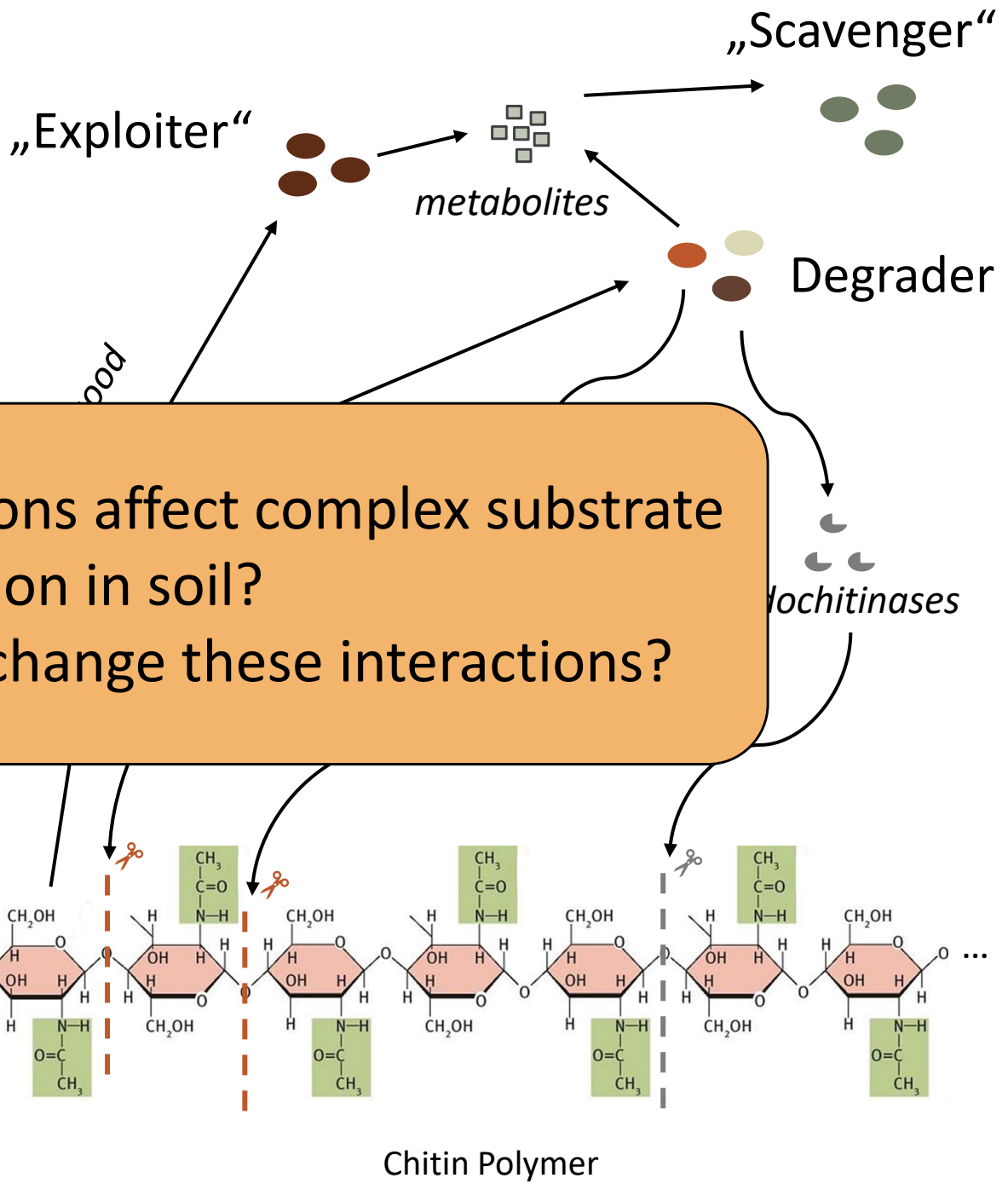
Model system to study how bacterial interactions and self-organisation can affect complex substrate degradation in soil



Beier & Bertilsson (2013), Pollak et al. (2021)

Chitin Degradation

- Chitin decomposition is a complex process
- “Social”
- Interac



How can bacterial interactions affect complex substrate degradation in soil?
Does labile C availability change these interactions?

Model system to study how bacterial interactions and self-organisation can affect complex substrate degradation in soil

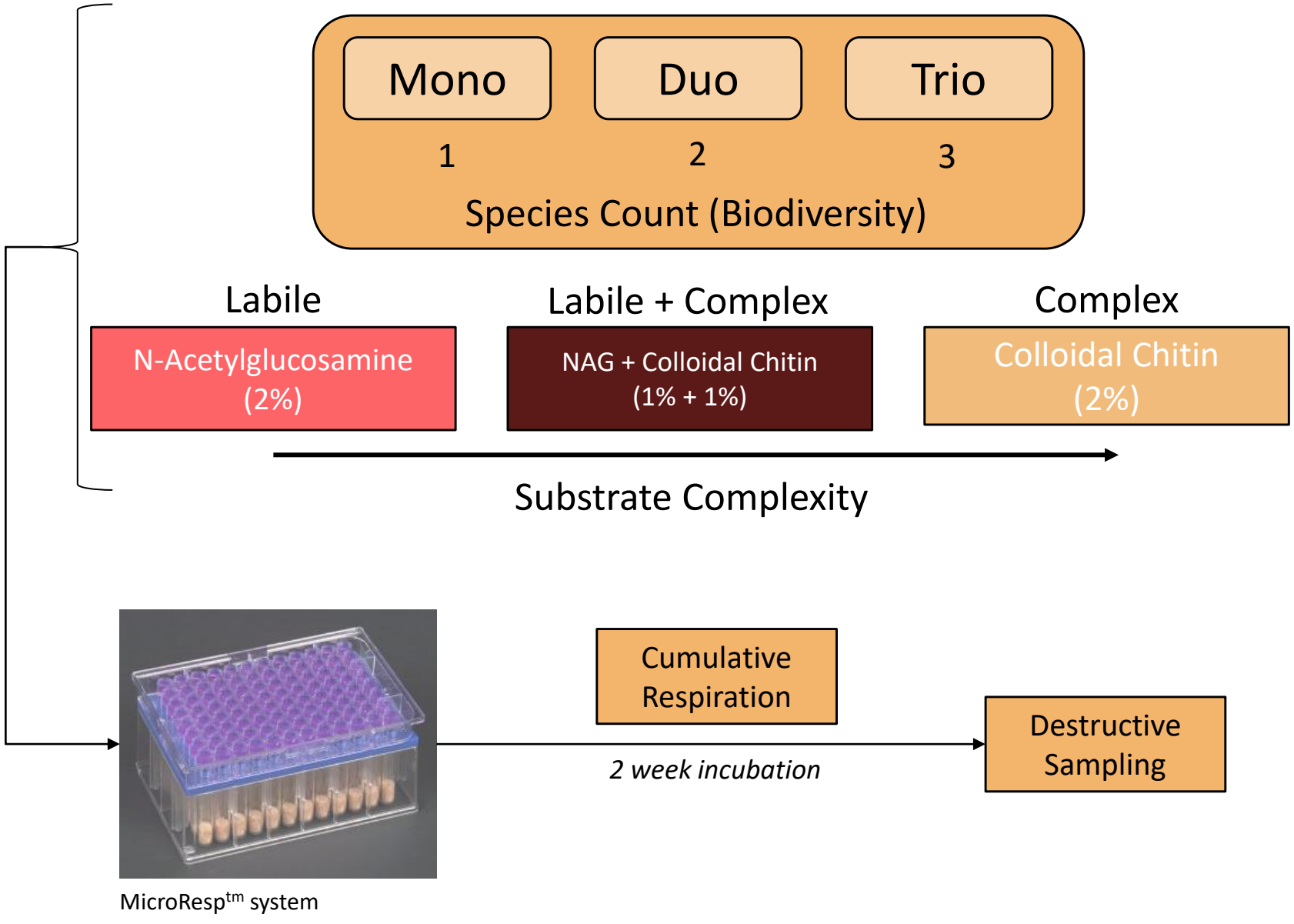
Beier & Bertilsson (2013), Pollak et al. (2021)

Model Consortium

- Three isolated, culturable soil bacteria from different phyla
- Genomic potential to produce different chitinases (MetaCyc)

Phylum	Species
Firmicutes	Paenibacillus alginolyticus
β-Proteobacteria	Paraburkholderia xenovorans
Actinobacteria	Solirubrobacter soli

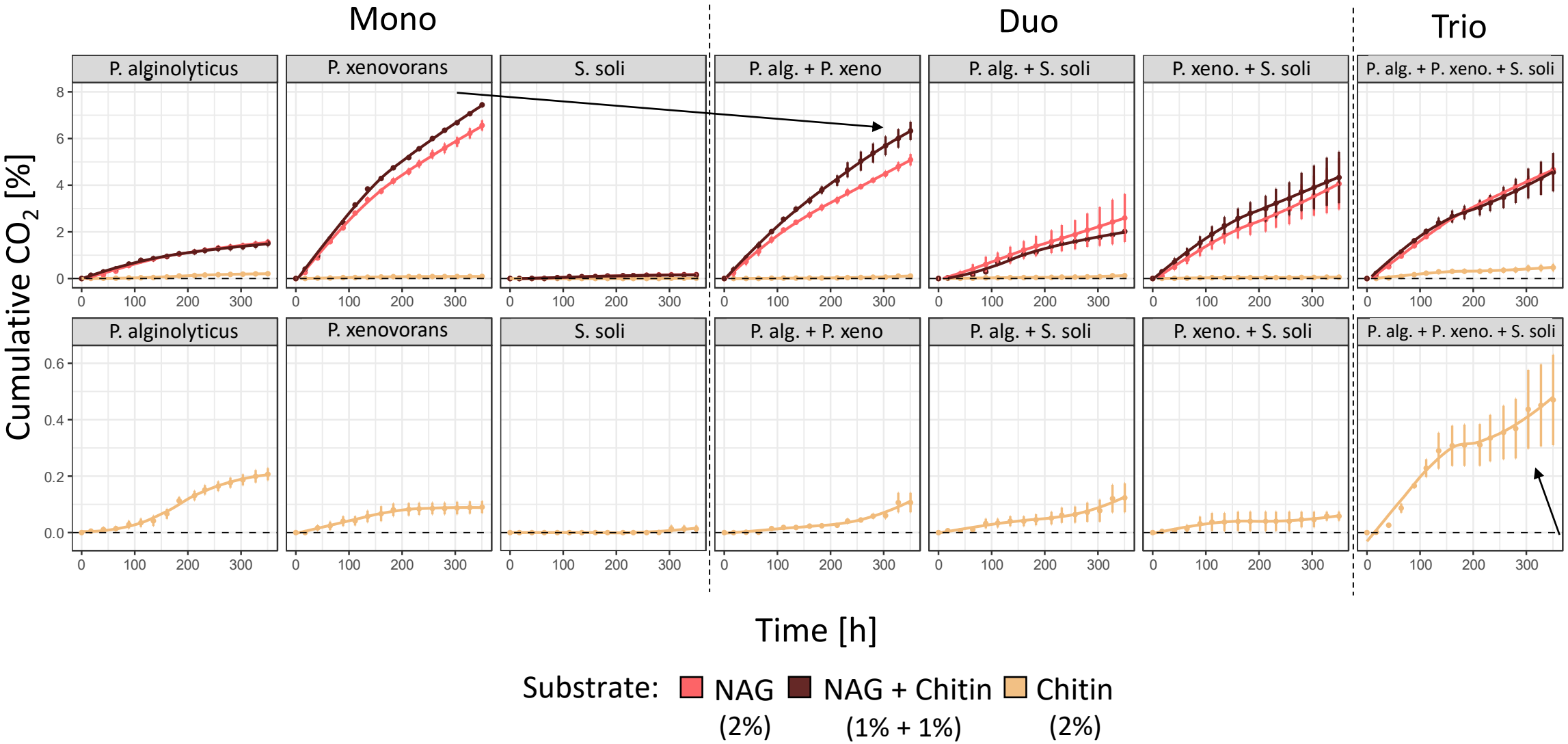
Experimental Setup



MicroResp^{tm} system

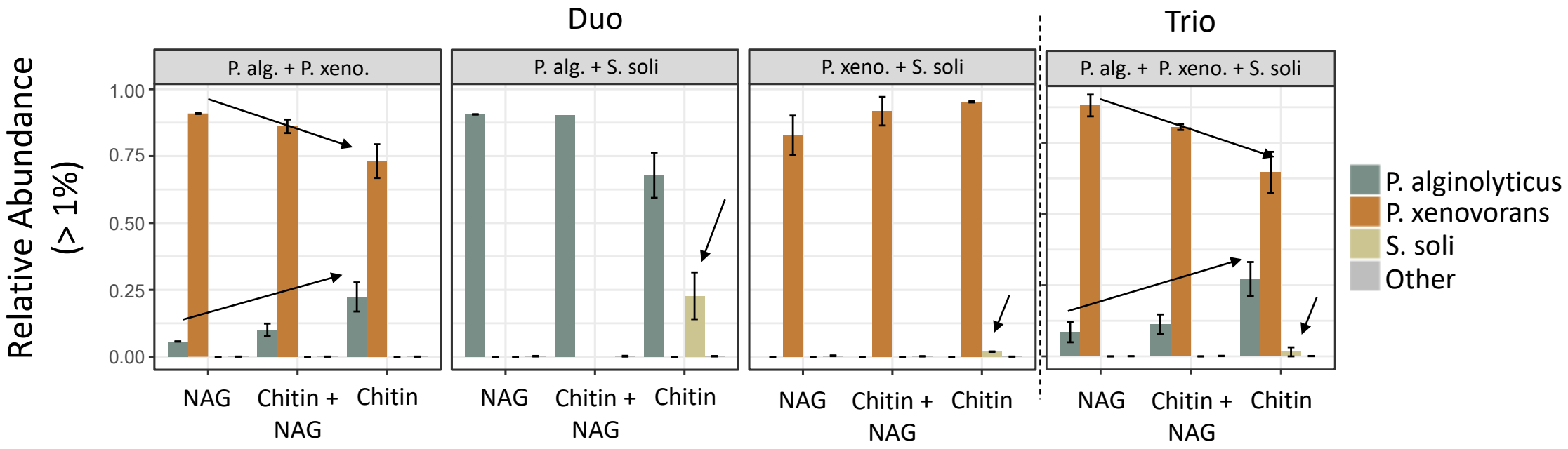
Campbell et al. 2003, Evans et al. 2017

Respiration Data



Final Community Composition

16s Amplicon Sequencing



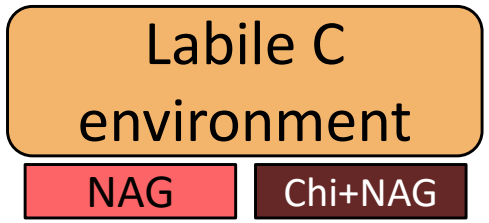
Main Findings

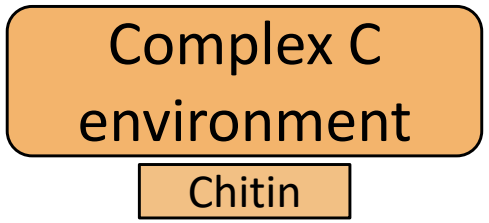
NAG availability affected respiration and final community composition

Signs of both competition and cooperation, depending on substrate conditions

Increased survival of less competitive strains with more complex substrate

Summary & Conclusion





- Strong competitor grows fast on labile substrate and outcompetes the other strains
- No positive interactions possible as weaker competitors are too low in abundance or completely removed

- Weaker competitors (slower growers) are not immediately overpowered
- Stable multispecies community
  - Stabilized by metabolic crossfeeding (data not shown)
- More efficient chitin decomposition
  - Production of different chitinases?

Low availability of labile substrate increased survival of less competitive strains, allowing positive interactions and affecting the decomposition of complex SOM

Thank you!

Margarete Watzka

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Christina Kaiser

Julia Mor Galvez

Lauren Alteio

somSOM

Joana Séneca

Petra Pjevac

Márton Palatinszky

DOME/JMF

Summary & Conclusion

Labile C environment

NAG | Chi+NAG

- Strong competitor grows fast on labile substrate and outcompetes the other strains
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Complex C environment

Chitin

- Weaker competitors (slower growers) are not immediately overpowered
- Stable multispecies community
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Contact me!

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References

Images:

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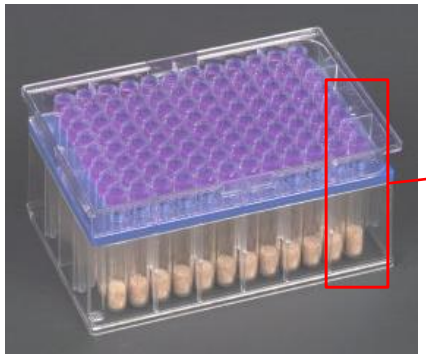
Supplementary Slides

Experimental Setup - MicroResp



Cumulative Respiration

Indicator Plate

Rubber Seal

Deepwell Plate

380 µl Substrate + 120 µl culture

M9 Minimal Media

N-Acetylglucosamine (2%)

NAG + Colloidal Chitin (1% + 1%)

Colloidal Chitin (2%)

4 Substrates

Mono

1 strain

Duo

2 strains

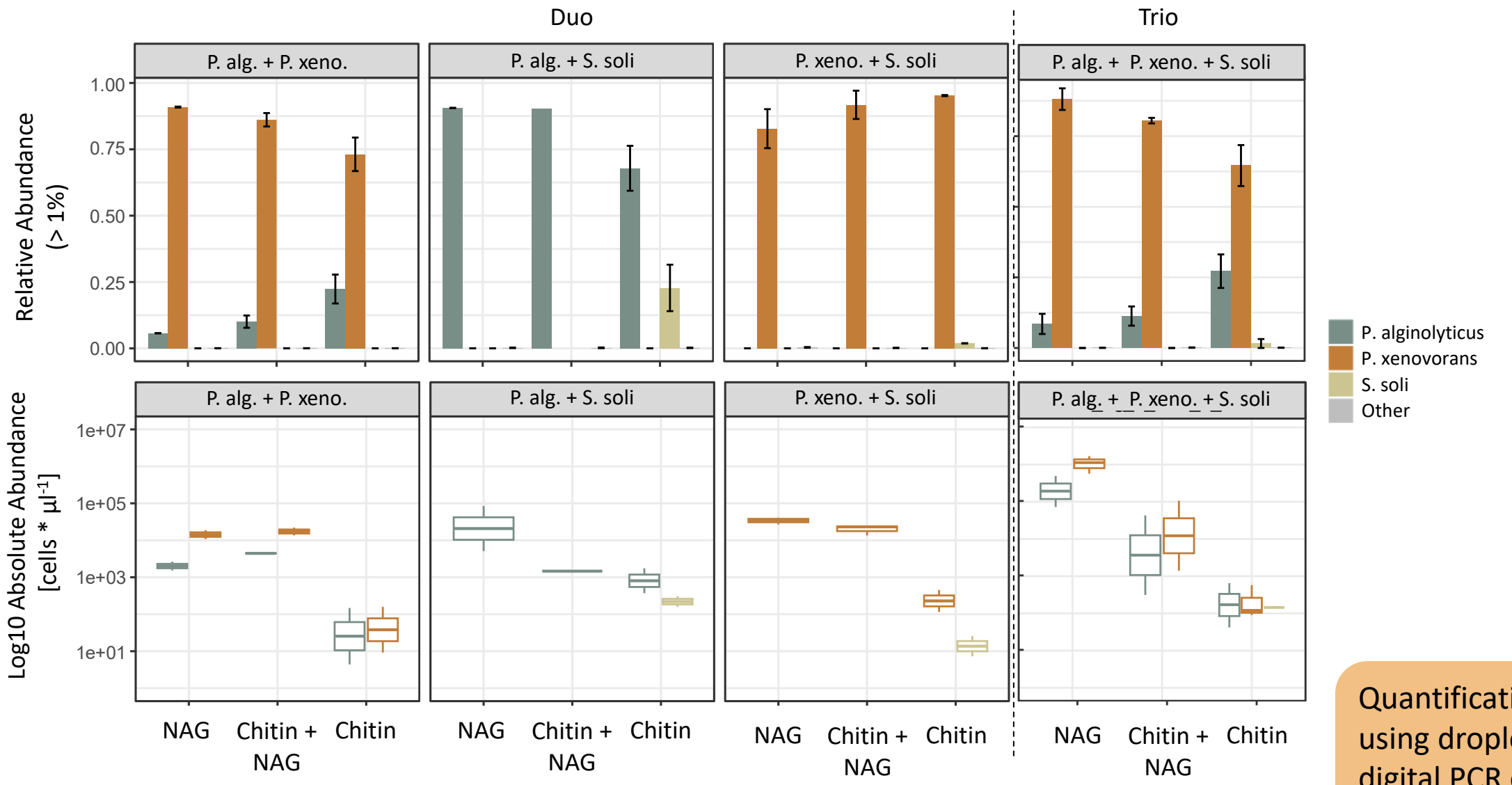
Trio

3 strains

3 Biodiversity Treatments

Campbell et al. 2003, Evans et al. 2017

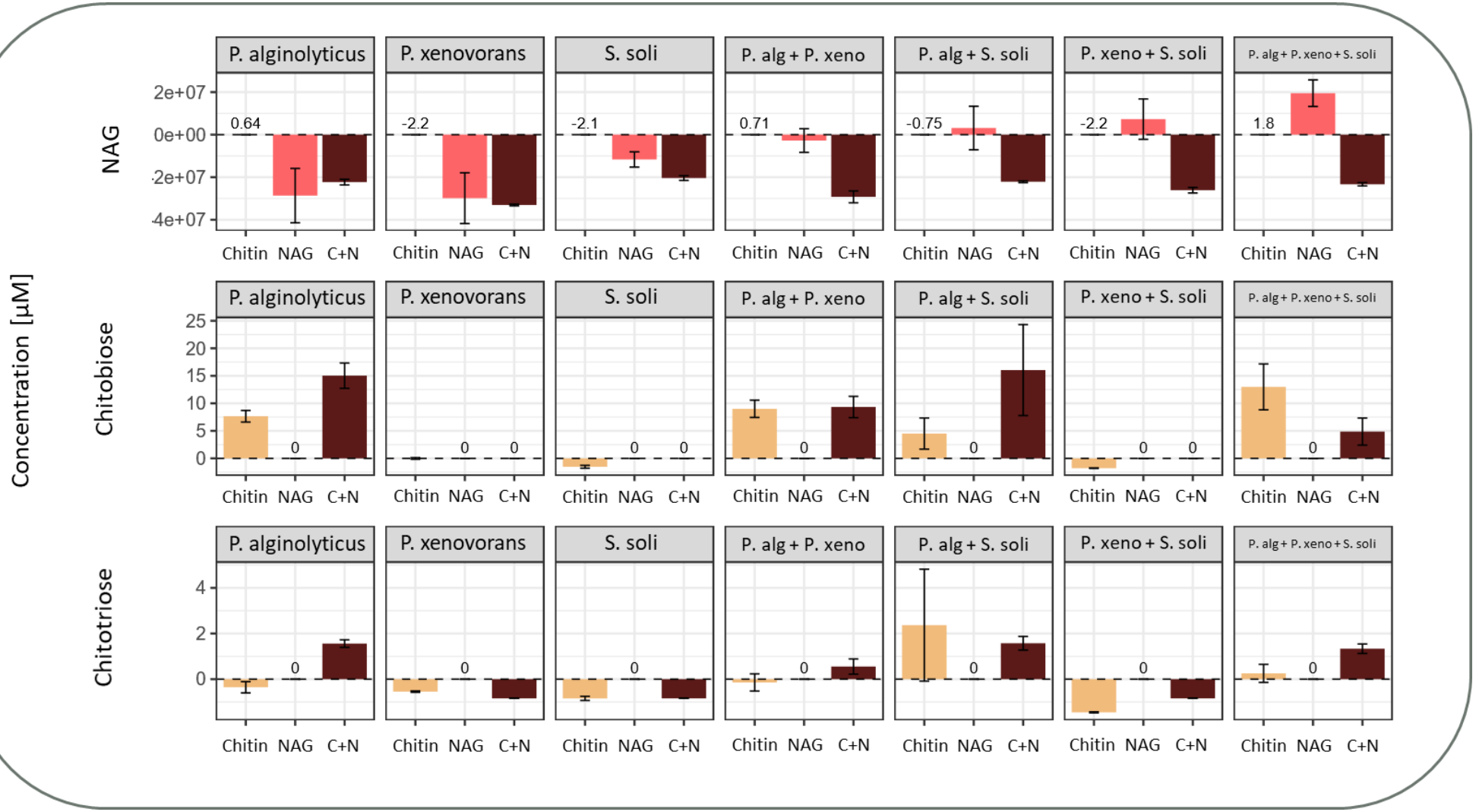
Final Community Composition



Absolute abundance followed similar patterns as respiration

Quantification using droplet digital PCR of the 16s region

Chitin Oligomers (UPLC-MS)



Highest Chitobisoe concentration in Trio-treatment

Metabolites (HPLC)

Acetate

Succinate

Butyrate

Formate

Produced metabolites not accumulating in Trio-treatment