

# **EVOLUTION OF MICROBIAL COMMUNITIES IN AEROBIC GRANULAR SLUDGE DURING CHANGES OF THE WASTEWATER COMPOSITION**

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SWISS NATIONAL SCIENCE FOUNDATION



ÉCOLE POLYTECHNIQUE  
FÉDÉRALE DE LAUSANNE

# Microbial processes for wastewater treatment

## Activated sludge

- Conventional microbial process in wastewater treatment plants
- Flocular structures, settle slowly



After 1  
minute  
settling

## Aerobic granular sludge

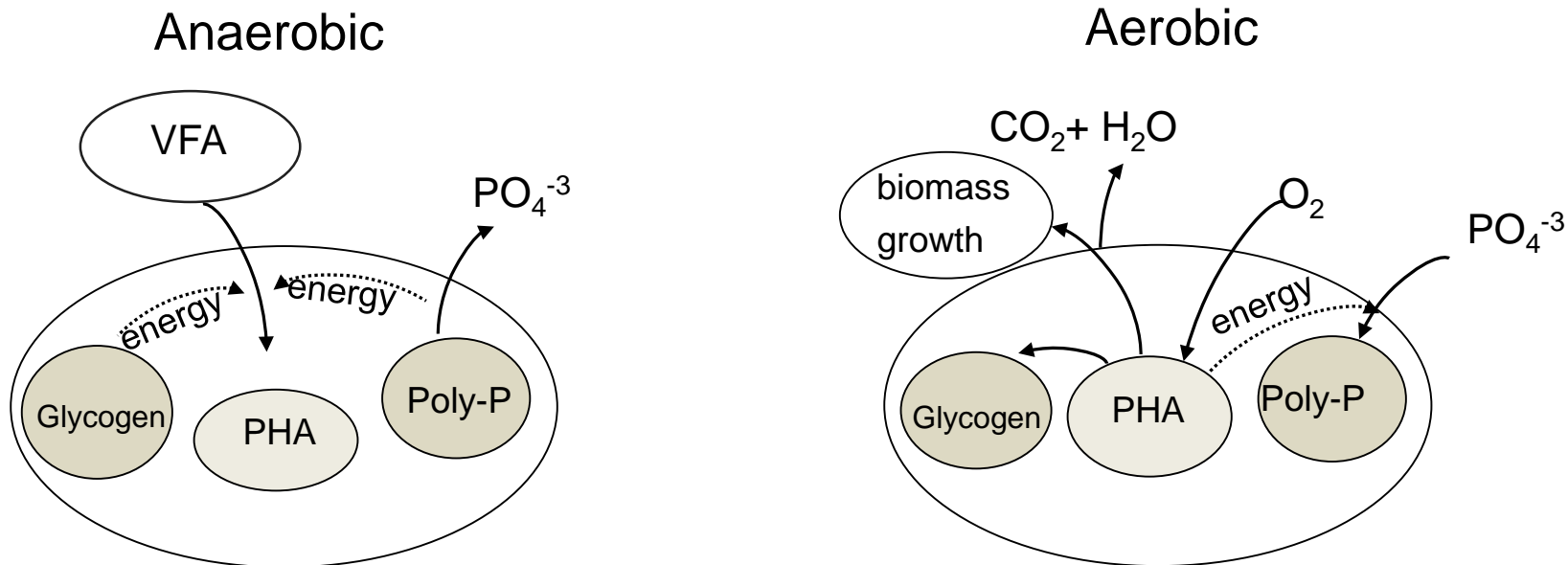
- Granular structures, settle fast
  - Allows high sludge concentration
  - Suited for biological phosphorus removal
    - > chemicals saving
- Space and time saving



# Phosphate accumulating organisms (PAO)

PAO model organism

*Accumulibacter*

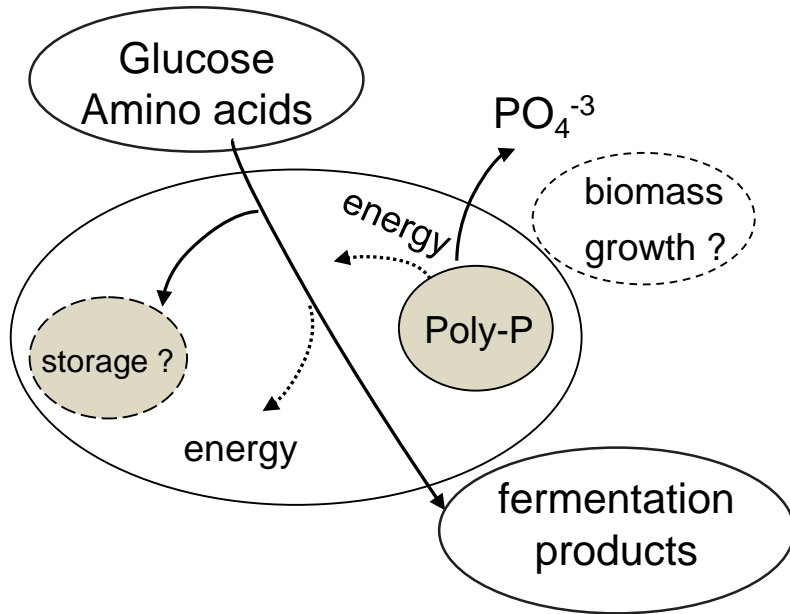


# Phosphate accumulating organisms (PAO)

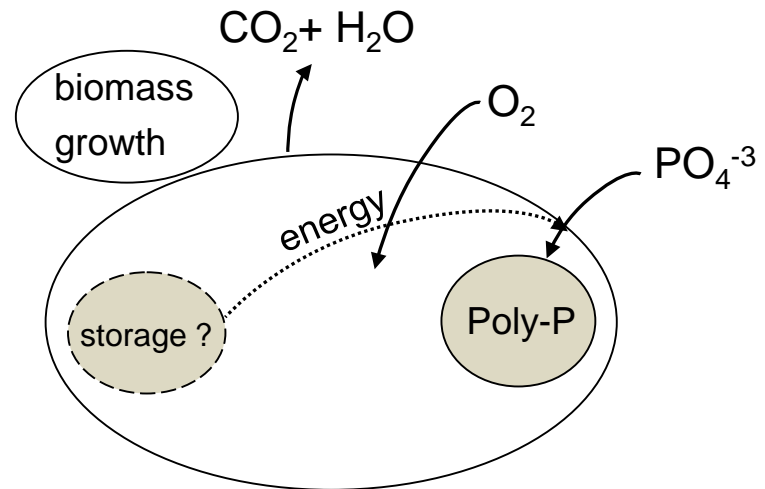
## Fermentative PAO

*Tetrasphaera*

Anaerobic

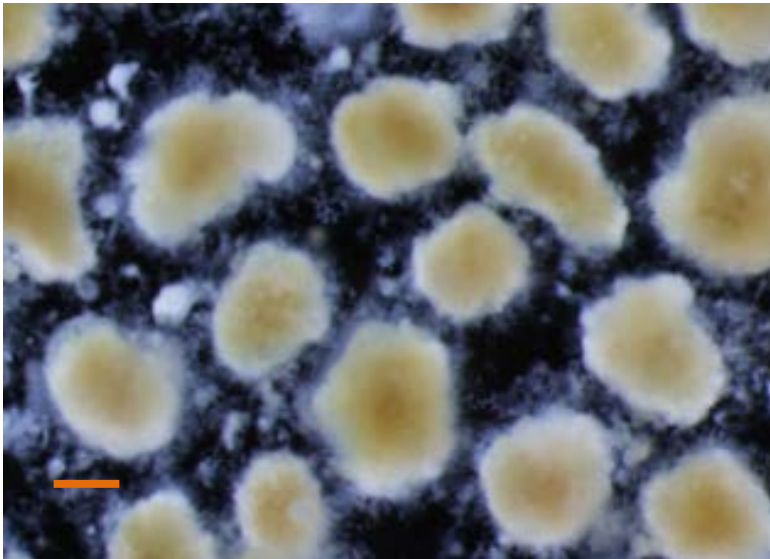


Aerobic

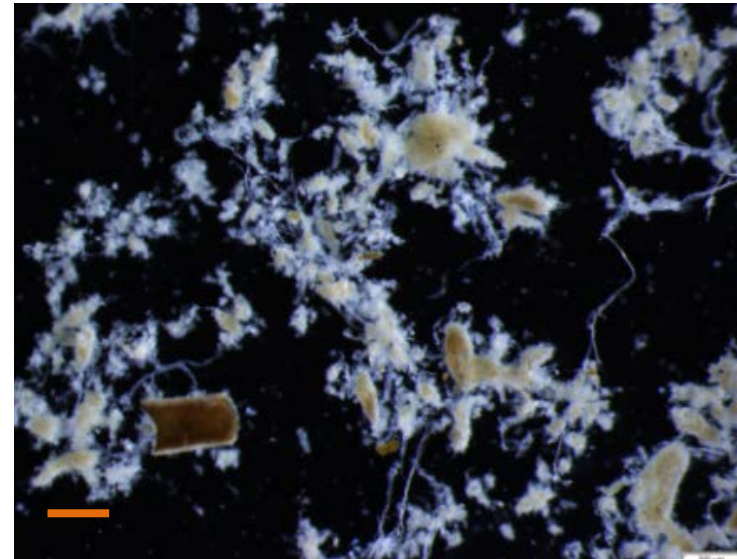


# Aerobic granular sludge (AGS) for wastewater treatment

AGS fed with simple synthetic wastewater ...



... and with raw municipal wastewater

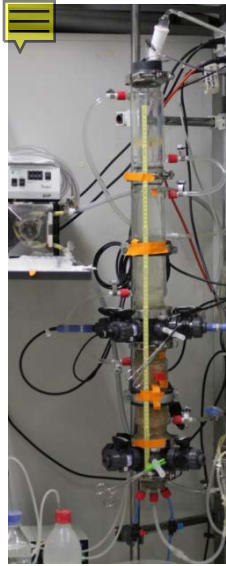


— 500 $\mu$ m

Eawag- LTE

- Are **fermentable** or **polymeric** compounds responsible for this difference ?
- How do they impact - the settling characteristics,
  - the nutrient removal,
  - the microbial communities of the AGS?

# Progressive changes of the wastewater composition in two lab-scale reactors



lab-scale reactor

1 reactor ← 2 reactors → 1 reactor

Transition to  
**simple  
monomeric  
wastewater**

AGS fed with  
**complex  
monomeric  
wastewater**

Transition to  
**complex  
polymeric  
wastewater**

**VFA**

**VFA, glucose,  
amino acids**

**VFA, glucose,  
amino acids,  
starch, peptone**

Introduction

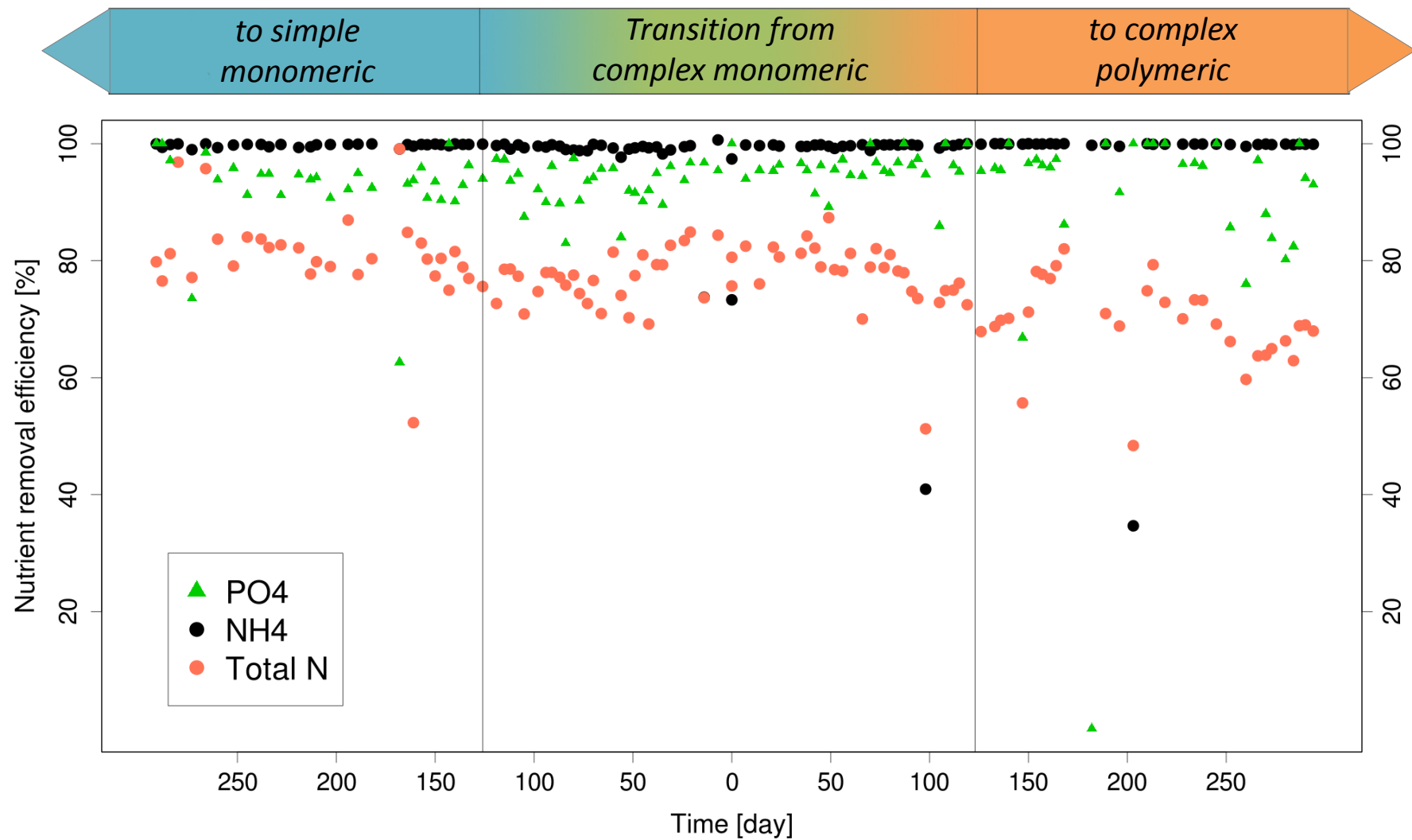
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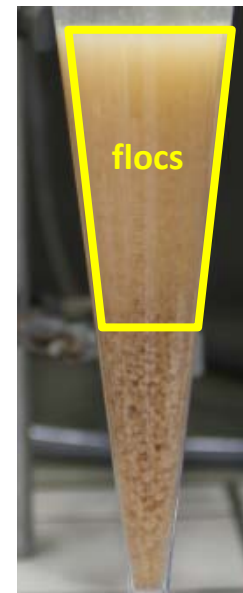
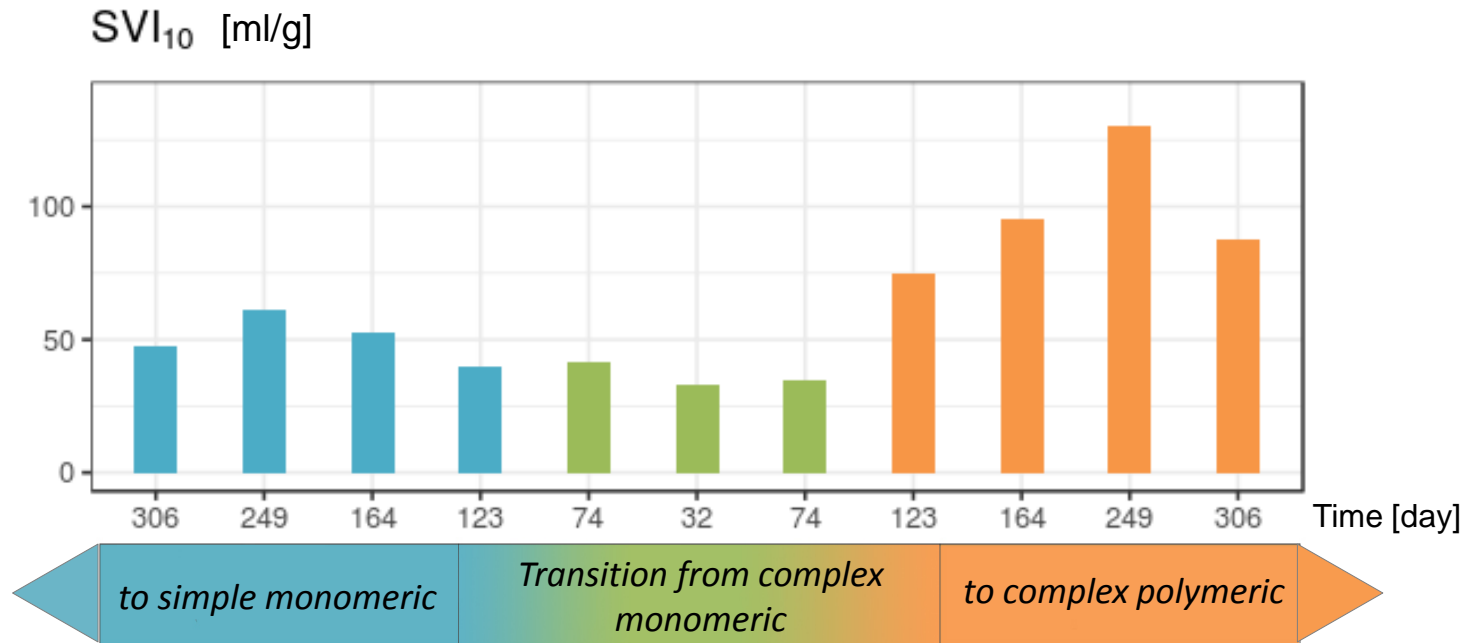
Conclusion

# Evolution of nutrient removal efficiency



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# Evolution of the settling properties



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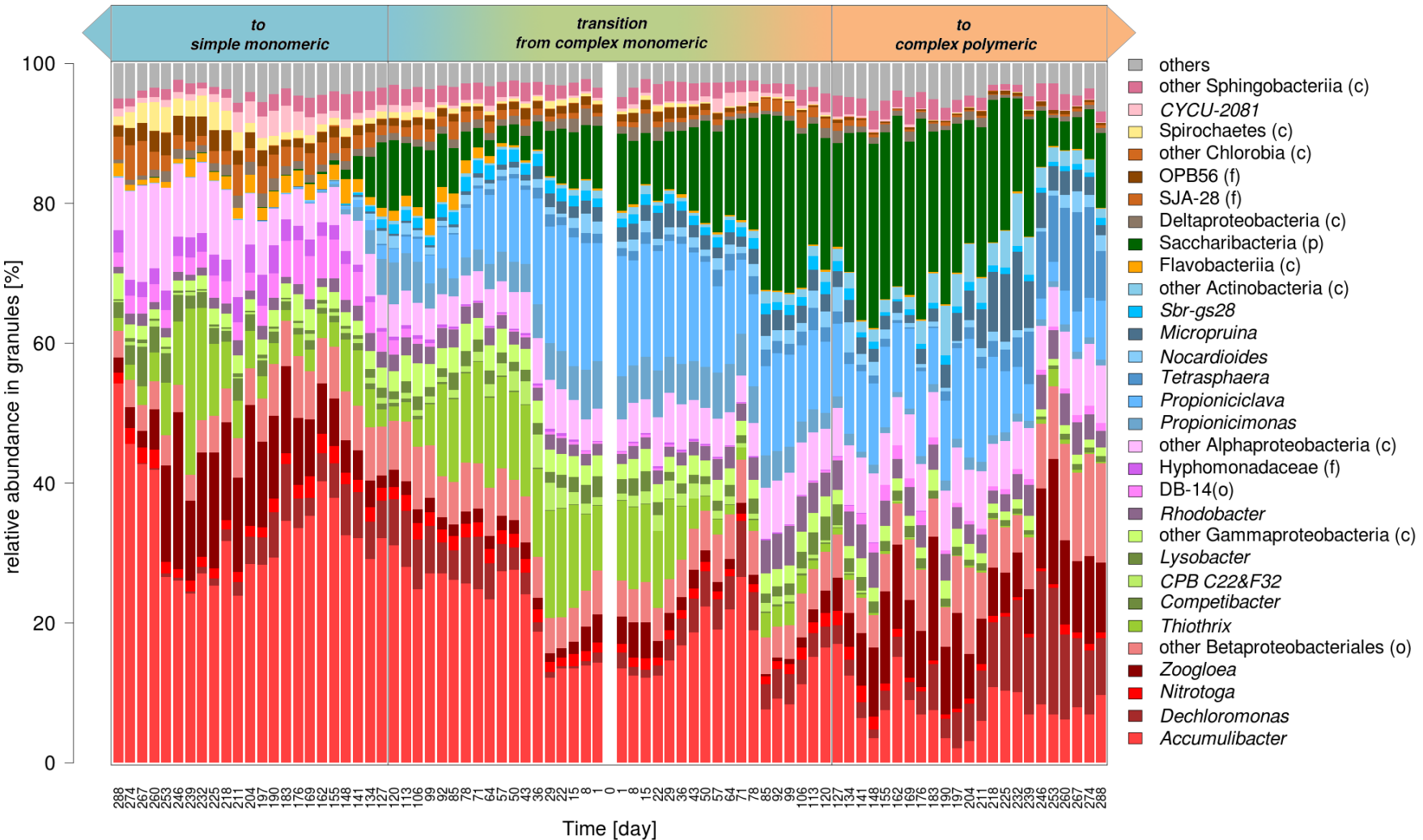
Conclusion



# Evolution of the structure of the bacterial communities



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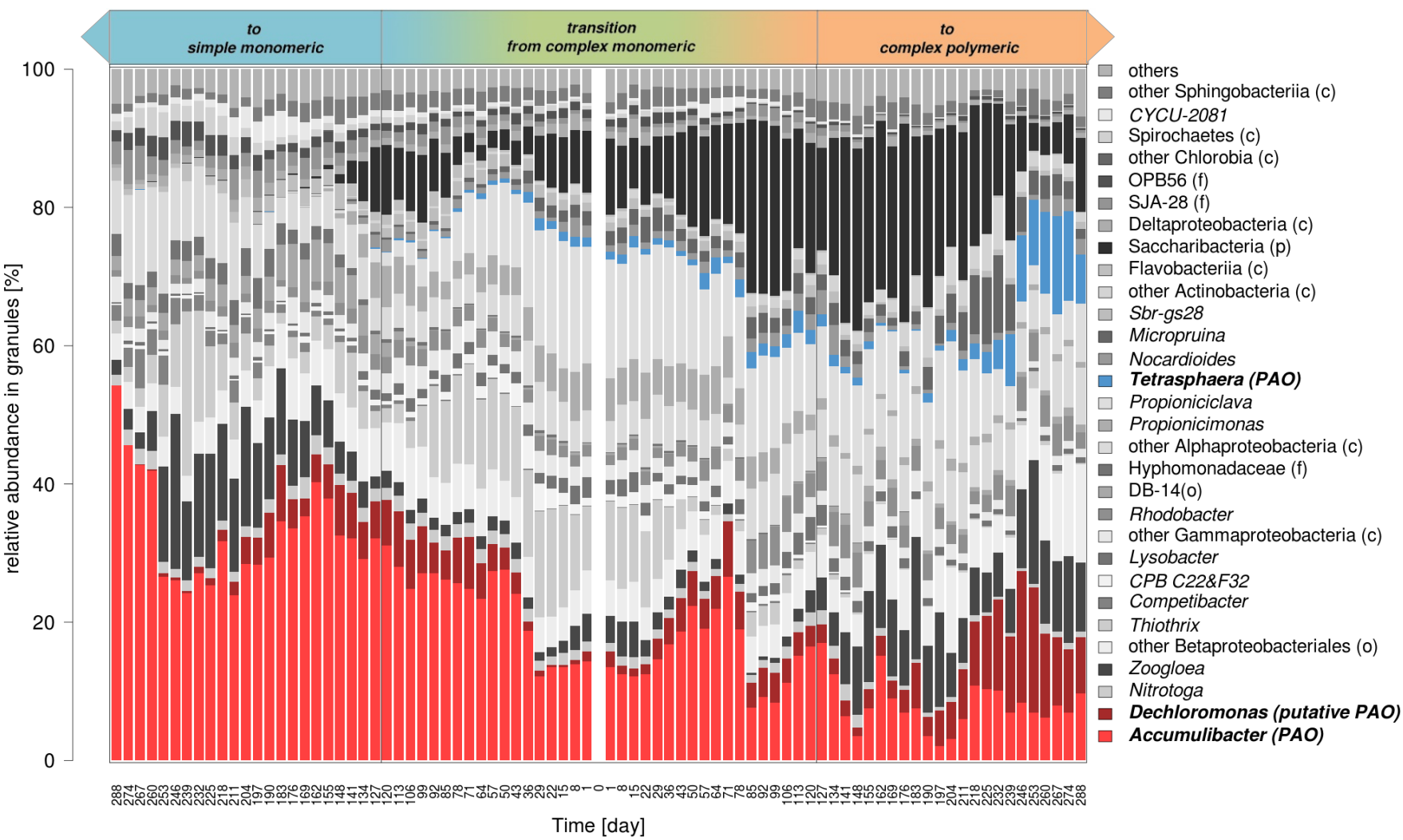


# phosphate accumulating organisms (PAO)

Accumulibacter

Tetrasphaera

Accumulibacter



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# fermenting bacteria



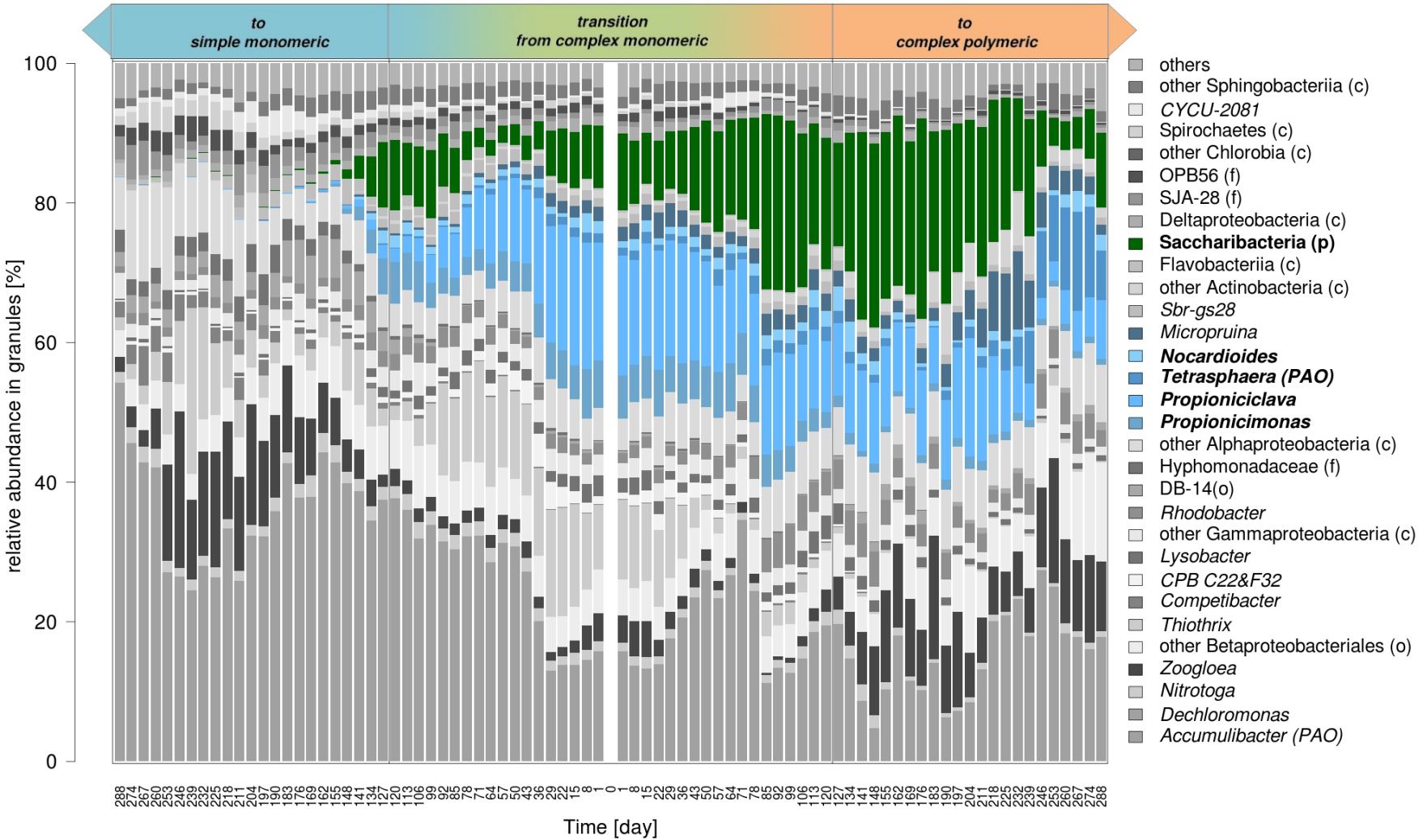
Introduction

Objectives

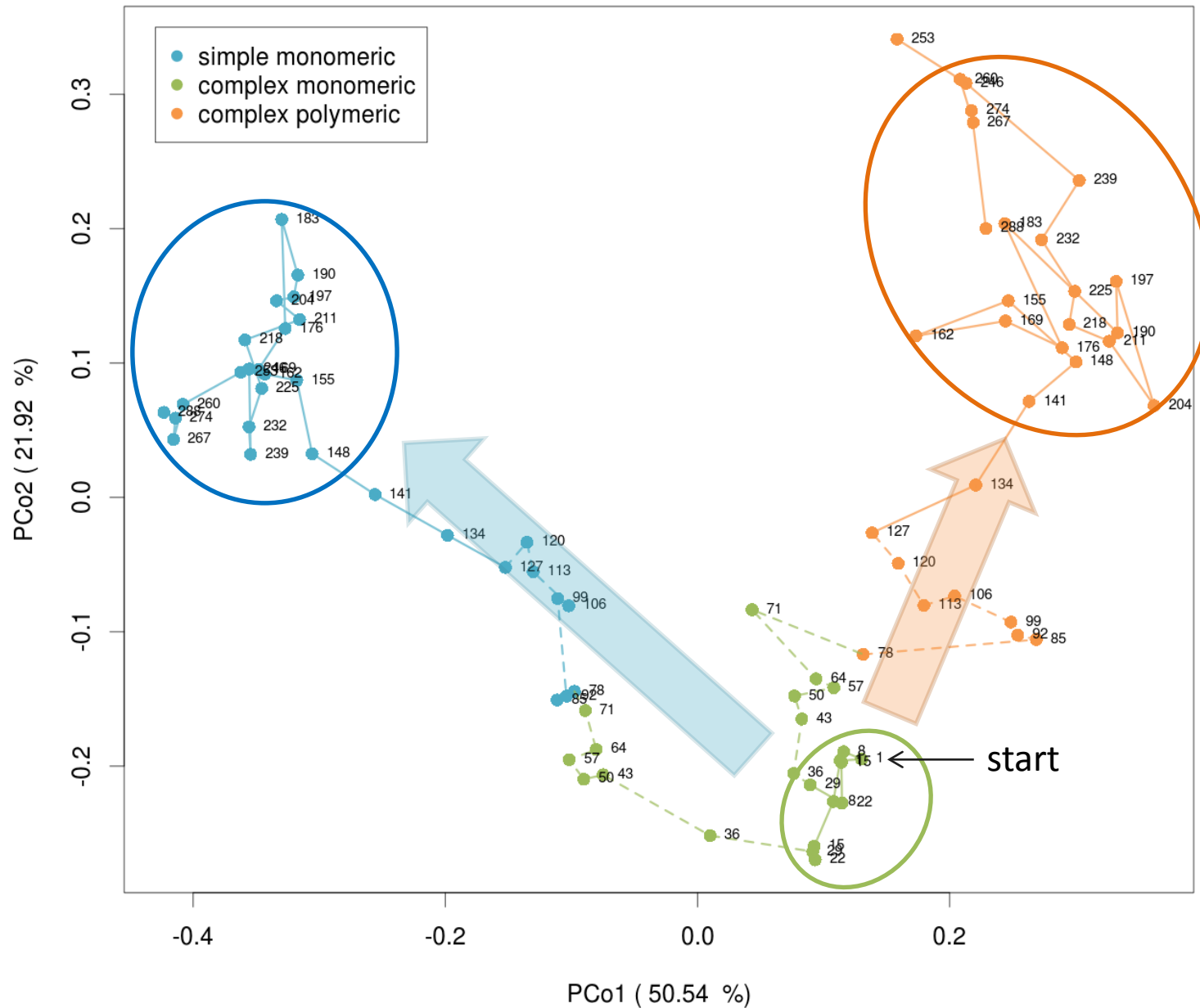
Method

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# Overall evolution of the microbial communities



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# Conclusions

- The AGS settleability and the nutrient removal performances were good with the simple and the complex monomeric wastewaters.
- With the introduction of polymeric compounds, a significant proportion of flocs appeared and the N-removal decreased.
- Accumulibacter was the predominant PAO with the simple wastewater. With the fermentable and polymeric compounds, the guild of PAO was more diverse.

# Acknowledgments

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## DPE - Eawag

Manuel Layer

Nicolas Derlon

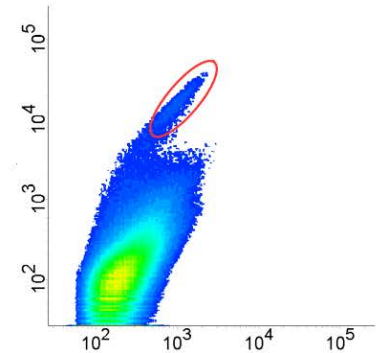
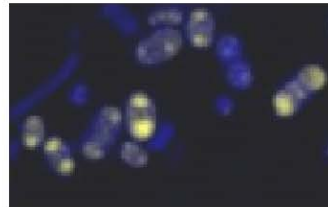
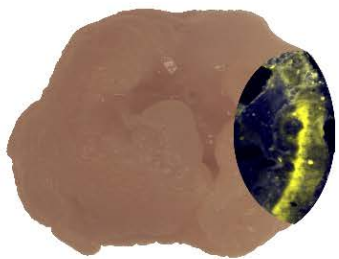
Eberhard Morgenroth



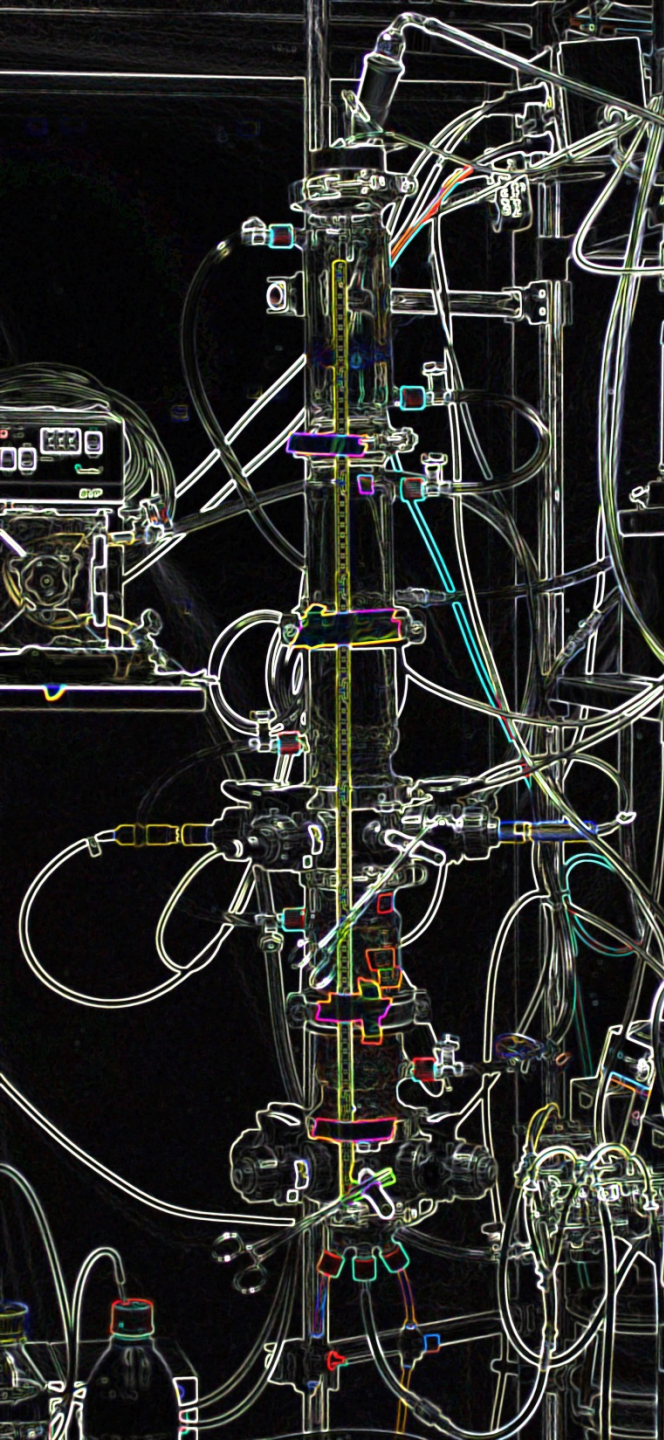
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Arnaud Gelb

Identification of microorganisms in aerobic granular sludge actively involved in biological phosphorus removal



Poster n°51



Thank you for your  
attention !



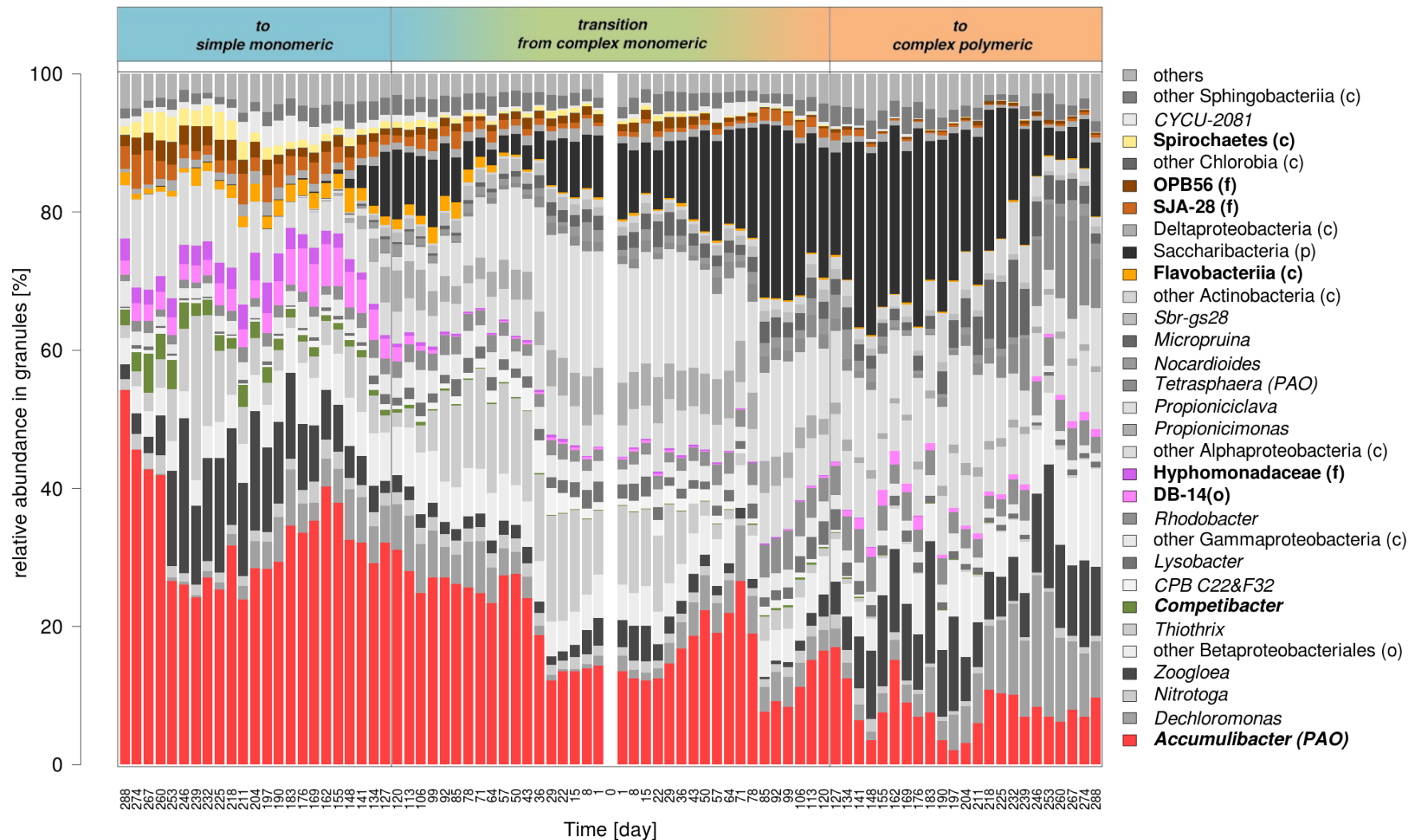
# Synthetic wastewater compositions

<i>Medium</i>	<i>COD [mgO<sub>2</sub>/L]</i>	<i>VFA</i>	<i>Glucose and amino acids</i>	<i>Starch and peptones</i>
<b>Simple monomeric</b>	450	100 %	-	-
<b>Complex monomeric</b>	600	33 %	66 %	-
<b>Complex polymeric</b>	600	33 %	33 %	33 %

**Phosphorus : 22 [mg/L]**

**Nitrogen : 56 [mg/L]**

# Some taxa are found in higher abundance with the simple wastewater



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# Some taxa are found in higher abundance with the complex wastewater



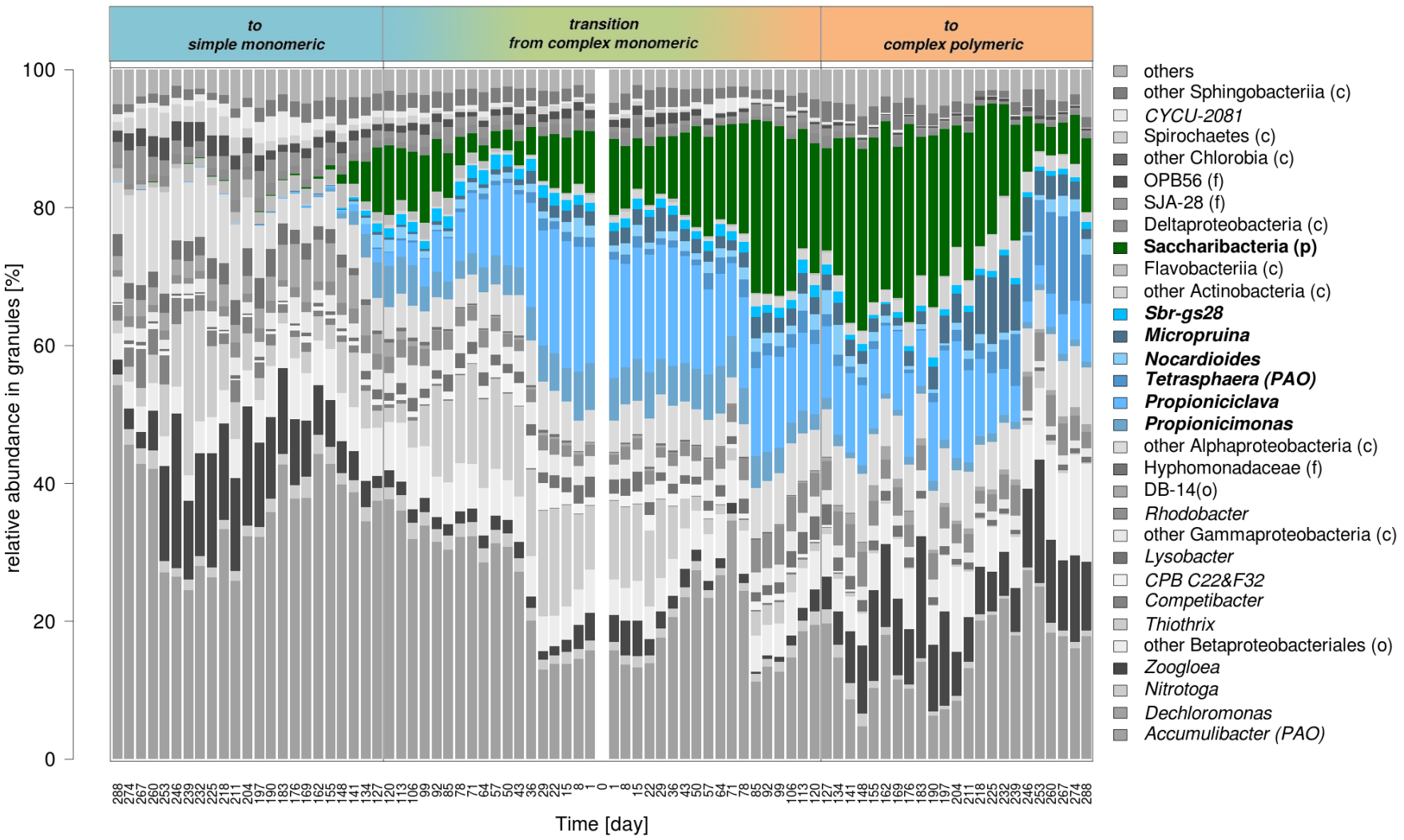
Introduction

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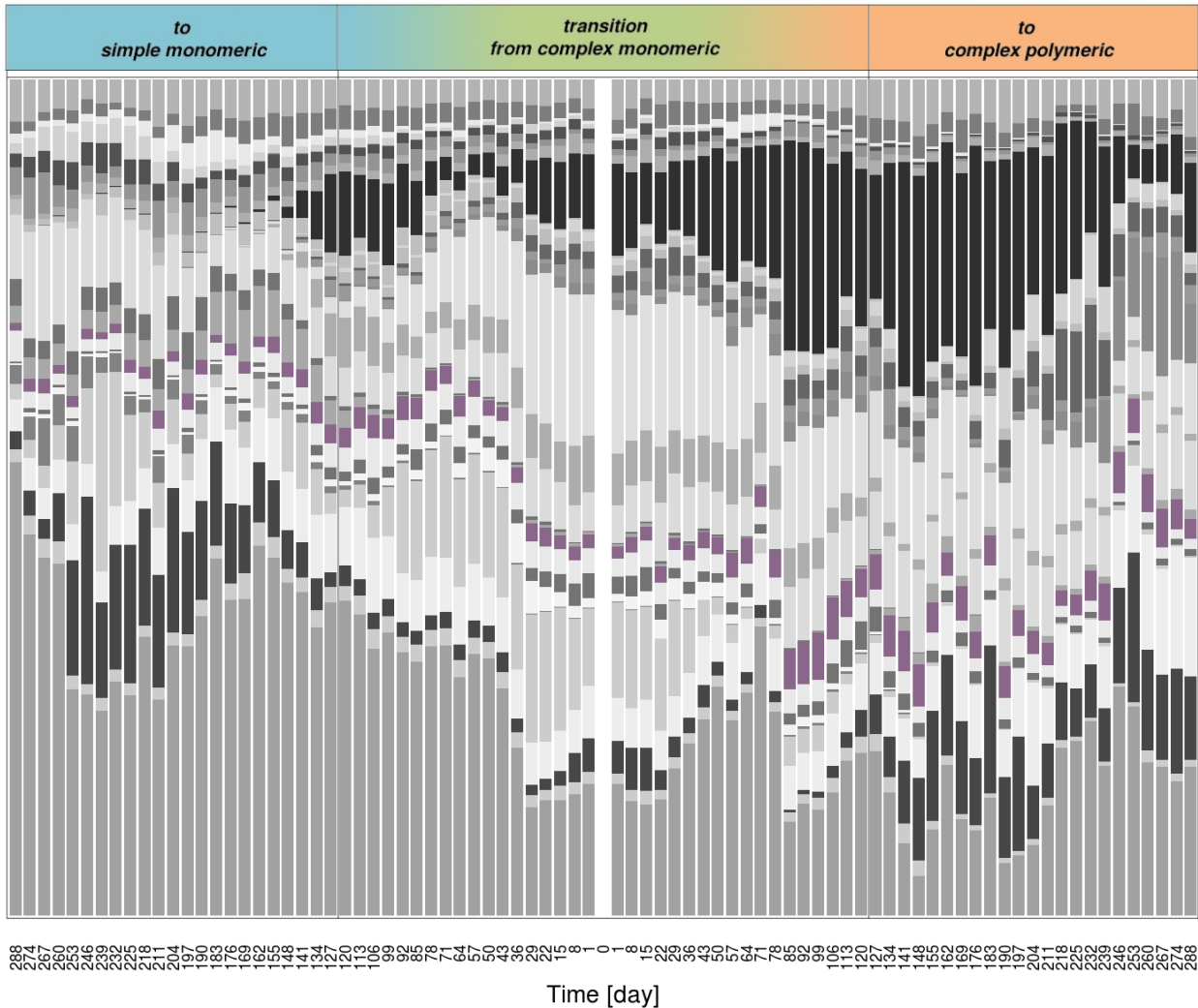
**Results**

Conclusion



# Rhodobacter was found in higher abundance with the polymeric wastewater

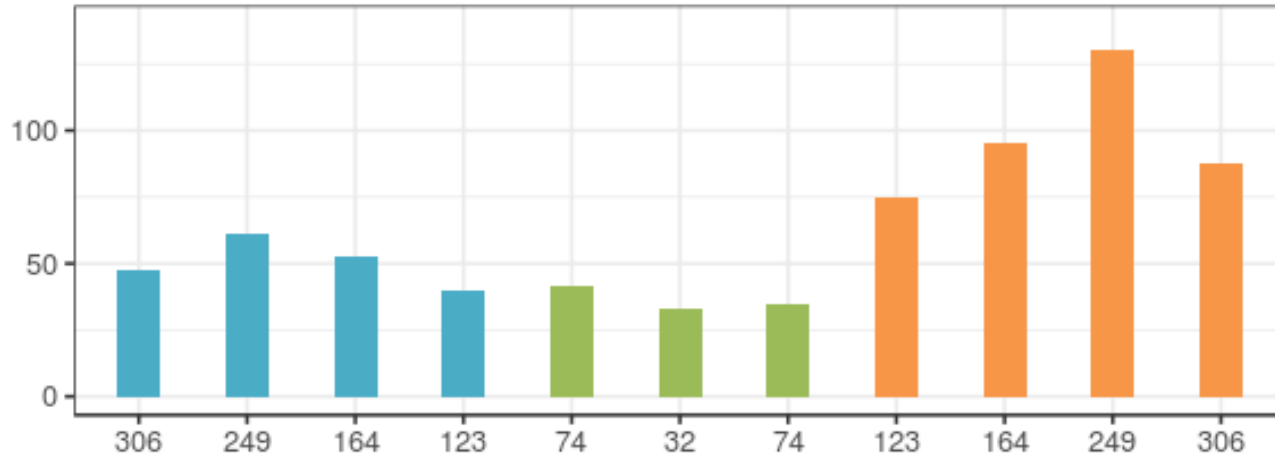
relative abundance in granules [%]



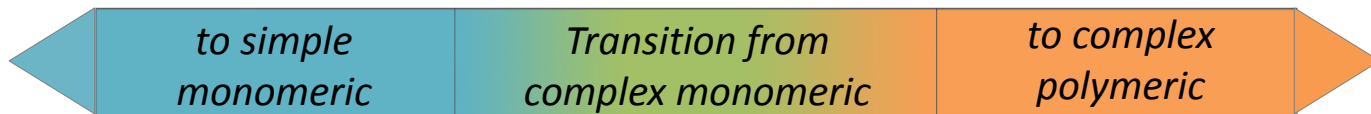
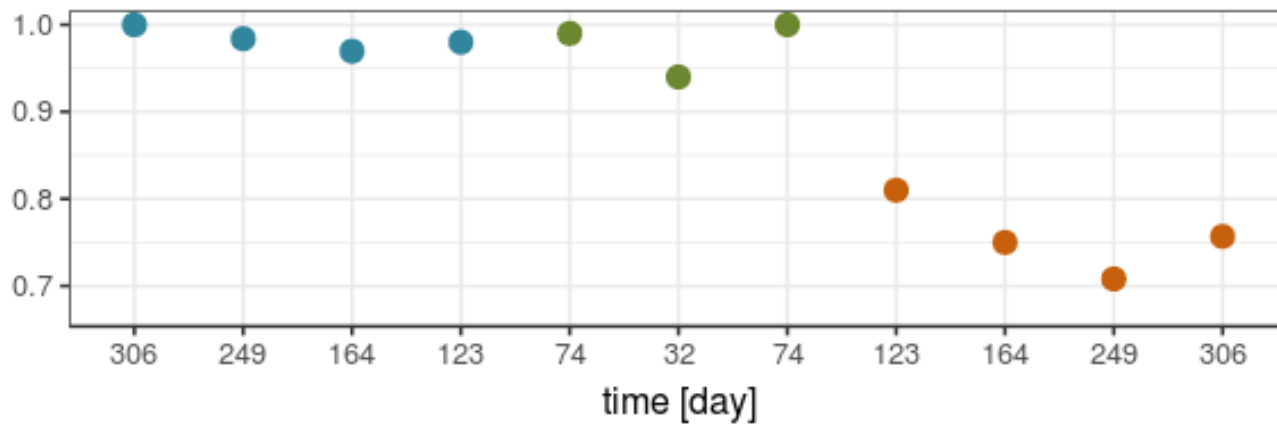
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# Sludge volume index (SVI)

SVI<sub>10</sub> [ml/g]



ratio SVI<sub>10</sub>/SVI<sub>30</sub>



Introduction

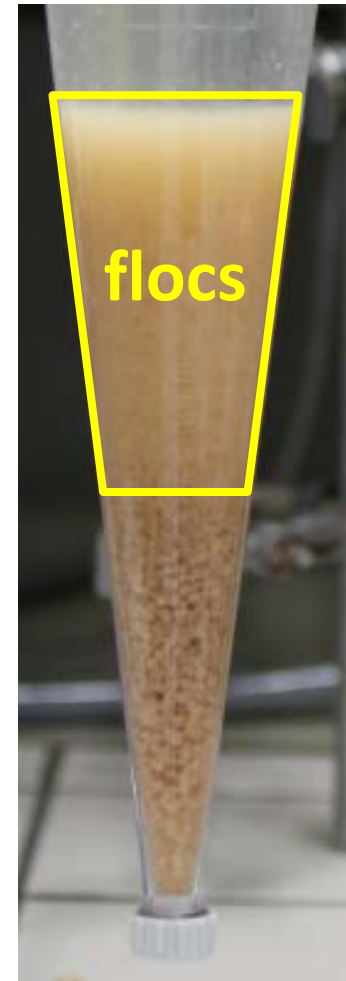
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# Evolution of the settling capability of the AGS



Transition to **simple monomeric**

**Complex monomeric**

Transition to **complex polymeric**

Introduction

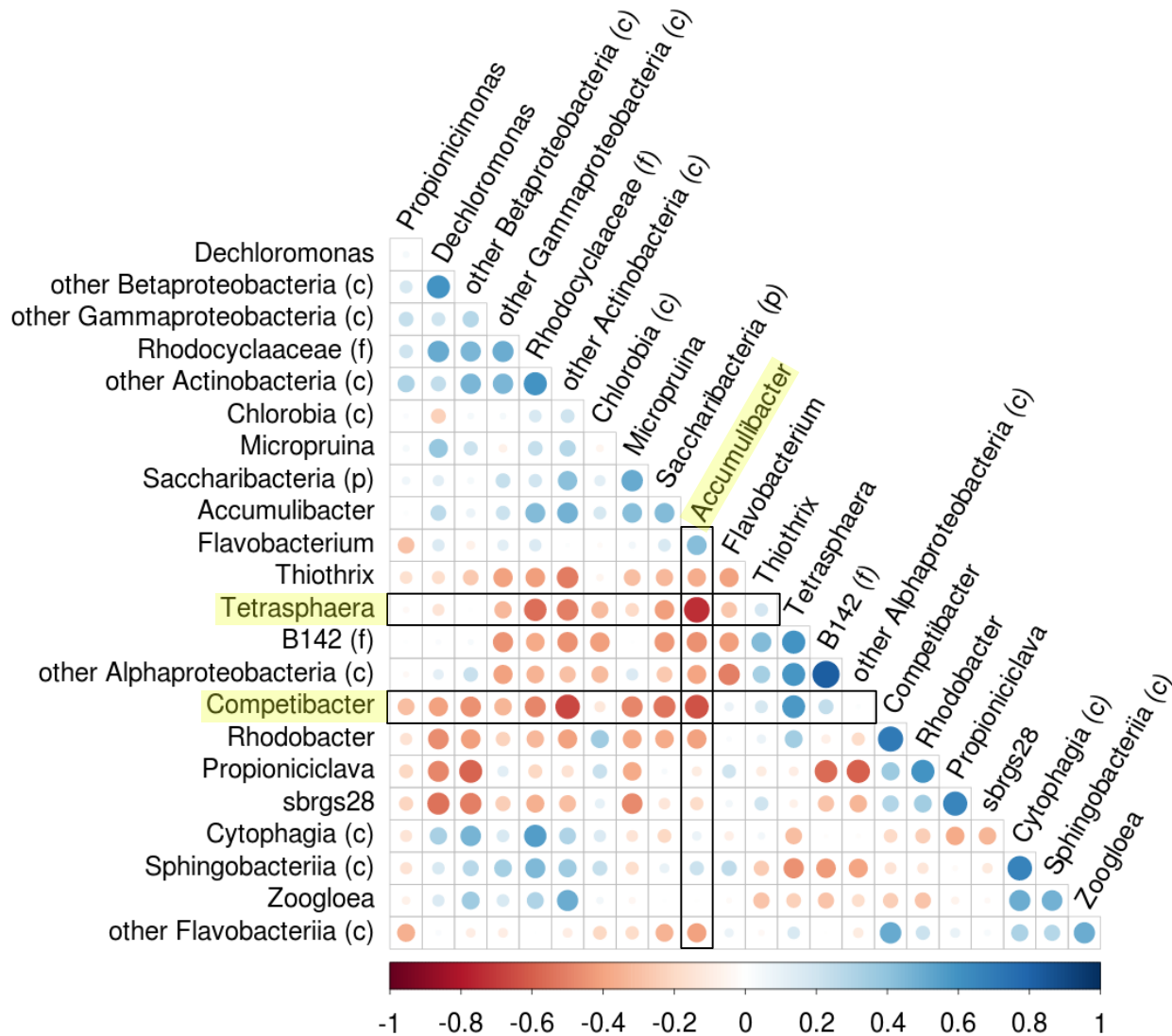
Objectives

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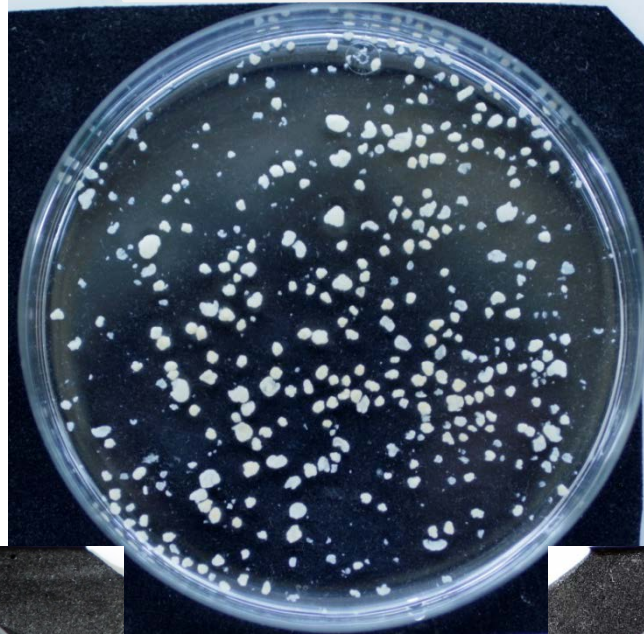
**Results**

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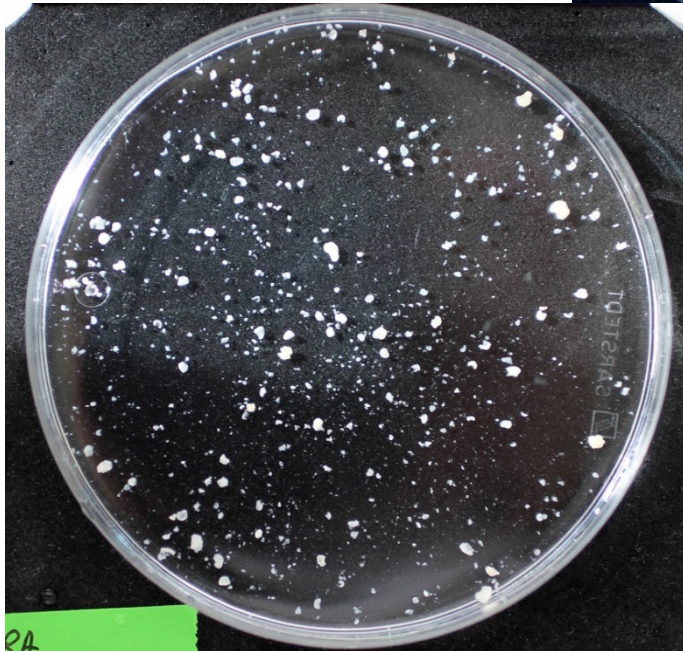
# Correlation between the relative abundance of main taxa with complex monomeric wastewater



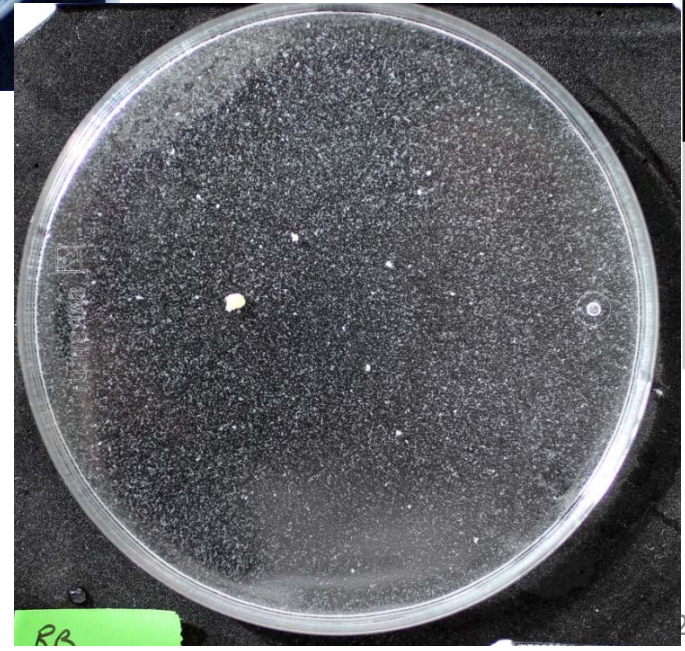
Complex  
monomeric



Simple  
monomeric



Complex  
polymeric



Introduction

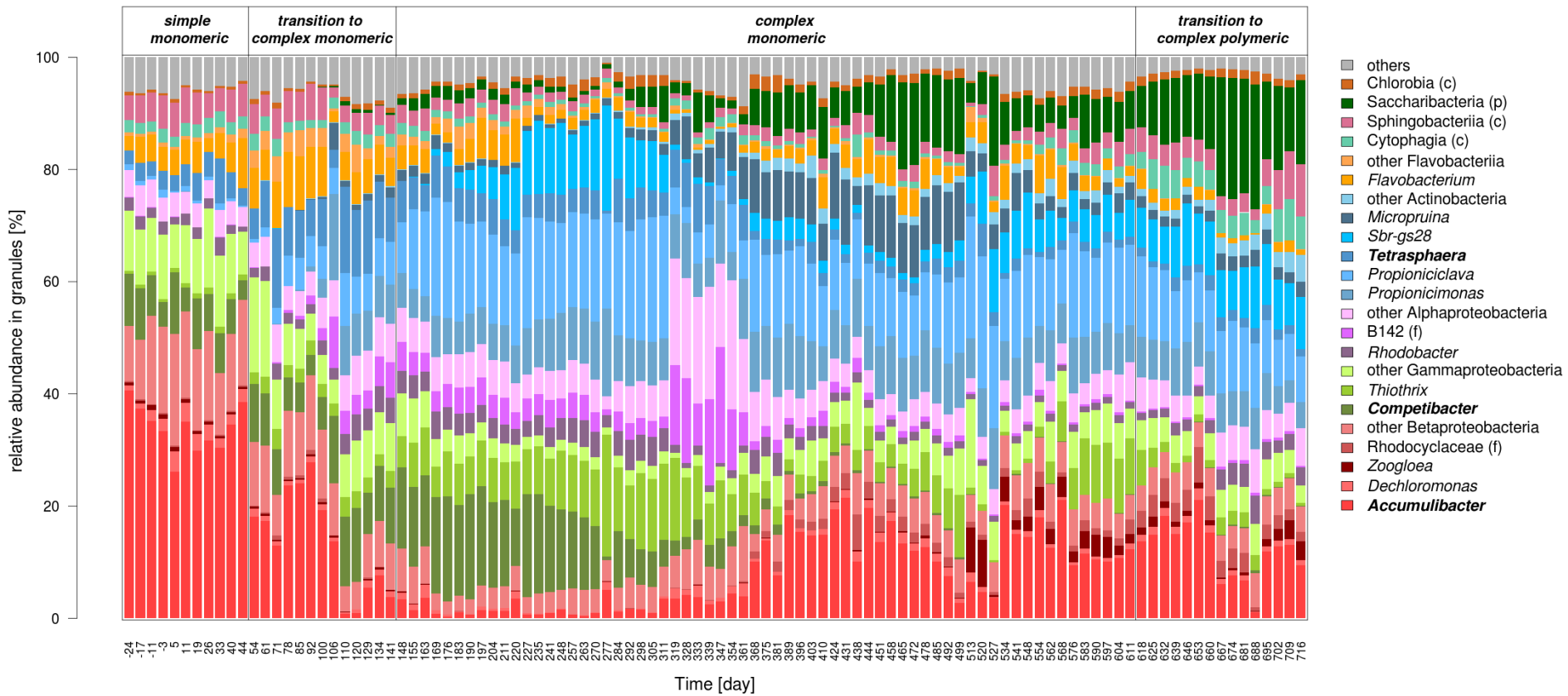
Objectives

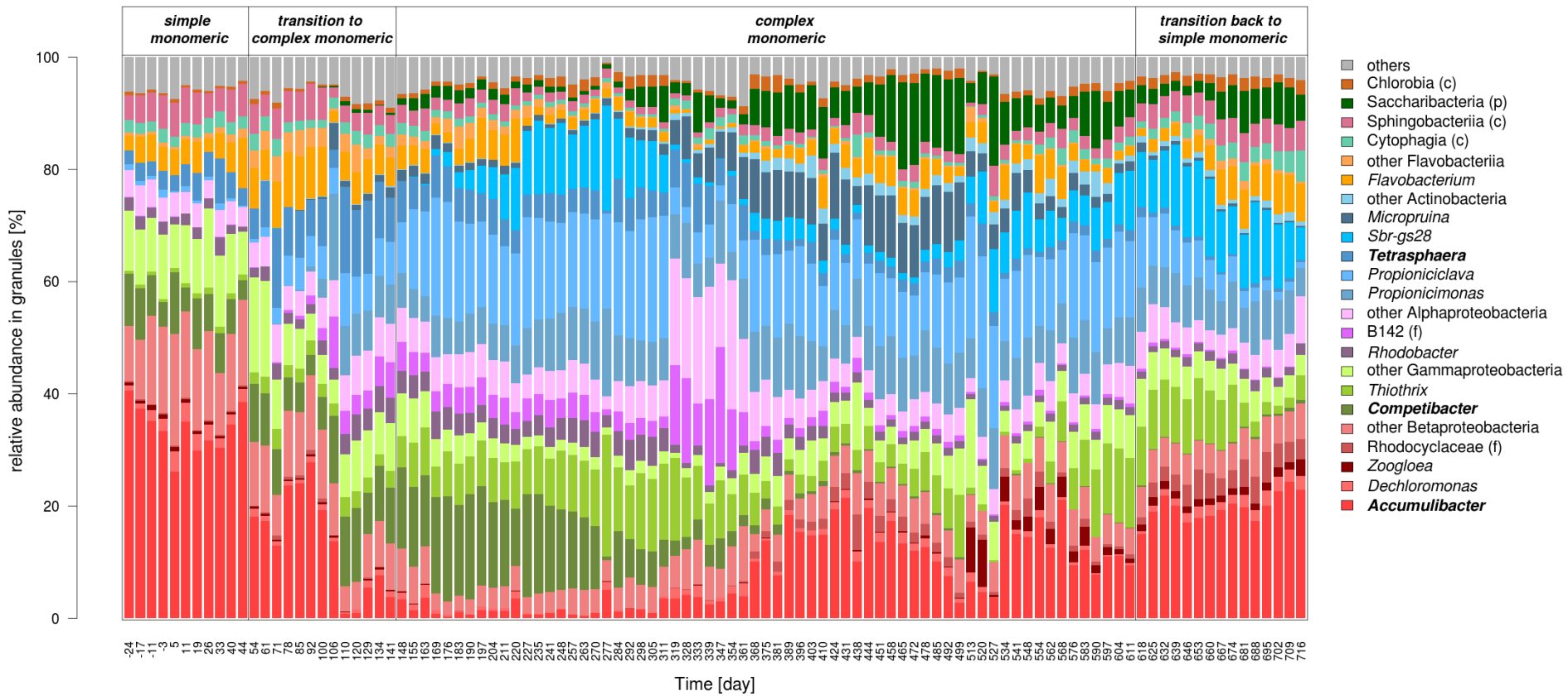
Method

Results

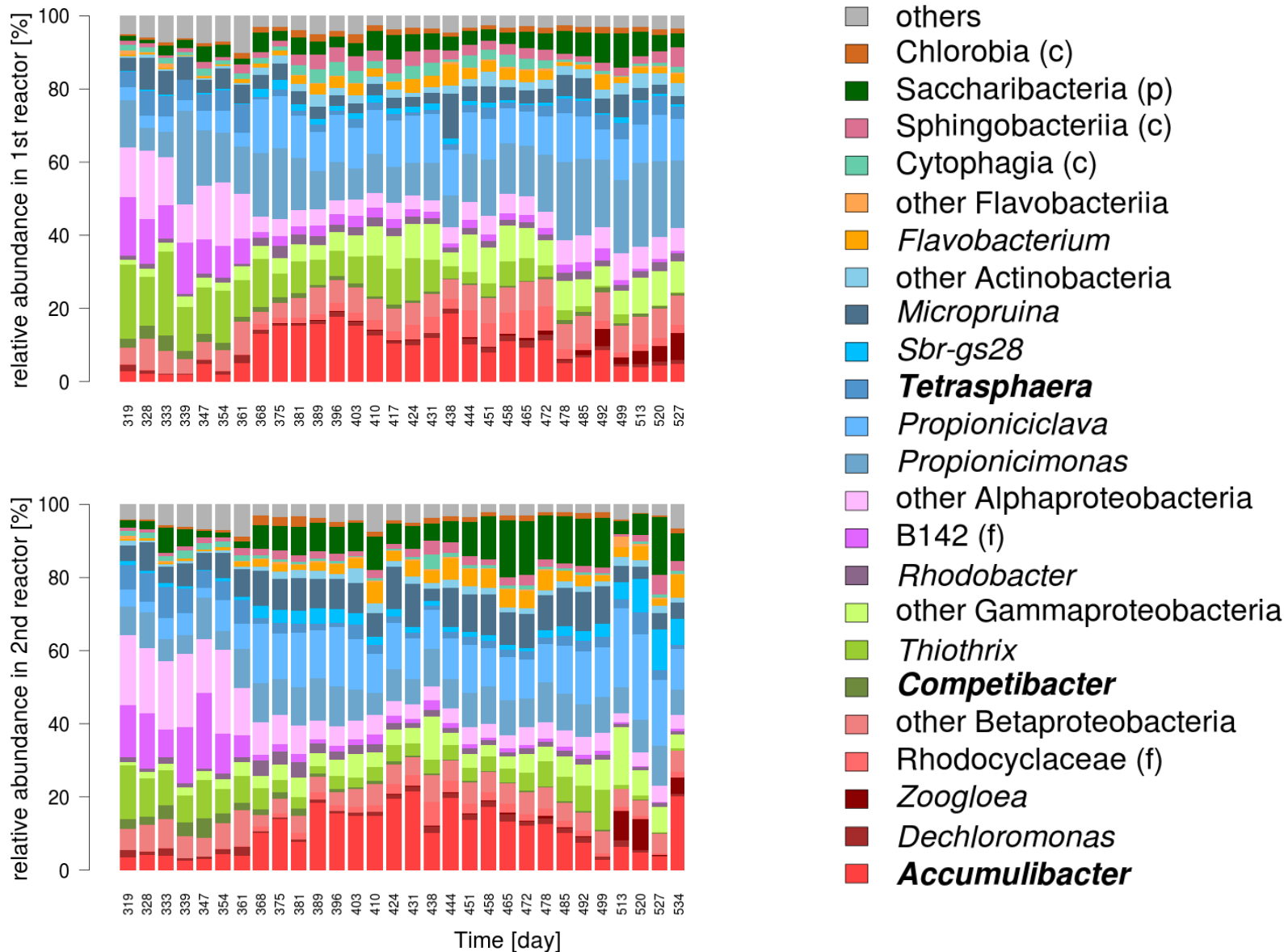
Conclusion







# Microbial communities evolution in two reactor fed with complex monomeric wastewater



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