Evolution of Microbial Communities in Aerobic Granular Sludge During Changes of the Wastewater Composition

Aline Adler, Valérie Berclaz,

Marie Horisberger, Julien Maillard and Christof Holliger

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

  Space and time saving

- Suited for biological phosphorus removal
  - > chemicals saving

Phosphate accumulating organisms (PAO)

PAO model organism   *Accumulibacter*

Anaerobic

VFA

PO_4^{-3}

energy

energy

Glycogen

PHA

Poly-P

Aerobic

$CO_2 + H_2O$

biomass growth

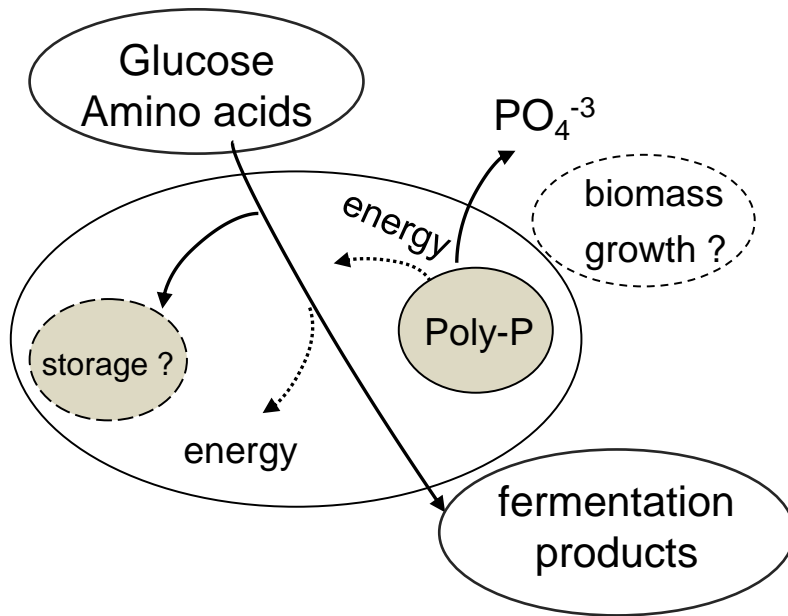O_2

PO_4^{-3}

energy

Glycogen

PHA

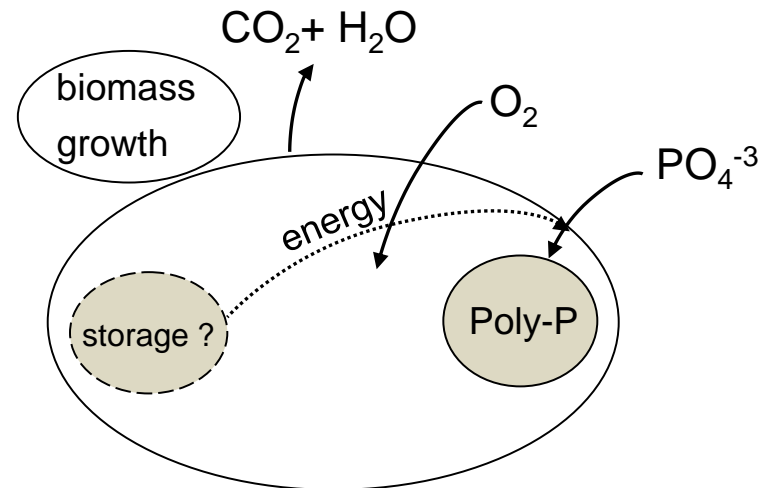Poly-P
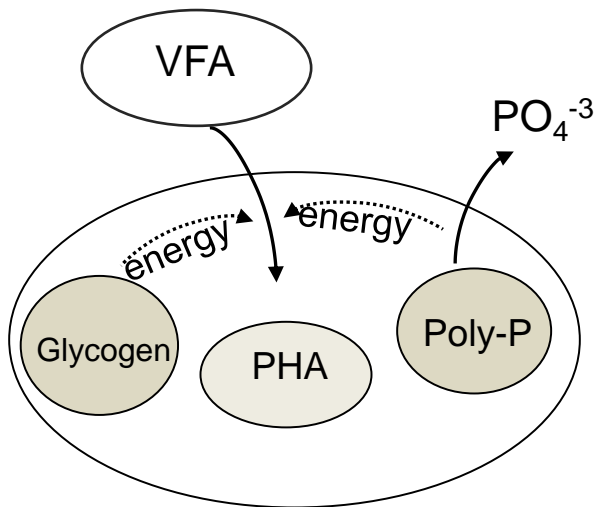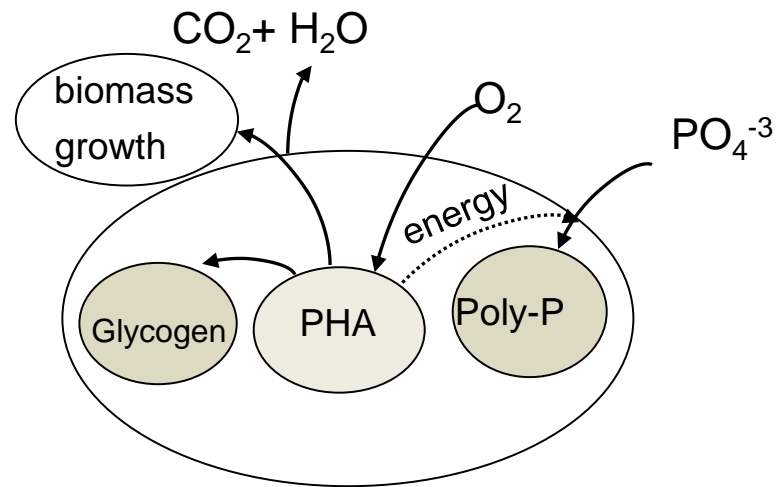
Phosphate accumulating organisms (PAO)

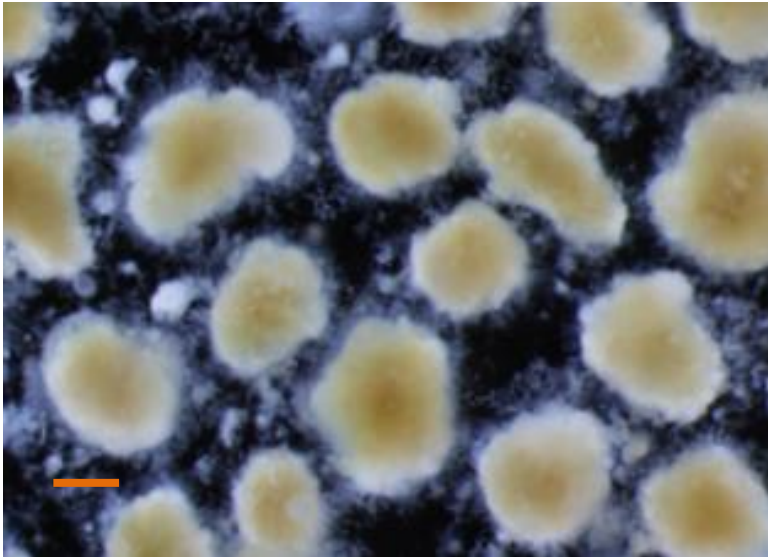## Fermentative PAO

Tetrasphaera

Anaerobic

Aerobic

4

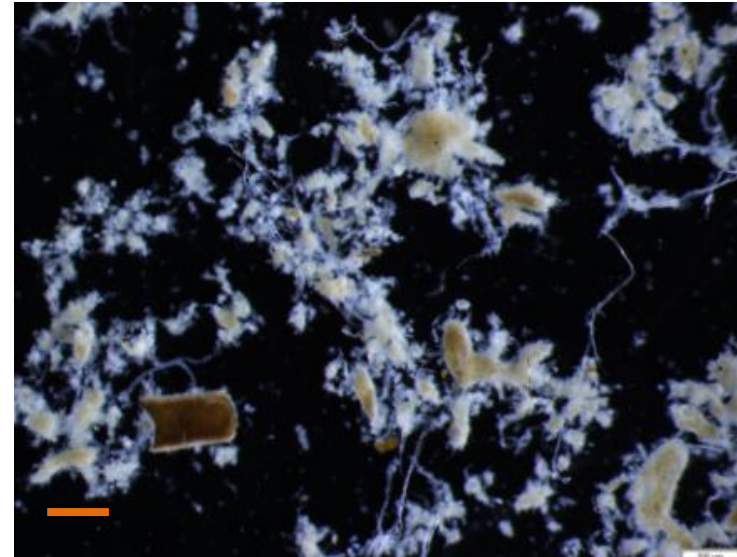# Aerobic granular sludge (AGS) for wastewater treatment

AGS fed with simple synthetic wastewater …
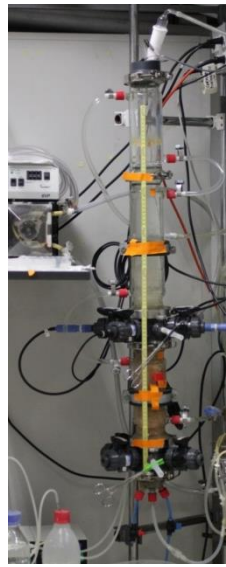
… and with raw municipal wastewater

— 500µm

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?

5

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**
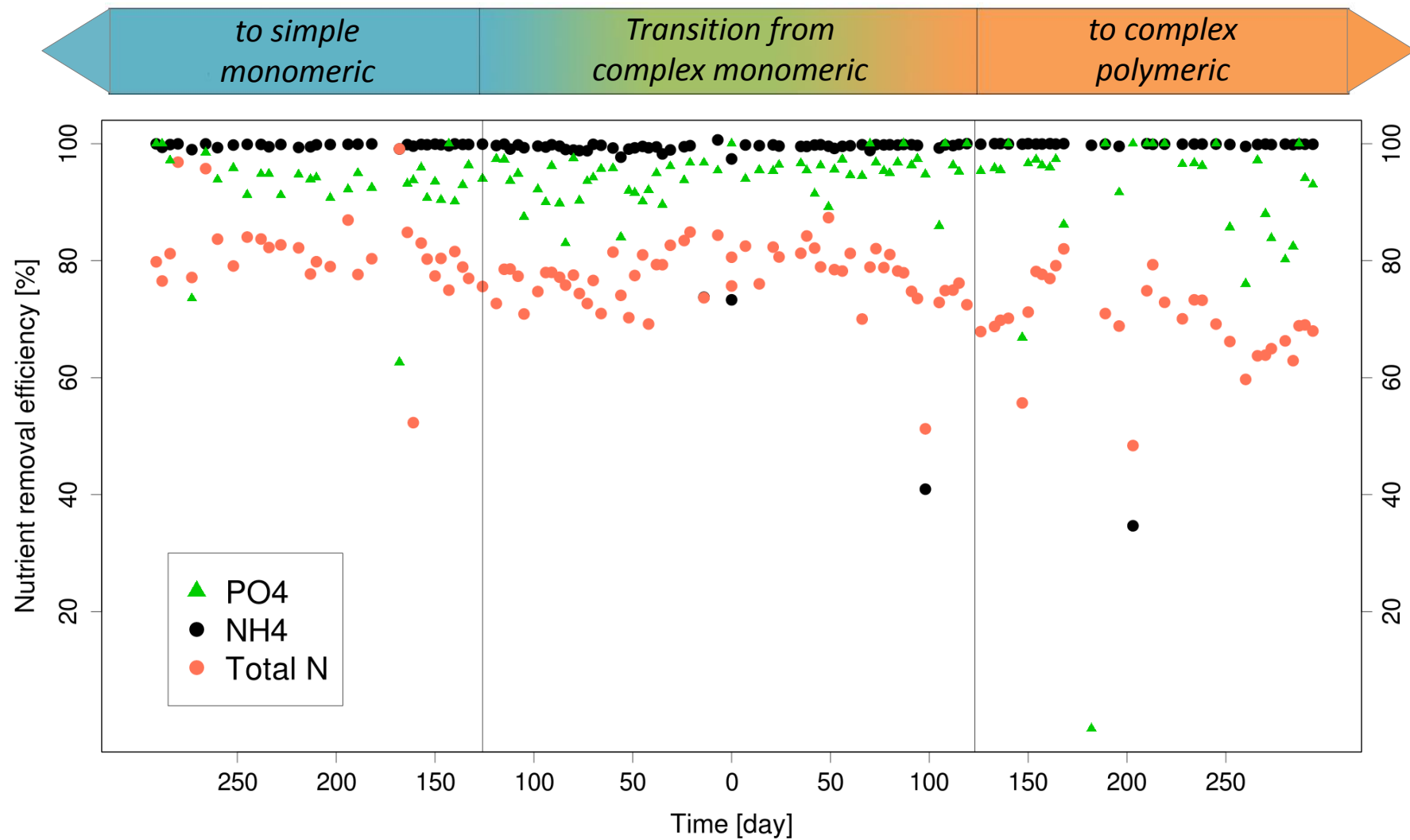
Evolution of nutrient removal efficiency

Evolution of the settling properties
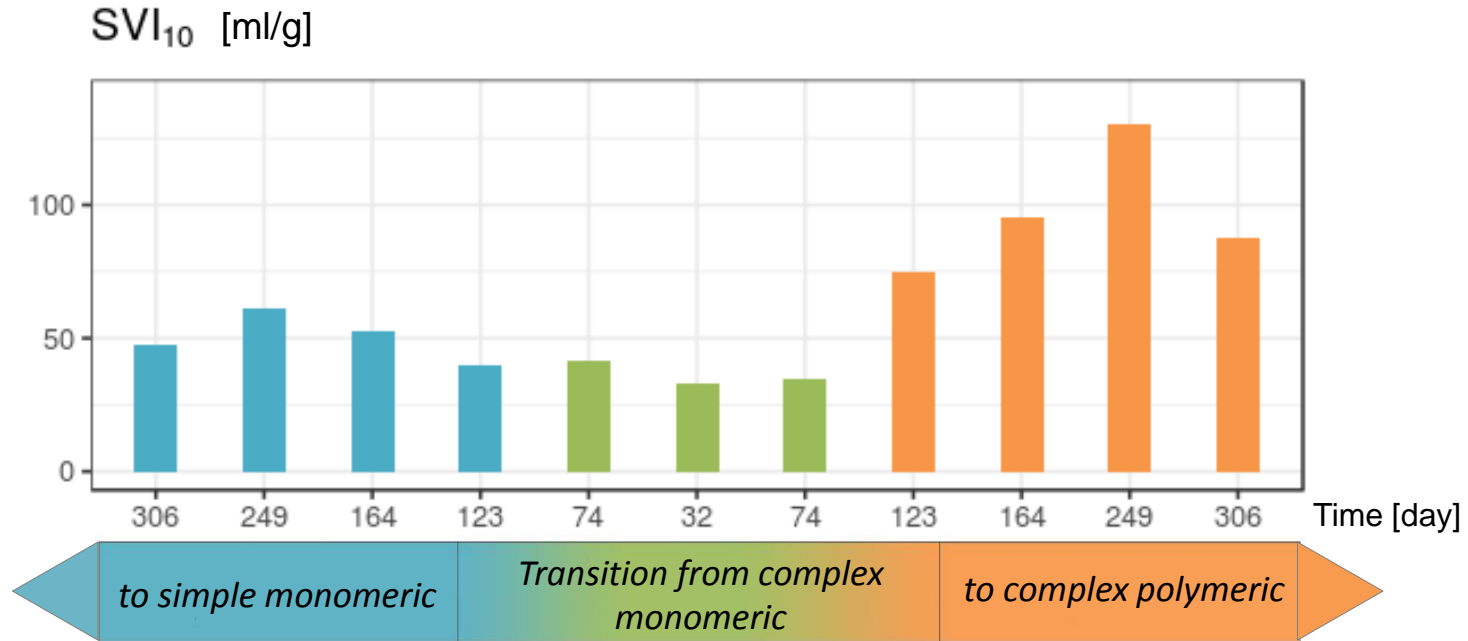
Evolution of the structure of the bacterial communities
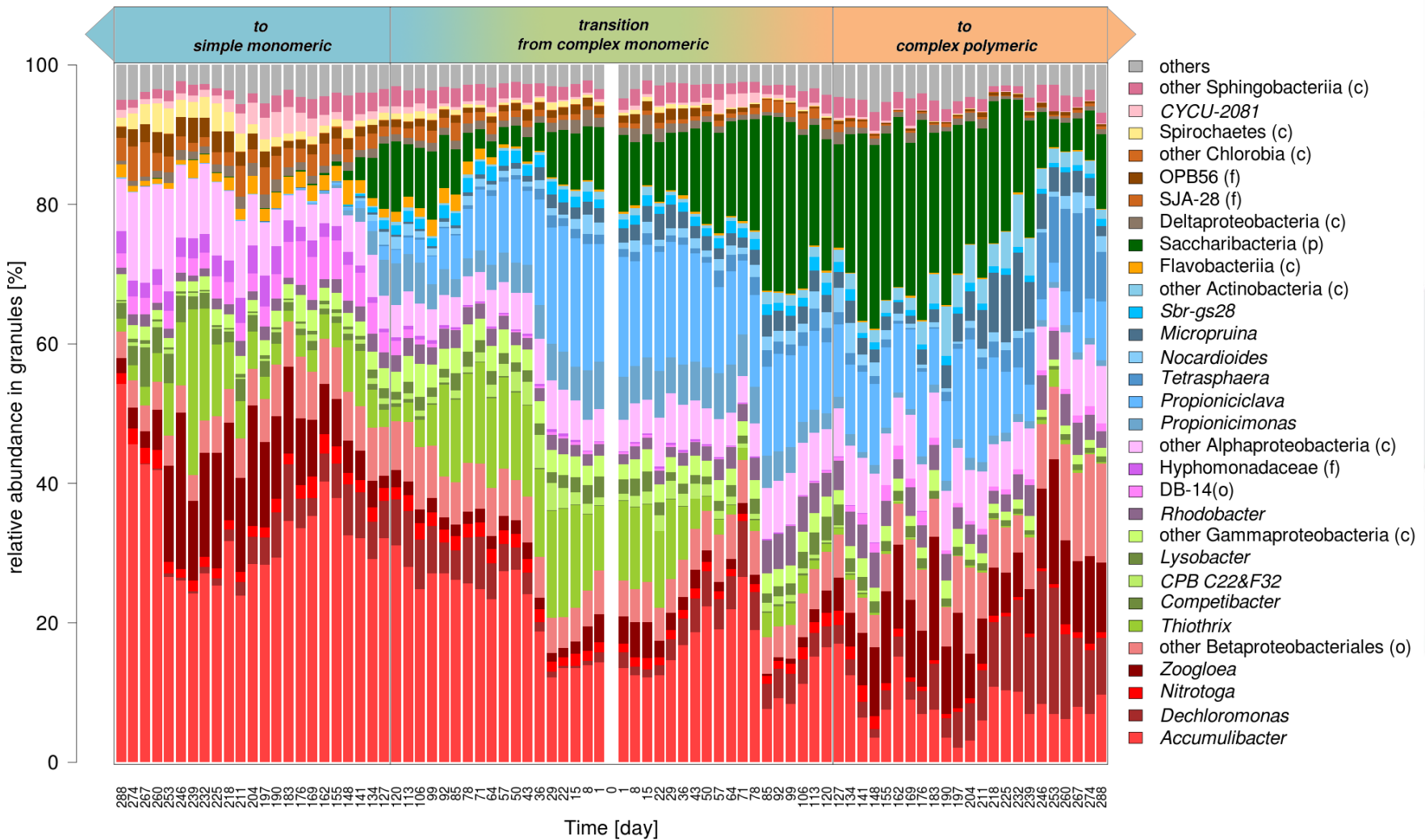
phosphate accumulating organisms (PAO)
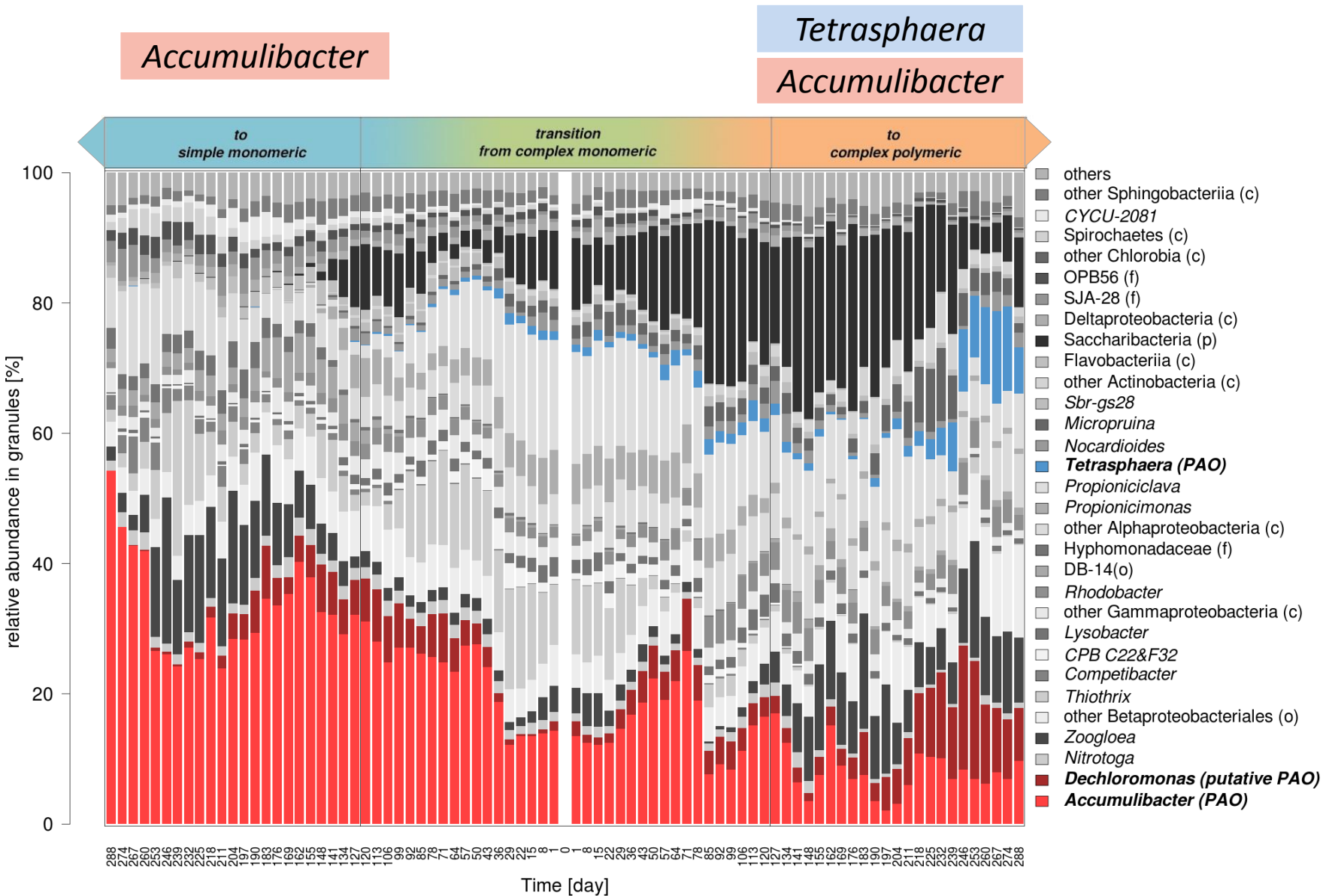
fermenting bacteria
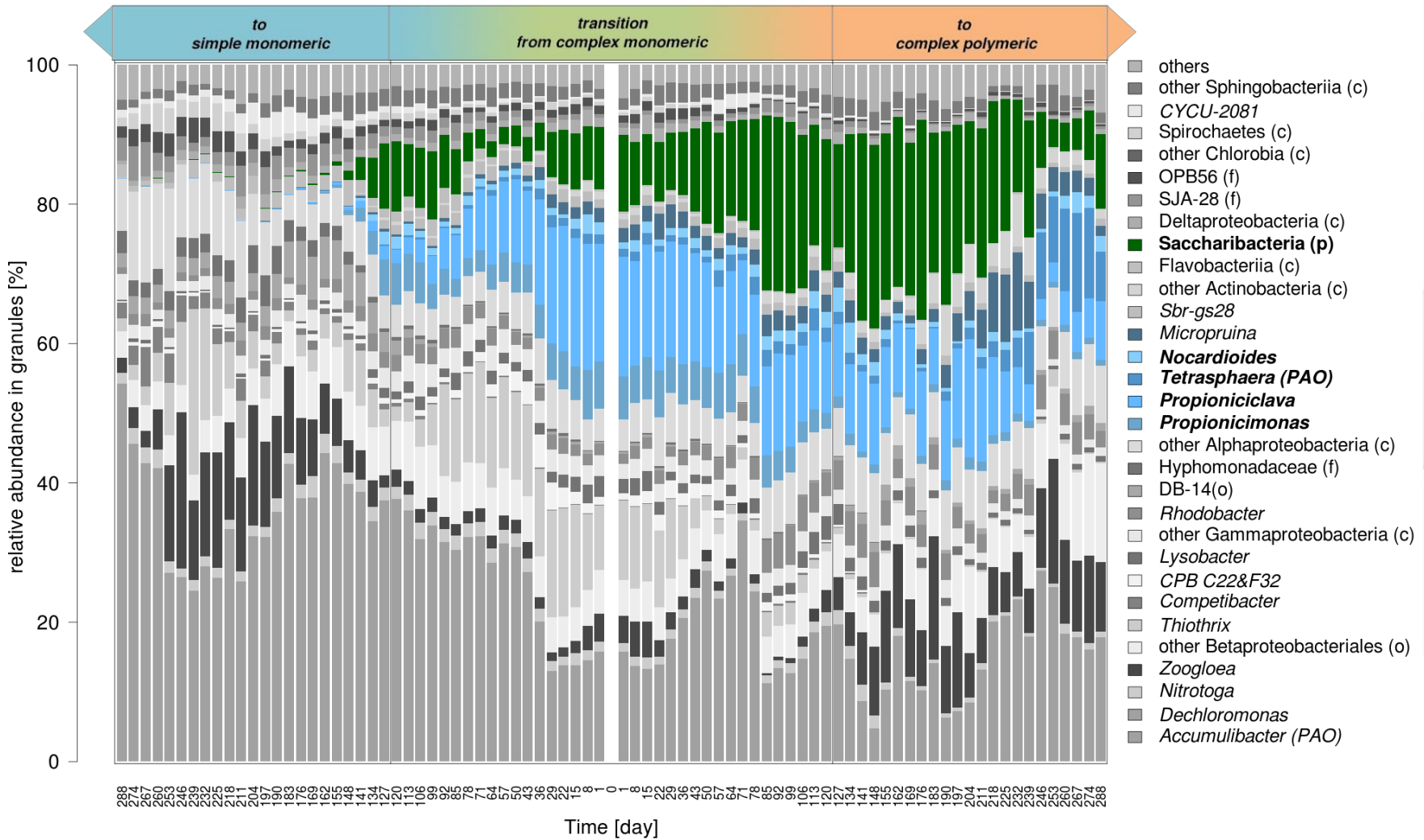
Overall evolution of the microbial communities
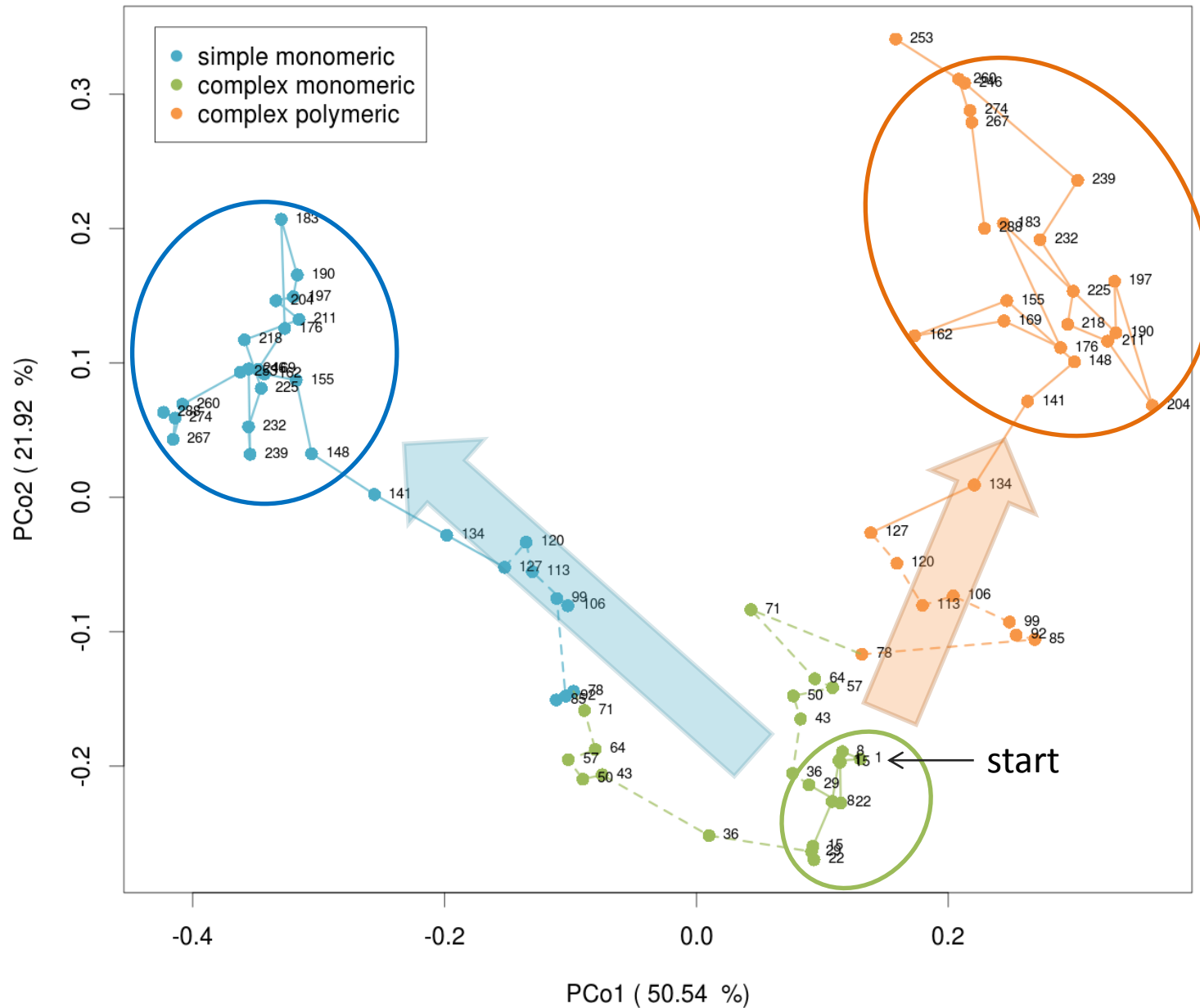
Conclusions

- 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

LBE - EPFL

Marie Horisberger

Valérie Berclaz

Idriss Hendaoui

Emmy Oppliger

David Scheibler

Romain Savary

Dylan Van Tuan Magnin

Emmanuelle Rohrbach

Stéphane Marquis

Marc Deront
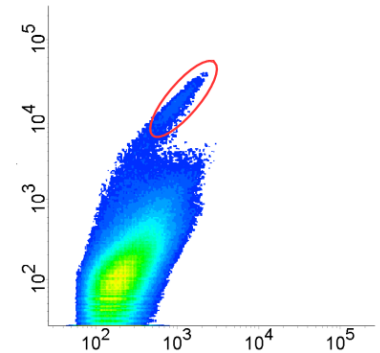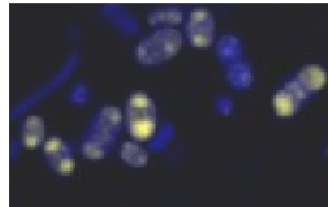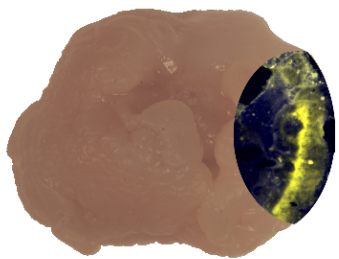
Julien Maillard

Christof Holliger
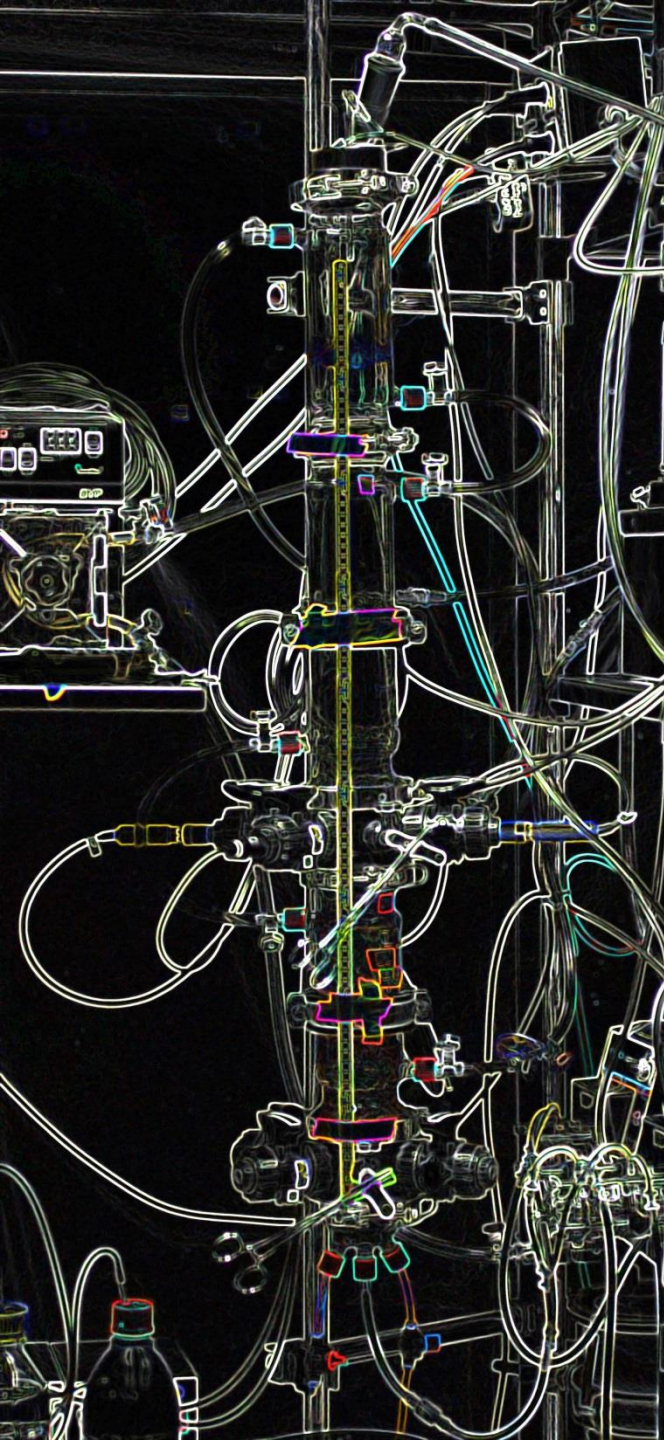
DPE - Eawag

Manuel Layer

Nicolas Derlon

Eberhard Morgenroth

Arnaud Gelb

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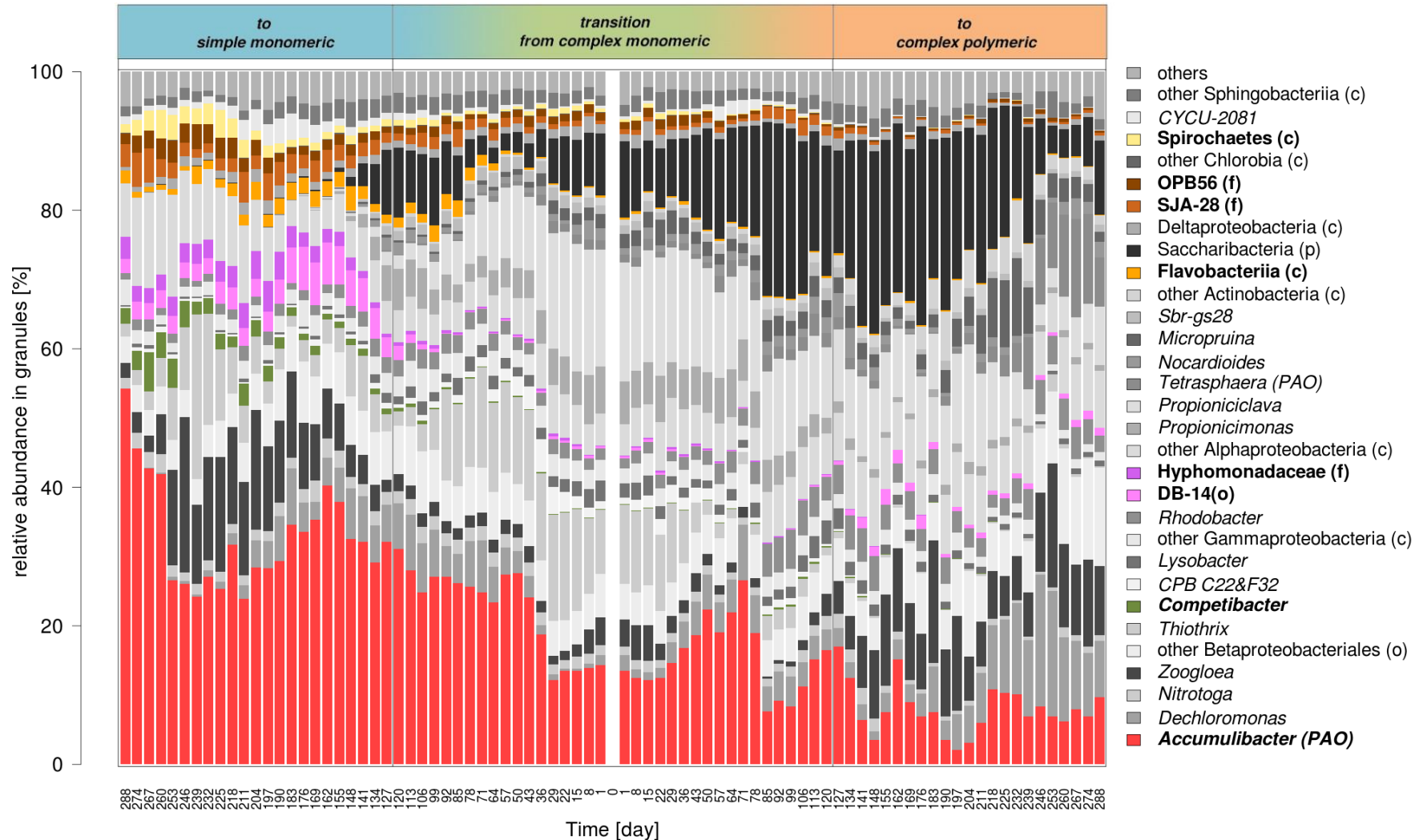

Poster n°51

Thank you for your attention !

Synthetic wastewater compositions

Medium	*COD [mgO2/L]*	*VFA*	*Glucose and amino acids*	*Starch and peptones*
Simple monomeric	450	100 %	-	-
Complex monomeric	600	33 %	66 %	-
Complex polymeric	600	33 %	33 %	33 %

Phosphorus : 22 [mg/L]
Nitrogen : 56 [mg/L]

17

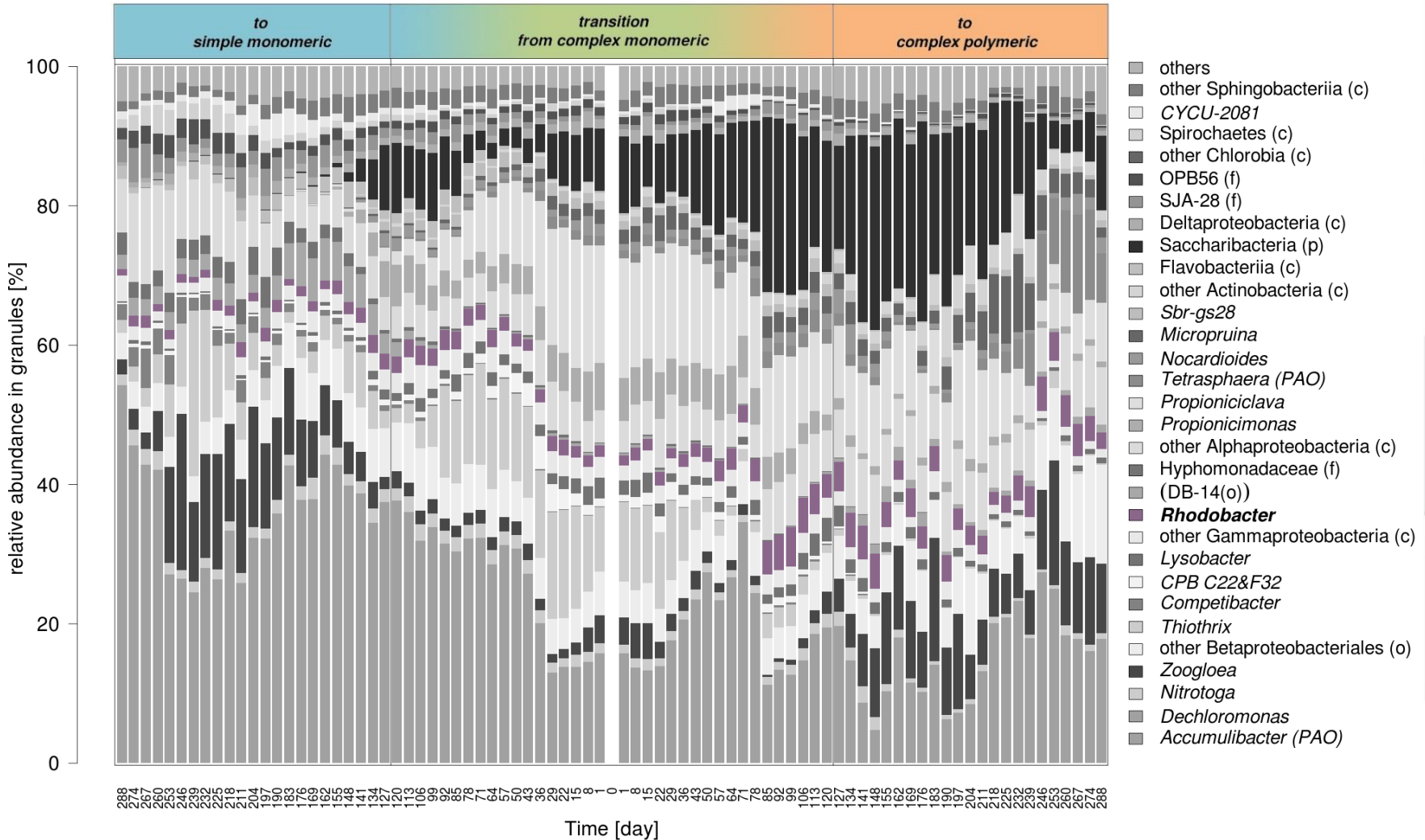# Some taxa are found in higher abundance with the simple wastewater

Some taxa are found in higher abundance with the complex wastewater
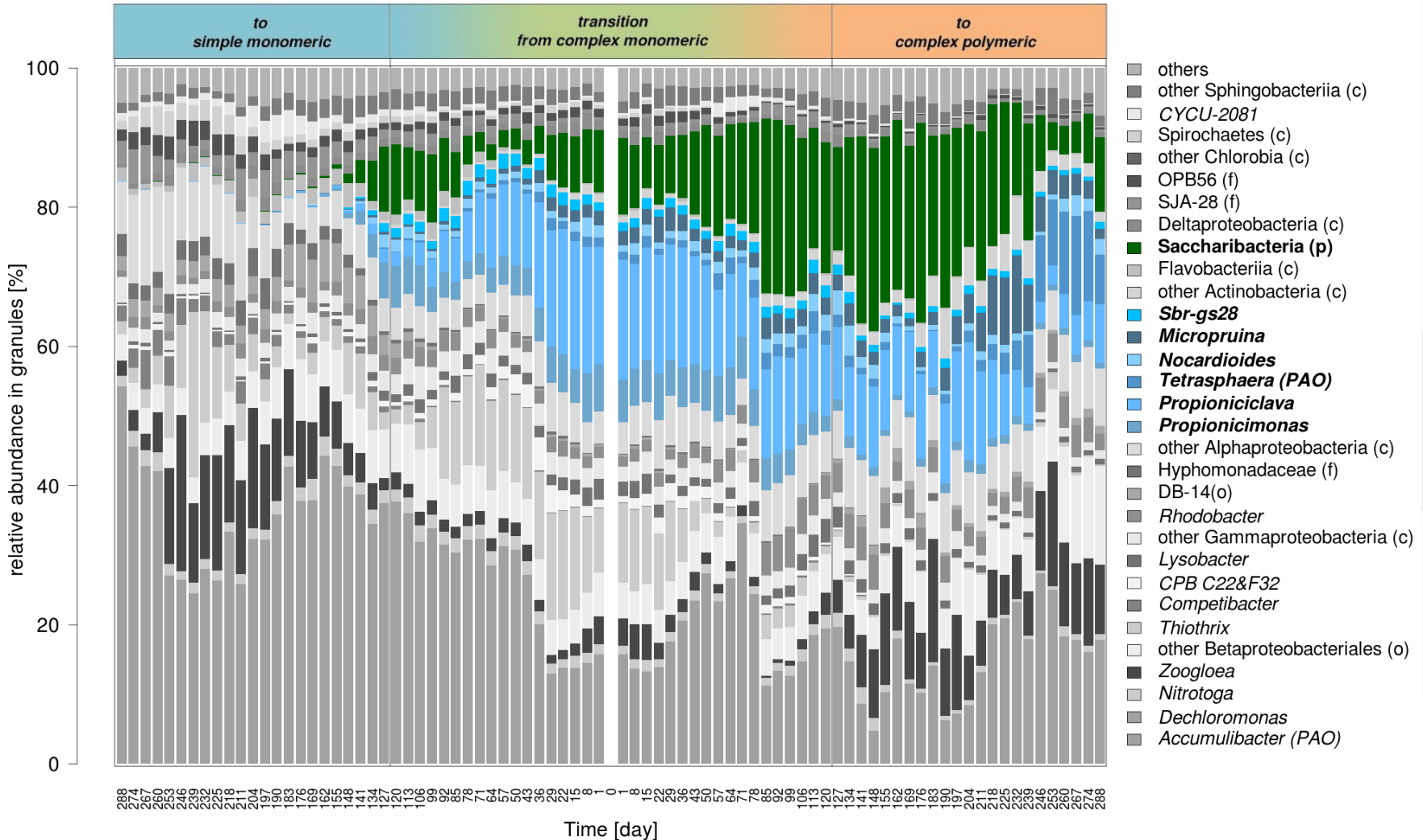
Rhodobacter was found in higher abundance with the polymeric wastewater

Sludge volume index (SVI)

SVI_{10} [ml/g]
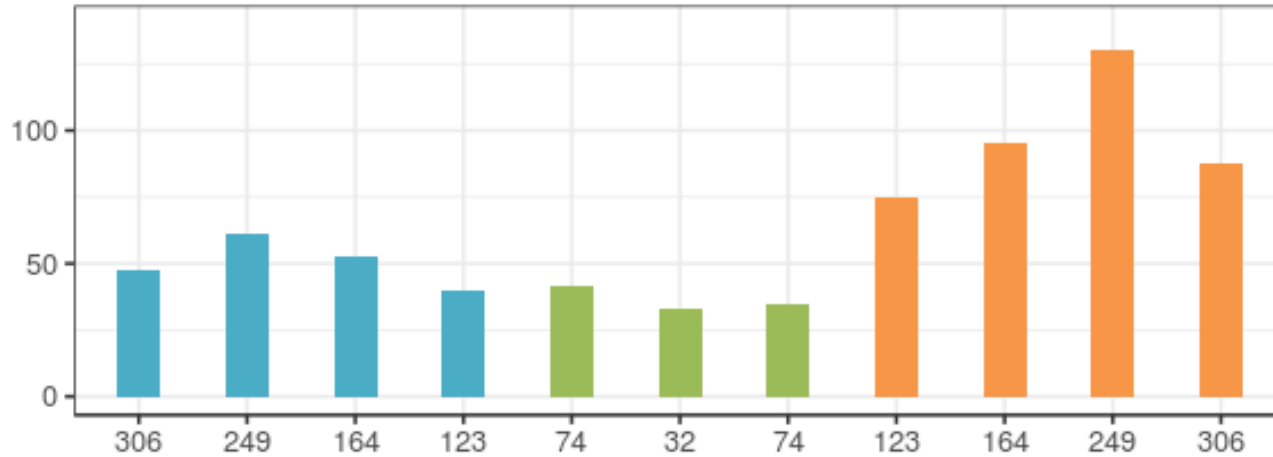
ratio SVI_{10}/SVI_{30}

time [day]

| to simple monomeric | Transition from complex monomeric | to complex polymeric |

21
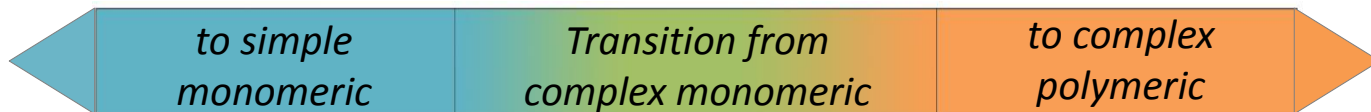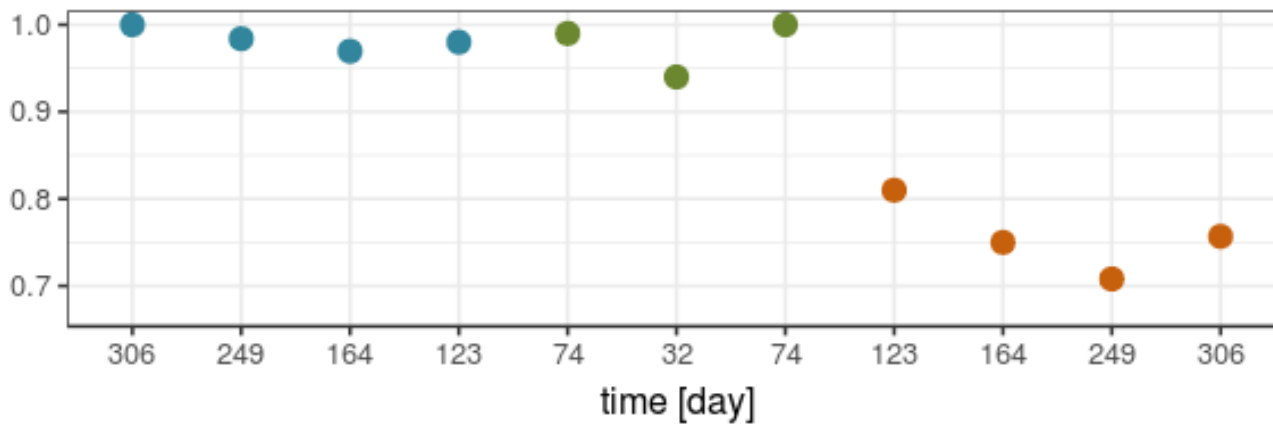
Evolution of the settling capability of the AGS

flocs
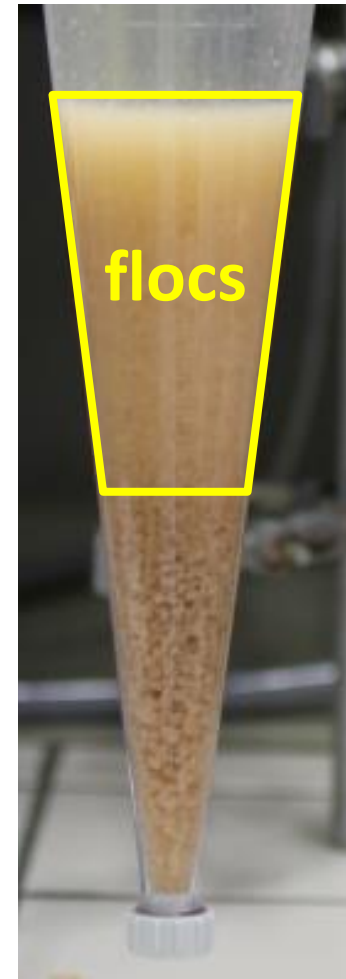
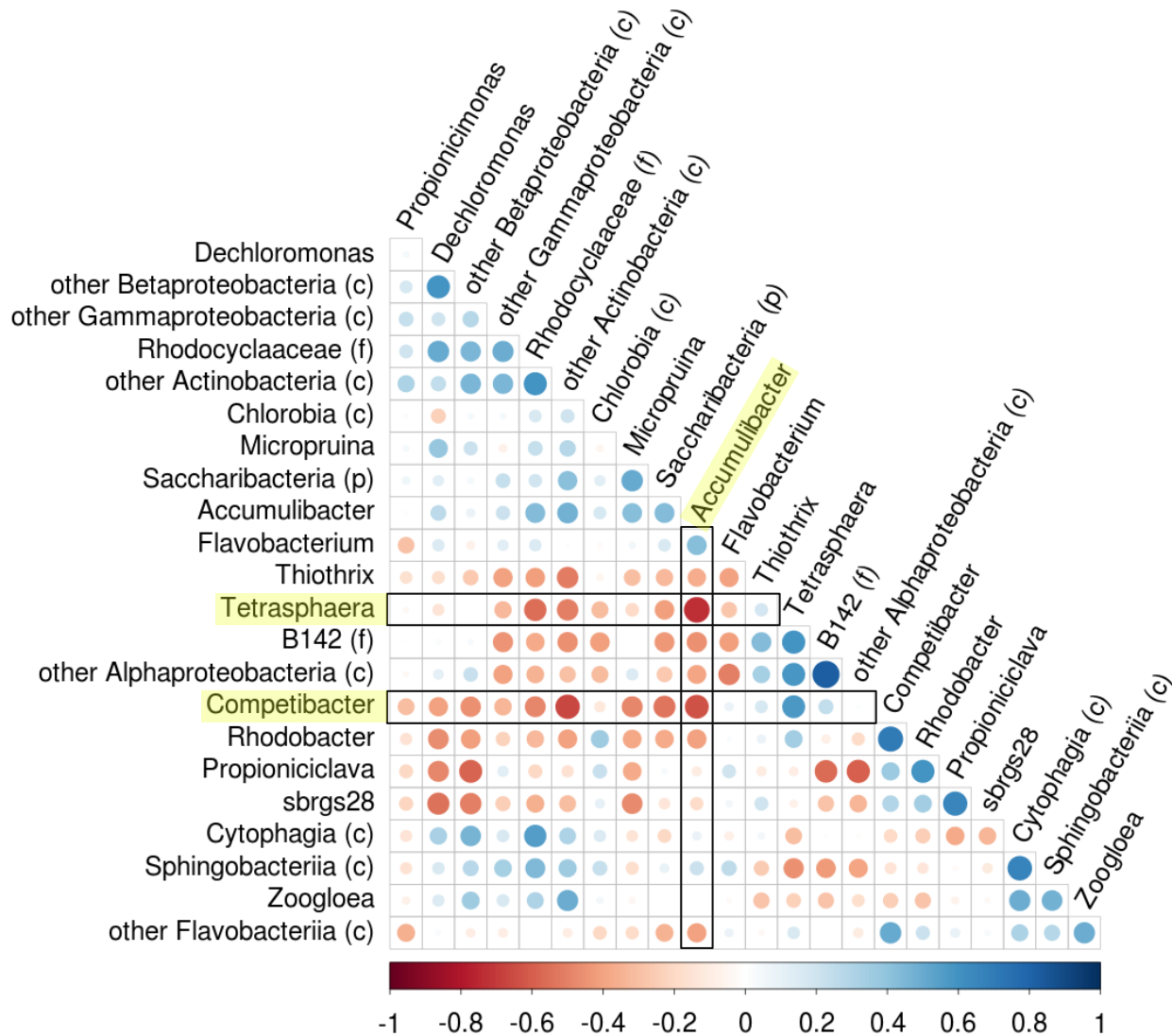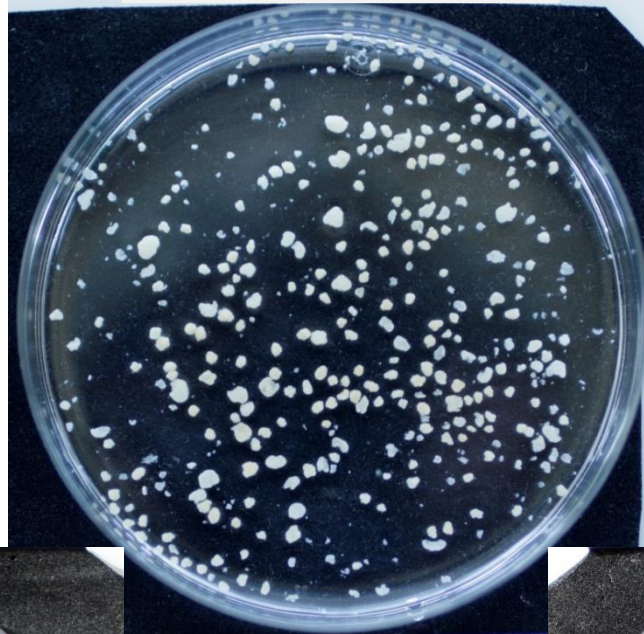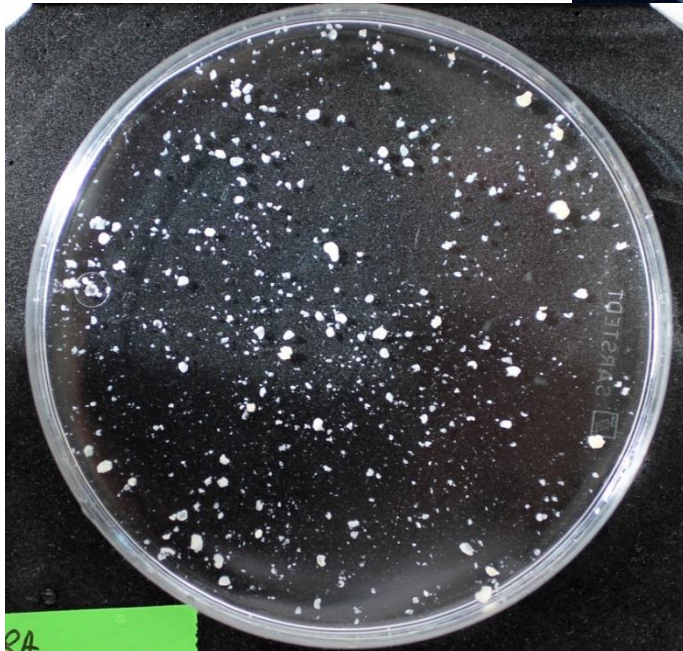| Transition to **simple monomeric** | **Complex monomeric** | Transition to **complex polymeric** |

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

Complex
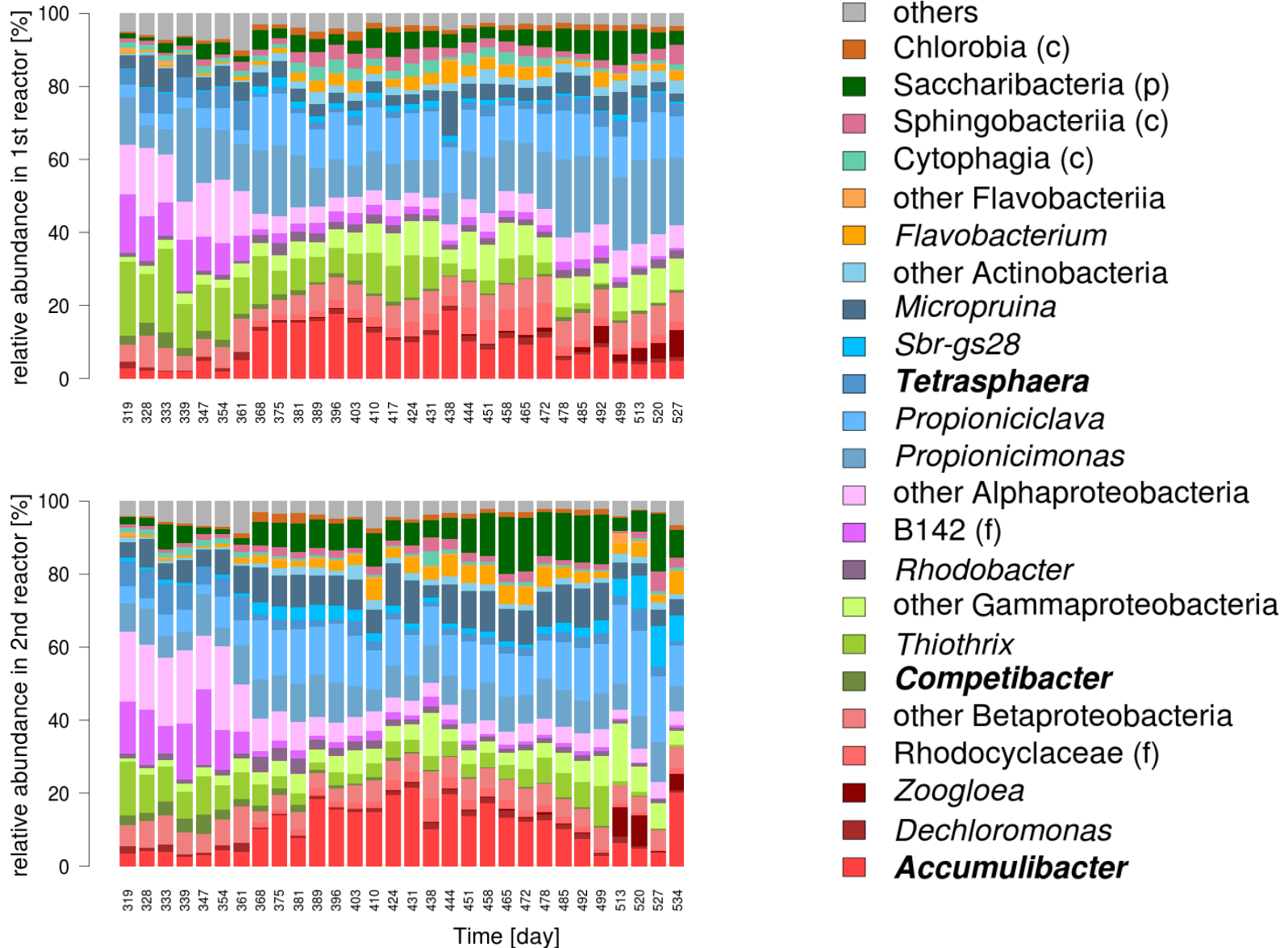monomeric

Simple
monomeric

Complex
polymeric
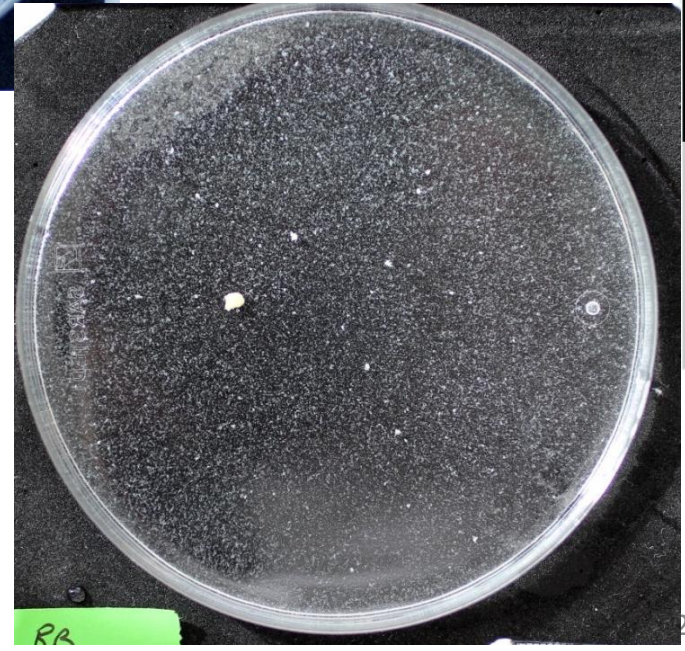
Microbial communities evolution in two reactor fed with complex monomeric wastewater

25