

INFLUENCE OF WASTEWATER COMPOSITION ON THE MICROBIAL COMMUNITIES OF AEROBIC GRANULAR SLUDGE

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ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Microbial processes for wastewater treatment

Activated sludge

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



Aerobic granular sludge

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

After 1
minute
settling



Phosphate accumulating organisms (PAO)

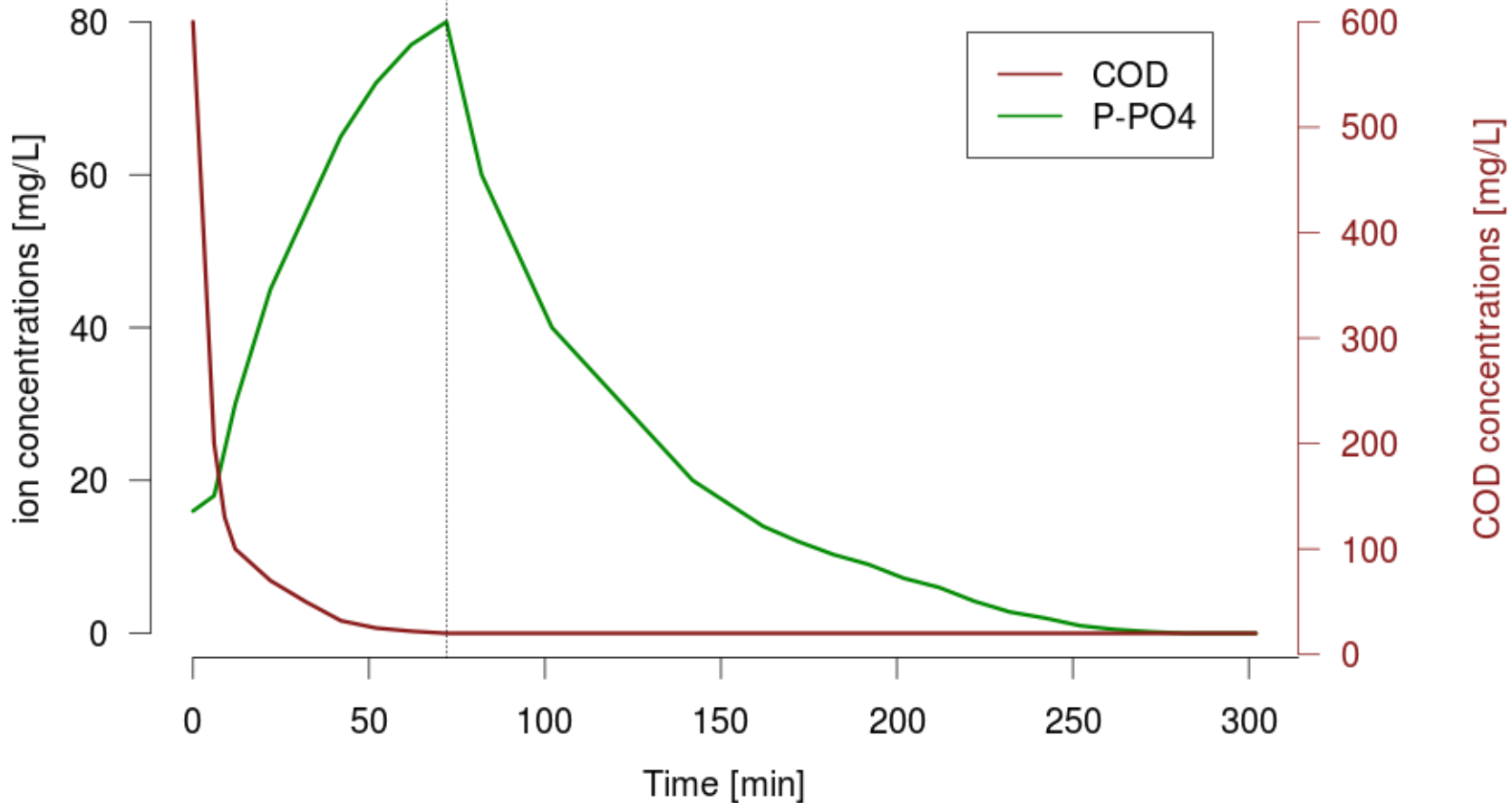
PAO model organism

Ca. Accumulibacter

Tetrasphaera

Anaerobic

Aerobic



Introduction

Objectives

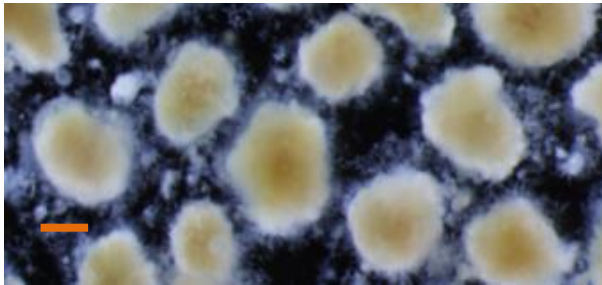
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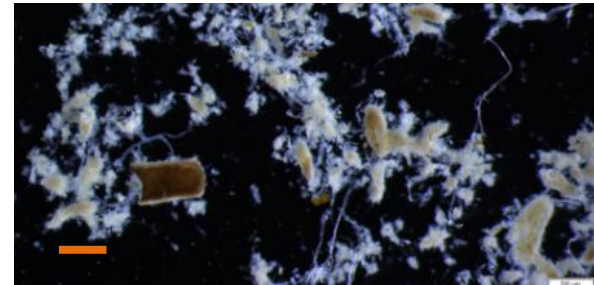
Conclusion

Aerobic granular sludge (AGS) for wastewater treatment

AGS fed with simple synthetic wastewater ...



... and with raw municipal wastewater



— 500 μ m

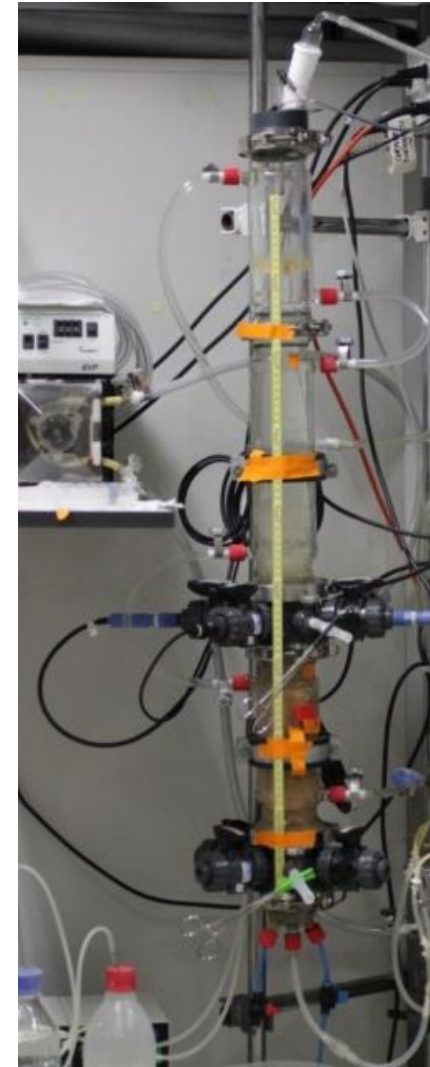
Eawag- DPE

- 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?

Influence of particulate substrates on AGS

1st experiment (DPE-Eawag)

- Start-up AGS from activated sludge
- 4 reactors in parallel with different wastewater
 - Simple synthetic (VFA)
 - Complex synthetic (VFA, glucose, amino acids, starch, peptones)
 - Primary effluent wastewater
 - Raw wastewater



lab-scale reactor

The bacterial communities from inoculum to AGS

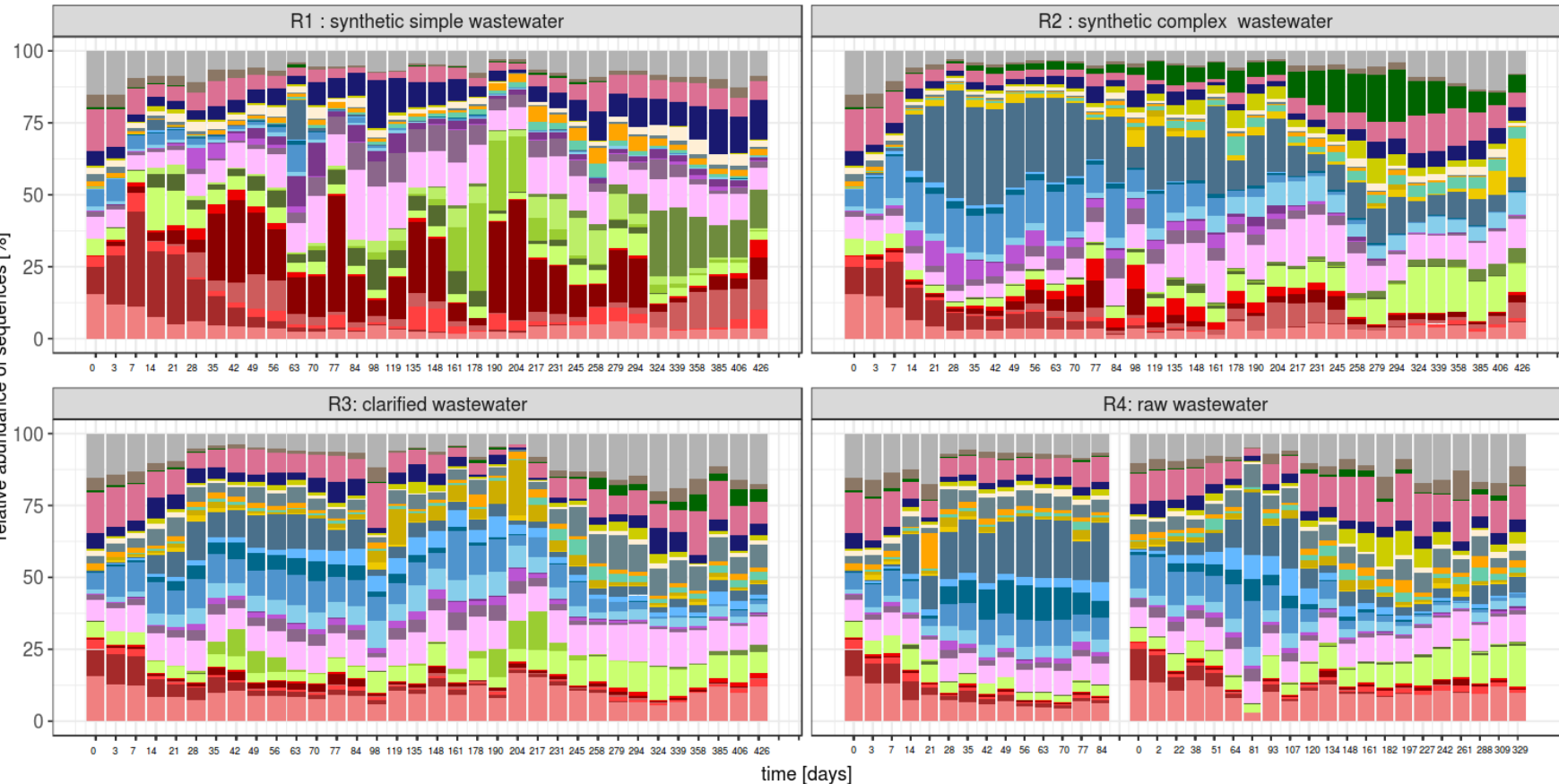
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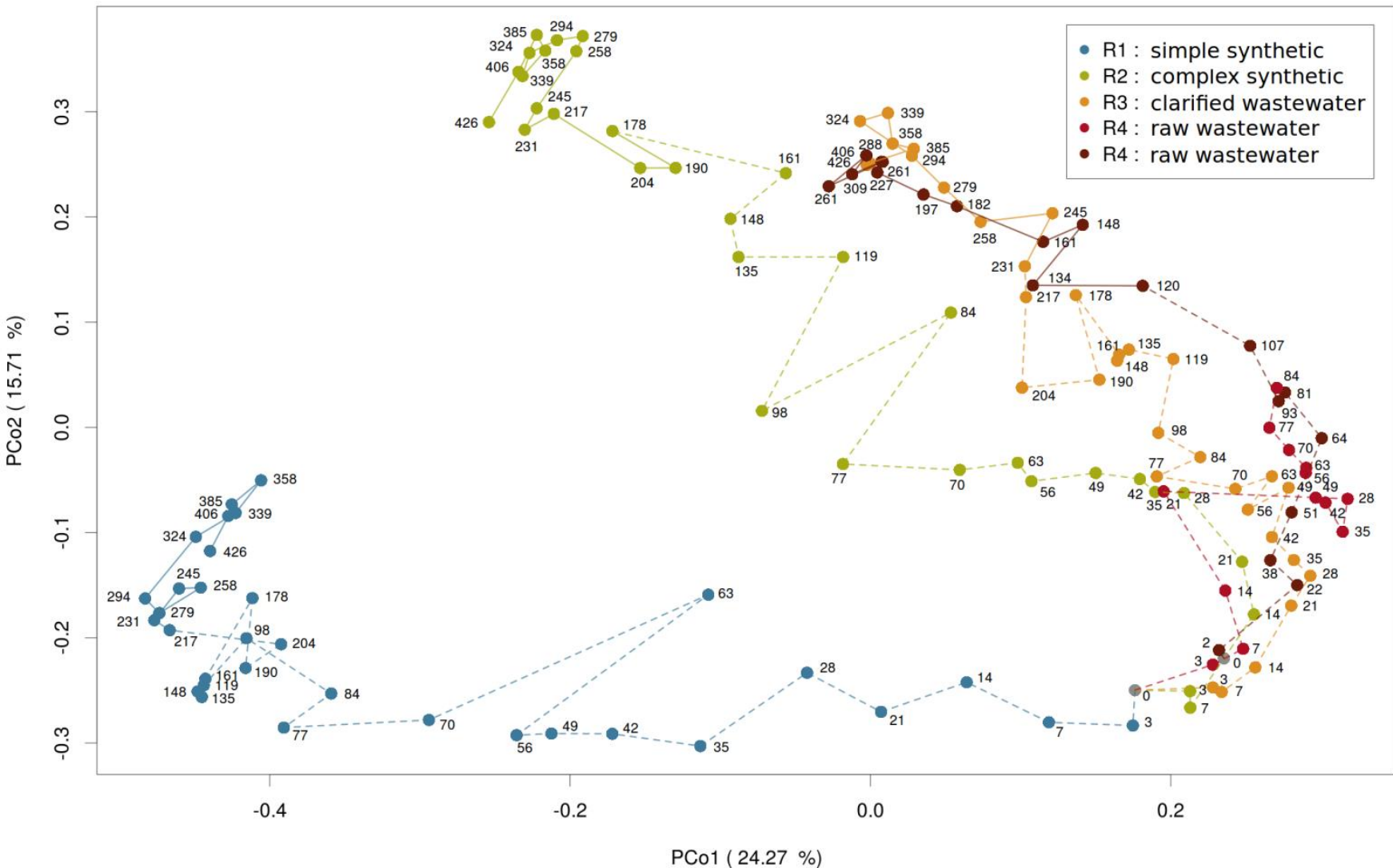
Results

Conclusion



- | | | | | |
|-----------------------------|---------------------------|------------------------|------------------------|-----------------------------|
| other Betaproteobacteriales | <i>Ca. Contendobacter</i> | <i>Meganema</i> | <i>Trichococcus</i> | Spingobacteriia (class) |
| <i>Dechloromonas</i> | <i>Thiothrix</i> | other Actinobacteria | Cytophagia (class) | Saccharibacteria (phylum) |
| <i>Ca. Accumulibacter</i> | <i>CPB_C22&F32</i> | <i>Tetrasphaera</i> | Flavobacteriia (class) | Deltaproteobacteria (class) |
| <i>Azoarcus</i> | <i>Ca. Competibacter</i> | <i>Lapillicoccus</i> | Acidimicrobiia (class) | others |
| <i>Zoogloea</i> | other Alphaproteobacteria | <i>Propioniceclava</i> | Anaerolineae (class) | |
| <i>Thauera</i> | <i>Rhodobacter</i> | <i>Micropruina</i> | <i>Kouleothrix</i> | |
| other Gammaproteobacteria | <i>Paraccocus</i> | other Bacilli | <i>Nitrospira</i> | |

Principal component analyses of the bacterial communities from activated sludge inoculum to AGS

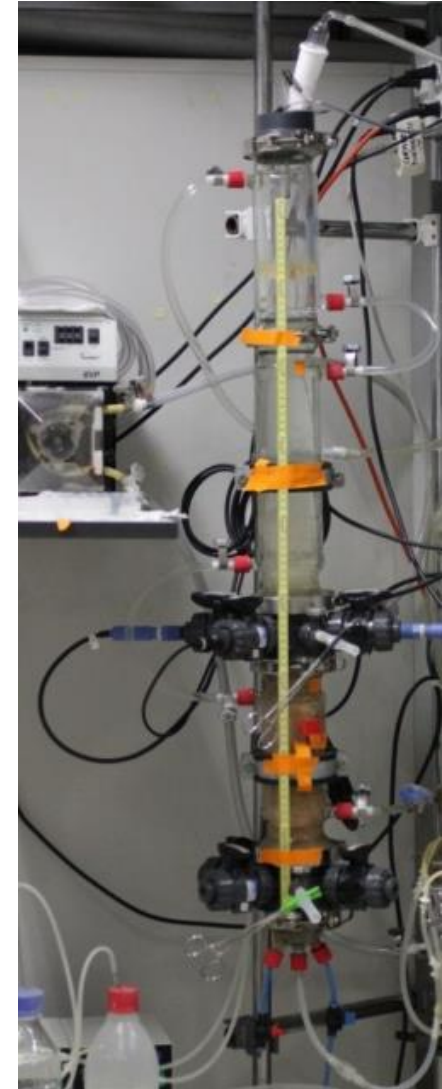


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Influence of particulate substrates on AGS

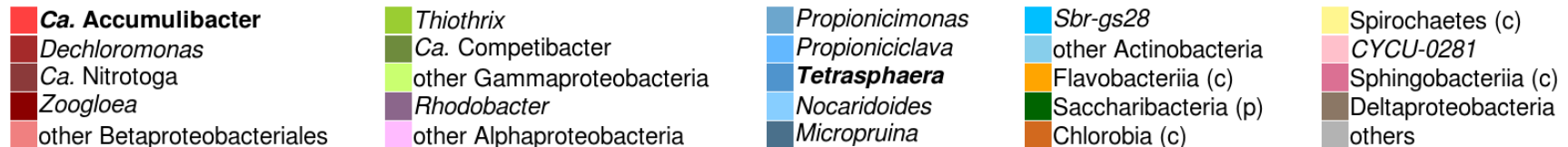
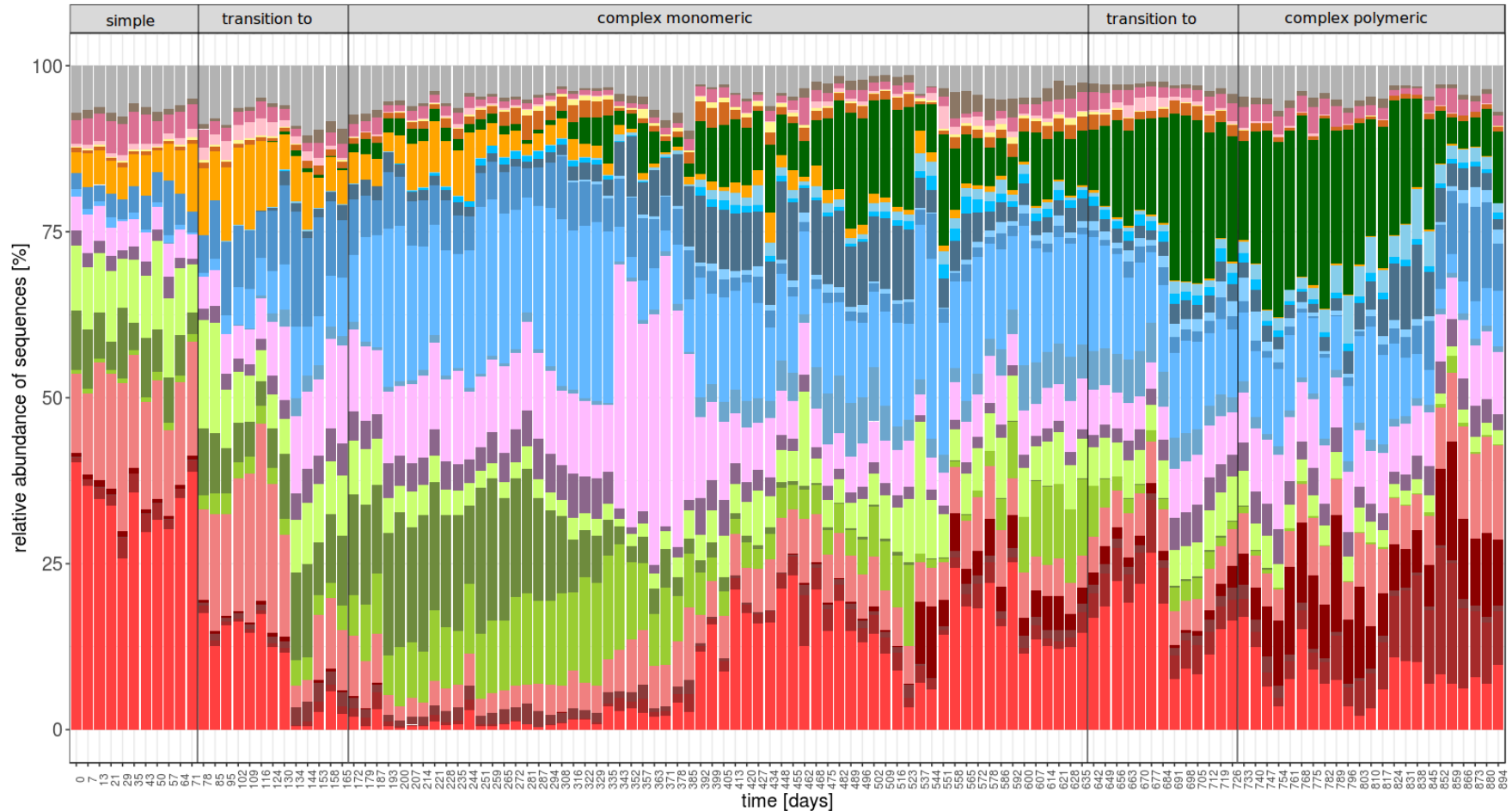
2nd experiment at EPFL (LBE)

- Progressively change the wastewater composition
 - From **simple** synthetic (VFA)
 - To **complex** synthetic **monomeric** (VFA, glucose, amino acids)
 - To **complex** synthetic **polymeric** (VFA, glucose, amino acids, starch, peptone)



lab-scale reactor

The bacterial communities during the transition from simple to complex polymeric wastewater



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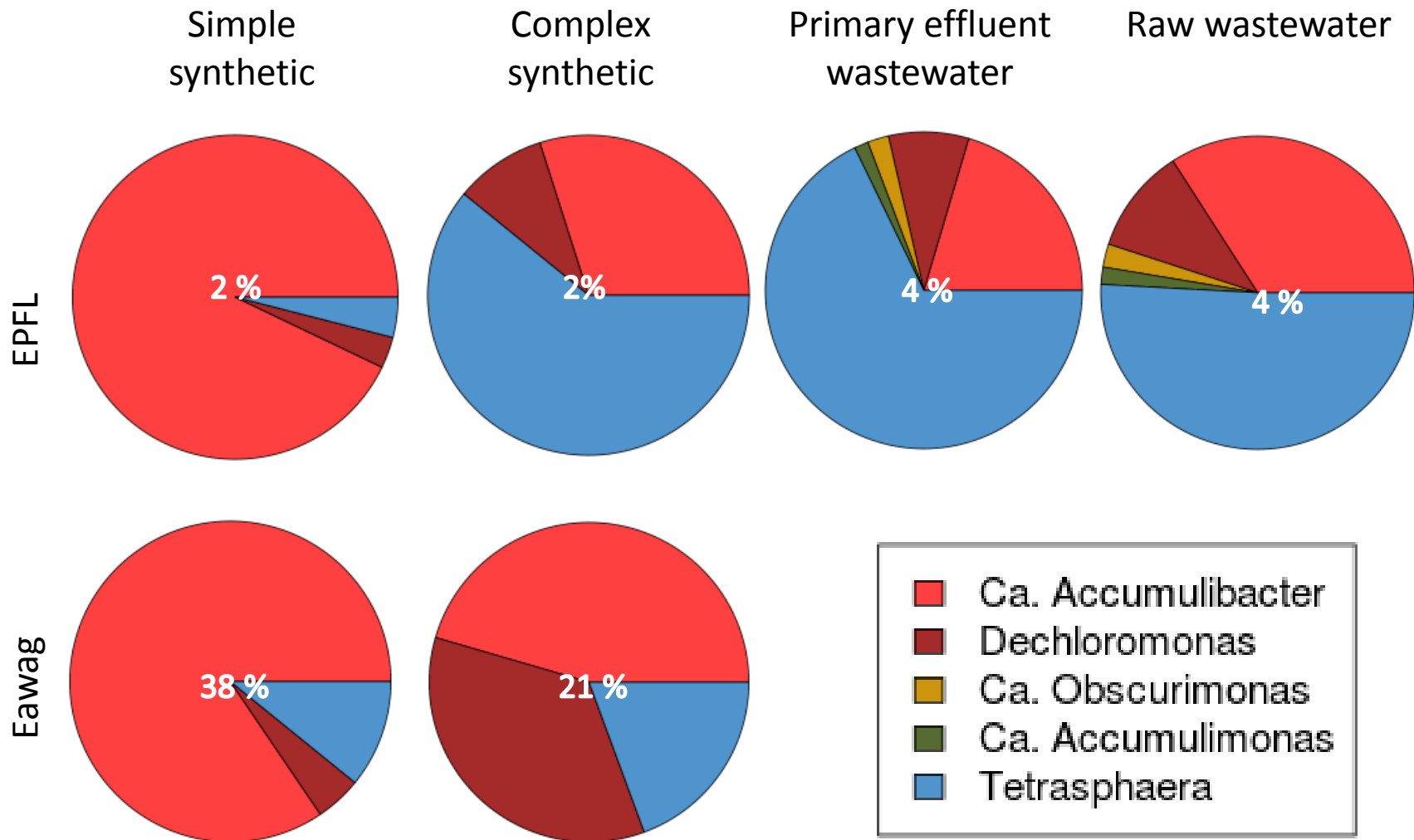
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PAO distribution depending on wastewater composition



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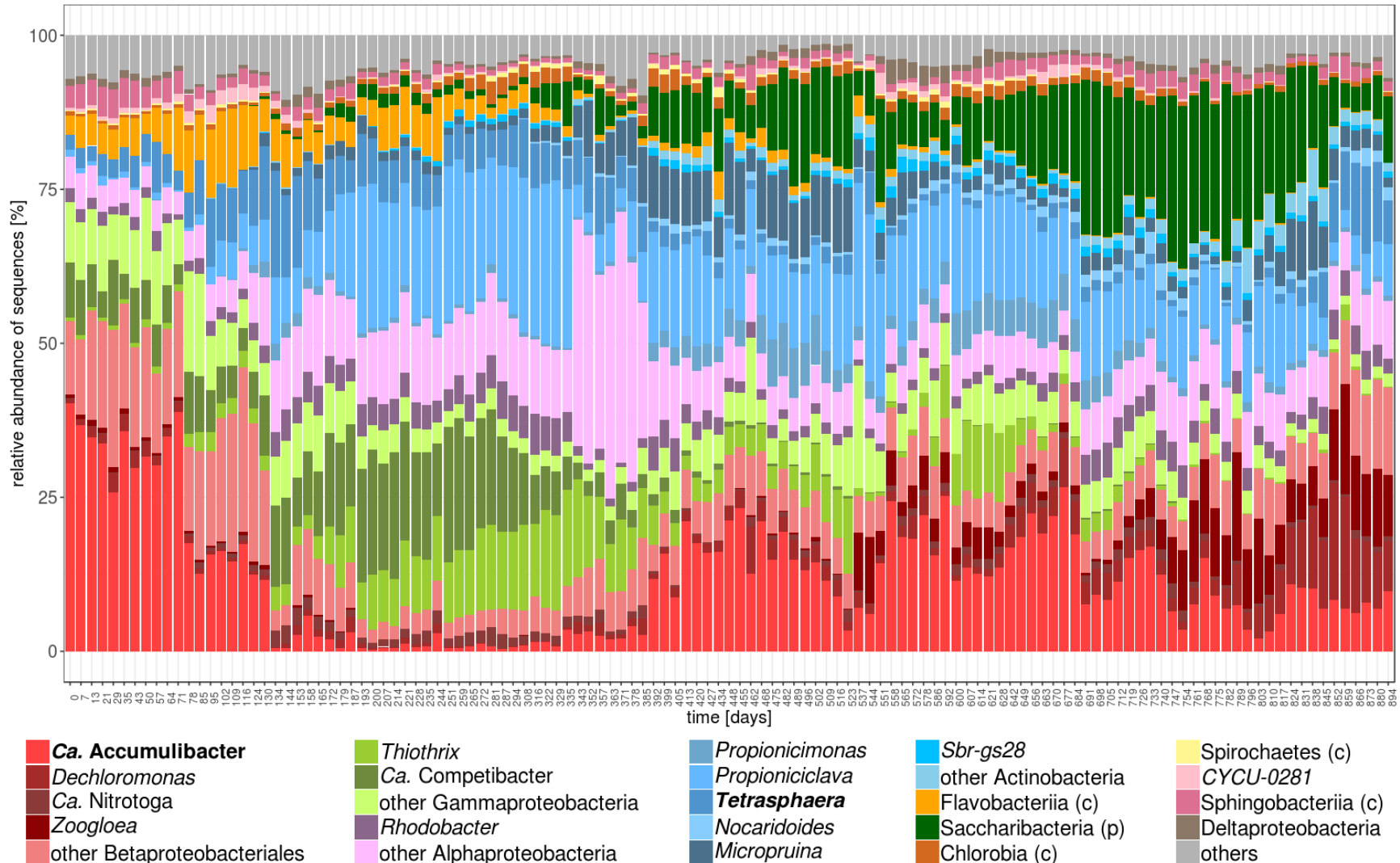
Properties of aerobic granular sludge treating different wastewaters

Wastewater	Dominant PAO	N-removal	P-removal	Settling properties
synthetic simple	Accumulibacter	++	+++	+++
synthetic complex monomeric	Accumulibacter Tetrasphaera (Dechloromonas)	++	+++	+++
synthetic complex polymeric	Accumulibacter Tetrasphaera (Dechloromonas)	+	++	+
municipal wastewater	Accumulibacter Tetrasphaera (Dechloromonas)	+	++	+



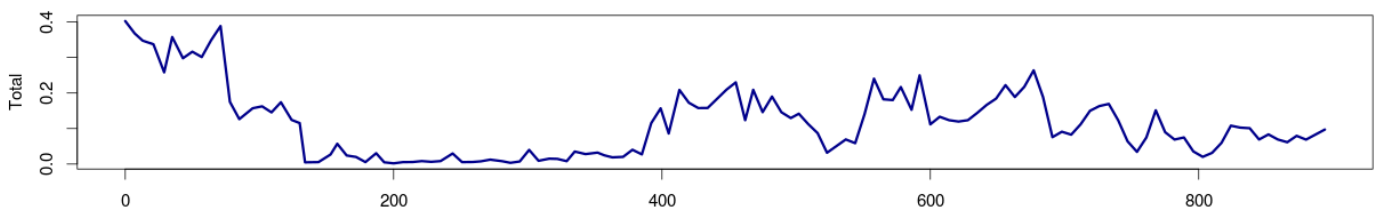
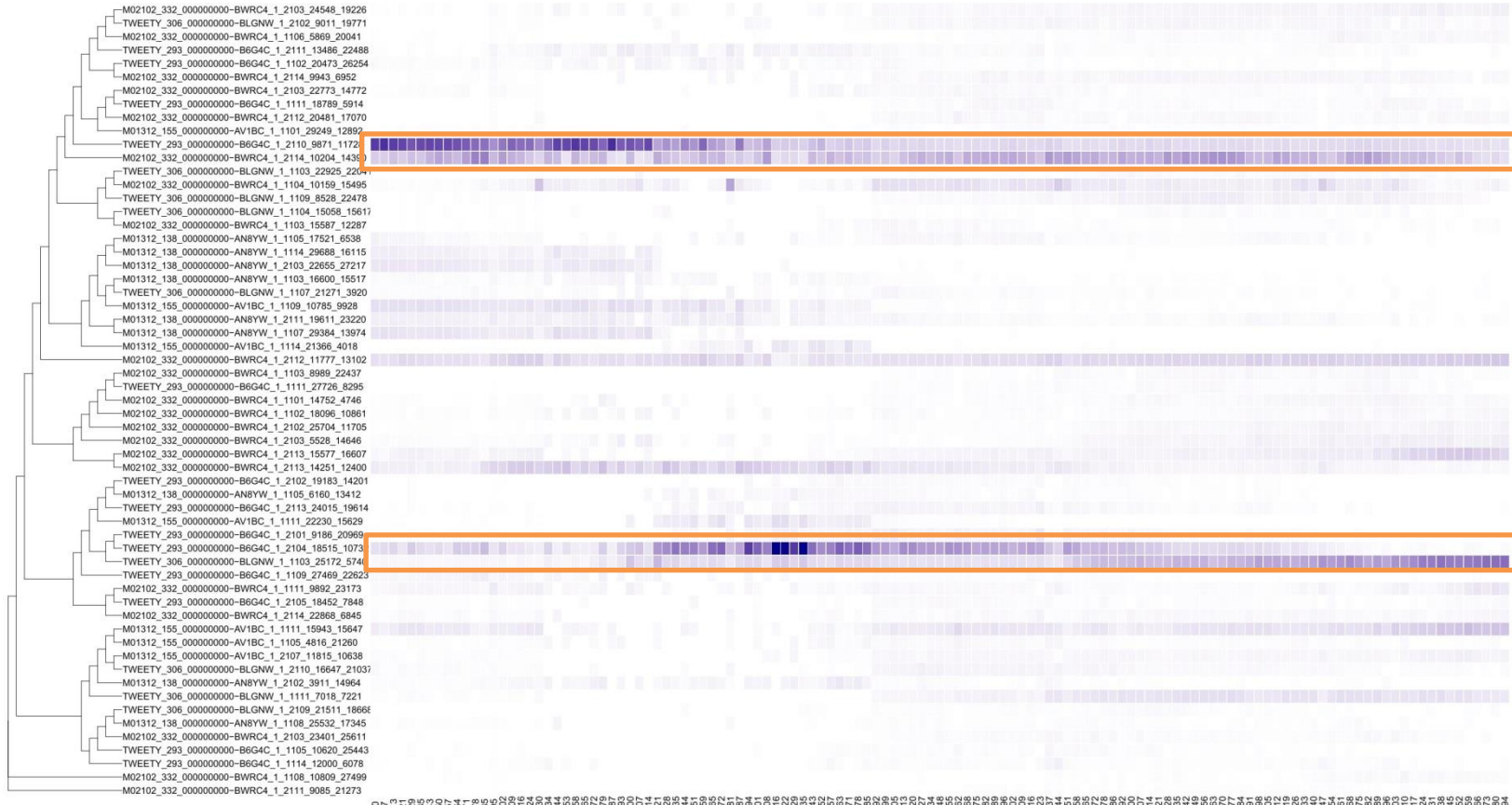
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Dynamics of *Ca. Accumulibacter* OTUs



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Dynamics of Ca. Accumulibacter OTUs



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Conclusions

- AGS fed with complex synthetic wastewater is more similar to AGS treating municipal wastewater than the traditional simple synthetic wastewater. It offers a tunable model to study AGS systems.
- *Ca. Accumulibacter* was the predominant PAO with the simple wastewater. With the fermentable and polymeric compounds, the guild of PAO was more diverse.
- Different OTU affiliated to a single genus can have different dynamics.

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DPE - Eawag

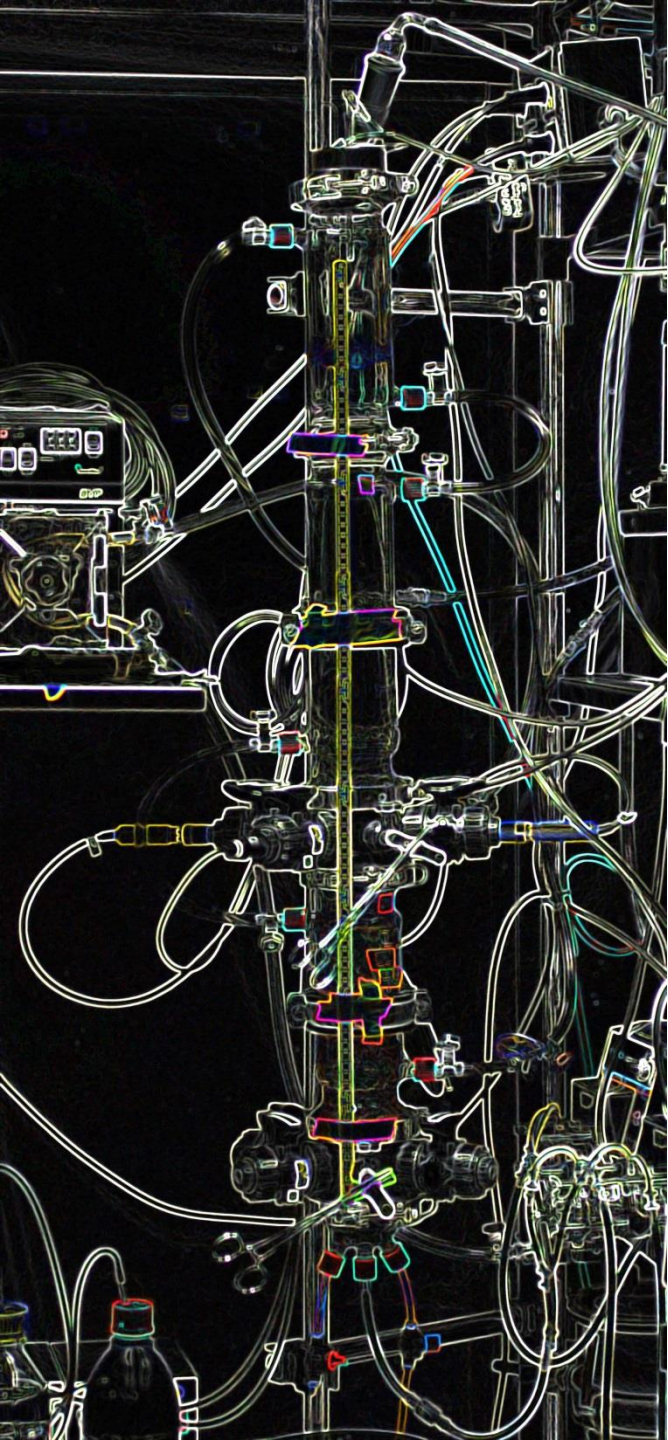
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Thank you for your
attention !

wastewater compositions

	<i>Medium</i>	<i>COD [mgO₂/L]</i>	<i>VFA</i>	<i>Glucose and amino acids</i>	<i>Starch and peptones</i>	<i>Phosphorus [mg/L] (filtered)</i>	<i>Nitrogen [mg/L] (filtered)</i>
EPFL	Simple synthetic	450	100 %	-	-	22	56
	Complex synthetic monomeric	600	33 %	66 %	-	22	56
Eawag	Simple synthetic	600	100 %	-	-	6	44
	Complex synthetic polymeric	600	33 %	33 %	33 %	6	38
	Primary effluent wastewater	370	10 %	NA	NA	3	28
	Raw wastewater	800	5 %	NA	NA	3	30

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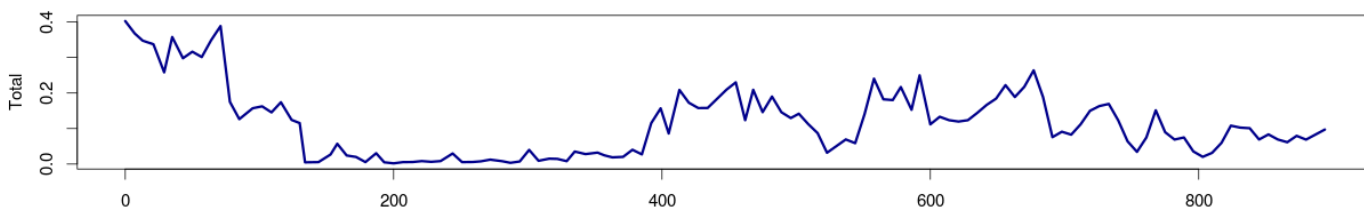
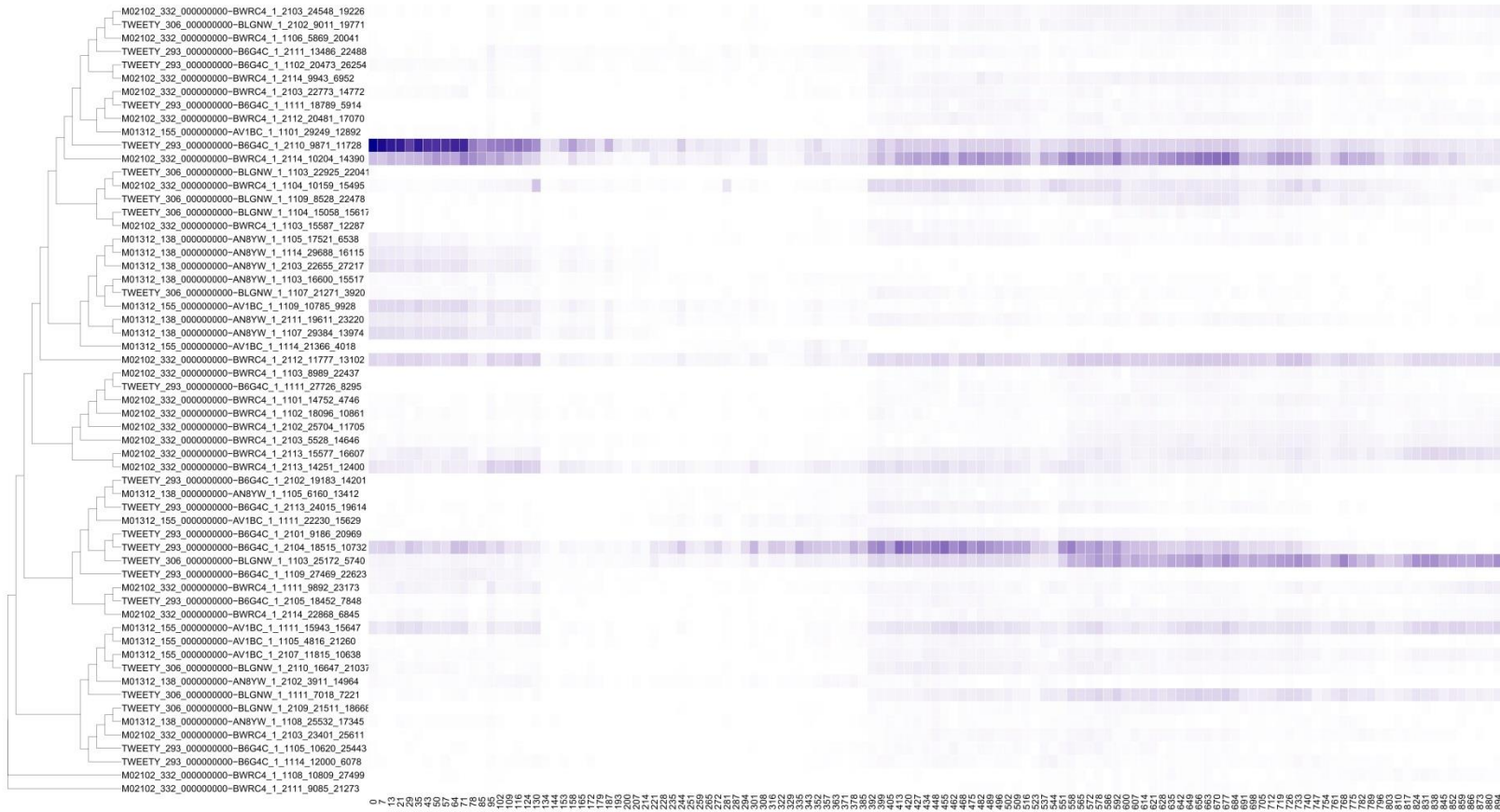
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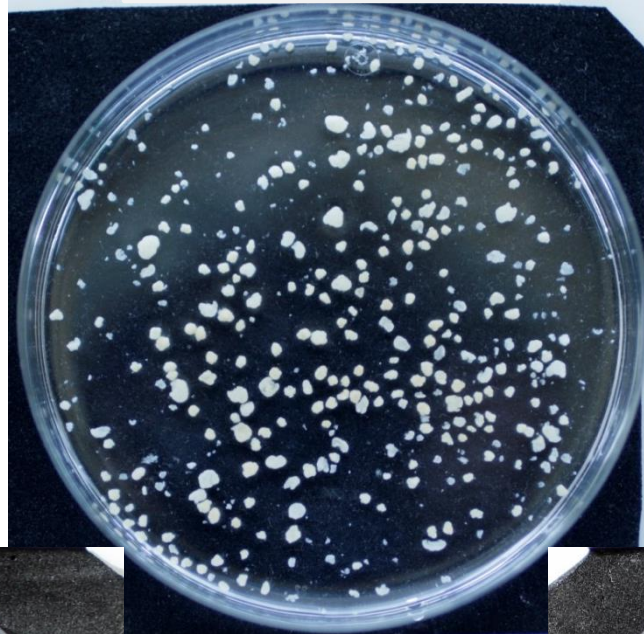
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OTU dynamic of *Ca. Accumulibacter*

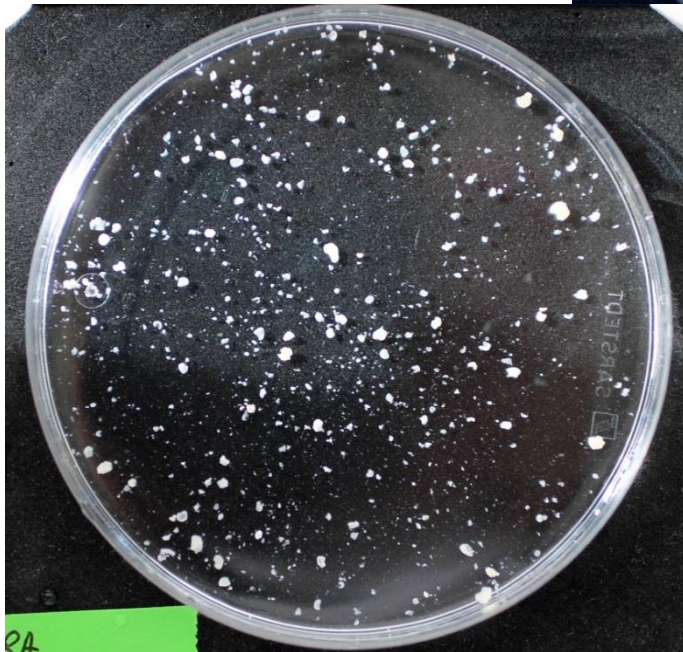


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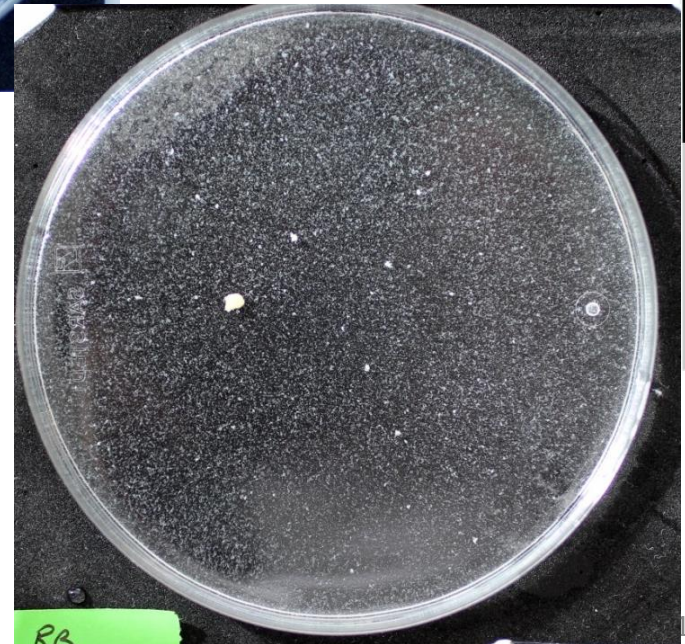
Complex monomeric



Simple monomeric



Complex polymeric



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