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Microbial successions during wastewater treatment start-up using microalgae

Amandine Galès[1, 2], Elodie Lanouguère[1], Anaïs Bonnafous[2], Claire Carré[1], Cécile Roques[1], Christophe Leboulanger[1], Audrey Caro[1], Emilie Floc'h[1], Clothilde Poullain[3], Bruno Sialve[2], Jean-Philippe Steyer[2], Vincent Jauzein[3], Eric Fouilland[1]

[1] Centre for Marine Biodiversity, Exploitation and Conservation (MARBEC), UMR 9190, IRD-IFREMER-CNRS-UM, Université de Montpellier, Montpellier Cedex 5 34095, France
[2] LBE, INRA, 102 avenue des étangs, F-11100, Narbonne
[3] SAUR, 2 rue de la Bresle, 78310 Maurepas, France

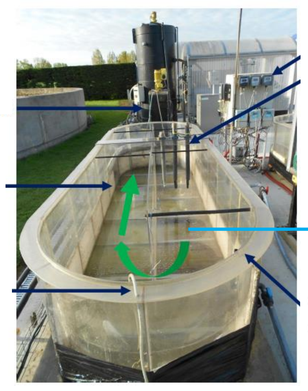
INTRODUCTION

The use of **High Rate Algal Pond (HRAP) for wastewater treatment** has gained more attention because of both the ability of **microalgae** to produce high levels of oxygen required for carbon, nitrogen and phosphorus removal and the potential valorisation of algal biomass.
Several studies highlighted the **interactions between microalgae and bacteria for the heterotrophic degradation of the organic carbon** [1] and the importance of microalgal species and algal predators succession on the seasonal performance [2, 3, 4].
However little is known on the initial establishment of the algal, bacterial and zooplanktonic communities in wastewater treatments.

The present study describes the dynamic of the **bacterial, algal and zooplanktonic communities during the initiation phase** of an urban wastewater treatment pilot until the stability of the bioremediation process in carbon, nitrogen and phosphate is reached.

METHODS

Pilot scale!



Process parameters

- 1.9m³ HRAP
- real urban wastewater
- continuously supplied with 315 L.d^{-1}
- 6-days hydraulic retention time
- 40 cm high

Sampling (Treated water)

A pilot scale HRAP located in North of France, under an oceanic climate, was setup in April, 2015 and supplemented with raw wastewaters from a wastewater treatment plant.

Microscopy

- Identification
- Enumeration
- Zooplankton
- Microalgae

Physico–chemical analyses

- Standard Methods
- Total and soluble chemical oxygen demand (COD)
- Phosphorus
- Ammonium

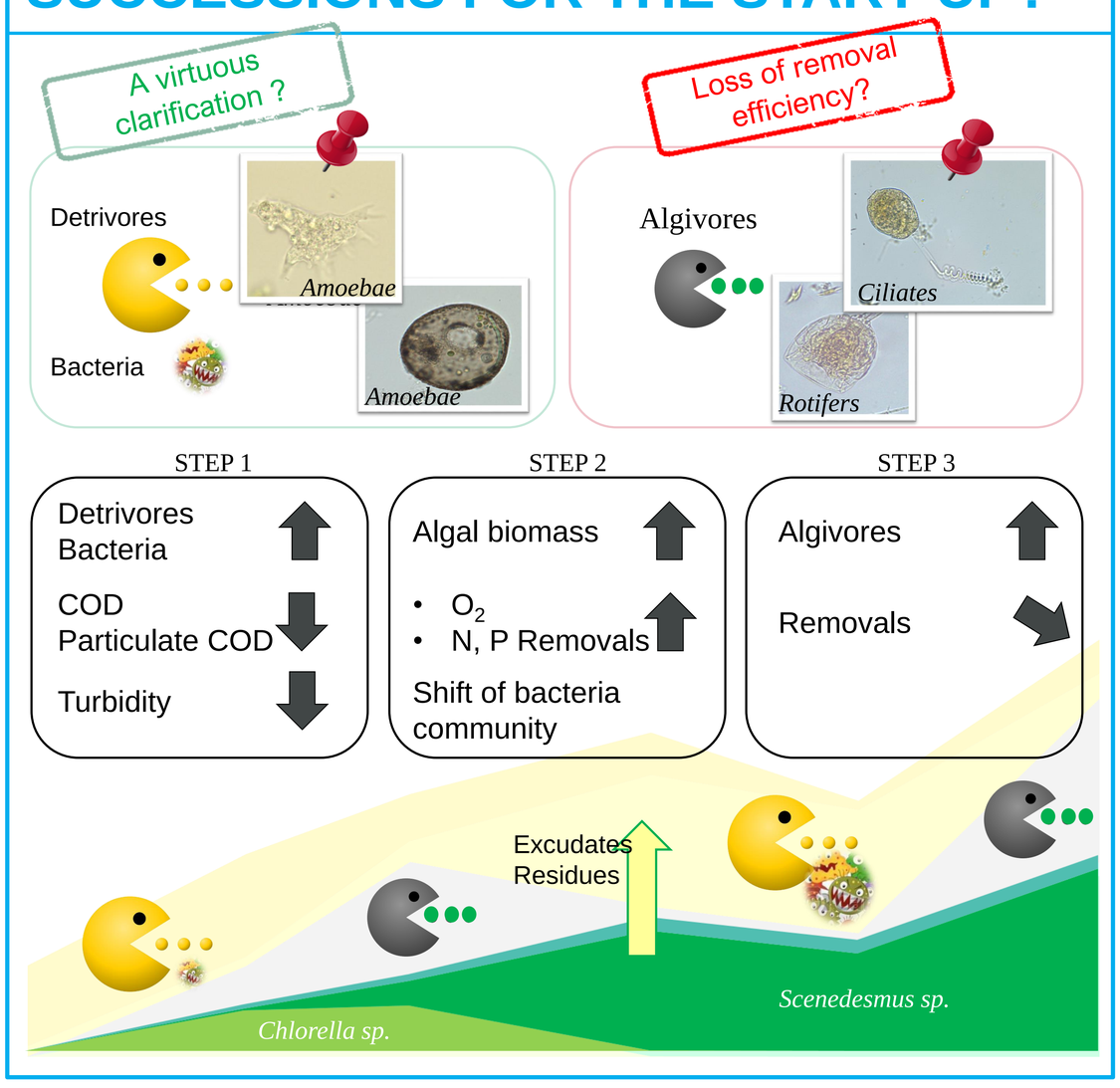
Molecular tools

- qPCR
- Sequencing
- Bacteria
- Cyanobacteria

C conversion

- Conversion factors from literature [5, 6, 7] were used to converted biomas into mg C/L

SUCCESSIONS FOR THE START-UP?



RESULTS

First, a substantial **reduction of organic particles** was observed within the first 3 weeks, concomitantly with an **increase in detrivores and bacterial abundance**. Then, a reduction of COD, ammonium and phosphate occurred during the following 3 weeks when the algal biomass started to grow with **a rapid development of *Chlorella sp*.** (Figures 1 & 2).

Figure 1 – C, N, and P removal performance

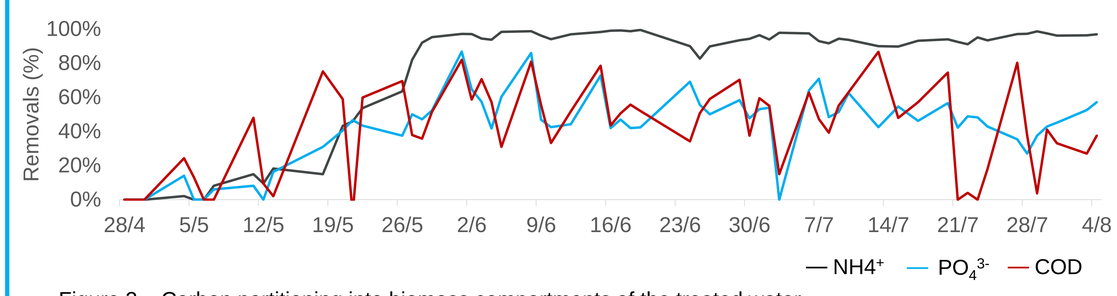
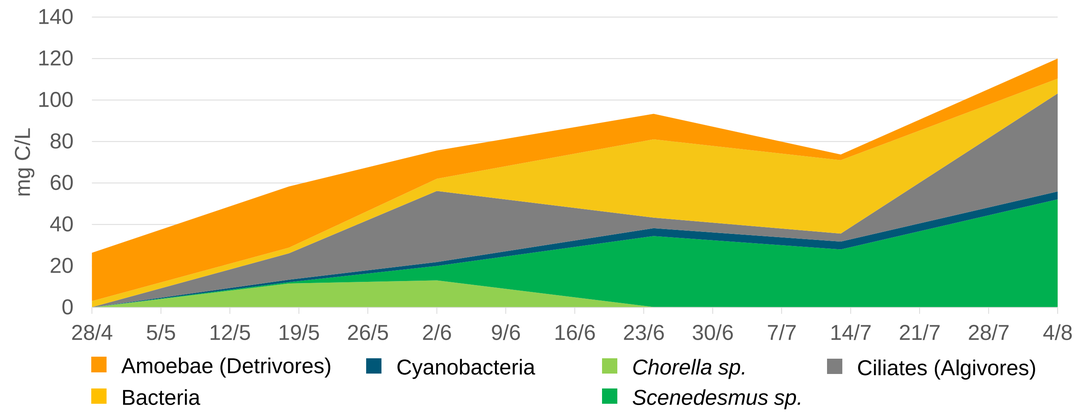
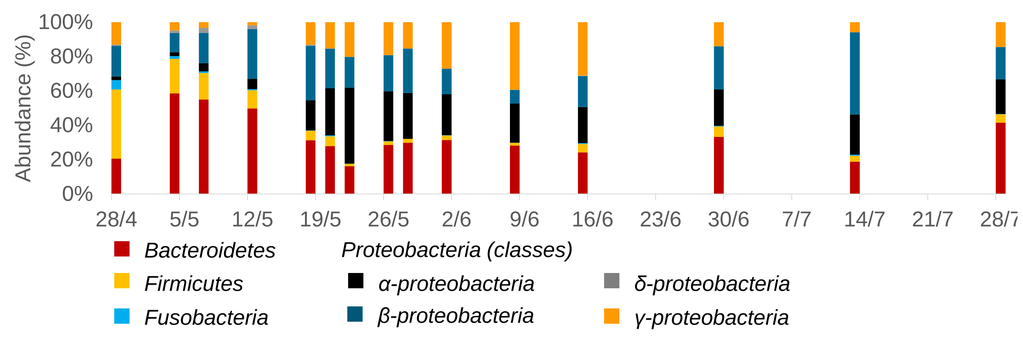


Figure 2 – Carbon partitioning into biomass compartments of the treated water



The maintaining of a high C, N, and P removal performance was associated to the slower development of larger autotrophic cells *Scenedesmus.* **Microalgae growth patterns were associated to algivores growth** (Figures 1 & 2).

Figure 3 – Phylum-level identifications of bacterial sequences of treated water



Firmicutes (Clostridi and Bacilli) were found to have a high relative contribution, consistent with the bacterial communities typically present in the wastewaters, The development of *Chlorella sp* seemed to be associated with **a shift in the bacterial community** with a drastic decrease of *Firmicutes* and the dominance of the *Proteobacteria* phylum (Figures 2 & 3).

CONCLUSIONS

« Turbidivores » as key organisms

Detrivores and bacteria consume the organic particles leading potentially to a turbidity reduction: this may favor the initiation of the microalgae growth

The pressure of Algivores

Grazers reduce the microalgal biomass and this could affect the process efficiency and stability

Support by a model

These two hypotheses are supported by a modelling approach (see C. Martinez oral presentation)

References

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Amandine.Gales@ifremer.fr
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