16 Febbraio 2018

AQUAFARM

Sfruttamento di interazioni specie-specifiche tra alghe e batteri per un efficiente trattamento delle acque reflue

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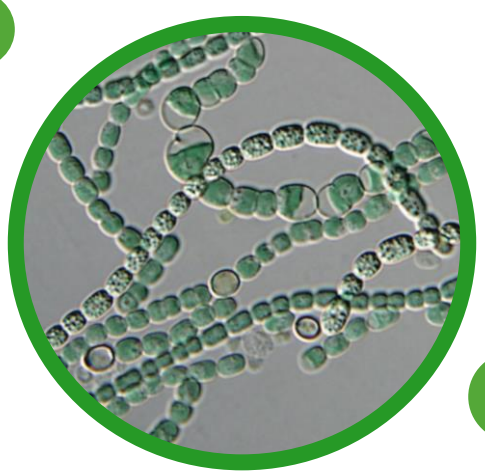


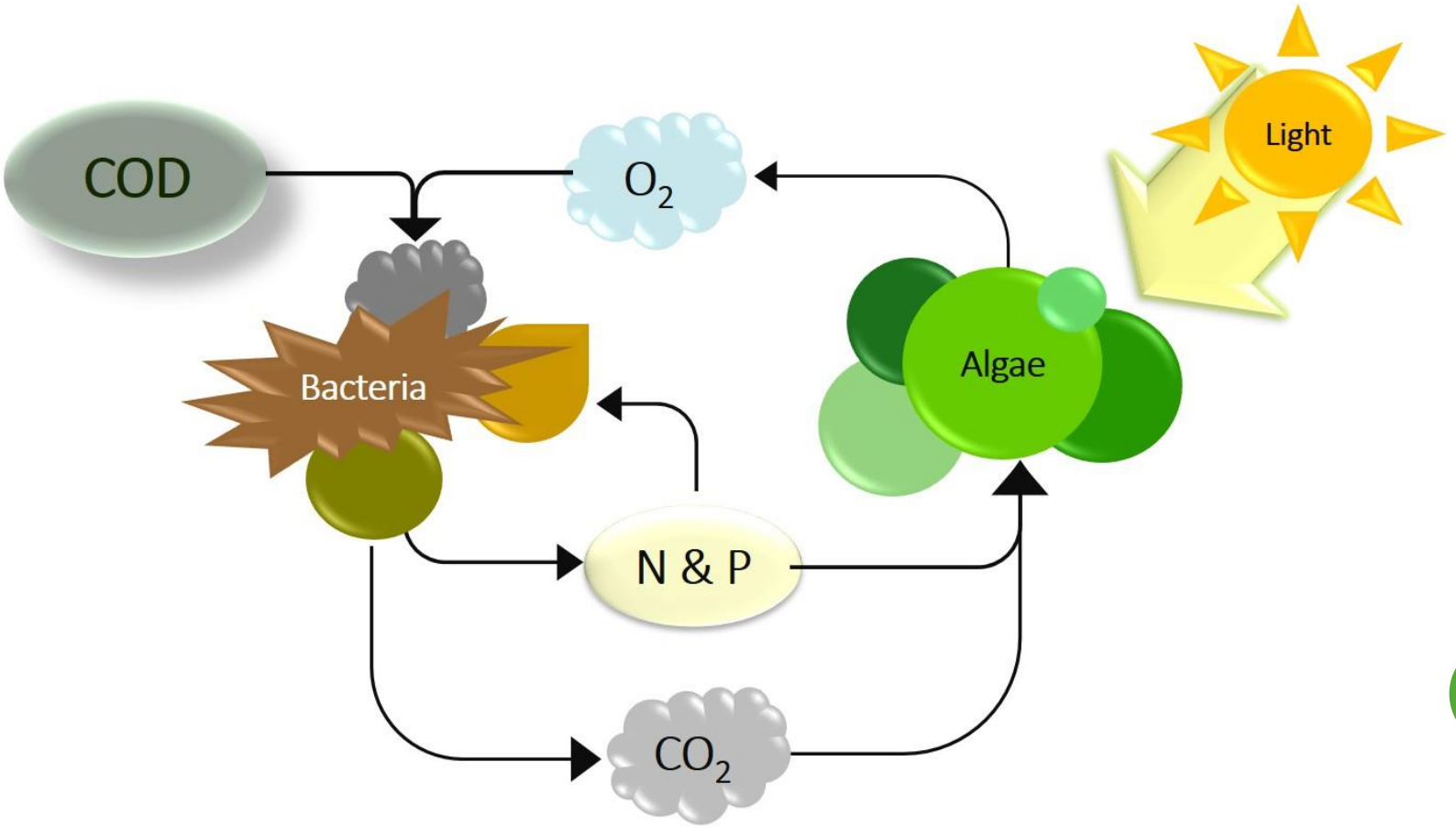
Introduction: freshwater issue and conventional wastewater treatment

The continuous growth of the population and the increasing amount of wastewater generated by human activities from one side, the water scarcity and the increasing demand for high quality from the other, make freshwater availability as one of the greatest future global challenges of our modern society

Conventional wastewater treatments, although efficient and implemented for a long time, are usually rather expensive. One of the major issues of current wastewater treatment processes is related to the energy consumption

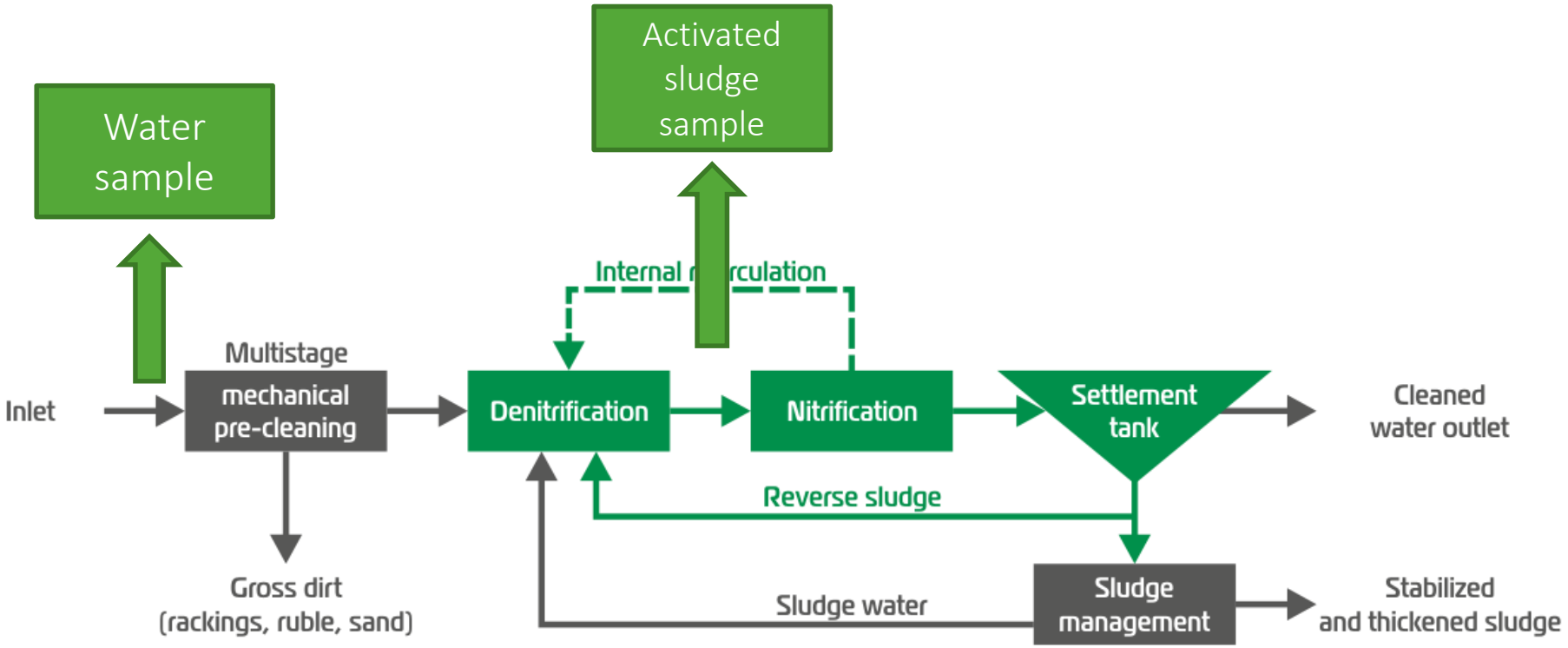
Microalgae- bacteria consortium

Microalgae use CO_2 and a part of nutrients dissolved in wastewater (N and P) to grow, releasing oxygen as byproduct. Aerobic bacteria use this dissolved oxygen to consume organic substrate. The CO_2 produced is used by microalgae for photosynthesis, closing this biological circle.



Wastewater source

The wastewater and the activated sludge bacteria were sampled from the wastewater treatment plants of Montebello (VI), Italy.



Methods

In this work, an integrated microalgal-bacteria system to efficiently treat wastewater is applied, with the aim to better understand the possibility to exploit the oxygen produced by photosynthesis to support the aerobic removal of organic compounds by the microbial community.

Methods

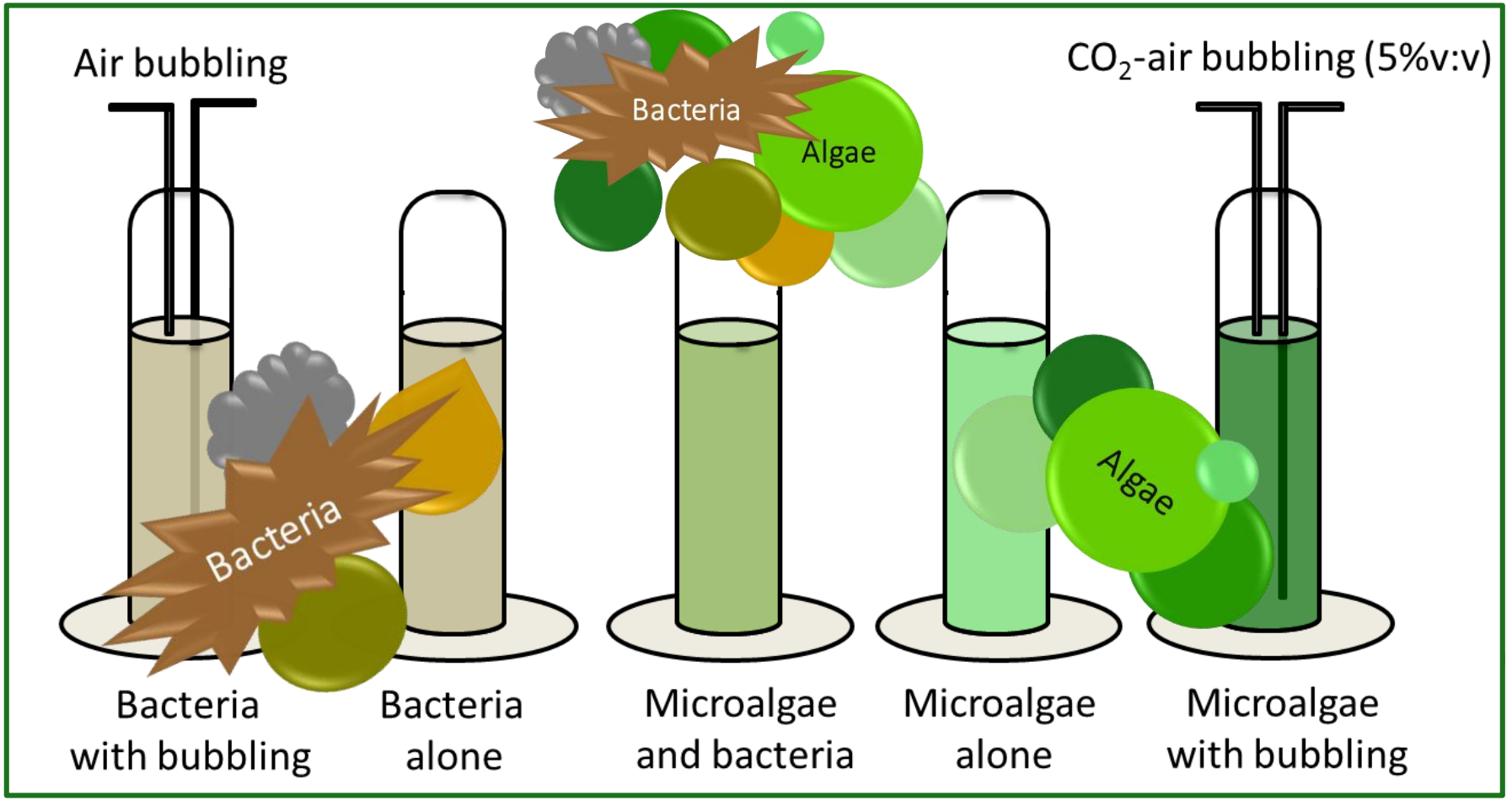
- *Batch growth curve*
  - *Measure of growth parameters*
  - *Nutrient removal: $N\text{-}NH_4$, $N\text{-}NO_3$, $N\text{-}NO_2$, Ntot, $P\text{-}PO_4$, COD*
- *Respirometric tests*

Microalgal species

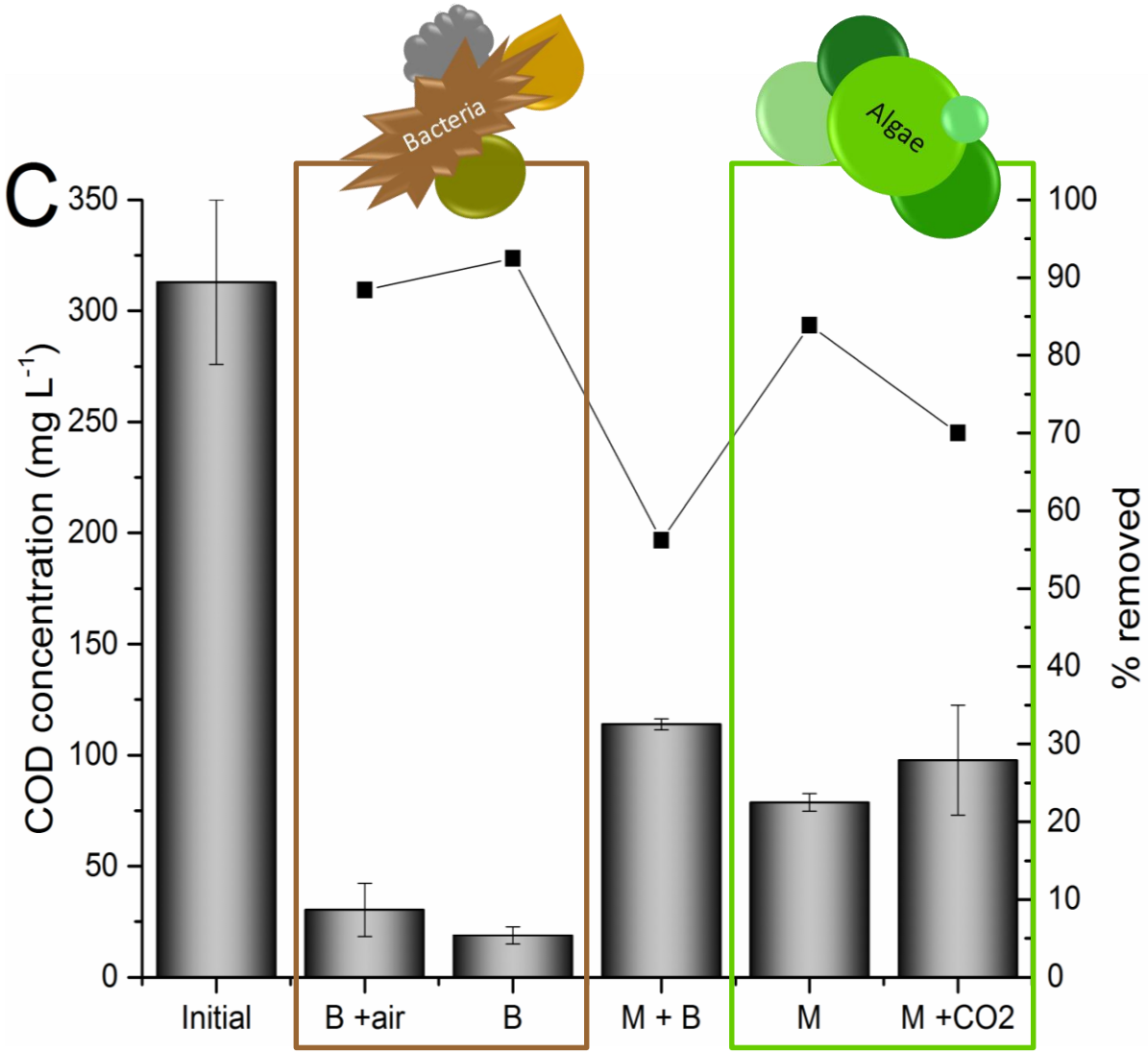
- *Chlorella protothecoides: strong and flexible species, already proved to be able to grow in wastewater*

Experiments in synthetic wastewater

Five conditions were applied, to understand the effect of gas exchange and the interactions among the different populations involved

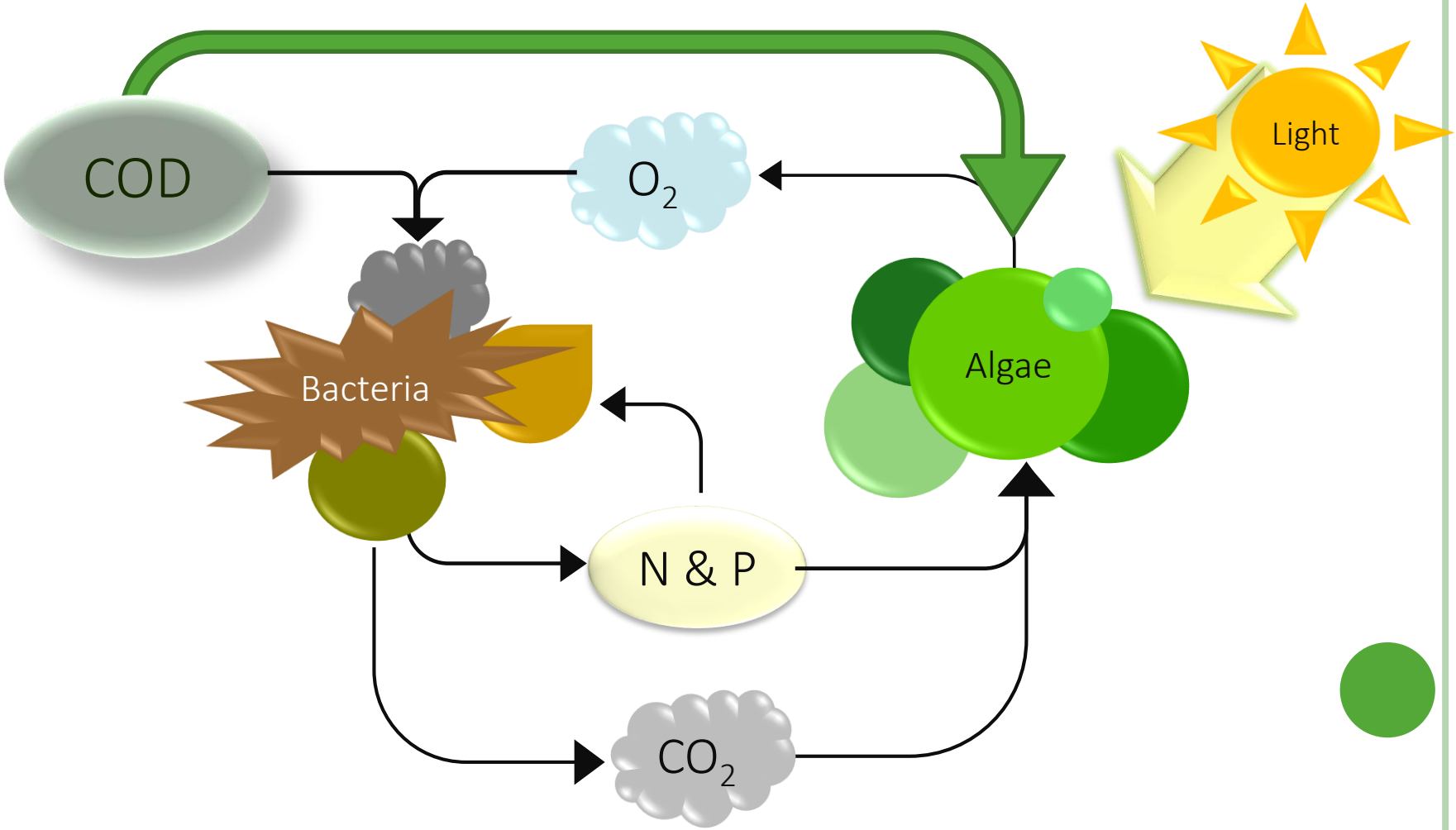


Consortium in synthetic wastewater: COD removal

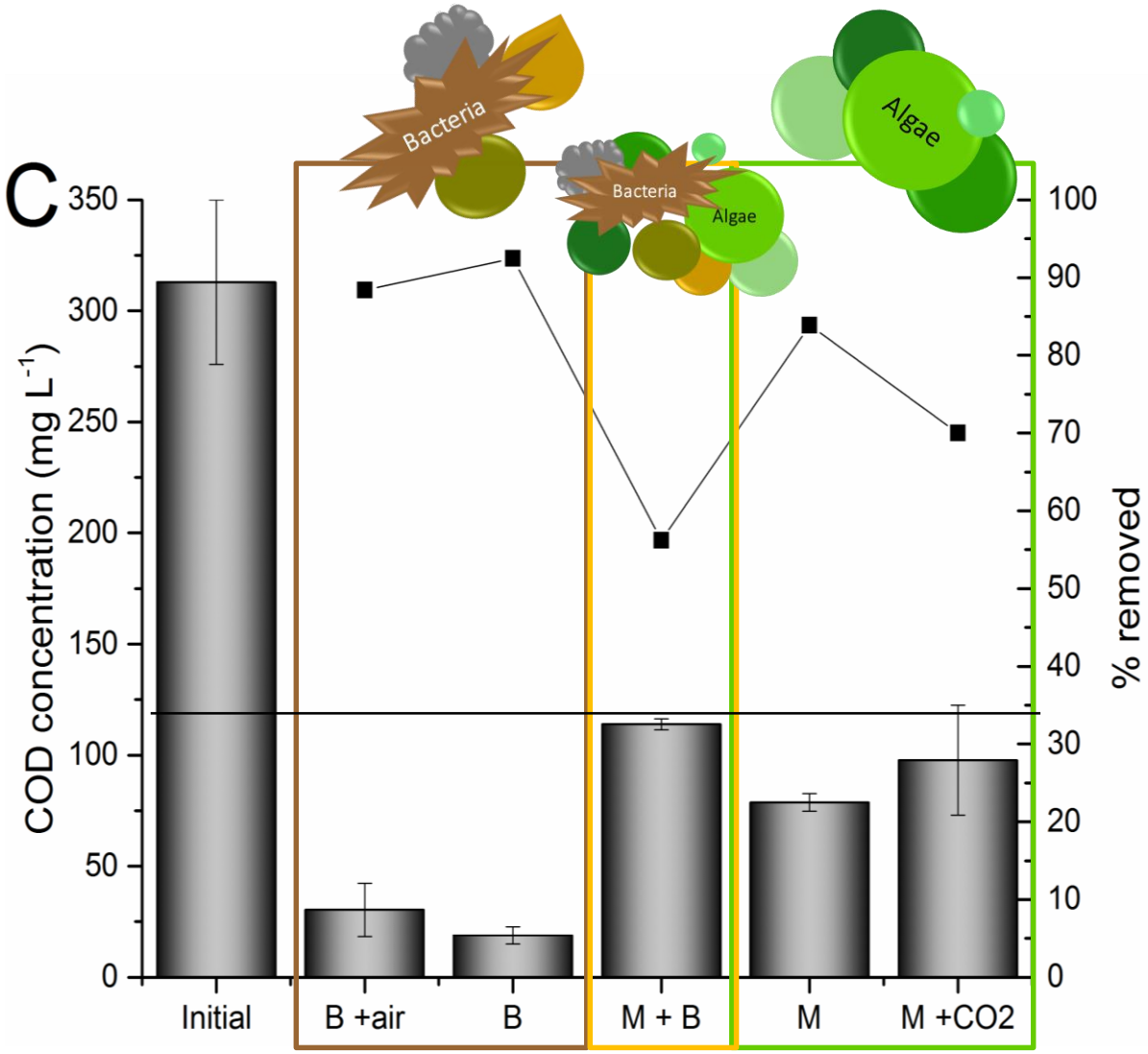


- *Bacterial removal of COD is very efficient*
- *A reduction of COD removal was observed in co-cultivation*
- *COD is removed also by microalgae, as a result of mixotrophic metabolism*

Effect of mixotrophy on M-B consortium



Consortium in synthetic wastewater: COD removal



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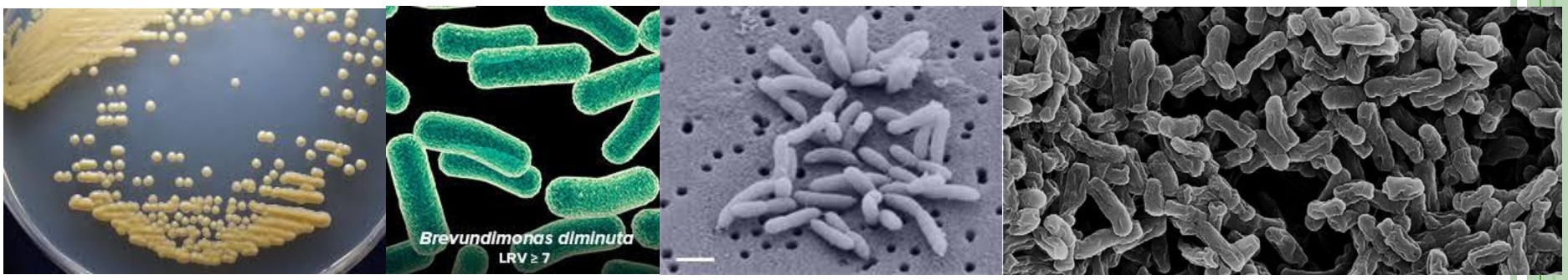
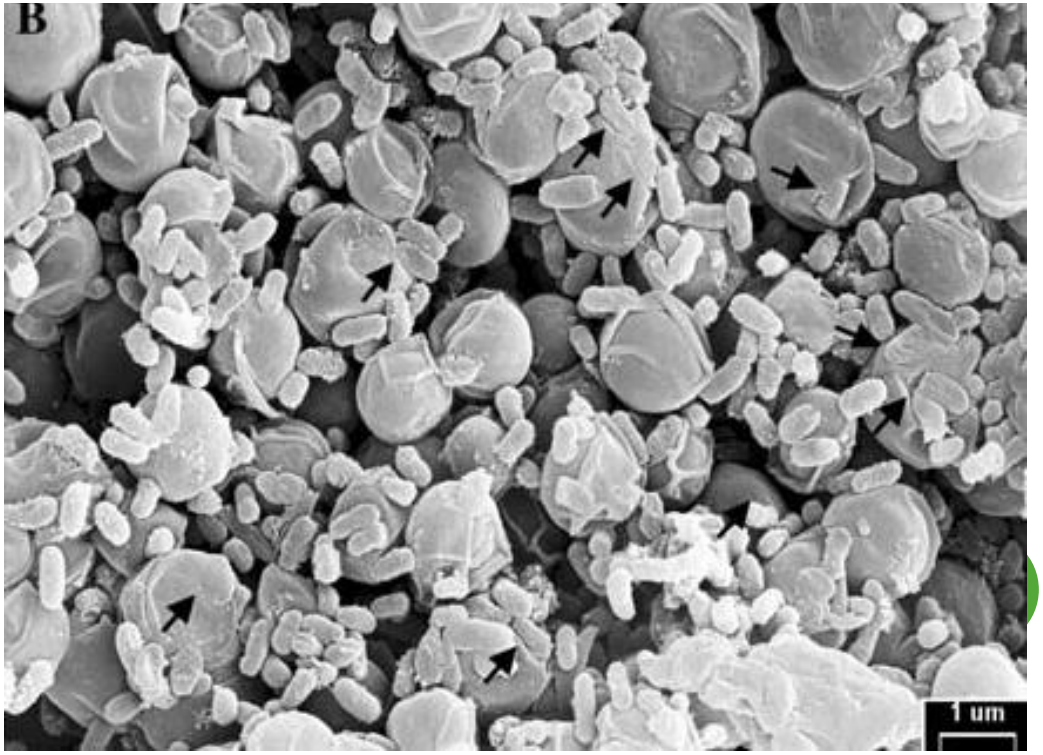
Species-specific interactions

Brevundimonas diminuta



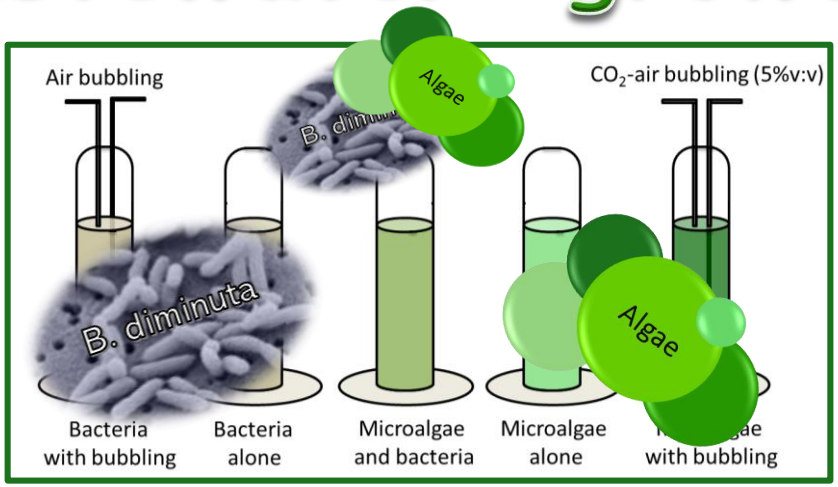
Micrographs of the scanning electron microscopy of *Brevundimonas diminuta.* (Ji et al., 2016)

- Gram negative, *Caulobatteraceae*
- Optimal growth conditions: pH = 7 and temperature 30-37 °C
- Motile
- Aquatic



Scanning electron microscope pictures of the *C. ellipsoidea* culture either with *Brevundimonas* sp (Park et al., 2008)

Consortium in synthetic wastewater: growth



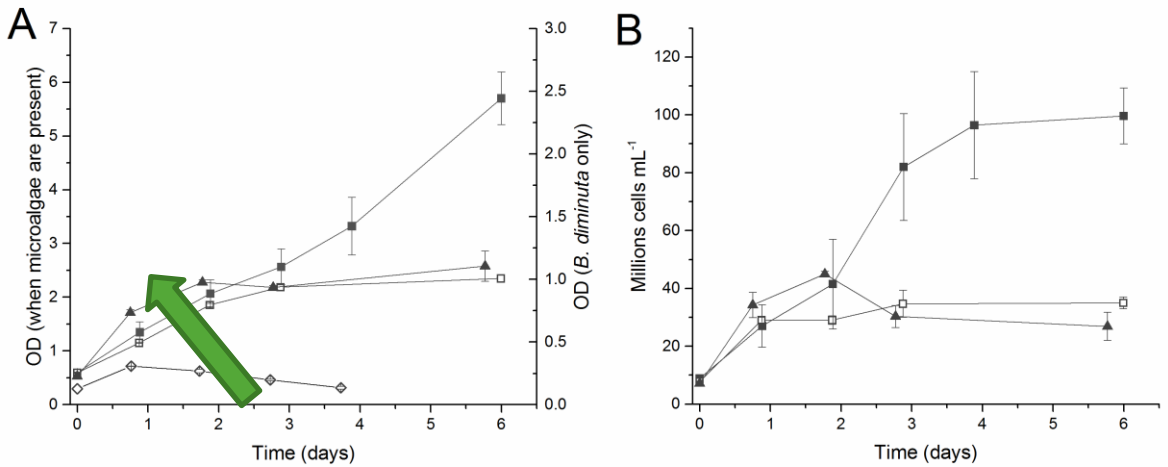
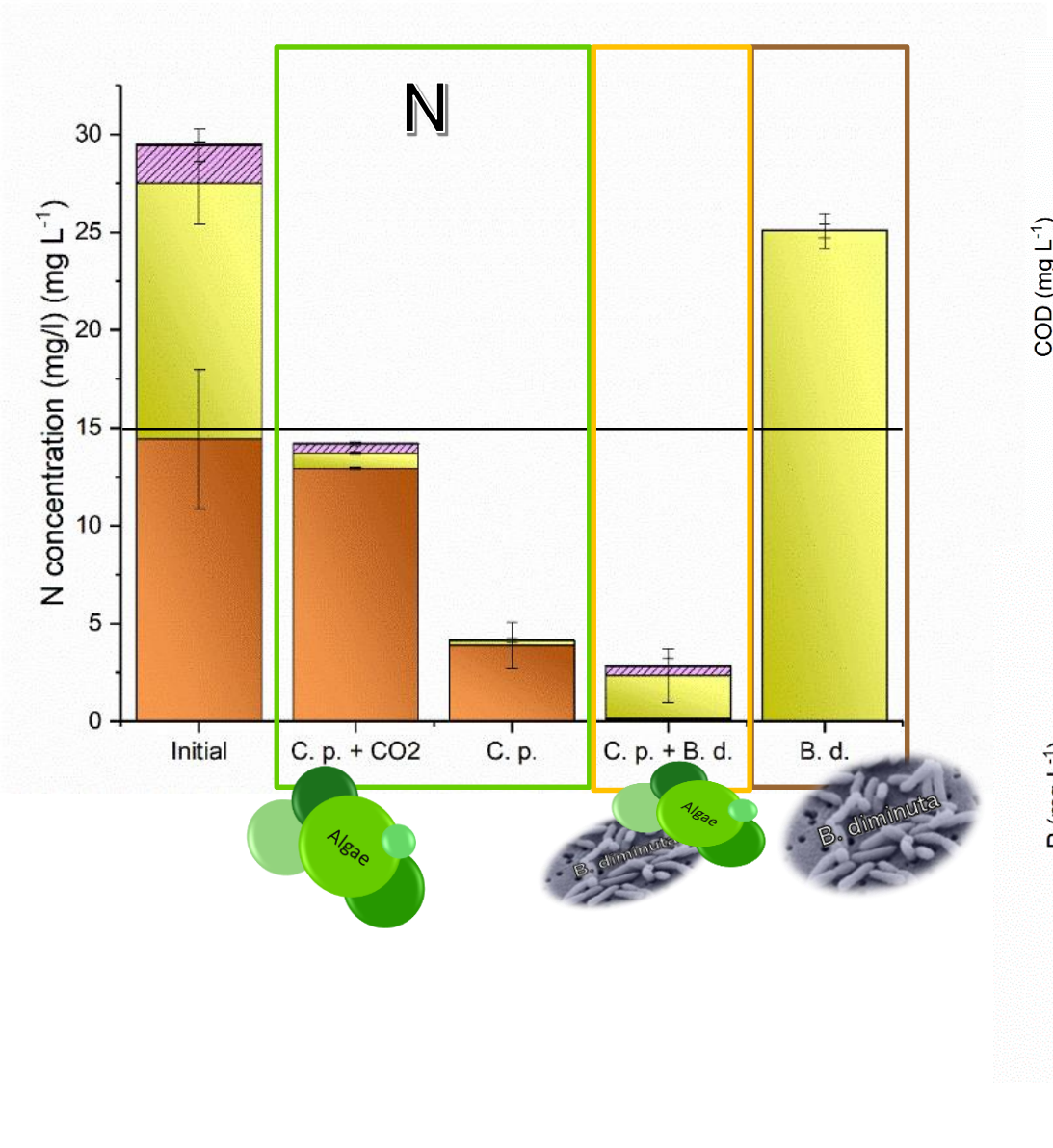
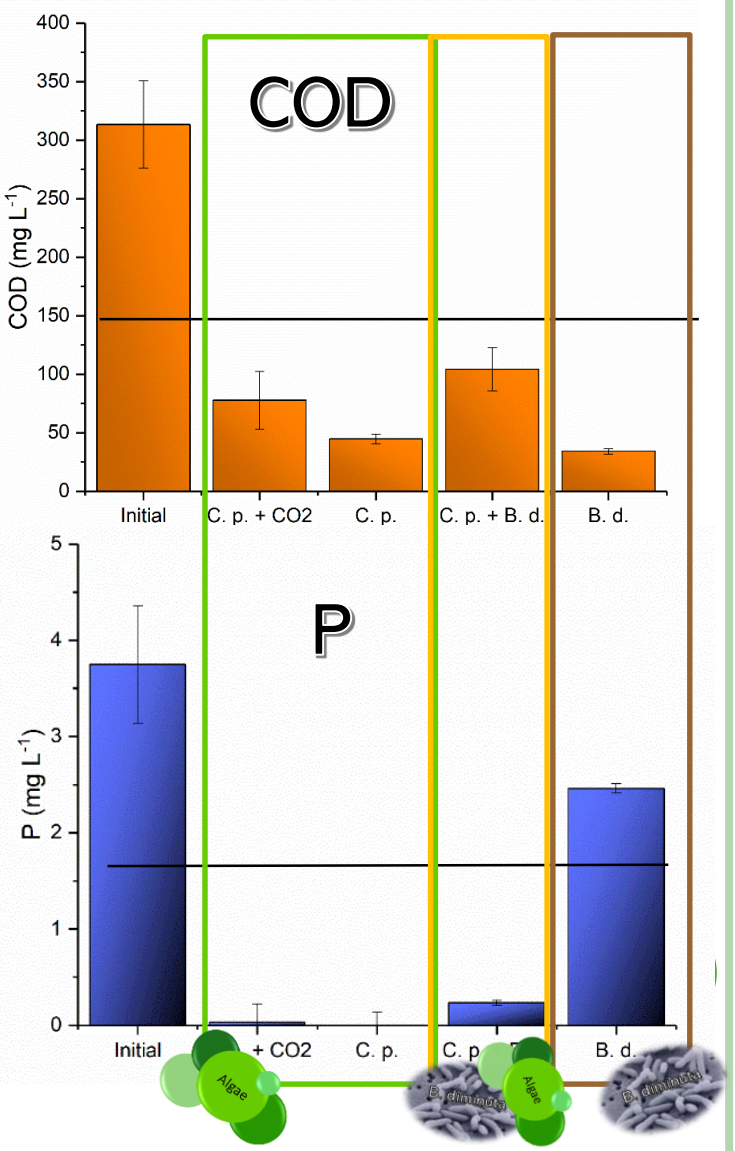


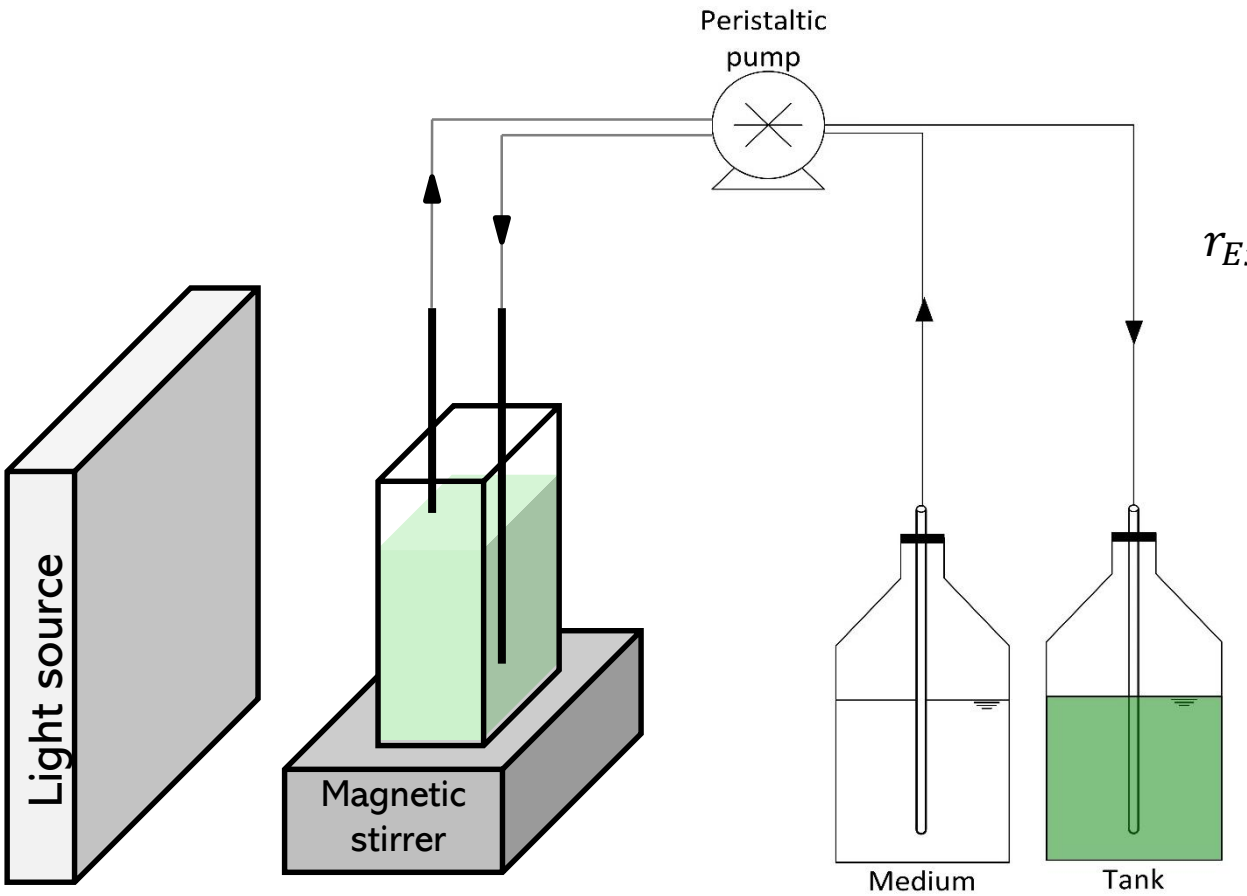
Figure 1. Growth curve (OD data in A, cells count in B) of C. protothecoides – B. diminuta consortium (dark triangle), microalgae alone without bubbling (open square) and with non-limiting CO_2 supply (dark squares) and B. diminuta alone (open diamonds) in synthetic wastewater. In Fig 1A, data of cultures with bacteria only (open diamonds) are referred to right Y axis, for graphical reasons only.

Consortium in synthetic wastewater: nutrient removal





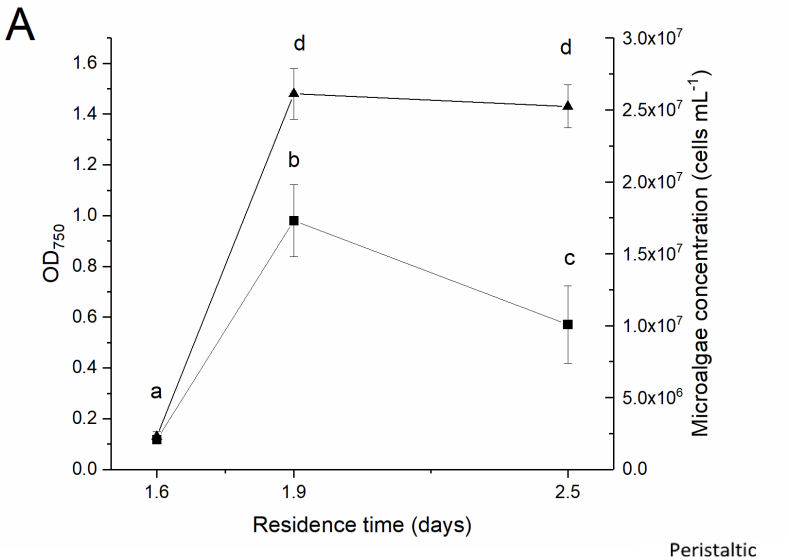
Continuous system

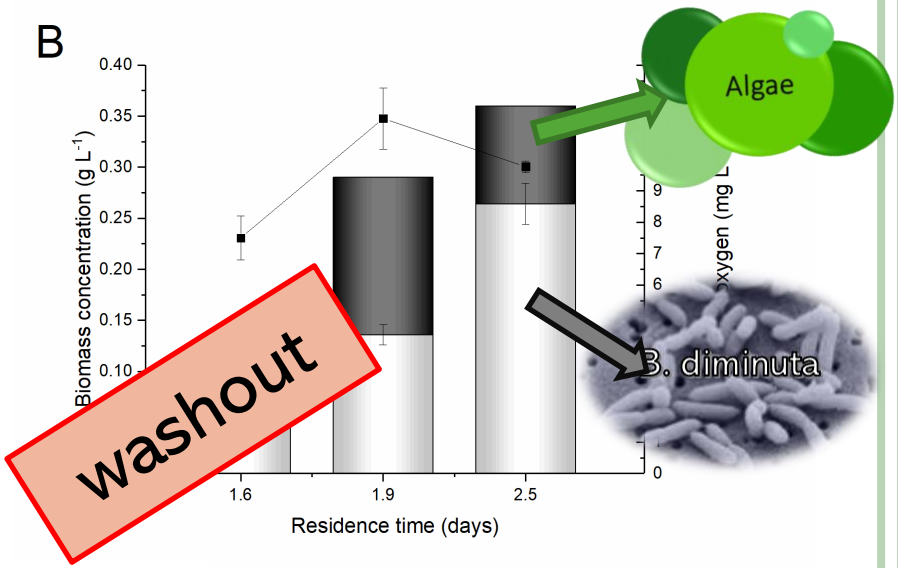


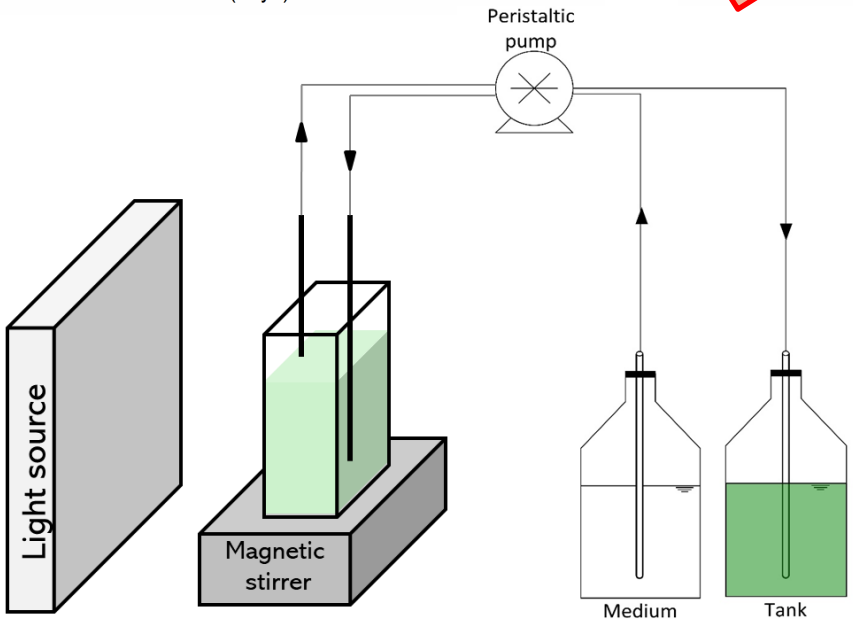
$$\tau = \frac{V_{pbr}}{Q}$$

$$r_{Ex} = \frac{PFD_{abs} * A_{pbr}}{c_x * V_{pbr}}$$

Effect of residence time τ



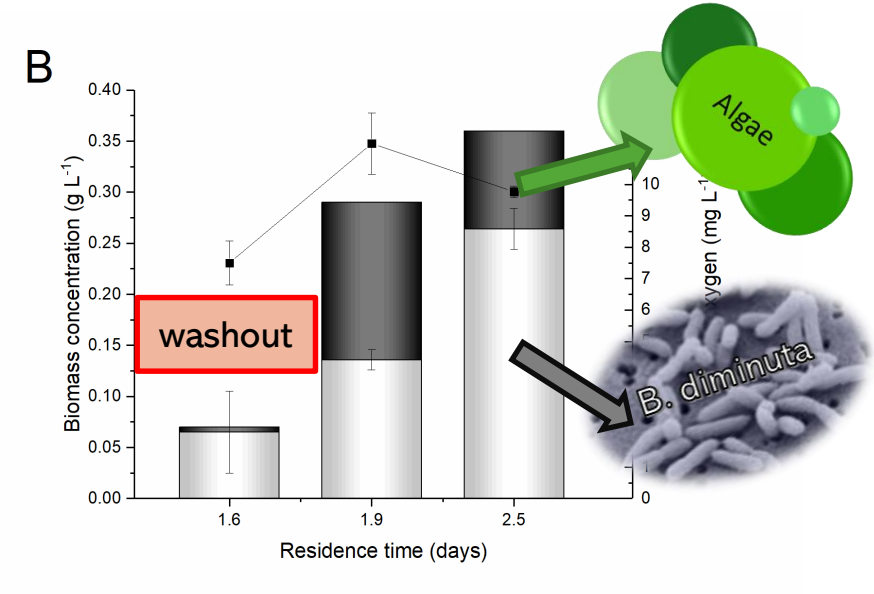


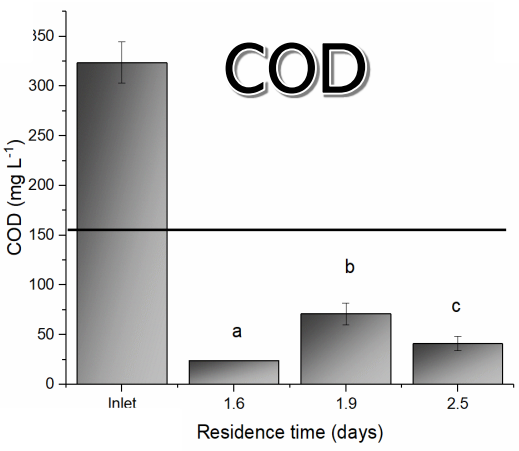


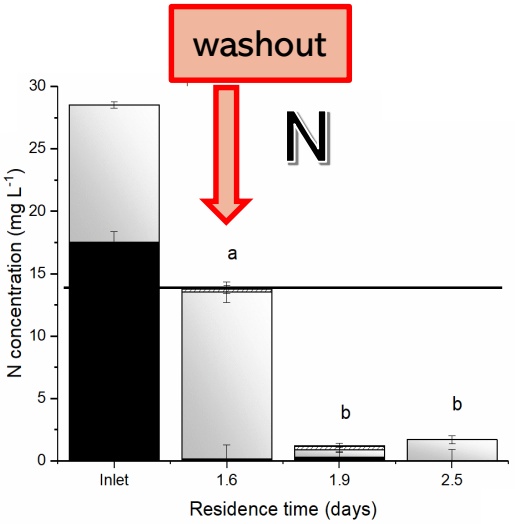
$$\tau = \frac{V_{pbr}}{Q}$$

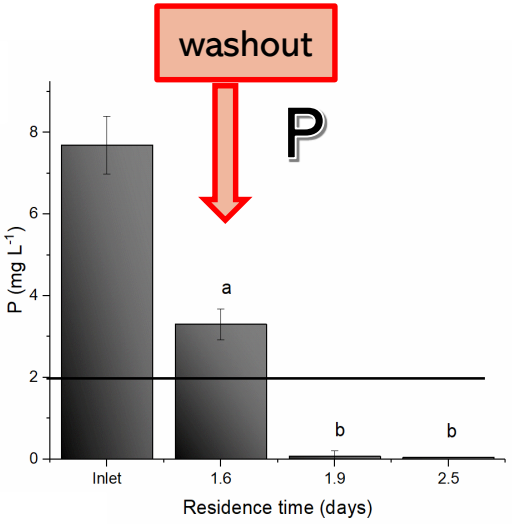
$$\mu = \frac{1}{\tau}$$

Effect of residence time τ

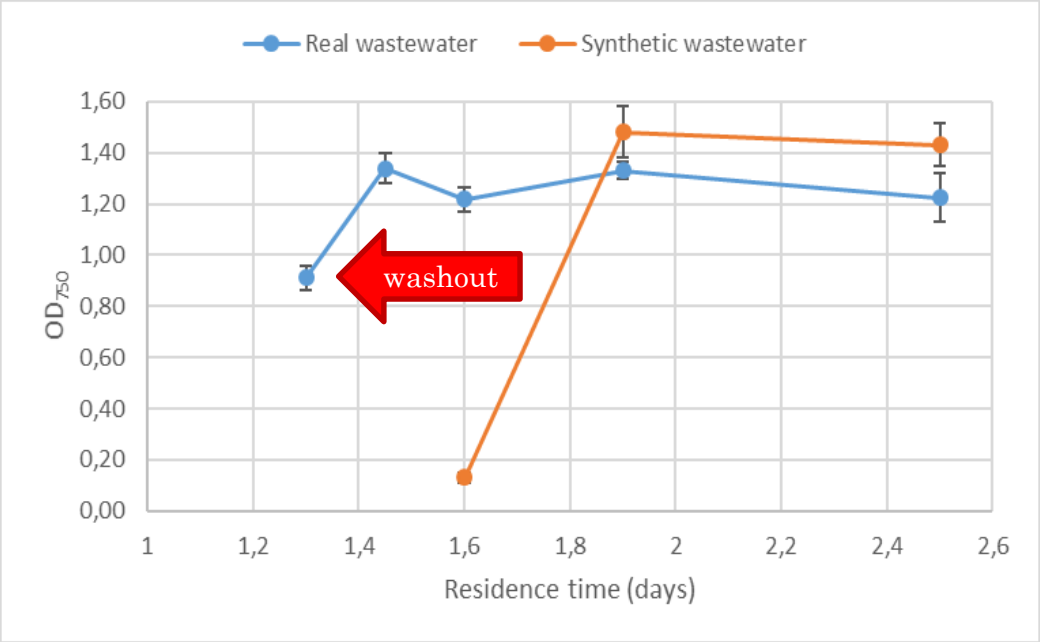


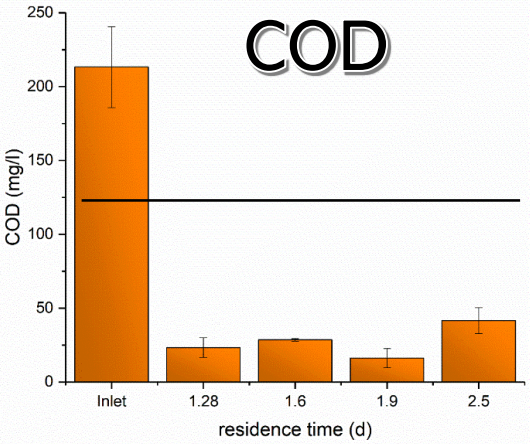


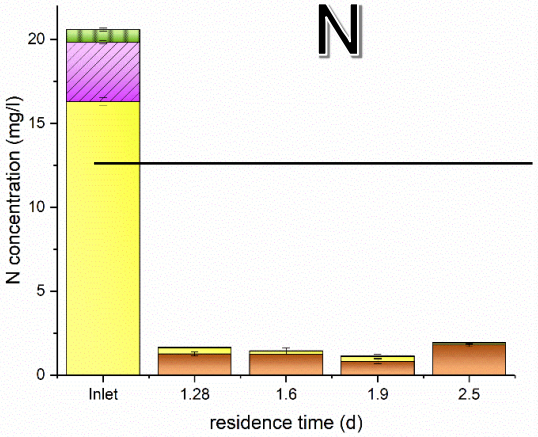


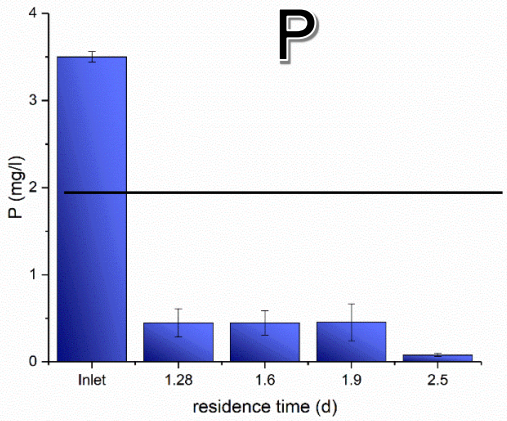


B. diminuta and C. prototheocoides: what happens in real wastewater?









Conclusions

- Microalgae and bacteria are able to growth in wastewater and remove pollutants
- The interactions are not only due to gas exchange
- Microalgae perform MIXOTROPHY in urban WW
- The exploitation of symbiotic interactions between species-specific consortia may improve the perfomance of the treatment
- The consortium between *B. diminuta* and *C. protothecoides* is very efficient also in real wastewater and in continuous reactors

Thank you for your attention
Eleonora Sforza