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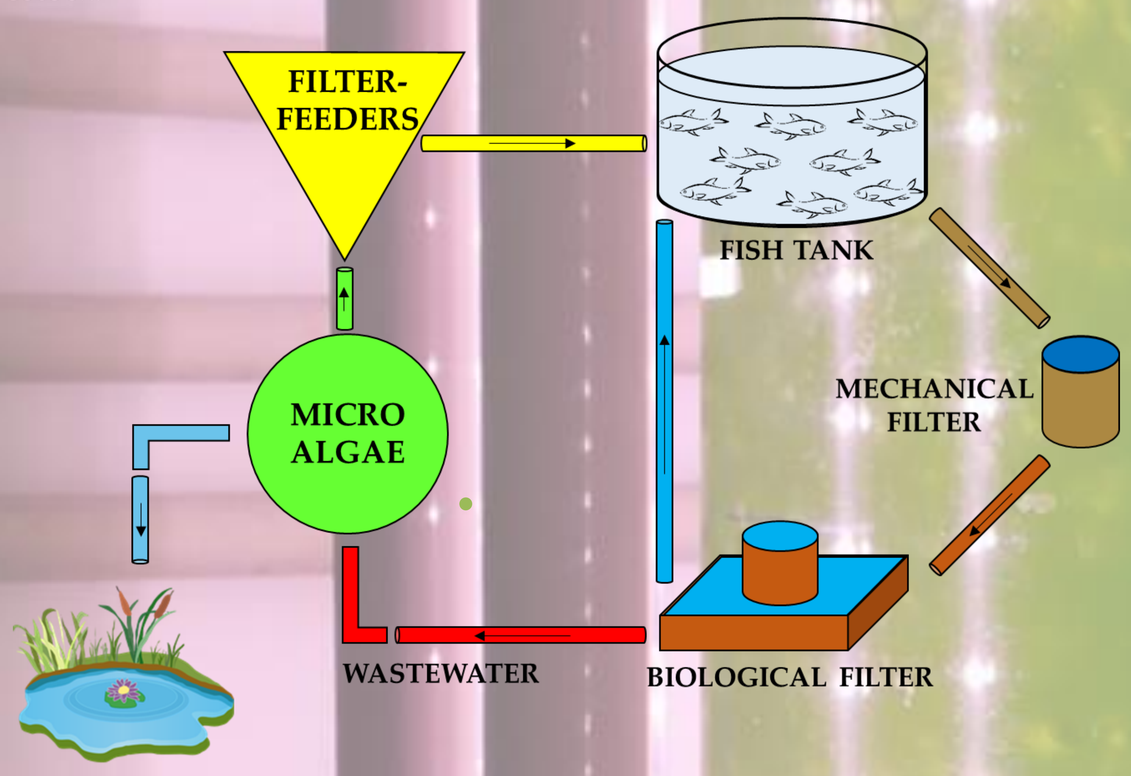
The use of biological traps for water treatment in Recirculating Aquaculture Systems (RAS)

RAS reduce potential environmental impacts of wastewater by concentrating nutrients and organic matter but not by overall reduction in discharges (Piedrahita, 2003). High concentration of dissolved nutrients in RAS wastewater may allow new opportunities to develop technologies for exploiting the waste as a valuable resource (e.g. integrated multi-trophic aquaculture approach) (Martins *et al.*, 2010) and to reduce nutrient release into the surrounding environment.

IN THIS PROJECT we are testing: (1) if microalgae can efficiently remove dissolved nutrients from RAS wastewater and (2) if filter-feeders can remove those microalgae from the water. Filter-feeding animals grown with microalgae, such as crustacean waterfleas and freshwater mussels, can be further used as feed for fish or livestock.



1. USE OF MICROALGAE for nutrient uptake

- We compared nutrient removal efficiency of several temperate zone microalgae species in RAS wastewater.
- RESULT: All green microalge removed nutrients efficiently in 4 days (Fig.1).

2. LED LIGHTS for growing microalgae

- We tested the effect of LED grow lights with 3 different continuous spectra on growth and nutrient uptake efficiency for 4 green microalgae in RAS wastewater.
- RESULT: Microalgae grew and removed nutrients equally well under all tested spectra.

3. FILTER-FEEDERS as harvesters for green microalgae

- So far we have tested how well a waterflea *Daphnia magna* can filter and grow with different microalgae cultured in RAS wastewater.
- RESULT 1: Waterfleas removed up to 80% of certain microalgae from RAS wastewater in two days (Fig.2)
- RESULT 2: Waterfleas increased 2-4 times in weight when fed microalgae for 4 days (Fig.3).
- NEXT STEP: to test the lake mussel *Anodonta anatina* as harvesters for microalgae.

Fig.1. Removal of dissolved nutrients from RAS wastewater after 4 days

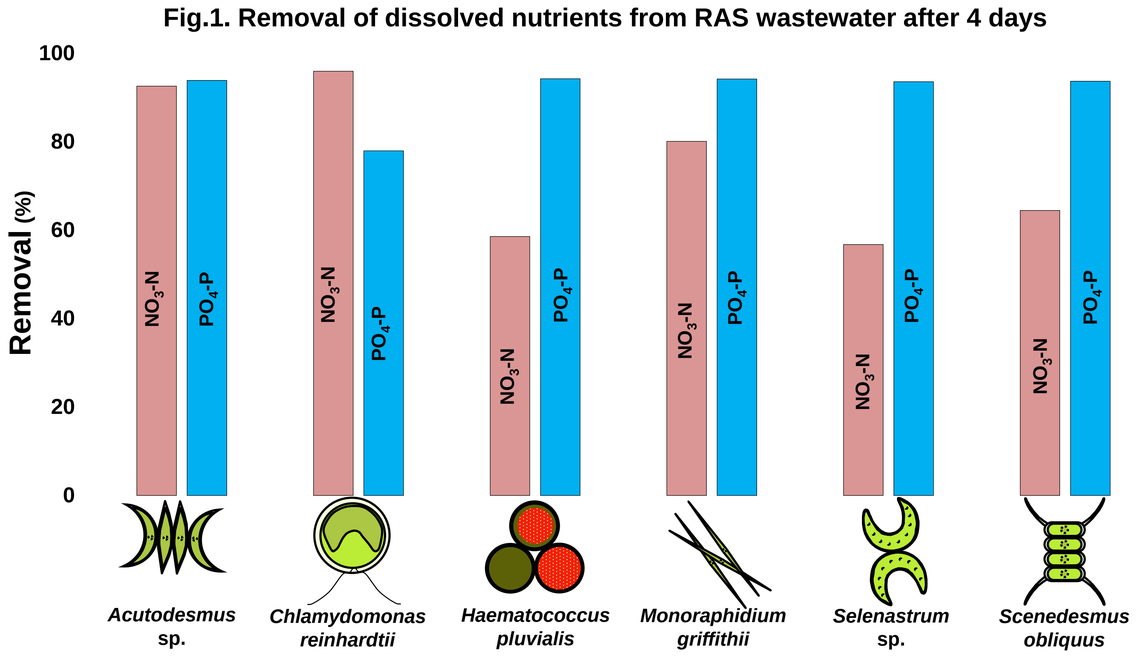


Fig.2. Removal of microalgae from RAS wastewater by *Daphnia magna* after 2 days

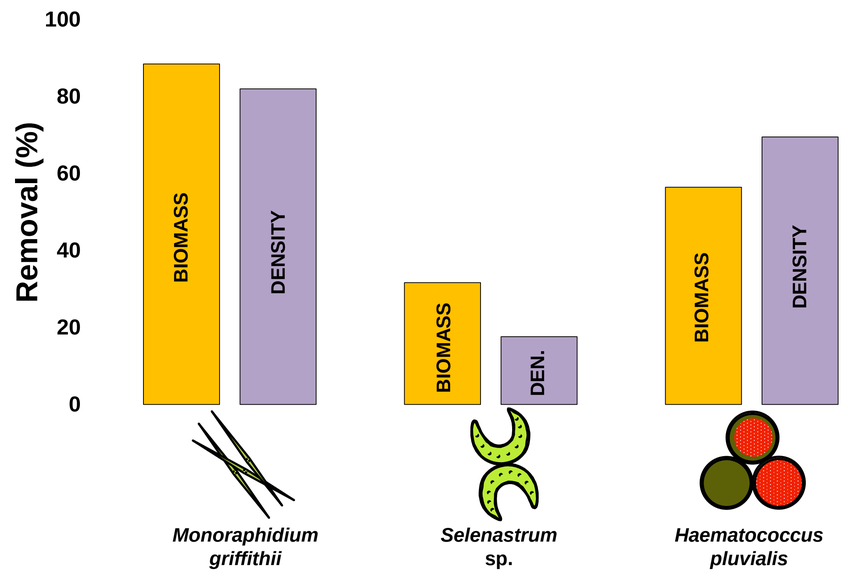
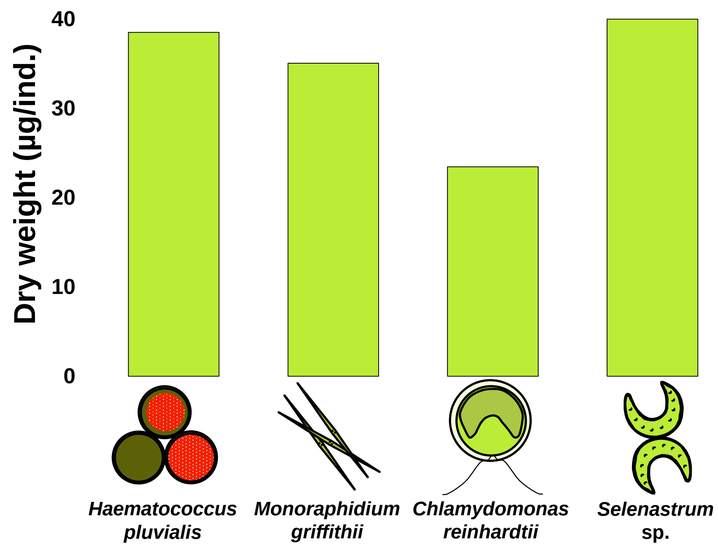


Fig.3. Growth of *Daphnia magna* after 4 days fed with 4 microalgae cultivated in RAS wastewater



CONCLUSIONS

- **Unfiltered RAS wastewater promotes growth of green microalgae.**
- **Biomass production and nutrient removal in RAS wastewater varies among the tested species of microalgae.**
- **Green microalgae can be used for RAS wastewater treatment as they improved the water quality by reducing the concentrations of nitrate and phosphate.**
- **Continuous spectrum LED lights may be used efficiently to obtain high removal of dissolved nutrients and high microalgal biomass.**
- **Waterfleas (*Daphnia magna*) are capable of filtering and consuming green microalgae for their growth in RAS wastewater.**
- **This technique has a potential to promote circular economy of RAS.**

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References:
Piedrahita, R.H., **2003**. Reducing the potential environmental impact of tank aquaculture effluents through intensification and recirculation. *Aquac.* 226, 35–44.
Martins, C.I.M., Eding, E.H., Verdegem, M.C.J., Heinsbroek, L.T.N., Schneider, O., Blancheton, J.P., Roque, E., Verreth, J.A.J., **2010**. New developments in recirculating aquaculture systems in Europe: A perspective on environmental sustainability. *Aquac. Eng.* 43, 83–93.