Biofilm on plastic is a low-quality food resource for the grazer *Radix balthica* (Gastropoda)

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Motivation

Plastic debris accumulates in freshwater habitats, becoming an artificial substratum for biofilms, an important food resource for grazing invertebrates. The effects of plastic on two trophic levels of the benthic food web was investigated: Primary production, i. e. biofilm development and primary consumption, i. e. the grazing snail *R. balthica*.

Hypotheses:

- Biofilm composition on plastic differ compared to biofilms on natural substrates.
- Biofilms on plastic provide a low nutrition supply.

Conclusion

Plastic affects the composition and establishment of primary producers leading to adverse effects on primary consumers. Hence, plastic may cause alterations in aquatic food webs.

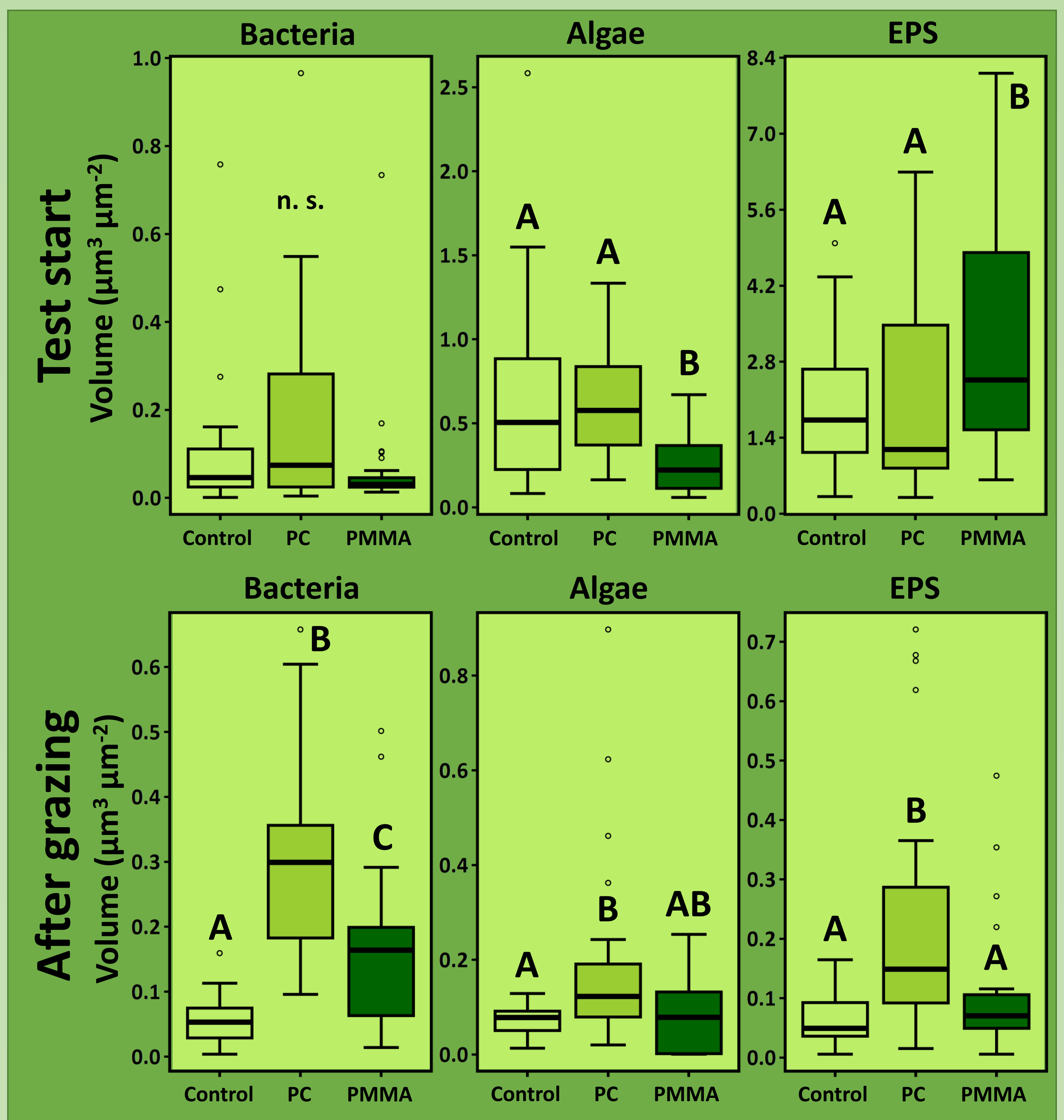

Fig. 1: Composition of biofilm grown on glass (control), PC and PMMA. Different letters indicate significant differences with $p < 0.05$ (n.s. = no significance). Test start - Bacteria: Kruskal-Walis. Algae: ANOVA; post hoc max_{-t} test. EPS: ANOVA; post hoc Tukey 'HSD'. Test end - Bacteria and EPS: ANOVA; post-hoc Tukey 'HSD. Algae: ANOVA; post hoc max_{-t} test. N = 25 for all groups.

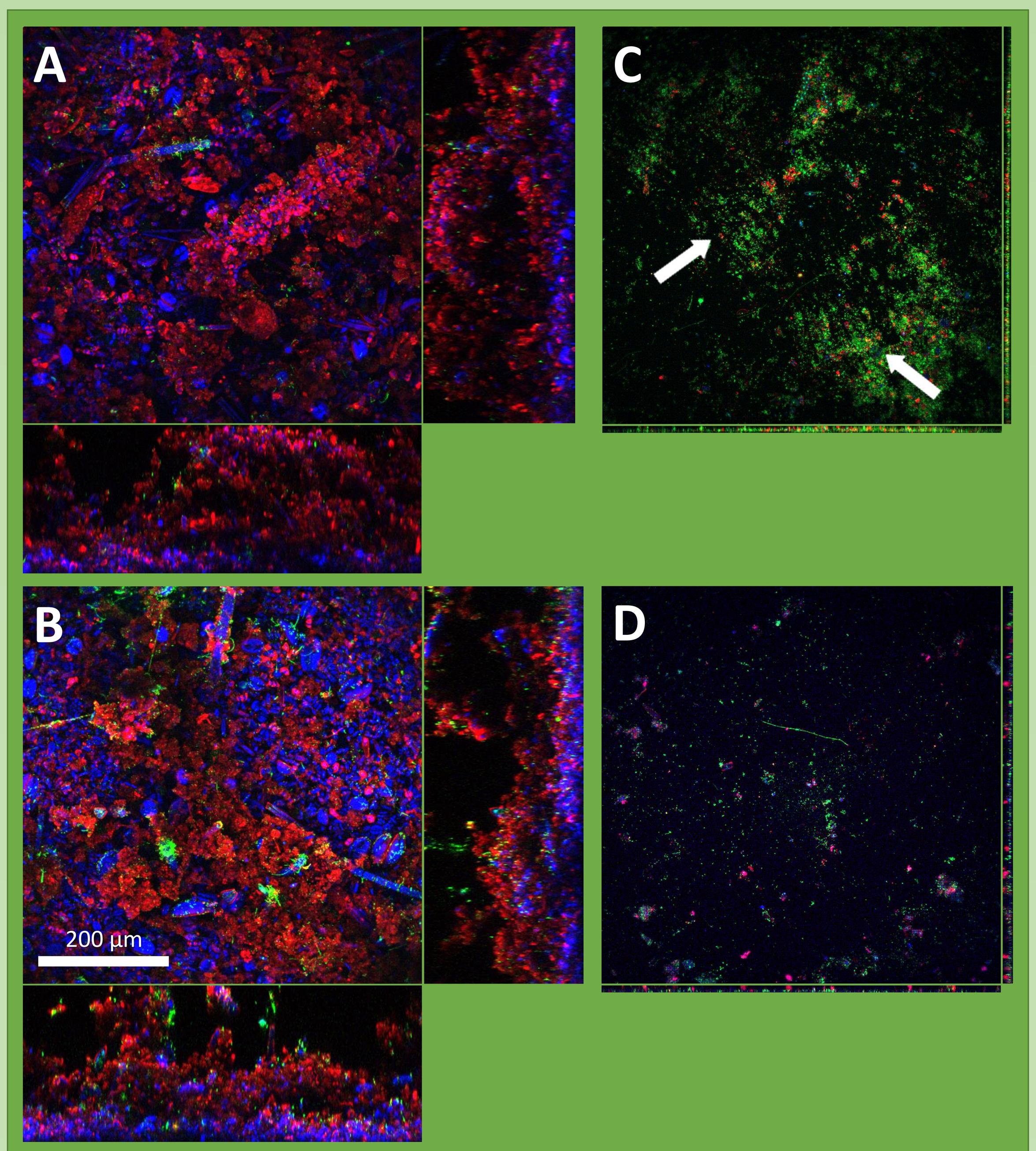

Fig. 2: CLSM XYZ projections – squared centre images: projections in z-direction, bottom images: projections in y-direction, right-hand pictures: projections in x-direction. Bacteria are plotted in green, algae in blue and EPS in red. (A) Typical biofilm structure, PMMA, test start; (B) Typical biofilm structure, Control, test start; (C) Bare area with radula traces (white arrows), PMMA, grazed biofilm after test end; (D) Bare area, Control, grazed biofilm after test end.

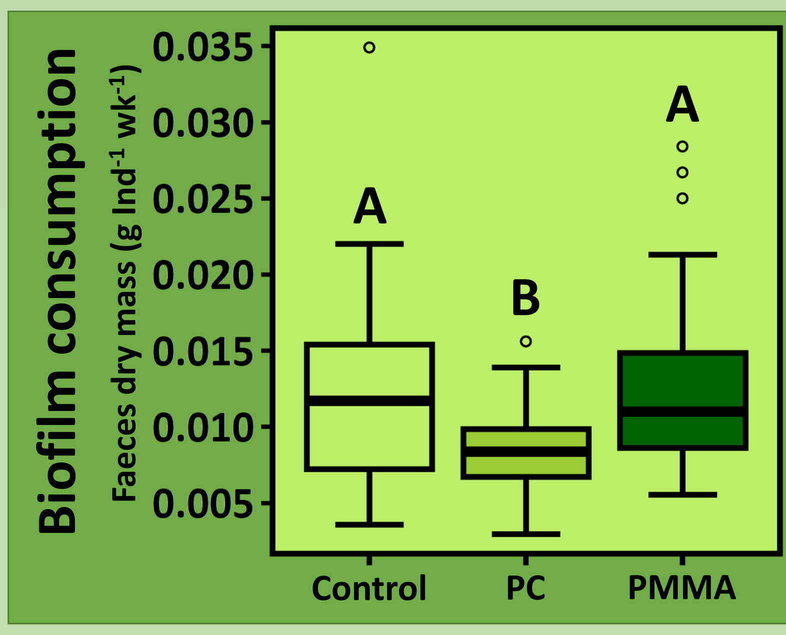

Fig. 3: Consumed biofilm during grazing test. Different letters indicate significant differences with $p < 0.05$. ANOVA; post hoc Games-Howell. N = 35 for all groups.

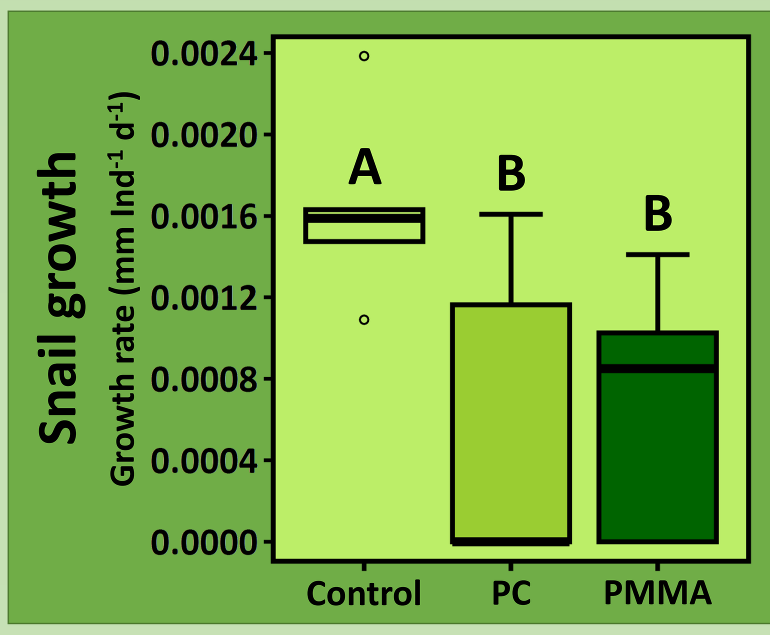

Fig. 4: Shell growth during the last eleven days of grazing test. Different letters indicate significant differences with $p < 0.05$. Kruskal Wallis test with LSD post hoc. N = 5 for all groups.

Results

- PMMA biofilm had significantly higher EPS and lower algae volumes, compared to both control and PC biofilms (Fig. 1).
- After grazing test glass was completely bare, while on both plastic substrata patches of biofilm remained.
- Feeding traces of snail radula on both plastic types, while on glass only few residues appear (Fig. 2).
- Biofilm consumption was significantly lower in the PC treatment, compared to PMMA and control (Fig. 3).
- Growth rates were significantly lower in both plastic treatments compared to control at test end (Fig. 4). Some individuals even stopped growing.

Discussion

- Surface properties of plastic might lead to stronger attachment of biofilms, what could explain the remaining biofilm patches after grazing, as well as the radula traces revealed by CLSM data.
- Low snail growth rates may result from:
  - lower biofilm consumption on PC.
  - lower nutritional value, due to low algae volumes on PMMA.

Methods

Polycarbonate (PC) and Perspex (PMMA) were chosen as test substrata and glass was used as control substratum. Biofilm was grown under natural conditions in a highly productive lake for seven weeks. Biofilm composition was examined using confocal laser scanning microscopy (CLSM). In a laboratory grazing test, 15 individuals of *R. balthica* were fed with the biofilm for five weeks. Sub lethal effects on snails were tested observing biofilm consumption and shell growth rates.

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