Testing the effects of environmentally relevant microplastic in sediment on sixteen invertebrate species under ecologically relevant conditions

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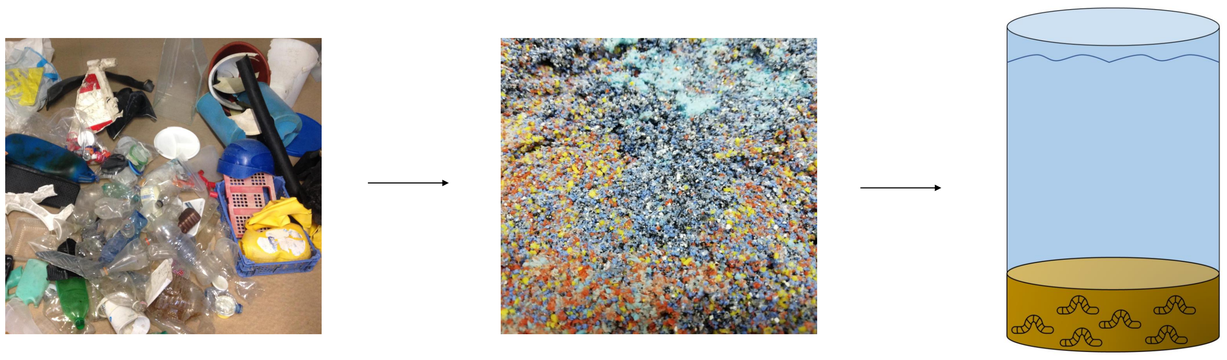
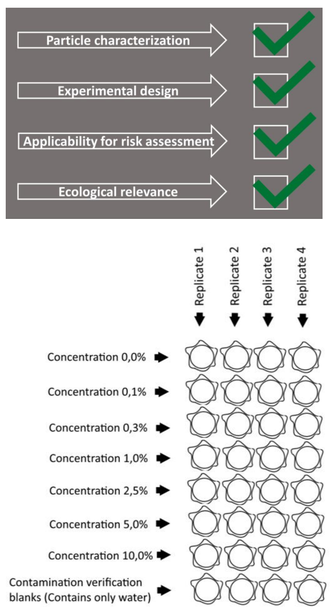
Introduction

Microplastic is a multidimensional contaminant and requires a risk assessment framework that reflects all these dimensions, while only considering high quality data. Therefore, effect tests should only use diverse, environmentally relevant microplastics (ERMP) and meet high quality requirements. Using a systematic approach, we tested sixteen marine and freshwater invertebrate species.



Materials & Methods



ERMP was made by cutting and grinding plastic items from nature such that it represented the natural diversity of microplastics, in terms of weathering, polymer type, size and shape. The test design fulfilled twenty previously published quality assurance and quality control (QA/QC) criteria from de Ruijter *et al.* (2020)[1]. For instance, key features of the quality assurance were that multidimensional particles were characterized extensively; contamination was minimized, exposure concentrations were homogenous and verified, natural particles were included to allow for biofouling of MP in order to increase environmentally relevance [2,3], use of environmentally relevant concentrations, and six replicated doses to enable dose-response modelling in order to detect and report of effect thresholds.

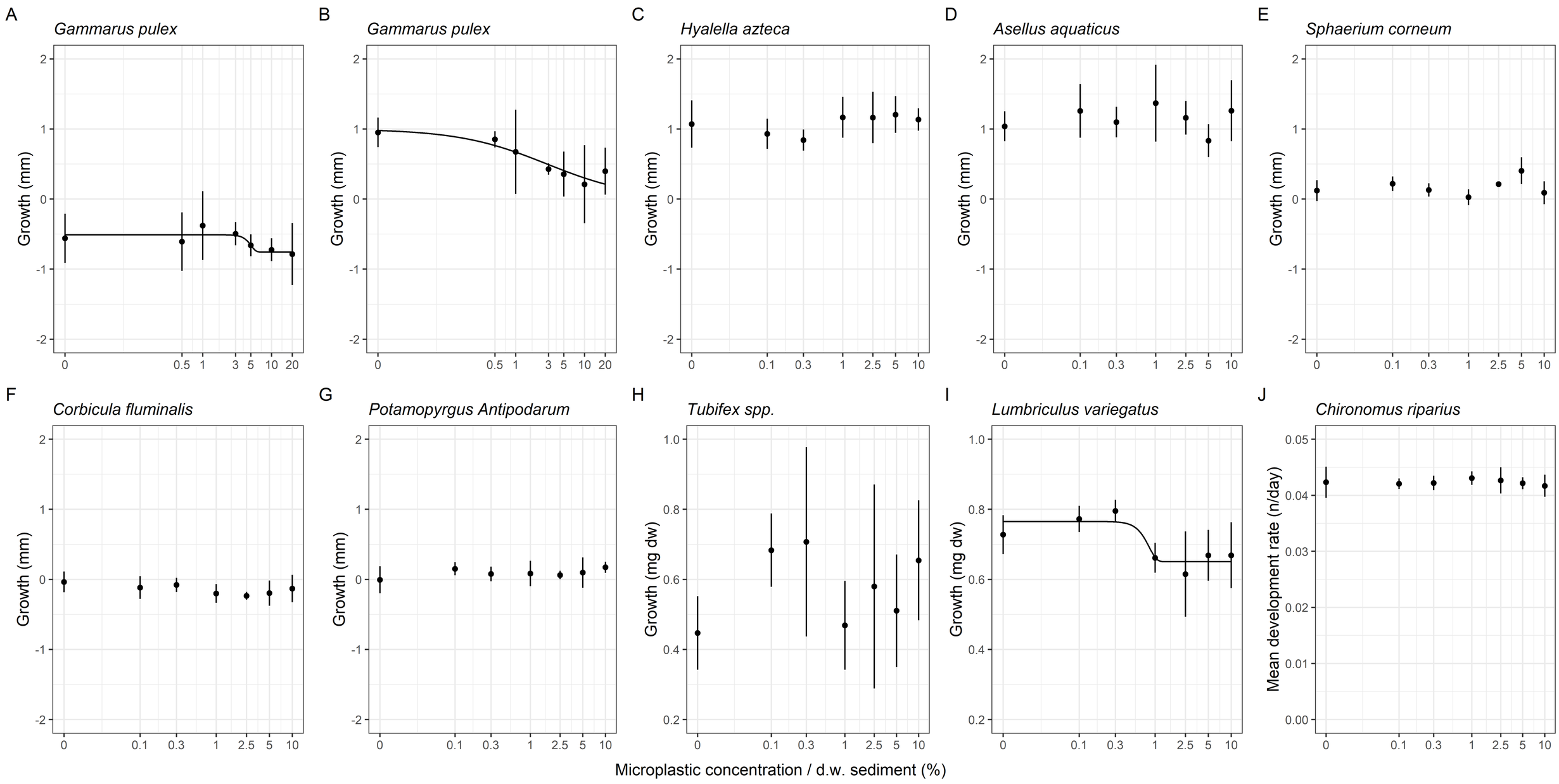
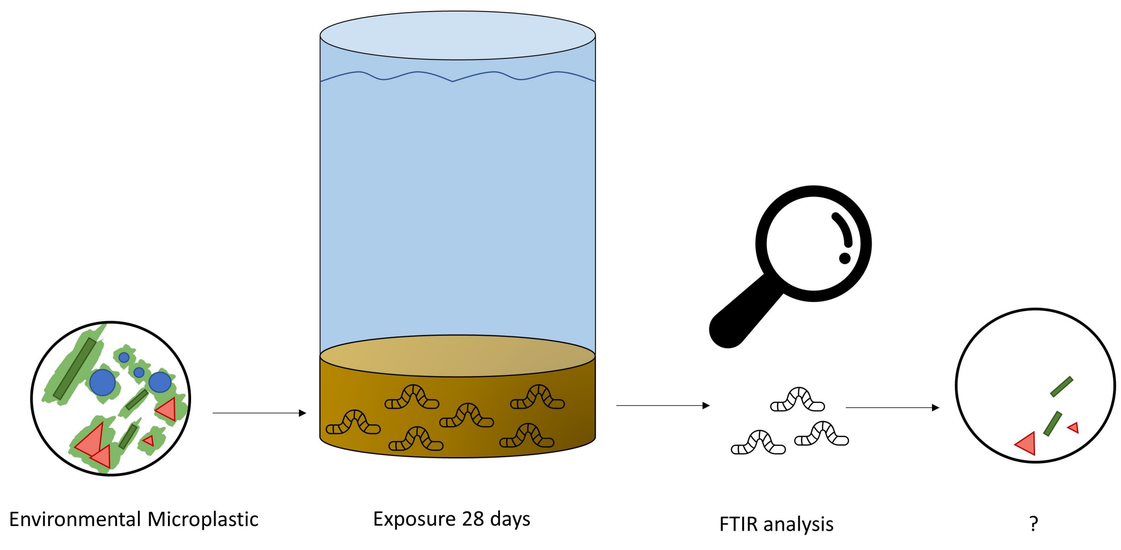


Figure1: Mean growth (± s.d., n=4) expressed in length (mm) of *G. pulex* exposed to PS (A), *G. pulex* exposed to ERMP (B) with concentrations up to 20% in d.w. sediment. Mean growth (± s.d.) expressed in mm or mg of *H. azteca* (C), *A. aquaticus* (D), *S. corneum* (E), *C. fluminalis* (F), *P. antipodarum*, (G), *Tubifex spp.* (H) and *L. variegatus* (I) exposed to ERMP + PS with concentrations up to 10% in d.w. sediment. Mean development rate (± s.d., n=4) of *C. riparius* (J) exposed to ERMP + PS with concentrations up to 10% in d.w. sediment. Exposure time for all freshwater species was 28 days.

Conclusion

Adverse effect thresholds (EC_{10}) were found at ERMP concentrations of 0.11 ± 0.17 (*Gammarus pulex*, growth), 0.50 ± 0.37 (*Lumbriculus variegatus*, growth) and 1.90 ± 1.08 (*Lumbriculus variegatus*, reproduction) % sediment dry weight. A positive effect on survival was found for *Cerastoderma edule* and *Sphaerium corneum* with an EC_{10} of 0.021 ± 0.027 % and 7.67 ± 3.41 % sediment dry weight, respectively. For the other species tested; *Hyalella azteca*, *Asellus aquaticus*, *Corbicula fluminalis*, *Potamopyrgus antipodarum*, *Tubifex spp.*, *Chironomus riparius*, *Alitta Virens*, *Limecola balthica*, *Corophium volutator*, *Arenicola marina*, *Porcellana platycheles* and *Mytilus edulis*, no effects were detected up to the highest ERMP dose of 10% d.w. This work demonstrates that ecologically relevant effect thresholds can be measured for a contaminant as complex as microplastics, while meeting strict QA/QC criteria. Furthermore, we show that several lab-based single species effects thresholds of environmentally relevant microplastic particles occur at concentrations lower than those found in the environment. Our current next step is to measure the ingested (i.e. bioavailable) ERMP fractions.

Future research



Acknowledgments

We acknowledge financial support from the European Chemical Industry Council (CEFIC) Long Range Research Initiative (LRI), project ECO49 – Microplastics Effect Threshold for Aquatic Species (METAS).

References

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