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# Heterogeneous mixture of microplastics: impact on the freshwater ecosystem engineer (*Tubifex tubifex*)

## and its role in biogeochemical processes

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### Introduction

Deposit-feeding bioturbators are key actors in sediment functioning of aquatic ecosystems. Bioturbators, such as *Tubifex tubifex*, contribute to organic matter degradation and nutrient recycling in freshwater sediments due to their ability to rework sediment, and to produce and irrigate biogenic structures (galleries). By their bioturbation activities, *tubificid* worms can stimulate microorganisms and associated biogeochemical processes occurring at the water-sediment interface.

However, the presence of contaminants in sediments can significantly modify these biogeochemical processes by impacting the survival, the physiology and the bioturbation activities of *tubificid* worms. Among these contaminants, **microplastic pollutants** are predominant in most sedimentary environments and can affect deposit-feeding organisms like *tubificid* worms. Indeed, the impacts of microplastic ingestion by *Tubificidae* have been reported in literature (Hurley et al., 2017, EST). Nevertheless, the consequences of microplastic ingestion on bioturbation activities and biogeochemical processes have never been studied.

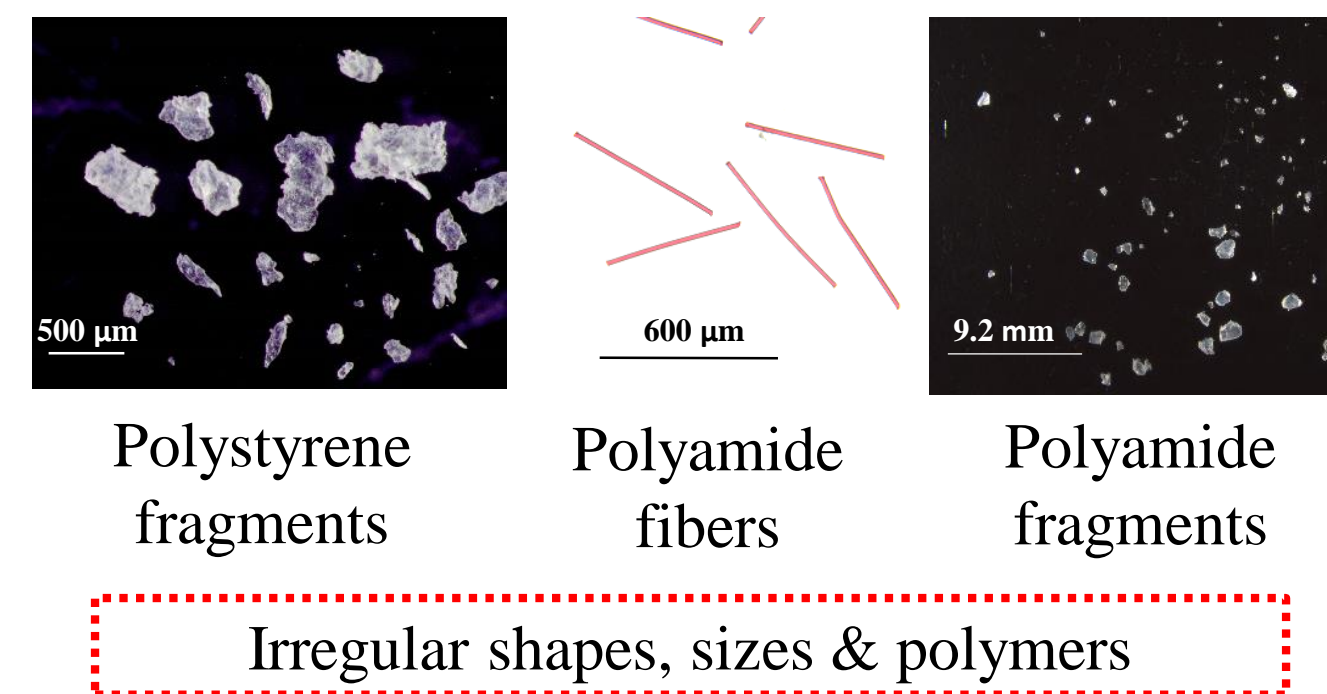
Therefore, the **objective** of this study was to investigate the **effects** of sediment contamination with a **heterogeneous mixture of different shapes, sizes and polymer types of microplastic pollutants** (i.e. polymers of polystyrene and polyamide) on the survival, the physiological state and the bioturbation activity of *tubificid* worms.

### Acknowledgement

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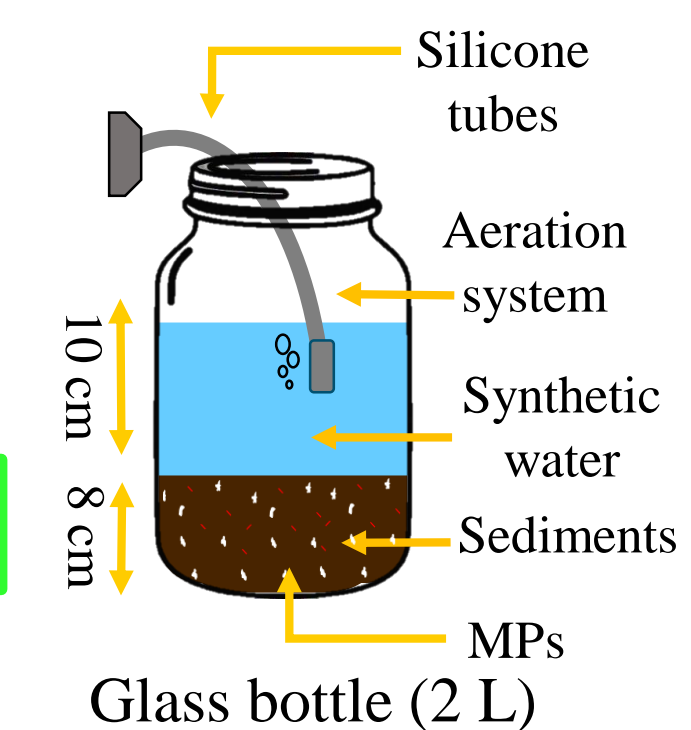
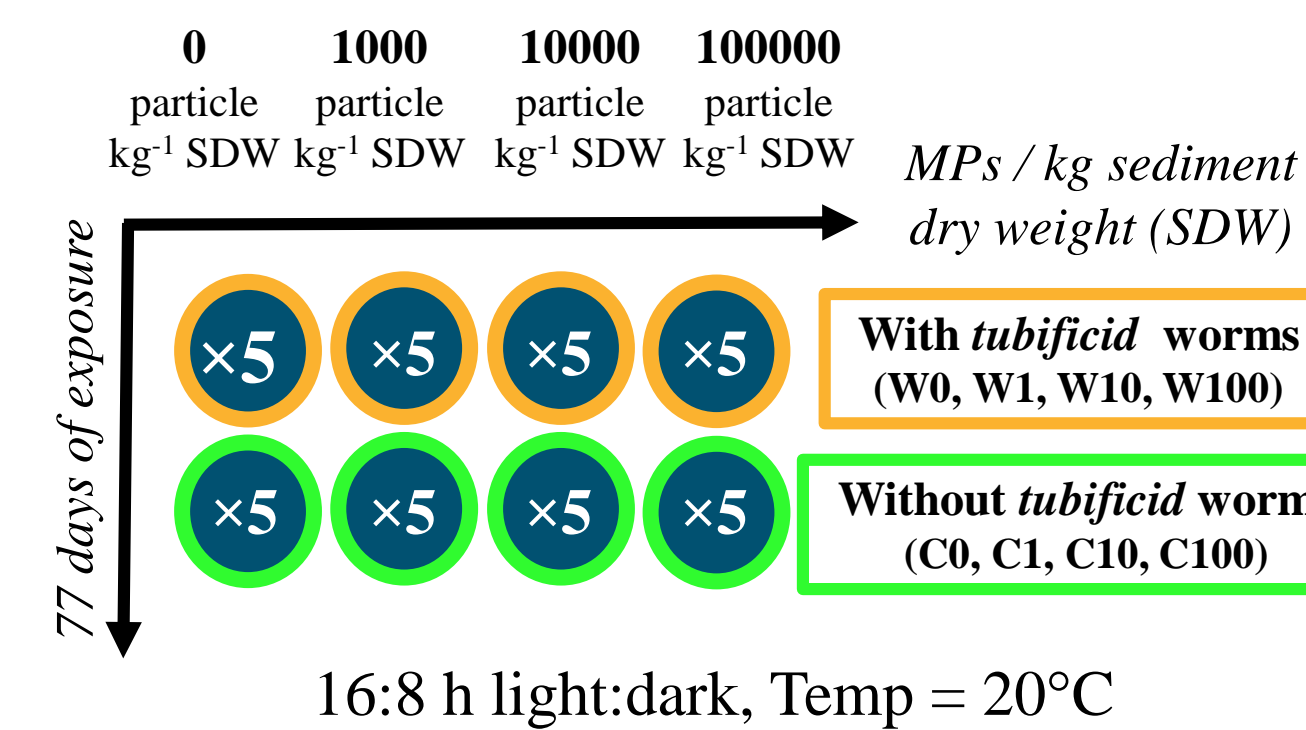


### Microplastics (MPs)



### Material and Methods

#### Experimental Setup

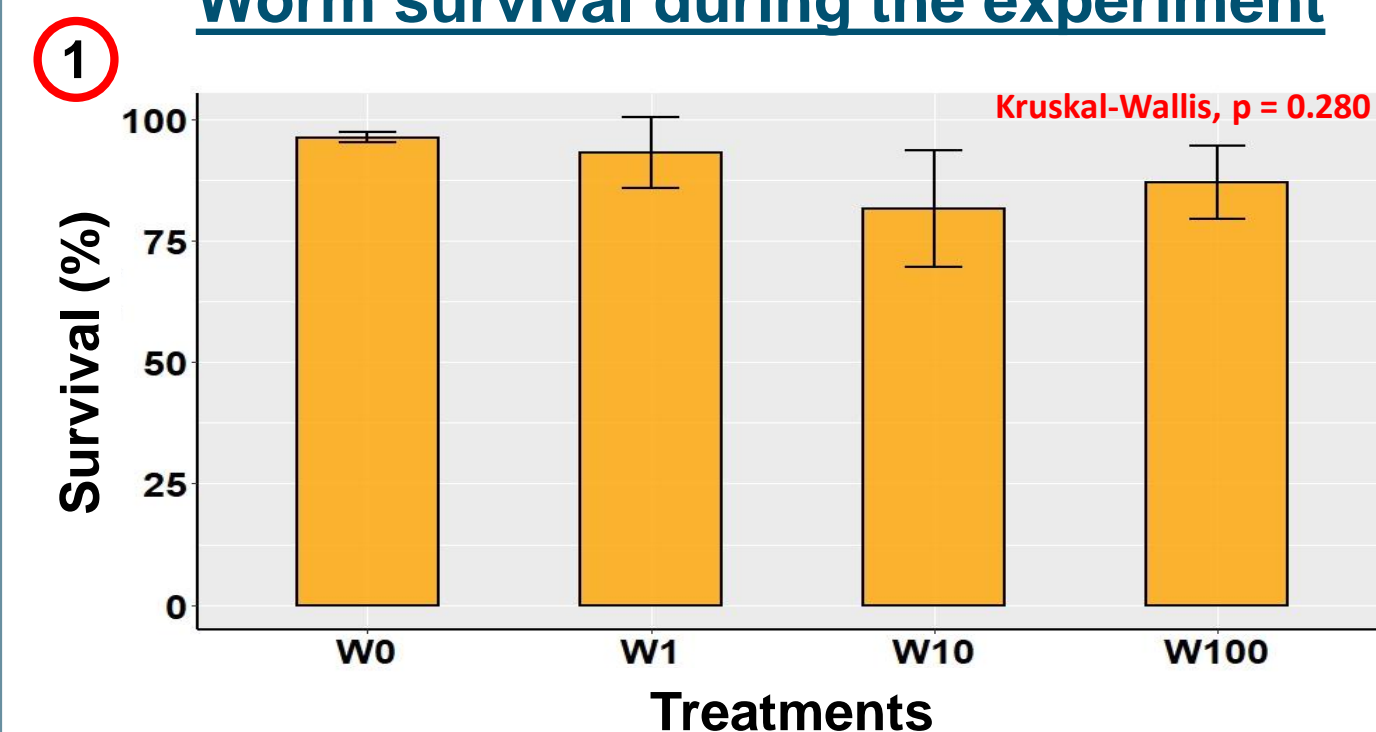


#### Measurements

- ★ **Impact on worms**
  - Survival
  - Superoxide dismutase activity
- ★ **Impact on bioturbation activity**
  - Sediment reworking (*fecal pellet deposition*)
  - Water exchanges at the water-sediment interface
- ★ **Impact on fluxes**
  - CO<sub>2</sub> fluxes
  - NO<sub>3</sub><sup>-</sup> fluxes

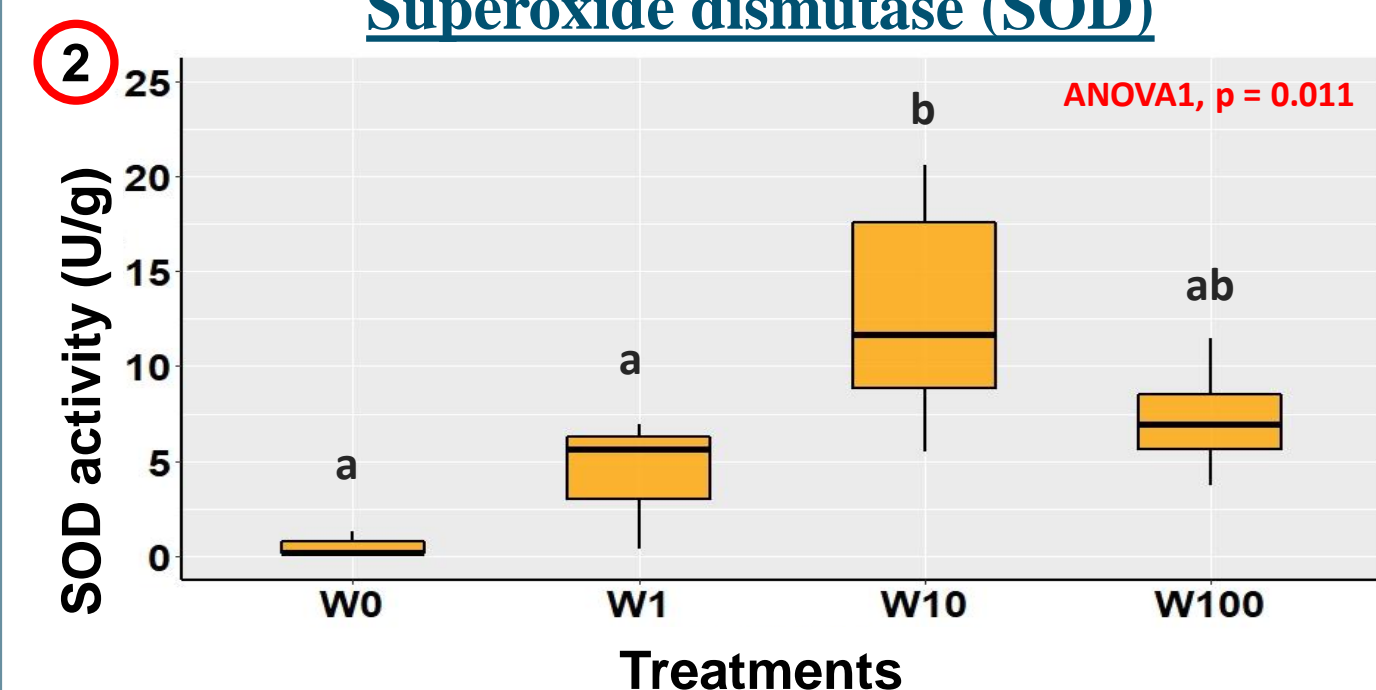
### Results

#### Worm survival during the experiment



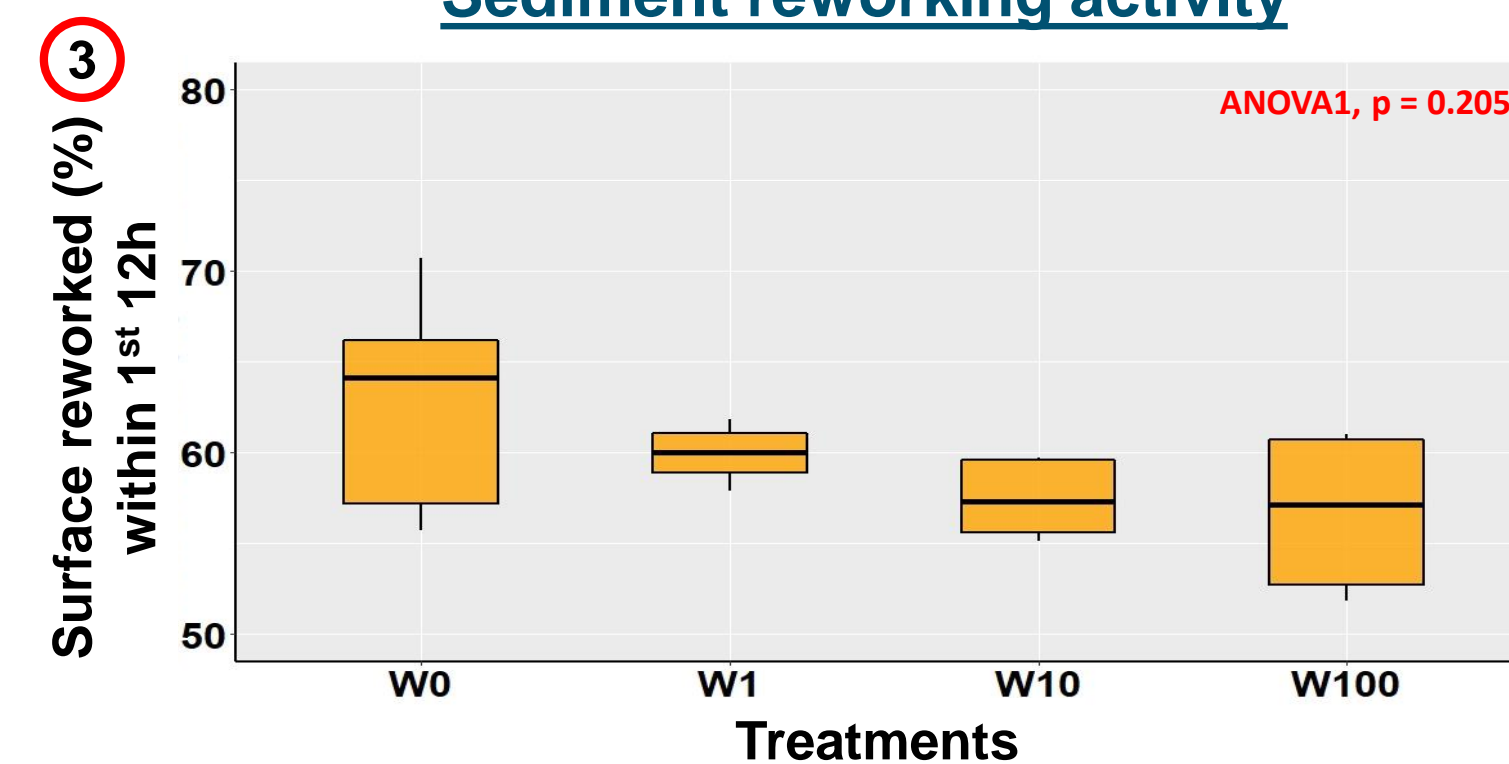
- Although non significant, worm survival tended to decrease with MPs contamination

#### Superoxide dismutase (SOD)



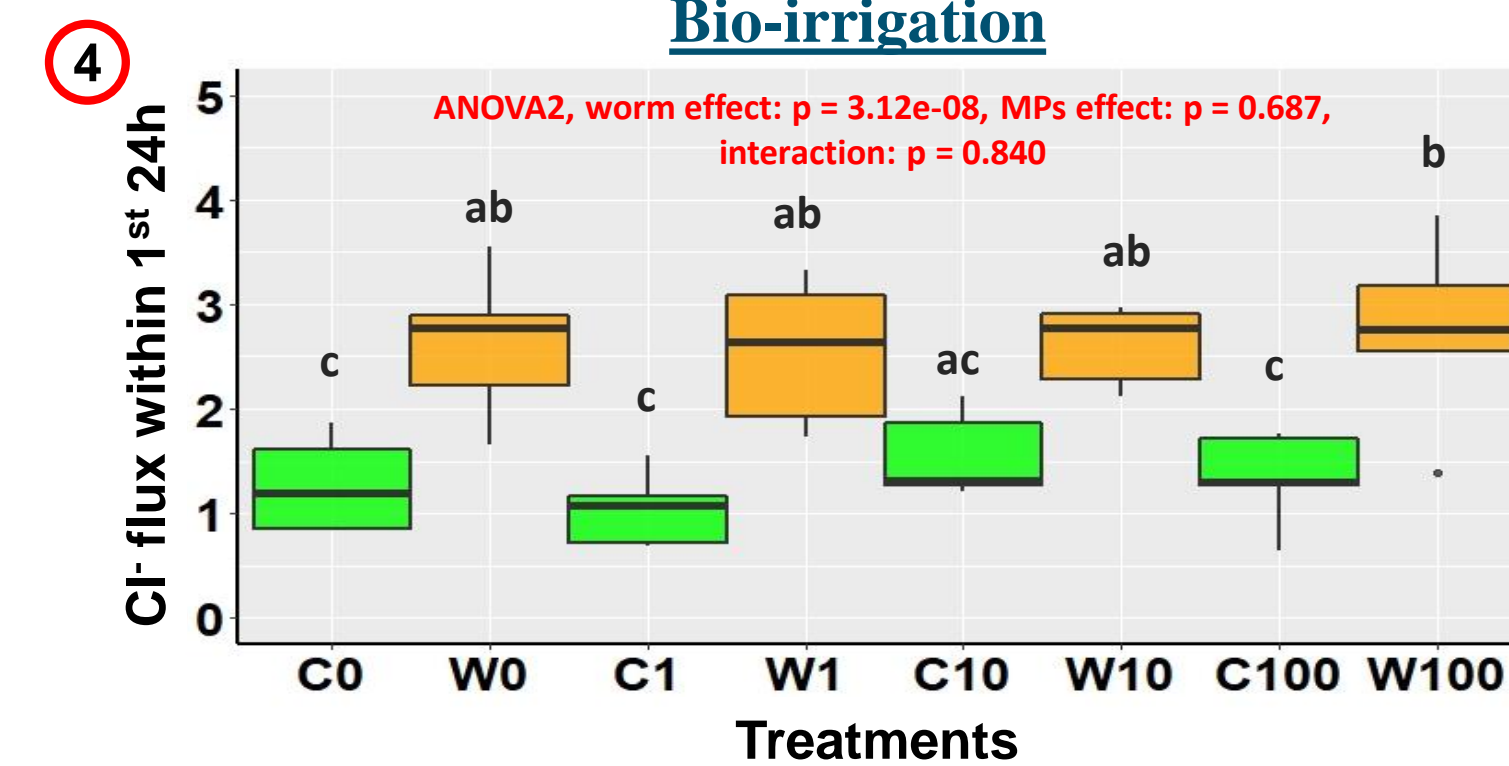
- Oxidative stress (SOD activity) increased with MPs addition
- The highest SOD activity was measured in W10 treatment (Different letters means significant differences among treatments) (Tukey test at  $p \leq 0.05$ )

#### Sediment reworking activity



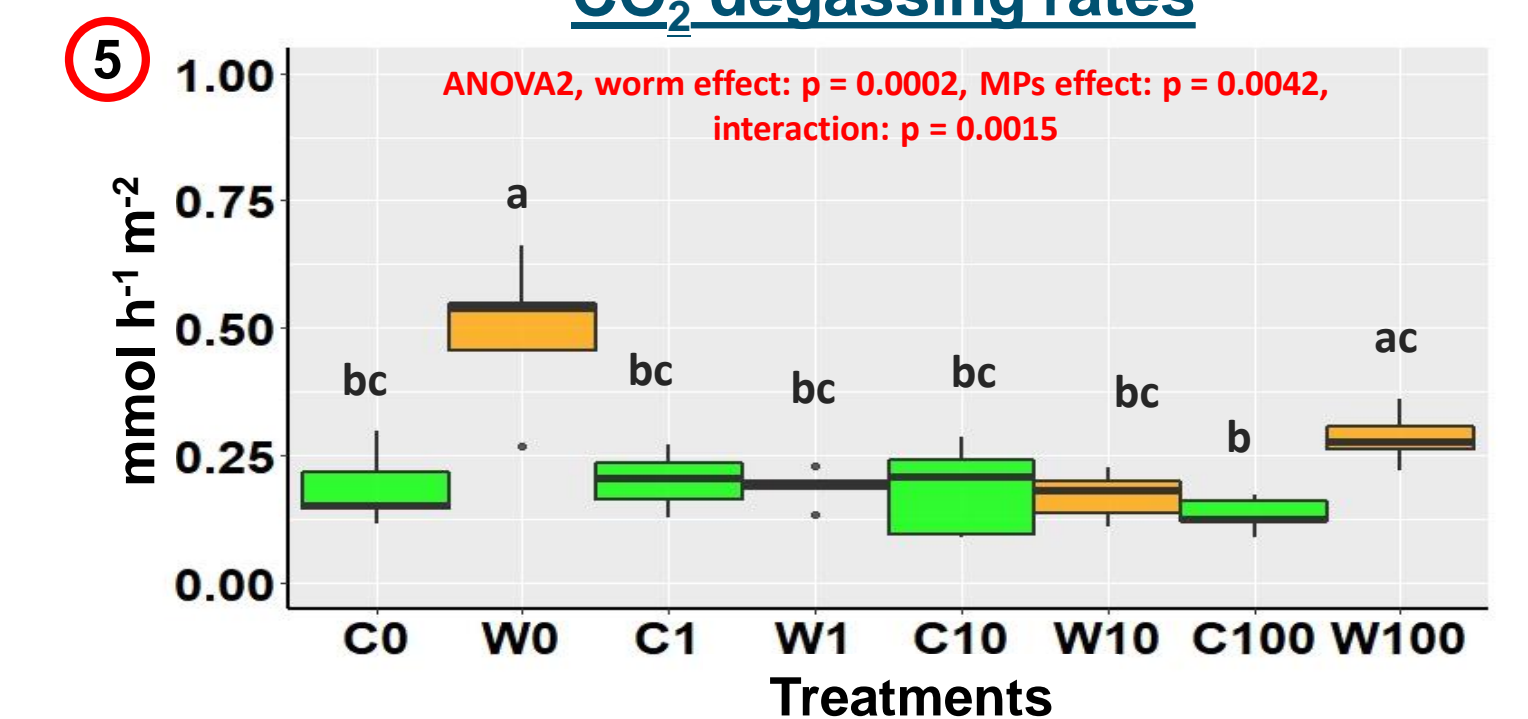
- Although non significant, sediment reworking through worm feeding activity tended to decrease with MPs contamination

#### Bio-irrigation



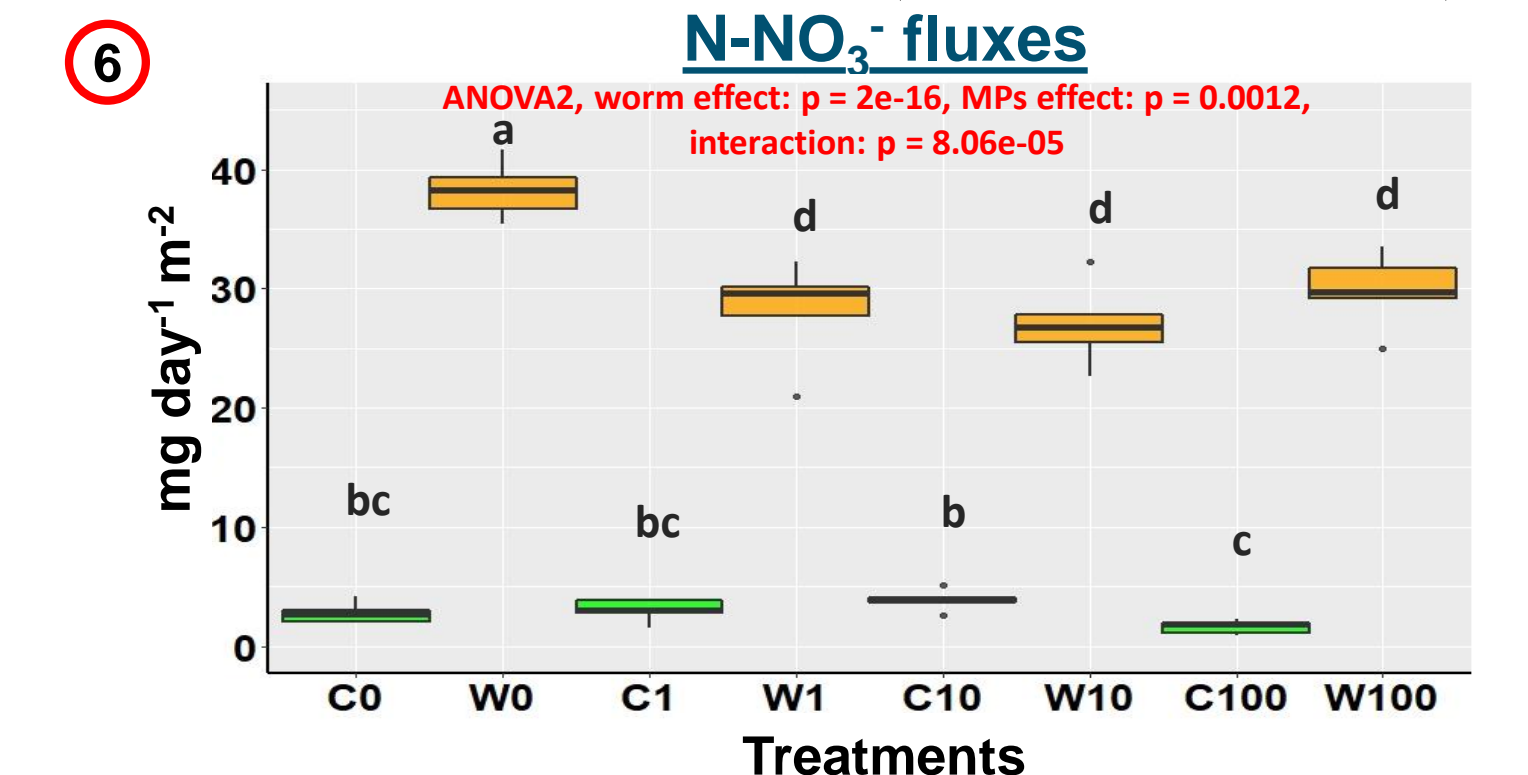
- Worms stimulated water exchange between sediment and water
- No effect of MPs (Different letters means significant differences among treatments) (Tukey test at  $p \leq 0.05$ )

#### CO<sub>2</sub> degassing rates



- In sediments without MPs addition, *tubificids* increased CO<sub>2</sub> flux by around 2 fold (W0 vs C0)
- The stimulation of CO<sub>2</sub> fluxes by worms was inhibited with moderate contaminations with MPS (W1 vs C1 & W10 vs C10)

#### N-NO<sub>3</sub><sup>-</sup> fluxes



- Tubificids* increased NO<sub>3</sub><sup>-</sup> efflux rates in all MPs treatments
- Worm effect on NO<sub>3</sub><sup>-</sup> flux was reduced by MPs contamination (Different letters means significant differences among treatments) (Tukey test at  $p \leq 0.05$ )

### Discussion & Conclusion

- An increase in oxidative stress was observed in *tubificid* worms exposed to MPs. Significant cellular damage indicated by SOD activity was considered as an early warning for worm population because of the inverse trend on *Tubifex* survival depending on MPs exposure.
- Worm feeding activity (*fecal pellet* production) was apparently more affected by MPs contamination than bio-irrigation activity.
- In link with feeding activity decreasing trend, the roles played by *tubificid* worms on organic matter mineralization (CO<sub>2</sub> flux) and nutrient cycling (NO<sub>3</sub><sup>-</sup> flux) were affected by MPs contamination. Surprisingly, at the highest MPs concentration (W100), worms tended to be less affected than at a moderate MPs concentration (W10). One explanation of this interesting result would be that, at the highest concentration, MPs were more easily detected and avoided by worms than at lower concentrations..