Plastic Pollution in Aquatic Systems

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Introduction

Plastics originated from either voluntary or involuntary release, urban discharges and surface runoff are transformed into microplastics and have a long-term impact on the environment. Owing to their small sizes, they are ingested by aquatic organism and can accumulate in the food chain. In our work we studied
i) the characteristics of different charged microplastic particles;
ii) the microplastic ecotoxicity on living microorganisms;
iii) the plastic pollution by sampling in lake Leman.
This study is expected to better understand the sources, behaviors, origins and the impacts of the microplastics in aquatic systems by considering scientific and social aspects.

Materials and methods

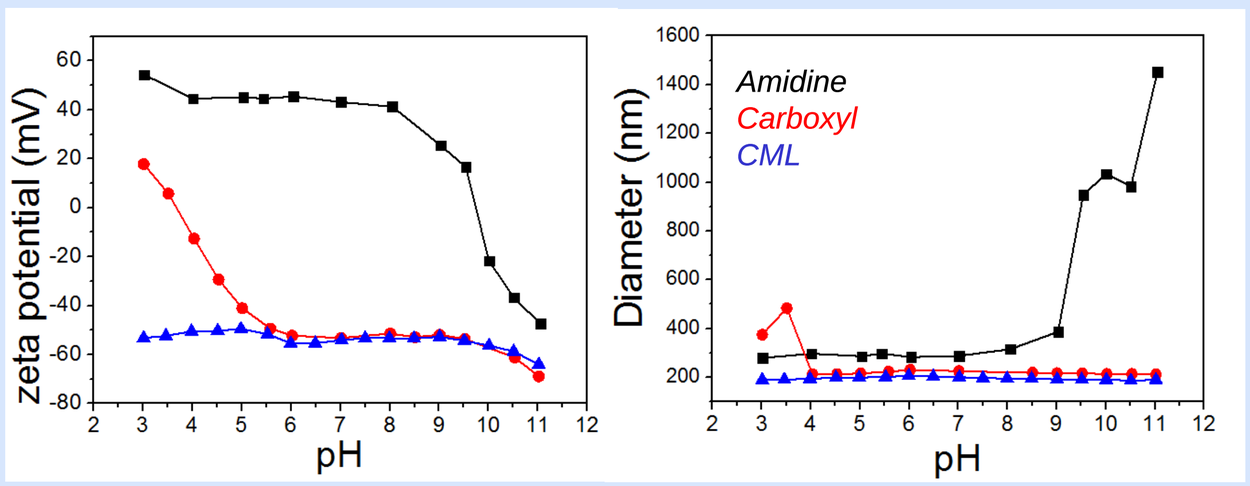
Three commercially available latex beads (4% w/v, 200 nm nominal size) :

- One positively charged: Amidine groups
- Two negatively charged: Carboxyl and CML groups

- Malvern Zetasizer Nano ZS: the zeta potential (charge) and z-hydrodynamic diameter (size)
- Ecotoxicity test with *Daphnia magna*
- Manta net deployment to collect plastic from Lake Geneva (4 sites)
- Envirochip microscope for plastic image analysis

Results

Size and Charge - in ultrapure water



- Amidine, the size and charge changed at pH > 8
- Carboxyl, the size and zeta potential changed at pH < 6
- CML, the size and zeta potential are stable

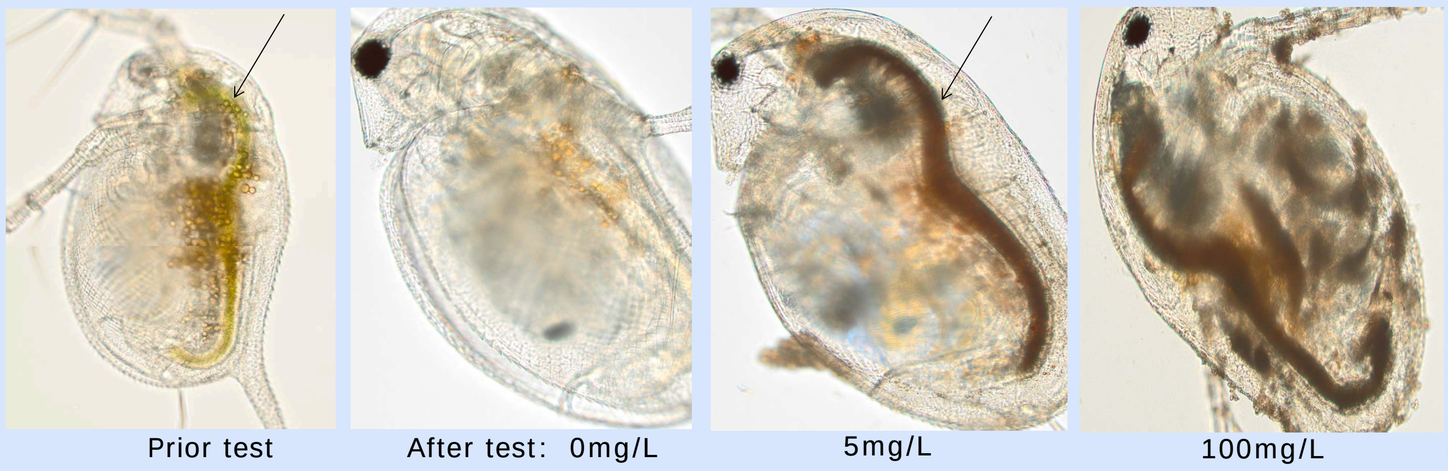
in natural water (pH 8.2) and ecotoxicity media (pH 7.4)

Latex	Media	Zeta (mV)	Diameter (nm)
Amidine	River	-1.0	2032.8
	Lake	3.3	1487.8
	Daphna	42.7	325.9
Carboxyl	River	-28.6	223.1
	Lake	-26.4	227.7
	Daphna	-33.7	209.2
error < 5 % of value			

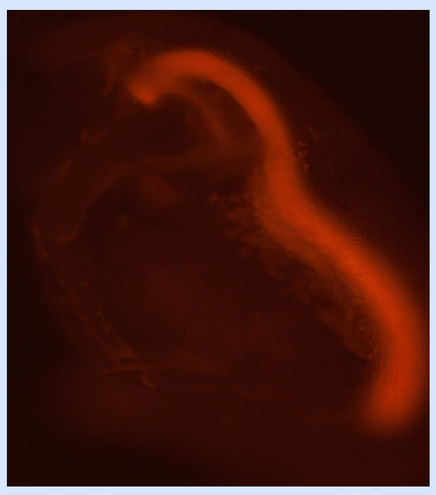
- Charge and size depends on latex beads and on solution
- Amidine charge and size in natural water cannot be predicted by pH

Ecotoxicity with *Daphnia magna (48h assay)*

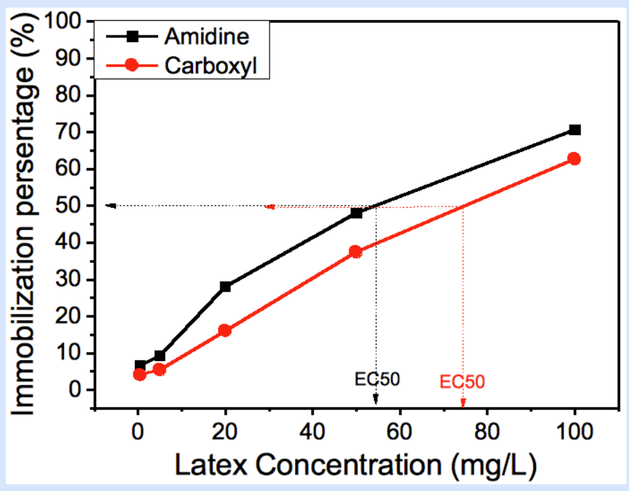
Algae in digestive tube — Exposure without feeding — Latex in digestive tube



Prior test | After test: 0mg/L | 5mg/L | 100mg/L



5mg/L (fluorescence, ex 580 nm)



- Toxicity of latex beads similar for both beads (EC50 55-75 mg/L)
- Toxicity possibly associated with feeding on beads and not from size and charge

Different plastics from Lake Geneva

0.5-3.5 (mm) | 0.4-9.8 (mm) | 0.3-3.1 (mm) | 0.6-4.8 (mm) | 0.3-26 (mm) | 0.2-7.8 (mm) | 0.6-1.1 (mm)

- 196 different particles collected (69 macro-plastic, 127 micro-plastic)
- From 1296 m^3 water filtered, we collected 7.53 g dry material including 0.09 g plastic material (1.2 %)
- Assuming an homogeneous distribution: 7.3 kg of small plastic materials float on the surface of the lake Geneva

Conclusions

- The behavior of plastic beads depends on charge and pH but also from other properties of the solution (organic matter?)
- Toxicity could be associated with consumption by zooplankton, but EC50 are < that the plastic content in Lake Geneva
- Different plastics were found in Lake Geneva with different size, shape and chemical composition suggesting multiple sources

We expect this work will provide valuable insights into determining the mechanism of the degradation, the influence to the environment, and that it will also offer **a starting point for stakeholders, and society more broadly to develop community-centered social initiatives related to plastic pollution in our environment.**

Master Thesis Work

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Reference:
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2) Dynamic Adsorption, Complexation, Aggregation and Sedimentation Processes in Aquatic Ecosystems. Http://www.unige.ch/files/3914/1691/5993/Abstract.pdf