Effects of a mixture of pharmaceuticals in a freshwater model ecosystem

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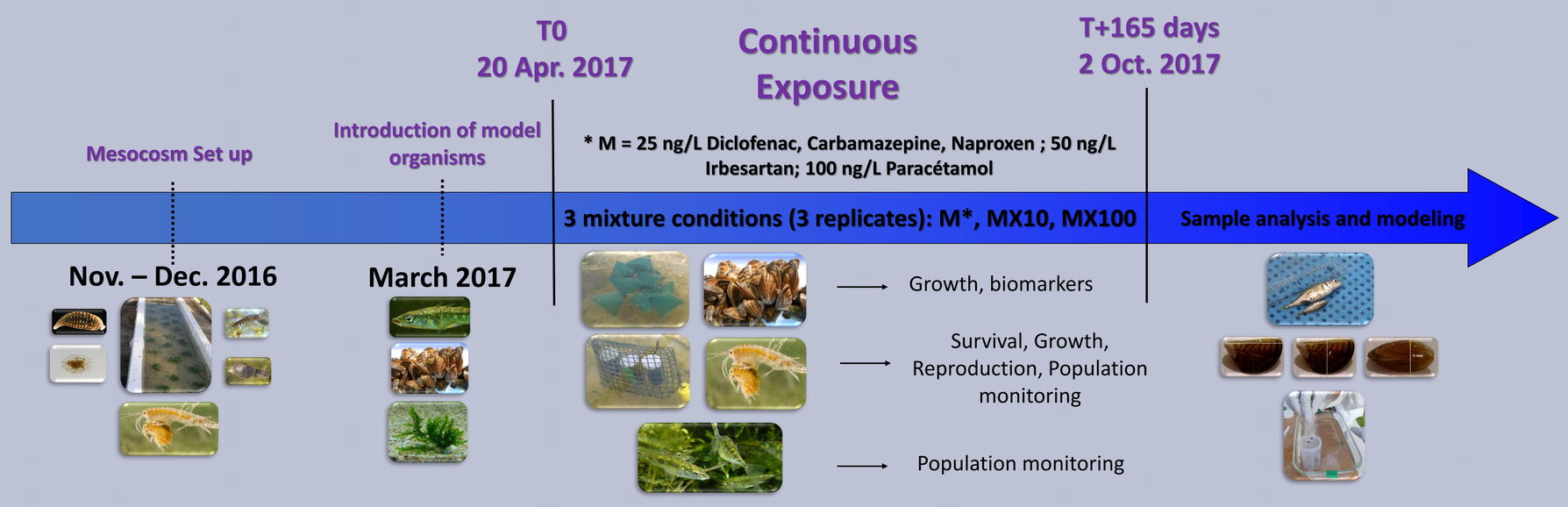
Introduction

Owing to their ecological importance, freshwaters provide important services which leads to a strong societal demand concerning the preservation of their quality. They are the receptors of many contaminants emitted by human activities and more specifically by wastewater treatment plants effluents. Water resources of the Meuse watershed are used on both sides of the French-Belgian border which involves a coherent and joint management. In that framework, the DIADeM project suggests developing and spreading out a cross-border multidisciplinary approach to improve the diagnosis and the chemical and biological (biomarkers) monitoring of freshwaters using the Meuse river as a case study. In the past, results from chemical surface water monitoring of the Meuse has revealed the occurrence of numerous substances and more particularly pharmaceuticals. Overall, the project suggests coupling chemical and biomarkers analysis on caged organisms (a crustacean: *Gammarus fossarum*, a mollusk : *Dreissena polymorpha*, a moss : *Fontinalis antipyretica* and a fish species : *Gasterosteus aculeatus*) with predictive mathematical population level models. In order to calibrate and validate these models, a lotic mesocosm experiment was set up. A mixture of five substances were chosen: ***Diclofenac, Carbamazepine, Naproxen, Paracetamol and Irbesartan.*** This poster presents the preliminary experimental results.

Material and Methods

Figure 1 : The mesocosm platform with 12 lotic mesocosms of 20 m long and 1 m wide



Results

Water concentrations of the pharmaceuticals

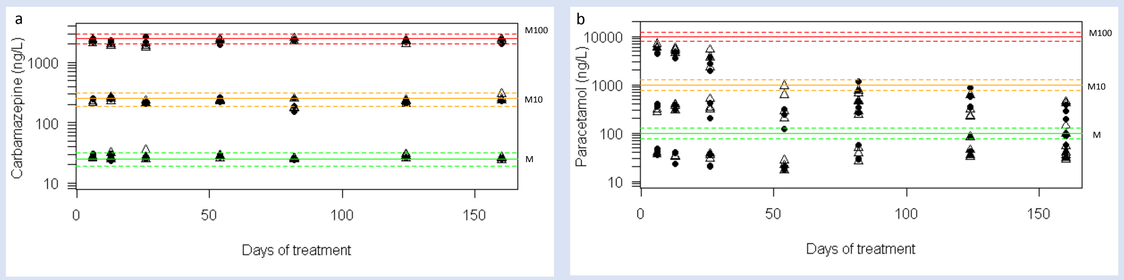


Figure 2 : Measured concentrations in water of Carbamazepine (a) and Paracetamol (b) at 5 (circles) and 19 m (triangles) along each mesocosm and for each condition. Solid lines represent target concentrations and dotted lines represent mean measurement uncertainties

Measured concentrations in water of Carbamazepine (Figure 2a), Naproxen, Diclofenac and Irbesartan at 5 m and 19 m along each mesocosm and for each condition ranged between 60% to 100% of the target concentrations throughout the experiment. Measured concentrations of Paracetamol ranged only between 0% to 50% (Figure 2b).

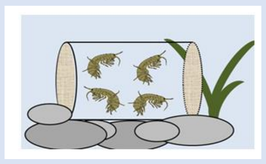
Mean measured concentrations in water are presented in Table 1.

Table 1 : Mean measured concentrations of the five pharmaceuticals in water. Values represents the mean concentration throughout the experiment for each condition (mean of the three replicats).

Condition	Carbamazepine (ng/L)	Diclofenac (ng/L)	Naproxen(ng/L)	Irbesartan (ng/L)	Paracetamol (ng/L)
M	27 +/- 2	21 +/- 13	20 +/- 2	50 +/- 5	41 +/- 54
M10	230 +/- 28	177 +/- 40	185 +/- 41	488 +/- 109	288 +/- 164
M100	2233 +/- 195	1682 +/- 306	1836 +/- 353	4218 +/- 438	2165 +/- 2247

Effects on *Gammarus fossarum*

- (Sub)individual responses in short-term assays (encaged organisms)



No effects were observed on adult feeding rate and some biomarkers (AChe, Cbe, GST, PO) during a 7 day experiment performed in Sept. in all conditions. Juvenile growth was also not impacted (21 day experiment in Sept.).

- Long term population responses during the whole experiment

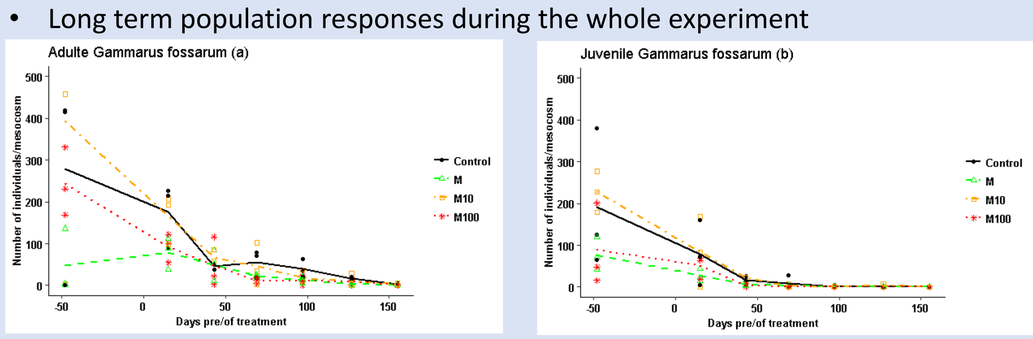


Figure 3 (a, b) : Number of adult (a) and juvenile (b) *Gammarus fossarum* for each condition. Value represents number of individuals for each mesocosm and condition

Progressive population decline was observed at all conditions including the control (Fig. 3 a and b) throughout the experiment. Abundances were near zero at the end of experiment. No effects of the conditions were observed at the population level for *Gammarus fossarum* (RM-ANOVA, p>0.05) and also for the macroinvertebrate community (PRC, p>0.05, data not shown).

Effects on *Gasterosteus aculeatus*

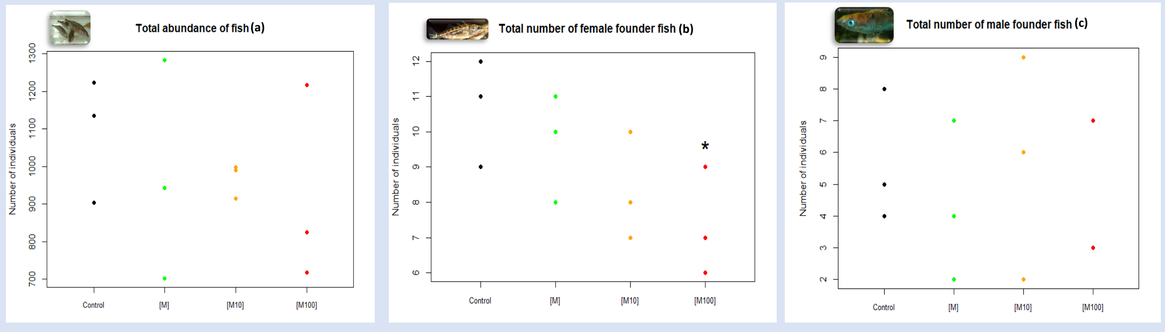


Figure 4 a, b, c : Total abundance of fish (a) Total number of female founders (b) Total number of male founder (c) at the end of the experiment

During the experiment, no effects were observed on fish larvae abundance along with population size frequencies distributions for all conditions (ANOVA, p>0.05, data not shown). At the end of experiment, no effects were observed on total fish abundance and on the total number of male founder fish (ANOVA, p>0.05, Fig. 4 a,c). The total number of female founder fish was impacted at M100.

Perspectives

- Fish

Effects were observed at the individual level mainly on female founder fish at the highest tested condition (MX100). Survival of female fish seems to have been impaired. Analysis of fish population data is still on going and will enable to highlight eventual population level effects.

- Mollusk

The effects of the different conditions on the growth rate and filtration rates of encaged *Dreissena polymorpha* is currently being studied.

- Crustacean

Population decline of *Gammarus fossarum* in all conditions including the control suggests that either biotic and/or abiotic conditions in the mesocosm are not adequate to ensure the development of stable populations.

Effects on other populations and communities such as periphyton, macrophytes, zooplankton along with physicochemical parameters are currently also being studied enabling us to improve our understanding of the overall effects.

A consortium associating research, water stakeholders and scientific culture

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