Multi-level assessment of the ecotoxicity of pesticide seasonality in two gammarid species in a drained agricultural catchment

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ECOTOXICITY ASSESSMENT OF SEASONALITY OF PESTICIDE TRANSFERS IN A CONTEXT OF DRAINED AGRICULTURAL CATCHMENT USING MULTILEVEL BIOMONITORING APPROACH

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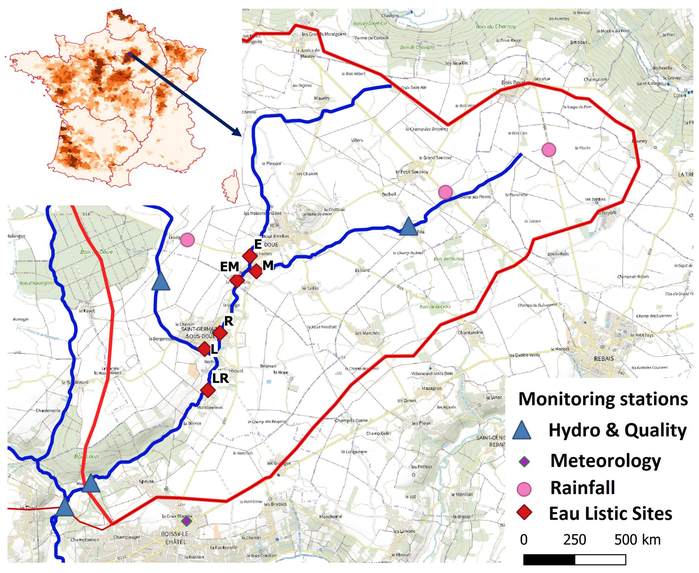
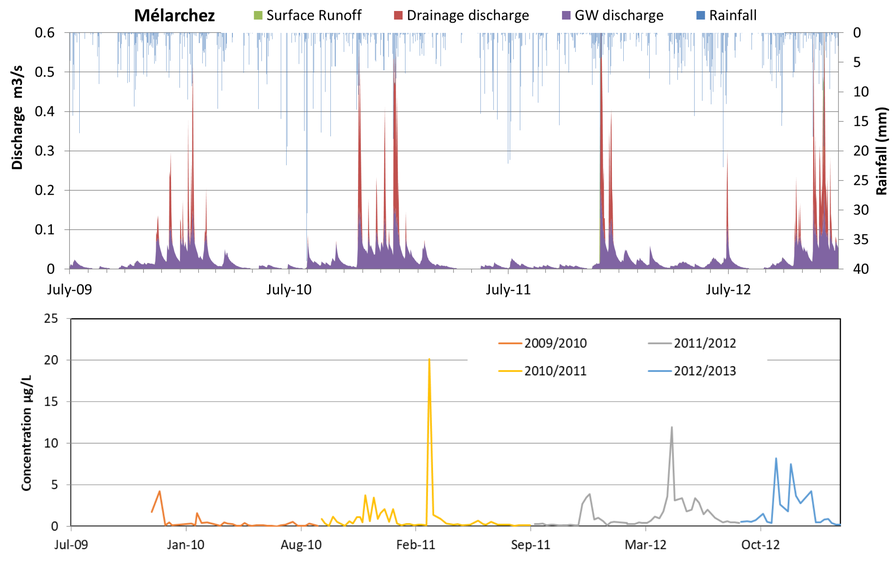
Context and Objective

In an agricultural context, surface and subsurface runoff leads to hydraulic transfers of various contaminants, including pesticides, to hydro-systems, depending on hydrological behavior and farming applications. In artificially drained catchment, the buried drains increases these transfers (contamination can occasionally exceed 100 µg/L). Due to the contamination of aquatic media, early diagnosis of health status of wildlife is therefore essential, to prevent ecological deteriorations.

The objective of this work is to evaluate and predict the seasonal impact of pesticide transfers on biodiversity at different levels of biological organization (from cell to ecosytem), and its associated ecological functions.



Part of drained arable land, and the 6 experimental sites at Orgeval : hydrological and ecotoxicological monitoring

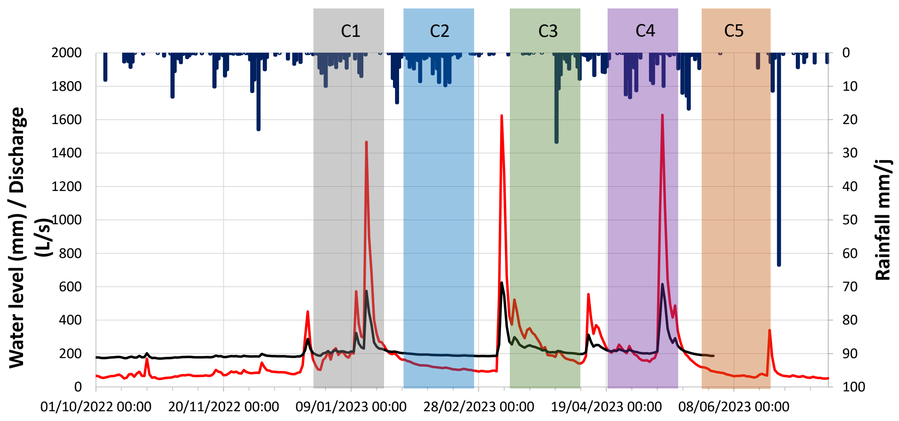


Seasonality of water discharge and pesticides transfer : *herbicides reach the outlet early in autumn, at the start of drainage discharge, while fungicides mainly take place during spring rainfalls*

Method

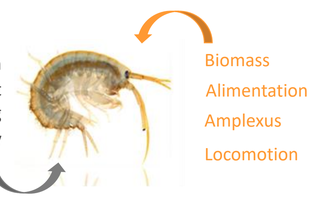
At Orgeval catchment (70 km east of Paris, France), under intensive agriculture, several parameters are simultaneously monitored during the hydrological season 2022-2023 on 6 experimental sites (see map):

- **Chemistry:** water sampled by automatic samplers for analysis of > 300 pesticides
- **Physicochemistry:** multi-sensors for continuous measurements (O2, T°C, cond. …)
- **Ecotoxicology:** Caging of two gammarid species (*G. fossarum* and *G. pulex*) for 2 weeks to assess inter-species sensitivity to chemical fluctuations using behavioral biomarkers (locomotion, feeding rate, amplexus rate and biomass) and mortality
- **Ecology:** Deployment of litter bags for 2 weeks to assess microbial and macroinvertebrate-degradation of litter as ecosystemic function.
- **Hydrology:** water flow, water level, velocity, …



Cages of 80 gammarus in triplicate

Glucosidase, Galactosidase ⇒ Digestion
Chitobiase ⇒ Moult
Glutathion S transferase ⇒ Detoxifying
Acetylcholinesterase ⇒ Neurotoxicity

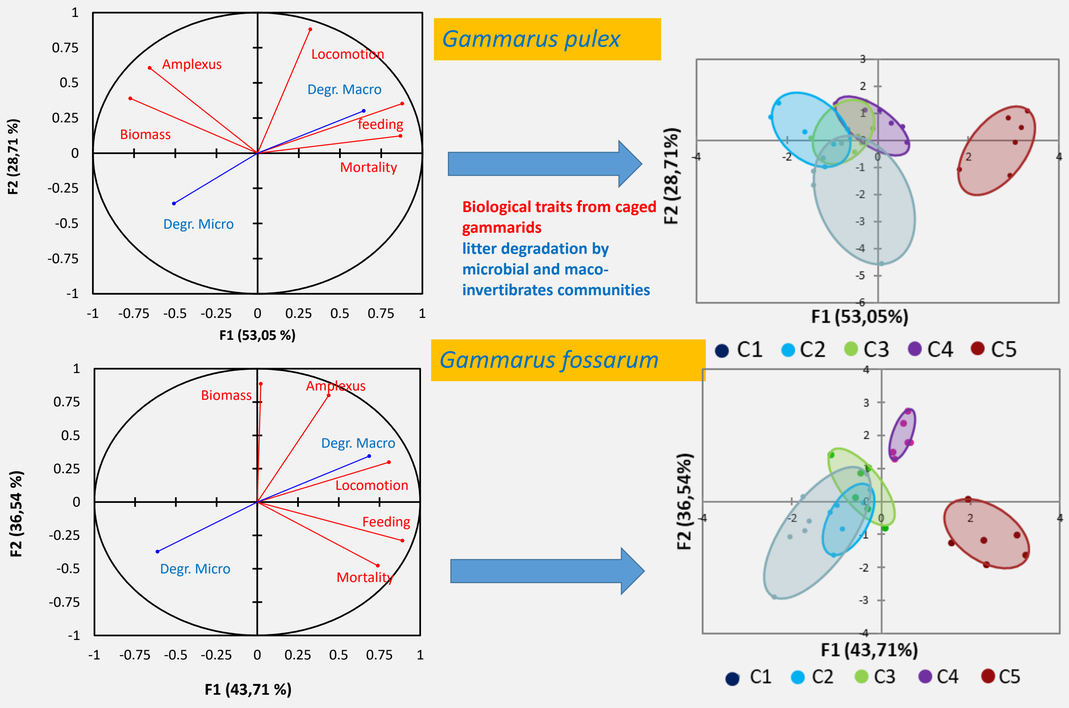


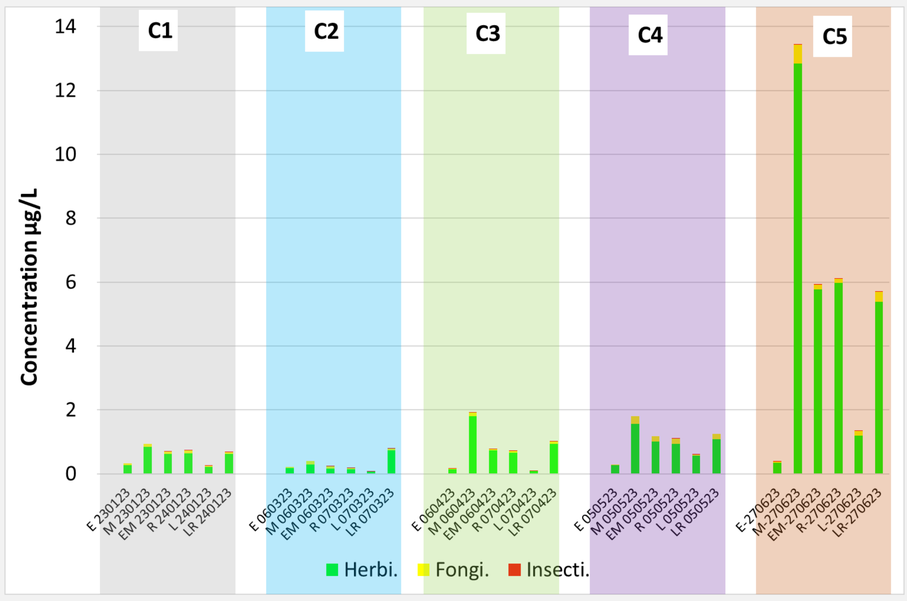
Hydrology at Orgeval *& deployment campaigns (C1-C5) of caged gammarids and litter bags on six sites*

Main results

I. Biological and ecological responses

- By combining all ecological and biological traits, the multi-variable analyses allow to distinguish the different deployment campaigns, in particular C5.
- This temporal distinction involves different biological trait sets according to the species (i.e. mortality for *G. pulex* and locomotion for *G. fossarum*)
- This combination of tools shed on light changes occurred both at the individual and community levels.





II. Contamination levels of experimental sites

- The 6 sites monitored at Orgeval catchment are mainly contaminated by herbicides
- Spatial and temporal fluctuation of contamination levels are quantified
- The pesticide levels of campaign C5 are 4-5 fold higher compared to others campaigns, in accordance with the integrated biological/ecological responses.

Conclusion et perspectives

- The biomarkers developed in the two gammarid species are sensitive to spatial and temporal variability of the exposome and complementary to follow the seasonal impact of agricultural contaminants, mainly pesticides.
- The influence of some abiotic factors, such as T° and O2, on the monitored biological traits must be considered for the accurate assessment of environmental risk.
- Additional investigations on biochemical parameters (e.g. enzymes, stress markers) will allow to link cellular events to the ecosystem alteration and then to prevent its alteration.
- In order to strengthen the relationships between drainage discharge, critical periods of pesticide transfers and biodiversity impacts, a second campaign over a complete hydrological season will be carried out.