Transfer of perfluorinated compounds from sediment to benthic invertebrates

Delphine Bertin[1], Pierre Labadie[2], Benoît J.D. Ferrari[1], Jeanne Garric[1], Hélène Budzinski[2], Marc Babut[1]

[1]IRSTEA,UR MAEP, Ecotoxicology department, Lyon (France)
[2]UMR 5805, Laboratory EPOC, LPTC, Université de Bordeaux I (France)

Introduction

• Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are **chemicals of emerging concern**, which have been found in almost all **aquatic media** including biota.

• PFASs are known to be **bioaccumulative**; exposure pathways for aquatic biota remain poorly understood.

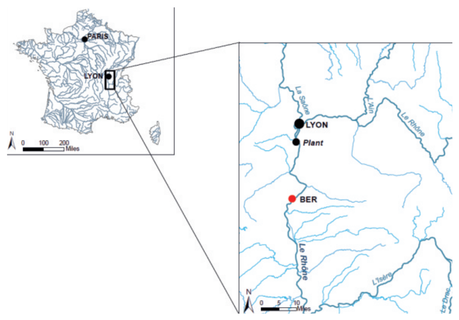
We propose:

• (1): to assess the **accumulation** kinetics of various PFASs in the benthic invertebrate *Chironomus riparius*.

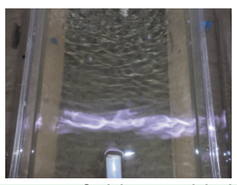
• (2): to evaluate the influence of **temperature** on accumulation rates.

Methodology

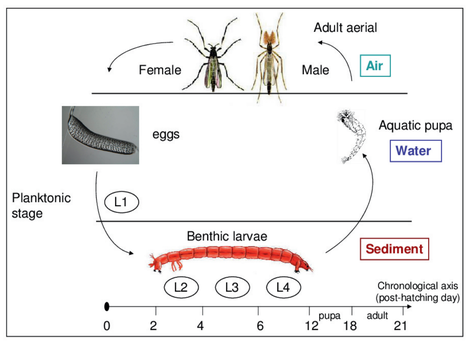
Study site: oxbow connected to the main channel of the Rhone river, 40 km downstream of Lyon.



Sediment sampling: Sieved at 2 mm, pooled in polypropylene jar and stored at 4°C.



Exposure of chironomids in microcosms. 20L aquaria filled with 4L of sediment / 15L water - stabilized for 1 week before starting experiments.



Chironomus riparius life cycle.

Dosage of PFASs: 11 carboxylates acids (C_4-C_{14}), 5 sulfonates (C_4-C_{10}) and 6 precursors.

Exposure conditions

(1) Kinetics of accumulation

• Fourth instar larvae exposed 4 days.
• Food: Tetramin®, ad libitum (Péry *et al.*, 2002).
• Exposure temperature: 21°C.
• Sampling surface water, interstitial water (Rhizon® system), sediment and organisms at day 2, 3 and 4.

(2) Temperature effect

• Fourth instar larvae exposed 4 days.
• Food: Tetramin®, ad libitum.
• Temperatures: 12, 17 and 21°C (mean seasonal temp. in the Rhone river).
• Sampling surface water, interstitial water (Rhizon® system), sediment and organisms at end.

Contact:
Delphine Bertin; delphine.bertin@irstea.fr
MALY-Irstea Centre de Lyon

Plan Rhône
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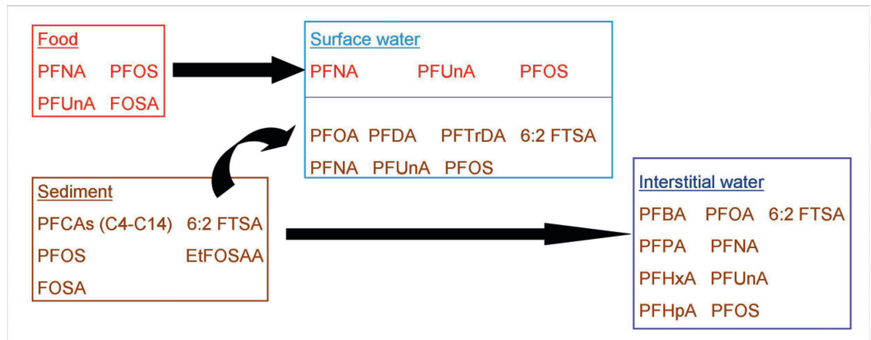
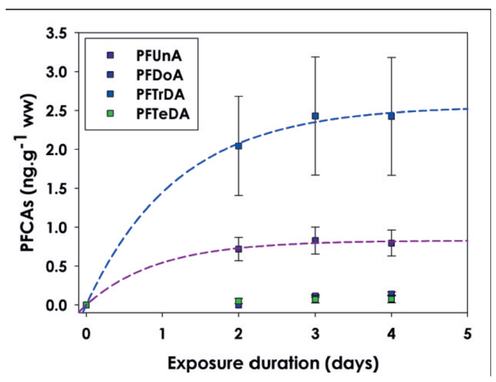
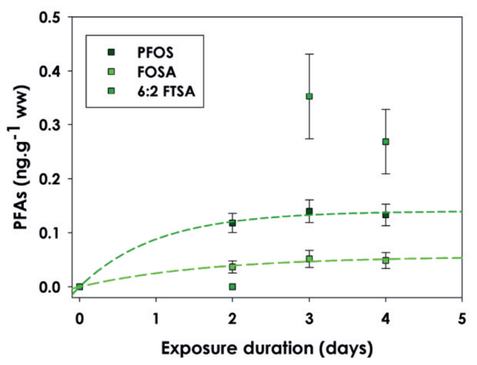
Results and Discussion



PFASs partition between abiotic compartments in the aquaria

(1) Accumulation kinetics





PFASs accumulation kinetics in *Chironomus riparius*. Left: carboxylates acids (PFCAs); right: sulfonates (PFSAs) and precursors.

• Steady state reached.
• Bioaccumulation of PFCAs > 10 fluorinated carbon (PFUnA, PFTrDA), PFOS, FOSA and 6:2 FTSA.
• BSAFs an order of magnitude lower as those in Lasier et al. (2011), but not the same species, food added ...
• No relationship between $BSAFs^{ww}$ and chain length.
• Model fit:

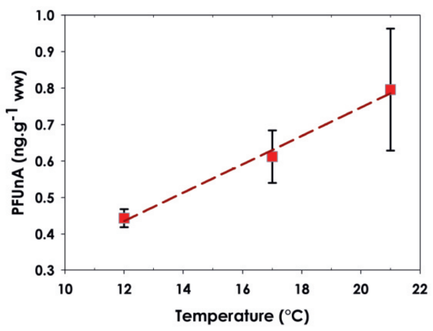
$$C_{org}(t) = a * \left(1 - e^{-bt}\right)$$

Assuming a partition model (Landrum, 1989),

$$a = \frac{k_U * C_{sed-OC}}{k_E} \quad \text{and} \quad b = k_E$$

• k_U range 0.0007 (PFUnA) - 0.006 (FOSA) ;
• k_E range 0.34 (PFUnA) - 0.99 (PFOS).

(2) Temperature effect



• PFASs accumulation positively correlated with temperature for PFUnA, PFDoA, PFTrDA and PFOS.
• No effect for 6:2 FTSA.
• Accumulation values < LQ for PFTeDA and FOSA at 12 and 17°C.

Conclusion and Perspectives

• Refine the understanding of exposure routes (isotopes)
• Determine (experimental) k_E values
• Explore concentration dependency (uptake - elimination)

Landrum, 1989, Env. Sci Technol., 23: 588-595.; Lasier et al., 2011, Env. Tox. Chem, 30, 2194-220; Péry et al., 2002, Env. Tox. Chem, 21, 2507-2513.