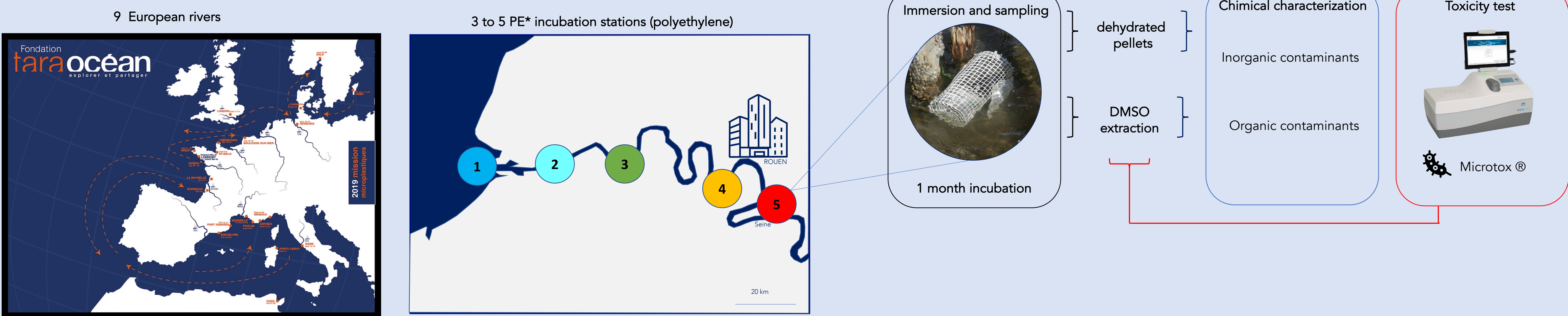


Uncoupling between microplastic inorganic and organic pollutants and toxicity in nine European rivers

David Leistenchneider^{1,2}, Jérôme Cachot³, Isabelle Calvès¹, Edouard Lavergne¹, Grégoire Balluais¹, Christelle Clérandeau³, Fleurine Akoueson⁴, Guillaume Duflos⁴, Bénédicte Morin³, Jean-François Ghiglione², Boris Eyheraguibel⁵ and Anne-Leila Meistertzheim¹

¹ SAS Plastic At Sea, Observatoire Océanologique de Banyuls, Banyuls sur mer, France ² Sorbonne Université,CNRS, Laboratoire d’Océanographie Microbienne LOMIC, UMR 7621, Observatoire Océanologique de Banyuls, Banyuls sur mer, France ³ Univ. Bordeaux, CNRS, Bordeaux INP, EPOC, UMR 5805, F-33600 Pessac, France ⁴ ANSES, Laboratoire de Sécurité des Aliments, Boulevard du Bassin Napoléon, F-62200 Boulogne-sur-Mer, France ⁵ Université Clermont Auvergne, CNRS, Institut de Chimie de Clermont-Ferrand (ICCF), UMR6296, Clermont-Ferrand, France

Introduction



Chemical diversity

Adsorption effect of plastics in rivers

Different quantification methods :

Trace elements & metals on pellets and DMSO extractions → 5800 ICP OES Agilent system

Organic pollutants and additives on pellets→ pyrolyse-GC-MS/MS et LC/MS

Organic pollutants and additives on DMSO extractions→ GC/MS et LC/MS



Diversity of chemical pollutants adsorbed on the surface of polyethylene pellets depending on the river and site selected

Name	PE	H01		H02		H03	H04	H05	H06		H07	H08		H09	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24	H25	H26	H27	H28	H29	H30	
		EBR1	EBR2	EBR3	EB4				ELB3	GAR1		GAR2	GAR4																							LOI1
Endocrine disruptors	2	1	1	0	1	1	1	1	1	2	2	0	0	1	3	3	1	1	0	0	2	3	2	1	2	1	1	0	1	2	1	1	0	2	1	
Pharmaceuticals	0	2	11	0	0	8	6	0	0	0	0	1	0	0	1	0	2	4	8	6	2	3	1	3	0	4	7	3	4	1	0	5	10	4	1	
Phenol & bisphenol	0	1	3	0	0	1	3	0	0	0	1	0	0	0	0	3	3	1	2	1	0	1	1	2	1	1	0	0	0	0	0	2	1	2		
PHA, PDBE, PCB	1	0	1	1	1	1	3	1	4	1	2	1	2	1	1	0	1	1	1	3	7	2	3	1	0	1	1	1	1	3	4	1	1	1	1	2
Antimicrobial	0	2	6	1	1	2	3	1	1	1	1	1	1	1	1	2	2	1	1	3	4	1	5	1	3	2	1	3	2	1	3	3	3	2		
PFAS	1	1	4	3	2	1	1	1	1	1	3	3	2	0	1	3	3	2	1	2	9	2	7	8	1	2	1	1	1	1	1	1	1	2	2	
Extremely Hazardous Substances - 40CFR355	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	1	0	0	1	1	
Water Contaminants	1	1	3	0	0	2	3	1	2	2	1	0	1	2	2	2	1	3	1	1	2	3	1	2	2	3	0	3	2	1	0	1	1	2	2	
Pesticides	2	7	24	1	0	9	14	1	2	0	2	2	3	3	2	2	6	11	10	3	4	2	6	2	3	11	5	3	1	3	15	12	5	2		
Plastic Additives	7	11	30	10	4	12	22	2	7	4	9	6	3	9	7	13	17	11	13	10	17	14	27	10	19	17	9	13	7	7	19	17	26	8		
TOTAL DETECTED	14	26	83	16	9	37	56	8	20	11	21	13	14	20	17	28	38	38	35	28	50	29	55	27	35	45	21	29	19	19	45	47	47	23		

- 8 to 83 different pollutants detected at each site (from 6 to 53 if **plastic additives** are excuded)
- The Elbe, Ebro and Rhône rivers are contaminated mainly by **pharmaceutical compounds, pesticides and antibiotics**
- The Thames and the Tiber are mainly contaminated by **PFAS and antimicrobial substances**

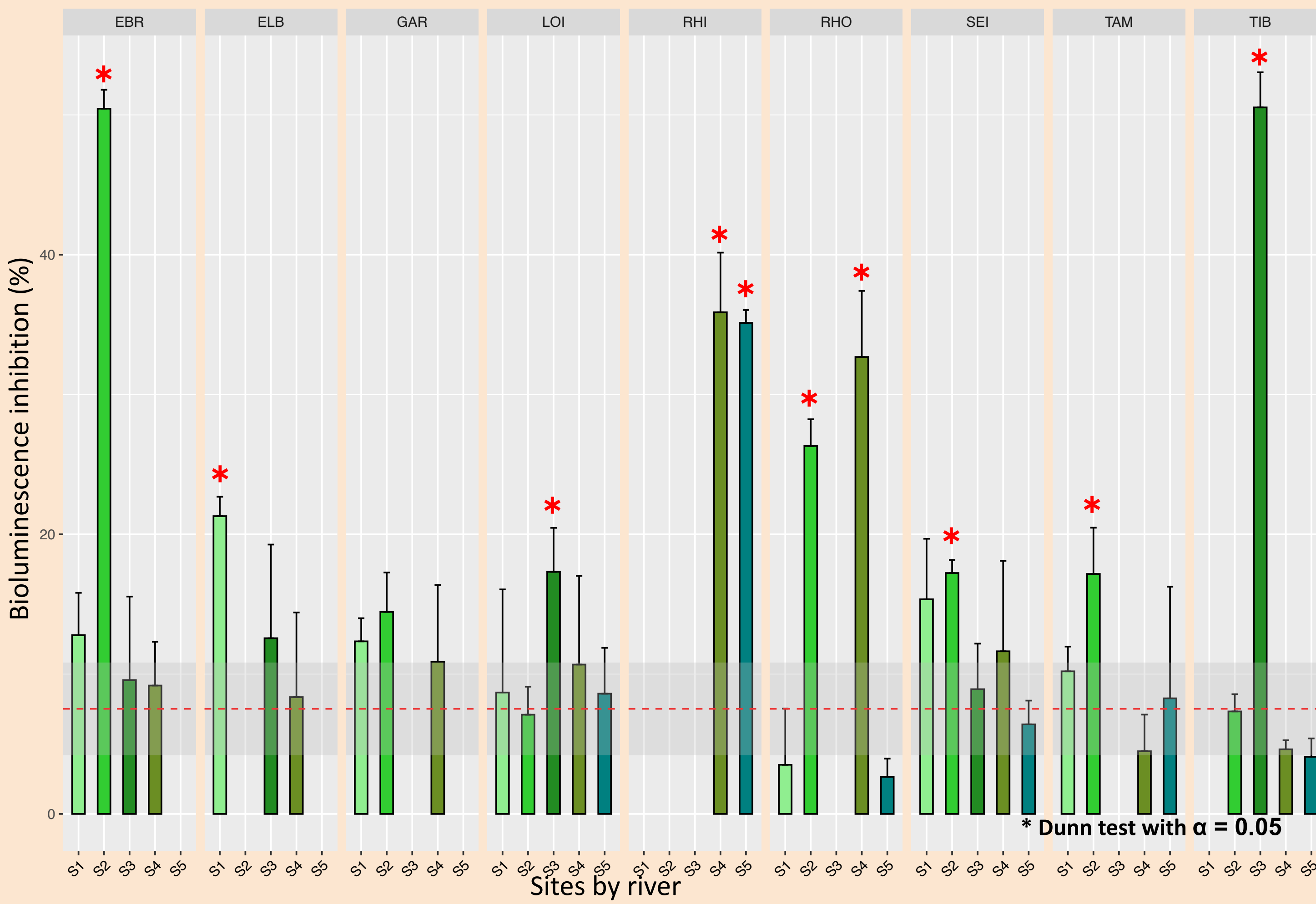
Correlaction between diversity, quantity of adsorbed pollutants and biological toxicity

Biological toxicity

Effect of adsorbed substances on a standardized test

Bioluminescent inhibition of the marine bacteria *Aliivibrio fischeri* (ISO 11348 guidelines)

Toxicity of DMSO extractions of polyethylene pellets on the Microtox® test



Red line corresponds to DMSO control with raw polyethylene (standard deviation in dark gray)

1 % DMSO control corresponds to 7.24 % bioluminescence inhibition

- For the Seine and Elbe rivers, **toxicity increases** with proximity to the estuary
- Antibacterial effect** of adsorbed substances demonstrated by the Microtox® test
- Cocktail effects** are well marked in view of the complexity of the responses

Highlights

- Sponge effect** of polyethylene, pollutants present in the **freshwater compartment**, before runoff into the marine environment
- Adsorption** of the polymer depends on its physicochemical properties, as well as its ageing process (*Rai et al. 2022*)
- Variety of responses depending on the organisms tested (sea urchins, oysters and bacteria), as well as the nature of the polymer (polyethylene and polyoxymethylene)