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Direct and trophic exposure of polystyrene and environmental nanoplastics on *Corbicula fluminea*

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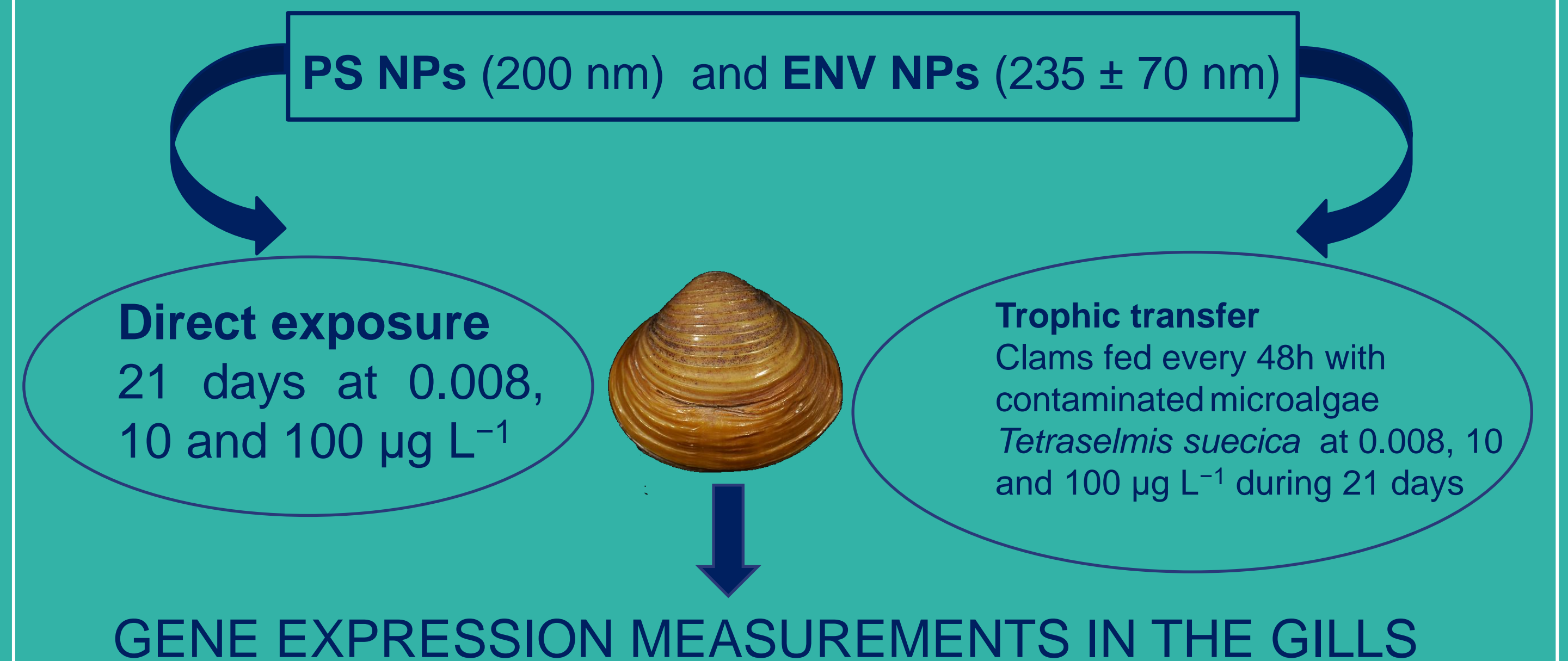
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Objective

Nanoplastics (NPs) are major ecotoxicological concerns in aquatic environments. Among aquatic organisms, filter feeders are particularly exposed to the ingestion of NPs, filtering large quantities of water for food and having an unselective feeding strategy. As part of the TROPHIPLAST project*, the present study investigates the effect of environmental nanoplastics (ENV NPs) generated from macro-sized plastic debris collected in the Garonne River (France), and polystyrene NPs (PS NPs) on the freshwater bivalve *Corbicula fluminea* (Müller 1774) by direct and trophic exposure.

Methodology



Results and discussion

		DIRECT EXPOSURE					TROPIC TRANSFER					
		PS NPs 0,008	PS NPs 10	PS NPs 100	ENV NPs 0,008	ENV NPs 10	ENV NPs 100	PS NPs 0,008	PS NPs 10	PS NPs 100	ENV NPs 0,008	ENV NPs 10
Endocytosis	ctl	1,43		2,27			0,24				0,23	0,20
	cav										0,42	0,46
Detoxication	mt								0,15			
	mdr	1,71	2,93		1,84			0,30			0,06	0,19
	gst	8,33	12,7	7,23	8,61			1,67				
Respiratory chain	cox1							0,34			0,35	0,38
	12s			2,71				0,29			0,21	0,25
Oxidative stress	sod2			1,57				0,43				0,24
	sod1							0,38				0,22
	cat			3,55			0,22				0,17	0,09
	gpx7		1,32		1,59		0,14	0,31			0,19	0,10
Immunity	atg13	3,08	3,82		3,38			0,15			0,14	0,13
	atg12	2,33		2,52			0,20	0,12	0,14		0,11	0,05
	AcP	2,46	3,13	2,69			0,31	0,19			0,11	0,14
	gal	2,00						0,35			0,30	0,19
Apoptosis	bcl2	2,96	2,25	2,14			0,28	0,32			0,25	0,14
	p53	2,83	2,48				0,06	0,09	0,10		0,08	0,02
	bax	1,88									0,18	0,04
	gadd45		2,82	2,29			0,21	0,22			0,23	0,06
Neurotoxicity	AChE	2,25	2,28	2,15			0,12	0,08	0,06		0,02	0,02

Results are presented as fold-change factors between gene expression in controls and gene expression in exposed organisms (> 1: induction, in green; < 1: repression, in red). Only significant differences are represented (p values ≤ 0.05) and only factors <0.5 and >1.5 are considered as significant.

► Direct exposure :

PS NPs : an up-regulation of genes, mainly involved in immunity, apoptosis, neurotoxicity, oxidative stress and detoxication was measured. Important immune system activity was observed even at low concentrations of NPs. Such a shift in the immune response has already been reported for bivalves exposed to MPs and NPs [1,2]

ENV NPs : an up-regulation of *gst* and *mdr* genes was measured, representing essential chemical detoxification route → it suggests the presence of additives and/or some chemical compounds adsorbed on the surface of the ENV NPs. This is consistent with the high metal concentrations measured in the ENV NPs used in our study.

► Trophic transfer :

Different expression pattern compared to direct exposure.

Intense repression of gene expression involved in almost all functions studied for both type of plastic particles → this could lead to strong adverse effects in a long-term. Possible surface biocorona → could impact the transportation, uptake, distribution, biotransformation and toxicity of NPs [3]

PS NPs : effects on gene expression at concentrations of 0.008 and 10 µg L⁻¹

ENV NPs : effects observed for all tested concentrations.

Conclusion

This study highlighted the need to use NPs sampled in the environment for future ecotoxicological studies, compared to manufactured PS NPs as their properties (composition, size distribution, surface charge, additive and adsorbed contaminants) induce different effects at the molecular level to living organisms. In addition, exposures led to changes in gene expression patterns at environmentally relevant concentrations, whether the plastic source, manufactured plastics beads (PS) or environmental particles (ENV).

*TROPHIPLAST project: « Micro- and nanoplatic particules toxicity on aquatic organisms along a freshwater-marine continuum : evaluation of a trophic transfer », supported by ANSES 2018-2022

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3 - Cao, J., Yang, Q., Jiang, J. et al. Coronas of micro/nano plastics: a key determinant in their risk assessments. Part Fibre Toxicol 19, 55 (2022).