

PhD PROPOSAL FOR THE DOCTORAL SCHOOL « Végétal, Animal, Aliment, Mer, Environnement »

GENERAL INFORMATION

<p>Thesis title: Effects of cocktails of organic and inorganic contaminants associated with microplastics on the blue mussel (<i>Mytilus</i> spp.)</p>
<p>Acronym of the project: COCKTAIL</p>
<p>Disciplinary field 1: Ecotoxicology Disciplinary field 2:</p>
<p>Three keywords: Microplastics, Organic Contaminants, Blue Mussel</p>
<p>Registration establishment: Nantes Université</p>
<p>Research unit: ISOMer</p>
<p>Name of the thesis director HDR (Accreditation to supervise research) required: Zalouk-Vergnoux Aurore Email address of the thesis director: aureore.zalouk-vergnoux@univ-nantes.fr Name of the thesis co-director (if applicable): HDR (Accreditation to supervise research) required: Poirier Laurence Email address of the thesis co-director (if applicable): laurence.poirier@univ-nantes.fr Name of the thesis co-supervisor 1 (if applicable): Email address of the thesis co-supervisor 1 (if applicable): Name of the thesis co-supervisor 2 (if applicable): Email address of the thesis co-supervisor 2 (if applicable):</p>
<p>Contact(s) (mailing address and E-mail): laurence.poirier@univ-nantes.fr / aureore.zalouk-vergnoux@univ-nantes.fr</p>
<p><input checked="" type="checkbox"/> Doctoral school contest <input type="checkbox"/> Interview <input type="checkbox"/> Other (specify):</p>

SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

Socio-economic and scientific context: (10 lines)

Human activities are the cause of many environmental contaminations. The substances of greatest concern belong to different families, and are organic contaminants [polychlorinated biphenyls (PCB), polycyclic aromatic hydrocarbons (PAH), perfluorinated substances (PFAS), organochlorine pesticides], metallic trace elements (TME) or microplastics (polyethylene, polypropylene, polystyrene). The environmental risks associated with these substances are in some cases well documented when considered individually, particularly, with regard to their toxicity and exposure levels. However, there are few studies assessing the risks posed by cocktails. Furthermore, microplastics have the capacity to sorb organic and inorganic contaminants, thus acting as reservoirs, potentially vectors of contamination. They therefore pose a physical but also a chemical hazard through the release of contaminants when organisms are exposed to them.

Assumptions and questions (8 lines)

Since the marine environment is the final receptacle of contamination, the mussel *Mytilus* spp. was chosen as a model species for the thesis (sessile, feeding by filtration, wide geographical distribution, human consumption). The various scientific hypotheses are

- Are microplastics vectors or sinks for other contaminants for bivalves?
- Does the presence of organic and inorganic compounds on the surface of microplastics modify the effects produced on organisms (synergy, addition, antagonism)?
- What is the dose-response relationship of a cocktail of environmental contaminants?
- What are the mechanisms of action of the contaminants on the chosen marine model?

The main steps of the thesis and scientific procedure (10-12 lines)

Three main steps will make it possible to respond to the scientific hypotheses:

- In-depth bibliographic study: The objective of this first step will be to take stock of the contaminants used in cocktails, including microplastics, during exposures of marine organisms in the laboratory. The concentrations used will also be valuable in identifying bibliographic gaps that can be filled in subsequent steps. This first step can be promoted in the form of an article review.
- Exposure of mussels to different contamination conditions at environmental concentrations for 3 weeks: (i) control (without contaminants), (ii) microplastics alone, (iii) microplastics with adsorbed other organic and inorganic contaminants and (iv) mixture of organic and inorganic contaminants without microplastics.
- Exposure of mussels to increasing concentrations of microplastics with adsorbed other organic and inorganic contaminants in parallel with the control (no contamination).

Methodological and technical approaches considered (4-6 lines)

Chronic exposures will be performed in microcosms to ensure environmental representativeness using *Mytilus* spp, a marine model species, as a biological model. Effects and/or bioaccumulation will be studied at the organism level using a multiscale approach. Biochemical biomarkers of oxidative stress, cellular metabolism, neurotoxicity, immunotoxicity will be combined with omics tools (genomics, lipidomics) to determine the potential perturbations of contaminants on organisms. Then, a behavioral approach will be implemented to measure potential effects on feeding activity of exposed individuals.

Scientific and technical skills required by the candidate

This thesis would be particularly suitable for a dynamic and inquisitive student with a Master's degree in environment, aquaculture and/or ecotoxicology (or equivalent) and a strong preference for laboratory work. Knowledge and interest

in microcosm exposure, biological impact assessment and communication is desirable, broader knowledge of marine biology and/or analytical chemistry would be appropriate.

THESIS SUPERVISION

Unit name: ISOMer (UR 2160)	Team name: RSBE ² (Remote Sensing Benthic Ecology and Ecotoxicology)
Unit director name: Pr Olivier Grovel	Team director name: Pierre Gernez
Mailing address of the unit director: Olivier.grovel@univ-nantes.fr	Mailing address of the team director: Pierre.gernez@univ-nantes.fr
Thesis director Surname, first name: Zalouk-Vergnoux Aurores Position: Professor Obtained date of the HDR (Accreditation to supervise research): 19/07/2019 Employer: Nantes Université Doctoral school affiliation: VAAME Rate of thesis supervision in the present project (%): 50% Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 190% Number of current thesis supervisions/co-supervisions: 5	
Thesis co-director Surname, first name: Poirier Laurence Position: Professor Obtained date of the HDR (Accreditation to supervise research): 06/02/2020 Employer: Nantes Université Doctoral school affiliation: VAAME Rate of thesis supervision in the present project (%): 50% Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 150% Number of current thesis supervisions/co-supervisions: 4	

Professional status of previous PhD students supervised by both director and co-supervisors (from 5 years)

Please provide the following information for each PhD students supervised

Surname, first name: Marjorie Lortholarie

Date of PhD beginning and PhD defence: 01/04/2021

Thesis supervision: 50% L. Poirier et 50% A. Zalouk-Vergnoux

Professional status and location: Post-doc Université de Reims

Contract profile (post-doc, fixed-term, permanent): post-doc

List of publications from the thesis work:

Lortholarie M*, Zalouk-Vergnoux A, Kamari A, François Y, Herrenknecht C, Poirier L. 2020. Rare earth element bioaccumulation in the yellow and silver European eel (*Anguilla anguilla*): A case study in the Loire estuary (France). *Sci. Total Environ.* 719, 134938.

Lortholarie M*, Poirier L., Kamari A, Herrenknecht C, Zalouk-Vergnoux A. 2021. Rare earth element organotropism in European eel (*Anguilla anguilla*). *Sci. Total Environ.*, 719, 142513.

+ 2 in progress

Five main recent publications of the supervisors on thesis subject:

Couderc M, Marchand J, **Zalouk-Vergnoux A**, Kamari A, Moreau B, Blanchet-Letrouvé I, Le Bizec B, Mouneyrac C, **Poirier L***. 2016. Thyroid endocrine status of wild European eels (*Anguilla anguilla*) in the Loire (France). Relationships with organic contaminant body burdens. *Sci. Total Environ.* 550, 391-405.
doi:10.1016/j.scitotenv.2015.12.136

Phuong NN, **Poirier L**, Pham QT, Lagarde F, **Zalouk-Vergnoux A**. 2018. Factors influencing the microplastic contamination of bivalves from the French Atlantic coast: location, season and/or lifestyle? *Mar. Pollut. Bull.* 129, 664-674.
doi:10.1016/j.envpol.2015.12.035

Khalid A, **Zalouk-Vergnoux A**, Benali S, Mincheva M, Raquez JM, Bertrand S, **Poirier L**. 2021. Are bio-based and biodegradable microplastics impacting for blue mussel (*Mytilus edulis*)? *Mar. Poll. Bull.* 167, 112295.
doi.org/10.1016/j.marpolbul.2021.112295

Moncrieffe R, Masry M, Cai B, Rossignol S, Kamari A, **Poirier L**, Bertrants S, Wong-Wah-Chung P, **Zalouk-Vergnoux A***, 2023. Study of the ageing and the sorption of polyaromatic hydrocarbons as influencing factors on the effects of microplastics on blue mussel. *Aquatic Toxicol.*, 262, 106669
doi.org/10.1016/j.aquatox.2023.106669

Rétif J*, **Zalouk-Vergnoux A**, Kamari A, Briant N, **Poirier L**, 2024. Trophic transfer of rare earth elements in the food web of the Loire estuary (France). *Sci. Total Environ.*, 914, 169652
doi.org/10.1016/j.scitotenv.2023.169652

THESIS FUNDING

Origin(s) of the thesis funding: CDE
Gross monthly salary: 2100 € raw
Thesis funding state: Non acquired
Funding beginning date/duration of the thesis funding: 01/10/2024 for 3 years

Date: 29/02/2024

Name, signature of unit director:

Pr. Olivier GROVEL
 Directeur ISOMer

 UR 2160 ISOMer
 NANTES UNIVERSITE
 UFR des Sciences Pharmaceutiques
 et Biologiques

Name, signature of team director:

Pierre GERNEZ



Name, signature of thesis project director:



All sections must be filled in. Once completed, please save the proposal form in PDF format using the following naming: Supervisor Name_Unit_Subject Acronym_EN.pdf Please also send a Word version to make it easier to change the layout if necessary.

Documents to be send to: ed-vaame@doctorat-paysdelaloire.fr