Metabolomic insights of the impact of agricultural chemical stress on photosynthesis and primary production in freshwater biofilms

Context & objectives

In the « One-Health » context, one major challenge in ecotoxicology is to better understand the relationship between the exposure to complex mixture of chemicals and the response at high level of biological organization in order to establish if chemical stress can alter ecosystem functions and associated services. To do so, it is needed to better characterize the (molecular) mechanisms involved in the response of communities to chemical stress and how these responses are modulated by environmental factors in order to propose relevant solutions for monitoring, substitution and remediation. Also, the protection of aquatic microbial communities involved in many ecosystem services (e.g. biogeochechemical cycle, primary production, bio-remediation,…) is a key environmental, societal and economic challenge, in particular regarding the chemical pollutants that end in aquatic ecosystems. In this context, agricultural activity is of growing economic concern because of the benefice that it brings to society *vs* associated environmental and human risks. This led to the implementation of national (PNSE, plan ecophyto…) and european regulations (WFD) aiming to reduce the emission of chemicals and their impact on humans and biodiversity. Nevertheless, if current bio-monitoring approaches allow the characterization of the exposure and asssociated responses at the individual or even at the population levels, they do not provide information about the actual impact at the community level and on associated services. Thus, increasing the ecological relevance of current bio-monitoring apprach is a major challenge that would consist in the discovery of early, sensitive and specific markers able to detect alteration of biodiversity and ecosystems functions associated to exposure to complex mixture of chemicals with various mode of action. To this end, untargeted metabolomics is a cutting–edge approach of choice regarding the chemical stress because it allows the simulteneous characterization of the exposure (i.e. xeno-métabolome) and the associated response (i.e. endogenous metabolites) in addition to provide knowlege on the molecular mechanisms involved in these responses (i.e. metabolic pathways). Thus, its application to microbial communities in parallel to the assessment of more usual functional and structural descriptors could make the link between exposure and ecosytem responses.

In this context, this PhD project aims to tackle these challenges through the implementation of an untargeted metabolomic approach on freshwater biofilms in order to characterize the molecular responses at the community level following exposure to mixture of chemicals from agricultural activity. The combination of this approach with more usual descriptors focusing on the photosynthesis and the primary production will support :

(i) Better understanding of the molecular mechanisms (metabolic pathways) involved in the regulation and alteration of the photosynthesis and primary production under chemical stress at the community level

(ii) Identification of « ecosystem » molecular markers (metabolites or group of metabolites) allowing the early, sensitive, and specific detection of alteration of ecosystem functions supported by aquatic microbial commuunities that may endanger associated services

Overall methodology

The methodology will consist in the sampling of mixture of pesticides in surface water by using passive samplers ; the implementation of exposure of aquatic biofilms in controlled conditions to reference chemicals and extracts of passive sampler followed by the characterization of the molecular (metabolomic), physiological (photosynthesis) and structural (algal composition) of these communities ; the characterization of the influence of environmental factors in the metabolomic responses ; the identification of specific metabolites associated to the photosynthesis (candidate effect biomarkers) and to exposure to particular class of pesticides (candidate exposure biomarkers by using chemometric methods; in situ investigation of the identified candidates marjers on caged and autochtonous biofilms.

Altogether, these investigations will allow to improve knowledge about the molecular mechanism of toxicity of environmental chemical mixture at the community level in the multi-stress context and to propose relevant markers to evaluate the eco(toxico)logical status of aquatic ecosystems in order to maintain their functions and associated services in the global change context.

Host institute

INRAE is the French National Research Institute for Agriculture, Food and the Environment. INRAE has as its mission to carry out excellent science in order to provide innovative solutions addressing global challenges, notably climate change, biodiversity and food security while at the same time enabling the much needed agroecological, nutritional and energy transitions. This research also serves policy making from regional to international levels, thereby contributing to the Sustainable Development Goals. With more than 250 research and experimental units (within 18 regional research centres and in 14 scientific departments), INRAE works in close cooperation with a wide range of external partners (farmers, industry groups, SMEs, NGOs, regional governments, higher education…) supporting a continuum between fundamental research and applied research and fostering a cross-disciplinary approach. It has a well-established network of national and European-led research infrastructures providing the data and services required to advance public and private research.

Host laboratory

This thesis will be implemented in the EABX Research unit (Aquatic Ecosystems and Global Change), in the team ECOVEA (ecology of aquatic plant communities and impact of multiple pressures) focusing on understanding the biodiversity and functioning of plant communities (macrophytes, phytoplankton, phytobenthos) in rivers and lakes, as well as their responses to natural and anthropogenic disturbances, in particular the chemical stress. Thus, the PhD fellow will beneficiate of multidisciplinary expertize of the team (ecology, ecotoxicology, environnemental chemistry, metabolomic) related to the characterization of the chemical exposure and functional and structural biofilm responses. Also, he/she will have support for field and laboratory experiments of skillful technical staff which has long-standing experience, as well as by state of the art analytics at the Bordeaux Metabolome platform.

Required Skills

Master 2 (or equivalent) in ecotoxicology and/or in environnemental chemistry. Skills in the design and the implementation of *in situ* investigation (sampling, environmental parameters monitoring) and/or laboratory exposure and/or analysis (bioassay, biochemistry, chemical analysis, …) are expected. Skills in biostatistic (univariate and multivariate analysis) would be appreciated, as well good writing, speaking and relationship ability.

Modalités d'accueil

Unit: EABX (équipe ECOVEA)
Town : Gazinet Cestas (33612)
Type of Working contract : CDD
Duration : 3 years
Starting date : 1st of November 2021
Salary : 1 874,41€ before taxes

How to apply ?

Send a CV, a Master certificat with scores, a motivation letter and a recommandation letter to Nicolas Creusot (nicolas.creusot@inrae.fr), Nicolas Mazzella (nicolas.mazzella@inrae.fr) et Soizic Morin (soizic.morin@inrae.fr), **before the 31th of August 2021**