PhD Project

Valve behaviour in *Dreissena polymorpha*: a useful tool for assessing the quality of aquatic environments.

Keywords : valvometry, proteomics, immunity, biosensor, biomonitoring

Aquatic environments represent a final outlet for many contaminants resulting from human activity. These environments are generally contaminated by numerous families of chemicals (trace metals, pesticides, polycyclic aromatic hydrocarbons, etc.), as well as microorganisms that may or may not be pathogenic to humans (*Escherichia coli*, *Cryptosporidium* spp, Adenovirus, etc.).

In this context, the UMR-I 02 SEBIO laboratory has been developing research work for over 15 years into the use of a freshwater bivalve mollusc, *Dreissena polymorpha*, as a biological probe for assessing and monitoring environmental quality. This work has enabled not only to define the conditions for a genuine *in situ* bioassay based on an active approach involving the transplantation of organisms that are as standardized as possible, but also to highlight the added value of this approach with regard to chemical contamination (Hani et al., 2021), microbiological contamination (Capizzi-Banas et al., 2021) and the assessment of toxicity (i.e. immunotoxicity, genotoxicity, energy metabolism, Catteau et al., 2022) in water bodies. This set of responses (bioaccumulation, biomarkers) already provides an interesting assessment of the quality of water bodies. However, considering the biology of our model organism, a behaviour of closing the valves of individuals in response to the quality of the environment (chemical, microbiological, physical) cannot be excluded during the exposure by caging. This could i) represent a factor affecting the exposure of individuals and, consequently, the biological responses measured as biomarkers, but also ii) represent a marker of toxicity if a relationship between the modulation of this behaviour and markers of early effects (i.e. at the molecular level) can be established. Valve-closing behaviour isolates the soft body of bivalves, protecting them from any external threats, and can be modulated by a number of parameters (toxic algae, nocturnal lighting, circadian rhythm, etc.; Tran et al., 2020; Durier et al., 2022; Botté et al., 2023). More specifically, various studies have highlighted changes in valve behaviour in different species of bivalves in response to the presence of parasites (Chambon et al 2007; Basti et al 2009), or chemical contaminants (Chen et al., 2012; Shen and Nugegoda., 2022). In laboratory conditions, changes in behaviour have been observed as a function of the dose (Liu et al., 2016) or time of exposure (Tran et al., 2003) to the contaminant. Behaviour monitoring the of bivalve molluscs (Andrade et al 2016; Vereycken and Aldridge 2023) to detect environmental changes, particularly in mussels, are now being proposed as Biological Early Warning Systems (BEWS) using the Musselmonitor as an example.

The aim of the doctoral project is to study the relationships between responses measured at the individual level (valve behaviour) and molecular markers of disturbances to different physiological functions. To this end, the project will simultaneously study responses at the molecular and individual levels (accumulation, behaviour) in mussels exposed under controlled laboratory conditions to a concentration gradient of different stresses (chemical/biological). The original data thus obtained will improve our knowledge of the behaviour of our biological model and establish relationships between molecular and behavioural responses. Ultimately, this knowledge will make it possible to define whether behavioural metrics can be considered as markers of toxicity (and not just of a change in the quality of the environment) and/or should be taken into account when interpreting biological measurements (accumulation, molecular markers).

For this project, the PhD student will rely on the system set up within the SEBIO laboratory in Reims to monitor the valve behaviour of the mussels (video and image processing approach) and on the expertise of the INRAE in Lyon for the application of a targeted proteomics approach in the mussels for proteins measured in different organs that are a priori involved in carrying out different functions (osmoregulation, immunity and detoxification).

Host laboratory and collaboration :

UMR-I 02 SEBIO, Stress Environnementaux et Biosurveillance des milieux aquatiques, Université de Reims

INRAE, Unité de recherches RiverLy, Ecotox team Centre de Lyon-Grenoble Auvergne-Rhône-Alpes

Doctoral School : Agriculture, Alimentation, Biologie, Environnement, Santé (ABIES –Reims)

Thesis supervisors: Dr Mélissa Palos Ladeiro (Université Reims Champagne Ardenne, UMR-I 02 SEBIO) et Dr Davide Degli Esposti (INRAE, Unité de recherches RiverLy, Ecotox team Centre de Lyon-Grenoble Auvergne-Rhône-Alpes)

Scientific supervision : Supervisors and Pr Alain Geffard (Université Reims Champagne Ardenne, UMR-I 02 SEBIO)

Desired profile - Candidates must have a Master's degree in animal biology, (eco)toxicology or physiology/molecular biology. Desired skills (but not compulsory) : Ecology of organisms - Experiments with model organisms in the laboratory or in the field, study of stress responses. - Good level of statistics, notions of bioinformatics.

- Good level of English - Ability to communicate and work in a team - Willingness to disseminate science at specialist events (conferences) and to the general public.

Contacts :

- Mme Palos Ladeiro : melissa.palos@univ-reims.fr (Tel : 03 26 91 33 47)

To apply, send before the 10th May at :

melissa.palos@univ-reims.fr et davide.degli-esposti@inrae.fr

i) motivation letter, ii) a document of no more than 4 pages on how you intend to develop the subject, iii) letters of recommendation (with contact details of referees), iv) transcript of Master's grades.

Références :

Andrade et al., 2016. High frequency non-invasive (HFNI) bio-sensors as a potential tool for marine monitoring and assessments. Front. Mar.Sci.3:187. doi: 10.3389/fmars.2016.00187

Basti et al., 2009. Effects of the toxic dinoflagellate Heterocapsa circularisquama on the valve movement behaviour of the Manila clam Ruditapes philippinarum. Aquaculture 291, 41–47. https://doi.org/10.1016/j.aquaculture.2009.02.029

Botté et al., 2023. Is part-night lighting a suitable mitigation strategy to limit Artificial Light at Night effects on the biological rhythm at the behavioral and molecular scales of the oyster Crassostrea gigas? Science of the Total Environment 905, 167052

Capizzi-Banas et al., 2021. The utility of Dreissena polymorpha for assessing the viral contamination of rivers by measuring the accumulation of F-Specific RNA bacteriophages. Water 2021, 13, 904. https://doi.org/10.3390/w13070904

Catteau t al., 2022. Interest of a multispecies approach in active biomonitoring: Application in the Meuse watershed. Science of The Total Environment, 808, 152148

Chambon et al., 2007. Influence of the parasite worm Polydora sp. on the behaviour of the oyster Crassostrea gigas: a study of the respiratory impact and associated oxidative stress. Mar. Biol. 152, 329–338. https://doi.org/10.1007/s00227-007-0693-1

Chen et al., 2012. A real-time biomonitoring system to detect arsenic toxicity by valve movement in freshwater clam Corbicula fluminea. Ecotoxicology 21, 1177–1187.

Durier et al., 2022. Use of valvometry as an alert tool to signal the presence of toxic algae Alexandrium catenella by Mytilus edulis. Front. Mar. Sci. 9:987872. doi: 10.3389/fmars.2022.987872

Hani et al., 2021. 1H-NMR metabolomics profiling of zebra mussel (Dreissena polymorpha): A field-scale monitoring tool in ecotoxicological studies. Environmental Pollution 270, 116048

Liu et al., 2016. The valve movement response of three freshwater mussels Corbicula fluminea Müller 1774, Hyriopsis cumingii Lea 1852, and Anodonta woodiana Lea 1834 exposed to copper. Hydrobiologia 770: 1–13.

Shen and Nugegoda, 2022. Real-time automated behavioural monitoring of mussels during contaminant exposures using an improved microcontroller-based device. Sci. Total Environ. 806, 150567.

Tran et al., 2020. Bivalve mollusc circadian clock genes can run at tidal frequency. Proc. R. Soc. B 287: 20192440. http://dx.doi.org/10.1098/rspb.2019.2440

Tran et al. 2003. Estimation of potential and limits of bivalve closure response to detect contaminants: application to cadmium. Environmental Toxicology and Chemistry 22: 914–920.

Vereycken and Aldridge., 2023. Bivalve molluscs as biosensors of water quality: state of the art and future directions. Hydrobiologia, 850:231–256