

## Internship proposal (level Master II or equivalent)

### Refining the TK part of GUTS models to improve ERA – A case study with the sentinel species *Gammarus fossarum* exposed to cadmium

#### Lab partners

Laboratory of Biometry and Evolutionary Biology (LBBE), University Claude Bernard Lyon 1, team “Modelling and predictive ecotoxicology” (MEPS), UMR CNRS 5558.

INRAE – Laboratory of Ecotoxicology, Lyon.

#### Supervising team

Pr Sandrine CHARLES (University Lyon 1, LBBE, team MEPS)

Dr Christelle LOPES (University Lyon 1, LBBE, team MEPS)

#### Collaborators

Dr Arnaud CHAUMOT (INRAE – Ecotoxicology)

Dr Olivier GEFFARD (INRAE – Ecotoxicology)

#### Context

The General Unified Threshold models of Survival (GUTS) are today recognized as ready-to-use tools for Environmental Risk Assessment (ERA), in particular for use in the risk assessment of pesticides on aquatic fauna (EFSA PPR Panel, 2018). These models translate time-variable chemical exposure information into expected survival of organisms over time. They are species and compound specific and explicitly describe the internal exposure dynamics within a whole organism (toxico-kinetics, TK) and the related damage and effect dynamics (toxico-dynamics, TD). Regarding the TK part, considering organisms as a whole prevents a full understanding of physiological functions (namely, organs) that are really impaired during exposure. The current ANR project APPROVe has specifically set itself the objective of delineating the fate of chemical compounds within organisms in order to improve the link with the TD part. To this end, the sentinel species *Gammarus fossarum* has been chosen as well as three metals for which internal concentrations within several expected target organs are followed over time, in combination with the measurement of classical life history traits, like survival. And an innovative organ-based TK model (namely a PBTK model) has newly been developed that needs now to be related to the TD part.

#### Objective

The main objective of this internship is to refine GUTS models, used in their reduced version as recommended by EFSA, in order to combine the above-mentioned PBTK model to the TD part based on survival data for *G. fossarum* exposed to cadmium.

#### Content and deliverables

The internship will consist of the following modelling steps: (1) appropriate GUTS models, especially the reduced versions; (2) refine the models by including the above-mentioned PBTK model; (3) implement the inference process of this new PBTKTD model for survival within a Bayesian framework; (4) compare results with the reduced GUTS modelling approach, with the perspective to argue the expected added-value of a refined GUTS model. These steps will be based on both the R-package ‘morse’ already allowing to fit reduced GUTS models to survival data, and survival data for *G. fossarum* exposed to cadmium, already available for both the organ-based TK part and the TD part. The main deliverable will be an R script able to fit the newly developed PBTKTD model on survival data within a Bayesian framework, and to predict the expected survival of *G. fossarum* under any environmentally realistic scenarios of exposure to cadmium.

#### Expected skills

- Good level in R software
- Basic level in Bayesian statistics
- Good scientific writing skills
- Ability to work at the interface between mathematics and life science
- Rigor, autonomy and curiosity

#### Contact and application

Send a CV and a motivation letter to Pr Sandrine CHARLES, [sandrine.charles@univ-lyon1.fr](mailto:sandrine.charles@univ-lyon1.fr).