

## “Laboratoire Microorganismes : Génome et Environnement (LMGE)/ Institut de Chimie de Clermont-ferrand (ICCF).”

### Thesis proposal

**PhD student position:** Development of a natural preventive process for bioremediation of agricultural soils to limit the spread of pesticides in the environment.

#### Organisation

The candidate's host laboratories will be the “Microorganisms: Genome and Environment (LMGE, UMR CNRS 6023)” Laboratory and the Institute of Chemistry of Clermont-Ferrand (ICCF) at the University Clermont Auvergne (UCA). The LMGE is organized in 6 teams, working on prokaryotic and eukaryotic microorganisms (Archaea, Bacteria, Protists, Fungi) and on viruses, from molecular and cellular aspects to the role of these organisms in ecosystems. The main objectives of the “Microbial communities: Ecotoxicology and Health” team (CMES) are to analyse the structure and dynamics of microbial communities in ecosystems (soil, water, ...) and to determine their response to chemical aggressions. The BIOcatalysis and METAbolism team (BIOMETA) of the ICCF develops its expertise at the chemistry / biology interface for the study and use of enzymes whether isolated (biocatalysed synthesis) or organized in metabolic networks (biodegradation of substrates). More specifically, the research activities of the META theme are focused on understanding the metabolism of microorganisms during the degradation of carbonated substrates in an environmental context (atmosphere, soil, water) and on the impact of different environmental parameters on these metabolic pathways.

These two teams have worked together over the past 15 years and have complementary expertise in the biodegradation of pesticides. These teams combine biological and chemical approaches and expertise to understand the environmental fate of pesticides in water and soil compartments, ranging from the isolation of pesticide-degrading microorganisms to the establishment of their biodegradation pathways. This involves identifying the chemical structures of the metabolites formed using complementary analytical tools and the enzymes involved. The impacts of pesticides on microbial communities in soils and aquatic ecosystems are also studied. Particular attention is focused on the impact of environmental parameters (soil components, multi-contamination, etc.) on the kinetic and metabolic pathways of biodegradation. In recent years, the CMES and BIOMETA teams have also developed innovative bioremediation approaches in soil and water.

#### Position

In this period of change in agriculture between all pesticides (leading to increasing contamination of all environmental compartments) and biocontrol solutions that are struggling to emerge in the field, our project aims to offer an intermediate solution which consists in developing "a new agricultural practice", combining the rational use of phytosanitary products and preservation of the fertility of agricultural soils and the quality of water, in a context of sustainable agriculture. Indeed, the objective of the project is to use the capacity of natural microorganisms from the environment to biodegrade / mineralize a pesticide molecule of interest by providing one or more specific microbial strain(s) in the field, simultaneously or sequentially in a short period of time with the pesticide, in a preventive approach avoiding its diffusion into the environment, while

retaining its action on its target. To achieve this objective, this project combines complementary and cross-disciplinary scientific and technical expertise from the CMES and BIOMETA teams, from applied industrial research in biotechnology (BIOVITIS) and also from the agricultural domain (committee of farmers of the Territorial Innovation Laboratory of the Challenge 1 of the I-SITE in Clermont).

Although this work is ongoing in the laboratory, the candidate will have to continue the bibliographic analysis allowing the selection of the most relevant pesticides for this project and confronting his(her) research with the problems of actors in the agricultural field (3 months). He(she) will then have to isolate and identify pure microbial strains/ consortia degrading the selected pesticides via enrichment cultures (1st year) and characterize the biodegradation pathways (by LC-MS, 1D and 2D NMR) before proceeding to toxicity tests on potential metabolites produced (bio-assays on different organisms) (end of 1st year - 2nd year). He(she) must check the capacity of the strains to keep their degradation activity after formulation and optimize the degradation conditions (2nd year). Then, he(she) will test the efficiency of each [pesticide-microorganism(s)] pair highlighted under laboratory conditions in planted microcosms for different pedoclimatic conditions, first with a fresh culture of microorganisms, then using their formulation (3rd year). Monitoring of pesticide dissipation (soil extraction, concentration and analyses by LC or LC / MS), the survival of the strain (enumeration) and the impact of the strain on the edaphic microbial community and on the plant of interest (plant coverage, root length, high-throughput sequencing (NGS)) will be carried out over time, comparing the pure pesticide and couple [pesticide + microorganism] conditions. Depending on the progress of the project, current agronomic practices recommending the spreading of pesticide cocktails, additional studies could be carried out in soil microcosms to check that the microorganism spread is not sensitive to the presence of other pesticides and retains its degradation capacities under different multi-contamination conditions. Work on microbial consortia could also be undertaken, each strain being specific for the degradation of a molecule of the cocktail.

### Requirements

- Diploma required: To apply, the candidate must have passed the 2nd year of a Master's degree with an average of at least 12/20 and be classified in the first half of the class-list.
- The candidate must have specialized training in microbial ecotoxicology and have skills in Pasteurian microbiology. He(she) will have to control the use of the fundamental statistical tools for biology and microbial ecology (R software, ...). Notions in analytical chemistry (HPLC, mass spectrometry) will be appreciated. A good knowledge of written and spoken English is required.

### Conditions

- The candidate will be recruited for 3 years from November 1, 2020.
- He(she) will work at University of Clermont Auvergne (Aubière, France) in the CMES and BIOMETA teams located on the same campus.
- Salary : € 1,768.55 gross / month
- Possibility for expertise acquisition during the thesis: Ecotoxicology, Microbiology, Analytical chemistry.

### Application

- Deadline to apply: September 30, 2020.
- The candidate must provide a copy of his(her) 2<sup>nd</sup> year Master's diploma, his(her) exams results as well as his(her) ranking. He(she) must send his(her) CV and a letter explaining his(her) motivations for the subject as well as contact details of at least two reference people to Isabelle Batisson (isabelle.batisson@uca.fr) and Pascale Besse-Hoggan (pascale.besse@uca.fr).