Postdoctoral Position (24 months)

Glyphosate bioremediation by algal–bacterial consortia: from experiments to mechanistic models

1- General information

- **Position:** Postdoctoral researcher
- **Discipline:** Biology / Biotechnology / Bioprocess engineering
- **Specialties:**
  - Algal–bacterial cultures
  - Bioremediation
  - Batch and chemostat photobioreactors
- **Contract type:** Fixed-term contract (24 months)
- Renewable: No
- **Monthly net salary:** according to Inria postdoctoral salary scales, adjusted to the candidate's experience (exact range provided during recruitment).
- **Benefits:**
  - Full integration into two complementary research environments: the postdoctoral researcher will be fully embedded in the Laboratoire d'Océanographie de Villefranche-sur-Mer (LOV, CNRS – Sorbonne Université) and closely connected to Inria (GreenOwl project-team), benefiting from a stimulating scientific environment and from the professional, social, and institutional advantages offered by both institutions.
  - Scientific activities and resources: travel for scientific visits and conferences will be supported, together with full access to experimental platforms and complete coverage of experimental and analytical costs within the AEx GlyphoClean project (Inria).
  - Practical support: partial support for transportation costs, possible assistance in finding accommodation, and access to subsidized staff restaurants at LOV Villefranche-sur-Mer and Inria Sophia Antipolis.

- **Keywords:**
  Algal–bacterial consortia; glyphosate degradation; photobioreactors; microbial ecology; bioprocess optimization

Host institution & location

This postdoctoral position is funded within the Inria Exploratory Action **AEx GlyphoClean**, hosted by Inria within the **GreenOwl** project-team (Centre Inria d'Université Côte d'Azur), whose research focuses on the modeling, analysis, and control of biological and environmental systems in close interaction with experimental platforms. The postdoctoral researcher will be physically based and fully integrated at the **Laboratoire d'Océanographie de Villefranche-sur-Mer** (LOV, CNRS – Sorbonne Université), a leading laboratory combining experimental biology, bioprocess engineering, and advanced chemical analytics, enabling long-term, well-instrumented experimental campaigns on algal–bacterial cultures in a coastal research environment.

2- Supervision

Main supervisors

- **Walid Djema**, Centre Inria d'Université Côte d'Azur, GreenOwl project-team, LOV – CNRS / Sorbonne Université, France
  (Scientific leader of the Inria Exploratory Action GlyphoClean)
- **Francis Mairet**, Ifremer, PHYTOX, Nantes, France
- **Olivier Bernard**, Centre Inria d'Université Côte d'Azur, GreenOwl project-team, LOV – CNRS / Sorbonne Université, France

Active interactions with project partners

The postdoctoral researcher will also interact closely with several partners involved in the GlyphoClean project, including:
Antoine Sciandra and **Francesca Casagli** (LOV, Villefranche-sur-Mer, CNRS, France),
Eleonora Sforza (University of Padova, Italy), and
Mustafa Khammash (ETH Zurich, Switzerland).

3- Scientific background

Algal–bacterial consortia play a central role in many ecological and biotechnological processes, including water treatment and bioremediation. These systems rely on complex interactions that can be mutualistic, neutral, or competitive, involving exchanges of nutrients, vitamins, carbon compounds, and chemical signals. Characterizing and quantifying such interactions remains challenging, particularly under environmental stress, such as exposure to pollutants (Ashraf et al.). In bioengineering applications, the use of algal–bacterial consortia has already demonstrated strong potential. An important and promising aspect is that these consortia can be designed *de novo*, rather than relying exclusively on naturally occurring communities. This opens a wide range of opportunities to construct microbial assemblages with enhanced efficiency, stability, and functional complementarity, specifically tailored to targeted processes such as pollutant degradation.

In this context, **Borella et al. (2023)** recently established a key experimental proof of concept, demonstrating that a synthetic consortium composed of three bacterial strains and one microalga, cultivated in small-scale continuous photobioreactors (chemostats), can efficiently degrade glyphosate in polluted freshwater. Importantly, this removal was achieved without detectable accumulation of aminomethylphosphonic acid (AMPA), a major degradation product of glyphosate. These experiments provide a solid and convincing experimental foundation for further developments.

The **GlyphoClean project (Inria Exploratory Action, starting in 2026)** builds directly upon this strong proof of concept. The goal of the proposed postdoctoral position is to go beyond the initial study by conducting a broader and more systematic experimental investigation. This includes exploring a wide range of culture conditions both without pollutants and with glyphosate, in order to (i) better understand algal–bacterial interactions in the absence of stress, (ii) characterize how these interactions are reshaped by pollutant exposure, and (iii) quantitatively assess the associated exchanges and fluxes that will form the basis for mechanistic modeling. Quantification of glyphosate and AMPA will be performed through dedicated analytical platforms and external facilities, in collaboration with project partners. The experimental data generated in this project will support the development and calibration of dynamic models used for control and optimization purposes. Ultimately, the objective is to progressively improve the degradation process, explore scaling-up strategies, and test alternative bioprocess control conditions aimed at enhancing degradation efficiency while ensuring the long-term stability of the microbial consortium.

4- Application procedure

Application deadline: **March 17th, 2026**

Applicants should submit a single PDF file including:

- a detailed CV, including referees' contact details (letters of recommendation may be requested at a later stage of the selection process),
- a motivation letter clearly explaining why the candidate is well suited for the position,
- a list of publications (including submitted preprints and target journals),
- a list of conferences and invited talks,
- availability for interviews,
- expected availability date to start the postdoctoral position.

Applications should be submitted by email as a single, complete PDF file and sent simultaneously to all three of the following addresses:
walid.djema@inria.fr
francis.mairet@ifremer.fr
olivier.bernard@inria.fr
An acknowledgment of receipt will be sent after initial review of the application, and shortlisted candidates will be contacted for interviews before the application deadline.

5- Description of the position

Main missions

- Design, set up, and conduct batch and chemostat experiments on algal–bacterial cultures.
- Investigate algal–bacterial interactions in the absence of pollutants under various conditions (nutrient-poor vs enriched media, vitamin supplementation, particularly vitamin B_{12}), with a specific focus on species coexistence, interaction regimes, and long-term stability.
- Implement progressive adaptation protocols to glyphosate, inspired by Borella et al. (2023) and extended beyond their original experimental framework, including the study of robustness and persistence of the consortium under increasing pollutant stress. Explore the impact of different species ratios and community compositions on glyphosate degradation efficiency, coexistence, and resilience.
- Test dynamic environmental conditions (*e.g.* non-stationary or periodic culture conditions) and assess their effects on degradation performance and microbial stability. Progressively scale up culture volumes and experimental configurations, while monitoring degradation efficiency, reproducibility, and long-term process stability.
- Contribute to the generation of quantitative, high-quality datasets for the construction, calibration, and validation of mechanistic dynamic models (Weiße et al. 2015). A particular emphasis will be placed on parameter identification, model consistency, and validation against experimental observations, which represent a central and time-consuming component of the project. Model-based analyses may subsequently be used to suggest alternative operating conditions or experimental scenarios, potentially explored in interaction with other project partners, within an iterative experiment–model feedback framework.

Main activities

- Design, preparation, and execution of experimental campaigns on algal–bacterial cultures, including batch and chemostat operation, preparation of culture media, setup of experimental platforms, and long-term monitoring of cultures under a wide range of operating conditions.
- Launching, maintenance, and monitoring of microbial cultures, with particular attention to species coexistence, community structure, and long-term stability.
- Regular sampling and quantitative measurements, including biomass estimation, optical density, growth rates, and indicators of consortium stability and resilience.
- Close interaction with analytical platforms for the quantification of glyphosate and its metabolites, and contribution to data organization, quality control, and curation.
- Active participation in the analysis and interpretation of experimental data, supporting the construction, calibration, and validation of mechanistic dynamic models and, when relevant, hybrid modeling approaches combining mechanistic and data-driven components.

- Contribution to the exploration of model-based and control-oriented strategies, including the formulation and testing of dynamic or non-stationary operating conditions, and implementation of experimental protocols inspired by modeling insights (Gutiérrez Mena et al. 2022).
- Preparation of scientific deliverables and peer-reviewed publications, and active contribution to the dissemination of results at conferences and workshops.
- Scientific coordination of the GlyphoClean postdoctoral project, including the preparation and presentation of progress reports and results during meetings with project partners.
- Daily work within the LOV alongside biologists and engineers, regular interactions with project partners (Ifremer Nantes, University of Padova), and active involvement in the scientific supervision and interaction with one or several Master's students (M2) working on closely related topics.

Work organization

- Predominantly laboratory-based experimental work.
- High level of autonomy under scientific supervision.
- Planning and monitoring of long-term experiments (chemostats), requiring rigor and continuity.

6- Candidate profile

Required profile

- **PhD** in biology, biotechnology**,** microbiology, microbial ecology, bioprocess engineering, or a closely related field.
- Strong experience in microbial cultures, ideally involving both algae and bacteria.
- Proven ability to set up, monitor, and analyze batch and/or continuous cultures.
- Autonomous laboratory practice, including solution preparation, consumable management, and compliance with QHS and safety regulations.
- The position is primarily experimentally oriented, with a strong focus on laboratory work on algal–bacterial cultures, while also requiring a genuine interest in quantitative analysis and model-based interpretation of experimental data.
- **Personal qualities:** Autonomy, experimental rigor, teamwork, collaboration, and willingness to supervise and interact with Master's students.

Desired skills

- Experience with standard measurement tools (optical density, growth rate estimation, cytometry)
- General knowledge of biomolecular techniques applied to microbiology
- Programming and data analysis skills (R, Python, or Julia).
- Interest in mechanistic dynamic modeling and hybrid (mechanistic–data-driven) approaches.
- Strong written English skills and experience publishing in peer-reviewed journals.

Working conditions

- **Experimental work involving glyphosate will be conducted within established safety protocols**, and the postdoctoral researcher will receive appropriate training in accordance with institutional and regulatory guidelines.
- **Remote work**: not compatible with the nature of the position, except in very rare and exceptional circumstances.
- **Travel**: short scientific visits to Ifremer Nantes and the University of Padova may be required.

7- Expected outcomes / KPIs

The main expected outcome of this postdoctoral project is a quantitative characterization of algal–bacterial interactions, initially focusing on the species studied in Borella et al. (2023), both with and without glyphosate. These results will provide the experimental basis for the construction, calibration, and validation of mechanistic dynamic models, which constitutes the primary scientific objective of the project.
In addition, the project will assess the contribution of model-based and control-oriented strategies to process improvement, with the following indicative KPIs:

- **Stability and persistence**: extension of stable operating durations and sustained coexistence of bacterial and microalgal species.
- **Community robustness**: improved stabilization of bacterial coexistence under pollutant stress and dynamic conditions.
- **Process performance**: increased glyphosate degradation efficiency through optimized operating conditions.

The project is expected to result in the preparation and submission of at least two peer-reviewed journal articles in high-quality international journals.

References

- Borella, L., Novello, G., Gasparotto, M., Renella, G., Roverso, M., Bogialli, S., Filippini, F. and Sforza, E., 2023. **Design and experimental validation of an optimized microalgae-bacteria consortium for the bioremediation of glyphosate in continuous photobioreactors.** *Journal of Hazardous Materials*, *441*, p.129921.
- Ashraf, N., Ahmad, F. and Lu, Y., 2023. **Synergy between microalgae and microbiome in polluted waters.** *Trends in Microbiology*, *31*(1), pp.9-21.
- Weiße, A.Y., Oyarzún, D.A., Danos, V. and Swain, P.S., 2015. **Mechanistic links between cellular trade-offs, gene expression, and growth**. Proceedings of the National Academy of Sciences, PNAS, 112(9), pp.E1038-E1047.
- Gutiérrez Mena, J., Kumar, S. and Khammash, M., 2022. **Dynamic cybergenetic control of bacterial co-culture composition via optogenetic feedback**. Nature Communications, 13(1), p.4808.