Phd proposal 2023-2026

CoME-ON: **Co**astal **M**icrobiom**E** under river run-**O**ff i**N**fluence

Hosting research Unit: Ifremer/ DYNECO (Brest, France)

Funding: % project Horizon Europe BioOcean5D

Supervisors:

Raffaele Siano, HDR, Ifremer, DYNECO, Pelagos (raffaele.siano@ifremer.fr)

Mathieu Chevalier, Ifremer, DYNECO, LEBCO (mathieu.chevalier@ifremer.fr)

Key-words: environmental genomics; environmental DNA, metabarcoding, biostatistics, co-occurrence networks, coastal ecology, parasites, Harmful Algal Blooms, *Alexandrium*, *Crassostrea*, observatory network.

Scientific context

The coastal microbiome is represented by communities of unicellular organisms, both prokaryotic and eukaryotic, including viruses, bacteria and protists. These communities are characterized by a higher specific richness than other marine communities (e.g. macrofauna) but also by pathogenic species for humans or for marine organisms intended for commercialization. The spatio-temporal dynamic of these microorganisms, their interactions and their relationship (predation, symbioses, interspecific competition) with multicellular organisms (for example mesozooplankton or bivalve filter-feeding organisms) are extremely variable and depend on biotic and abiotic forcings of the coastal ecosystem. River inputs represent the most important cause of variability in coastal ecosystems, particularly in estuarine ecosystems. Nutrients, organic matter, chemical contaminants, and microorganisms of terrigenous origin can cause variations in the trophic and the biogeochemical balance of these systems. The potential cascading effect of these changes on the marine food web makes the coastal ecosystem particularly vulnerable. When shellfish farming is established in these ecosystems, the sustainability and safety of this economic resource are put at risk.

This PhD project will focus on assessing the vulnerability of estuarine ecosystems under the influence of river inputs through:

1) analysis of variations in microbial interactions (bacteria-protists-mesozooplankton) between coastal areas and open seas in the same coastal ecosystem;

2) the assessment of new risks related to variations in microbial community composition depending on river run-off for shellfish farming in coastal areas.

The PhD project will use environmental DNA (eDNA) data produced in the context of the ROME project (*Réseau D'Observatoires de microbiologie Environnementale Intégrée*, https://rome.ifremer.fr/) coordinated by Ifremer since 2020. The ROME project is based on an observatory network settled at both national and European levels. the overarching aim of the project in to analyse coastal ecosystems to improve our ability to protect aquaculture resources and human health. It is based on 4 coastal

observatories located in estuarine ecosystems where oyster farming is an important activity. The targeted ecosystems are: the Bay of Veys Bay in Normandy, the Bay of Brest in Brittany, the Marennes-Oléron basin in New Aquitaine and the Thau Lagoon in Occitanie. The ROME project relies on the metabacording analysys of the environmental DNA collected both in water (fortnightly sampling) and in the tissues of oysters (*Crassotrea gigas*) from farmed populations (monthly sampling) to ultimately characterize communities of bacteria and protists. The sampling of eDNA, together with the application of massive sequencing techniques, now makes it possible to broaden the spectrum of observation of microorganisms to groups and genera not observable with conventional techniques used in other observation networks (e.g. microscopy). With the use of eDNA, ROME therefore proposes to supplement the observations made within these traditional networks in order to have an exhaustive overview of coastal microbial communities.

Expected results

The thesis project aims to answer different questions developed in separate chapters:

1) how is the diversity of the microbiome of estuarine systems structured according to the influence of river run-offs?

2) How do the interactions between bacteria, protists and mesozooplankton vary at the local scale of an estuary, depending on the run-off and at the biogeographic scale considering the 4 sites (3 coastlines) of the ROME network? Are certain target species (e.g. the toxic dinoflagellate *Alexandrium minutum*) characterized by specific interactions?

3) Is there a biogeographical pattern of estuarine microbiomes at the European scale and what are the factors structuring this diversity?

4) What are the new microbiological risks for oyster farming in estuarine systems subject to fluvial run-off?

These chapters will give rise to various publications and will make it possible to enhance the 3-year data of the ROME network (Sept. 2020-Sept. 2023).

In addition, the analysis of mesozooplankton diversity will allow a new use of eDNA samples (size >20µm) from ROME to study the interactions between mesozooplankton and microorganisms and therefore assess the potential of eDNA as an appropriate tool to build a future coastal biology observatory. This project will propose eDNA-based monitoring methods to analyze the vulnerability of estuarine systems and protect its aquaculture resources. The biostatistical approaches envisaged will include interaction network methods that are particularly innovative in microbiology which, on the basis of the co-occurrence of genetic data, will make it possible to formulate hypotheses regarding the existence and ecological dynamic of true biological interactions.

International partnership

Beyond the consortium of scientists of the ROME project, the PhD project is carried out within the context of the Horizon Europe BioOcean5D project (https://www.biocean5d.org/) which further relies on the scientific program TREC (Traversing European Coastlines, https://www.embl.org/about/info/trec/). The doctoral student will therefore benefit from a high-level international context and scientific collaborations with important scientific partners (Tara Foundation,

EMBL) in the context of global environmental genomics. As part of the TREC project, eDNA data from 30 European estuaries will complement the ROME data-set, in order to identify biogeographical patterns of estuarine microbiomes at the European scale. The PhD project will also benefit from collaborations with another Horizon Europe project, Obama-NEXT (https://obama-next.eu/), whose objective is to develop bioindicators of disturbance of coastal ecosystems related to terrigenous contributions from eDNA data.

Candidate profile:

- Master 2 in ecology or marine microbial biology;

- knowledge of the diversity, genetics and ecology of marine microorganisms;

- knowledge of environmental genomics approaches and eDNA analyses;

- propensity for data analysis and biostatistics (knowledge on the R software and on methods classically used in community dynamics)

- management of metabarcoding data;

- interest in coastal zone management;

- very good knowledge of English;

- availability to travel internationally for congresses and meetings of associated scientific projects.

Closing date for applications:

July 16, 2023

Selection of candidates:

July 17 – August 4

Contract start date:

October 9, 2023

For Information:

Raffaele Siano, HDR, Ifremer, DYNECO, Pelagos (raffaele.siano@ifremer.fr)

Mathieu Chevalier, Ifremer, DYNECO, LEBCO (mathieu.chevalier@ifremer.fr)