

## Master project 2021-2022

### Personal Information

<b>Supervisor</b>	Ramiro Logares
<b>Email</b>	ramiro.logares@icm.csic.es
<b>Institution</b>	Institute of Marine Sciences (CSIC)
<b>Website</b>	<a href="https://www.log-lab.barcelona">https://www.log-lab.barcelona</a>
<b>Group</b>	log-lab and Ecology of Marine Microbes

### Project

## Computational genomics

### Project Title:

The ocean microbiome: population dynamics and evolution in a changing planet

### Keywords:

metaomics, microbiome, ocean, populations, evolution

### Summary:

Oceans are vital for the functioning of the Earth and the regulation of climate. The tiny organisms it contains are crucial for global ecosystem function. For example, microbial phytoplankton in the ocean fix as much carbon from the atmosphere as land plants, and other heterotrophic microbes guarantee that a part of the fixed carbon is circulated through food webs sustaining animal life. In a context of global change, it is fundamental to increase our understanding of marine microbes and how they may be affected by the warming ocean. The genomic machinery of the ocean microbiome has been investigated intensively during the last 15 years thanks to the advent of High Throughput Sequencing. Millions of new genes have been retrieved from the ocean and connected to metabolisms and genomes. Yet, we still have a poor understanding of the fine-grained genomic variation that is normally associated to populations. These populations may show specific adaptations to different oceanic conditions allowing us to comprehend the action of natural selection and to discover gene variants that may code for proteins with functional variation. In addition, we still have a rudimentary comprehension of how that fine variation behaves over time or space, due to selection or drift, leading to evolutionary change. All in all, population genomics and fine evolutionary change are possibly two of the greatest challenges in ocean microbiome research for this decade. The proposed master project aims to 1) determine the population variation of selected ocean microbes (using Single Nucleotide Polymorphisms [SNPs]) and 2) find out whether some of the previous variation is due to evolutionary processes that occurred relatively recently in geological time. This project will occur within the recently funded project MINIME (Microbial Evolution and population genomics in a changing ocean. PI: Ramiro Logares, financed by the Spanish Research Agency). The project will use short (Illumina) and long read (PacBio) metagenome datasets from two global ocean expeditions (Tara Oceans and Malaspina) as well as monthly metagenomes from two coastal microbial observatories in the Mediterranean Sea over 7 years. In combination, these datasets include Terabytes of genomic data being possibly the best representation we have so far of the diversity and function of marine microbes. We will build metagenome-assembled genomes (MAGs) and then map short metagenomic reads from the global ocean or the time-series to a number of selected MAGs of ecological importance. Afterwards, we will perform a SNP calling analysis, aiming to dive into populations genomics. Populations will be determined and we will aim to link them with environmental or geographic features. SNPs analyses will indicate whether part of the detected variation has emerged through adaptive evolution. Most of the work will involve bioinformatics, statistics and machine learning. Analyses will be performed at our marine bioinformatics platform Marbits <https://marbits.icm.csic.es> as well as at the Finisterrae II supercomputer at CESGA in Galicia via CSIC agreements. This project is well-suited for a motivated student that is up for the challenge to work at the interface between microbiology, metaomics, bioinformatics & oceanography. Work in this project can open future opportunities in other more applied projects within the EU prioritized research area of blue biotech via bioprospecting gene variants of the ocean microbiome that could be used in industry ([https://ec.europa.eu/maritimeaffairs/policy/biotechnology\\_en](https://ec.europa.eu/maritimeaffairs/policy/biotechnology_en)). There are possibilities of economical support via the CSIC's JAE intro programme (next deadline 12th April 2021, more calls coming in the future (<https://sede.csic.gov.es/intro2021>) or via other projects (to be discussed). The project is designed so it can occur even in a scenario of Covid19 restrictions. The log-lab has hosted 5 master students from the master in bioinformatics for health sciences in the past and most of them continued with PhD studies at the Institute of Marine Sciences (ICM-CSIC) or abroad or work as bioinformaticians at the ICM-CSIC. The ICM-CSIC is the largest center of marine research in Spain and a leading in its field that has recently received the Severo Ochoa excellence distinction. The ICM has a dynamic, motivating and multidisciplinary research environment that aims at promoting the career development of young researchers (<https://www.icm.csic.es/en>).

**References:**

Falkowski, P. The power of plankton. *Nature*, 2012. 483(7387): p. S17-20. Logares R, et al. (2020) Disentangling the mechanisms shaping the surface ocean microbiota. *Microbiome* 8:55 Santos-Júnior CD, et al. (2020) Uncovering the genomic potential of the Amazon River microbiome to degrade rainforest organic matter. *Microbiome* 8:151 Sunagawa, S., et al., Structure and function of the global ocean microbiome. *Science*, 2015. 348(6237): p. 1261359. Carradec, Q., et al., A global ocean atlas of eukaryotic genes. *Nat Commun*, 2018. 9(1): p. 373. de Vargas, C., et al., Eukaryotic plankton diversity in the sunlit ocean. *Science*, 2015. 348(6237): p. 1261605.

**Expected skills::**

To be familiar with Bash and R and good communication in English

**Possibility of funding::**

To be discussed

**Possible continuity with PhD: :**

To be discussed

**Comments:**

Feel free to contact me for more details or if you have any questions

---