



project news

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Welcome to the third newsletter of the MaCuMBA project. In this issue: Interview with WP3 leader Dr Anne Godfroy P.1 Culture Club: Meet the scientists making MaCuMBA possible P.2 Under the Microscope: Marine Microorganisms in the News P.3 BIOALVO Promoting MaCuMBA P.3 Petri Dish Profiles: MICROBES-2-MODEL P.4

Dr Anne Godfroy is the leader of MaCuMBA Work Package 3 (WP3), *Improving culture efficiency of already isolated and cultured microorganisms*. She is a researcher at L'Institut Français de Recherche pour l'Exploitation de la Mer (Ifremer) in the laboratory of Microbiology of Extreme Environments, a joint research unit at the University of Brest, France.



Dr Anne Godfroy

Can you briefly outline, for a wider audience, the aims of your work package (WP) and how it contributes to the overall aims of the MaCuMBA project?

The aim of this WP is to develop innovative cultural methods to improve the cultivation of marine microorganisms, using both previously isolated microorganisms and those isolated by MaCuMBA WP2. The MaCuMBA project will target a diverse range of ecosystems, including coastal or open sea water, and extremely salty, deep sea lakes and hydrothermal vents. These ecosystems host microbial communities with a wide variety of physiological and metabolic properties (from phototrophs which thrive on sunlight, to thermophiles which can be found flourishing in the extreme temperatures around deep sea vents); so the approaches that will be used to cultivate these microorganisms

also need to be highly diverse. The methods we will use include the design of new culture mediums, the optimisation of growth conditions in bioreactors and the development of culture systems mimicking natural conditions. Another innovative approach proposed by the University of Amsterdam (UvA) is the use of computing tools based on genomic data in order to design new culture conditions that will then be tested experimentally.

What factors most affect the efficiency of the cultivation of marine microorganisms?

There are numerous factors that can affect the cultivation of marine microorganisms. One of the difficulties is to be able to provide all the nutrients they need for growth. The design of new cultivation mediums is one of the ways to address this problem. Combining medium improvement with physicochemical conditions (temperature, light, pressure, etc.) will allow us to grow microorganisms in conditions that are as close as possible to their natural environment. Microorganisms also naturally live in communities, so another way to improve cultivation is to maintain them in these communities instead of trying to grow them separately.

How do you create cultivation conditions that mimic the natural environment?

There are a number of ways to do this, depending on the natural environment you are trying to copy. In our lab in Brest we will improve the cultivation of thermophilic microbial communities that colonise hydrothermal chimneys by immobilising them in a polymer matrix and cultivating them in a bioreactor in order to closely mimic their natural "attached" way of life. The use of high pressure, high temperature incubators is also a good way to improve cultivation of deep sea microbes. The Royal Netherlands Institute for Sea Research (NIOZ) will also create synthetic biofilms (thin, slimy films of microorganisms that adhere to a surface) mimicking natural cyanobacteria biofilms.

Could the results of WP3 have benefits beyond the scope of the MaCuMBA project?

Of course they will! Improving the cultivation of marine microorganisms is not only useful for demonstrating their biotechnological potential. Cultivating microorganisms is the best way to assess their metabolic and physiological properties and thus understand their fundamental role in the ecosystem they come from and in the global biogeochemical cycles on Earth.

Culture Club: MaCuMBA Researcher Profiles

Just like the marine microorganisms it studies, the MaCuMBA project relies on a community structure to thrive. Here we meet some of the scientists from all over Europe working together to achieve the project's aims.



Marco Fusi
Post Doctoral Researcher
University of Milan, Italy

Marco is a post doctoral fellow hired in 2012 to work with the MaCuMBA project at the University of Milan, Italy. His PhD studies focused on assessing ecophysiological traits of key species of microorganisms in mangroves along the East African forest. The aim of his work within the MaCuMBA project is to identify the key bacterial species in the tissues of crabs living in mangrove ecosystems using cultivation-independent methods, and to try to bring them into culture by designing culturing media that mimic the ecophysiological and chemical conditions these organisms experience in their natural environment.



Vanessa Rédou
PhD Student
European University of Brittany, France

Vanessa Rédou is a PhD student in marine microbiology at the Laboratoire Universitaire de Biodiversité et Ecologie Microbienne (LUBEM) at the European University of Brittany, France. Her supervisors are Prof Georges Barbier and Dr Gaëtan Burgaud. As part of the MaCuMBA project Vanessa is interested in the genetic and functional diversity of fungal communities occurring in the deep biosphere. The aims of her research are to develop a metabarcoding approach for different deep-sea ecosystems in order to evaluate the distribution of extreme fungal communities and to establish a culture collection of endemic deep-sea fungal strains using methods mimicking in situ conditions.



Rohit Ghai
Postdoctoral Researcher
Universidad Miguel Hernández, Spain

Rohit is interested in understanding aquatic microbial communities (marine, freshwater and hypersaline systems), their interactions and adaptations to the natural environment. This includes a broad based approach focused not only on the prokaryotic members but also their phages. Metagenomics provides us with the ability to see these systems in unprecedented detail, so Rohit uses and develops methods to analyse metagenomic and genomic data to address these questions. In the scope of the MaCuMBA project, Rohit is working as part of the team at the Universidad Miguel Hernández (UMH), Spain, on work package 6 (WP6) and the large DNA sequencing efforts of the project.



Nikole E Kimes
Postdoctoral Researcher
Universidad Miguel Hernández, Spain

Nikole's research interests are focused on marine microbial communities (bacteria and viruses) associated with corals, deep-sea sediments, and the Mediterranean Sea. She uses genomic and metagenomic techniques coupled with more traditional phenotypic/physiological studies to investigate the ecological impact of individual community members as well as the community as a whole. Within the MaCuMBA project, Nikole is utilising her lab's vast experience with genomes and metagenomes to help develop novel isolation methods for marine microbes. She is also organising the genomic and metagenomic sequencing, as well as the administrative tasks, for work package 6 (WP6).



Marta Abrantes
Robotic Unit Senior Scientist
BIOALVO, Portugal

Marta holds a PhD in microbial biology from the Instituto de Tecnologia Química e Biológica (ITQB) in the Universidade Nova de Lisboa, Portugal. She also has a master's degree in pharmaceutical chemistry and a five-year degree in biochemistry from the University of Lisbon (UL), Portugal. She has experience in molecular biology, bacterial microbiology, genetics, isolation and identification of compounds, macrophage cell culture and DNA microarrays. At BIOALVO, Marta is responsible for the Robotics Unit, where screenings are performed. Within the MaCuMBA project, she is responsible for the isolation of new bacteria from the collected sediment samples.



Ricardo Pinheiro
Analytical Chemistry and Robotic Unit
Senior Scientist
BIOALVO, Portugal

Ricardo holds a degree in biotechnology engineering, from Universidade Lusófona de Humanidades e Tecnologias, Lisbon, Portugal. Ricardo joined BIOALVO in September 2007 as Lab Technician. In 2010/2011 he was seconded to University of Girona in the frame of an IAPP/FP7 Marie Curie European project. He was promoted to Junior Scientist in 2011. Currently, he is responsible for Analytical Chemistry and is Senior Scientist of the Robotics Unit. As part of the MaCuMBA project, Ricardo will be involved in the isolation of new microorganisms and the screening of extracts.

Under the Microscope: Marine Microorganisms in the news

Canadian Mine May Host 2.6-Billion-Year-Old Ecosystem

Dating techniques indicate that water circulating through fractures in the rocks of a Canadian copper mine has been isolated from the rest of the planet for up to 2.64 billion years – making it a time capsule from the early days of life on Earth.

<http://www.newscientist.com/article/mg21829174.400-canadian-mine-may-host-26billionyearold-ecosystem.html#.Ubm1OvnVCS0>

Symbiotic Bacteria Programme Daily Rhythms in Squid Using Light and Chemicals

Glowing bacteria inside squid use light and chemical signals to control circadian-like rhythms in the animals.

http://www.eurekalert.org/pub_releases/2013-04/asfm-sbp032913.php

Researchers Make Breakthrough in Race to Create 'Bio-Batteries'

Scientists at the University of East Anglia have made an important breakthrough in the quest to generate clean electricity from bacteria.

<http://www.uea.ac.uk/mac/comm/media/press/2013/March/bio-batteries>

Spanish Researchers Sequence the Genome of Global Deep Ocean

A team of Spanish researchers, coordinated by the Spanish National Research Council (CSIC), has started to sequence the genome of the global deep ocean.

http://www.eurekalert.org/pub_releases/2013-06/snrc-srs061213.php



Mariana Trench: Deepest Ocean 'Teems with Microbes'

The deepest place in the ocean is teeming with microscopic life, a study suggests.

<http://www.bbc.co.uk/news/science-environment-21806406>

Chalking up a Marine Blooming Alga: Genome Fills a Gap in the Tree of Life

The genome of *Emiliana huxleyi* (Ehux), which can trap as much as 20% of organic carbon, derived from CO₂, in some marine ecosystems, has been sequenced by the US Department of Energy Joint Genome Institute (DOE JGI).

<http://phys.org/news/2013-02-eu-project-deep-sea.html>

BIOALVO Promoting MaCuMBA

On 19 June 2013, BIOALVO received a visit from members of the Portuguese Pavilion of Knowledge Senior Club. The visitors were introduced to the MaCuMBA project, the importance and biotech potential of deep-sea bacteria, and the work being done by BIOALVO. The visitors were also able to experience the bacterial isolation process firsthand by participating in a mock experiment, where they streaked



Mock experiment of bacteria inoculation performed by members of the Portuguese Pavilion of Knowledge Senior Club.

Lysogeny broth (LB) agar plates with a suspension of deep sea sediments. They were then able to observe fresh isolates BIOALVO had prepared for MaCuMBA, obtained by incubating similar sediments at different temperatures.

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PETRI DISH PROFILES: MICROBES-2-MODEL



Dr Daniel Sher

MaCuMBA Project News continues its series of Petri Dish Profiles featuring other European-funded projects related to the study of marine microorganisms. In this issue, Dr Daniel Sher of the Leon H. Charney School of Marine Sciences, University of Haifa, Israel, discusses the FP7-funded MICROBES-2-MODEL project.

Can you give a brief outline of the aims of MICROBES-2-MODEL?

The MICROBES-2-MODEL project aims to characterise the interactions between *Prochlorococcus*, a tiny single-celled cyanobacterium, and co-occurring heterotrophic bacteria, which consume and respire organic molecules. We study how growing these two organism types together (“co-culture”) affects the physiology of each organism, as well as the regulation of the various genes in their genomes. We then use this data to construct mathematical models, which describe and interpret how the lives of these organisms are intertwined. We hope that understanding and modelling these simple laboratory co-cultures will give us insight and tools for interpreting the relationships between large and complex communities of these organisms in the ocean, and their impact on the global carbon cycle.

What is *Prochlorococcus*, and why is it important and interesting to study it?

Prochlorococcus is a tiny, single-celled bacterium, which is arguably the most abundant photosynthetic organism on Earth. It has been suggested that approximately 20% of the oxygen we breathe comes from this organism and its close marine cousins, which clearly makes it an important organism to study. It is also a fascinating organism for many other reasons: It has the smallest known genome of any photosynthetic organism, making it a great model to study the basic, core genes and processes that support microbial life in the oceans. *Prochlorococcus* are in fact not a single organism, but rather a group of genetically related “ecotypes”, each adapted to life in different oceanic niches. There are more than a dozen strains that are routinely

maintained in laboratory cultures, and whose genomes have been sequenced. This enables us to test hypotheses on how specific genes and genetic pathways affect the physiology of these organisms and to learn how these genes and pathways have evolved. Finally, *Prochlorococcus* has been studied extensively during research cruises around the world, including the Mediterranean and Red Seas. The abundance of ecological data allows us to try to relate observations and experiments performed in the lab, at the cellular or even molecular scales to the “real world” – the dynamics of these cells in the oceans, at scales of hundreds or thousands of kilometres. There are not many organisms for which such “cross-scale” research is possible.



How do you model microbial interactions?

That is perhaps the most difficult and exciting challenge of the entire project. Mathematical models are essential if we want to be able to predict the dynamics of any biological system, and models of marine microbes (mainly phytoplankton) are routinely incorporated into global ocean models which, in turn, inform decision makers (e.g. the Intergovernmental Panel on Climate Change (IPCC)). However, most of these models do not explicitly recognise microbial interactions, despite a growing body of evidence that such interactions are critically important and can strongly affect ecosystem dynamics. We have teamed up with Prof Mick Follows from Massachusetts Institute of Technology (MIT), USA, a global leader in marine ecosystem modelling, to explicitly represent microbial interactions in ecosystem models.

Might the results of MICROBES-2-MODEL have applications beyond the scope of the project?

Microbial interactions abound not only in the oceans. Microbes interact in the soil, in our guts, on our skin, in food, on hospital appliances ... everywhere! We believe that the concepts and tools we are developing as part of the MICROBES-2-MODEL project will be very useful for researchers in the fields of agriculture, biotechnology and human health, to name just a few.

Will you be collaborating with European researchers during this project?

Yes, certainly. The MICROBES-2-MODEL project has allowed us to initiate collaborations with researchers in Germany and the UK, as well as from the US and Canada. We think it is especially important that the project has helped to forge a strong collaboration between experimental biologists and theoreticians, which we believe will be critical if we want to be able to understand and model marine microbial populations, and ultimately predict how these populations will evolve in a changing world.

For more information, contact Daniel at dsheer@univ.haifa.ac.il