

Thesis Title	Bi-Modal Mixotrophy in harmful microalgae (BMMix)
Contract type	PhD thesis
Department/Office	Physiology and Biotechnology of Algae (RBE/PBA) & Phycotoxines (ODE/PHYC) labs
Duty station	Ifremer Centre Atlantique, Nantes
Date of issue :	
Doctoral School	Ecole doctorale Sciences de la Mer et du Littoral (ED SML)
Thesis supervisor	Francis Mairet (Ifremer PBA)
Co-supervisors	Per Juel Hansen (University of Copenhagen) Thomas Lacour (Ifremer PBA) Damien Réveillon (Ifremer PHYC)
Reference (HRD)	

The Institute and the recruiting department

This thesis will benefit from the knowledge and skills of the PBA laboratory on ecophysiology, nutrition and controlled cultures of microalgae, and those of the PHYC laboratory in terms of toxin analysis and metabolomics. These two laboratories should merge soon in a new research unit on harmful microalgae.

https://wwz.ifremer.fr/pba_eng/

https://wwz.ifremer.fr/laboratoire_phycotoxines/

Summary

Context: Organisms that combine photosynthesis and phagotrophy are called mixotrophs. Phagotrophy by the photosynthetic microalgae will considerably impact system primary production, biogeochemical cycles and food webs (Ward & Follows, 2016; Stoecker et al., 2017) both in coastal and oceanic waters.

Harmful algal blooms (HAB) are expanding, with huge impacts on ecosystems and coastal economies (aquaculture, tourism, etc.). Mixotrophy by harmful microalgae may partly be responsible for their ecological success, particularly in relation to the context of global change. The importance of mixotrophy in microalgae recently attracted increased attention. However, the knowledge on the role of phagotrophy during nutrient limitation is still sparse.

Initial experiments with the role of phagotrophy in a model microalgae have been carried out at the Ifremer PBA laboratory, Nantes. Surprisingly, we observed the appearance of two sub-populations differentiated by their chlorophyll content. Our preliminary results suggested that phagotrophy may only occur in a fraction of the population.

This unexpected phenomenon of bi-modality in a homogeneous environment has been observed in some unicellular microorganisms and it is a crucial key to understand some microbial responses, such as antibiotic resistance (Ackermann, 2015). Thus, in general, observation of the overall population masks certain characteristics and can lead to misleading conclusions. Nevertheless, current studies on phytoplankton take no account of phenotypic heterogeneity. In this context, this thesis project focuses on understanding the causes and consequences of trophic heterogeneity in mixotrophic harmful microalgae.

Objective: The thesis aims at understanding the phenomenon of trophic bi-modality, with as central questions:

- What are the phenotypic, toxic and genetic characteristics of each sub-population when growing with prey?
- Is the phenomenon of trophic bi-modality common among other microalgae?
- What are the possible biomarkers of (the degree of) each trophic mode?

Through these questions, we want to evaluate the possible consequences of trophic heterogeneity on the global functioning of the ecosystem, particularly in terms of species competition and carbon fixation.

Methodology: The trophic heterogeneity of our model species will be further characterized by coupling ecophysiological approaches, transcriptomic, metabolomic and toxin analyses. The real challenge will be to characterize each sub-population separately. Different experimental conditions (with various levels of nutrients, preys or light intensity) will be carried out to vary the ratio between sub-populations to finally deconvolve their respective properties. Additionally, the project will rely on cytometry with cell imaging (to characterize their chloroplasts) and cell sorting (followed by biochemical analyses or regrowth experiments). The objective will be to characterize for each sub-population, their growth, photosynthetic rates, pigment and toxin contents, the presence of food vacuoles, etc. We will also study gene expression via a global RNAseq-type approach, with the aim of identifying specific genes in each population.

To assess the generality of trophic bi-modality, a few species will then be considered. Their trophic heterogeneity will be evaluated using flow cytometry. Finally, for each species, the autotrophic and mixotrophic modes will be compared through metabolic fingerprinting to find biomarkers (identified by classical dereplication or molecular networks).

Key words

Ecophysiology, toxic phytoplankton, trophic mode, phagotrophy, phenotypic heterogeneity

Expected profil

The candidate must hold a Master's degree, specialized in microbiology, with knowledge of algal culture, molecular biology and/or chemistry. The student will also have to show an interest in multidisciplinary research and marine ecology, and good communication skills in English.

Specific working conditions

The thesis will be co-supervised by Per Juel Hansen (University of Copenhagen). A three-month stay of the PhD candidate at Copenhagen is expected.

Phd is a real opportunity to work on Ifremer's scientific and technological priority themes. It entitles the holder to a gross monthly salary of 1900 euros for a period of 3 years, which cannot be combined with other scholarships.

How to apply for this position ?

Your application file must include:

- a curriculum vitae
- a covering letter
- a reference letter
- an academic transcript (Bachelor + Master 1 and first semester Master 2)

Your application must be **compiled into 2 PDF files, up to 1.5 MB for each file:**

<https://ifremer-en.jobs.net/en-GB/job/phd-bi-modal-mixotrophy-in-harmful-microalgae-bmmix-m-f/J3V5Q777M5JW91PP1SY>

In case of any problem in attaching your documents, please upload your CV on this page (this step is mandatory for your application to be considered) and send all the documents to the thesis supervisor : **francis.mairet@ifremer.fr**

The deadline for applications is **2nd of May, 2021**. Nevertheless, we strongly urge you to let us know as soon as possible of your intention to apply, by contacting the subject supervisor.

Doctoral students' contracts will start as of October 1st, 2021, subject to the submission of administrative documents authorizing Ifremer to recruit the doctoral student (certificate of completion of the Master 2 or engineering degree + visa for foreign doctoral students outside the EU).

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