

**« Phenolic compounds used in the chemical protection and photoprotection of marine plants: metabolic conditioning, sustainable extraction and relations structure/function» (Acronyme Pheno-veg)**

**Research teams:**

\* Laboratoire des Sciences de l'Environnement Marin (LEMAR)  
UMR6539 UBO/CNRS/IRD/IFREMER, IUEM Plouzané (29).

\* Société Science & Mer (SIMER SAS)  
Venelle du Caros, Le Relecq-Kerhuon (29)

**Collaborations:**

PTF Biodimar UBO, CHIMEX, C-WEED Aquaculture (PME), MMS-Univ. Nantes

**Main supervisor:**

Valérie Stiger-Pouvreau (MC UBO/HDR)

**Contact :**

[stiger@univ-brest.fr](mailto:stiger@univ-brest.fr)

LEMAR-IUEM-UBO

Tél : 02 98 49 88 06

**Supervisors:**

Valérie Stiger-Pouvreau (MC UBO, LEMAR équipes 2 & 3)

Maud Larnicol (Dir. R&D, Société Science & Mer)

Nathalie Poupart (MC UBO, LEMAR équipes 2 & 3)

Fabienne Guérard (PR UBO, LEMAR équipes 1 & 2)

**Abstract:**

Studies conducted during the PhD project relate, at the same time to the ecophysiology of marine plants (macroalgae and halophytes), biotechnologies, but also the development of innovative processes of extraction/purification with respect of the environment and standardization of antioxydant biotests. The objectives of the PhD are to study the phenolic compounds produced by marine plants, to isolate them and to know their role in the chemical protection of marine plants, and finally, to propose them as marine active ingrédients for industrial applications. The PhD project integrates all the chain value of production of a cosmetic product: selection of biomass for its particular composition in phenolic compounds, with the extraction of new active compounds via innovating eco-efficient processes, until the comprehension of the synthesis of compounds within marine plants and the development of cosmetic formulations. Works carried out within the framework of the PhD thesis will concentrate on the photoprotective and antimicrobial properties, naturally brought by the phenolic compounds synthesized by the marine plants.

**Contexte, objectifs et intérêts scientifiques :**

Marine plants, i.e. macroalgae and halophytes, living in coastal zones undergo many stresses of the environment. Face to these constraints, some species develop a chemical defense, by secreting often original molecules of protection and which are known to present high biological activities, acting at very weak concentrations. A large number of green evolutionary lineages synthesize phenolic compounds, having for goal to protect them against various environmental constraints (Stengel and al. 2011). The family of phenolic compounds gathers a large number of compounds which have all in common a phenol group.

Thus, phenolic acids, MAAs, Phlorotannins are synthesized and are known for their role in the chemical protection of the marine plants: against grazers, micro-organisms like pathogens or biofouling for examples, but also in protection against radiations UV for algae living in the intertidal zone (Connan et al. 2004, Stiger et al. 2004, Hupel et al. 2011, Le Lann et al. 2012, Stiger-Pouvreau et al. 2014, Tanniou et al. 2014, Surget et al. 2015). These molecules with multiple properties can thus be used like natural preservatives (antimicrobial property), like solar filters (photoprotant property), or then like active anti-age (antioxydant properties) and being thus used in cosmetic as natural ingredients and to replace the synthetic actives, for which the use is heavily discussed. Currently, several cosmetic industries use phenolic compounds from terrestrial plant (like Caudalie with the use

of polyphenols C15, extracted from grape seeds for example), but at the present time, no cosmetic product presents marine active polyphenolic compounds.

The project of this thesis seeks to isolate such compounds with multiple properties, by proposing the photo-protective, antimicrobial and anti-ROS functions of the phenolic compounds extracted from marine plants. With this intention, several stages will be to be implemented during this PhD project:

- (1) From the marine resource: the PhD project will concern species largely present in the natural environment whose harvest does not cause a threat (ecological monitoring), and also resulting from species cultivated by the SME C-WEED AQUACULTURE which use whole thalli cultivated out in sea and in basins, but which also develops a culture of early stages. For this last type of resource, a study of the conditions of culture supporting the production of phenolic compounds will be necessary (metabolic forcing)
- (2) The research of the respectful processes of extraction applied to the phenolic compounds and biological activities required: extracts obtained from sustainable processes during the extraction (Accelerated solvents Extraction, use of fluids in a supercritical and/or subcritical state, enzymatic hydrolysis, etc) and of the purification (centrifugal chromatography of division, flash chromatography, SPE, etc) of compounds.
- (3) The obtaining of stabilized marine phenolic compounds. This PhD project seeks to develop new ranges of marine diversified products, proposing the photo-protective, antimicrobial and anti-ROS functions.

At present, no single phenolic compound was yet isolated from Fucales and regional halophytes. Moreover, these compounds are often unstable (loss of activity) after their extraction. Thus the challenge will be to search desmoyens to stabilize the extracted compounds.

#### **Financial supports:**

A mid-allocation of research UBO is requested to finance le salary of the PhD student. The complementary mid-allocation for the salary of the student will be given **by the research project FUI 20 RIV-AGE 2.0** (Dec 2015-nov 2019) supervised by the SME Science & Mer. **This project groups industrial partners** (Science & Mer, C-WEED AQUACULTURE, CHIMEX) **and 2 academical partners** (LEMAR-IUEM-UBO and MMS-Univ. Nantes). This project will **finance also the functioning of the PhD thesis** (sampling and monitoring missions, extraction/purification/ structural identification of marine active compounds, diffusion on the project, etc...).

#### **Pre-necessary:**

An expérience in the isolation and identification of active polyphenolic compounds is extremely recommended. In parallel of this research program, the PhD student will have in charge to link the LEMAR and the SME Science & Mer. It is thus strongly wished that the PhD student acquired first experience (master course or employment) in cosmetic company, and is able to establish this link between academic and private structures, to be able to apply on this PhD subject.

#### **Bibliographic References in the text**

- .Connan S, Goulard F, Stiger V, Deslandes E, Ar Gall E (2004) Phlorotannins in belt forming brown algae of a sheltered shore. *Bot Mar* 47:410–416
- .Hupel M, Lecointre C, Meudec A, Poupart N, Ar Gall E (2011) Comparison of photoprotective responses to UV radiation in the brown seaweed *Pelvetia canaliculata* and the marine angiosperm *Salicornia ramosissima*. *JEMBE* 401 : 36-47
- .Le Lann K, Connan S, Stiger-Pouvreau V (2012) Phenology, TPC and size-fractioning phenolics variability in temperate Sargassaceae (Phaeophyceae, Fucales) from Western Brittany: Native versus introduced species. *Marine Environmental Research* 80: 1-11
- .Stengel DB, Connan S, Popper ZA (2011) Algal chemodiversity and bioactivity: Sources of natural variability and implications for commercial application. *Biotechnology Advances* 29: 483–501
- .Stiger V, Deslandes E, CE Payri (2004) Phenolic contents of two brown algae, *Turbinaria ornata* and *Sargassum mangarevense* on Tahiti (French Polynesia): interspecific, ontogenic and spatio-temporal variations. *Bot. Mar.* 47(5): 402-409
- .Stiger-Pouvreau V, Jégou C, Cérantola S, Guérard F, Le Lann K (2014) Phlorotannins in Sargassaceae species

from Brittany (France): interesting molecules for ecophysiological and valorisation purposes. *Advances in Botanical Research*, 71: 379-412

- .Surget G, **Stiger-Pouvreau V**, Le Lann K, **Couteau C**, **Coiffard L**, **Guérard F**, **Poupart N** (2015) Sunscreen and antioxidant photoprotective capacities of polyphenolic compounds originated from a salt-marsh plant extract from Brittany (France). *Journal of Photochemistry and Photobiology B: Biology* 143, 52–60
- .Tanniou A, Vandanjon L, Incera M, Serrano Léon E, Husa V, Le Grand J, Nicolas JL, **Poupart N**, Kervarec N, Engelen A, Walsh R, **Guérard F**, Bourgougnon N, **Stiger-Pouvreau V** (2014) Assessment of the spatial variability of phenolic contents and associated bioactivities in the invasive alga *Sargassum muticum* sampled along its European range from Norway to Portugal. *J. Appl. Phycol.* 26: 1215-1230