Sujet de thèse: Genetic Adaptation and Phenotypic plasticity in haploid-diploid red algae: invasive potential and habitat shift in Gracilariaeace

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Publications récentes des directeurs de thèse avec leurs anciens doctorants:

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Descriptif du sujet de thèse et méthodes envisagées:

Marine ecosystems are today subject to many disturbances due to human activities and climate change. Non-native species (or species that changes of habitat) profoundly alter local communities and ecosystem function (Maggi et al., 2015). The successful establishment of non-native population can be facilitated by microevolution (Colautti and Lau, 2015) through several mechanisms that may occur either before invasion (or habitat change) by local adaptation in the geographical area of origin, either after adaptation introduction after arrival in a new habitat (Lee, 2015), or sometimes through a genetic mixture of several different sources (Lavergne and Molofsky, 2007). Alternatively, it is also possible that no adaptation has occurred, for example when phenotypic plasticity allows successful implantation in non-native habitats (Geng et al., 2007).

The red algae of the family of Gracilariaeace are good models to study these questions. The ability of these red algae species to switch from sexual reproduction to asexual reproduction, their high tolerance to stress and their resistance to herbivores are supposed to be the cause of their ecological success both as invasive species: Agarophyton vermiculophyll (as Gracilaria vermiculophyll) and as cultivated species: Agarophyton chilensis (Guillemin et al., 2008, Krueger- Hadfield et al., 2016, Softka et al., 2018). This PhD project aims to better understand the ecological and evolutionary characteristics of these invasive or potentially invasive haploid-diploid species combining population genomics and experimental approaches.

Taking advantage of recent samples and genomic data sets (thousands of SNPs markers) collected over the whole species distribution range by Nelson and M-L Guillemin, pers com; we propose to contrast genetic signature and ecological response of individuals attached to rocks and populations of drifting individuals in estuarine mudflats. Genomic trace of selection between floating and attached populations will be identified using a genome scan analysis based on the SNPs data set. Please note that the UMI, jointly with the team of M. Cuck and S. Coelho (Roscoff, both with long experience with whole genome). The results will help in identify factors that contribute to range expansion and invasion success in marine red seaweeds, a group of taxa for which extremely rapid spread have been reported in the invasive range that can have enormous ecological and economic impacts.

In this project, we propose to combine laboratory experiments and population genetic analyses to decipher what factors affect these shifts in habitats and explain, in part, the range expansion of A. chilensis. The project will address two major questions:

1) What is the part of genetic adaptation underlying the habitat shift observed in A. chilensis between populations of individuals attached to rocks and generally encountered on more wave-exposed habitats and populations of individuals occurring on low-energy estuarine mudflats drifting as unattached thallus?
2) Are floating populations from New Zealand pre-adapted to range expansion and colonization of Chile?
3) To respond to the first question, we will search for genomic signature of selection in individuals drifting in estuarine mudflats using SNPs data sets obtained by massive sequencing. For the second question, we will combine prediction of dispersal trajectories in the Pacific using oceanographic modeling with the phenotype in common garden experiments of attached or drifting living thalli sampled from distinct regions in New Zealand and Chile.

Stratégie de publication:
Results of genomic signature of selection will be published in a journal with broad target audience (e.g. Molecular Ecology). The second paper will concern dispersal trajectories and possible change in ecological niche between region of origin, oceanic currents during rafting and newly invaded regions. The phenotyping should result in a third article, which may be aimed at comparing the results obtained in G. chilensis a species that can be considered as an old invader in Chile with the ones already obtained in A. vermiculophyll a more recent invader of the northern hemisphere. Since the results will help in identify factors that contribute to range expansion and invasion success in marine species that can have enormous ecological and economic impacts we expect to reach at least strong journals available for evolutionary ecologists.

Réorientation possible du sujet si échec:
Risks exist in addressing the question of preadaptation. Study of dispersal trajectories requires rigorous integration with physical oceanographers and none of the thesis advisors have extensive experience in this thematic. However, specialists in NZ, Chile and France with which CD or MLG have worked previously will be integrated in the study, a strategy that should ensure feasibility. If the work does not proceed at a sufficient rate, we will re-orient to focus on testing for abiotic or biotic differences between habitat where fixed and floating populations are encountered.

Faisabilité sur 3 ans (échéancier):
Samples and genomic datasets (thousands of SNP markers) have already been collected throughout the species' range (New Zealand, Chatham and Chile) and in both habitat types. Test for signature of selection could then begin directly in year 1. Year 2 will be devoted to the search for abiotic biotic differences and dispersal trajectories. This information is crucial for determining the factors to be tested in the common garden. It is also during the second year that the manuscript on the genomic signature of the
selection will be submitted.
Year 3 will consist in setting up experiments in common garden in Chile and France and finishing the writing of the articles and the thesis document.
As part of the cotutelle, the student will divide his time between France and Chile.

Profil du candidat recherché:
The candidate should have solid theoretical foundations in both evolution and population genetics (or even population genomics, if possible). Experience in oceanography or algae ecology will be a great advantage. The student must be prepared to display a strong ability to work and learn independently and as part of the UMI and FONDECYT-GRACILARIA teams. Part of the work will occur in France, Chile and in NZ, so the candidate will be expected to work in multilingual teams (French and English although speaking Spanish is not a requirement). Candidates with extensive experience in the field or lab experimentation with living marine organisms in common garden will be favored.