All animals reproduce sexually and develop through embryogenesis, but nearly half of metazoan phyla contain species that can also reproduce asexually: new individuals arise from somatic tissues and therefore we talk of Non-Embryonic Development, or NED. In our lab we are studying tunicates, the sister group of vertebrates, as a model to better understand the evolution of NED in chordates. In fact, many tunicate species have the tremendous ability to fully regenerate from tiny pieces of tissues and/or to proliferate asexually via diverse modes of somatic budding. Distribution of NED across tunicates suggest that it was acquired and lost several times independently during evolution, however NED has been studied only in very few models so far. Thus more comparative investigations are needed to better understand the plastic evolution of NED.

The present PhD project will focus on salps, which are planktonic tunicates ubiquitous throughout the world’s oceans and famous for their impressive seasonal blooms that make them central to ocean ecology. The main driver of salps exponential blooms is their extraordinary mode of asexual proliferation called budding, during which a single individual can produce hundreds of clones in few days, when environmental conditions are suitable. The present PhD project aims to study budding in salps by two complementary approaches: (i) an anatomical, cellular and molecular characterization of budding to better understand the mechanisms and the evolution of NED in tunicates, and (ii) an ecology-oriented approach aiming to test the effect of environmental factors on these mechanisms.
In the first part the PhD student will use 3-D and live imaging (photonic and confocal) combined with various cell labeling and proliferation assays in order to describe with an unprecedented precision the nature, the role and the behaviors of cells involved in bud formation, and to identify putative stem cells or progenitors playing a role in asexual reproduction. This anatomical and cellular descriptions will subsequently guide transcriptomic analyses: RNA-seq will be performed to characterize the dynamic of gene expression during budding and then explore the gene regulatory networks involved in NED regulation. Comparing these results with what is already known in other tunicates will provide new insights on the molecular mechanisms underlying the plastic evolution of NED in tunicates.

The results obtained above will be used to better understand how environmental parameters impact bud production in salps during seasonal blooms. Salps collected in the Bay of Villefranche-sur-mer will be maintained in laboratory-controlled conditions and the effect of various parameters (for instance temperature, concentration of phytoplankton) will be tested. Bud formation, as well as cell proliferation, will be investigated under different conditions and correlated with the salps density observed on the field. In addition, the transcriptomic profile of budding tissues will be compared under chosen conditions and the function of candidate genes will be studied in more detail, in order to understand how environmental variations impact the molecular regulation of budding, and eventually the demography of salps.

All together, the results obtained during the PhD thesis will give a holistic view on the mechanisms of budding and on their environmental influences, in a group of animals – salps - that is pivotal to understand the evolution of NED in metazoans but also the role of this mode of reproduction in the ecology of our changing environment.

**Faisabilité du projet de thèse (1/2 page maximum, en anglais)**

*Explicit le faisabilité du projet en terme d'expertise de l'équipe d'accueil, des collaborations potentielles qui pourront être mises en place pour certains aspects du projet, de la disponibilité des appareils nécessaires au bon déroulement du projet...*

The proposed project will use two species of salps (*Thalia democratica* and *Salpa fusiformis*) that are very abundant in the bay of Villefranche-sur-mer, where our laboratory is located. Sampling, breeding and animal manipulation will be performed with the support of our oceanographic staff (two vessels collecting plankton daily) and the technical staff of animal facility. The first part of the project will benefit from the expertise of our group and from our tight interactions with the other groups of our institute, as well as from our on-site imaging platform (P.I.M.). The proposed experimental protocols have been already established, including for instance immuno-labeling, Edu staining, micro-dissection, RNA extraction and in-situ hybridizations. For what concerns live and 3-D imaging, several photonic and confocal microscopes available in our institute can be used by the PhD student. Researchers from our team have a strong background in transcriptomic and bio-informatics analyses, and we also take advantage of the Bio-Informatics platform of our institute, ensuring the success of the RNA-seq approach. The second part of the project (ecology part) will be conducted in collaborations with the group of Bettina Meyer, expert on plankton physiological response to environmental perturbation, and with the help of Fabien Lombard who has a longstanding experience in salp ecology and Time Series Observation in Villefranche-sur-mer. Necessary equipment (for instance large tanks and equipment for aquarium maintenance) will be provided to ensure the success of the experiments. Our group have secured enough funding to ensure the feasibility of the project. Pending and future grant applications may also beneficiate to this project, if needed.
Ecole Doctorale COMPLEXITE DU VIVANT – Fiche Projet CONCOURS

Thèses actuellement en cours dans l’équipe
Tous les encadrements doivent être indiqués (y compris les co-directions avec un autre HDR pour des doctorants d'une autre ED, et les encadrements dans le cadre de programmes doctoraux tels qu'IPV, FDV...)

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Trois publications récentes du directeur de thèse (du co-directeur ou du co-encadrant s’il y a lieu). Mettre en gras le nom du directeur de thèse.


Docteurs encadrés par le directeur de thèse ayant soutenu entre la date de dépôt de ce dossier et il y a 5 ans et publications relatives à leur sujet de thèse. Mettre en gras le nom du directeur de thèse et celui du docteur.

Aucun