MASTS PECRE Final Report

Project
Development of amphioxus as marine chordate regeneration models
A two way exchange from January 2015 for 6 weeks

Awardee
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Background
Cephalochordates (amphioxus or lancelets) are important marine invertebrate chordate models for studies of the evolution and development of vertebrate characters (Bertrand and Escriva 2011), with potential implications for biomedicine. They also play a pivotal role in the oceans´ foodchains, acting as a direct link between the phyto and zooplankton upon which they depend for food, and predators within and above the sandy bottom for which they are themselves prey. In some parts of Asia, lancelets are also an important food source for human consumption. This, combined with environmental disturbance, has resulted in the severe decline of some amphioxus populations, highlighting their value as environmental quality monitors.
Although the fundamental importance of cephalochordates is now recognised, most aspects of their biology are poorly understood. In particular, we know little about one of their most striking properties; namely, their ability to regenerate an entire functional tail upon amputation, complete with nerve cord, musculature and notochord. Recently, we began to uncover some of the cellular and molecular mechanisms underlying this amazing process in the European amphioxus (*Branchiostoma lanceolatum*), and showed that it shares many properties with regeneration in vertebrate models of regeneration like salamanders or frog tadpoles (Somorjai et al 2012a, 2012b). However, comparative data from other species are entirely lacking, representing a real gap in our knowledge.

Aims of project
The goal of this project was to study regeneration in additional species of amphioxus in order to begin to understand the evolutionary basis and mechanisms underlying the process in the cephalochordates as a group. Up until this point, only brief mentions of regenerative ability in other amphioxus species could be found in the literature, and it was unclear as to whether or not these were accurate, or to what degree regenerative ability might differ across species. Dr Yu raises several species in his laboratory in Taiwan, including *Brachiostoma floridae* (American), *Branchiostoma belcheri* (Asian), and *Branchiostoma japonicum* (Asian), allowing regeneration experiments to be performed at the same time in a number of different species under controlled conditions. It was therefore an ideal and unique opportunity to begin to test some of our theories.

Outcome

The results of the 2x two-week research visits to Taiwan include:
-Long term regeneration experiments in the three species available in the laboratory, including photographic documentation of the regeneration process
-comparison of regeneration profiles of *Branchiostoma floridae* of different sizes and ages, made possible by culture of the animals in the laboratory.
-collection of regeneration samples for future analysis (microscopy, measurement of growth profiles etc)
An unplanned outcome of the second trip was a visit to Kenting National Park, where we successfully collected several individuals of *Asymmetron lucayanum*, the most molecularly and anatomically divergent of the amphioxus species. This allowed preliminary regeneration experiments to be performed for the first time on this species, which regenerates exceptionally well.
Altogether, the project funded by the PECRE award met its objectives and was a great success, and will provide multiple future collaborative opportunities.

Added value

Due to careful budgeting of grant funds, as well as generous additional matched funding by Dr Yu´s laboratory (eg Kenting trip), I was able to make two further trips in order to capitalise on the first results collected in Taiwan. First, I joined Dr Nicholas Holland (Scripps Institute of Oceanography, University of California San Diego, USA) in Bimini, Bahamas, at the original collection site for *Asymmetron lucayanum*. I then later joined Drs. Nick and Dr Linda Holland at their laboratory at Scripps, where I spent a further 3 weeks performing experiments on *Asymmetron lucayanum* and *Branchiostoma floridae* raised in the laboratory. The latter was made possible by accommodation provided by Drs Nick and Linda Holland in California. The total time awarded to the project was therefore 8 weeks.

Exchange with MASTS and wider University of St Andrews community.

Dr Yu came to Scotland for one week, where he participated in the MASTS AGM in Glasgow, at which I reported on some of the findings of the exchange with Taiwan. He also gave a talk on his research projects during the CBD seminar series at the University of St Andrews.

Future outputs

The visits to the laboratories in Taiwan and the USA solidified the links with these laboratories, and have resulted in new collaborations. We hope to publish at least two articles as a direct result of the data I collected during these trips. The preliminary results have already led to a grant application to the Leverhulme Trust (decision pending end 2016).

Selected references

Bertrand S, Escriva H. Evolutionary crossroads in developmental biology: amphioxus. Development. 2011 Nov;138(22):4819-30.
Somorjai IM, Somorjai RL, Garcia-Fernàndez J, Escrivà H. Vertebrate-like regeneration in the invertebrate chordate amphioxus. Proc Natl Acad Sci U S A. 2012 Jan 10;109(2):517-22.
Somorjai IM, Escrivà H, Garcia-Fernàndez J. Amphioxus makes the cut-Again. Commun Integr Biol. 2012 Sep 1;5(5):499-502.