

# **The Amphioxus Model System**

*Guest Editor*

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# Preface

## ***Amphioxus: the model system with a distinguished past and a very bright future***

The amphioxus (lancelet) was first described by Pallas in 1774 and incorrectly assigned to mollusks. Since then, amphioxus attracted generations of zoologists. It took however almost one hundred years until Alexander Kowalevsky recognized that the larval stages of amphioxus had much in common with vertebrate embryos. Widely studied around 1900 as the 'elementary vertebrate', amphioxus as a model went out of fashion with the decline of comparative anatomy. Due to the scarcity of taxa at the invertebrate-to-vertebrate transition, amphioxus nevertheless remained the species with a privileged position in animal phylogeny. Its resurrection as the popular model of evolutionary developmental biology came with the advent of modern molecular biology and genomics. In the 1990s amphioxus developmental control genes were identified and characterized at a fast pace with the hope that such studies could provide novel insight into an important evolutionary transition: the origin of vertebrates. Indeed, amphioxus was found to be vertebrate-like but much simpler. Its body resembles that of the vertebrate, but it lacks most of the complexities associated with typical vertebrate organs. Its genome is only 1/6 of the human genome and it has not undergone the whole genome duplications that occurred in the vertebrate lineage. For all of these reasons, amphioxus became widely regarded as a useful proxy for the primitive ancestor of all vertebrates. A persistent problem interpreting amphioxus in the phylogenetic context is the difficulty to distinguish ancestral features, and those that are secondarily derived. There is no doubt that an integrative approach combining information from various disciplines is needed in order to help resolve such issues. Anatomy and comparative morphology has always been strong since the dawn of amphioxus research. Recent developments such as the availability of genomic sequences for three *Branchiostoma* species, established laboratory cultures of amphioxus that can be spawned at the investigator's will, or techniques allowing transgenesis and gene knockouts represent a major leap for studies on how the genotype generates a phenotype. These advances also enable the smooth transition of amphioxus from the model system of a distinguished past into the one with a very bright future.

The selection of articles included in this Special Issue of "*The International Journal of Developmental Biology*" covers diverse areas. Contributions from founders of the modern era molecular biology research in amphioxus, 'the three Hollands' (Linda and Nick Holland from Scripps Institution of Oceanography, and UK-based Peter Holland) provide personalized views about the history of amphioxus research. Since amphioxus remains an inexhaustible source of hypotheses about chordate evolution and vertebrate innovations, most articles in the Special Issue provide an overview of specific aspects of amphioxus biology and discuss possible evolutionary implications. The high-quality genome of the European amphioxus has recently become available, facilitating focused gene-based studies that are also included here in this Special Issue. Finally, three contributions describe technological advances, an area that is, without doubt, the key for future spreading of this exciting model organism to new laboratories worldwide. As diverse as it is, the collection of articles in this Special Issue only covers a part of the research currently being undertaken on amphioxus.

This Special Issue came into existence more than 20 years after I first encountered the animal myself during a talk by Peter Holland at the EMBO practical course in 1993. I am grateful to Richard Behringer whose idea it was to assemble an Amphioxus Special Issue and who suggested that I serve as its Guest Editor. Notably, his suggestion was brought up during our joint visit to the lab of Nick and Linda Holland at the Scripps Institution of Oceanography in September 2015. I would like to especially thank all the colleagues who have contributed to this Special Issue of the *Int. J. Dev. Biol.* Many of them I met while collecting amphioxus adults in Florida in the late 1990s and early 2000s, an endeavour that was pushing the model forward in the difficult times when laboratory cultures were not available. Yearly summer trips to Florida provided the amphioxus community with a great opportunity to socialize and interact informally. These collection trips are fortunately no longer needed due to the availability of laboratory cultures. To maintain fruitful community interactions, amphioxus satellite meetings are currently organized bi-annually as part

of the Euro EvoDevo conference. For me personally, it was a real pleasure to assemble this Special Issue, and to see the diversity of studies currently performed on amphioxus. I am extremely grateful to Juan Aréchaga for all his help, patience and encouragement during the course of production of this Special Issue. Finally, I would like to thank all the members of the editorial team of *The International Journal of Developmental Biology* for their high-quality work, and especially Dr. David J. Fogarty in his role as Managing Editor throughout the final months of preparation.

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Prague, Czech Republic, November 2017

**Further Related Reading, published previously in the *Int. J. Dev. Biol.***

**From the American to the European amphioxus: towards experimental Evo-Devo at the origin of chordates**

Jordi Garcia-Fernández, Senda Jiménez-Delgado, Juan Pascual-Anaya, Ignacio Maeso, Manuel Irimia, Carolina Minguillón, Èlia Benito-Gutiérrez, Josep Gardenyes, Stéphanie Bertrand and Salvatore D'Aniello  
Int. J. Dev. Biol. (2009) 53: 1359-1366  
<https://doi.org/10.1387/ijdb.072436jg>

**Evolution of CUT class homeobox genes: insights from the genome of the amphioxus, *Branchiostoma floridae***

Naohito Takatori and Hidetoshi Saiga  
Int. J. Dev. Biol. (2008) 52: 969-977  
<https://doi.org/10.1387/ijdb.072541nt>

**Peter Holland, homeobox genes and the developmental basis of animal diversity**

Sebastian M. Shimeld  
Int. J. Dev. Biol. (2008) 52: 3-7  
<https://doi.org/10.1387/ijdb.072394ss>

**Developmental expression of the High Mobility Group B gene in the amphioxus, *Branchiostoma belcheri tsingtauense***

Xiangwei Huang, Lifeng Wang and Hongwei Zhang  
Int. J. Dev. Biol. (2005) 49: 49-46  
<http://www.intjdevbiol.com/web/paper/041915xh>

**Cell morphology in amphioxus nerve cord may reflect the time course of cell differentiation**

T C Lacalli  
Int. J. Dev. Biol. (2000) 44: 903-906  
<http://www.intjdevbiol.com/web/paper/11206331>

**Embryonic development of heads, skeletons and amphioxus: Edwin S. Goodrich revisited**

P W Holland  
Int. J. Dev. Biol. (2000) 44: 29-34  
<http://www.intjdevbiol.com/web/paper/10761843>

**Amphioxus Hox genes: insights into evolution and development**

J Garcia-Fernández and P W Holland  
Int. J. Dev. Biol. (1996) 40: S71-S72  
<http://www.intjdevbiol.com/web/paper/9087701>

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