
Characterizing the transposable element landscape of the vertebrate water-to-land transition

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Abstract

The vertebrate water-to-land transition represents a pivotal event in the history of life on Earth. In order to adapt their body plan to terrestrial environments, early tetrapods must have undergone changes in their gene regulatory landscape. It is now well accepted that transposable elements (TEs) contribute to evolutionary processes by providing and mobilizing cis-regulatory elements (CREs). Thus, our work aims to explore the role of TEs in the evolution of the adaptations that enabled the water-to-land transition in vertebrates.

We began by generating repeat annotations for lobe-finned fishes – closest extant relatives of tetrapods – and amphibians, representing an early branching tetrapod group. Intriguingly, lungfishes and salamanders possess giant genomes between 20 and 132 Gbp in length, and it remains to be determined whether their genomic gigantism reflects a higher rate of transposition or a failure to purge ancient repeats. If this second possibility were the case, it would allow us to explore the origins of ancient CREs and determine to what evolutionary innovations might have arisen thanks to the action of TEs.

Unfortunately, genomic gigantism represents a major technical challenge in terms of annotating their TE landscape with existing tools. Thus, we developed a suite of TE annotation pipelines able to handle extreme genome sizes. Following de novo repeat library generation, our toolkit performs consensus extension and incorporates searching through highly-sensitive HMM models. It also identifies orthologous TE insertions across species and thanks to its efficiency and scalability, we have deployed it across a collection of lobe-finned fish and tetrapod genomes in order to explore the TE dynamics of the water-to-land transition.

Through this comprehensive exploration of TE involvement in the water-to-land transition, we anticipate shedding light on the fascinating TE biology and deepening our understanding of their significance in driving the emergence of evolutionary innovations.

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